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REVIEW ARTICLE

A decision-making tree for evaluating an esthetically compromised single dental implant

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Abstract

Objective: To develop a comprehensive decision-making tree for evaluating mid-facial peri-implant soft tissue dehiscence in the esthetic zone and provide a systematic approach for assessing various clinical case scenarios, determining appropriate treatment strategies, and considering factors such as the need for soft tissue augmentation, prosthetic changes, or implant removal.

Clinical Considerations: This clinical decision tree illustrates numerous case scenarios with various esthetic complications around an esthetically compromised, but clinically healthy single implant and provides clinicians with possible solutions as a predictable map for horizontal and vertical soft tissue augmentation in order to manage different clinical circumstances. According to current evidence, the key to treating such esthetic complications is the use of an adequate pre-surgical prosthetic interdisciplinary approach with proper surgical techniques in order to optimize soft tissue dimensions and create better esthetic results. This may be accomplished through a purely surgical, combination of surgical and prosthetic, or purely prosthetic approaches.

Conclusions: The present report describes a series of successfully treated peri-implant esthetic complication cases in accordance with the decision-making tree that the authors recommend in order to achieve better long-term esthetic outcomes.

Clinical Significance: The combination of adequate pre-surgical prosthetic interdisciplinary collaboration and proper surgical technique is critical in the optimization of sufficient soft tissue dimensions and contributes to a more highly esthetic result. This study demonstrates a clinical decision-making tree to provide comprehensive, effective therapy of an esthetically compromised dental implant by using one of the following approaches: purely prosthetic, purely surgical, or a combination of surgical and prosthetic with or without abutment removal.

KEYWORDS

connective tissue, dental, dental implants, esthetics, gingiva/surgery, gingival recession/surgery

1 | INTRODUCTION

Managing peri-implant esthetic complications can be challenging, with a prevalence of up to 64% among immediate implants.[1–3] In the past, much focus was given to peri-implant supporting bone as a principal criterion for long-term success of dental implants.[1] However, recent studies and best-evidence consensuses support the peri-implant soft tissue component as an additional factor to consider for the establishment and maintenance of peri-implant health.[2,4–8] This is supported not only from a biological perspective but also from an esthetic standpoint.[8,9] Furthermore, patients' esthetic demands have increased due to the increased utilization of tooth replacement therapy with implant-supported prostheses.[2–4]

The ideal location of the scalloped mucosal margin around the implant should match that of the contralateral tooth.[3] However, peri-implant mucosal deficiencies exist in some clinical situations and can lead to unsatisfactory esthetic outcomes for the patient. Peri-implant facial soft tissue recession is defined as an apical shift of the peri-implant facial mucosal margin, revealing the metal structure of the implant or abutment.[3,5] Soft tissue augmentation to address midfacial peri-implant soft tissue recession has been shown to be less successful than natural root recession coverage, especially with Miller recession class I and II (or Cairo RT1) defects, which tend to be more predictable in terms of treatment and maintenance.[10,11] These peri-implant defects are also referred to as peri-implant soft tissue dehiscence/deficiencies (PSTDs).[3,5,6]

PSTDs are associated with multiple etiological factors, but most cases are related to improper buccal implant positioning.[2] Additionally, the classification of PSTDs is significant for an accurate prognosis and selection of proper surgical techniques.[3,5] Considering the available literature, it is important to note that most of the information regarding mid-facial peri-implant soft tissue dehiscence in the esthetic zone is derived from a limited number of controlled studies and a succession of case reports based on individual clinical experiences.[12,13] Furthermore, other authors have also reported clinical decision-making pathways and provided examples to guide the determination of whether to save or remove an ailing implant.[2,13–16]

The decision to remove an implant may lead to the creation of an even more severe esthetic compromise with questionable results due to the lack of predictability in terms of surgical and prosthetic outcomes.[13–17] Various surgical techniques have been proposed to attenuate esthetic defects related to implant malpositioning, particularly in the buccal dimension. Therefore, case selection is fundamental to achieving a satisfactory outcome with long-term stability. This article provides the clinician with a comprehensive decision-making tree in the management of esthetic complications and clinical recommendations based on case scenarios.

2 | DECISION-MAKING PROCESS

2.1 | General overview

This clinical decision tree consists of four categories and relies on individual case assessment, involving detailed evaluations of prosthetic factors, implant positioning, and both soft and hard tissues for a single esthetically compromised dental implant bounded by the adjacent teeth. The peri-implant soft tissue dehiscence decision-making tree is depicted in Figure 1, while Table 1 illustrates the three main evaluation criteria.

Among these factors, three-dimensional implant positioning plays a crucial role in determining treatment options and influencing other considerations. The initial step involves analyzing clinical and radiographic examinations, including periapical and/or cone beam computed tomography, to determine if the implant position is inside or outside the alveolar contour (Figure 2F). In the previous classification proposed by Carvalho et al.,[13] adequacy (A) or inappropriateness (I) were the main terms used. The adequacy of the implant position encompasses its placement within the bone housing, as well as the ability to achieve appropriate restoration, including correct implant abutment design and contouring. Once the implant position is determined, the evaluation of bone and soft tissue status becomes crucial. The importance of buccal bone thickness is a topic of debate, with no consensus on the ideal dimensions. It is noted that even in cases of thin buccal bone or dehiscence, a satisfactory esthetic and stable result can be achieved with an adequate volume of healthy soft tissue.[18] Evaluating the presence of dehiscence prior to flap elevation can pose challenges, especially when the buccal bone covering the implant is thin. In contrast, diagnosing interproximal bone presence is generally easier, aided by factors such as papillae, sounding of the adjacent teeth's interproximal bone peak, and periapical radiography. Recession is a significant factor, resulting in a longer clinical crown and asymmetry or disharmony of the mucosal margin compared to adjacent teeth. Estimating the prevalence of recession at implants is a challenging task, but certain factors such as dimensions and the absence of keratinized mucosa have been identified as potential risk indicators.[13] The significance of keratinized mucosa width (KMW) in peri-implant health remains debated, with inconclusive evidence regarding its impact. Although inadequate KMW (<2 mm) has been associated with peri-implant mucositis and bone loss, the exact minimum requirement for optimal long-term outcomes is unclear. Considering current evidence, it is suggested to categorize KMW as inadequate (<2 mm) or adequate (≥2 mm) to guide treatment decisions.[19] By completing these evaluations, clinicians should be able to determine if a surgical, prosthetic, or combination approach (with or without removal of the implant) is warranted.

2.2 | Various clinical approaches

According to this clinical decision-making evaluation criteria, the appropriate clinical decision can be divided into four main categories (Figure 2A–D). Pathways for each category may be followed by referencing the clinical decision-making tree (Figure 1):

1. Pure prosthetics management: In this approach, the prosthesis (usually a crown) is changed without any soft tissue manipulation. This option is chosen when the implant placement and the surrounding soft tissue are in good condition and without the need

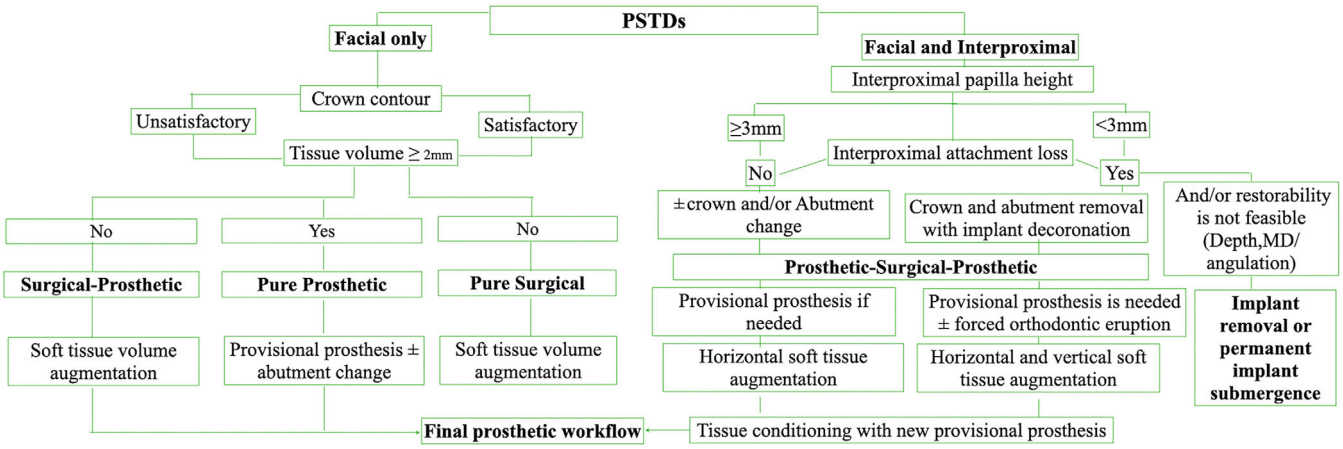

FIGURE 1 This decision-making tree illustrates the four approaches for evaluating and managing esthetic complications associated with a single dental implant.

TABLE 1 The following table illustrates the three main evaluation criteria.

Prosthetic evaluation	Implant position evaluation	Soft and hard tissue evaluation
• Is the crown/ and or abutment located outside the teeth alignment? • Is the crown/ and or abutment associated with MD compromise? • Is the midfacial recession associated with an over-contoured crown? (Figure 2E) • Is there availability of required prosthetic components? (restorability is not feasible)	• Is the implant positioned inside or outside the alveolar contour? (Figure 2F) • Is the implant depth adequate, shallow, or deep? • Is the implant position close to the adjacent tooth (<1.5 mm)? • Is there a possibility of implant retrieval?	• Is the interproximal soft tissue width and height adequate (<3 mm) • Is the buccal soft tissue deficiency (<2 mm) associated with prosthetics compromise? • Is there any interproximal bone loss on adjacent teeth? If so, what is the degree of CAL on the adjacent teeth? • Is the palatal soft tissue at an adequate height compared with buccal tissues? • Is there a clear presence of buccal concavity (bone or soft tissue defect or both)?

Abbreviations: CAL, clinical attachment loss; MD, mesiodistal.

for additional manipulation. This is the least invasive approach and is typically selected when the patient is unsatisfied with the current appearance and function of their implant-supported prosthesis with sufficient tissue volume (≥2 mm)[19] or there is asymmetrical mucosal level with the contralateral natural tooth due to over-contoured crown. The treatment plan would involve fabrication of a new crown with an under-contoured cervical area to facilitate coronal migration of the soft tissue (Figure 2A,F).

2. Pure surgical management: This approach is selected when there is a soft tissue deficiency in keratinized mucosa width <2 mm or thickness <2 mm[19] that requires surgical intervention, but without the need for removal of the existing prosthesis. For example, if there is a lack of keratinized tissue around the implant, or the mucosal thickness is deficient, a surgical procedure such as a soft tissue graft may be performed to improve the soft tissue quality and quantity around the implant. In this approach, the implant-supported prosthesis is not disturbed or removed (Figure 2B).
3. Surgical-prosthetic management: This approach is chosen when there is a soft tissue deficiency in keratinized mucosa width <2 mm or thickness <2 mm,[19] but addressing the prosthetic is needed but it is not critical during the surgical or healing period. In this scenario, a soft tissue graft or other soft tissue augmentation procedure is performed to improve the soft tissue quality and quantity around the implant with the presence of old prosthesis. After the soft tissue has stabilized and healed, the final prosthesis is placed (Figure 2C).
4. Prosthetic-surgical-prosthetic management: This approach is the most common scenario and is chosen when there is a need to condition the soft tissues, especially when the interdental papilla is compromised and/or associated with clinical loss of attachment (CAL), in order to facilitate coronal migration of the mucosal margin. In this approach, the existing prosthesis and/or abutment may or may not be removed prior to the planned soft tissue augmentation procedure (it depend on the height of interdental tissue and/or presence of CAL). After soft tissue healing and maturation, a new abutment and prosthesis are placed. This approach is more invasive than the others and requires multiple appointments but is necessary in order to achieve optimal esthetic and functional outcomes (Figure 2D).

3 | CLINICAL SCENARIOS

The following clinical cases illustrate the four clinical scenarios, from the correction of the soft tissue defect with prosthetics management,

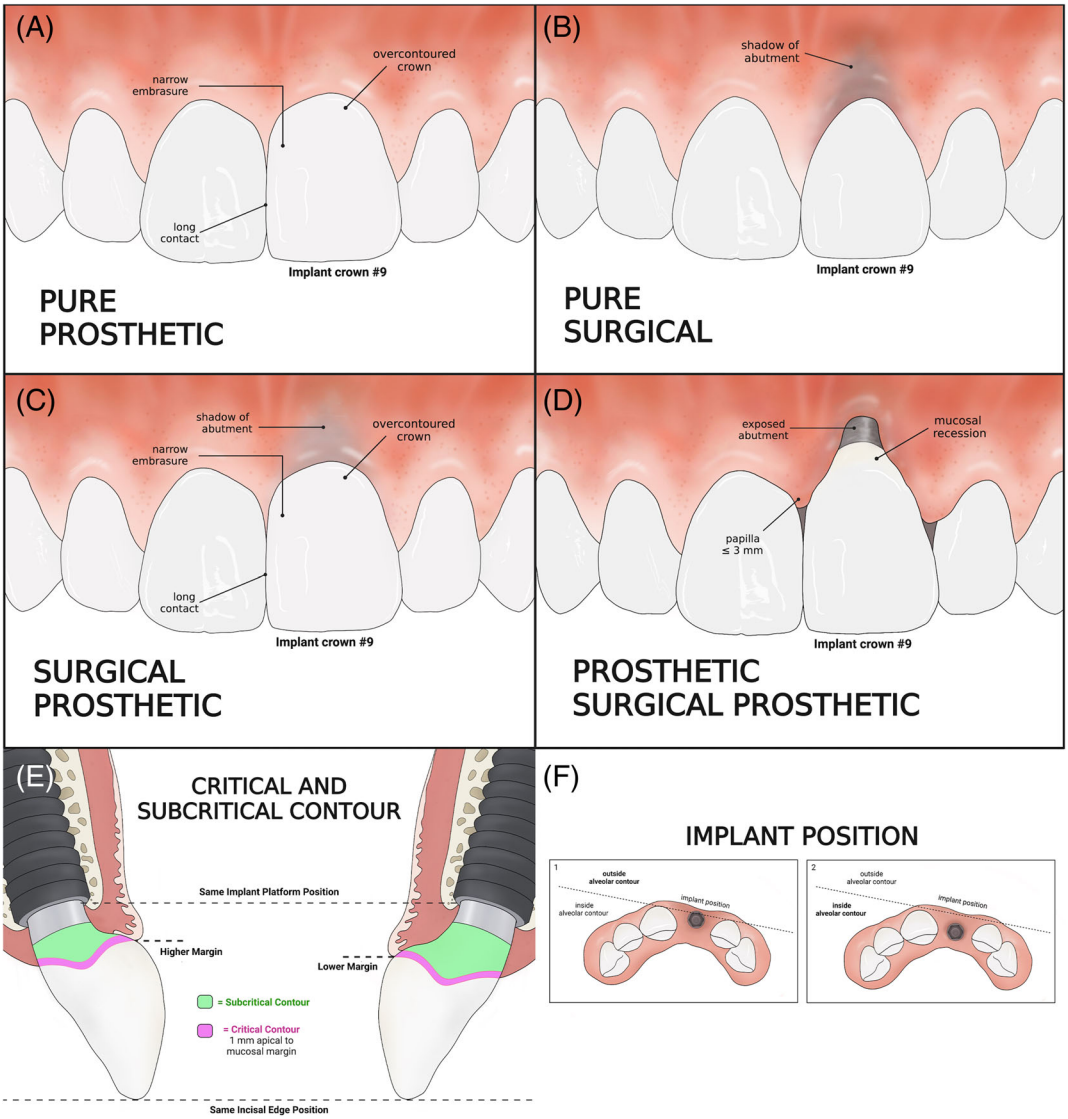

FIGURE 2 Schematic illustrations displaying the four clinical decision-making categories: (A) pure prosthetic approach; (B) pure surgical approach; (C) surgical prosthetic approach; (D) prosthetic surgical prosthetic approach; (E) sagittal view showing critical and subcritical zones and when the crown has over contoured cervical area will cause shifting of the mucosal margin apically; (F) cross-sectional view showing implant position in case of outside alveolar contour (1) and inside alveolar contour (2).

to implant submergence or removal without causing remediate esthetic defects. In addition, all subcategories are illustrated in Table 1 with figures outlining each intervention type based on the evaluation questions before to address the patient's chief complaint.

3.1 | Clinical scenario A

In this scenario, the patient presents with a buccally positioned implant with significant abutment angulation about 25° and thin peri-implant soft tissue <2 mm. The patient also has labial mucosal recession that was restored with pink porcelain and compromised interdental papilla from the implant crown impingement. However, the implant is diagnosed with peri-implant health. To address these issues, a prosthetic-surgical-prosthetic approach without abutment removal is recommended. The treatment steps involve making an impression as an index to prepare provisional crowns to replace the existing crowns. A provisional acrylic crown with adequate embrasures for the interdental papilla is then delivered to allow for more tissue maturation before any surgical intervention.

After 2 months, there should be an improvement in tissue quality and interproximal tissue height compared with baseline measurements. A digital smile analysis is then performed to determine how much coronal advancement of the flap is needed compared with the contralateral tooth. An envelope coronally advanced flap is performed after securing the connective tissue graft (CTG) over the abutment and bone with periosteal sutures and delivering a temporary crown away from the tissues that is

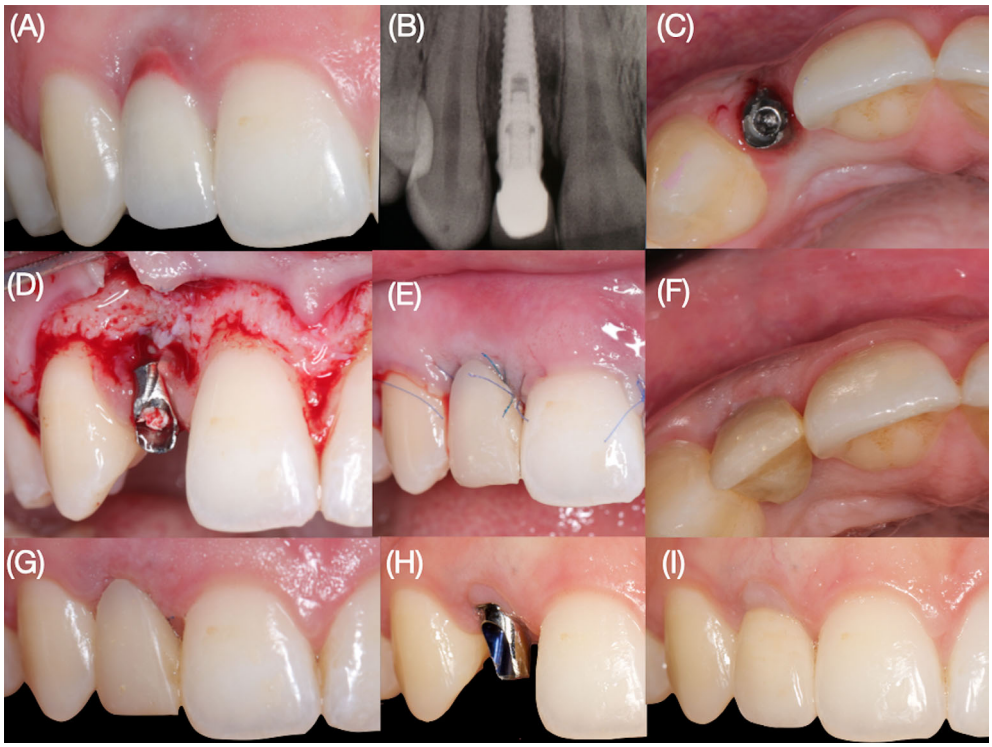

FIGURE 3 (A) Frontal clinical view shows esthetically failing # 7 implant with pink porcelain extended apically to mimic the gingival color (Class III Subclass B peri-implant soft tissue dehiscence/deficiency); (B) periapical radiograph showing implant Mesio-Distal position and depth of the implant without presence of interproximal bone loss; (C) occlusal view showing the position of the implant bucco-palatal in relation to the adjacent teeth; (D) frontal clinical view showing envelope flap with full thickness reflection over the teeth and split thickness reflection over the implant site with interdental papilla split; (E) frontal clinical view showing final position of the coronally advanced envelope flap secured with sling sutures with placement of temporary crown; (F) occlusal view showing the buccal soft tissue gain after 3-months of soft-tissue healing; (G) frontal clinical view after 12 weeks post-surgical showing the healing of the peri-implant tissues; (H) frontal clinical view showing new angled stock narrow abutment was connected to the implant; (I) frontal clinical view showing the final prosthesis after 12 months follow-up.

then subsequently modified after 2 months post-surgery to allow for soft tissue creeping. After 3-months of soft-tissue healing, a definitive restoration on a new abutment is delivered. The end result should be improved tissue quality and interproximal tissue height, as well as a more esthetically pleasing restoration (Figure 3A–I).

3.2 | Clinical scenario B

In this scenario, the patient presents with significant mucosal recession >3 mm on the midfacial aspect of the abutment and crown due to the implant position being placed too facially. Additional factors to consider would be the presence of clinical attachment loss (CAL) of 5 mm on the adjacent tooth, and the patient has a high smile line with thick peri-implant phenotype >2 mm. The solution to this clinical situation is a prosthetic-surgical-prosthetic approach for managing interdental papilla loss with implant decoronation (i.e., removing the crown, abutment and placing Maryland fixed bridge). The first step is to decoronate the implant by placing a sterile cover screw and delivering a Maryland bridge. The bridge is modified every month to allow for the soft tissues to gradually migrate coronally for 3-months. Forced orthodontic extrusion is a treatment technique that involves applying orthodontic forces to the adjacent teeth of an implant in order to extrude them from the alveolar bone. This technique is often employed with the goal of improving the clinical attachment level of the teeth and enhancing the overall esthetic and functional outcomes of the implant-supported restoration (Figure 1 decision-making tree). It is important to note that forced orthodontic extrusion should only be considered in specific clinical scenarios where there is a need to optimize the clinical attachment level around the implant. The decision to use this technique should be based on a thorough evaluation of the individual case, including the condition of the adjacent teeth, the amount of available bone, and the desired esthetic outcome.[13] The rationale behind forced orthodontic extrusion is to create a more favorable environment for the attachment of soft tissues around the implant. By extruding the adjacent teeth, the gingival tissues can be repositioned at a coronal level, thereby improving the emergence profile and harmonizing the gingival contour with the implant-supported crown. This can lead to enhanced esthetics and a more natural appearance of the implant restoration. Unfortunately, no longitudinal, well-conducted studies may support this particular application at this time.[13]

After 3-months, vertical and horizontal soft tissue augmentation may be performed using a connective tissue platform technique with delivering a new Maryland bridge. After 6-months, the second stage

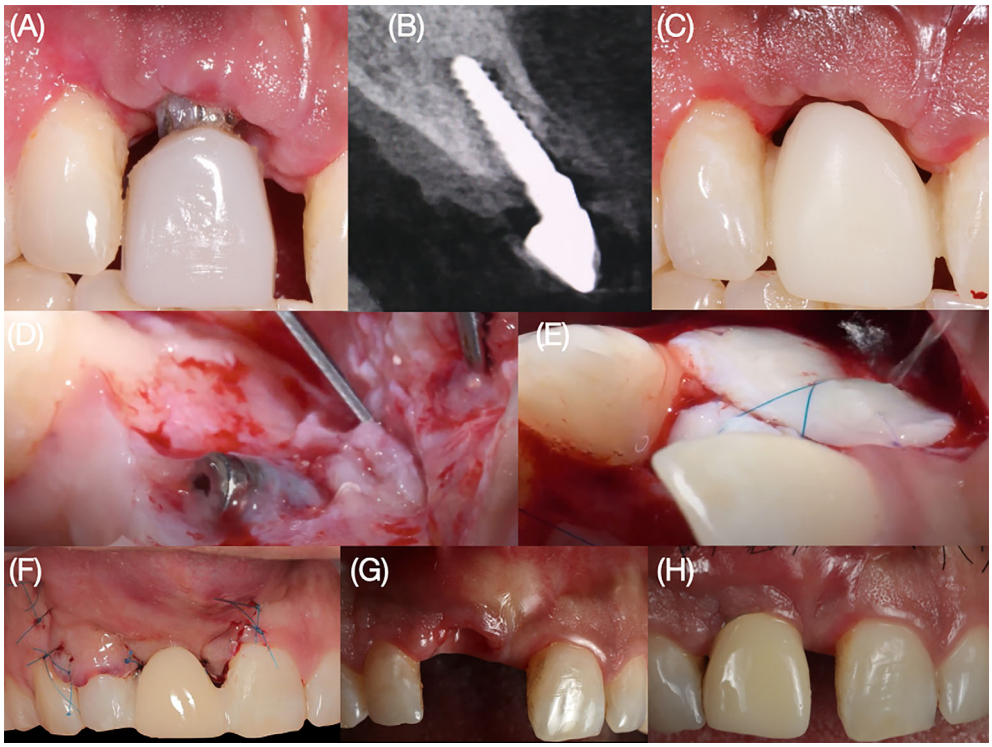

FIGURE 4 (A) Frontal view demonstrates clinical photo of malpositioned implants #8 with buccal and interproximal soft tissue deficiency and attachment loss (Class IV Subclass C peri-implant soft tissue dehiscence/deficiency); (B) sagittal view of CBCT shows malposition of implant # 8; (C) frontal clinical view showing same area 2 months after crown and abutment removal with temporary implant submergence and delivering Maryland bridge; (D) side clinical view showing split thickness elevation over the implant with preserving connective tissue adhesion and the severity of buccal malposition with absence of the buccal bone; (E) platform technique was done with palatal CTG fixed over the implant #8 from the buccal side and another palatal CTG was placed on the occlusal side to build deficient soft tissue vertically both were fixed with 7/0 PGA. Both grafts fixed with additional sutures 6/0 polypropylene sutures for more graft stability; (F) the flap was coronally advanced over both grafts toward the palatal side and secured with a sling and simple interrupted sutures. Adjusted Maryland bridge was delivered; (G) frontal view shows tissue healing after 12 months follow-up with the integration of the interproximal part; (H) 18-months follow-up shows the healing with more tissue creeping and stability.

of implant exposure should be completed, and a flat profiled healing or custom abutment inserted to redirect the submergence profile. After 2 weeks, a provisional crown is then fabricated and delivered. The peri-implant mucosal soft tissues are given a minimum of 8 weeks to mature before taking the final impression and fabricating the definitive restoration. The subgingival contours are carefully adjusted to provide optimal support and accommodation for the surrounding soft tissues, promoting long-term stability of the midfacial soft tissues. This approach is particularly useful in cases where there is significant interdental papilla loss and a high smile line, as it allows for the restoration of the proper peri-implant soft tissue profiles and the creation of a biomimetic final restoration (Figure 4A–H).

3.3 | Clinical scenario C

In this scenario, the appropriate clinical decision is a surgical-prosthetic approach. The initial complication is a significant fenestration on the midfacial aspect of the implant abutment, which may potentially compromise the stability of the peri-implant mucosa. The implant is clinically healthy. To address the problem, a surgical procedure is deemed necessary to cover the exposed abutment with a CTG harvested from the palate. The surgical step is necessary to stabilize the soft tissue around the implant and promote tissue regeneration. After the surgical procedure, at least 3-months healing period is necessary to allow for the soft tissue maturation. At this point, a new prosthesis may be fabricated to replace the existing one, requiring a prosthodontic intervention. The implant abutment can be modified to accommodate the new crown, and the definitive restoration can be constructed with compensatory subgingival contours to ensure ideal midfacial soft-tissue stability.

In summary, the appropriate clinical decision in this case is a surgical-prosthetic approach. The surgical step is necessary to first stabilize the soft tissue around the implant and promote tissue regeneration, while the prosthetic step is necessary to construct the definitive restoration with compensatory subgingival contours (Figure 5A–D).

3.4 | Clinical scenario D

In situations where the implant is severely positioned buccally (depth >3–4 mm, buccal angulation >25°) along with limited prosthetic solutions and the presence of peri-implantitis, the removal of the ailing

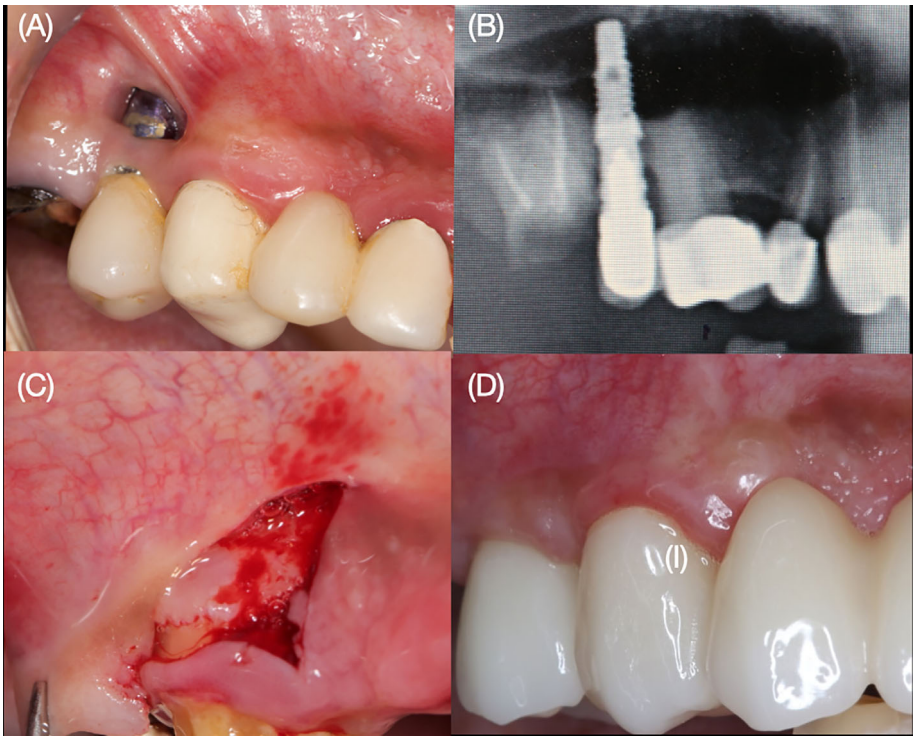

FIGURE 5 (A) Side clinical view shows failing # 4 implant with buccal mucosal dehiscence over the abutment area; (B) cropped panoramic radiograph showing implant Mesio-Distal position and depth of the implant without presence of interproximal bone loss; (C) side view showing lateral displaced flap was designed and moved to cover the abutment dehiscence; (D) side clinical view showing the final prosthesis after 12 months follow-up.

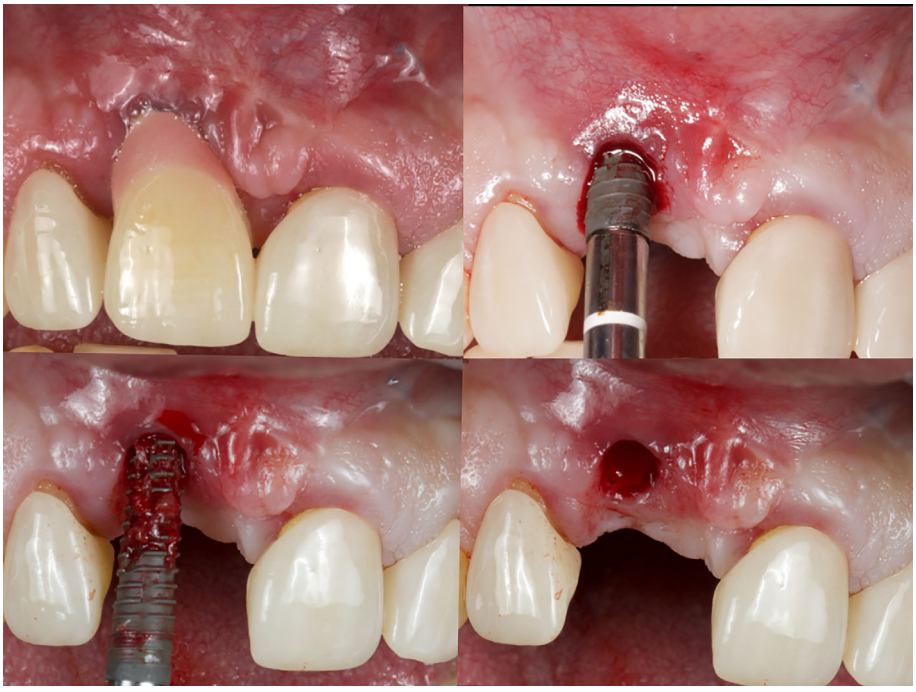

FIGURE 6 Clinical views of the removal process for ailing implant in position #8.

implant may be considered as a necessary step. This is because such implant positioning can compromise esthetics and provide inadequate support to the surrounding soft tissues and adjacent teeth. Moreover, limited prosthetic options can further contribute to functional and esthetic challenges associated with the implant.

In such cases, when an implant is not properly integrated or presents challenges for restoration, the decision to remove the implant can be made. By removing the implant, it allows for improved implant positioning, which can have positive implications for long-term prognosis and functional and esthetic outcomes. Removing the ailing implant provides an opportunity to explore alternative treatment approaches and establish a solid foundation for subsequent treatment. It allows clinicians to address the existing challenges, re-evaluate the patient's condition, and choose an alternative treatment option that is more suitable and likely to result in a more favorable overall outcome.

This decision-making process highlights the importance of regular clinical and radiographic assessments, as well as the consideration of various factors, including the feasibility of restorative options, patient preferences, and long-term prognosis, to ensure optimal treatment outcomes and patient satisfaction (Figure 6).

4 | DISCUSSION

This case series demonstrated various scenarios of maintaining a single healthy implant with a decision tree, with the primary objective of management of mid-facial deficiencies in the esthetic zone. As previously implied, the outcomes for treating gingival recession defects on teeth using conventional techniques and materials are not necessarily identical clinical situations regarding PSTD around implants. Anderson et al.[20] found a mean PSTD coverage of 40% and 28% following CAF with subepithelial CTG or acellular dermal matrix, respectively. Similarly, Burkhardt et al.[21] reported of the incomplete resolution of the PSTD at 6 months follow up for all cases. These results, however, may be attributed to the maintenance of the existing crown. Maintaining the permanent prosthesis during soft tissue reconstruction may complicate the procedure and compromise the final flap and/or graft position.[13,15] Hence, the modifications for vertical and horizontal soft tissue augmentation with CAF was proposed using a CTG on the crest of healed edentulous spaces as a platform to support the graft.[15] A critical factor in determining the appropriate clinical decision is based on the presence of interproximal soft tissue with adequate thickness (≥2 mm), height (>3 mm), and width (>2 mm), to provide an adequate vascular bed to supply the connective tissue graft and provide the support needed to coronally advance the flap.[3,14,16,22] As observed in the first clinical case, presence of thin, delicate interproximal papillae necessitates replacement of the crown with one of narrower dimensions to facilitate presurgical coronal growth of the interproximal tissue. However, in the presence of mid-facial recession with or without deficient interdental papilla, temporary implant submergence is also a viable treatment modality, as it creates an environment more amenable to augment soft tissue horizontally and vertically with a connective tissue graft, without tension, during primary closure, and to potentially restore lost papilla.[14,15,23,24] Furthermore, the utility of implant submergence is dependent upon the depth and degree of buccal placement and the need for vertical augmentation.[22] Tarnow et al. emphasized the need for a presence of palatal tissue at an adequate height, providing evidence of the importance of the supracrestal tissue attachment in relation to the apico-coronal location of the implant. In many cases, if the implant platform is not at least 3 mm apical from the height of soft tissue, complete closure over the cover screw may not be obtained and implant submergence may not be a useful tool in these instances to provide an adequate bed for a future soft tissue graft.[16,17,25–27]

This is demonstrated in the second scenario in which the interproximal soft tissue was restored. In cases of severe buccal implant positioning, and/or limited prosthetic solutions, a clinical example is presented in the third scenario demonstrating the necessity for either permanent implant submergence or implant removal.[16,27–29] It is important to consider that the removal of a fully osseointegrated implant can potentially result in bone fracture and create a larger defect. In such cases, alternative options like a fixed bridge or resin-bonded fixed dental prosthesis with a soft tissue graft covering the implant should be taken into consideration.[13] Some aspects that made these cases more challenging is the severely compromised hard and soft tissues quality surrounding the implant placement along with limited prosthetic solutions. Urban et al.[30,31] validated a case successfully of an implant esthetic complication that was managed with implant removal, vertical bone augmentation, delayed implant placement with a simultaneous CTG that was placed vertically on top of the implant head, and prosthetic soft tissue conditioning.

It has been advocated that the type of soft tissue graft source or material may also play a role on the treatment outcomes of peri-implant soft tissue dehiscence, and the proper selection of such a material is crucial for the graft survival and integration.[27] Unlike the tooth, the wound healing environment around a dental implant is highly avascular and devoid of living periodontal ligament cells that would normally provide a regenerative potential during early stages of wound healing.[11,22] Indeed, autogenous connective tissue grafting is still the gold standard in terms of coverage of recession defects, gaining clinical attachment, and improving the phenotype of the keratinized mucosa.[31–35] CTG obtained from the superficial palate, or the maxillary tuberosity, may be preferred due to its higher lamina propria content and density, along with minimal presence of fatty and glandular tissue.[22] Acellular dermal matrices may also be indicated when encountering a patient's resistance to necessitating a secondary surgical site or when autogenous harvesting may not yield enough tissue, such as in situations of generalized recession type defects.[35–37]

5 | CONCLUSION

Mid-facial peri-implant soft tissue recession is a common esthetic complication. Treatment options range from soft tissue augmentation to implant removal, depending on the case. Esthetic improvement may require a surgical and/or prosthetic approach. The decision tree provides solutions for various complications and emphasizes an interdisciplinary approach. Successful cases demonstrate the effectiveness of this approach for better long-term esthetic outcomes.

AUTHOR CONTRIBUTIONS

Conception and design of the study; performed the surgical procedures, initial and final drafting of the work: Abdusalam Alrmali and Sandra Stuhr. Initial and final drafting of the manuscript: Muhammad H. A. Saleh and Jessica Latimer. Design of the study; critical review of the draft and contribution to the writing of the manuscript: Joseph Kan, Dennis P. Tarnow and Hom-Lay Wang. All authors gave their final approval of the version to be published and accountable to the accuracy or integrity of the work.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they do not have any financial interest in the companies whose materials are included in this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in no data at no data.

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