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CLINICAL ARTICLE

The esthetic biological contour concept for implant restoration emergence profile design

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Abstract

Objective: Emergence profile design is important for stable peri-implant tissues and esthetically pleasing results with dental implant restorations, influenced by factors, such as, implant position and surrounding soft tissues. Different aspects of the emergence profile have been described, but detailed explanations of the different zones and corresponding designs are missing. This article describes the esthetic biological contour concept (EBC), differentiating important areas of the emergence profile and recommending particular designs for those zones.

Overview: The EBC concept considers specific parameters for proper design of the emergence profile of implant-supported restorations. Understanding the different zones of the emergence profile and their relation to factors like implant position, implant design, and soft tissue thickness is key. The suggested guidelines are geared toward providing more stable and esthetic results when restoring dental implants in the esthetic zone.

Conclusions: Each of the zones described in the EBC concept have a specific function in the design of the emergence profile. Understanding the importance and specific design features of the EBC zones facilitates esthetic and biologically sound treatment outcomes with interim and definitive implant restorations.

Clinical significance: Proper emergence profile design supports esthetic outcomes and provides favorable biological response to implant-supported restorations.

KEYWORDS

CAD-CAM abutments, dental implants, emergence profile, esthetic dentistry, implant provisionals

1 | INTRODUCTION

An esthetic implant-supported restoration emerges through the surrounding tissues like a natural tooth.[1,2] The transition between the restoration and the soft tissues must appear natural, and the emergence profile (EP) often requires customized modification.[3,4] Many techniques to condition the peri-implant soft tissues during the implant healing process have been described: immediate provisional restorations, custom healing abutments, as well as provisionalization techniques after the implant has integrated.[5-9] The three-dimensional (3D) position of the implant and quantity of soft tissues available are factors that influence the shape of the EP.[5,10-12] The final contour of the provisional restoration is essential to achieve an esthetic result.[10,13]

The concept of the critical and subcritical contours of the implant emergence profile was described by Su et al.,[14] who focus on the importance of shaping two different areas of the EP to achieve the desired outcome in the peri-implant tissues. However, there is still much confusion about the subcritical contour design when different soft tissue environments are present. Developing an adequate emergence profile by manipulating the peri-implant tissues should be done during the provisionalization stage. The technique used will depend

on the clinical approach for the case, delayed or immediate implant placement, and the need for adjunct soft-tissue enhancement. This article describes the esthetic biological contour concept (EBC) and explains the different areas of the emergence profile to help create an esthetic and biologically oriented contour of implant-supported restorations.

2 | EMERGENCE PROFILE ZONES

There are three zones referring to the subgingival contour of the emergence profile of an implant restoration (Figure 1). Each of these zones will be in contact with a specific type of tissue and its design will have a different function (Table 1; Figure 2).

2.1 | E Zone: esthetic zone (E)

The esthetic zone and its function have been described as the 1 mm subgingival area, apical to the free gingival margin (FGM). This area has also been termed the critical zone.[14] It should match the shape of the crown of the extracted or the contralateral tooth to emulate the appearance of a natural crown. Its contour should be convex and support the FGM location in the proper position, establishing the cervical morphology of the implant crown. Clinically, this area should be straight or concave only if the implant was placed too buccally.[15] This situation should be avoided with correct planning and the use of accurate surgical guides during implant placement. Leaving this area concave will cause loss of soft tissue support and inadequate appearance of the margin. If the convexity in this area is excessive, it will cause the margin to migrate apically. This area is termed the esthetic zone because it will influence the FGM position and its direct relation to the appearance of the implant restorations and surrounding tissue position.[14]

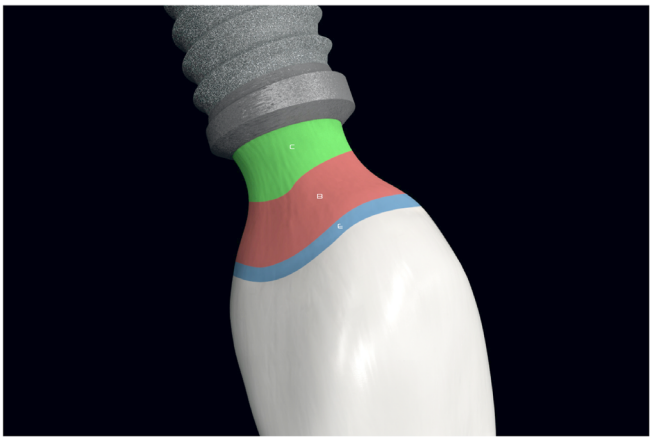

FIGURE 1 Front and lateral views of the esthetic biological contour zones of the emergence profile

2.2 | B zone: bounded zone (B)

In an ideally placed implant, which is 3–4 mm apical to the restorative zenith point, this area is apical to the E zone.[12] It is approximately 1–2 mm and is significantly affected by the quantity of the soft tissues and the implant position. If the tissues are deficient, a connective tissue graft may be required to enhance the gingival phenotype as well as promote crestal stability and an esthetic result.[16] Without a connective tissue graft, a convex design in this zone can help create the illusion of thicker tissues.[10,14] The B zone design is also influenced by the position and design of the implant neck.[12]

2.3 | C Zone: crestal zone (C)

The C zone is the 1–1.5 mm area located immediately coronal to the implant platform.[17,18] The abutment design in this area should be straight or slightly concave to avoid pressure on the hard tissues located adjacent to the restoration. The apico-coronal dimension can vary depending on the depth of the implant.[12] It is essential to understand that the supra-crestal connective tissue is present in this zone, and over contouring the provisional should be avoided to maintain the integrity of these tissues and prevent bone remodeling. Galindo Moreno has described the influence of vertical space from the implant connection to the initial convexity of the abutment.[19] The implant design, its width, and depth change the dimension of this area, making this the most variable zone.[20]

3 | IMPLANT DESIGN AND EBC ZONES

The implant design and depth can influence the design of the different zones, particularly the C zone, as some implant designs have incorporated this zone (Figure 3).

TABLE 1 The esthetic biological contour zones, Perio-prosthodontic characteristics

	Function	Design	Tissue	Histology	Length
ZONE E	Esthetic conditioning	Convex to provide support to gingival margin	Sulcular epithelium	Stratified squamous epithelium	1 mm
ZONE B	Biologic boundary area	Dependent on implant position and soft tissue thickness	Junctional epithelium	Non-keratinized epithelium	1–2 mm
ZONE C	Crestal bone stability	Straight	Connective tissue	Connective tissue	1–1.5 mm

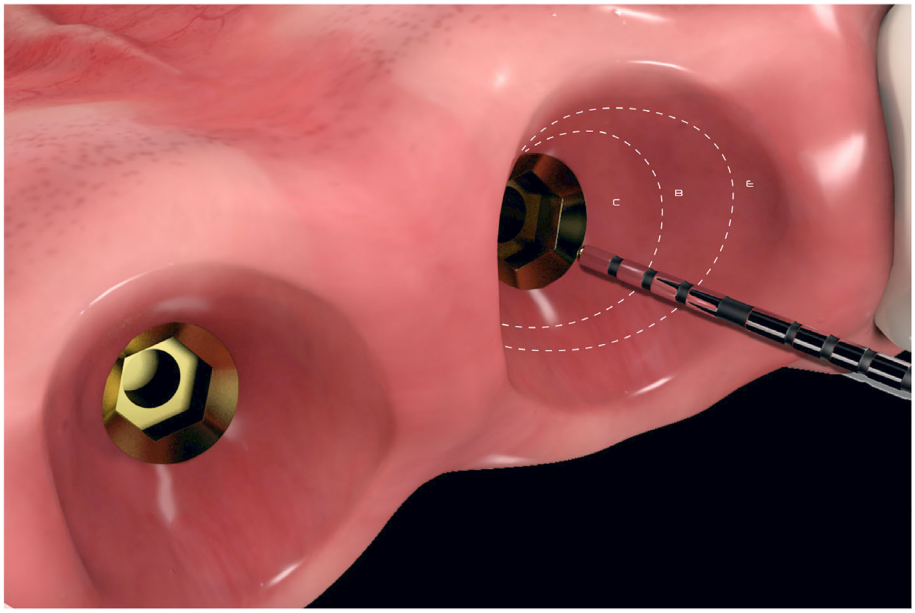

FIGURE 2 The esthetic biological contour zones: E. Sulcular epithelium. B. Junctional epithelium C. Connective tissue

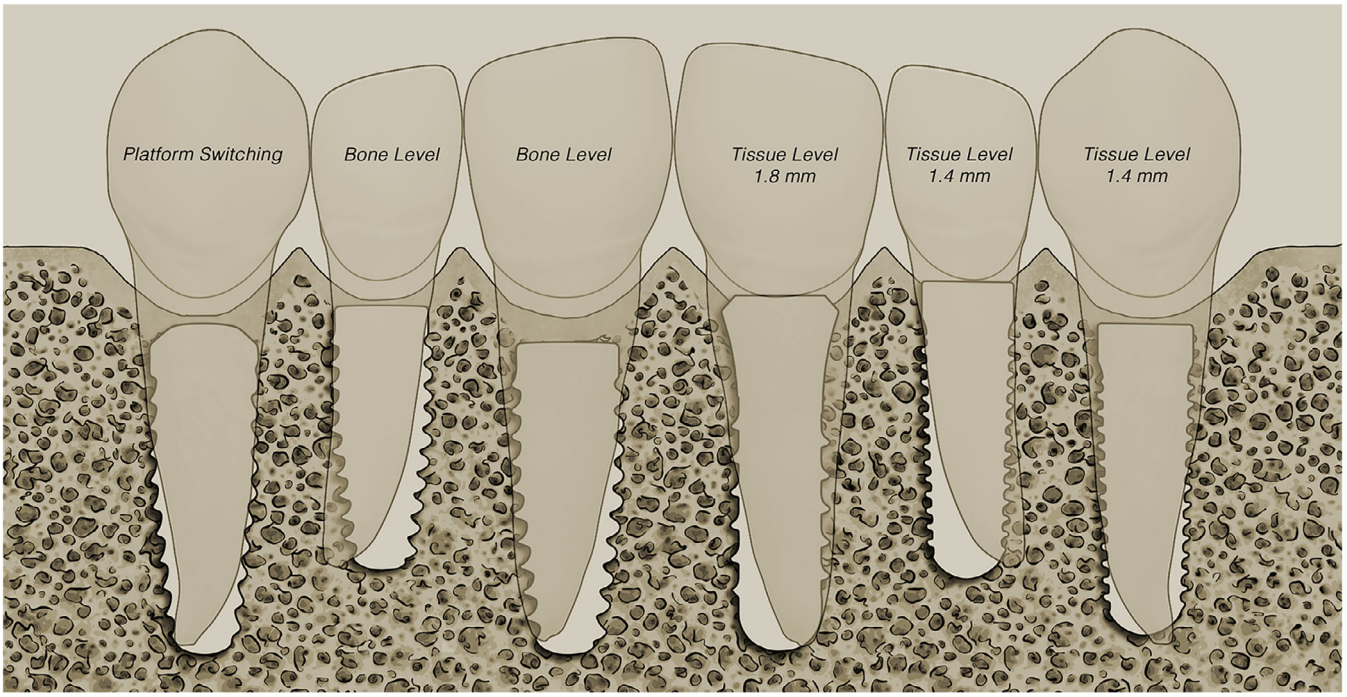

FIGURE 3 Schematic description of relation between implant design and position, and its influence on the esthetic biological contour zones

3.1 | Platform-switching implants

Platform switching may affect the shape of the EBC zones (Figures 4 and 5). This implant design has been associated to shorter "mucosal vertical dimension" than implants with conventional designs.[20] If an implant with this design is placed sub-crestally, an abutment with a longer C zone is recommended to allow it to emerge from the bone without generating undue pressure (Figure 6). This emergence design will also allow necessary space for the biological width to be reestablished (Figure 7). In narrow diameter implants, it may not be possible to have a very slim C-zone due to space limitations (Figures 8-12). Space availability for a platform switch design can directly influence the shape of the three zones. This is often seen in mandibular

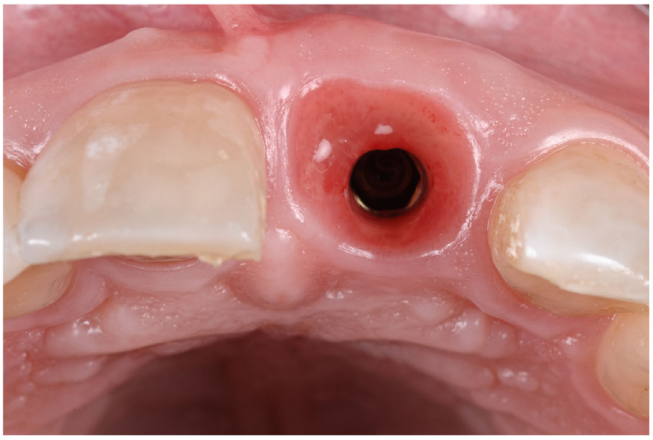

FIGURE 4 Occlusal view of emergence profile of a case with an implant with integrated platform switch

FIGURE 5 Emergence zones of a restoration on a platform-switched implant, notice the narrower portion in the C zone

incisors where the EBC zones are usually flat because of the limited available space (Figures 13-15).

3.2 | Bone-level implants

When a bone-level implant is placed 3–4 mm apical to the future restorative zenith point, a 1.5–2 mm C-zone design in the abutment is ideal. Convexities should be avoided in this area, as an over-contoured C-zone could increase remodeling of the crest to allow space for the establishment of the biologic width. This situation would lead to unesthetic consequences, such as, gingival recession or papilla loss.[21,22] Conversely, if the C-zone is undercontoured, it could lead to peri-implant soft tissue thickening.[23] Rompen and coworkers found that concave implant contours did not cause peri-implant tissue recession 2 years after final restoration delivery in 87% of the cases.[24] In delayed implant placement cases, the bone crest has a flat architecture allowing for a C-zone with a slightly increased flare, especially in molars, due to the increased interproximal distance.

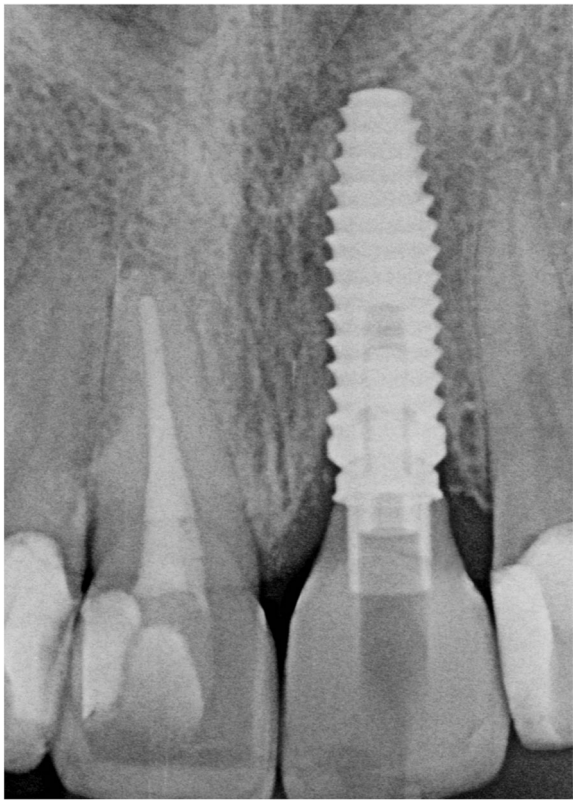

FIGURE 6 Radiographic view of the emergence profile on a platform-switched implant with a slim and straight C zone

FIGURE 7 Lateral view of proper emergence profile of the restoration on the maxillary left central incisor implant

3.3 | Supra-crestal implants

In clinical situations where a supra-crestal implant with a polished collar is used, a C zone design is not needed in the abutment as the implant design has this zone already built into its design. The polished collar of the implant is the C zone (Figure 16). These implants allow for a slightly shallow placement when compared to other designs. The biologic width around these implants is narrower as there is no

FIGURE 8 Preoperative intraoral view of patient requiring delayed implant placement

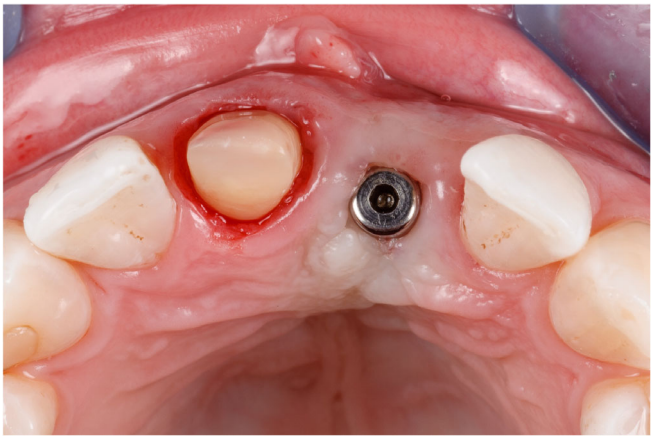

FIGURE 9 A narrow healing abutment can be used after placing an implant in a healed site or after a minimally invasive approach to access the connection of the implant following bone regeneration procedure. The site is gradually reshaped until the optimal emergence profile is achieved

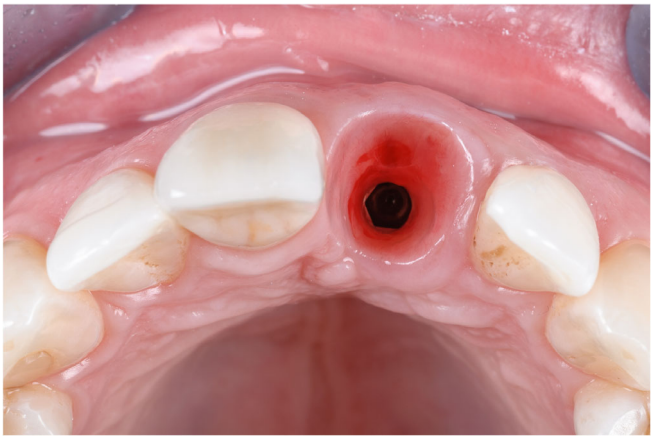

FIGURE 10 Ideal emergence profile shaped through provisional restoration

FIGURE 11 Emergence profile of the definitive restoration

FIGURE 12 Postoperative view of implant-supported restoration

micro-gap in proximity to the bone.[25] The B-zone for supra-crestal implants should be straight or convex to help create a natural emergence from the tissues that emulates natural teeth (Figure 17).

3.4 | Soft tissue dimensions

Peri-implant and dento-gingival soft tissues have similar dimensions. The supra-crestal connective tissue area, junctional epithelium area, and a sulcular epithelium area measure combined approximately 3 mm.[26] These areas can be variable depending on implant design and depth (Figures 18-19).[20] However, the orientation of the connective tissues is different on teeth and implants. Unlike teeth, fibers do not insert onto the implant or abutment surface, but are oriented parallel and circumferential to them, creating a long epithelial junction with limited sealing ability (Figure 20).[27] It has been suggested to place the implants 2–3 mm away from the gingival margin to avoid bone crest remodeling.[28] However, the implant depth should also be determined by the implant design as the biologic width formation is associated with the relation between the implant and the bone crest.[29]

Placing an implant more than 3 mm sub-crestally may lead to bone remodeling beyond the implant-abutment interphase, which would compromise the stability of the peri-implant tissues.[30] From a horizontal perspective, it is suggested that the facial soft tissues should be thicker than 2–3 mm to avoid discoloration related to the abutment (Figure 21).[31,32] Ideally, implants should not be placed too close to the buccal plate.[15] If this happens, abutment designs with an increased concavity should be considered to minimize pressure on the tissues as well as additional mucogingival procedures to improve the phenotype of the soft tissues.[33-35] The interproximal emergence profile design should not be over contoured to avoid pressure on neighboring hard and soft tissues that may lead to pain, bone resorption, and subsequent papilla loss.[35] Conversely, concave or straight profiles in this area maintain tissue stability.[36-38] Both designs can be used for specific situations, but excessive flares should be avoided, especially in the anterior sector.

4 | DISCUSSION

Many efforts have been made to explain the adequate management of the emergence profile of implant-supported restorations to

FIGURE 13 Implant-supported restoration with a straight C-zone of a lower incisor due to the limited space

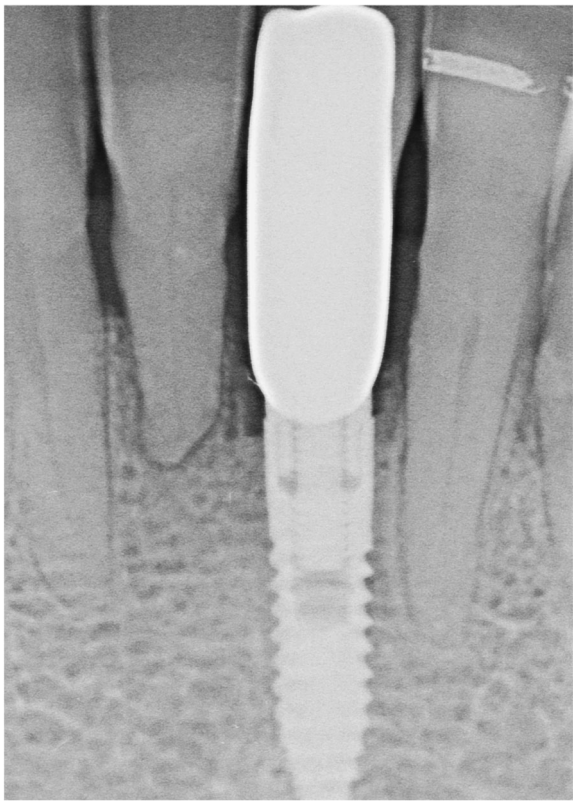

FIGURE 15 Radiographic view of implant-supported restoration

FIGURE 14 Intraoral view of implant-supported crown on lower left central incisor

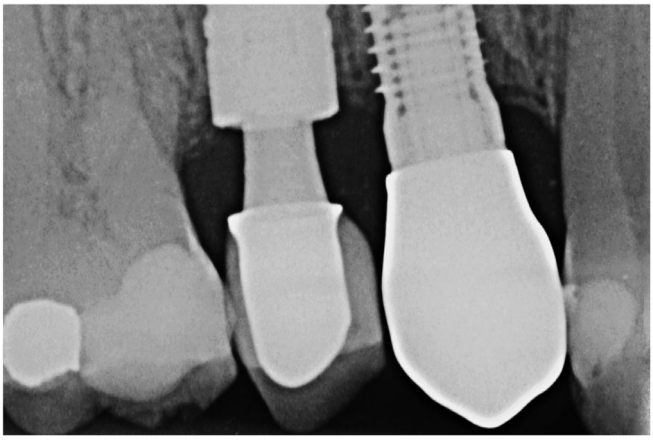

FIGURE 16 Radiographic image of the emergence profile design for a tissue-level restoration on a maxillary right first premolar implant. The polished collar replaces the C zone

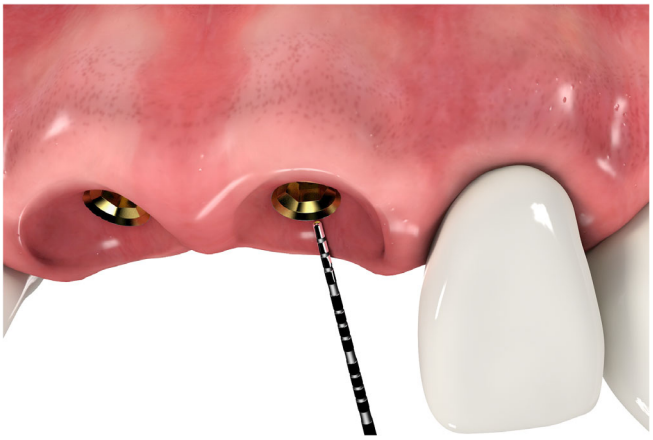

FIGURE 18 A shallow-placed implant reduces the space to develop an adequate emergence profile

FIGURE 17 Emergence profile design for a tissue-level implant restoration. The C-zone is already integrated in the implant design

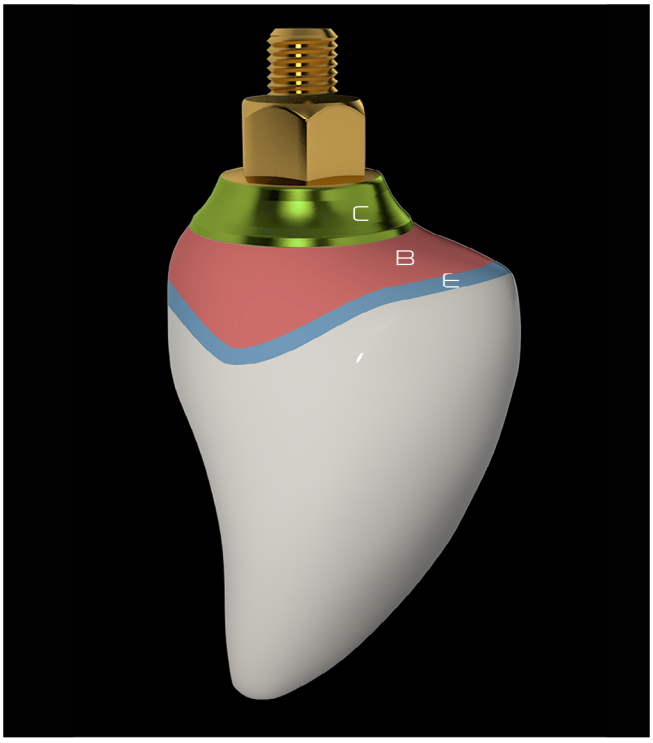

FIGURE 19 Emergence profile on a shallow implant. Note the emergence profile flat on the buccal side, turning the B zone into a horizontal surface. The C zone should remain straight from the connection of the implant, and the E zone should be convex to stabilize the gingival margin

maintain stability of the crestal bone and obtain esthetically pleasing results.[10,28] For the biologic width to reestablish itself around the neck of the implant without excess bone remodeling, adequate space is needed.[28] Implant position plays an essential role as it can alter the EBC zones. Inadequately placed implants will compromise the ideal dimensions on each of the zones, leading to changes in the peri-implant hard and soft tissues and affect the overall esthetic outcome.[12] Tissue thickness is also critical, more than 2 mm of vertical soft tissue thickness is needed to maintain crestal stability[21] and 2–3 mm of horizontal thickness are needed to hide the color of the underlying abutment.[31,32] Adequate restorations that shape and stabilize the peri-implant tissues are important to obtain a long-term stable esthetic result.[34,39] Proper tissue thickness helps protect the bone crest and allow the establishment of the biologic width.

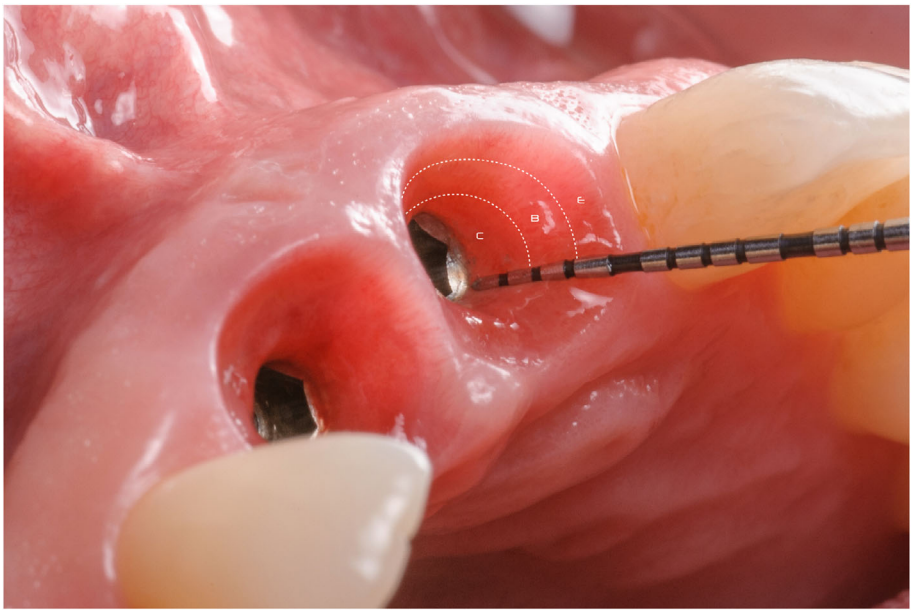

FIGURE 20 Clinical view of the esthetic biological contour zones

FIGURE 21 Clinical view of restorations with esthetic biological contour zones, which adapt to emergence zones in the tissue

FIGURE 22 Stable gingival outlines sculpted during the provisional stage

A convex shape of the emergence profile leads to an unstable result and may cause a gingival fenestration or recession because of the apical migration of the gingiva, especially in thin phenotypes. The E zone of the emergence profile is responsible for the final esthetic contour of the implant-supported crown (Figure 22). The profile of this area should be convex and always emulate the emergence of the contralateral tooth to project a natural-looking appearance. For this reason, the clinician must be careful to not over-contour this area to prevent apical soft tissue displacement. The B zone connects both the E zone and the C zone, and its primary purpose is to allow space for soft tissues. It has been suggested that the emergence profile of an implant should be concave if the implant is placed too far buccally and convex if it is placed palatally.[10] This approach might not be ideal if the site was previously grafted. In this situation, this zone of the EP should be concave and provide space for the soft tissues. A connective tissue graft to enhance the biotype should be placed in the site in case it is collapsed.[40] When a soft tissue graft is placed, the concavity of the B zone should be directly proportional to the amount of tissue grafted. This is even more important in an immediate implant site with a thin phenotype. The thickening of the soft tissues has been observed when the facial volume of the restoration is reduced.[41] The dimension of this zone can be changed after the healing period and modified periodically if necessary in case the clinician wants to compress the soft tissues to modify the papilla height or the facial contour of the restoration. The C zone, which is responsible for the crestal stability, has to be well designed and allow space for the soft tissues. A design with an excessive convexity will lead to crestal bone resorption, compromising the stability of the result as well as potentially precipitating mucositis or periimplantitis due to the increased pocket depth. The peri-implant tissue complex varies based on implant design,

FIGURE 23 Definitive restorations seated

FIGURE 24 Titanium base with a long cuff height on a narrow diameter bone-level implant to avoid pressure on the surrounding bone

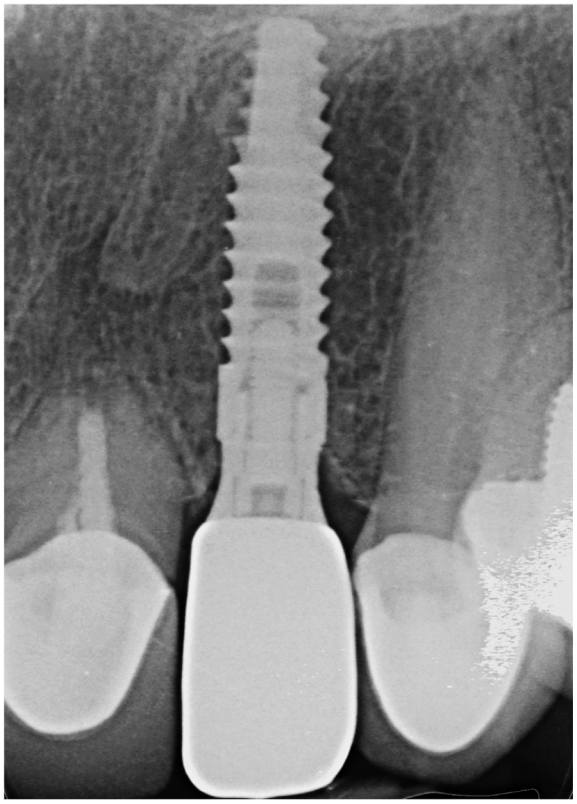

FIGURE 25 Radiograph of titanium base with restoration displaying space between the prosthesis and the bone

FIGURE 26 Patient with unrestorable maxillary left central incisor and facio-lingually-fractured crown on maxillary left lateral incisor

position, soft tissue quality, and the osseous structures, and it is impossible to standardize abutment designs for all cases[20] Therefore, each one of the different zones of the emergence profile has to be treated separately and with a custom design that fits the individual situation. The importance of the critical contour to achieve a natural esthetic result has been discussed before, but without distinguishing the two areas within the sub-critical contour or its relation to different implant designs.[14] As a consequence, the design of that area remains unclear for less experienced clinicians. The proposed EBC emergence profile zones simplify the understanding of adequate EP design to achieve optimal esthetic results as well as a biologically stable conditions reducing bone remodeling (Figure 23). It also aims to reduce future esthetic and biological complications. The E zone was previously described as the critical area and serves the same function, characteristics, and design.[14] The B zone is related to the soft tissue thickness and is very easily designed once the E and C zones have been established by joining the E and C zones with a straight or concave design. The C zone design should be straight and is relevant to maintain the bone crest stability. From a biological standpoint, the C area is the most critical and also impacts the esthetic result. Abutment height influences the stability of hard tissues around implants. Therefore, clinicians must respect soft tissue space in the C-zone, allowing for biologic width establishment and avoiding excessive crestal bone remodeling (Figures 24 and 25). The straight C zone design and the convex E zone design should be connected analogically or digitally through the straight or slightly concave B zone. It is ideal to create a concavity between zones C and B and a slight convexity when

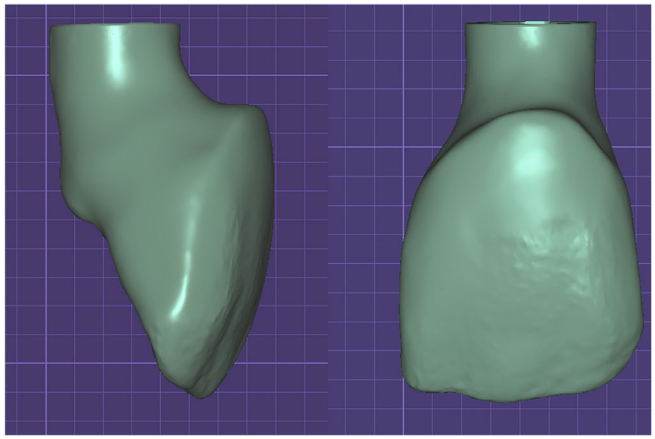

FIGURE 27 Digital design of the esthetic biological contour zones in interim restoration for a narrow diameter non-platform-switch implant

FIGURE 30 Frontal view of the esthetic biological contour zones in the final restoration of a narrow diameter non-platform-switched dental implant following provisional design

FIGURE 28 Milled polymethyl methacrylate (PMMA) interim restoration

FIGURE 31 Definitive implant-supported crown on the maxillary left central incisor and ceramic restoration on the maxillary left lateral incisor

FIGURE 29 Lateral view of the esthetic biological contour zones in the final restoration of a narrow diameter non-platform-switched dental implant following the provisional design

connecting zones B and E when soft tissue support and 3D position of the implant allow it. The modifications to the EBC zones should be made during the provisionalization stage. Even though much of the focus is put on the facial aspect of the emergence profile, the interproximal tissues may be affected by changes in the contours of these zones, and overcontouring must be avoided in all aspects of the restoration. With computer-aided design computer-aided manufacturing (CAD-CAM) (Figures 26 and 27), the emergence profile established in the provisionalization stage should be reproduced in the final restorations (Figures 28-31).

Understanding the different zones will allow for the design and fabrication of natural-looking emergence profiles that comply with the functional, biological, and esthetic requirements in modern implant therapy. These guidelines allow for esthetically and biologically sound results with both interim restorations and final abutments.

5 | CONCLUSIONS

Each of the zones described in the EBC concept have a specific function in the design of adequate emergence profiles in implant abutments. Understanding the importance and specific design features of the EBC zones and following the proposed guidelines facilitate esthetic and biologically sound treatment outcomes with both interim implant-supported restorations as well definitive implant abutments.

DISCLOSURE

DATA AVAILABILITY STATEMENT

Non-applicable

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