BUCCOLINGUAL IMPLANT POSITION AS A CONSEQUENCE OF THE ABUTMENT SHAPE
— A paradigm shift

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Introduction

Implant rehabilitation in the esthetic zone, especially in the upper arch, has always posed a number of challenges. Although high survival rates for implants in this region are well established, the new concept of success that involves soft-tissue integration depends on several factors. The pink esthetic score, white esthetic score and implant esthetic score1–3 are indexes usually used to evaluate the esthetic success of an implant rehabilitation. Many factors play an important role in the esthetic outcome of any implant-supported restoration. Among some of the major keys to success are an awareness of the possibility of sudden resorption of the buccal plate (bundle bone), along with accurate 3-D implant planning and positioning.

Many publications have addressed the problem of buccal plate resorption4, 5 and a recent literature review6 investigated the magnitude of dimensional changes in alveolar hard and soft tissue occurring for up to 12 months after tooth extraction in humans. The review found that, six months after tooth extraction, horizontal bone loss ranged from 29 to 63%, and vertical bone loss ranged from 11 to 22%.

If not promptly and correctly addressed, this phenomenon may compromise the final esthetic restorative result and even affect implant survival. Stability of the alveolar bone is paramount for maintaining the stability of the surrounding soft-tissue and guaranteeing a high level of esthetics over time.

Regarding implant positioning, several papers have offered guidelines regarding optimal 3-D positioning. However, since the most commonly used finishing line for restorative abutments is the horizontal type, guidelines for implant positioning have been conceived exclusively for that kind of geometry, but what if the abutment has a vertical rather than a horizontal finishing line?

The close relationship between the implant position, the abutment finishing line geometry, and the crown angles and contours is evident. The aim of this paper is, thus, to provide recommendations based on clinical evidence regarding the buccolingual implant position in the esthetic zone whenever a feather-edge (shoulder-less) abutment is chosen. In such cases, new guidelines should be taken into consideration to ensure a better soft-tissue response.
Implant position in the esthetic zone

The optimal implant position and diameter for the esthetic zone have been investigated extensively, with many authors proposing different approaches. Buser et al., attempting to identify the ideal implant position, stated that, in the mesiodistal dimension, the implant should be positioned no closer than 1.0–1.5 mm to the adjacent root surface(s); between two adjacent implants, the mesiodistal distance should be within 3.0 mm. However, when applying platform-switching, placement of implants closer than 1.5 mm to the adjacent tooth has been deemed acceptable and capable of maintaining the bone peak.

In the apicocoronal direction, Tarnow’s assumption that “a maximum of 5 mm distance from the alveolar crest to the contact point is necessary to obtain correct soft tissue esthetics in natural teeth” has been verified also for implants. Choquet stressed the importance of the apicocoronal position for preserving papillae and found in a retrospective study that, when the distance between the contact point and the bone was 5 mm, the papilla was present in 100% of the cases. More properly, the platform of the implant should be located 2–4 mm below the midfacial aspect of the free gingival margin. Bashutski and Grunder agree that, in the buccopalatal dimension, the implant should be inserted to preserve at least 2 mm of buccal bone.

Factors affecting mucosal recession around single-tooth immediate implants have also been evaluated in a systematic review. The authors suggested that, in highly esthetic cases, undersized implants should be selected and placed at the cingulum to enhance soft- and hard-tissue growth (Figs. 1a–c).

Importance of the biotype

One prerequisite for managing implant restorations in the esthetic zone is the presence of thick soft tissue surrounding the implant. Gingival biotype is used to describe the thickness of the gingival tissue in the faciopalatal dimension and it is classified into two main categories: thin and thick. The difference between the two biotypes is defined by the visibility of a periodontal probe through the gingival tissue: If it is visible, the biotype will be regarded as thin; if it is not visible, it will be classified as thick.

A study performed by Kan et al. analyzed the dimension of the periimplant mucosa around two-stage maxillary anterior single-tooth implants in humans after one year of function. The study showed a greater...
periimplant mucosal dimension in the presence of a thick periimplant biotype compared with a thin biotype.24

It has also been suggested that a direct correlation exists between gingival biotype and susceptibility to gingival recession after surgical and restorative procedures. There is agreement in the literature regarding the influence of soft-tissue thickness on implant survival and long-term success. Fu et al. have proposed an approach to increasing soft-tissue thickness through the esthetic triad and PDP management, in which “P” is the implant position, “D” is the implant design and “P” is the prosthetic design.15 They indicate as key factors the use of platform-switched or parallel-walled implants, more palatal and apical implant placement, and concave prosthetic designs to reduce periimplant bone and soft-tissue loss.

Abutment shape and contour

Working on the abutment shape and contour has been one of the present authors’ main tasks in recent years, with a specific focus on the portion of the abutment located below the gingival level. The implant–abutment contours can be divided into two separate portions: the critical contour (the area of the implant abutment and crown located immediately apical to the gingival margin) and the subcritical contour (located apical to the critical contour). These two entities will exist provided that sufficient running room (defined as the distance from the implant neck to the free gingival margin) is present. Both the critical and the subcritical contours, if properly modulated and shaped, may be used to modify the esthetic outcome of the restoration.16

As already summarized, to prevent buccal bone resorption, the literature suggests placing the implant at the cingulum of the future restoration14 or 1.5–2.0 mm palatal to the incisal margin of the central maxillary incisor.13 However, this approach can lead to problems that may jeopardize the esthetic outcome and the survival of the implant. For one thing, the crown contour created by such placement is substantially different from what exists in nature. In natural dentition, the tooth contour is basically formed by two separate entities: the emergence profile and the cervical contour.

Crown contour and emergence profile

The emergence profile is straight and corresponds to the part of the tooth emerging from the gingiva. The cervical contour is convex and located at the bottom of the gingival sulcus, corresponding to the area where the enamel overlaps the cementum at the cementoenamel junction (Figs. 2a & b). This convexity has been identified by Wheeler,17 who referred to it as the cervical ridge or cervical contour, and it has the function of holding the gingiva under definite tension.
The amount of this convexity is given by the value of the emergence angle (EA), which is defined as “the angle formed by the junction of a line through the long axis of the tooth, and a tangent drawn to the coronal of the tooth as it emerges from the sulcus”\(^{18,19}\) (Fig. 3). The EA was recently measured on natural maxillary extracted teeth\(^9\) and it was found to have a mean value of 15°.

In implant rehabilitation, the value of the EA and the convexity of the cervical contour are influenced by the buccopalatal position of the implant. The more palatal the implant placement, the greater the EA and cervical contour. Since the main task of the restorative dentist is always to make artificial crowns appear to be and function like a natural tooth, the artificially recreated angles and contours should be reproduced as closely as possible to nature.

**Changing the implant position according to the abutment shape**

For the past decade, the present authors have been working mainly with shoulderless abutments (both for implants and natural teeth). In doing so, it has become apparent that implant placement following the conventional guidelines often results in the fabrication of crowns with subcritical contours that differ greatly from those of a natural tooth. **Figures 4a–g** show an implant placed according to the conventional guidelines (i.e., at the cingulum of the future restoration) and restored using a shoulderless abutment. This resulted in a final restoration with an excessively convex EA that in the short term (one year) was already causing the surrounding soft tissue to react adversely.
Conventional guidelines for implant placement have been conceived and widely adopted for restorative abutments made with a horizontal preparation (shoulder or chamfer). However, as can be seen in Figure 5, placing an implant with a shoulderless abutment with a cingular (Fig. 5b) or palatal (Fig. 5c) position would lead to a crown with an EA and cervical contour far from the anatomical ones described by Wheeler and Du.\(^{17,20}\) However, when the implant is slightly more buccally positioned, as in Figure 5a, the EA and cervical contour look much more natural and physiological.

Whenever a shoulderless preparation is the geometry of choice, it is therefore advisable to change the position of the implant in a more vestibular direction, with the long axis corresponding to the incisal edge of the future restoration or of the adjacent teeth. This position will allow the creation of physiological crown profiles and angles closely resembling those of a natural tooth\(^{22}\) (Figs. 7–9).

Figs. 5a–c
(a) The long axis of the implant corresponds to the incisal edge of the future restoration, allowing a physiological EA.

(b) The long axis of the implant corresponds to the cingulum of the future restoration.

(c) The implant is placed more palatal, creating an unfavorable undercut that will make very difficult the cement removal.

Figs. 6a–c
(a) Failing implant-supported porcelain-fused-to-metal crown on tooth #26.

(b) Radiographic evaluation.

(c) The crown removed along with the implant. The presence of undetected cement was the reason for the failure.

Fig. 5a
The long axis of the implant corresponds to the incisal edge of the future restoration, allowing a physiological EA.

Fig. 5b
Cingulum of the future restoration

Fig. 5c
Palatal to the cingulum of the future restoration

Fig. 5a
Fig. 5b
Fig. 5c

Fig. 6a
Failing implant-supported porcelain-fused-to-metal crown on tooth #26.

Fig. 6b
Radiographic evaluation.

Fig. 6c
The crown removed along with the implant. The presence of undetected cement was the reason for the failure.
Figs. 7a & b
(a) Failing tooth-supported PFM crown on tooth # 21.
(b) Pre-op radiographic control.

Figs. 8a–c
(a) Digital planning of the implant surgery.
(b) The surgical guide made accordingly to the 3-D planning.
(c) Guided implant positioning through the surgical guide.
Conclusion

Whenever a vertical (shoulderless) preparation has been chosen for the definitive implant abutment rather than a horizontal (shoulder or chamfer) preparation, changing the buccolingual position of the implant is recommended, especially in the esthetic zone. The long axis of the implant should correspond to the incisal edge of the future restoration or of the adjacent teeth, assuming that 1.5–2.0 mm of the buccal bone can be maintained. This is the only position that enables fabrication of a restorative crown with a cervical contour resembling, as close as possible, what nature originally provided. It also eliminates problems with cement removal, greatly reducing the incidence of iatrogenic periimplantitis and making hygienic procedures much easier. Scientific data substantiating these observations are lacking. Therefore, randomized and prospective clinical trials are necessary.

Editorial note: A list of references is available from the publisher.