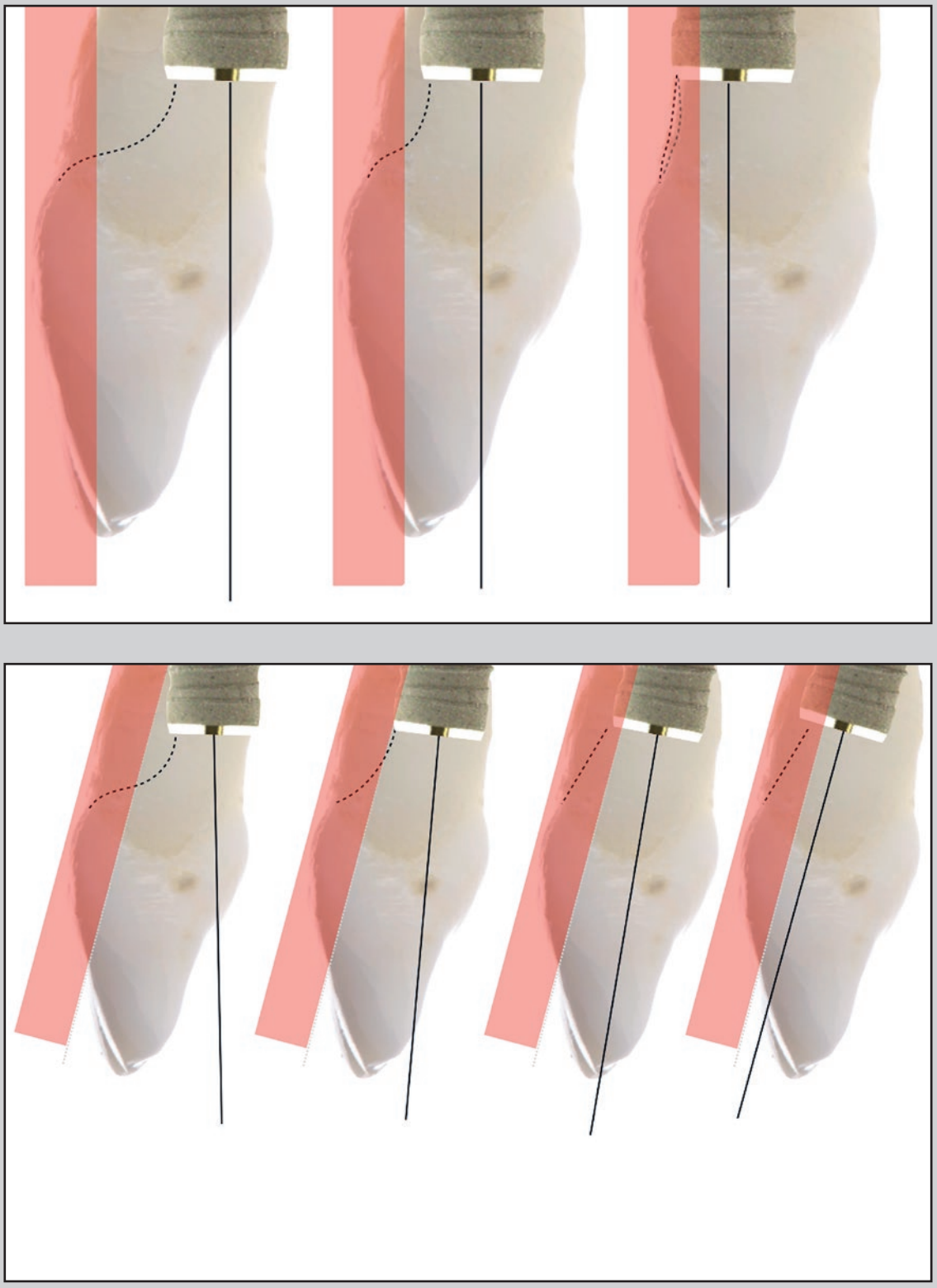
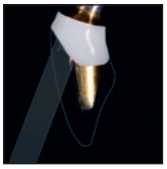


The Impact of 3D Implant Position on Emergence Profile Design



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Implant position and soft tissue thickness have a direct influence on implant abutment design. The goal is to place the implant in the optimal spatial position to maintain the adjacent bone and soft tissues. When the implant is not placed ideally, prosthetic variations to abutments and restorations must be made, which may limit the esthetic appearance of the final restoration or alter the biologic environment of the bone and tissues. This article illustrates and explains the effect of different implant positions on the emergence profile design in order to assist the clinician with treatment planning and selection in various clinical situations.
Int J Periodontics Restorative Dent 2021;41:79–86. doi: 10.11607/prd.5126

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Submitted May 13, 2020; accepted July 25, 2020.

Implant treatment in the esthetic zone is a complex challenge, and there are various guidelines to improve long-term esthetic success.[1] Teeth and implants are morphologically and biologically different from each other.[2] The platform of an implant is narrower and has a different shape than the cervical aspect of a tooth. The soft tissues and bone around an implant are less stable due to the absence of the periodontal ligament.[3] In addition, connective tissue fibers run in a different orientation than those around teeth.[4,5] The less-stable buccal plate and reduced soft tissue thickness often present a true challenge to the clinician. Protocols such as the socket-shield technique were developed to reduce these problems; however, they are complex and technique-sensitive.[6,7] Other techniques include immediate implant placement and provisionalization or a custom-made healing abutment to help stabilize the blood clot and increase the chances of highly esthetic results.[8–11] For a restoration on an implant to be perceived as esthetic, a natural tooth-like emergence profile through the soft tissues is fundamental. Optimal prosthetic designs are needed to provide proper support and stability of the soft tissues.[12] The emergence profile can be modified during the provisional stage, as it is largely dependent on

the implant position and soft tissue thickness.[13,14] This article illustrates and explains the effect of different implant positions on emergence profile design, which is essential for prosthetic treatment planning and long-term functional and esthetic success.

3D Implant Position and Emergence Profile Design

Optimal 3D implant position is the first and fundamental factor for esthetic treatment outcomes. Buser et al differentiated between a comfort and a danger zone for implant placement.[15] The dimensions to consider during implant placement are implant depth (D), interproximal position (I), bodily position (B), and axial inclination (A). Bone and soft tissue stability are directly affected when an implant is not placed in the optimal spatial position.[15] Correcting malpositioned implants may require additional surgical procedures and delay treatment. From a prosthetic standpoint, the selection of the abutment emergence shape and material is essential. However, this is greatly dependent on the implant position.[13,16] The emergence profile design has key elements for optimal biologic and esthetic outcomes. Su et al described the critical and subcritical contours as two important areas in the emergence profile design of implant restorations.[12] The critical contour is defined as the first millimeter below the gingival margin of the implant restoration, which has a direct influence on the crown shape and gingival margin position. The second area is the subcritical contour that ranges from the implant platform to the critical zone. It should be concave in shape to increase the space for soft tissue support.[12] A convex design seems to support facial and interproximal peri-implant tissues.[12] Steigmann et al correlated the emergence profile design of the implant restoration to the position of the dental implant[13]: Accordingly, the emergence profile should be convex when the implant is positioned lingually to push the soft tissues, slightly concave when the implant is positioned centered, and concave when it is positioned slightly labially to increase the thickness of the soft tissues. The correlation between the emergence profile and the implant position is further detailed in Table 1.

Implant Depth

Implant depth (D) is the first determining factor for the creation of a natural emergence for the implant restoration. Considering the differences in anatomical shape between an implant and a tooth root, sufficient height is needed to create a harmonious transition from the implant platform to the restoration. Ideally, the dental implant should be placed 3 to 4 mm apical to the ideal prospective gingival zenith on the restoration.[15] Placing the implant deeper than that increases the risk of biologic complications, such as mucositis and peri-implantitis.[17] Galindo-Moreno et al suggest a minimum distance of 2 mm from the implant platform to the beginning of the abutment flare for better stability of the bone crest.[18] An implant in a D0 and D1 position (as classified in Table 1) provides space for an abutment design that promotes crestal stability as well as a gradual transition with an emergence profile that adequately supports the surrounding soft tissues. Placing the implant less than 2 mm apical to the future zenith of the restoration (in a D2 or D3 position) will create biologic and esthetic challenges, as this requires an excessive flare of the abutment from the implant platform to the cervical contour of the crown (Fig 1).

Interproximal Position

Adequate mesiodistal or interproximal positioning (I) of the implant is often challenging. Biologic principles, such as necessary space between neighboring teeth and/or implants, must be considered.[5] At the same time, the prospective prosthetic design and the mesiodistal position of the gingival zenith on the anterior teeth must be determined, as they serve as a guide for proper implant placement.[19] In this dimension, the clinician must assess the quantity and quality of interproximal hard and soft tissues, which are associated with the osseous architecture and tooth form.[20,21] The interproximal bone is predominately flat in the posterior regions of the maxilla and mandible, gradually becoming more convex in the maxillary anterior regions.[22] Maxillary anterior anatomy types can be classified as flat, scalloped, and pronounced. The difference between

Table 1 Influence of Implant Positioning in Emergence Profile Design

Dimension	Implant position	Screw access	Emergence design
D			
0	4 mm from zenith point	N/A	2-mm straight followed by a progressive flare
1	3 mm from zenith point	N/A	Progressive flare
2	2 mm from zenith point	N/A	Evident flare
3	1 mm from zenith point	N/A	Aggressive flare
I			
0	Center of the mesiodistal width of the tooth	Center of the restoration	Bi-concave/convex
1	Offset 1 mm from the center of the tooth	Slightly offset to the center of the restoration	Straight on the side of implant offset. Concave (thick biotype) or with a slight convexity (thin biotype) on the most coronal part of emergence design, on the non-offset side.
2	Offset 2 mm from the center of the tooth	Offset to the center of the restoration	Flat on the side of implant offset Concave/convex on the non-offset side
B			
0	Slightly lingual in the bony housing or postextraction socket	Cingulum of the restoration	Concave or convex, depending on tissue thickness
1	Center of the alveolus or the bony housing	Between the incisal edge and the cingulum	Slightly concave
2	Slightly facial inside the post extraction socket or the bony housing	Incisal edge	Flat or minimal concavity
A			
0	Lingual angulation of the implant platform	Cingulum of the restoration	Very concave/convex, depending on quantity of soft tissues
1	No facial or lingual angulation of implant platform	Between the incisal edge and the cingulum of the restoration	Concave
2	Slightly facial angulation of the implant platform and body	Incisal edge of the restoration	Slightly concave/flat
3	Facial angulation of the implant platform and body	Facial aspect of the restoration	Flat

D = implant depth; I = interproximal position; B = bodily position; A = axial inclination.

these anatomical morphotypes is in the mean distance from the midbuccal alveolar crest to the interdental bone height (flat: 2.1 mm; scalloped: 2.8 mm; pronounced: 4.1 mm).[20] This is paramount to design the emergence profile of the interim restoration and final abutment, which should follow the anatomy of the hard and soft tissues of the implant to be restored. When two implants are placed next to each other, proper positioning is fundamental, as the papilla height between them is reduced.[23] The interproximal position of the implant will also change the design of the emergence profile of the abutments (Fig 2). Fabricating a concave or convex design will depend on the prosthetic and esthetic necessities of the patient, the distance to the neighboring tooth, and the quality and quantity of the soft tissues. A distance of 2 to 3 mm

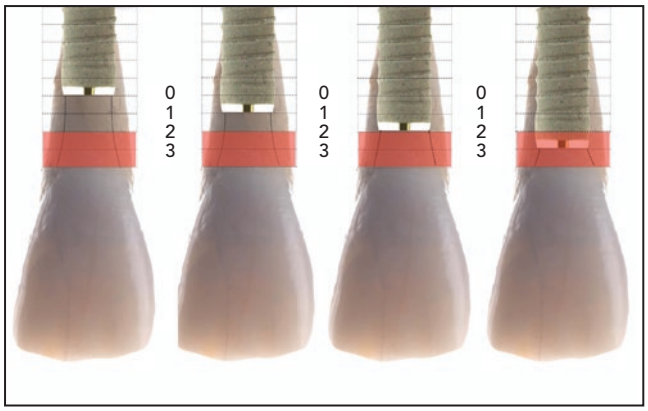

Fig 1 *Relation of implant depth and emergence profile, as defined in Table 1.*

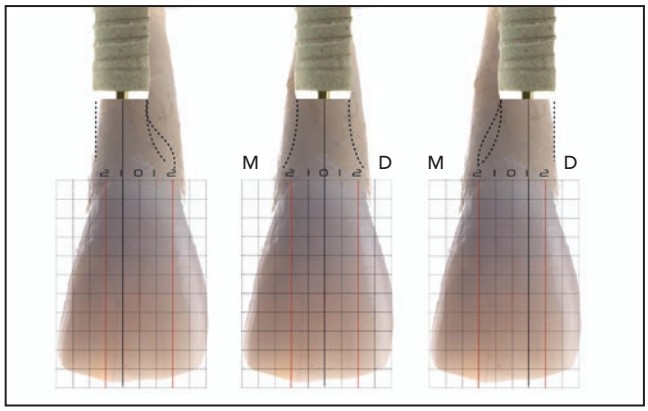

Fig 2 *Relation of implant interproximal position and emergence profile, as defined in Table 1.*

between implants or implants and teeth is suggested. A slightly convex implant abutment seems to facilitate incisal displacement of interproximal tissues.[12,14] When a dental implant is placed in an I0 position, the clinician will have space to modify the emergence profile as needed in both mesial and distal directions to displace the interproximal tissues. Conversely, when the implant is placed in an I1 or I2 position, the clinician can make limited modifications to the abutment on the side of the offset (Table 1).

Bodily Position

The bodily position (B) of the implant depends on the anatomy and morphology of the existing bone.[24] The surgeon should leave a space of at least 2 mm between the implant body and the buccal plate.[25] Moving the implant body lingually toward a B0 or B1 position facilitates the creation of a concave or convex emergence profile, based on the prosthetic needs and soft tissue volume.[13] In situations with a soft tissue volume that is less than ideal, a convex submucosal contour improves the overall esthetic appearance. Conversely, an excessive convexity may lead to loss of soft tissue unless a connective tissue graft is placed circumferentially in the respective space. An implant placed too far facially in a B2 position will limit the abutment design options and allow only for a flat emergence profile (Fig 3). Such placement will also increase the prevalence of buccal bone loss and, consequently, a compromised esthetic result.

Axial Inclination

The axial inclination (A) of the implant body and platform refers to their orofacial and mesiodistal inclinations. In the orofacial plane, excessive facial inclination should be avoided as it may cause prosthetic complications, reduce the thickness of abutments in the facial aspect, and lead to bone dehiscence and soft tissue deficiencies.[16] Excessive facial inclination is defined as the position where the long axis of the abutment screw is located in the middle or cervical third of the facial aspect of the prospective restoration. When the screw access is located incisally to this position, a cement-retained restoration or dynamic abutment may provide a proper solution.[26] The axial inclination is also crucial for the development of the emergence profile. When the implant long axis is tilted facially (in an A3 position, for example), the emergence profile will become more flat (Fig 4). Excessive facial tilt requires the use of a titanium abutment. A zirconia abutment would be too thin and prone to fracture.[16] Another consideration when an implant has an excessive facial tilt is the thickness of the buccal plate. The crestal bone is usually very thin in the most coronal aspect of a postextraction socket, and the first millimeters of bundle bone tend to resorb shortly after extraction.[24,25]

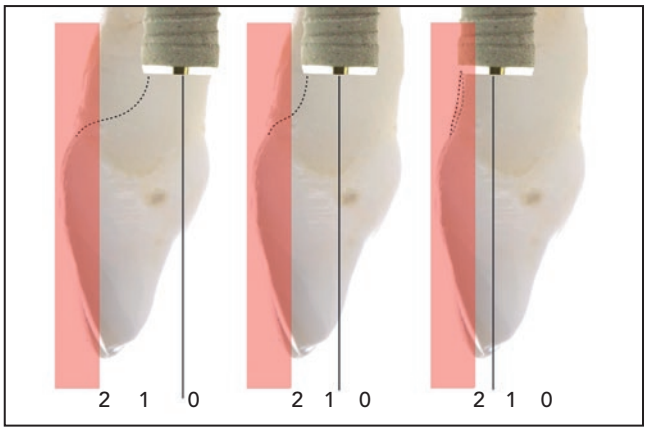

Fig 3 *Relation of implant bodily position and emergence profile, as defined in Table 1.*

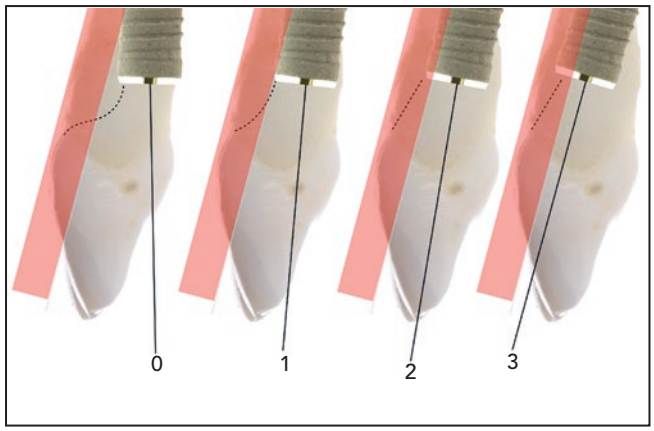

Fig 4 *Relation of implant axial tilt/inclination and emergence profile, as defined in Table 1.*

Clinical Scenario

A patient presented with implants in the maxillary right central incisor and left lateral incisor areas and with an implant-supported provisional fixed dental prosthesis (Fig 5). The provisional restorations were overcontoured and failed to meet the esthetic demands of the patient. New provisional restorations were fabricated with improved shape and contour to enhance the soft tissue outline and develop the pontic sites. A preferred way to evaluate whether implants are in the ideal prosthetic position is to fabricate provisional restorations with ideal tooth form. In this clinical scenario, the implants in both sites were placed with a facial axial inclination. The implant in the central incisor site was placed at an inadequate depth, with a D2–A3–I0–B2 position. The implant in the lateral incisor site was placed with a D1–A3–I0–B2 position (Fig 6).

In these situations, the main objective is to manipulate the soft tissues by recontouring the provisional restorations in an attempt to

Fig 5 *Initial situation with implant-supported provisional restorations.*

Fig 6 *The new screw-retained provisional restorations with improved contour reveal the prosthetic challenges due to the current implant position.*

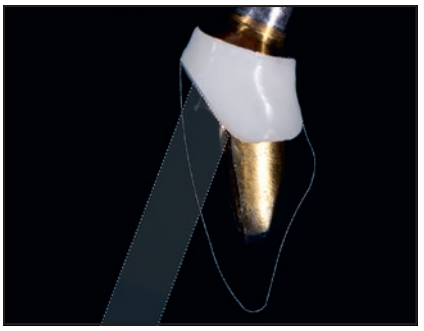

Fig 7 *Screw access hole in the cervical third of the facial aspect of the abutment. The implant has been placed in a D3–A3–B2 position, which limits the restorative options.*

Fig 8 *A ceramic ring is made to conceal the screw head below soft tissues.*

Fig 9 *Postoperative situation with an implant-supported fixed dental prosthesis. The overall outcome is compromised, as the soft tissue outlines, tooth shape, and overall esthetics are negatively impacted by the implant position.*

gain a maximum amount of space for the tissues, without jeopardizing the mechanical characteristics of the prosthetics. Situations where the depth of an implant is not ideal (D3 position) will lead to abutments with a marked flare from the implant platform to the crown margins, as there is no space to transition the emergence profile gradually. The buccolingual position and axial inclination of the implants led to a flat facial emergence profile. Creating a concavity was not possible due to limited material thickness (Fig 7). This excessive axial inclination and shallow depth resulted in the need to fabricate a ceramic ring to conceal the screw head from showing through the soft tissues (Fig 8). From the interproximal aspect, the abutment design was not affected by the implant position. The lack of soft tissue in the interproximal areas had to be addressed prosthetically. The abutment design was affected by the implant position, and the esthetic result was compromised (Fig 9).

Discussion

Esthetic success of both teeth- and implant-supported restorations has evolved over the years. A natural and healthy soft tissue appearance has become a fundamental aspect of implant therapy success.[27,28] An esthetic dental implant restoration must allow for adequate papilla fill and appropriate tissue level and contour, and must closely emulate the color and texture of the neighboring areas.[27] It is critical to match the form, size, color, and texture to neighboring teeth.[27] The importance of the emergence profile design of an abutment comes from its potential to modify the root-like eminence of the soft tissues, its contour, the shape of the papillae, and the position of the soft tissue zenith on the final restoration, all of which impact the esthetic outcome.

Proper implant position is essential for restorative success, despite the fact that the recent development of angulated abutment screw-access channels provides the clinician greater flexibility to correct moderate inaccuracies of implant placement.[26] Such abutments are mechanically reliable and allow for screw-retained restorations in situations that would have required cement-retained crowns in the past.[29] However, this modality does not correct inadequate implant depth, mesiodistal position, or excessive facial tilt, which may cause crestal bone resorption.

The proper emergence profile design of implant abutments is well-described in the literature.[12,13] Su et al discuss critical and subcritical contours of implant abutments and crowns, independent of the implant position.[12] The influence of implant position on the emergence profile was described by Steigmann et al.[13] However, this relationship was only discussed in the orofacial dimension, while the impacts of implant depth, interproximal position, and axial inclination on the abutment design are missing. Gonzáles-Martín et al[14] illustrated the relationship between the subcritical contour design and the buccolingual/apicocoronal position of the implant as well as the

restorative platform height. Those authors do not describe how axial tilt or mesiodistal position can alter the abutment design.[14]

In addition, the emergence profile design and the material selection of final abutments are influenced by the quality and quantity of surrounding soft tissues.[16,30,31] Patients with thinner soft tissue biotypes are more prone to soft tissue recessions around implant restorations.[29] Greater soft tissue thickness provides better tissue stability, less crestal bone loss, and simplified abutment material selection.[32,33] The aim of designing adequate abutment emergence profiles is to create a natural emergence of the implant restoration through the tissue and to mimic the natural harmony between the tooth and soft tissue.

Creating adequate space for the soft tissues with proper abutment designs is a fundamental task. The emergence profile can be modified with provisional restorations following the preestablished parameters to achieve adequate soft tissue support and stability.[12,14] Soft tissue modification during the interim restoration stage is done by adding or removing bulk to the contour in the critical and subcritical zones of the provisional restoration. Adding bulk to the critical zone displaces the tissues apically, which is useful for changing the zenith point position. Removing bulk from the contour in this zone can help when incisal displacement of the tissue is needed. The subcritical area of the abutment is influenced by soft tissue quantity and the implant position. This area should be concave when there is adequate soft tissue volume, and it should be convex when the implant is placed palatally and when the tissue is deficient and needs to be pushed facially.[12–14] Soft tissue modifications are limited by implant position and tissue quantity. Therefore, proper implant position and adequate soft tissues are critical for esthetic outcomes and have a great impact on the emergence profile of an implant-supported restoration.

Conclusions

Developing naturally emerging restorations on dental implants is a challenging, multifactorial task. The design of the emergence profile in implant restorations must be done with great precision and knowledge of both biologic and esthetic principles. The design of the abutment emergence profile is influenced by implant position and hard and soft tissue conditions. Adequate implant position and soft tissue volume increase esthetic success in dental implant therapy.

Acknowledgments

The authors declare no conflicts of interest.

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