



Surgical Management of Peri-Implant Soft Tissue: A Decision Tree

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Abstract

Clinical classifications of the main mucogingival conditions around natural teeth and their treatments are largely reported in the literature. With the increased use of dental implants, peri-implant soft tissue complications may also be encountered. However, there is lack of information regarding the most appropriate treatment methods for soft tissue deficiencies around dental implants. This narrative review discusses the various clinical situations where soft tissue grafting at implant sites is required. A review of all available literature was performed and a decision tree for soft tissue grafting around implants was developed. The purpose is to provide a general guidance for clinicians in selecting the appropriate treatment for the management of peri-implant soft tissue deficiencies. The decision tree takes into consideration the aim of the treatment and illustrates different techniques according to the most recent literature. Furthermore, considerations on etiological factors for peri-implant soft tissue deficiencies are discussed. To the knowledge of the authors, there is no other manuscript that proposes surgical management of peri-implant soft tissue deficiencies at different stages of implant therapy.

Keywords: Connective tissue; Dental implants; Esthetics; Dental; Oral surgical procedures; Periodontics

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Received Date: 02 Feb 2021

Accepted Date: 16 Feb 2021

Published Date: 19 Feb 2021

Citation:

Pedercini A, Pedercini C, Kormas I, Parachuru V, Wolff LF. Surgical Management of Peri-Implant Soft Tissue: A Decision Tree. *Ann Clin Med Res.* 2021; 2(2): 1023.

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Introduction

Soft tissue around implants plays a key role in oral hygiene, long-term prognosis and esthetic outcome [1,2]. However, a systematic review has shown that about 7.1% of end osseous dental implants present soft tissue complications at 5 years of follow-up [3]. To avoid soft tissue complications, prevention and treatment of alveolar ridge deformities should be performed prior to implant placement in order to preserve or reconstruct the hard and soft tissue anatomy [4]. Moreover, the lack of Keratinized Tissue Width (KTW) can lead to plaque accumulation which increases the risk of peri-implantitis development [5,1]. Indeed, a recent review demonstrated that soft tissue augmentation around dental implants improves gingival index scores and results in significantly less bone loss over time [6].

Consequently, many augmentation techniques around implants have been described in order to augment KTW, increase Mucosal Thickness (MT) or gain Recession Coverage (RC) [7,8]. Clinically-oriented classifications of the main mucogingival conditions and their treatments are largely reported in the literature only regarding the natural dentition [9,10]. With the lack of literature addressing classifications and treatments of peri-implant soft tissue defects, there is no decision tree displaying different treatment options for the clinical management of these concerns. Therefore, the purpose of this narrative review is to provide a decision tree to serve as a general guide for clinicians in selecting the appropriate treatment for the management of soft tissue deficiencies around dental implants.

Material and Methods

This study reviewed the latest evidence and current literature for the surgical management of peri-implant soft tissue deficiencies. An electronic search of the English-language literature was conducted using MEDLINE (via PubMed) for relevant articles with available full text published up to December 31st, 2019. Keywords typed on the electronic search were: Dental Implant; Peri-implant Soft Tissue; Keratinized Mucosa; Free Gingival Graft; Connective Tissue; Augmentation; Soft Tissue

Management. Titles and abstracts were screened by three reviewers (A.P., C.P., I.K.). If the abstract information fulfilled the purpose of this article, full text was obtained and reviewed in detail. Furthermore, the papers' bibliography was hand-searched for additional relevant literature. Particular attention was paid to articles describing novel techniques of peri-implant soft tissue plastic surgery.

Results and Discussion

A decision tree for surgical management of peri-implant soft tissue is shown in (Figure 1). This descriptive "thought-process" is based on the most recent literature and aims to give general guidance to the clinician in selecting the most appropriate treatment for peri-implant soft tissue deficiencies. It is out of the scope of this manuscript to discuss hard tissue augmentation techniques. It is also not the intention of the authors to make comparisons between different techniques, but rather to summarize all available treatment options that are reported in the literature.

Determine the time of intervention

Analysis of soft tissue thickness and width should always be assessed prior to implant surgery and if a deficiency is diagnosed, management of the soft tissue can be planned prior to implant placement (T_0), at the time of first stage surgery (T_1), at the second stage (T_2) or after implant loading (T_3). However, in many cases soft tissue deficiencies are encountered only after implant rehabilitation at T_3 . In such cases, the treatment plan should be based on the new classification of soft tissue deficiencies around dental implants in the esthetic zone [11]. These soft tissue deficiencies are defined by four classes depending on the position of the gingival margin and the restoration's emergence profile. Furthermore, subclasses of these soft tissue deficiencies are defined by the interdental papilla height. Surgical treatments are then recommended according to the class/subclass of the defect (Figure 1).

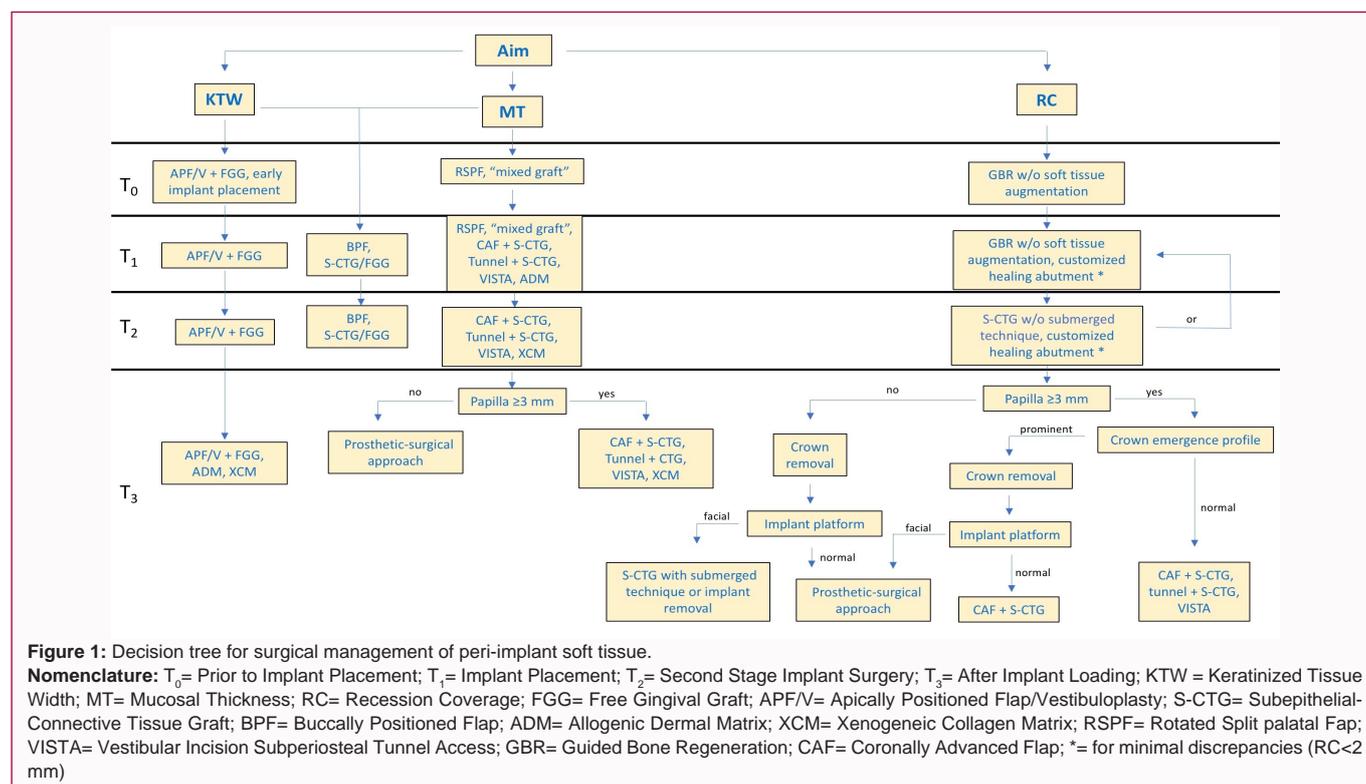
Determine the surgical technique

Once the time of intervention is selected, the appropriate surgical technique should be based on the aim of the surgical procedure. The objectives for the management of soft tissue around dental implants are: Keratinized Tissue Width (KTW), Mucosal Thickness (MT) and Recession Coverage (RC).

Keratinized tissue width

Whether or not keratinized tissue width around dental implants is essential for long-term stability is still controversial [12]. Some evidence shows that lack in the width of the keratinized tissue around implants is a poor predictor of recession within the following 2 years of loading [13]. Furthermore, it has been shown there is a low incidence of peri-implant diseases over long time periods in patients on a strict supportive implant maintenance therapy program, independent of the absence or presence of keratinized mucosa [14,15]. On the other hand, it has also been established that the absence or reduced KTW (<2 mm) around dental implants makes them more prone to brushing discomfort and plaque accumulation, increasing the risk of recession or peri-implant disease [1,5,7,16,17]. Therefore, the need for keratinized tissue is patient- and site-specific [18]. Even though, there is no agreement in the literature on the necessity of having an adequate KTW around implants, increasing the width of keratinized tissue should be considered to enhance the patients' plaque control and to maintain the mucosal tissue and crestal bone level [8,19].

The most effective technique used to augment KTW is an apically positioned flap/vestibuloplasty with a free gingival graft (APF/V + FGG) [1,5,8,20,21]. This surgical technique may be performed at any stage during implant rehabilitation (T_0 - T_3). Especially at edentulous alveolar ridge sites with inadequate keratinized tissue or vestibular depth (T_0), at T_1 or T_2 , an APF/V + FGG can be performed [1]. A case illustration of an APF/V + FGG at T_2 is shown in Figure 2.



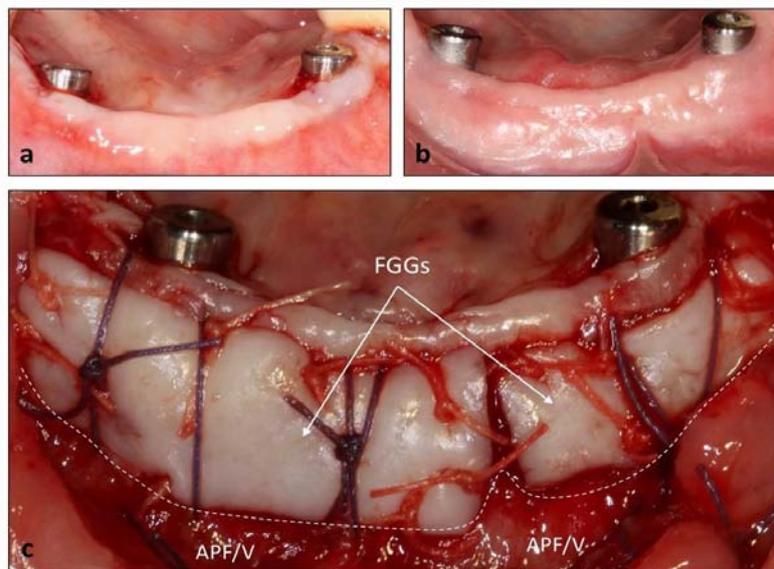


Figure 2: Surgical peri-implant soft tissue management to increase the Keratinized Tissue Width (KTW) -Apically positioned flap with a free gingival graft (APF/V + FGG) at second stage (T_2).

2a: Before APF/V + FGG clinical photo of lower canines implant sites after insertion of healing abutments;

2b: 12-week follow-up after APF/V + FGG at T_2 (prosthetic phase, not shown, includes implant-retained 6-unit bridge);

2c: Intra-operative photograph illustrating the apically positioned vestibule (APF/V) and the two FGGs in place.

In many cases, when implant rehabilitation is planned to replace a hopeless tooth, there may be no need for mucogingival surgery. The extraction could be performed and followed by early implant placement, around 4 to 8 weeks after the extraction, in order to gain 3 mm to 5 mm of additional keratinized tissue due to spontaneous soft tissue healing (T_0) [22]. Alternatively, a technique that has been described to improve the masticatory mucosa is the Buccally Positioned Flap (BPF), which increases the KTW as well as the soft tissue thickness and may be performed at T_1 and T_2 [23].

Finally, Acellular Dermal Matrix allograft (ADM) or a Xenogeneic Collagen Matrix (XCM) graft have been reported as alternatives to an autogenous soft tissue graft at T_3 [24,25]. However, although ADM and XCM are both capable of increasing the width of peri-implant keratinized mucosa, these materials should generally be used in patients where a donor or a second surgical site would best be avoided because of medical or psychological reasons. Nevertheless, when medical or psychological contraindications do not exist, an APF/V + FGG is still more effective in increasing the peri-implant KTW [26].

Mucosal thickness

Mucosal Thickness (MT) can be easily assessed with a periodontal probe [27,28]. If the probe is visible through the tissue while probing, the soft tissue is considered thin; whereas if it is not visible, the soft tissue is thick. Thin tissue phenotype can increase the risk of recession and early bone loss [10,29]. Moreover, thin tissue phenotype may result in the metal abutment showing through the mucosal peri-implant tissue. However, it has been determined this esthetic issue can be resolved by increasing the thickness of the tissue to ≥ 2 mm [30].

Augmentation of soft tissue thickness can be performed prior to implant placement (T_0), at the time of tooth extraction, or at the time of an immediate implant placement (T_1). In these cases, a Rotated Split Palatal Flap (RSPF) can be performed to cover the alveolar socket or the implant [31,32]. This technique not only allows closure of the

alveolar socket, but increases the peri-implant mucosal thickness creating an illusion of root prominence.

Another technique that has been reported is a “mixed graft”; a combination epithelized-subepithelial connective tissue graft that serves to cover the socket area with epithelium while augmenting the thickness of the soft tissue in the mid-facial mucosal region [33]. This technique may be performed at the time of tooth extraction with or without an immediate implant placement approach (T_0 , T_1). Finally, a Subepithelial Connective Tissue Graft (S-CTG) with either tunneling (tunnel + S-CTG) or Coronally Advanced Flap (CAF + S-CTG) techniques can be performed at any stage starting from implant placement (T_1 - T_3) [34-39]. Case scenario illustrating a tunnel + S-CTG procedure are shown in (Figure 3) where a tunnel + S-CTG was performed in a 2nd lower premolar implant site at T_2 .

In a case report, a technique comprising a subperiosteal vestibular incision with a tunnel access and a subepithelial connective tissue graft (VISTA) has been shown to be effective in soft tissue thickness augmentation around dental implants as well (T_1 - T_3) [40,41]. At T_1 ADM has been shown to produce comparative outcomes to S-CTG for mucosal thickness [42]. The use of XCM has also been reported to increase soft tissue thickness around dental implants at T_2 and T_3 [2,43].

There are also techniques which allow a surgeon to attain both KTW and MT. An example is the BPF technique described earlier in the KTW section [23]. Alternatively, at T_1 as well as at T_2 , a partially de-epithelialized connective tissue graft may be performed, based on the technique described by Langer & Langer for root coverage [44,45]. A split-thickness flap is performed, and a free gingival graft harvested from the palate is partially de-epithelialized. The portion of the graft with the epithelium is shaped around the implant crown/healing abutment and sutured to the lingual flap, whereas the de-epithelialized connective tissue graft is placed on the vascular bed and covered by the flap. In this way there is not only an augmentation of

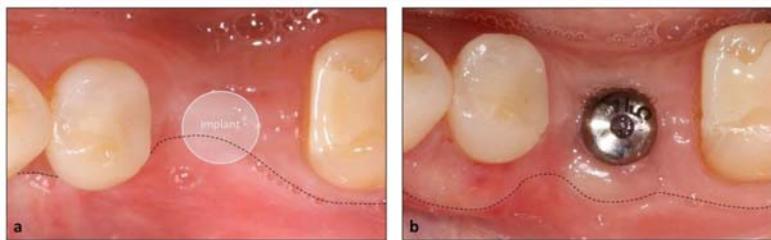


Figure 3: Surgical peri-implant soft tissue management to increase the Mucosal Thickness (MT) - Tunneling procedure combined with a subepithelial connective tissue graft (tunnel + S-CTG) involving lower left 2nd premolar implant site and the adjacent 1st premolar at second stage surgery (T₂).

3a: Photo before surgery showing the thin peri-implant soft tissue phenotype (dotted line) on the implant site;

3b: Result after tunnel + S-CTG at T₂ showing thick tissue phenotype (dotted line) on both the implant site and the adjacent tooth (prosthetic phase, not shown, includes final implant-retained crown restoration on the 2nd premolar implant site).

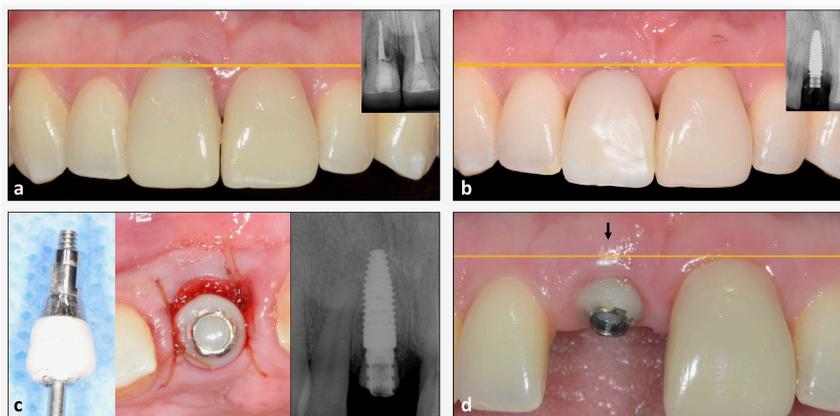


Figure 4: Surgical peri-implant soft tissue management for Recession Coverage (RC) - Technique demonstrating guiding peri-implant soft tissue maturation and gaining vertical height using a customized healing abutment after immediate implant placement (T₁) at maxillary central incisor implant site.

4a: After replantation, right maxillary central incisor had to be extracted due to an external resorption (radiograph on top right). The gingival margin was not aligned with the contralateral tooth displaying initial mucosal recession of 1 mm for future implant placement (yellow line);

4b: Temporary implant-retained crown after 12 weeks of customized healing abutment (radiograph on top right) showing the coronal migration of the mucosal margin (yellow line). Contralateral gingival margin can be predictably matched during the prosthetic phase now.

4c: Surgical procedure involving immediate implant placement with immediate customized healing abutment;

4d: 8-week follow-up showing the coronal migration of the mucosal margin utilizing a customized healing abutment (yellow line).

soft tissue thickness but also KTW as an S-CTG is combined with an FGG (S-CTG/FGG).

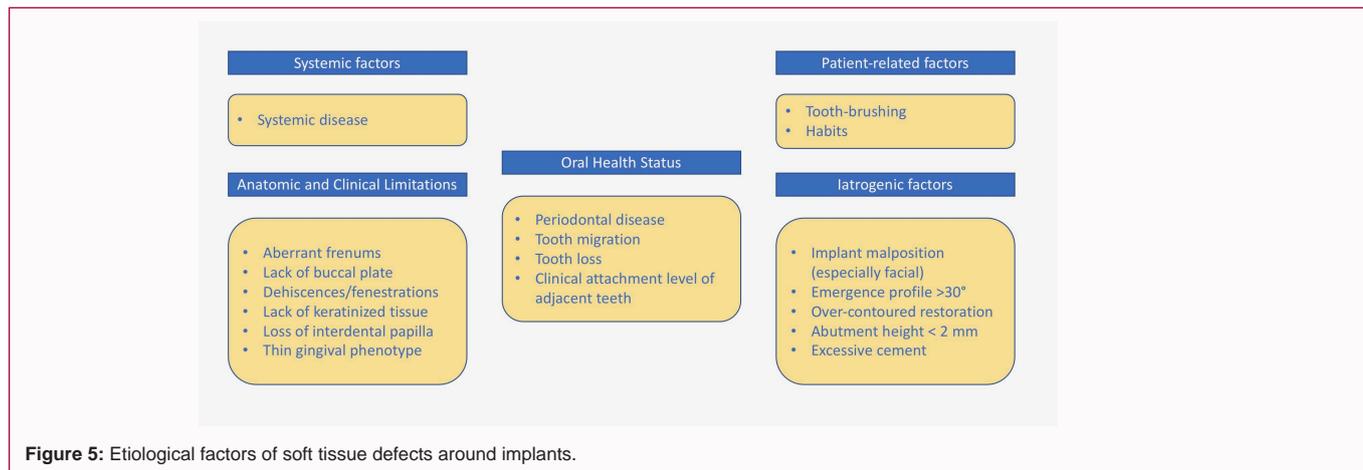
At T₃, when the implant is in place, mucogingival surgery should be planned depending on the height of the papilla. If the interdental papilla is ≥ 3 mm from the mucosal margin and no recession is present, a tunnel or a CAF + S-CTG technique is recommended [38,39,46]. If an interdental papilla is less than 3 mm, a prosthetic-surgical approach is indicated [11,47]. The prosthetic-surgical approach starts with the crown removal and the insertion of a polished narrow healing abutment for a time period of one month. The abutment allows an increase of the interproximal soft tissue with more vascular supply for the S-CTG. Thereafter, a CAF + S-CTG is performed and a temporary crown is fabricated to guide the soft tissue maturation. After 8 months of soft tissue maturation the final restoration can be delivered. The S-CTG can be harvested from the palate; however, the maxillary tuberosity area as a donor site is generally preferred as it has shown better volume after soft tissue grafting procedures [48,49].

Recession coverage

There is no agreement for the definition of mucosal recession around implants. In this paper, peri-implant mucosal recession is defined as the apical shift of the soft tissue margin with respect to the homologous natural tooth [50]. Consequently, a mucosal recession

may originate prior to implant placement due to anatomical reasons. Therefore, to prevent a recession, it is important to correctly anticipate where the future mucosal margin around the implant will be. A deficient ridge will result in a peri-implant mucosal recession issue according to the previously described definition. Presently, the reconstruction of the alveolar ridge through different regenerative surgical procedures has become predictable [51]. If there is a deficiency of the alveolar ridge that is identified prior to implant placement, it is advised not to proceed with the implant surgery as it will result in a receded future peri-implant mucosal margin. Thus, either a delayed approach with Guided Bone Regeneration (GBR) prior to implant placement (T₀) or concomitant GBR with implant placement (T₁) is advised [52].

If at T₂ a peri-implant soft tissue deficiency with mucosal recession is detected, an S-CTG can be performed with or without a submerged healing technique. If the deficiency also involves the buccal plate with the presence of fenestration/dehiscence and thread exposure, a GBR with an S-CTG would be preferred and T₂ surgery should be postponed [53]. Another option to address minimal discrepancies (RC < 2 mm) is to use a customized healing abutment either at T₁ or T₂ to guide the peri-implant soft tissue maturation [54]. This technique demonstrating guiding peri-implant soft tissue maturation and gaining vertical height using a customized healing abutment after



immediate implant placement is shown in (Figure 4) [55].

At T_3 , in case of recession there are three variables that will determine which therapeutic approach is indicated: 1) Interdental papilla height from the ideal mucosal margin, 2) restoration emergence profile, and 3) implant platform position [11]. If the interdental papilla is ≥ 3 mm from the ideal mucosal margin, the next step would be to assess the implant-supported prosthesis' profile. In case the profile of the crown is located in line with the imaginary curve that connects the profiles of the adjacent teeth at the level of the soft tissue margin, a CAF with S-CTG is recommended (T_3) [11,50]. A VISTA technique or tunnel + S-CTG may also be performed in this type of deficiency (T_3) [38-41,56]. On the other hand, if the prosthesis' profile is located more facially than the imaginary line connecting the profile of the crowns of the adjacent teeth at the level of the soft tissue margin, the crown needs to be removed and the position of the implant evaluated. Indeed, the position of the implant platform is very important as it is a risk factor for bone loss if it is too facial, especially in immediate implant placements [57]. When the implant platform is aligned with the adjacent teeth position, a CAF + S-CTG could be performed; whereas a prosthetic-surgical approach is advised in case the implant platform is not in an oral-facial ideal position. This approach starts with the crown removal and the insertion of a polished narrow healing abutment as previously described. A CAF + S-CTG is performed with the fabrication of a temporary crown before the final restoration is delivered (T_3) [11,58]. With the finding of the interdental papilla height being less than 3 mm from the ideal gingival margin, the crown has to be removed and the implant platform position assessed. A prosthetic-surgical approach can be attempted only if the position of the implant is in line with the position of the adjacent teeth. If the implant platform is facially placed, a submerged technique with an S-CTG or implant removal are the treatments of choice (T_3) [11,59].

Considerations

Etiological factors of soft tissue defects around implants are shown in Figure 5. It is important to identify and address these factors as related to the soft tissue deficiencies around implants prior to treatment. Multiple risk factors have been ascribed for peri-implant soft tissue deficiencies [60].

These factors can be systemic in origin, or even related to local anatomical and clinical features such as an aberrant frenum, loss of the buccal plate, presence of a dehiscence/fenestration, lack of keratinized tissue, loss of interproximal marginal bone level and

papilla height. Special mention should be made for a thin soft tissue phenotype, which has been reported to be a risk factor for peri-implant soft tissue deficiencies especially in immediate implant placement [61]. The periodontal status of the patient (periodontitis vs. non-periodontitis patient), and the current state of adjacent teeth (including clinical attachment level loss, tooth migration and tooth loss) are characteristics to be considered. Systemic diseases are correlated with complications after implant placements. Therefore, medical conditions should be under control prior to any periodontal plastic surgery [62]. If active periodontal disease is diagnosed, plaque control, periodontal therapy and pocket elimination should also precede mucogingival treatment [63-65].

Patient-related factors, such as tooth-brushing technique and habits, have also been associated with soft tissue deficiencies around dental implants [66]. Iatrogenic factors are also important, often being the cause of peri-implant soft tissue deficiencies including implant malposition, irregular prosthesis design with inappropriate emergence profile and over-contoured restorations [58,67]. As regards the emergence profile, if the restoration emerges with an angle exceeding 30 degrees it is more likely for the implant to develop peri-implantitis, especially if there is a convex crown profile [68]. The height of the abutment should be assessed as well, as it has been demonstrated that if the abutment is less than 2 mm the marginal bone loss is significantly greater than in those cases where the abutment is more than 2 mm long [69]. In cementable restorations, cement excess should also be checked as it can cause soft tissue dehiscence and bone loss [67,70]. Overall, the main reported risk factor for peri-implant soft tissue deficiencies around dental implants seems to be the implant platform position. The implant head should be located inside the straight imaginary line that connects the profile of the adjacent teeth at the level of the gingival margin [11,50].

Conclusion

Clinical judgment based on case selection and clinician expertise will certainly account for which treatment choice is indicated. However, the decision tree presented may be used as a guide-tool for clinicians to select the appropriate peri-implant soft tissue plastic surgery or associated restorative procedure according to the type of soft tissue deficiency. To the author's knowledge, this is the first decision tree proposed to surgically manage soft tissue deficiencies around implants, considering different options for each stage of implant therapy. Upon emergence of longitudinal studies and randomized clinical trials with evidence-based comparisons between

peri-implant soft tissue grafting procedures, further development of the decision tree will be required.

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