Replacing hopeless maxillary incisors with adjacent implants via an integrative biologically oriented approach

Nitzan Bichacho[1] and Mirela Feraru[2]

Abstract

Achieving successful immediate implant placement in periodontally compromised sites requires that current biologic insights be translated to the modern clinical workflow. The clinical challenge increases in the case of adjacent implants in the smile zone and when the immediately placed implants are to be immediately restored. This article describes and analyzes state-of-the-art concepts and clinical strategies used to maximize key influencing variables to attain success with this treatment modality. These factors that are described in detail include: precise virtual planning for accurate guided implant placement, a flapless surgical approach, bone augmentation and soft-tissue enhancement of the deficient thin biotype, a "one abutment, one time" prosthetic approach for screw-retained restorations utilizing a novel implant system, and model-based cervical design for optimal restorative integration with newly created peri-implant mucosa. The combined digital and analog workflow demonstrates the use of current tools that enable clinicians to predictably perform such treatment in a controlled manner for the right indications.

When replacing a natural tooth with an implant restoration in the smile zone, strict biologic, functional, and esthetic criteria must be fulfilled in order to attain an artificial restoration that looks like a natural tooth and functions within healthy supporting tissues.[1-3] This endeavor poses a challenge given the fact that the mucosal structure around implant restorations is different biologically and physiologically from the supporting periodontium of teeth.[4-7]

The mucosa of a single implant between natural teeth is also supported by the periodontal apparatus of the adjacent roots, which contributes to the natural look of the papillae. However, in cases of adjacent implants the inter-implant papilla stands alone (with no Sharpey fibers originating from an adjacent cementum), thus its volume and shape is naturally reduced and altered.[8-12] Different clinical strategies have been proposed to partially overcome the esthetic limitations of immediately placed adjacent implants in the smile zone with varying degrees of success.[13-15] In addition to these inherent deficiencies, if the teeth to be replaced have bone loss and initial reduced periodontal support, the challenge to recreate the missing bone and soft tissues around the implant increases dramatically.[16]

Use of current cutting-edge technologies is essential in today's workflow to achieve predictable, successful biologic and esthetic results. These tools include 3-dimensional (3D) computerized planning, guided implant placement, minimally invasive surgical techniques, biologically oriented implant systems (comprising both the implant and the restorative components), augmentation concepts, and state-of-the-art materials and techniques. This article will describe an integrative strategy employing these tools to immediately replace and restore periodontally deficient, hopeless central incisors.

[1] Nitzan Bichacho, DMD
Expert Professor of Prosthodontics, Oral Rehabilitation Department, Faculty of Dental Medicine, Hebrew University Hadassah Medical School, Jerusalem, Israel; Member, Prosthodontics Department, Tel Aviv University School of Dental Medicine, Tel Aviv, Israel; Past President and Life Member, European Academy of Esthetic Dentistry; Team Member, Bichacho Clinic, Tel Aviv, Israel

[2] Mirela Feraru, DMD
Team Member, Bichacho Clinic, Tel Aviv, Israel; Affiliate, European Academy of Esthetic Dentistry

Figure 1: The maxillary central incisors exhibited gingival recession, "black holes," flat interdental papilla, dark roots, thin periodontal biotype, and an uneven gingival line with grade 3 mobility (clinically).

Figure 2: Periapical radiograph. More than 60% bone loss was noticeable. The four incisors were splinted due to excessive mobility of the centrals.

Case Presentation

A 60-year-old healthy male patient presented to the authors' clinic complaining about his maxillary central incisors. His chief complaint was an inability to chew on these teeth, and he sought a stable, functional, and esthetic solution. According to the patient, he underwent periodontal surgeries in the posterior areas due to periodontal disease some years ago. His upper front region, however, was never treated surgically, and crowns on the central incisors were more than 20 years old. He reported that a few years earlier he received a hard knock on his front teeth and noticed that gingival recession, as well as mobility, had developed gradually in more recent years. The mobility had become unbearable in the previous 2 weeks.

Clinical examination revealed two single crowns on teeth Nos. 8 and 9, exposed dark roots, mobility grade 3 on No. 8 and grade 2 on No. 9 (with obvious occlusal trauma), a thin periodontal biotype, gingival recessions, a flat interdental papilla, gingival "black holes," and an uneven gingival line (Figure 1). Probing depths ranged from 5 mm to 9 mm. The smile line was relatively low and exhibited the distal papillae of the involved teeth, but not the central papilla. Also, the cervical aspect of the crowns was not revealed during function.

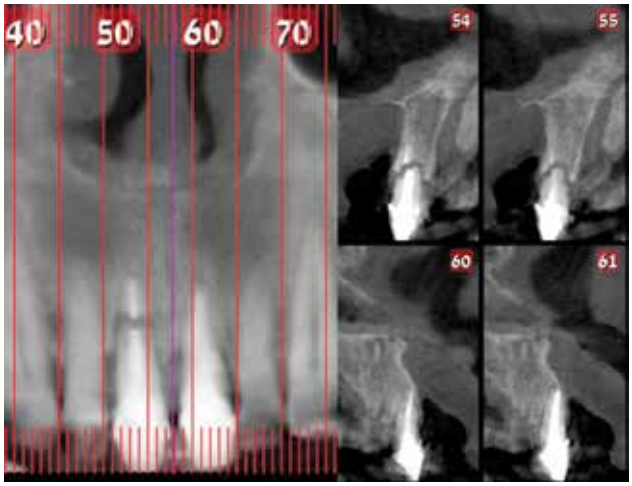


Figure 3: The CBCT depicted a horizontal root fracture at No. 8, considerable bone loss, and very thin or no labial cortical plates at both teeth.

Radiographic and cone-beam computed tomography (CBCT) images demonstrated more than 60% bone loss, horizontal root fracture of No. 8, and very thin or no labial bone plates (Figure 2 and Figure 3). Oral hygiene was good.

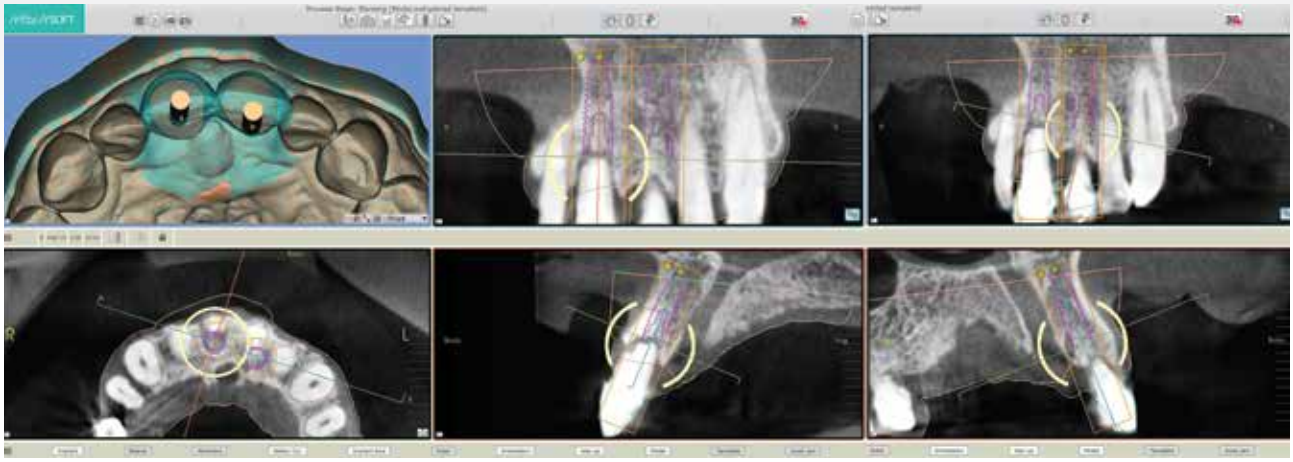


Figure 4: Virtual implant planning software. Implants positions were designed to engage maximum bone and allow for screw-retained restorations.

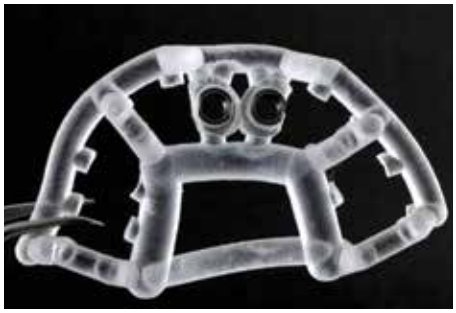


Figure 5: The surgical template was produced.

Figure 6: Teeth Nos. 8 and 9 were extracted in an atraumatic flapless manner.

Due to root fracture of No. 8, the severe bone loss of both teeth, their deep gingival pockets, and high mobility, the two teeth were diagnosed at the time with localized advanced periodontitis with occlusal traumatism with a hopeless prognosis. Clinical photographs were taken, both dental arches were scanned with an intraoral scanner (Trios® 3, 3Shape A/S, 3shape.com), and the four maxillary front teeth were splinted with composite resin until the surgical session.

Treatment Planning

After consultation with the patient regarding various restorative options for the treatment of missing central incisors, the chosen treatment plan was to replace the maxillary central incisors with fixed implant-supported crowns. The patient expressed a strong desire to minimize the number of treatment visits, and it was, therefore, agreed upon to remove the roots, place two implants, and augment the missing bone and soft tissue at the same operational visit. If the immediate stability of the implants allowed, immediate provisional crowns would be connected to the implants; if this was not plausible, a provisional resin-bonded fixed partial denture (FPD) would serve as an interim restoration. Definitive restorations would be produced 4 to 6 months after surgery.

The implant system used (V3, MIS Implants, mis-implants.com) was selected due to its excellent immediate stability features; triangular neck design, which allows for greater bone volume around the implant neck[17,18]; and its vast prosthetic arsenal. Also, the implant's 12-degree conical connection and component fit is conducive to enabling a strong mechanical connection and flawless seal.

The standard tessellation language (STL) file of the previously scanned arches was merged with the CBCT digital imaging and communications in medicine (DICOM) file in a virtual implant planning software (MSOFT, MIS Implants). Two implants were planned and virtually positioned (Figure 4) so as to maximally engage existing bone. At the time of treatment, this software was not operable with 16 mm implants, which were chosen for the case; therefore, two

Figure 7: Connect extension abutment. This 4mm diameter solid transmucosal abutment, in various heights, allows for rotation-free or anti-rotation suprastructure connection.

13 mm implants were virtually positioned 3 mm apically to the planned coronal plane to simulate precisely the actual 16 mm implants to be placed. The implant angulations were planned in a 3D position, which allows for the connection of screw-retained restorations. Whenever possible, the authors prefer non-cemented screw-retained restorations due to the well-established biologic and retrievability advantages.[19]

Because the gingival line at site No. 9 was initially at a more apical level than No. 8, the position of implant No. 9 was planned slightly more palatal than that of No. 8. This would allow more room for placement of augmentation materials, both hard and soft, buccally.

A surgical guide template (MGUIDE, MIS Implants) was manufactured accordingly (Figure 5). Both the resin-bonded FPD and splinted acrylic crown shells were prepared; one of these options would eventually be used based on the implants' primary stability at the surgery.

Surgical Treatment and Immediate Restorations

(To view a short video showing the main highlights of this clinical session, scan the QR code next to Figure 6.)

Figure 8: The 3mm height abutments connected to the freshly placed implants. The prosthetic platform was located 3mm to 4mm subgingivally and 3mm away from the implant heads. No. 9 was located more palatally to allow for more augmentation materials buccally.

Figure 9: Provisional restoration. Acrylic shells were connected chairside to titanium sleeves for screw-retained immediate provisionalization.

The patient was administered 1 gram of amoxicillin 1 hour before treatment. After local anesthesia infiltration, gentle intrasulcular incisions were made with a periotome. The roots were carefully extracted in an atraumatic flapless manner,[20-22] and the sockets were debrided (Figure 6). The surgical guide template was seated and fixed on the maxillary dentition, and the osteotomy sequence was performed through the titanium guide sleeves according to the recommended V3 drilling protocol.

For insertion of the implants, either they could be inserted through the sleeves or, as was done in this case (because at the time the guiding system was not suitable for 16 mm implants), the guide removed and the implants (3.9 mm x

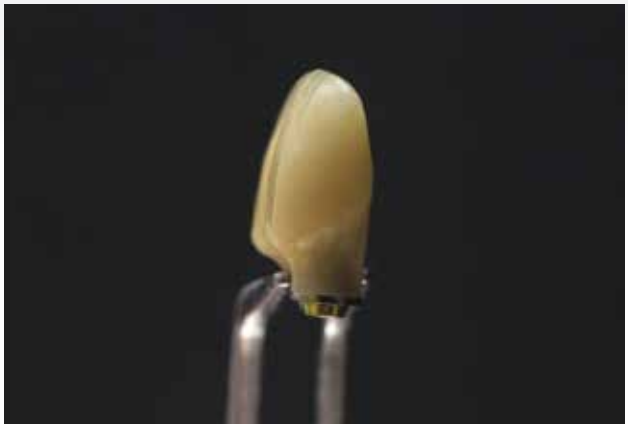


Figure 10: The cervical area of the provisionals was trimmed as narrow as possible.

Figure 11: De-epithelialized free gingival graft, harvested from the palate, was prepared.

Figure 12: Micro-knives were used to mobilize the soft tissues, creating a pouch for the graft.

Figure 13: Provisional crowns connected. A cross-suture at No. 9 pulled the tissue coronally.

16 mm) inserted freehand into the osteotomies. A primary stability of around 50 Ncm was achieved.

The implant drivers of this system have 3 mm and 6 mm markings to monitor the depth of the implant head in relation to the free gingival margin when placed flaplessly. As planned, the implant heads were positioned 6 mm apical to the existing free gingival margin, and a flat surface of the triangular neck of each implant was oriented buccally to allow for maximum space for the required augmentation.[23,24]

Immediately after implant placement, a solid transmucosal extension abutment 3 mm in height (Connect, MIS Implants) was connected to each implant and torqued down to 33 Ncm (Figure 7). This transmucosal abutment offers several benefits. First, because it is a solid one-piece unit there is no screw chimney that might allow for oral contaminants passing through to the abutment–implant junction.[25,26] When torqued down to 33 Ncm, this conical connection provides a perfectly hermetic seal with practically no micromovement between the abutment and implant and no microgap. The bone-level implant is actually transformed into a tissue-level implant where the prosthetic platform is away from the bone. Different available heights of this abutment allow for selection of the optimal prosthetic level in relation to the soft tissue regardless of the depth of the implant head. Furthermore, the narrow contour of the abutment allows for the connective tissue to heal and mature around it, providing an ultimate mucosal seal, and because the abutment is not removed after placement, repeated disruption of the soft-tissue seal during the prosthetic workflow is avoided. Finally, after the abutment is connected, the prosthetic workflow is kind to the tissue, painless to the patient, and easily controlled by the dentist.

Figure 14: At 4 months the peri-implant mucosa exhibited a healthy appearance and adequate volume.

Figure 15: Digital scanning of the restorative site.

Figure 16: Impression transfer copings connected to the abutments for traditional open-tray impression.

Figure 17: Ideal wax-up on the working model allowed for marking of cervical contours on the plaster.

The Connect prosthetic platform was now located 3 mm to 4 mm apical to the free gingival margin (Figure 8).

Because the initial stability of the implants allowed for immediate prosthetic connection, two titanium sleeves were screwed to the Connect abutments, and the acrylic crown shells were placed over them, loaded with fresh acrylic resin, allowed to set, and then removed. The provisional restorations were then finished, trimmed, and polished chairside in a traditional manner (Figure 9 and Figure 10). The cervical profile of the provisionals was trimmed as narrow as possible to avoid unnecessary pressure on the soon-to-be grafted surgical site.

De-epithelialized free gingival graft, harvested from the palate, was prepared (Figure 11). Mobilization of the soft tissue buccal to the implants, including the papillae, was gently performed with micro knives in a tunnel approach (Figure 12).

A combination of autogenous bone from the osteotomies and particulate bone mixture (70% allograft and 30% xenograft) was then gently packed around the implant necks; meanwhile, the Connect abutments were temporarily sealed with healing caps.[27-29] The connective tissue graft then was slid into the created pouch, between the abutments and the inner part of the gingiva. The graft was positioned so as to also support the bases of the papillae. A thicker graft was placed on top of implant No. 9. The soft-tissue grafts were secured in place with 6.0 polyglycolic sutures (Serafit®, Serag-Wiessner, serag-wiessner.de). Thickening the soft tissue, especially in thin biotype, allows for future stability of the healed and matured peri-implant tissues.[30,31]

The Connect healing caps were removed and the two splinted provisional crowns were screwed with a torque of 22 Ncm, and the screw openings were sealed. Then, an additional cross-suture was used to pull the tissue on top of No. 9 coronally and was anchored to the provisional crown with a composite resin (Figure 13).

The mandibular posterior teeth were temporarily built-up on their buccal cusps with composite resin stops to allow

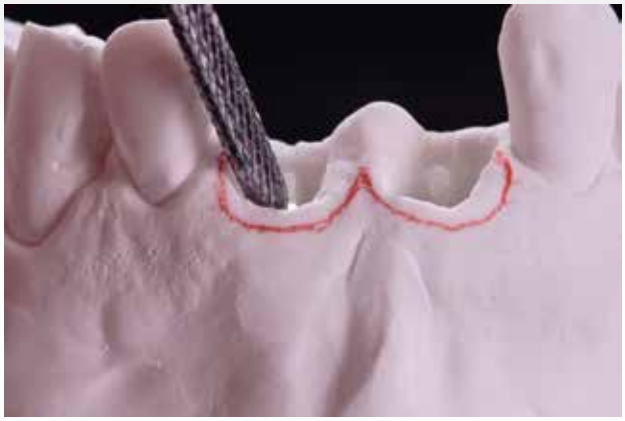


Figure 18: The tissue between the marking and the prosthetic platform was gently removed to allow smooth continuity of the cervical prosthetic site.

Figure 19: The peri-implant envelope was optimally designed.

Figure 20 and Figure 21: Definitive restoration. Splinted zirconia-based layered crowns were created (Fig 20) and connected to Ti-base sleeves (Fig 21) (Technician: Giuseppe Romeo, MDT).

temporary increase of the vertical dimension of occlusion to completely exclude any contact between the immediate implant crowns and their opposing teeth in all jaw positions and movements.

The patient received standard postsurgical instructions and one dose of 12 mg dexamethasone. He was instructed to follow an antibiotic regimen for 2 more days and to rinse his mouth three times daily with a chlorhexidine solution (Corsodyl 0.2% mouthwash, GSK, corsodyl.co.uk) followed by 0.025% hyaluronic acid solution (Gengigel® Hydrogel, Ricerfarma, ricerfarma.com) for 3 weeks. He was also instructed to avoid biting on his front teeth and consume a soft diet for 8 weeks.

Definitive Restorations

Four months after surgery the provisional restorations were removed revealing a healthy mucosa (Figure 14). Because the prosthetic platform is that of the Connect abutments (ie, 3 mm away from the implant head), all of the prosthetic steps can be executed without harming the biologic width that was created and organized during the healing period. As stated earlier, using such transmucosal extensions provides the flexibility of a two-piece implant system (eg, precise positioning according to the bone anatomy, implant submergence if needed, etc) with the advantages of a tissue-level implant, which include no abutment–implant microgap next to the bone (and, therefore, no bacterial colonization of the abutment–implant junction at the bone level), no micromovement close to the bone, no tissue disruption throughout the prosthetic workflow, and the ability to clearly view and access the implant in any region.[32-34]

The height of the extension abutment is chosen according to the clinical situation, and this can be replaced if significant tissue alterations occur. In this case, because the extension

Figure 22: Definitive restoration. Note that No. 8 had a non-engaged (free rotation) connection whereas No. 9 had an engaged (anti-rotational) connection.

Figure 23: Definitive restoration. The cervical profiles of the two crowns differed due to the different spatial positions of the prosthetic platforms.

abutments were never removed, the abutment also adheres to the desirable demand of "one abutment, one time."[35-37]

Impression of the Connect prosthetic platform and adjacent teeth and tissue can be made either by digital scanning (Figure 15) utilizing designated scan bodies or by traditional impression transfer coping (Figure 16) for open or close tray. The technician partner of the team in this case preferred the traditional analog method. (To view a brief video of the digital scanning of the restorative site, scan the QR code next to Figure 15.)

Cervical Contouring Concept:
A Model-Based Cervical Design

To create the ideal cervical contour of the definitive crowns, the cervical contouring concept was applied.[38-40] An ideal wax-up was duplicated on the working model, and the cervical crown contours were marked on the plaster (Figure 17). Then, the wax crowns were removed and the plaster between the marked line and the inner prosthetic platform was gently carved away (Figure 18). Thus, a smooth continuity of the cervical region, from the narrow prosthetic platform (4 mm diameter) to the wider diameter of the crowns as they emerge from the tissue, was achieved. Also, the inter-implant papilla was thinned and sharpened (Figure 19).

In this restorative concept, when referencing the traditional cervical part of an implant crown with its deep and superficial contours (also termed "critical" and "subcritical" contours, respectively[41]) the deep contour is composed of the pre-manufactured narrow Connect abutment, whereas the superficial contour is custom-made as per the cervical contouring concept. The modified cervical region in the model directs the design of the cervical contours of the crowns. When the crowns are connected intraorally the peri-implant mucosa will adapt to these optimal contours.

The definitive restorations in this case were chosen to be splinted zirconia-layered crowns (Figure 20) bonded to titanium sleeves (Figure 21). The sleeves of this prosthetic system can be either engaged or non-engaged. When multiple connected crowns are to be screw-retained, only one connection can be engaged, while the rest should be non-engaged in order to have maximal passive fit (although all of them could be non-engaged).

In this case, a non-engaged Ti-base combined together with an engaged one were chosen (Figure 22). The two cervical crown profiles differed due to the varying spatial positioning of the implants and the corresponding Connect abutments (Figure 23). The crowns were screw-retained at 25 Ncm, and the screw openings were sealed with an expanded polytetrafluoroethylene (ePTFE) plug (KWO, kwoptfe.de) and composite resin (Figure 24). A CBCT at this stage revealed acceptable bone and mucosal volumes around the implants and their abutments (Figure 25).

At 13 months recall, further maturation of the augmented tissue was obvious (Figure 26) and stable bone was noticeable in a periapical radiograph (Figure 27).

Conclusion

Immediate implant placement followed by immediate restoration is a demanding treatment modality[42] that requires

Figure 24: At 2 weeks the definitive crowns integrated well with the surrounding mucosa and teeth.

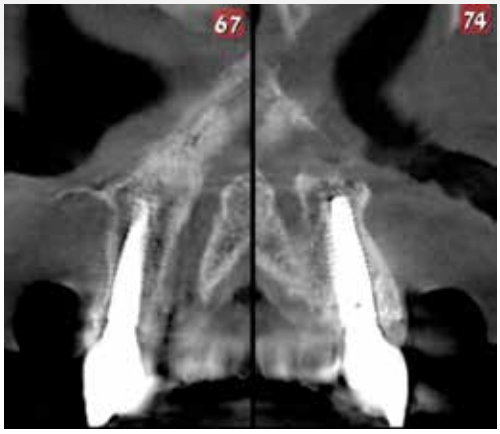
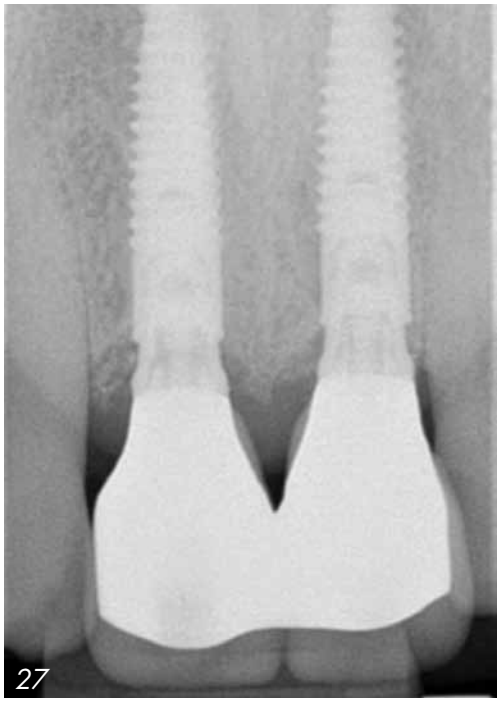


Figure 25: CBCT slices of the treated site. Adequate bone and mucosa surrounded the implants and abutments. No. 9 was positioned more palatally, allowing for more augmentation materials and thicker mucosa where the gingiva initially was deficient.

Figure 26: At 13-month recall, the mucosa was continuing to mature and grow, covering more of the crowns' cervical region.

Figure 27: Periapical radiograph at 13 months depicted stable bone next to the implants. Note the relationship of the implant heads, bone, and Connect abutments as well as the whole implants-restorative contours.



vast knowledge and experience and excellent clinical skills. A thorough analysis of the case, precise planning, and meticulous execution are fundamental for success, especially at the smile zone. Understanding the biologic and physiologic events following tooth extraction and implant placement is crucial to be able to choose the most suitable treatment strategy, techniques, materials (augmentation and restorative), and implant system (surgical, implant, and prosthetic components). Implementing this knowledge in an intelligent and rational clinical workflow increases the predictability for achieving healthy, esthetic, and stable results and a satisfied patient.

Acknowledgment

The authors thank the technician partner of the team in this treatment, Mr. Giuseppe Romeo, MDT, of Torino, Italy.

Disclosure

Dr. Bichacho is co-inventor of the V3 Implant System (MIS Implants) and declares a financial interest in this system. He is also a consultant to MIS Implants in Bar-Lev, Israel. Dr. Feraru has no financial interest in any of the products mentioned in this article.

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