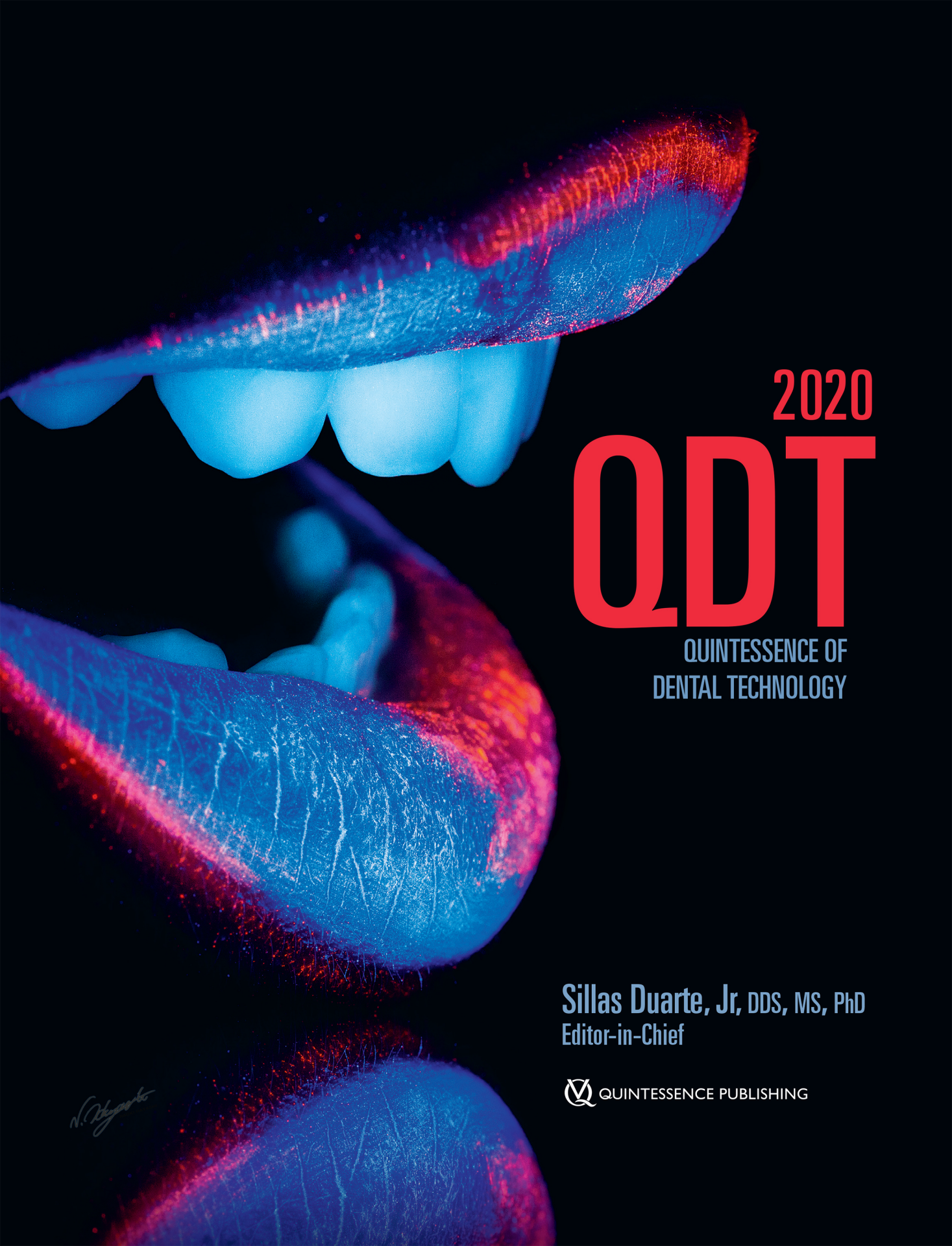

# 2020 QDT

## QUINTESSENCE OF DENTAL TECHNOLOGY

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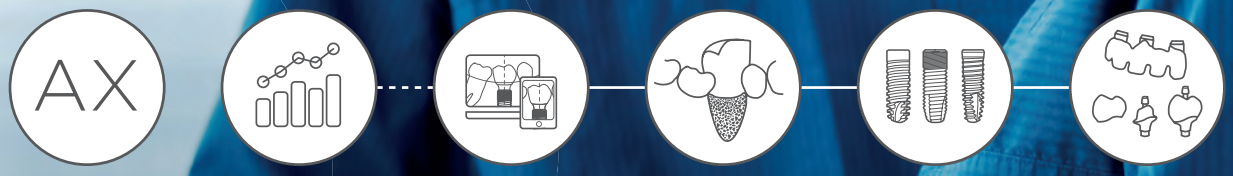


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# Computational Photography: Future and Challenge for Dental Photography

One of the areas in which technology has made a significant impact is photography—more precisely, computational photography, a new term that we all should be aware of. This concept is being driven by smartphone manufacturers, not by the traditional camera manufacturers. The convenience of a relatively small device with impressive computational abilities has prompted the development of novel features that are revolutionizing how we take or make photographs. The megapixel camera war continues, as newer smartphones have cameras up to 108MP. Even though some smartphones may produce high-resolution files, many manufacturers default to the pixel-binned resolution to decrease phone storage. However, due to the small sensor size, noise is still an issue with smartphone cameras. Thus, digital technology was employed to improve this shortcoming, but it went even further. Computational technology is now able to control the illumination of a scene through algorithms that can relight, enhance, and/or blur the whole or parts of an image. With some smartphone cameras, by the time one presses the shutter button the camera has acquired numerous frames at long exposure, fast shutter speed, and standard speed, in addition to the intended shot. All those files are then merged, analyzed, and processed for noise and details, pixel by pixel, to generate the final image. Human skin/hair receives the highest level of detail, whereas other areas of the image receive less attention. Apps are now available with the power to access, modify the original depth of field, and refocus almost any image. All of us who do intraoral photography understand clearly how all the aforementioned features would be a great ally to our photographic skills.

The quality of smartphone videos also has significantly improved, with 4K video resolution now available for most smartphones. But more impressive is the extended dynamic range and the cinematic-like in-body video stabilization that some smartphones have available. In extended dynamic range mode, the camera is actually taking dual-exposure videos at a normal exposure frame together with a short exposure frame (for instance, 120 and 60 frames per second) and combining them on the spot to create a single frame without any further processing. Moreover, smartphone apps are capable of creating 3D face scans that can be exported as STL or OBJ files.

With all this technology in everyone's hands, it is no wonder that the digital camera market continues to shrink. The Camera & Imaging Products Association (CIPA) has reported a huge drop in global digital camera shipments from 2017 to 2019, as well as a decline in sales for all major camera manufacturers.[1]

Despite its features and convenience, photographing extra- and intraorally with a smartphone poses an ethical dilemma: Is it permissible to store patients' electronic protected health information (ePHI) on a personal device? In the United States there are strict regulations that safeguard patient health information (Health Insurance Portability and Accountability Act, HIPAA[2]), and dental practices are responsible for implementing policies to protect personal information. In 2006, the Health Information Technology for Economic and Clinical Health (HITECH) Act[3] expanded the concept of ePHI protection and places liability on the practice to maintain HIPAA and HITECH compliance. The US Government has created a webpage with more information on privacy and security of using mobile devices, and it is worth your time to take a look.[4]

The digital disruption affects our personal and working lives almost every day, and the understanding of its power and, more importantly, its limits can only benefit our practices, patients, and treatments. I welcome you to experience the magnificent collection of opinions and techniques that challenge the boundaries between digital technology and dental art.

Sillas Duarte, Jr, DDS, MS, PhD
sillas.duarte@usc.edu

[1]http://www.cipa.jp/stats/documents/e/dw-201910_e.pdf
[2]https://www.hhs.gov/sites/default/files/privacysummary.pdf
[3]https://www.hhs.gov/sites/default/files/ocr/privacy/hipaa/administrative/enforcementrule/enfifr.pdf
[4]https://archive.healthit.gov/providers-professionals/your-mobile-device-and-health-information-privacy-and-security

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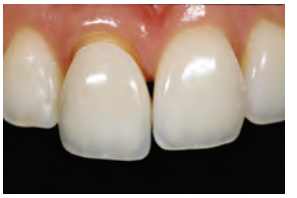

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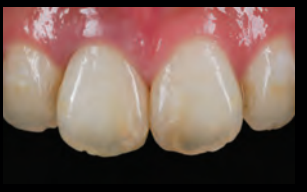

Naoki Hayashi (top left) and Naoto Yuasa (above) present at The 26th International Symposium on Ceramics - June 12-14, 2020 at Sheraton San Diego Hotel & Marina.

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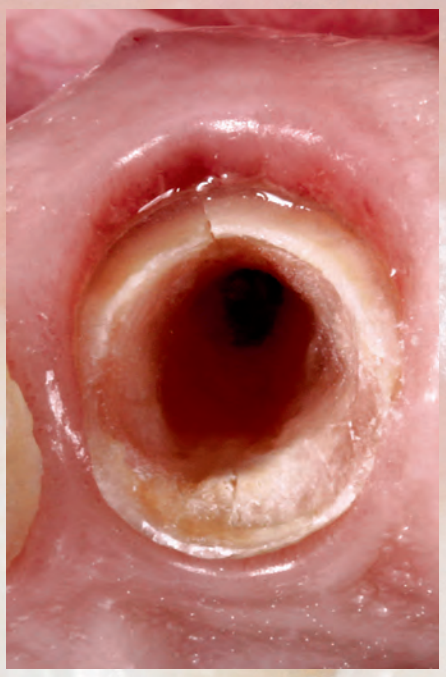

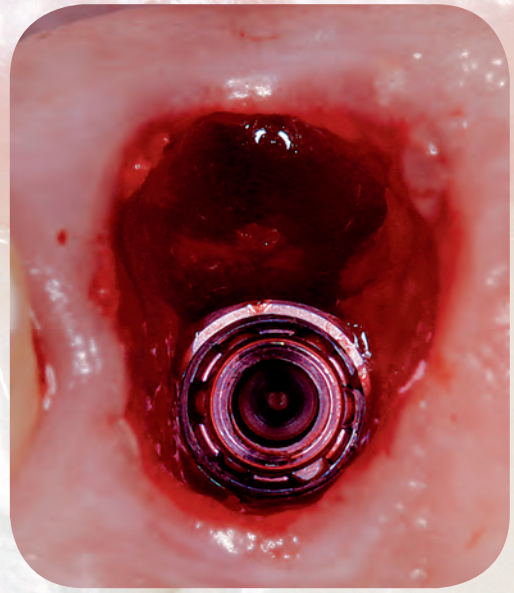

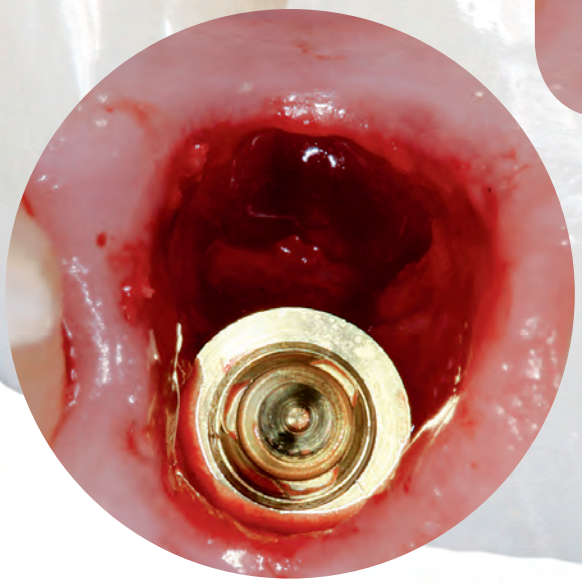

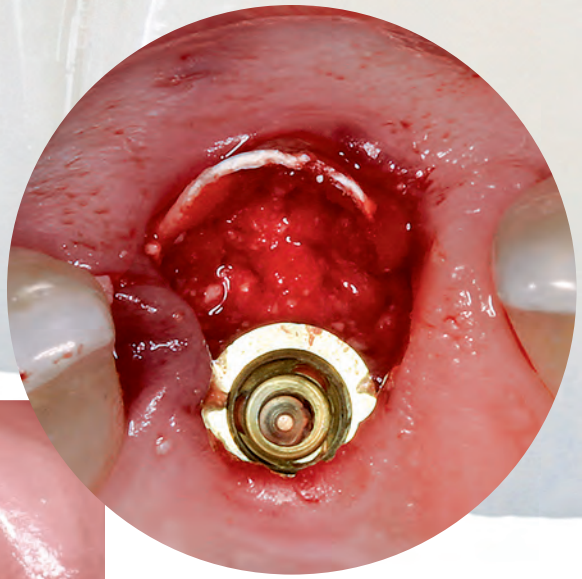

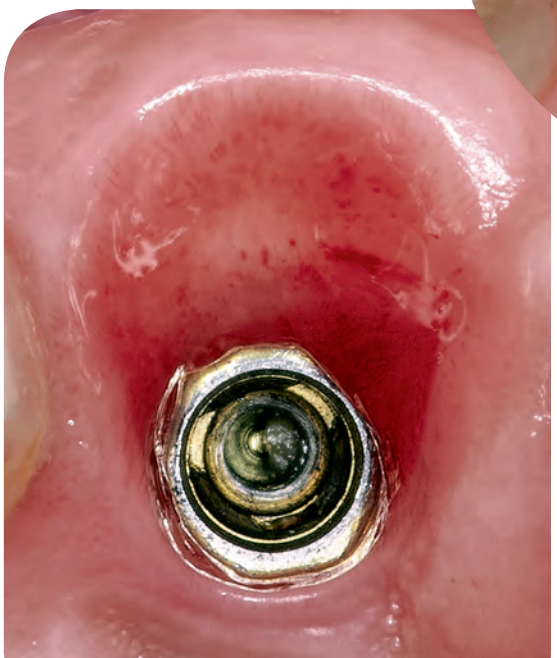

# The One-Time Intermediate Abutment—Clinical Application

Victor Clavijo, DDS, MS, PhD[1]
Paulo Fernando Mesquita de Carvalho, DDS, MS[2]
Cristiano Soares, CDT[3]

The importance of three-dimensional (3D) positioning for proper implant placement is well established.[1] However, in cases with esthetic-functional involvement, asymmetric gingival margins often generate uncertainty regarding the ideal depth for immediate implant placement. This potentially leads to an implant with a shallow or deep coronoapical position, which will require several appointments for peri-implant profile manipulations to achieve satisfactory results.

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To avoid this uncertainty and potential shortcoming, the definitive gingival margin should be established before planning the implant placement surgery. Decision-making guidelines for tissue manipulation and abutment material selection have been reported earlier (Clavijo and Blasi[2]). In order to transform margins from unfavorable to favorable, treatment planning should be performed before tooth extraction, followed by customization of the gingival architecture.

Even in conventional soft tissue manipulation, prosthetic reconnections[3–5] are necessary due to removal of the provisional. This may lead to some bone resorption and subsequent tissue recession from repeated injury to the tissue seal and to the biologic equilibrium around the implant and abutment connection. The one-abutment, one-time concept has been described to improve stability of the bone-implant interface,[6–9] but such a technique would be hard to reproduce given the difficulty to manipulate the peri-implant tissue when the abutment cannot be removed and in cases of cement-retained prostheses.

**BOX 1** Advantages and Disadvantages of the One-Time Intermediate Abutment

Advantages
- No reconnection around the implant neck; no aggression of the gingival seal formed around this area with the prosthetic connection
- More stable bone remodeling and more predictable maintenance of tissues around this connection
- Improved patient comfort during tissue-manipulation appointments
- Single body without access screw, platform switch, and gold coloration, allowing for increased amount of gingival tissue and superior esthetic quality (in terms of light reflection through thin gingiva)
- Reversibility and retrieval of component if necessary

Disadvantages
- The higher the intermediate abutment, the lower the possibility of peri-implant tissue manipulation
- Need for additional prosthetic components for fabrication of the restoration

A clinical alternative to keep both the bone-implant interface and peri-implant epithelium intact is the one-time intermediate abutment approach following placement of immediate implants or placement of implants with a tapered internal connection in healed sites. This allows for peri-implant tissue manipulation with more favorable bone remodeling and fewer reconnections that can damage the peri-implant tissue (Box 1). Key factors for the use of the immediate implant protocol after extraction include the residual bone, gingival margin position, buccal bone characteristics, and tissue biotype.[10] This article presents a case to describe the step-by-step application of the one-time intermediate abutment.[11]

# CASE PRESENTATION

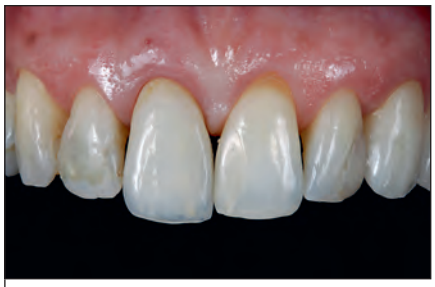
A 46-year-old woman came to the dental office reporting mobility of the maxillary right central incisor. The tooth had an all-ceramic crown with a fiberglass anatomic post-and-core composite resin restoration that had been fabricated approximately 10 years earlier. In addition, the patient was unhappy with the esthetics of her teeth, particularly their size and color, as well as the black spaces.

After clinical (Figs 1a to 1d), radiographic, and tomographic (Fig 1e) examinations, a fistula in the buccal area of the tooth (with suppuration and 9.0-mm probing depth) was observed, demonstrating partial loss of the buccal wall (confirmed by tomography) and suggesting longitudinal root fracture.

## *Treatment Plan*

The six-step treatment plan was carried out as follows:

1. Pre-extraction planning to define the final height of the gingival margin of the failing tooth through Digital Smile Design (DSD), initial impression-taking, and planning of the guided surgery
2. Surgical and prosthetic procedures for immediate implant placement, one-time intermediate abutment, and maintenance of the gingival and bone architecture of the tooth site
3. After 6 months of peri-implant tissue stability, peri-implant manipulation until margins are stable
4. Removal of unsatisfactory restorations, preparation of teeth, and final impression of teeth and implant
5. Laboratory steps for fabrication of abutment and ceramic restorations
6. Delivery of tooth-supported and implant-supported ceramic restorations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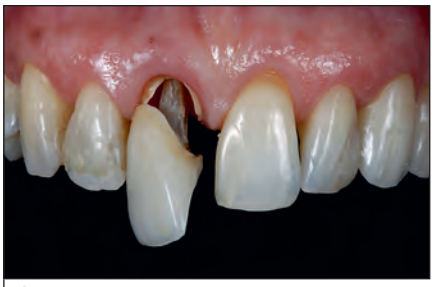
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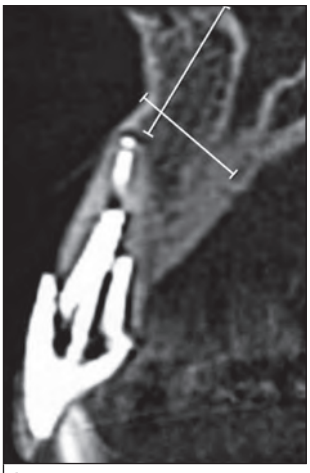
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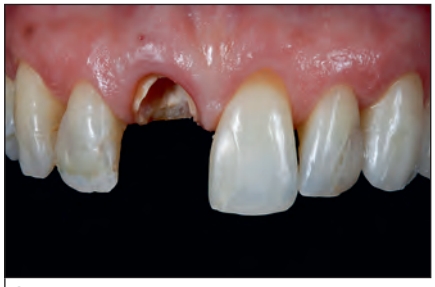
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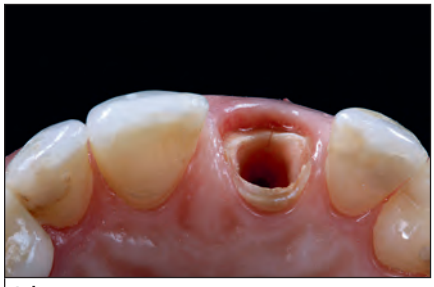
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**Figs 1a and 1b** Preoperative intraoral views.

**Figs 1c and 1d** Views of the root fracture.

**Fig 1e** Initial cone beam computed tomography (CBCT) image.

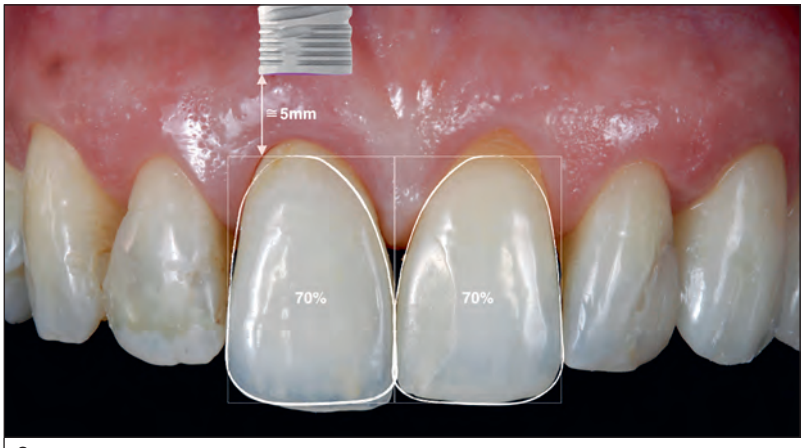

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**Fig 2** Final implant depth using Digital Smile Design references.

## *Step 1*

After decoronation of the maxillary right central incisor and clinical confirmation of the root fracture, an impression was taken for planning and laboratory preparation of the surgical guide.

The buccal volume of the extracted ceramic crown was reduced from its emergence profile, along with any occlusal contacts (at maximum intercuspal position and excursive movements) to prevent displacement during healing of the fistula through medication. The ceramic restoration was reseated with zinc phosphate cement, and the patient was provided instructions and dismissed.

The DSD was performed from the extraoral and intraoral photographs. The cementoenamel junction of the maxillary left central incisor was the reference for the final gingival margin (Fig 2) to achieve an optimal esthetic result in terms of tooth proportion.

The patient's files (DICOM and STL) were sent to the planning center (MCENTER, MSOFT Virtual Planning Process, Israel) to fabricate the surgical guide for implant placement. Implant placement was planned according to the 3D positioning and at 5 mm from the planned gingival margin of the adjacent tooth (in this case, the cementoenamel junction of the maxillary left central incisor) (Fig 2).

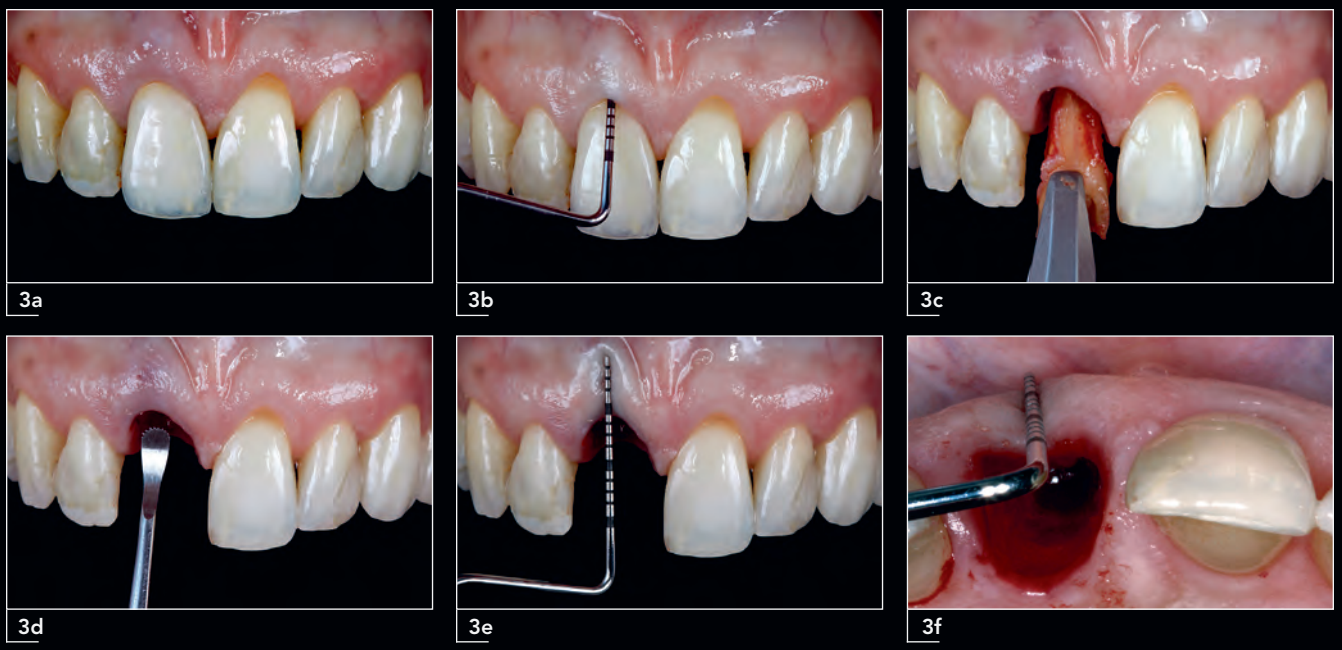



**Fig 3a** Ten days after crown cementation with zinc phosphate. Observe the coronal migration of the tissue. This gingival margin improvement was the result of reducing the crown's emergence profile.

**Fig 3b** Probing before tooth extraction.

**Fig 3c** Tooth extraction.

**Fig 3d** Decontamination of the socket.

**Figs 3e and 3f** Determination of the bone defect.

## *Step 2*

After the ceramic crown was removed, minimally traumatic extraction was performed upon visual confirmation of the root fracture (Figs 3a to 3c), followed by careful cleansing of the socket (Fig 3d) and buccal soft tissues. With the aid of a periodontal probe (Figs 3e and 3f), it was possible to carefully determine the extent of the bone defect in the buccal wall[12,13] (classified as wide/deep according to the immediate implant placement protocol of Joly et al[14]).

Guide drilling (MGUIDE) and implant placement procedures were performed according to the digital planning. The implant (V3, 3.9 × 13 mm, MIS Implants) was inserted, achieving a primary stability of over 45 Ncm (Figs 4a and 4b), which allowed for immediate provisionalization and placement of the one-time intermediate abutment (MIS Connect) (Figs 4c and 4d) with a 30-Ncm torque. The aim was to place the intermediate abutment at least 1 mm away from the future bone margin to improve the bone remodeling, since disconnection will take place above the bone level. Pick-up of the provisional was performed by joining the ceramic crown and the provisional metallic abutment. Criteria used for defining the peri-implant profile are described in Fig 5. As previously mentioned, the one-time abutment was placed in the subcrestal peri-implant area to create space between the connection and the bone-implant interface, thus optimizing bone remodeling. In the subcritical area, a concave profile was planned approximately 1 mm below the gingival margin to create space for the connective tissue graft and the clot. The critical cervical contours of the crown were maintained mesiodistally by slight reduction of the buccal and lingual emergence angle in an attempt to migrate the gingival margin coronally, following the decision tree on how to determine the critical or cervical contour of the provisional in immediate implants (Fig 6).

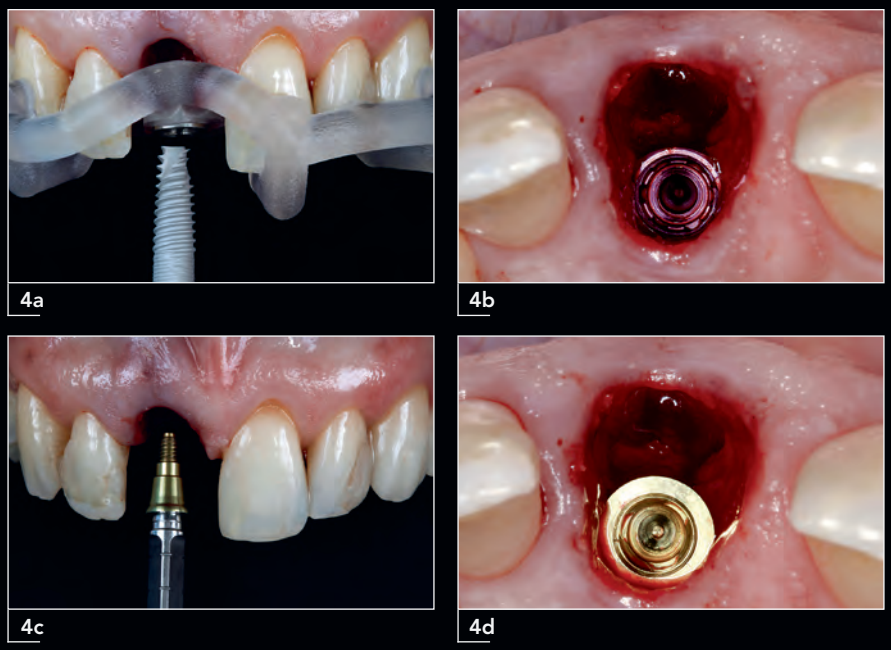



**Fig 4a** Guided implant placement.

**Fig 4b** Palatal approach from the digital implant treatment planning.

**Figs 4c and 4d** Delivery of one-time intermediate abutment.

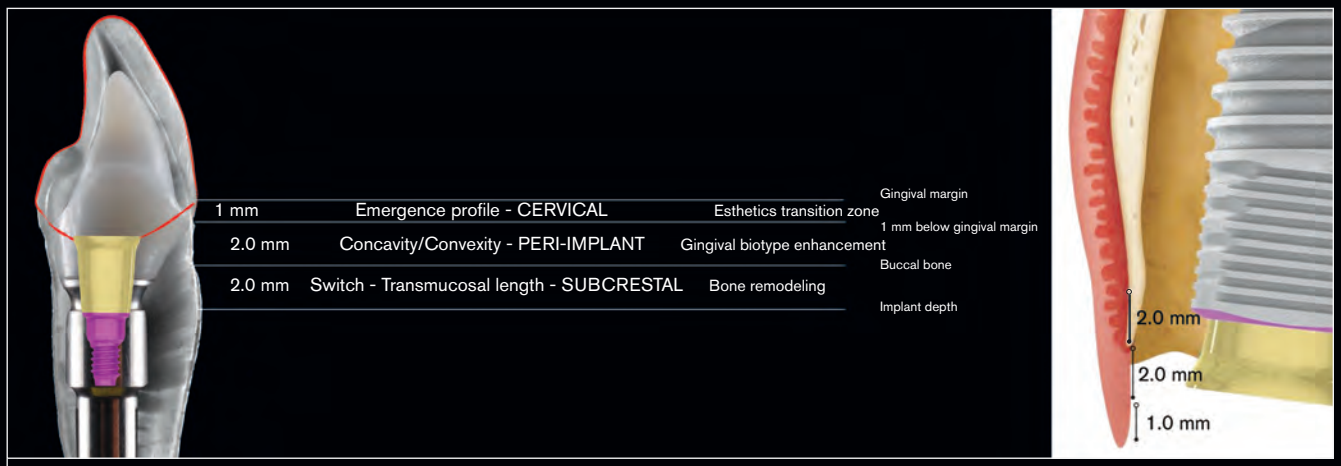



**Fig 5** Implant depth and function at each millimeter. An implant is usually placed 4 to 5 mm from the gingival margin in an ideal situation, which provides 1 to 2 mm subcrestal positioning. Within the 5 mm between the gingival margin and the implant head, there are three areas of importance:
1—*Area of the esthetic contour of the crown.* This area has the function of maintaining the gingival tissue, providing support for it and the correct sealing of the socket after extraction. This contour can be changed by removing its buccal volume, depending on the desired final gingival margin height after healing.
2—*Transmucosal area responsible for tissue volume around the implant.* This area should be very concave at the baseline to create space for the connective tissue that will change the thin tissue biotype around the tooth, close to the clot, into a thick tissue biotype around the implant.
3—*Area responsible for bone remodeling around the implant.* This area is usually subcrestal and is therefore important for bone remodeling. This area usually is polished titanium with a platform switch with a standard height. Bone remodeling may cause injury to the final result, so attention should be paid to this area. Components with transmucosal height of at least 1.5 to 2 mm should be used to avoid any pressure exerted on the bone around the implant.

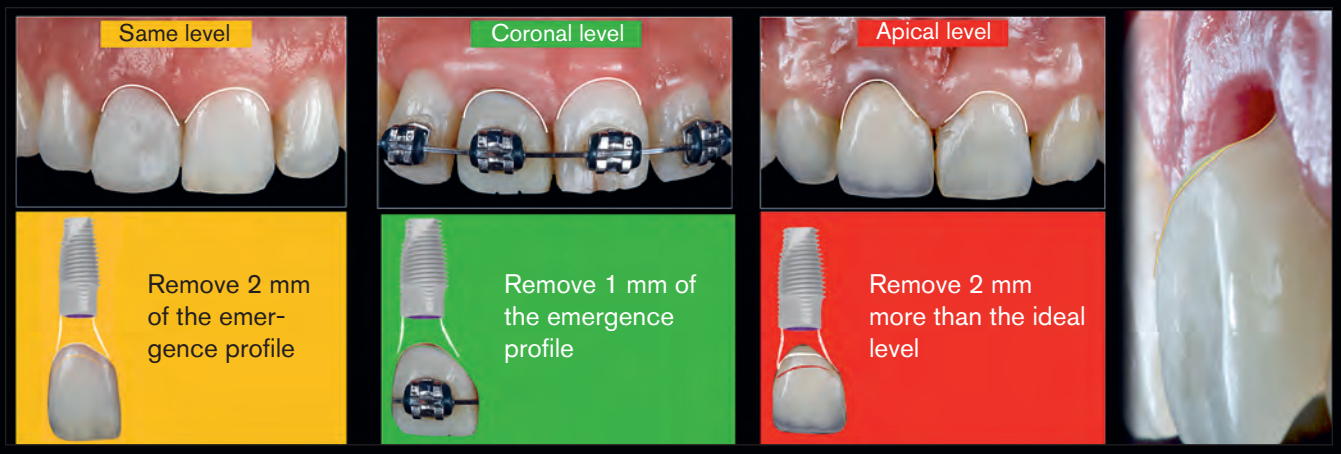



**Fig 6** Reduction of the provisional restoration emergence profile according to the initial gingival margin in relation to the adjacent tooth. At the time of provisional finishing, a less convex emergence profile is always required to generate an overcorrection of the gingival margin around the restoration to ultimately improve the predictability during peri-implant tissue manipulation.

—*Margin at same level.* After provisional finishing, remove 2 mm from emergence profile below desired future gingival margin.
—*Coronal margin.* After provisional finishing, remove 1 mm from emergence profile.
—*Apical margin.* After provisional finishing, remove 2 mm from emergence profile below desired future gingival margin.

The provisional restoration was polished and cleaned following a protocol published elsewhere.[15]

The provisional restoration was delivered, after which a mixed flap was performed using the tunnel technique at the site of the maxillary central incisors (Fig 7a) in order to create space for a connective tissue graft and allow for the flap to cover the recessions of the involved teeth. A properly sized connective tissue graft (Fig 7b) was removed from the palatal region for the treatment of both teeth. The graft was positioned subgingivally, close to the gingival margin, and stabilized by sutures at both ends (Figs 7c to 7e).

A resorbable membrane (Geistlich Bio-Gide Shape) was then inserted in the external portion of the socket, beneath the periosteum (Figs 8a and 8b). The membrane should be supported by healthy bone at least 3.0 mm laterally and apically. Excess membrane should be maintained to facilitate positioning and stability until the biomaterial is packed.

The biomaterial (Geistlich Bio-Oss Collagen) was trimmed and adapted to the shape of the defect. The first portion should be inserted below the membrane, reconstructing the lost wall portion. Other portions should be placed over any existing spaces so that they may be filled. The membrane can be trimmed close to the gingival margin or folded and placed toward the buccal aspect (Figs 8c and 8d).

The provisional restoration with the properly defined contour was screwed with a torque of 30 Ncm, allowing for the support of the papillae and sealing of the reconstructed socket. Flap and graft tension sutures anchored at the contact points were accomplished at the proximal spaces, allowing for the coronal advancement of both the flap and graft (Figs 8e and 8f).

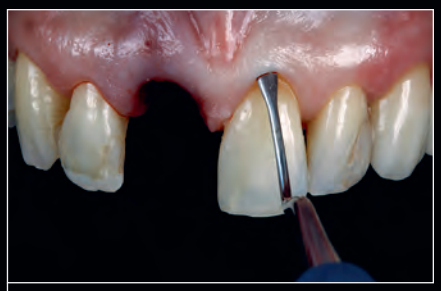
## *Step 3*

Six months after the graft placement, peri-implant tissue stability was achieved (Figs 8g and 8h) and peri-implant tissue manipulation was initiated. The surgical protocol was performed to obtain a margin coronal to adjacent tissue with a volume greater than 2 mm, limiting the prosthetic manipulation only to the restoration of the cervical contour or critical contour[16] with volume addition in this area.[2] For a precise determination of this margin, the technician performed the diagnostic wax-up, defining the correct gingival margin height (Figs 9a to 9e). The provisional was removed and flowable composite resin was added for manipulation of the margin.

**Fig 7a** Tunnel technique.

**Fig 7b** Connective tissue graft in position.

**Figs 7c to 7e** Graft is positioned subgingivally and stabilized by sutures at each end.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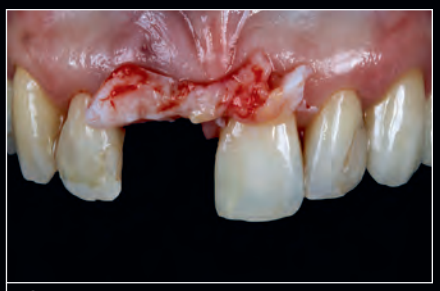
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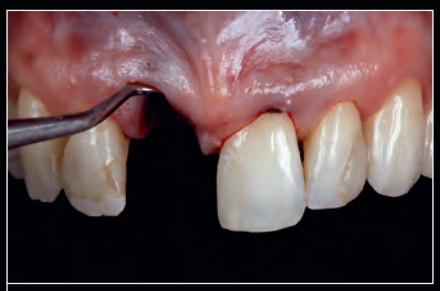
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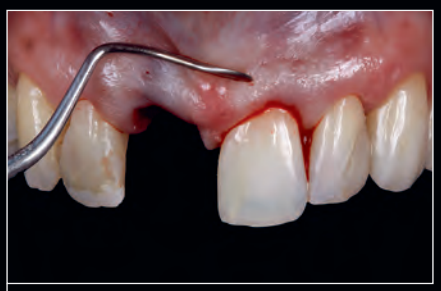
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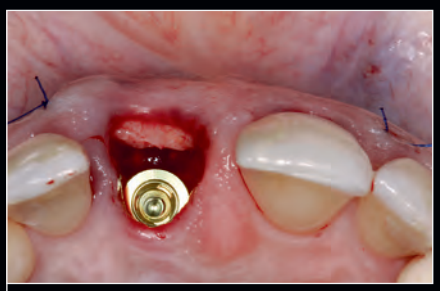
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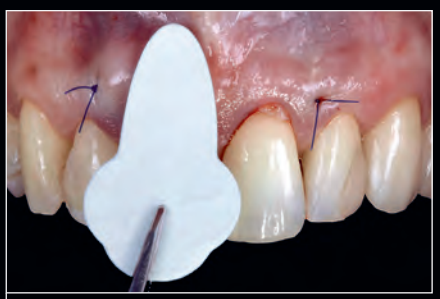
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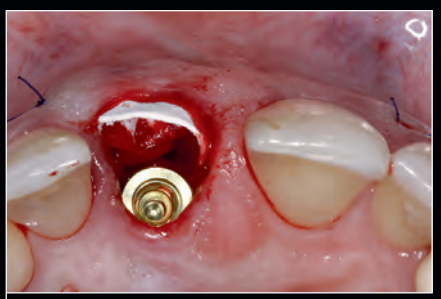
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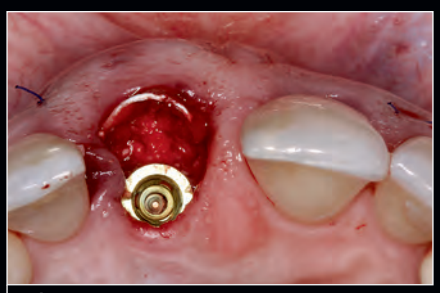
8c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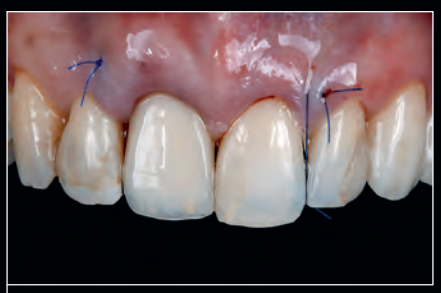
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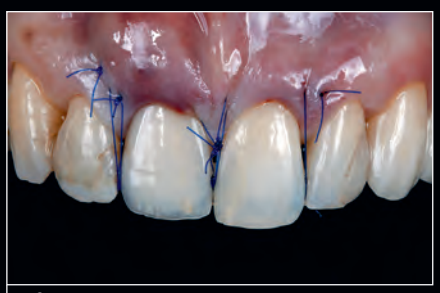

8f

**Figs 8a and 8b** Resorbable membrane.

**Fig 8c** Bio-Oss Collagen.

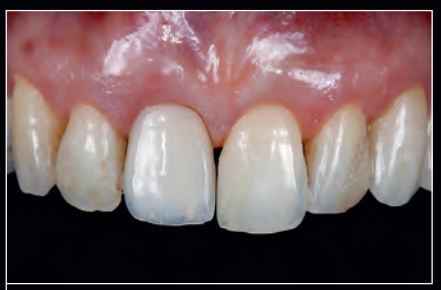
**Fig 8d** Bio-Oss Collagen in position.

**Fig 8e** First suture.

**Fig 8f** Second suture.

**Fig 8g** Six months after implant placement.

**Fig 8h** CBCT 6 months after implant placement.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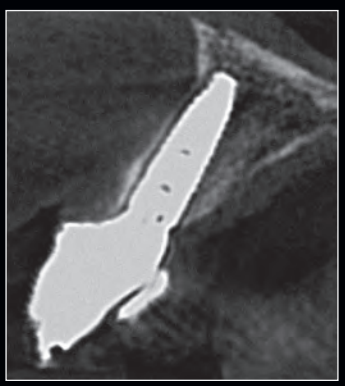
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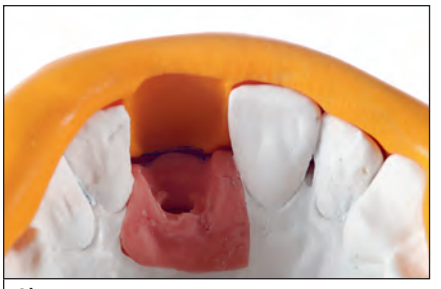
9a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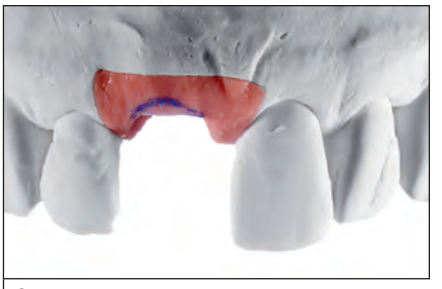
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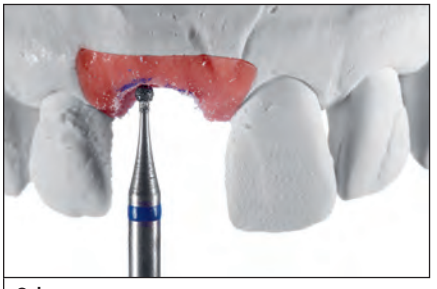
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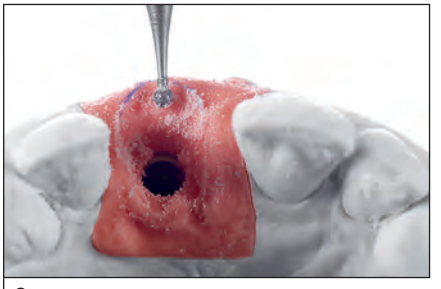
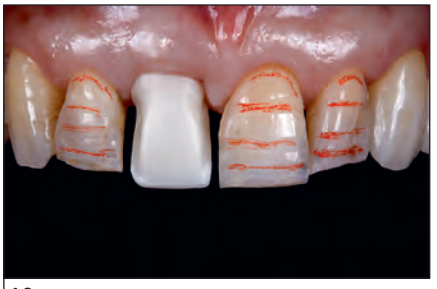

9e

**Fig 9a** Silicone guide of the ideal wax-up. Note the ideal zenith in blue color.

**Fig 9b** Placing the silicone guide on top of the stone model to visualize the ideal zenith.

**Fig 9c** Note the area that needs to be trimmed.

**Figs 9d and 9e** Removing the excess of the soft tissue guided by the ideal wax-up reference.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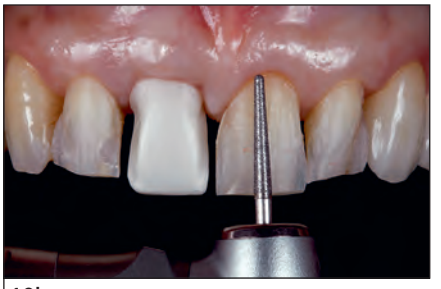
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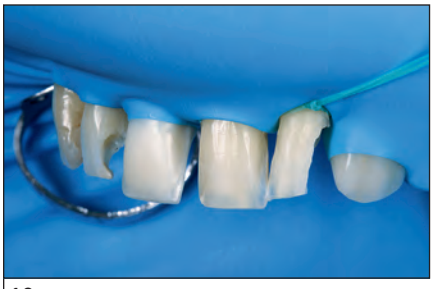
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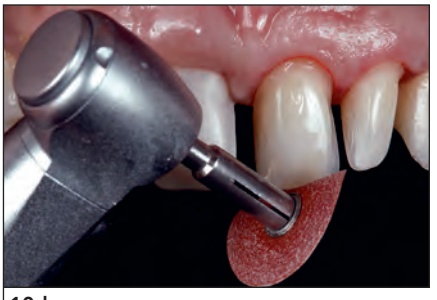
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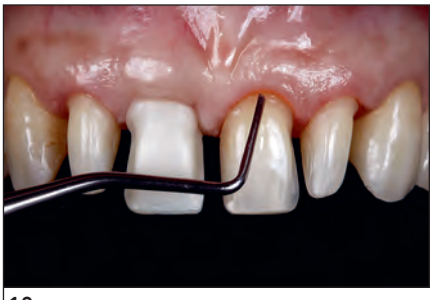
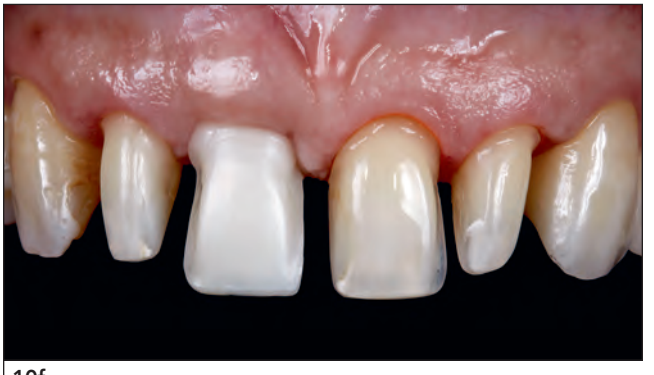

10e


10f

**Figs 10a and 10b** Guided teeth preparation creating 0.5 mm of thickness for the future veneers.

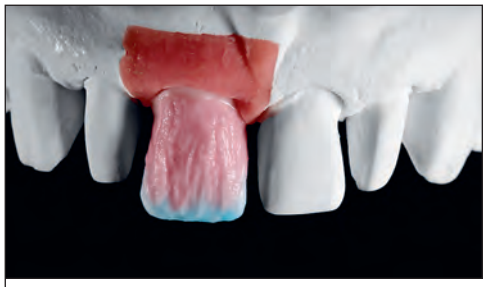
**Fig 10c** Placing new composite buildup.

**Figs 10d and 10e** Finishing of the teeth preparations.

**Fig 10f** Final teeth preparations with the zirconia abutment try-in.

11a

11b



11c

11d


11e

11f

**Fig 11a** Stone model with the zirconia abutment before shape and color customization.

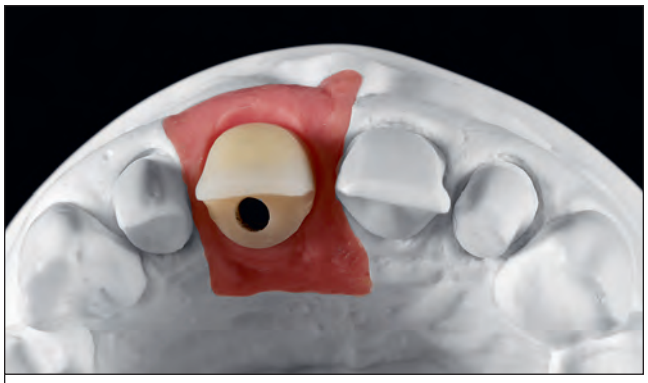
**Fig 11b** Reduction of buccal volume.

**Fig 11c** Ceramic buildup.

**Figs 11d and 11e** Finishing of the customized color and shape of the abutment.

**Fig 11f** Bonding the zirconia abutment into the titanium-base structure following the APC concept technique from Blatz et al.[18]

**Fig 11g** Final check of the shape and volume.



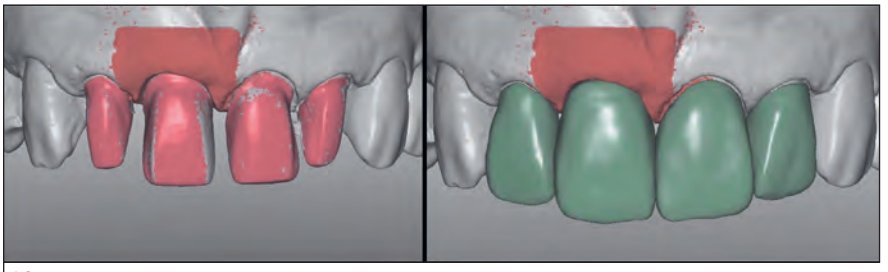
11g

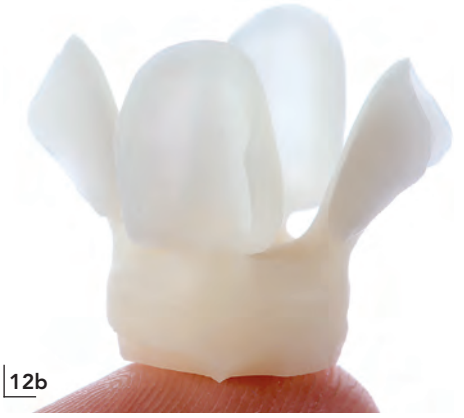
## *Step 4*

The unsatisfactory restorations were removed and composite resin restorations were placed. The teeth were prepared for ceramic veneers following the vertical axis of insertion in order to favor the closure of the black spaces and manipulation of the papillae (Figs 10a to 10f). Transfer digital and analog impressions were obtained and sent to the laboratory with shade and shape information.

## *Step 5*

After the cast fabrication, a digital workflow in the laboratory was undertaken. First, a zirconia abutment was fabricated on the titanium link (MIS Ti-Base CONNECT), replicating the preparation shape with a slight labial reduction for subsequent ceramic application to mimic the shade of the adjacent teeth and to create a bonding area on the abutment (Figs 11a to 11g). This procedure favors the


12a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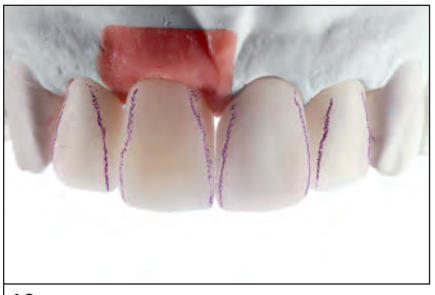
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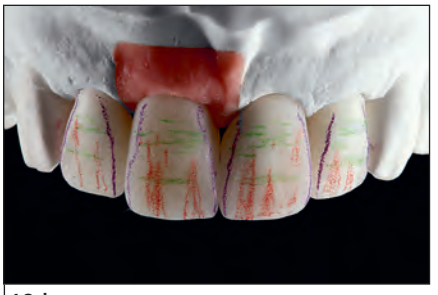
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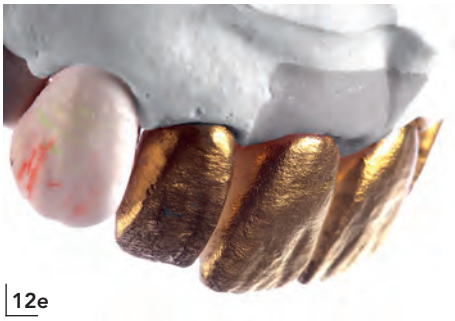
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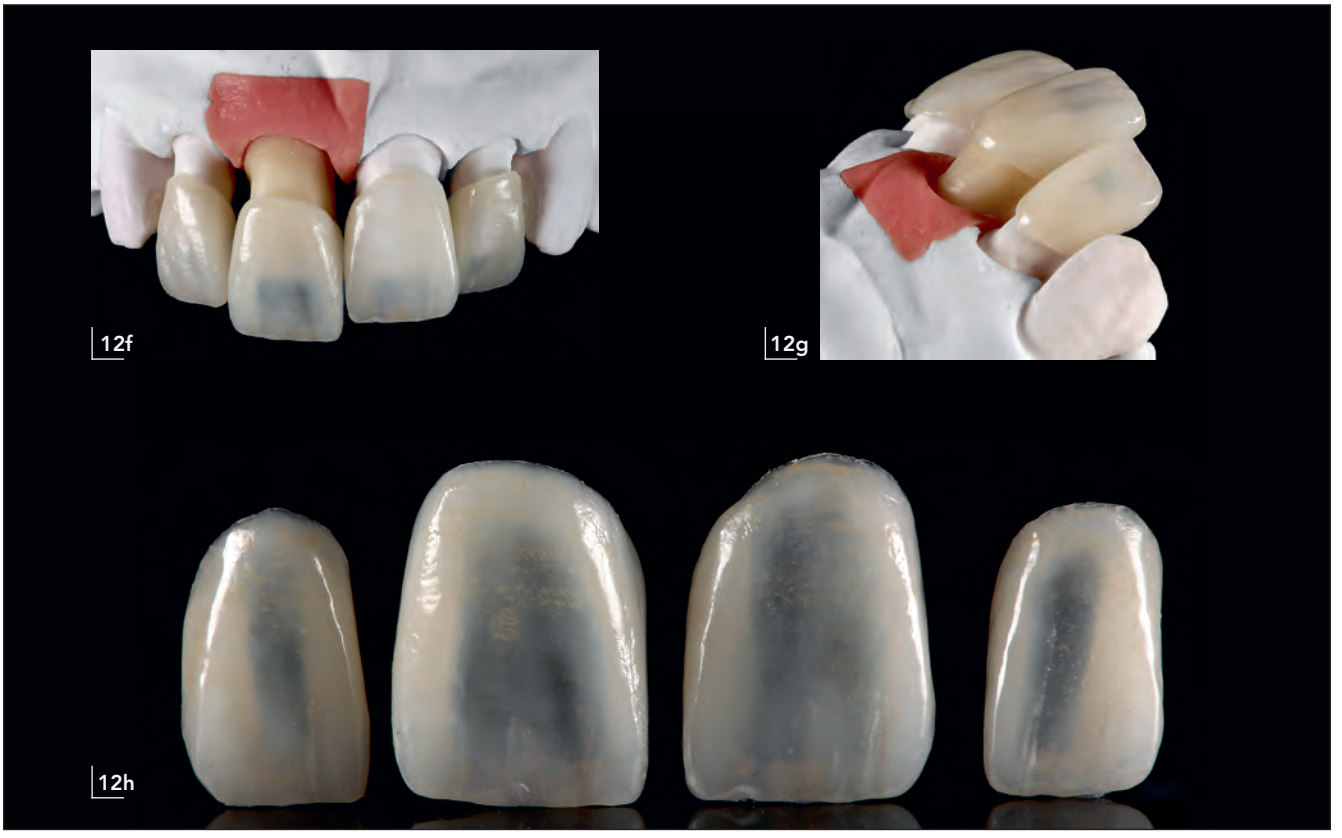


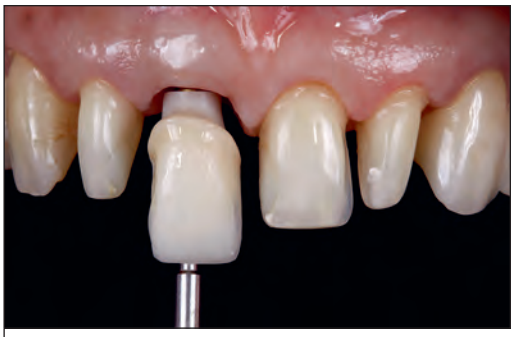

**Fig 12a** Digital design from the final veneers.

**Fig 12b** Pressable lithium disilicate (e.max Press) veneers.

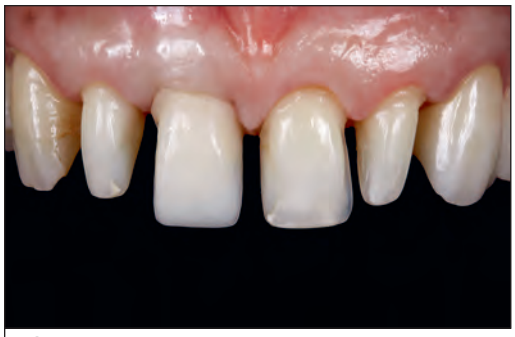
**Fig 12c** Finishing the lithium disilicate veneers.

**Figs 12d and 12e** Final texture.

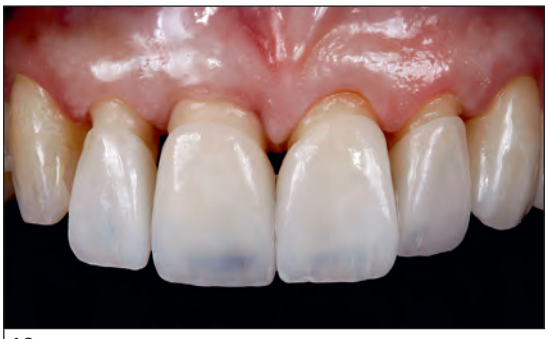
**Figs 12f to 12h** Final veneers.



13a



13b



13c

**Figs 13a and 13b** Customized abutment try-in.

**Fig 13c** Veneers try-in.

adhesive cementation and matching of the substrate. After the shade and shape equilibrium was achieved, the teeth and abutment were scanned again to obtain the digital design of the ceramic veneers (Fig 12a) following the reference of the initial diagnostic wax-up.

The ceramic veneers were milled in wax and then injected with lithium disilicate (e.max Press, Ivoclar Vivadent). After finishing, the veneers were characterized and glazed, and the final polishing was performed (Figs 12b to 12h).

## *Step 6*

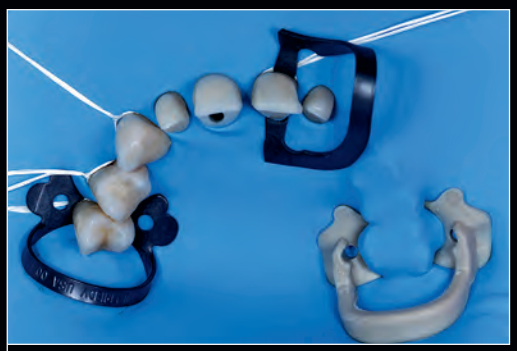
After removal of the provisional, any residues of temporary cement were removed, the abutment was placed, and the ceramic veneers were individually tried-in for their adaptation (Figs 13a and 13b). All the veneers were then placed to check the contact points (Fig 13c). After the "dry" test, a glycerin-based paste (Variolink Esthetic LC, Ivoclar Vivadent) was used to perform the try-in. The patient approved the shape and color, and the cementation of the ceramic veneers proceeded.

Rubber dam isolation was performed with thick rubber sheets (Nictone), a rubber dam adult frame, and 212 Hu-Friedy clamps (Figs 14a and 14b).

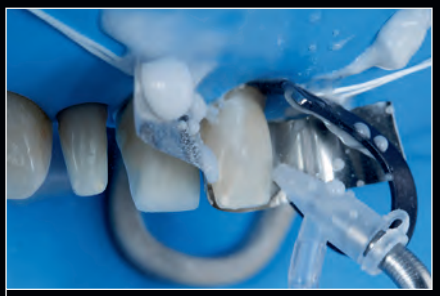
The veneers were individually bonded using light-cured resin cement (Variolink Veneer, Ivoclar Vivadent) following the etching protocol for lithium disilicate with 5% hydrofluoric acid for 20 seconds, followed by rinsing and drying. To remove glass particle debris, 37% phosphoric acid was applied, followed by rinsing and drying. Silane was subsequently applied for 60 seconds and air dried, after which a thin layer of adhesive was placed, air-thinned, and left uncured. Enamel was etched with 37% phosphoric acid for 30 seconds, and dentin areas were etched for only 15 seconds. Etched enamel and dentin were thoroughly rinsed and dried with a gentle airflow and absorbent paper. A thin layer of adhesive was applied using a disposable applicator, followed by gentle airflow to remove the excess and promote solvent evaporation. The adhesive resin was light cured for 20 seconds.

The luting material was placed inside the veneers, which were positioned on the tooth surfaces. Excess cement was removed, and light curing was performed for 40 seconds.

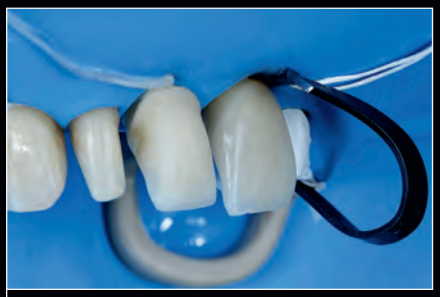

14a


14b

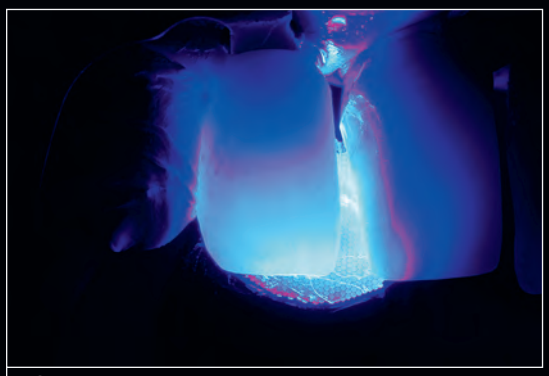

14c


14d


14e


14f


14g


14h

**Figs 14a and 14b** Rubber dam placement.

**Fig 14c** Checking the veneer fit after rubber dam placement.

**Fig 14d** Sandblasting with 27-µm aluminum oxide.

**Fig 14e** Phosphoric acid at 37% per 30 seconds in enamel and 15 seconds in dentin.

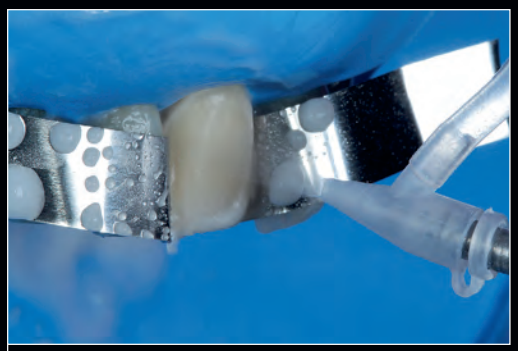
**Figs 14f to 14h** After a thin layer of adhesive, excess was removed with air and the veneer was placed with a resin cement and light cured.

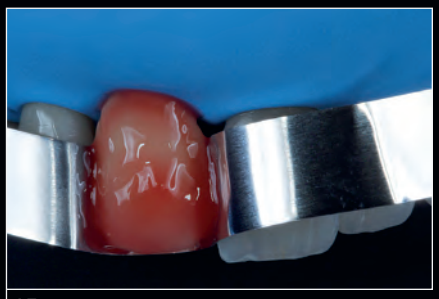
Glycerin was placed at the tooth-ceramic interface to prevent oxygen inhibition and improve the polymerization process at the veneer margins (Figs 14c to 14h).

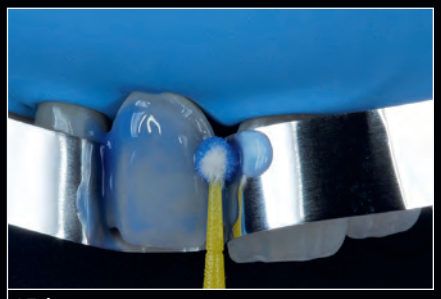
The veneer on the implant abutment was bonded following the protocol described by Clavijo et al[17] for bonding feldspathic ceramic with lithium disilicate structure (Figs 15a to 15i).

After cementation, the excesses were removed with a #12D scalpel, and margins were polished with composite resin rubber polishers. Occlusal adjustments were performed and radiographs were taken for control. One-week and 2-year follow-up images are shown in Figs 16 and 17.


15a


15b


15c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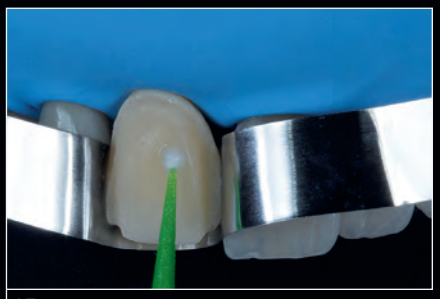
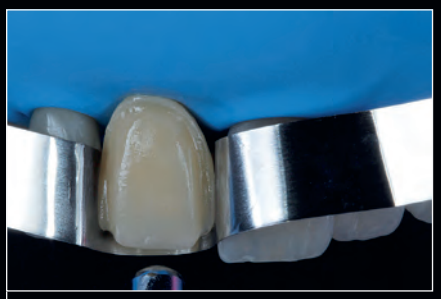
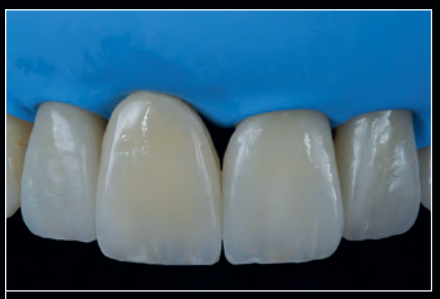

15e


15f


15g


15h


15i

**Fig 15a** Implant veneer in position after bonding.

**Fig 15b** Sandblasting with 27-µm aluminum oxide.

**Fig 15c** Application of 10% hydrofluoric acid for 90 seconds.

**Fig 15d** Application of 37% phosphoric acid for residual removal.

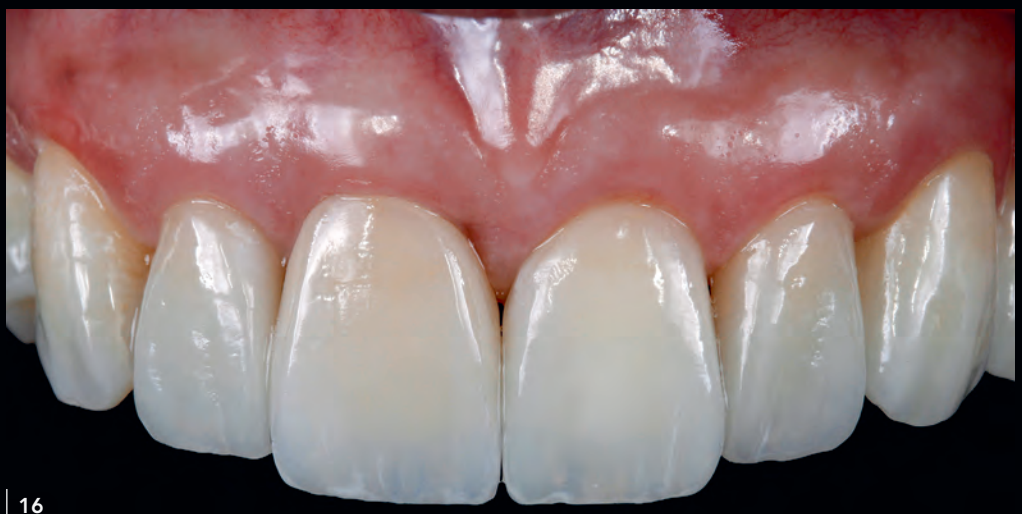
**Fig 15e** Silane application for 60 seconds.

**Fig 15f** Thin adhesive layer application.

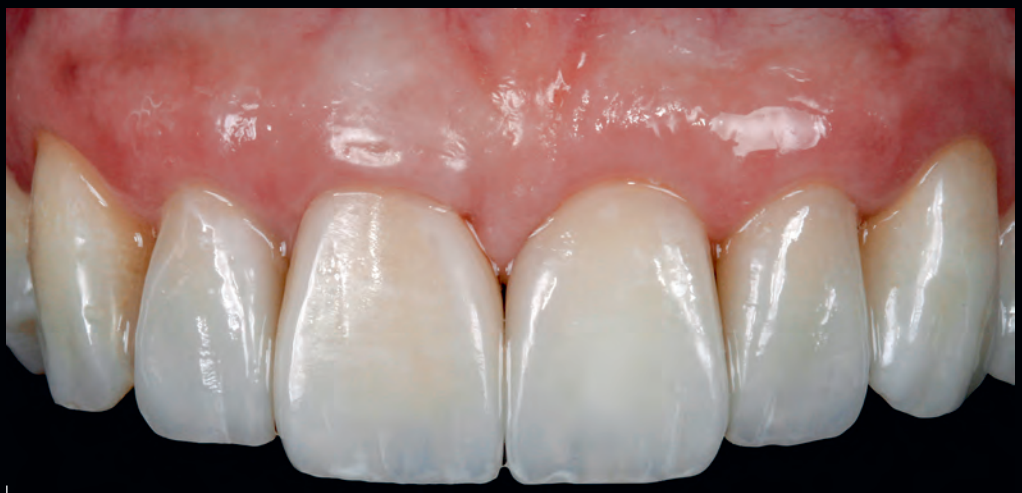
**Fig 15g** Excess adhesive removed after air jets.

**Fig 15h** Veneer in position.

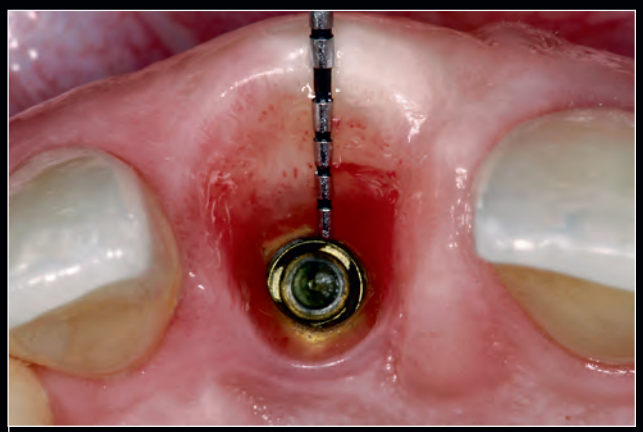
**Fig 15i** Final light cure for 40 seconds.



16

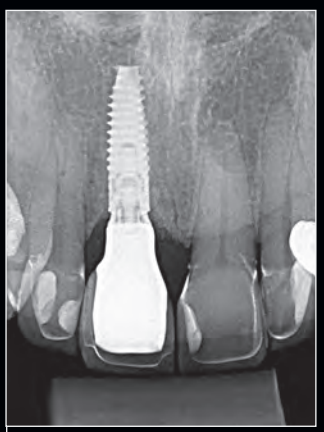


17a



17b

17c



17d

**Fig 16** One week follow-up.

**Fig 17a** Two-year follow-up after implant and one-time intermediate placement.

**FIg 17b** Peri-implant tissue after 2 years.

**Fig 17c** Screw-retained crown removed after 2 years. Observe the zirconia and lithium disilicate areas.

**Fig 17d** Two-year radiographic follow-up. Observe the bone surrounding the intermediate abutment after immediate implant placement.

## CONCLUSION

The one-time intermediate abutment is a new option to optimize bone remodeling and to increase the amount of tissue volume around implants. The abutment should be placed at least 1 mm above the future bone margin with a torque of 30 Ncm. With the one-time immediate abutment it is possible to protect the interface surrounding the peri-implant bone and mucosa, while providing the opportunity to customize the emergence profile using a screw-retained prosthesis.

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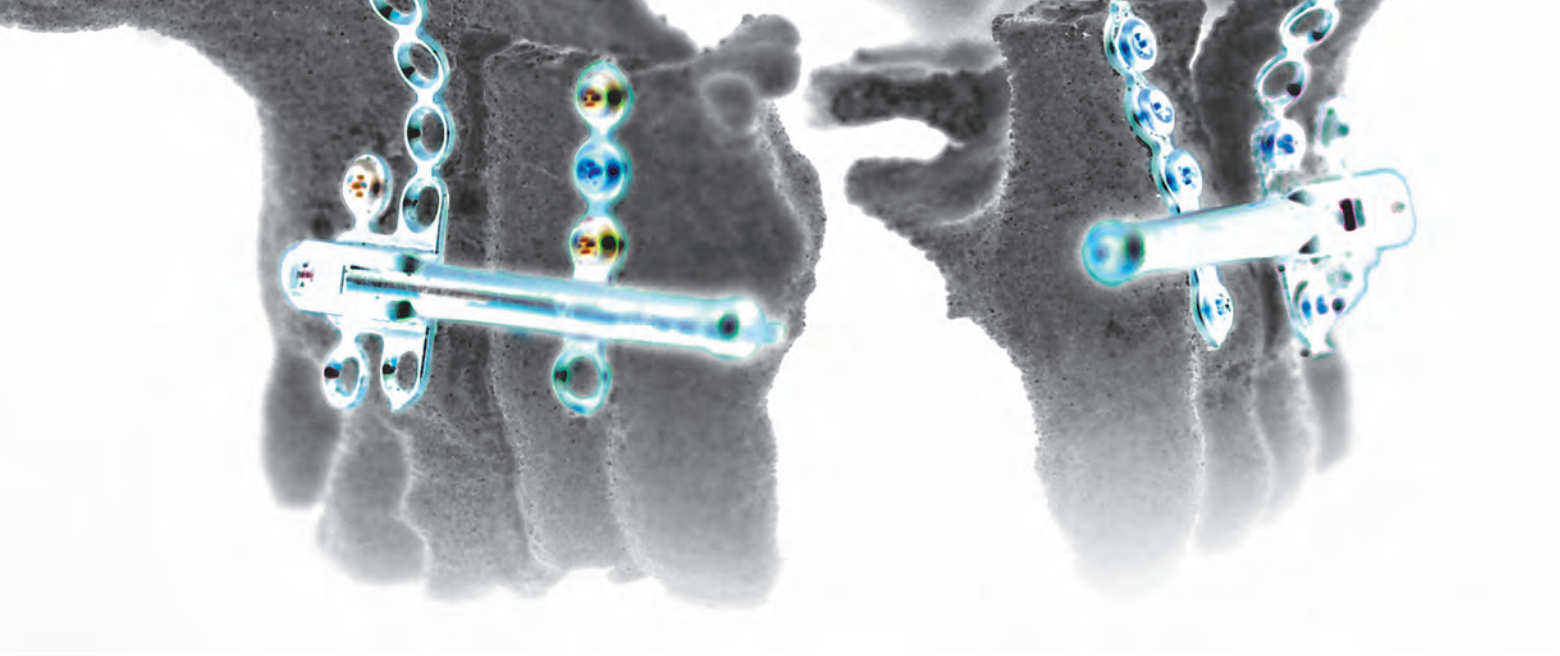

# MASTERCLASS

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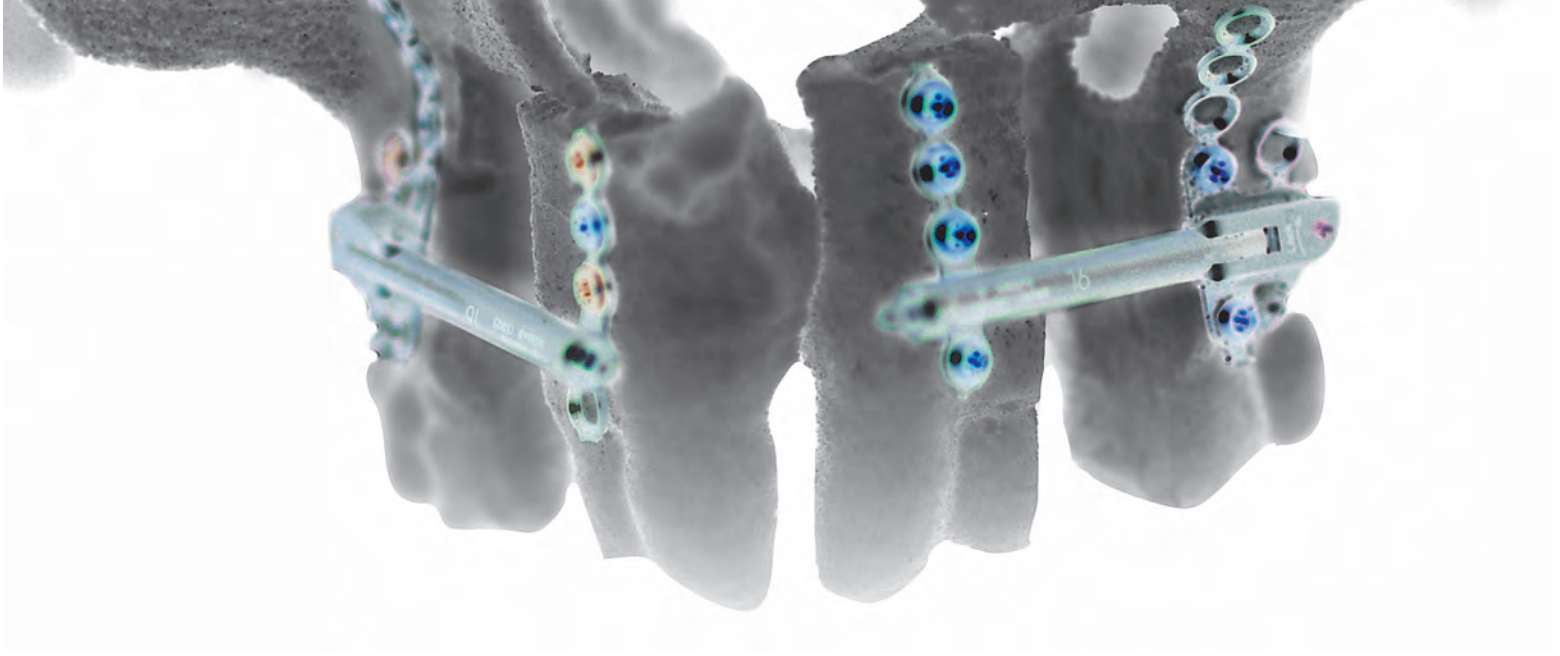


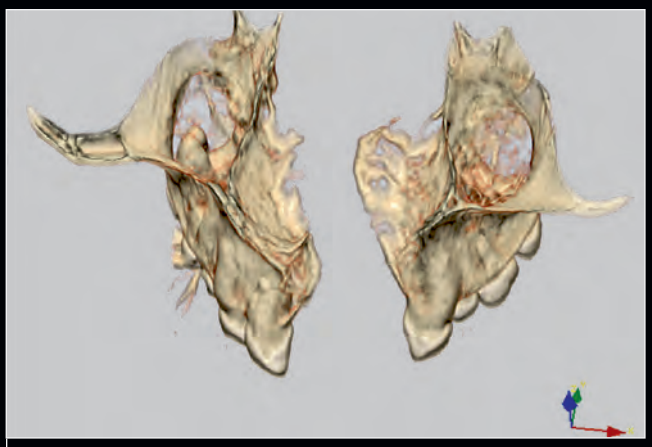
# Bilateral Cleft Palate with Palate Involvement: Putting All in Place for an Esthetic Restoration

The patient presented in this article was referred for restorative finalization after treatment by an oral and maxillofacial surgeon and orthodontist for bilateral cleft palate with palatal involvement. Upon referral, the esthetic situation was extremely poor due to the patient's gingival recession and the implant positioning. The surgical and orthodontic treatment are described, followed by the treatment to provide an acceptable esthetic solution for this complex situation.

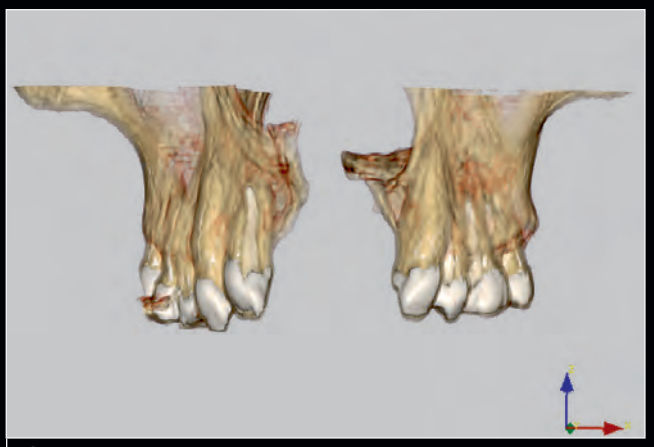
## INITIAL PRESENTATION

Prior to the surgical and orthodontic treatment, the patient presented as follows (Figs 1 to 3):

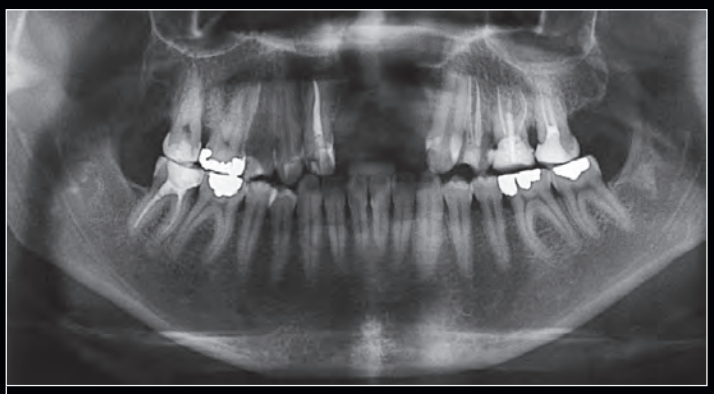
- Skeletal Class III, Class I right molar, and Class II left molar, bilateral cleft palate with palate involvement
- Missing teeth: Maxillary right central incisor and first premolar; maxillary left central and lateral incisors and second premolar (#14,11,21,22,25)
- Removable partial denture for the anterior edentulous area
- Anterior crossbite



1a



1b



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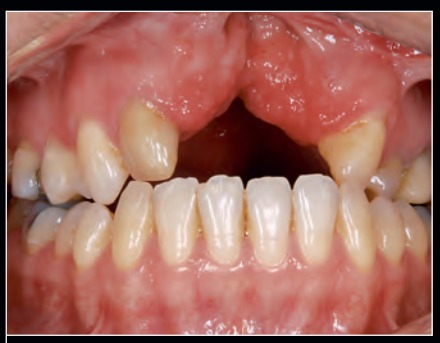
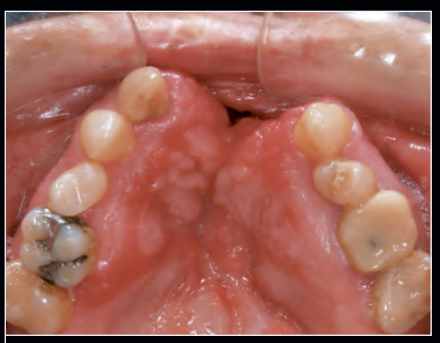
**Figs 1a and 1b** CBCT of the maxillary defect of the cleft palate patient. *(a)* Apical and *(b)* frontal views.

**Fig 2** Initial panoramic radiograph.

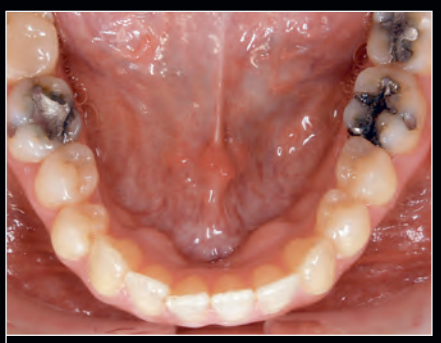
**Figs 3a to 3c** Initial intraoral photographs of the defect.



3a



3b



3c

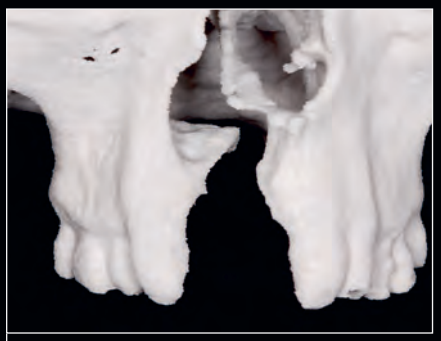
## SURGICAL AND ORTHODONTIC TREATMENT

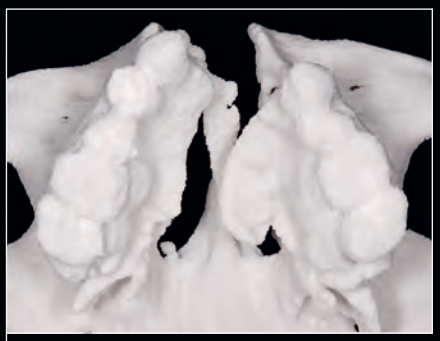
Bone distraction osteogenesis was performed first on printed models, to visualize the surgical strategy and select the adequate hardware (Figs 4 and 5), and then on the patient. On the day of the surgery, the segmental osteotomies were performed with piezosurgery based on the preplanned surgery on the printed model (Fig 6). A week after the surgery, the patient started with the distraction sequence by moving both lateral segmental osteotomies 1 mm a day, 0.5 mm in the morning and 0.5 mm at night, until both sides touched at the central midline of the face. The severe arch discrepancy (Figs 7a to 7c) was due to the patient's initial Class III malocclusion as well as the anterior movement into the large bone defect.

Orthodontics was then performed to realign the teeth to create a nice arch form and best position the torque of the teeth prior to opening the vertical dimension with the help of posterior implants (Fig 8). Six months after the comple-

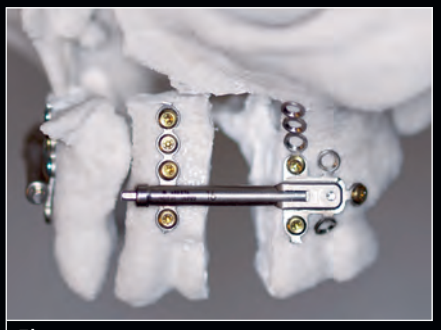
**Figs 4a and 4b** Frontal and occlusal views of the 3D-printed model of the CBCT.

**Figs 5a to 5c** Distraction osteogenesis surgical mock-up on 3D-printed models: *(a)* frontal, *(b)* right lateral, *(c)* left lateral.

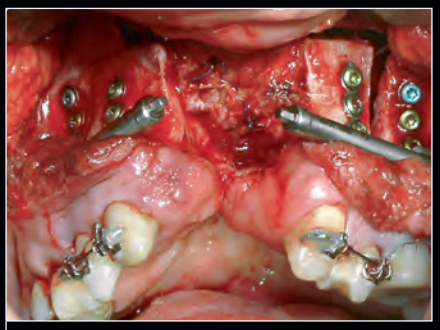

4a


4b


5a


5b


5c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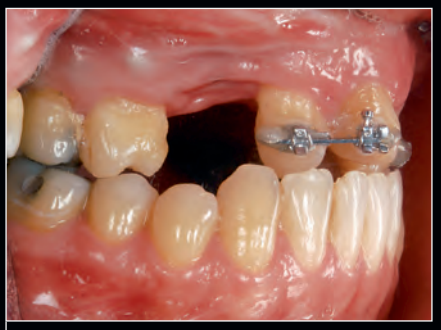

7a

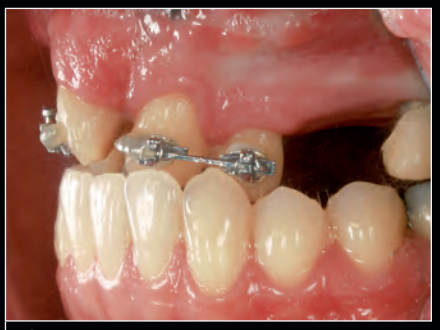
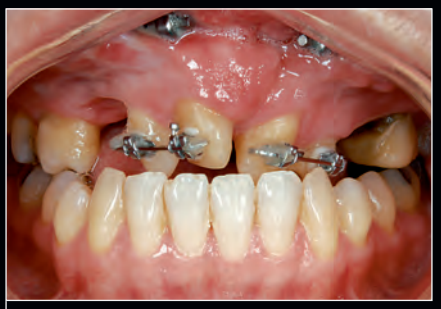

7b

**Fig 6** Day of segmental osteotomy: Refreshing of the bone blocks that were cut with piezosurgery for precision with the corresponding distraction hardware in place.

**Figs 7a to 7c** Distraction osteogenesis movements were started 1 week after the surgery.

**Fig 8** Orthodontic treatment was undertaken to open the vertical dimension and provide torque and arch alignment on the four anterior teeth.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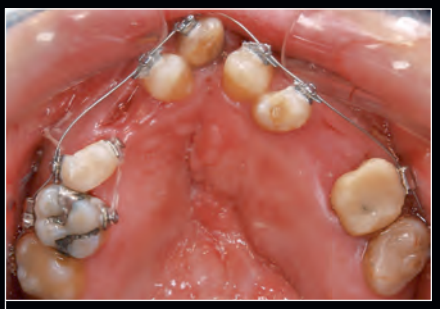
8

tion of the distraction osteogenesis, implants (Nobel Replace, Nobel Biocare) were placed by the surgeon to fill the posterior distal edentulous spaces (tooth sites 13, 23, 24, 25) created by the mesial movement of the segmental osteogenesis. After implant osseointegration, screw-retained provisional restorations were fabricated to use as anchorage and to increase vertical dimension in order to obtain the best anterior guidance.