Adjacent Implant-Supported Restorations in the Esthetic Zone: Understanding the Biology

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ABSTRACT

Traditionally, when considering adjacent implants in the esthetic zone, clinicians have encountered problems associated with deficient interproximal soft tissues. These discrepancies were often solved either by fabricating restorations with long interproximal contacts or by adding pink ceramics, both of which represent an esthetic compromise in today's demanding standard of care for restorative dentistry.

This challenge has led to the recent introduction of scalloped implants. An understanding of the biology of wound healing of bone and soft tissue around implants and the remodeling process with implant-supported restorations allows the dental team to offer patients an alternative restorative solution consisting of combining conventional flat prosthetic table implants and scalloped implants.

CLINICAL SIGNIFICANCE

This article illustrates the biologic behavior of wound healing associated with dental implants and shows a step-by-step clinical case in which a patient received four adjacent implants in the esthetic zone. It also describes key elements in laboratory communication when dealing with the aforementioned restorations.

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In contemporary implant dentistry, implant-supported restorations in the esthetic zone are considered successful only when an inconspicuous result is obtained. When evaluating the gingival interface, the soft tissues—the dentogingival angle, gingival level, and interproximal papillae—should mimic those of a natural tooth.

Extensive literature has detailed that whether between natural teeth or osseointegrated implants, the presence or absence of interdental papillae is dependent upon the interproximal bone. Predictable papillae are present when the distance between the crest of bone and the contact point is 4.3 mm, 4.5 mm, or up to 5.0 mm (depending on the study).[1–3] For single-tooth implant restorations, predictable interdental papillae rely on the adjacent natural teeth having adequate interproximal bone.[4–9]

Normally, implants are placed 3 mm apical to the gingival margin of the tooth being replaced to allow for an adequate emergence profile of the restoration. It is believed that the biologic width remodeling around an implant occurs apical to the implant abutment junction. The subcrestal mesiodistal placement of the implant in the maxillary anterior region occurs with all implants based on the midfacial tissue height. Because most available

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implants have a flat top, the midfacial position is the same as the interproximal position. Although the subcrestal biologic width remodeling around the implant undermines the interproximal bone, a normal attachment level at the tooth side maintains the bone level and the presence of a natural papilla. This is only true when the implant is not placed in close proximity to the root surface of the adjacent teeth.[10]

Biologically, the conventional implant staged approach typically depicts bone remodeling to the first thread, as seen in periapical radiographs. This may be due to the fact that from the time of cover screw removal, repeated assembly and reassembly of components such as healing abutments, impression copings, and final abutments lead to epithelialization (owing to rupture at the hemidesmosomal attachment) of the periimplant sulcus to the lowest level of these components. Once the epithelium is established, the connective tissue zone is created to separate the bone from the epithelium, which can only be achieved by a bone-remodeling process.

ADJACENT IMPLANTS

When two adjacent implants are placed, the biologic width remodeling process around flat prosthetic table implants generally does not support the papilla interproximally between the implants. In fact, the subcrestal formation of the biologic width around implants violates the interimplant bone because of lateral bone loss.[11] The lateral distance from the crest of the bone to the implant has been found to be approximately 1.3 mm on average.[12] In this scenario the interproximal bone generally remodels below the level of the implant abutment junction. The difference between the soft tissues surrounding teeth and implants indicates reduced blood perfusion to the periimplant tissue.[13]

A recent clinical study stated that the average facial dimension of periimplant mucosa placed in two stages is slightly greater than that of the dentogingival complex (3 mm).[7] However, it has also been reported that the volume of soft tissue that can be predictably generated coronal to the bone crest interproximally between implants is less than that between natural teeth, averaging 3.4 mm.[5] Although a distance of 5 mm from the contact point to the crest of bone would predictably generate a papilla between teeth, it would only provide a partial fill between implants. Therefore, controversy has existed regarding the placement of adjacent implants in the esthetic zone since the presence of the interdental papilla is highly unpredictable owing to the horizontal defect created by biologic width remodeling. Consequently, the distance between the osseous crest and the contact point is larger than the average values, and the interdental tissues are typically deficient.

Some authors have recommended a minimum interimplant distance of 3 mm to preserve an interproximal peak of bone that would support the interproximal papilla. However, further prospective, controlled, randomized clinical trails are essential to corroborate these average values.[14] For this reason, treatment planning the replacement of the maxillary four incisors with osseointegrated implants has become dubious, and a number of authors have advocated caution.[13–16]

Traditionally, when the four maxillary incisors were missing, the standard of care consisted of preparing the adjacent canines and fabricating a six-unit fixed partial denture. An alternative approach could be the placement of two osseointegrated implants in the position of the lateral incisors to have a four-unit implant-supported fixed partial denture.[17]

The problem pertaining to interdental tissue between implants in the esthetic zone has been addressed with the advent of the newly designed scalloped implant. It is believed that the advantage presented by the scalloped implant is the preservation of interproximal bone.[18]

CASE PRESENTATION

A 32-year-old patient presented with severe external root resorption on her four maxillary incisors (Figures 1–3). Treatment options were discussed, and it was decided to

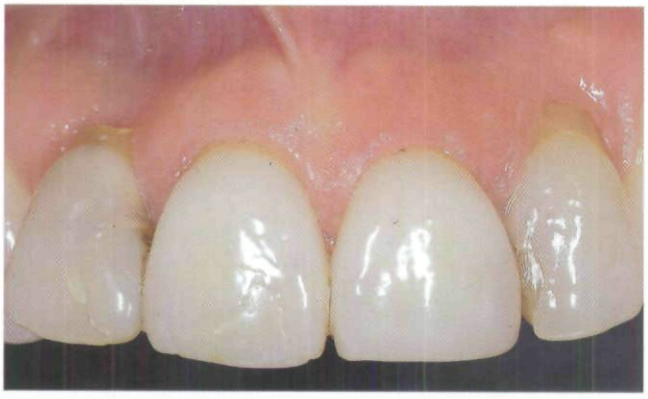

Figure 1. Preoperative condition. An aberrant gingival outline is evident.

proceed with the immediate placement of four osseointegrated implants following extractions and immediate function with a provisional restoration.

Considering the aforementioned concepts regarding the biologic behavior of the different available implant systems, it seemed feasible to replace both central incisors with scalloped-type implants (Nobel Perfect, Nobel Biocare, Yorba Linda, CA, USA). The lateral incisors would be replaced with conventional flat prosthetic table implants (Replace Select, Nobel Biocare). The scalloped implants on the central incisor region would support the interproximal papillae between the implants; for the distal aspect of the lateral incisors, the papillae would be supported by the canines' mesial bone.

It should be noted that a distinctive feature of the scalloped implant's configuration is the implant-abutment or crown-implant interface.

For conventional flat-top prosthetic table implants, the most commonly used prosthesis consists of an abutment (which is secured on the implant) and a cemented crown. A well-defined finish line contained by the abutment is established to cement the crown, creating a smooth emergence profile.

The apicocoronal placement of flat prosthetic table implants is 3 mm apical to the restoration's proposed gingival margin. The size discrepancy of the implant's diameter and the tooth's diameter at the gingival margin dictates how much vertical space is required. This usually entails the fabrication of a custom abutment that generates a smooth emergence profile. Its finish line follows the soft tissue scallop and is normally left 1.0 mm subgingivally to hide the abutment-crown interface and allow easier access for excess cement removal.

Conversely, with the scalloped implants, the abutment is secured

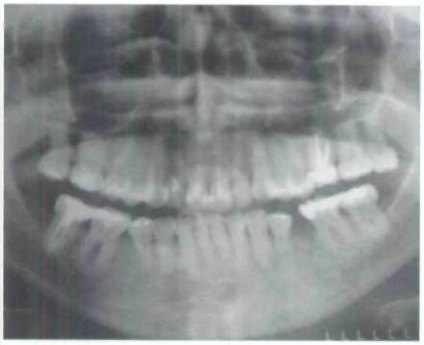

Figure 2. Panoramic radiograph depicting severe root resorption of maxillary incisors.

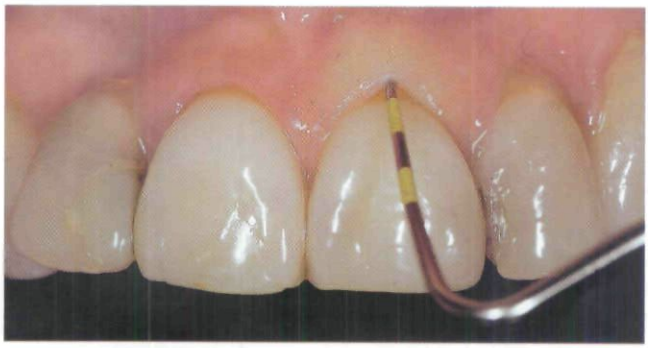

Figure 3. Bone sounding to establish the position of the bone crest.

in the internal portion of the implant in such a way that the most coronal portion of the implant becomes the finish line on which the crown is cemented.[18] Considering these differences, the apicocoronal placement of the scalloped implant (in an extraction socket) should not exceed 2 mm from the gingival margin to ensure the proper removal of excess cement at the time of final prosthesis delivery.

Implant Placement

A diagnostic wax-up was generated to fabricate a provisional restoration and a surgical stent (Figures 4–6). Following atraumatic extractions of the four maxillary incisors (Figures 7 and 8), a clear acrylic surgical stent was used to assist implant placement (Figure 9). The stent provided essential information: (1) incisal edge position (to provide proper angulation parameters) and (2) gingival margin (to provide the apicocoronal location).

Once the implants were placed, temporary abutments were secured on the fixtures and torqued (Figure 10). A provisional shell of autopolymerizing acrylic resin (Temporary Bridge Resin, Dentsply/Caulk, Milford, DE, USA) was relined and cooled with copious irrigation, and a vertical motion was exerted to prevent the provisional restoration from locking while the polymerization shrinkage took place. Once the acrylic had set, it was trimmed, polished, and cemented with a temporary agent (Tempbond, Kerr Manufacturing Co., Romulus, MI, USA) (Figure 11). The provisional restorations were left undisturbed for a period of 3 months to secure the osseointegration phase (Figures 12 and 13).

Impression Procedures

After 3 months the provisional restoration was removed along with the temporary abutments, and impression copings (Nobel Biocare) were secured (Figure 14). After radiographic corroboration of an adequate fit, an impression was made using polyvinylsiloxane material (Imprint, 3M ESPE, St Paul, MN, USA) to obtain a master cast (Figure 15). Alginate impression (Hydrogum Soft, Zhermack, Rovigo, Italy) of the opposing cast and jaw relation records were obtained.

It is essential to make an alginate impression of the provisional restorations for laboratory communication. Cross-mounting of these casts allows the ceramist to preserve fundamental esthetic parameters such as incisal edge position, tooth size, and midline.

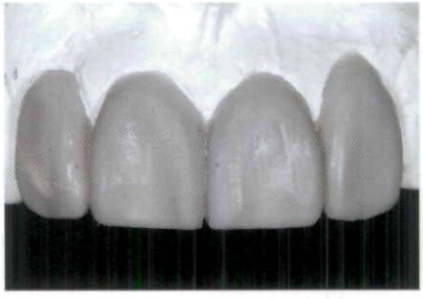

Figure 4. Diagnostic wax-up.

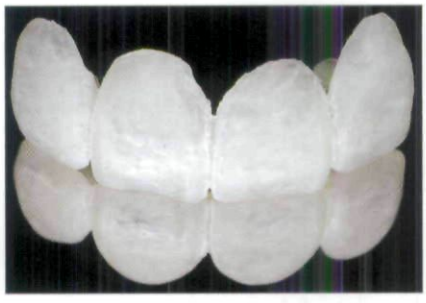

Figure 5. An autopolymerizing acrylic shell is fabricated.

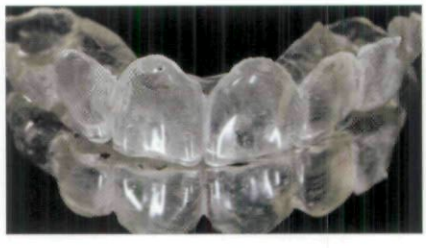

Figure 6. A clear acrylic surgical stent is fabricated.

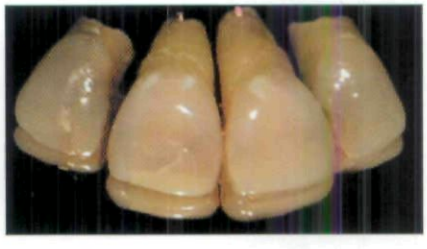

Figure 7. Extracted teeth showing severe root resorption.

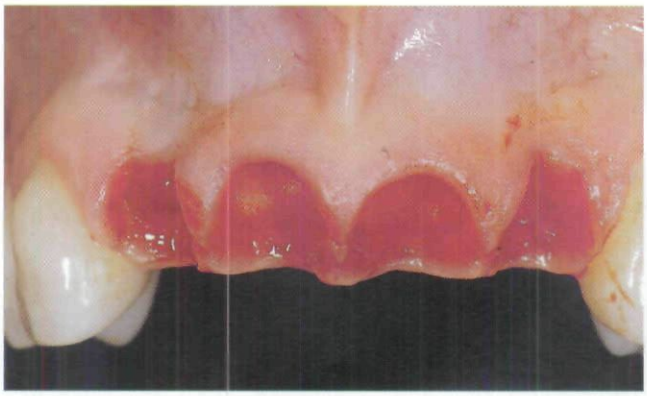

Figure 8. Extraction sites. Soft tissue was managed atraumatically.

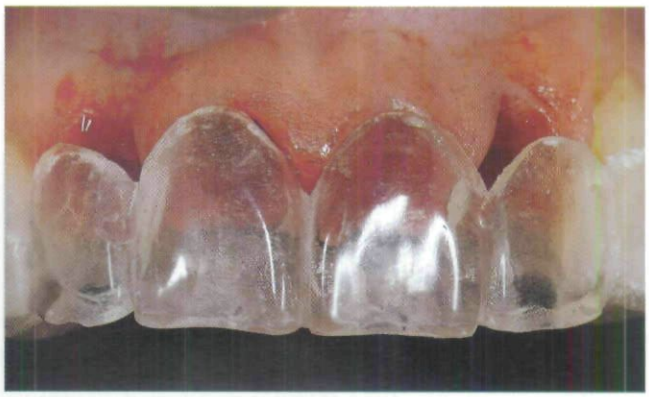

Figure 9. Surgical stent in place to assist during implant placement.

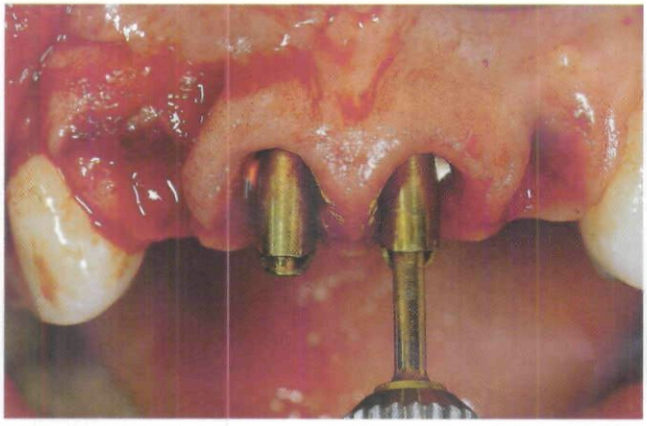

Figure 10. Scalloped implants are placed in the region of the central incisors, and the temporary abutments are secured in place.

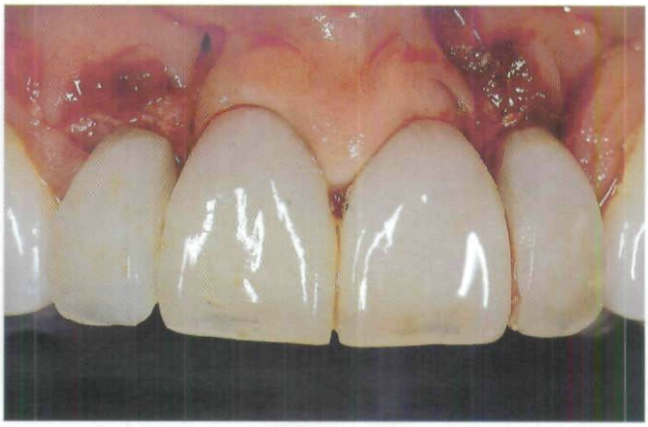

Figure 11. Following the placement of four temporary abutments, the acrylic shell is relined, trimmed, polished, and temporarily cemented.

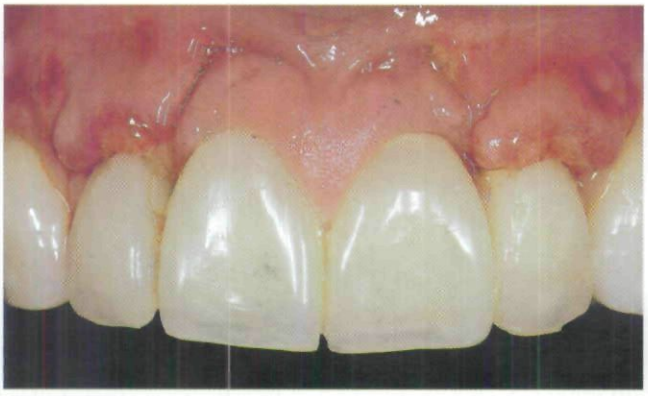

Figure 12. One week postoperatively.

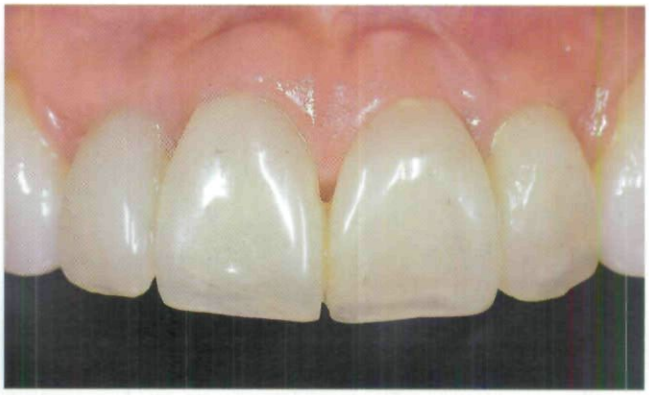

Figure 13. Three months postoperatively.

Definitive Prosthesis

Master Cast Fabrication. The impression was poured using a type-four dental stone (Fuji Rock, Fuji, Japan), and the master cast was obtained (Figure 16). The analogs (Nobel Biocare) were blocked with wax, and a silicone impression (Sil-tech, Ivoclar Vivadent, Schaan, Liechtenstein) was made to register the soft tissue topography (Figures 17 and 18). The gingival area surrounding the analogs was removed from the master cast, uncovering 50% of the laboratory analogs (Figure 19).[19]

The analogs were then blocked using orthodontic white wax (Figure 20), and the silicone matrix was positioned back on the master model with pink acrylic resin (Ortho Resin, Dentsply/Caulk) in such a way that the ridge was rebuilt with acrylic (Figure 21). Once a prototype wax-up was made on top of the rebuilt acrylic ridge, the gingival outline was marked with a pencil and the acrylic was scored to open the implant sites and establish an ideal emergence profile (Figure 22).

Abutment and All-Ceramic Crown Fabrication. Stock abutments were used for the central incisors, and computer-aided design/computer-aided manufacturing (CAD/CAM)-generated zirconium abutments (Procera, Nobel Biocare AB, Gothenburg, Sweden) were fabricated for the lateral incisors (Figures 23–27). Using a double-scanning technique, CAD/CAM-generated aluminous oxide copings (Procera, Nobel Biocare AB) were obtained (Figures 28 and 29) and the ceramic crowns were taken to completion (Rondo Ceramic System, Nobel Biocare AB) (Figures 30–33).[20]

Insertion. Following the removal of the provisional restoration and temporary abutments, the definitive abutments were secured (Figure 34). Once the fit was assessed radiographically, the abutment screws were torqued to 35 Ncm. The screw access holes were obliterated with a light-curing temporary restorative material (Systemp. Inlay, Ivoclar Vivadent, Liechtentein).

Starting with the central incisors (Nobel Perfect implants), the ceramic crowns were cemented using resin-modified glass ionomer cement. Care must be taken to

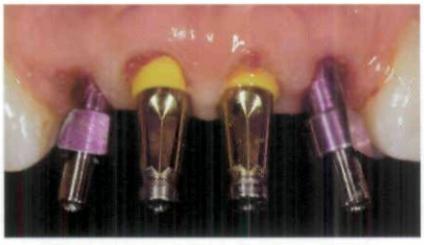

Figure 14. Impression copings are secured on the implants.

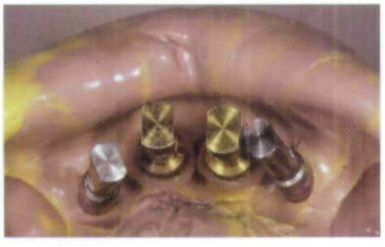

Figure 15. Analogs are secured on the impression copings in the polyvinylsiloxane impression.

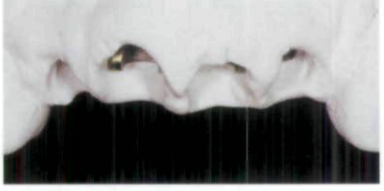

Figure 16. The impression is poured with type-four dental stone.

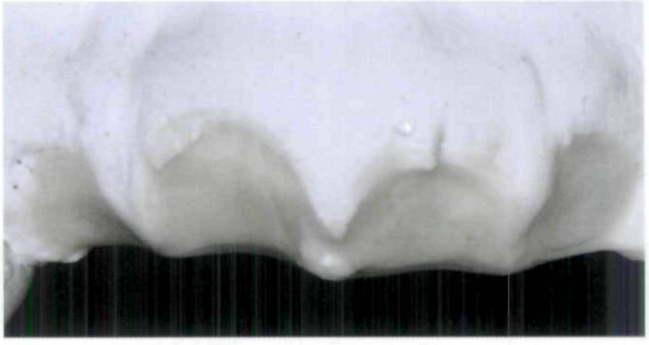

Figure 17. The implant sites are blocked with orthodontic wax.

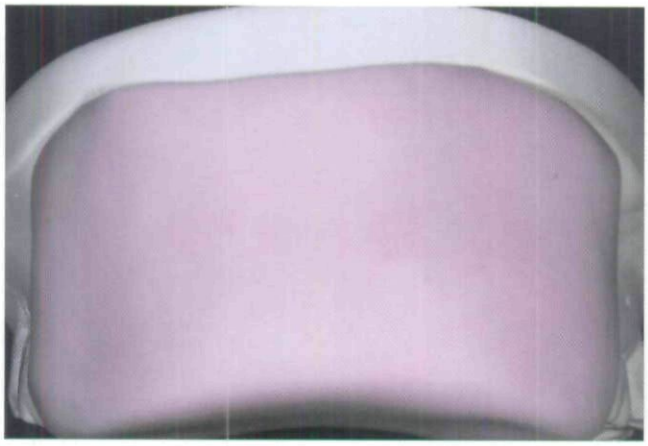

Figure 18. A silicone matrix is made of the blocked anterior ridge.

Figure 19. The anterior ridge is removed, leaving 50% of the analogs undisturbed.

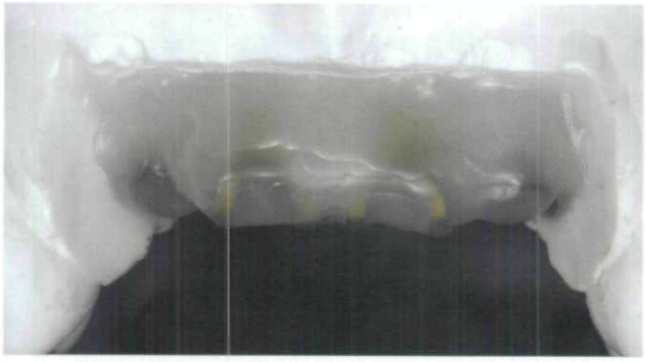

Figure 20. The analogs are blocked with orthodontic wax.

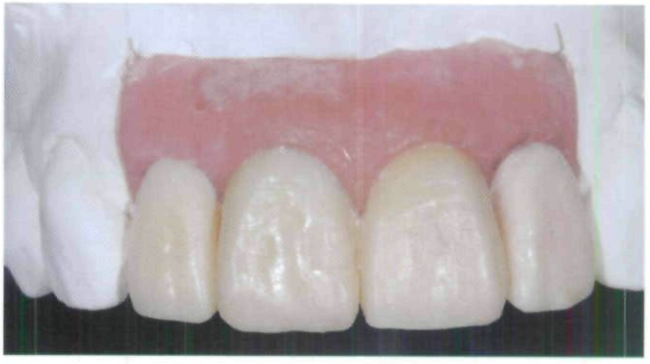

Figure 21. The ridge is rebuilt with pink acrylic resin, and a prototype wax-up is fabricated.

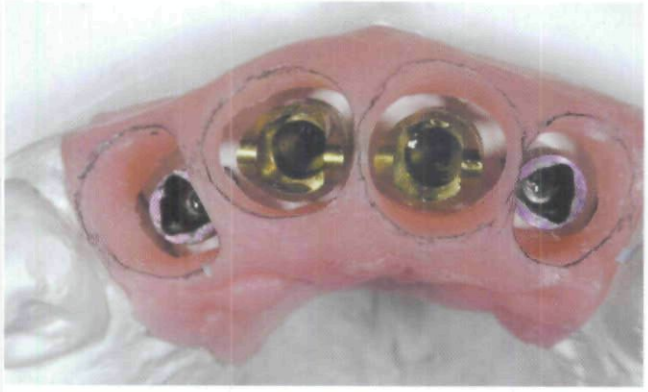

Figure 22. Once the gingival outline is marked, the acrylic ridge is scored to facilitate the creation of an ideal emergence profile.

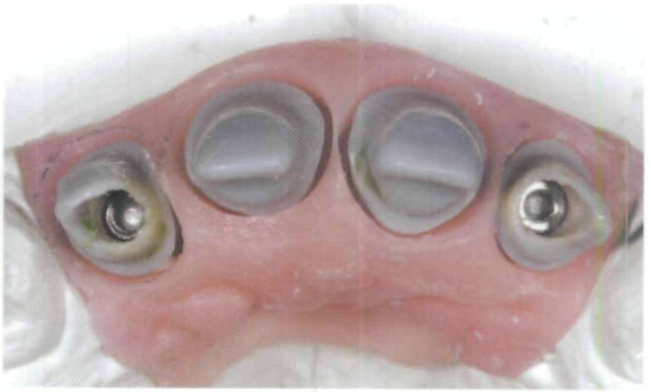

Figure 23. Occlusal view of wax-up for scanning the abutments on the lateral incisors and the copings on the central incisors.

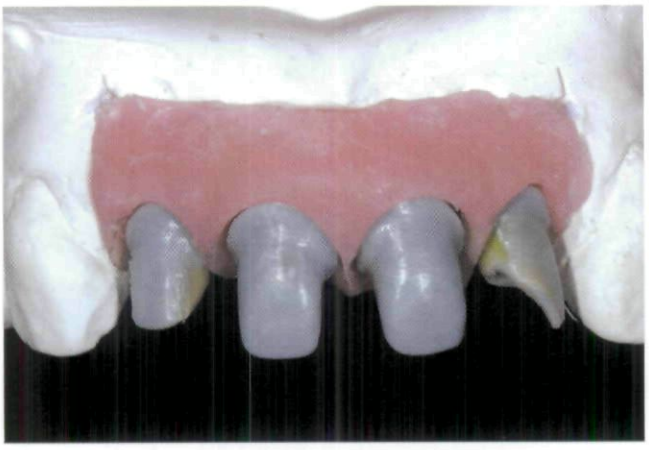

Figure 24. Buccal view of wax-up for scanning the abutments on the lateral incisors and the copings on the central incisors.

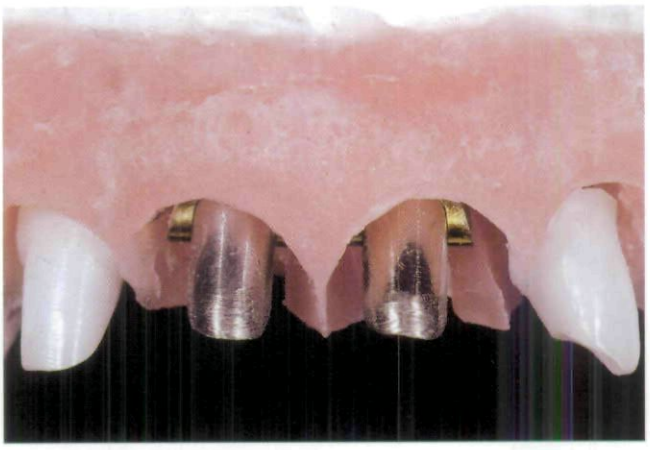

Figure 25. Buccal view of the abutments: stock abutments on the central incisors, zirconium abutments on the lateral incisors.

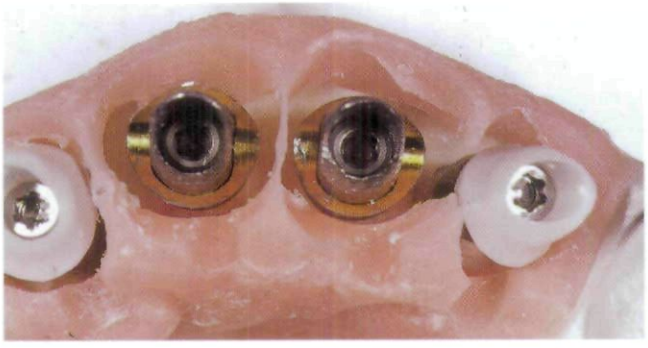

Figure 26. Occlusal view of the abutments: stock abutments on the central incisors, zirconium abutments on the lateral incisors.

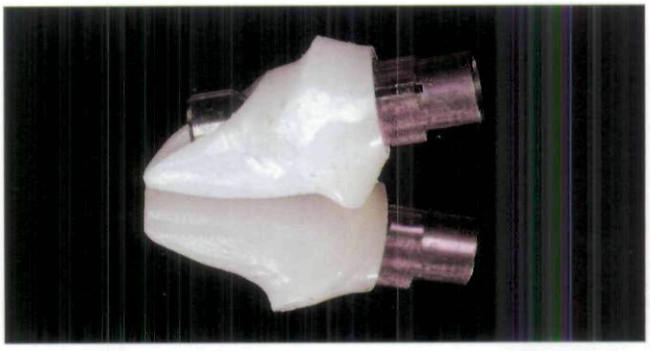

Figure 27. CAD/CAM-generated zirconium abutment.

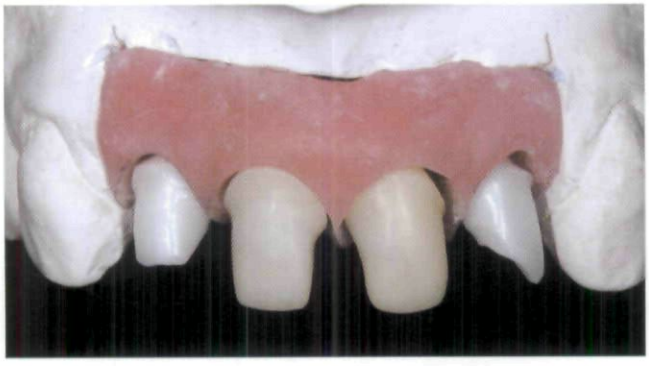

Figure 28. The aluminous oxide copings are CAD/CAM generated using a double-scanning technique.

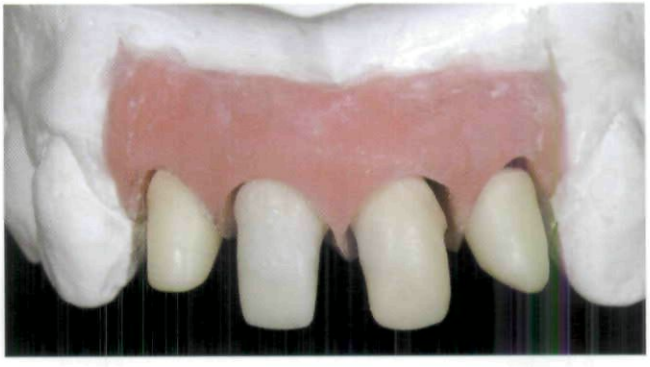

Figure 29. Aluminous oxide copings ready for ceramic layering.

ensure that all the excess cement is removed (Figures 35 and 36). The occlusion was adjusted.

The patient was given instructions regarding hygiene, and follow-up visits were arranged (Figures 37–40).

The patient returned for a 1-year follow-up clinical and radiographic examination (Figures 41–46).

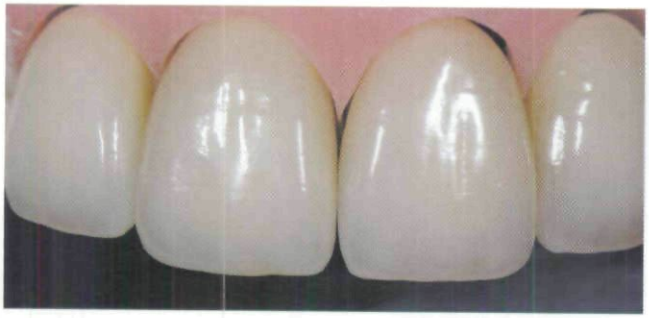

Figure 30. Buccal view of finalized all-ceramic crowns.

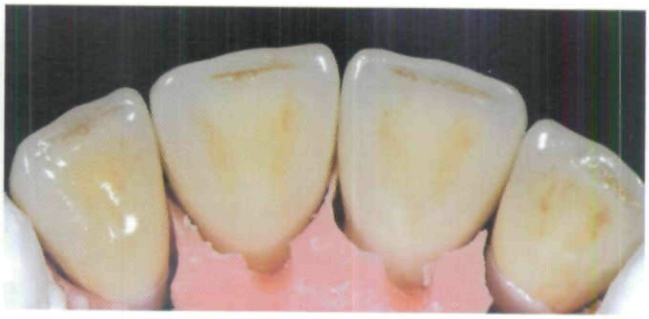

Figure 31. Occlusal view of finalized all-ceramic crowns.

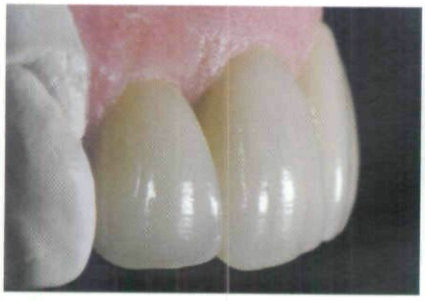

Figure 32. Sagittal view of finalized all-ceramic crowns.

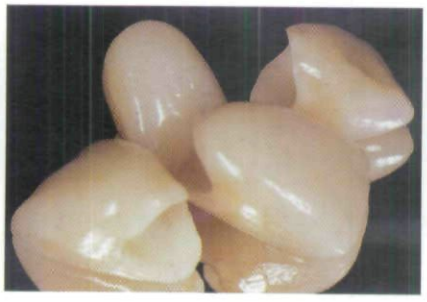

Figure 33. All-ceramic crowns ready for insertion.

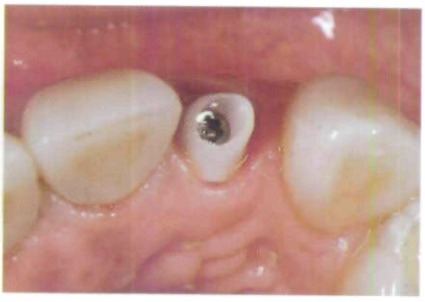

Figure 34. The abutments are secured on the implants.

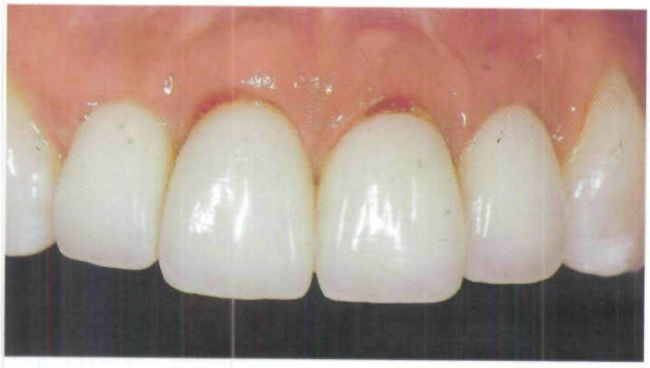

Figure 35. Once the crowns are cemented, excess cement is meticulously removed.

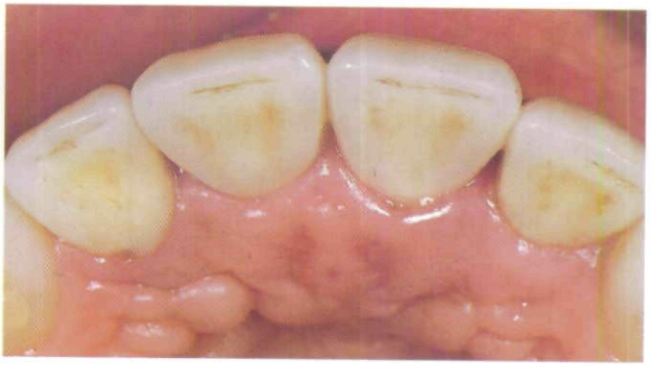

Figure 36. Occlusal view of cemented definitive restorations.

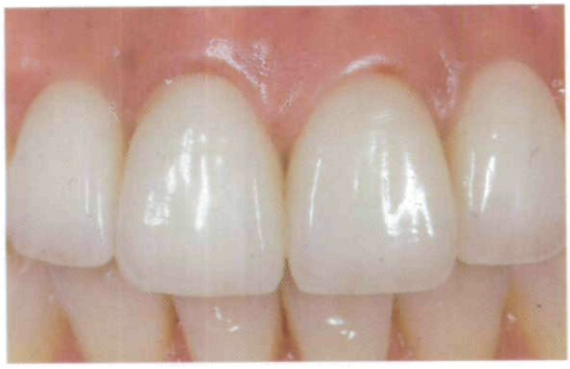

Figure 37. Definitive restorations 1 month postinsertion.

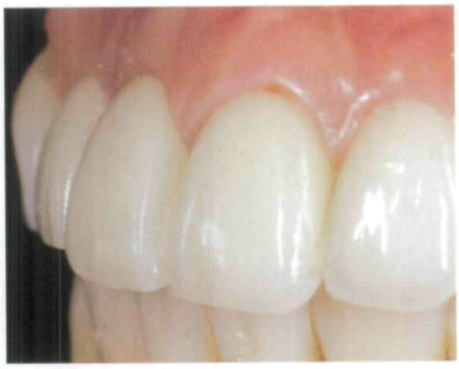

Figure 38. Sagittal view of all-ceramic implant-supported restorations.

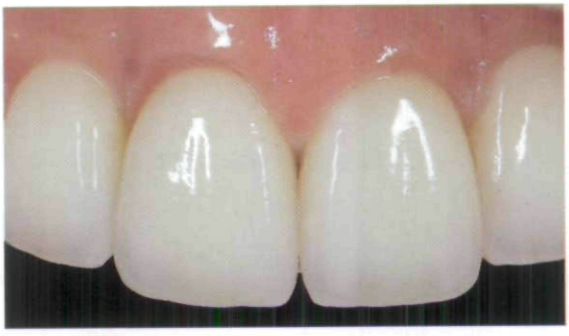

Figure 39. Three months postoperatively.

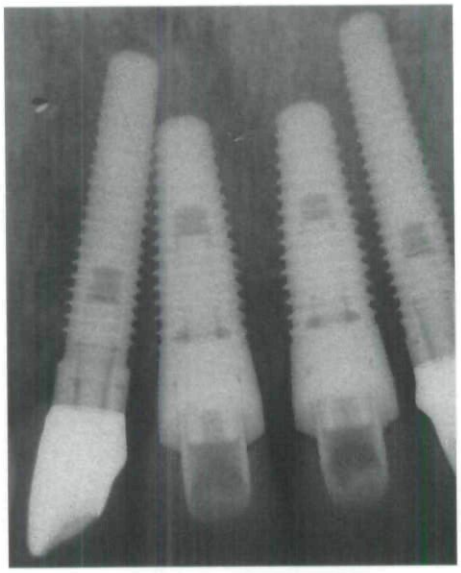

Figure 40. Radiographic view of definitive restorations.

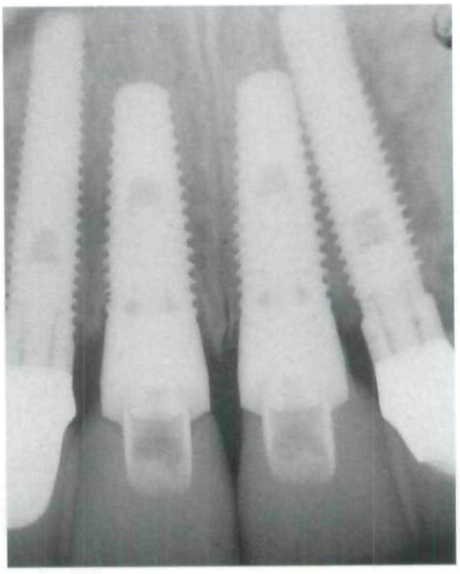

Figure 41. Radiographic image 1 year postoperatively. Interproximal bone peaks are evident between implants.

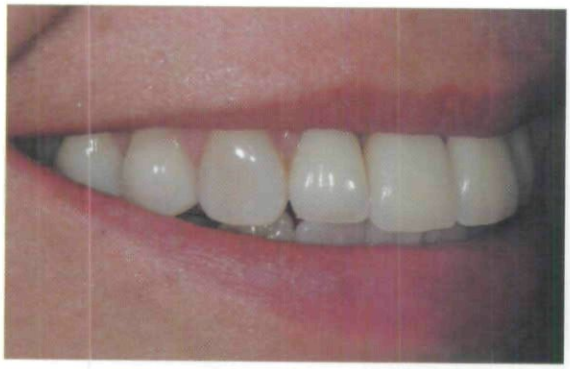

Figure 42. Dentofacial view 1 year postoperatively.

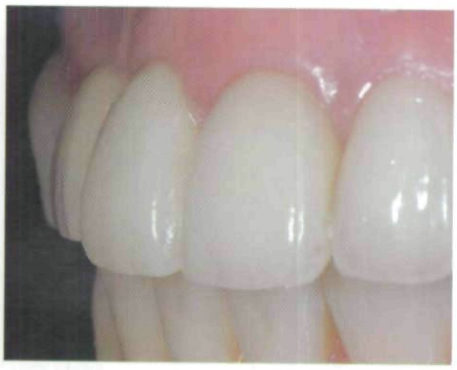

Figure 43. Sagital view of the dentogingival angle 1 year postoperatively.

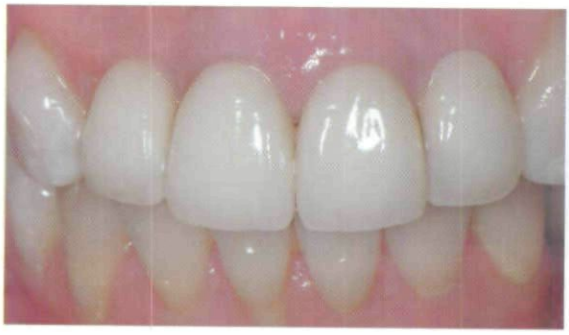

Figure 44. Dentogingival integration is evident 1 year postoperatively.

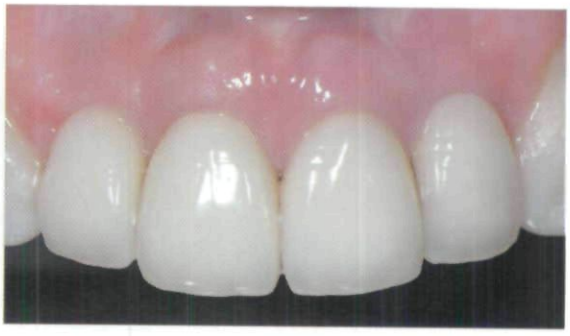

Figure 45. Soft tissue architecture has remained stable 1 year postoperatively.

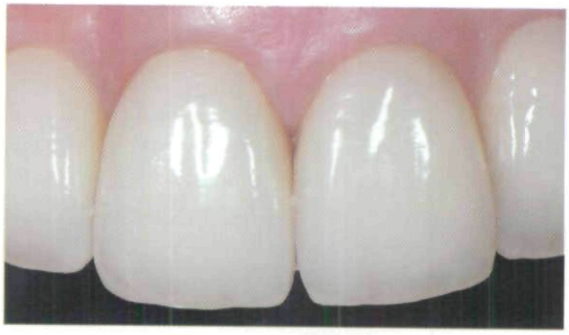

Figure 46. Close-up view of maxillary central incisors 1 year postoperatively.

CONCLUSIONS

To obtain optimal results when dealing with adjacent implants in the esthetic zone, care must be taken not only to ensure ideal three-dimensional placement of the implants, but also to use an implant system whose design preserves the interproximal bone to support the interproximal soft tissue.

An understanding of the biology behind bone remodeling allows for a combination placement of scalloped and flat prosthetic table osseointegrated implants, particularly in a

situation of extraction and immediate function.

DISCLOSURE

The author has been an occasional paid lecturer for Nobel Biocare.

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COMMENTARY

ADJACENT IMPLANT-SUPPORTED RESTORATIONS IN THE ESTHETIC ZONE: UNDERSTANDING THE BIOLOGY

Daniel Y. Sullivan, DDS*

Restoration of the maxillary anterior region with dental implants when multiple incisor teeth are missing has always presented esthetic challenges. Provisional therapy with removable partial dentures can result in rapid changes in soft tissues and interproximal papillae. Immediate loading of immediately placed implants has been introduced as an alternative technique but requires precise surgical placement with an understanding of implant stabilization and equally precise prosthetic control of occlusal forces and tooth contours. This article by Mitrani, Adolfi, and Tacher opens with a well-referenced discussion of implant biologic width and the resulting bone response to implant shape and apical location. It concludes

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with a well-conceived and beautifully illustrated presentation of the restoration of the four maxillary incisors with dental implants. The authors solve the potential problem of soft tissue changes under removable appliances with the use of a provisional fixed prosthesis that is immediately loaded on immediately placed dental implants. This case report benefits from proper patient selection as this patient's incisor teeth display extreme root resorption and most of the implant body is inserted into mature bone. Understandably, caution would need to be exercised if these circumstances did not exist.

The prosthetic treatment phase after the provisional restoration employs well-conceived, step-by-step controls to ensure appropriate final tooth contours. The laboratory sequence is exceptionally well documented and ideally executed to produce a beautiful end result for this patient.

One has to wonder about the inherent desire that seems to exist among restorative dentists to replace each missing tooth with a dental implant. It would seem that from standpoints of cost efficiency and technical execution (surgical and prosthetic), this alternative is more expensive and more complicated. As the authors explain, the other alternatives would be a conventional six-tooth fixed prosthesis or a four-tooth fixed prosthesis supported by two implants. The latter alternative would be more predictable for the majority of our less-experienced surgical and restorative colleagues. Certainly, the authors have demonstrated that in experienced hands, this elected treatment alternative can work beautifully over the short term using the new implant design they describe. This raises an inevitable question: will this treatment alternative using the new scalloped implant design hold bone in its initial position and thus support the interproximal papilla for many years? There are of yet no published long-term clinical studies that support the claims of bone maintenance over several years of observation.

Critical analysis of this case report and other similar attempts at adjacent incisor replacement demonstrate to me that the limiting factor is not the new technology, which in itself is well conceived, but the surgical execution of the implants being placed. Even in this beautifully completed case report, it appears that the patient's right lateral incisor implant could have been placed closer to the natural canine tooth root, thereby allowing a larger space between central and lateral implants. Greater distance between implants results in more bone to support the interdental papillae. This site, in particular, may be prone to long-term bone loss and papilla change.

The second area of necessary surgical expertise is placing the scalloped implant in an ideal apical location and, at the same time, predicting the intended subgingival location of the interproximal rise of the implant scallop design. The authors outline a protocol that states that one should not exceed a depth of 2 mm with the apical position of the scallop rise interproximally. Depths > 2 mm complicate the cementation of the final crown restoration, which seats directly on the implant shoulder and necessitates mandatory aggressive subgingival cement cleanup. This case demonstrates how difficult it is to correctly predict the final soft tissue height relative to the location of the apical scallop rise for cases of immediate placement, especially when a flapless surgical technique is employed and direct visualization of the scallop seating is compromised. The implant crown junction on the distal aspect of the central incisors appears well beyond the 2 mm that the authors suggest.

The concept of intentionally using two implant table designs to achieve anticipated long-term bone support is intriguing and well thought out by the authors. The surgical execution is really the key as space limitations are so imposing that small errors are magnified. The end result, photographed here at approximately 1 year after implant placement, is both beautiful and extremely promising. The proof, however, is in the pudding—in this case, the interdental tissues. Let us hope that these results continue to look this good at 3- and 5-year recalls. I look forward to a follow-up article by the authors.