



COMMENTARY

The fate of the distal papilla around tooth-bound implant-supported restorations in maxillary central incisor sites

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Abstract

The distal papilla around tooth-bound implant-supported restorations in maxillary central incisor sites tends to exhibit an atrophied aspect after tissue maturation following the delivery of the final prosthesis. This article provides an explanation to this phenomenon, as well as a set of therapeutic considerations to minimize its occurrence and optimize the outcomes of tooth replacement therapy with dental implants in this specific anatomic location.

KEYWORDS

bone, decision making, dental implant, prosthodontics

1 | INTRODUCTION

Tooth replacement in the anterior zone with implant-supported restorations (ISR) can lead to excellent esthetic outcomes.¹⁻³ However, after tissue maturation following the delivery of the final prosthesis, the distal papilla around tooth-bound ISRs on maxillary central incisor sites tends to be shorter and less voluminous, exhibiting an atrophied aspect compared to that of the original interdental papilla. This was clearly illustrated in an article published in 2009 by Belser et al.⁴ In this study, out of a total of 45 maxillary teeth, 26 central incisors were replaced with an ISR. The esthetic outcome was evaluated at a variable time point between 2 and 4 years after delivery of the final prosthesis using a modification of the Pink Esthetic Score (PES) originally described by Fürhauser et al.⁵ The specific score for the mesial and distal papilla around ISRs placed in maxillary incisor sites was 1.84 and 1.30, respectively, being two the highest (most esthetic) possible score. To the best of our knowledge, a comprehensive and plausible explanation to

this phenomenon, as well as a set of clinical guidelines to minimize its occurrence, have not been provided to date.

2 | THE MYSTERY OF THE ATROPHIC DISTAL PAPILLA

A commonly wielded argument is that the vertical distance between the bone crest and the contact point between a tooth and a contiguous implant-supported crown primarily dictates the papillary response,⁶ in resemblance to reported observations around natural teeth.⁷ Conforming to this rationale, all papillae between teeth and ISRs should exhibit a consistent pattern of behavior in different interproximal locations. Therefore, the midline papilla, located between the ISR and the contralateral maxillary central incisor, should undergo a degree of atrophy comparable to the distal one. But this is not always the case as the distal papilla often exhibits a more depressed appearance in both the vertical and horizontal dimension (Figure 1). So, why



FIGURE 1 **A).** Initial clinical situation prior to initiation of tooth replacement therapy for the maxillary left central incisor. **B).** Clinical aspect of the restorative outcome at 12 months after delivery of the final implant-supported restoration. Using the reference lines, note the horizontal and vertical papillary atrophy. **C).** Periapical radiographs obtained at baseline and at the 12-month follow-up. Note the remodeling of the bone crest towards the implant shoulder. **D).** Lateral view of the papilla at the 12-month follow-up

does the distal papilla typically exhibit a more pronounced atrophy?

There are different etiologic factors that may play a role in the occurrence of this commonly observed phenomenon:

2.1 | Post-extraction healing dynamics

Understanding the sequence of biologic events that follow tooth extraction is essential to recognize tissue remodeling patterns and make substantiated clinical decisions leading to predictable therapeutic outcomes.^{8,9} Immediately after the extraction of a tooth-bound maxillary central incisor, the supracrestal soft tissue partially collapses because of the absence of structural support that was provided by the tooth (Figure 2). As the extraction site heals, a varying degree of bone remodeling also takes place, because of a local inflammatory response initiated by the surgical trauma and the absence of direct biomechanical stimulation of the alveolar bone proper.¹⁰ Notably, the facio-lingual dimension of the maxillary lateral incisor is typically narrower than that of the central incisor.¹¹ Additionally, the lateral incisor is usually located in a slightly more palatal position respective to the central incisor in a normally aligned dental arch. As bone remodeling occurs, the anatomical arrangement of the lateral incisor may lead to the palatal displacement of the interproximal alveolar bone crest and the establishment of a narrower facio-lingual dimension as compared to baseline, resulting in a horizontal depression of the papilla and negatively

influencing the appearance of volume (Figure 3). This event may not be evident in sites that undergo minimal interproximal remodeling or if the position of the lateral incisor relative to the central incisor is not palatal enough. It is also important to recognize the role of the facial bone thickness in post-extraction healing dynamics. As demonstrated in several clinical studies, the thicker the facial bone, the less bone loss that occurs after the healing period.^{9,12-13}

2.2 | Anatomic factors

In addition to the physiologic process of alveolar ridge remodeling that follows tooth extraction, some local anatomic factors may impact the morphologic characteristics of papillae between an ISR replacing a missing maxillary central incisor and its adjacent lateral incisor. Among them, the position and configuration of the cementoenamel junction (CEJ) are of paramount importance.

The CEJ is the location in the cervical region of teeth where the enamel and the cementum meet. Following a normal process of active and passive tooth eruption, the connective tissue attachment is established immediately apical to the CEJ. The papillary soft tissue adjacent to teeth is partly free (non-attached) and partly attached (Figure 4). However, around implants, the zone of connective tissue that is located apical to the junctional epithelium and coronal to the peri-implant bone does not attach to conventional transmucosal prosthetic components.¹⁴ Therefore, in absence of a history of attachment loss, the level of

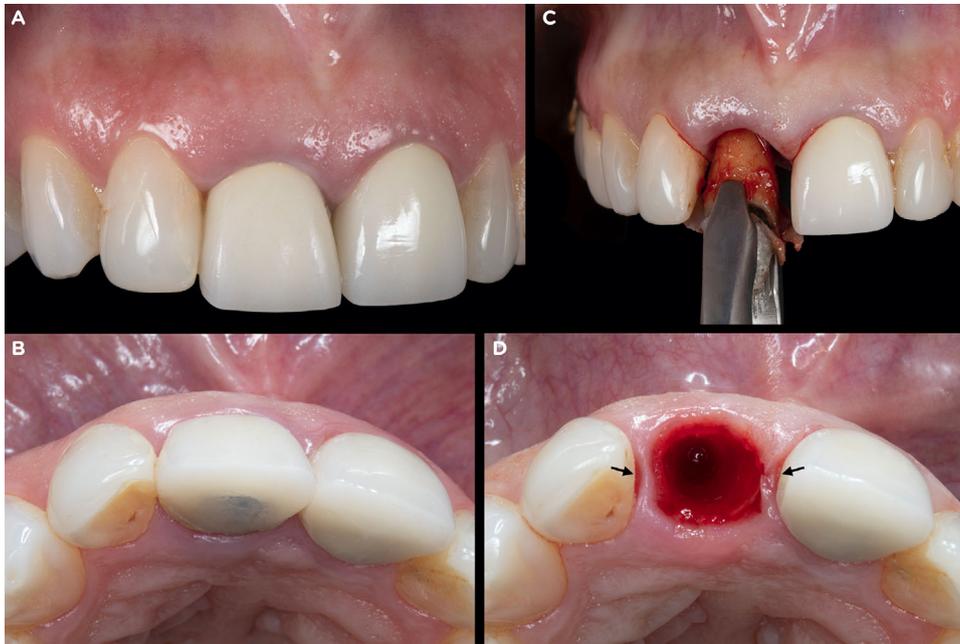


FIGURE 2 A) and B). Frontal and occlusal view of a hopeless maxillary right central incisor. C). Minimally traumatic extraction. D). Occlusal view of the site shortly after tooth extraction. Note the papillary collapse, as pointed by the black arrows

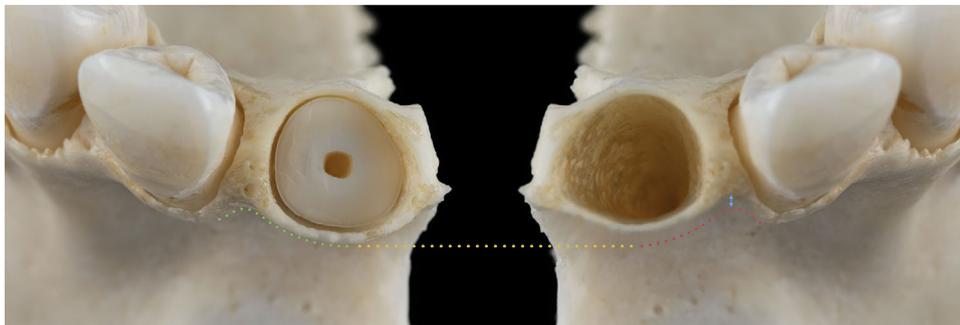


FIGURE 3 Left – Occlusal view of a dry hemimaxilla with the root of the central incisor in the socket. The green dotted line follows the facial contour of the alveolar ridge from the mesial line angle of the lateral incisor to the mid-facial aspect of the central incisor. Right–Mirror image depicting the facial contour changes that may affect the interproximal bone (illustrated by the blue arrow over the red dotted line) after extraction of the maxillary central incisor. The extent of alveolar bone remodeling varies from site to site and, therefore, it may not be clinically relevant in some scenarios. However, if it occurs, it can significantly influence the horizontal dimension of the interproximal papilla between the lateral incisor and the implant-supported restorations (ISR)

attachment of the papilla existing between an ISR and a tooth would be primarily determined by the position of the interproximal CEJ. It is also important to remark that, in the normal periodontium, the alveolar bone crest usually follows the contour of the CEJ at a distance ranging from 1 to 3 mm, depending on tooth type and cervical morphology. Interestingly, in a classic article published in 1953, Ritchey and Orban stated that “in the absence of periodontal disease, the cemento-enamel junctions are the deciding factor in the profile of the alveolar crests”.¹⁵

This information is fundamental to understand the role that the position and contour of the CEJ play on the clinical appearance of the papilla between a maxillary lateral

incisor and an implant-supported prosthesis replacing its neighboring central incisor. But why?

In many clinical scenarios, the position of the mesial CEJ of maxillary lateral incisors is located slightly apical to the distal CEJ of central incisors (Figure 5). Consequently, after physiologic remodeling of the interproximal bone crest following tooth extraction, the connective tissue attachment migrates apically respective to its original position, which was mainly determined by the presence of the central incisor. Furthermore, the interproximal contour of the CEJ of maxillary central incisors is generally more scalloped than that of lateral incisors, which often exhibit a less pronounced, more flat delineation. These

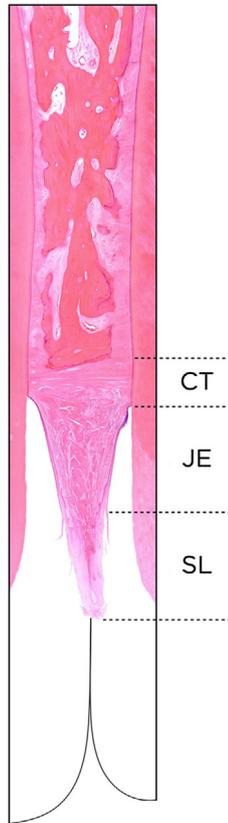


FIGURE 4 Histomicrograph of human histologic sample obtained post-mortem after mesio-distal sectioning of the interdental space between a central and a lateral incisor (Hematoxylin and Eosin staining). Lines were added to illustrate the approximate crown contour of both teeth (CT, Connective tissue attachment; JE, Junctional Epithelium; SL, sulcus epithelium)

anatomical features of the lateral incisor may determine the vertical dimension and contour of the interdental papilla upon tissue maturation. This phenomenon can be influenced by tooth morphology. For example, the distance between the zenith of the mid-facial and the interproximal CEJ is increased in teeth presenting a tapered or triangular morphology compared to square-shaped teeth.¹⁶

2.3 | Surgical management

When feasible, tooth extraction should be performed according to the principles of minimally invasive surgery to avoid structural damage to the supporting periodontal tissues.⁸ Alveolar ridge preservation therapy or ridge reconstruction, if a bone defect is identified, should be considered upon tooth extraction whether immediate implant placement is performed or not,¹⁷ in order to maximize the stability of the alveolar ridge architecture, which will contribute to preserve an adequate papillary anatomy.^{9,18} Additional horizontal and vertical soft tissue

augmentation for peri-implant phenotype modification may contribute to boost the esthetic outcomes.^{19,20} Whether immediate or delayed, implant placement in an unfavorable position can also influence the esthetic outcomes of tooth replacement therapy. Inaccurate implant placement can lead to the occurrence of distal papilla deficiency because of, for example, an excessively deep position of the restorative platform, which may induce severe saucerization and extensive peri-implant bone remodeling, and/or close proximity to the lateral incisor.²¹

2.4 | Prosthetic management

Immediate provisionalization using a full contoured restoration or a custom healing abutment with an adequate transmucosal configuration that leverages on the principles of the critical and subcritical contour can assist in the early manipulation of the peri-implant soft tissues to minimize the collapse of the distal papilla and optimize the final outcome.²² On the contrary, inadequate prosthetic management of the provisional or final restoration, including, but not limited to unfavorable transmucosal contour and crown design, may lead to constriction of the papillary tissue and a subsequent suboptimal outcome.

3 | ADDITIONAL THERAPEUTIC CONSIDERATIONS

The goal of tooth replacement via implant therapy is to achieve a satisfactory outcome that is compatible with long-term function, esthetics, and peri-implant health. A key aspect to obtain optimal esthetics is to mimic nature by minimizing the impact that tooth loss would have on the tissues that surround and support an ISR. As pointed out in previous sections, a meticulous baseline analysis of the anatomical features of the interproximal area between a maxillary central and lateral incisor, including the characteristics of the periodontal tissues and the configuration and position of the mesial CEJ of the lateral incisor, is germane to establish a solid treatment plan and set realistic expectations for patients interested in replacing a maxillary central incisor.

When the architecture of the papilla existing prior to tooth replacement is favorable, its maintenance should be a therapeutic priority. This can be achieved by proper evaluation, planning, and execution of the surgical technique and prosthetic work, including assessment of the periodontal status and characteristics of the mesial CEJ of the lateral incisor, adequate management of the extraction site, implant placement in a favorable position, implant provisionalization accounting for the principles of the critical



FIGURE 5 **A)** Composite image illustrating the relationship between the distal and mesial CEJ contour of maxillary central and lateral incisor, respectively. **B)** Sagittal view of a dry hemi-maxilla with the central incisor in its socket. Note the relationship of the contour of the cementoenamel junction (CEJ) and the crestal bone, as highlighted by the dashed line. **C)** Frontal view of another dry left hemi-maxilla with the anterior teeth in their sockets. Note the vertical discrepancy of the interproximal crest between the central and the lateral incisor, as shown by the white arrow. The dotted black arrow represents the minimum vertical remodeling of the interproximal bone crest expected after extraction of the central incisor

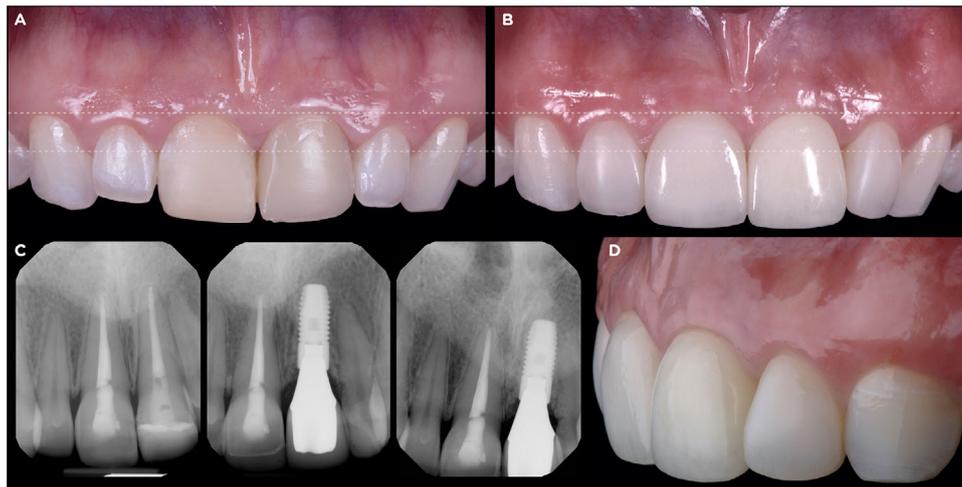


FIGURE 6 **A)** Frontal view of a hopeless maxillary left central incisor planned for replacement with an implant-supported prosthesis because of a vertical root fracture on the palatal aspect. **B)** Restorative outcome at 24 months after delivery of the final restoration. Using the reference lines, note the maintenance of the distal papilla. Composite resin restorations were made to increase the vertical dimension of the lateral incisors. **C)** Periapical radiographs obtained at baseline, prosthesis delivery and 24-month follow-up visit. Note the remodeling of the bone crest towards the implant shoulder. **D)** Lateral view of the papilla at the 24-month follow-up

and subcritical contour and a delivery of a final ISR with optimal structural design and esthetics (Figure 6).

On the other hand, papillary loss may occur because of severe interproximal attachment loss, either existing prior to or because of unfavorable post-extraction tissue remodeling, inadequate surgical, and/or prosthetic management, or a combination of them. In clinical scenarios of high esthetic priority in which there is significant attachment loss, a thin soft tissue phenotype, a marked gingival scallop associated to triangular tooth shape, and/or the position of the lateral incisor is disadvantageous, different adjunctive procedures may be performed prior to initiating or in the course of tooth replacement therapy in order to recreate a more favorable environment and minimize

the risk of papillary loss. This may include (a) orthodontic tooth alignment and/or forced extrusion with the objective of positioning the CEJ more favorably,²³ (b) soft tissue augmentation to modify the profile of the facial and interproximal tissue,¹ and/or (c) periodontal regeneration, if the configuration of an existing bony defect makes it feasible.²⁴

4 | SUMMARY

Atrophy of the distal papilla around ISRs in maxillary incisor sites is a commonly observed clinical phenomenon. Its incidence and extent may be influenced by post-extraction healing dynamics, the position and



contour of the CEJ on the mesial aspect of maxillary lateral incisors and/or inadequate surgical/prosthetic management. An exhaustive clinical (e.g, periodontal exam and bone sounding) and radiographic (e.g, complete mouth series and cone-beam computed tomography) analysis is the foundation to adopt effective therapeutic strategies that lead to predictably obtain satisfactory esthetic outcomes in the context of implant therapy. Further research is warranted to determine the prevalence of distal papilla atrophy around ISRs replacing maxillary central incisors, its correlation with different etiologic factors and the effectiveness of therapeutic strategies to minimize or avoid its occurrence.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest pertaining to the preparation of this article.

AUTHOR CONTRIBUTIONS

Oscar Gonzalez-Martin and Gustavo Avila-Ortiz conceived the commentary and equally contributed to the writing.

Both authors agree to be accountable for all aspects of the work.

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