2019

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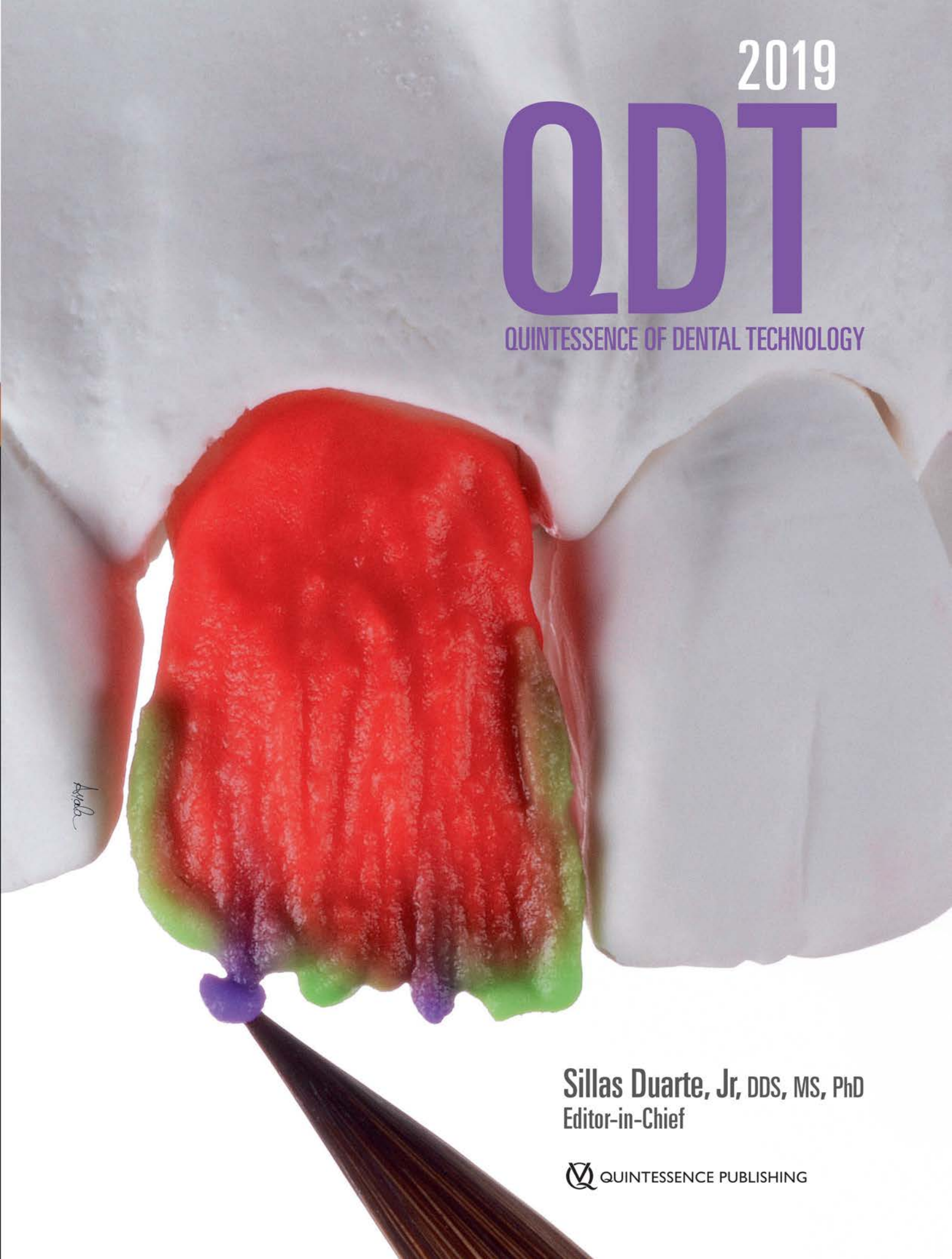
QUINTESSENCE OF DENTAL TECHNOLOGY



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Editorial

New Horizons for Digital Technology in Dental Education

Digital technology in dentistry is a fact that can no longer go unnoticed by academic institutions. Of all the dental laboratory technology programs in the United States that are accredited by CODA (Commission on Dental Accreditation), only a few currently include dedicated courses in digital technology as an integral part of their programs. Similarly, dental schools have yet to fully embrace digital technologies as an integral part of their curriculum. It is clear that the logistics of implementation is challenging the eagerness for its application.

Fortunately, several positive attempts have been made to introduce digital technology to the dental curriculum. Just a few weeks ago, the American Dental Education Association (ADEA) organized a conference where deans and invited leadership of all American and Canadian dental schools gathered to discuss digital technologies in dental education and in health care. The American College of Prosthodontists (ACP) has also worked very hard to promote a digital curriculum for dental schools. CODA recognizes the importance of digital technology and has recently included standards focusing on new technologies with which educational institutions must comply. For Dental Laboratory Technology programs, CODA emphasizes that students need to be exposed to as many new technologies as possible—including digital scanning and digital design (Dental Laboratory Technology CODA Standards 2-19 and 2-20). For Predoctoral Dental Education programs, CODA accreditation standards require that students must be able to evaluate, assess, and apply current and emerging science and technology (CODA Standard 2-24); dental schools must show evidence of the use of technology in didactic and clinical components of the curriculum (CODA Standard 3-2); and that patient care must be evidence-based, and dental schools should use evidence to evaluate new technology and products as well as to guide diagnosis and treatment decisions (CODA Standard 5-2).

Our experience with the Digital Technology Curriculum at the University of Southern California has been amazingly positive. Students' engagement and eagerness to learn has increased, as has the overall quality of their work, since digital technology allows students to become more critical of their own work. Digital technology should be expanded beyond methods of fabrication of single-unit crowns to include minimally invasive adhesive restorations (inlays, onlays, veneers), digitally guided implant-supported treatment (treatment planning, surgical guides, and restorations), removable prosthodontics (digital design and 3D printing), and, of course, crown and bridge restorations.

It is time to fully embrace digital technologies in education. Implementation of digital technology into dental curricula should be made as early as possible in the student's education, and not as a "selective" or isolated course at the end of a student's educational program. The next generation of practitioners (dentists and dental technicians) should be exposed to all the possibilities, advantages, as well as limitations that digital technology brings to the field. The way in which restorative dentistry has been practiced is changing rapidly. Education should follow a similar path by making preservation of dental tissues through minimally invasive adhesive dentistry and digital technology a priority in future dental technicians' and dentists' curricula.

Please join me in appreciating the collection of superb clinical and scientific works in this edition of *Quintessence of Dental Technology,* where the fusion of digital technology, adhesion, dental materials, artistry, and implant therapy are challenged to promote esthetic and functional outcomes.

Sillas Duarte, Jr, DDS, MS, PhD
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MASTERPIECE

Novel Approach for Predictably Matching a Veneer to an Implant Crown

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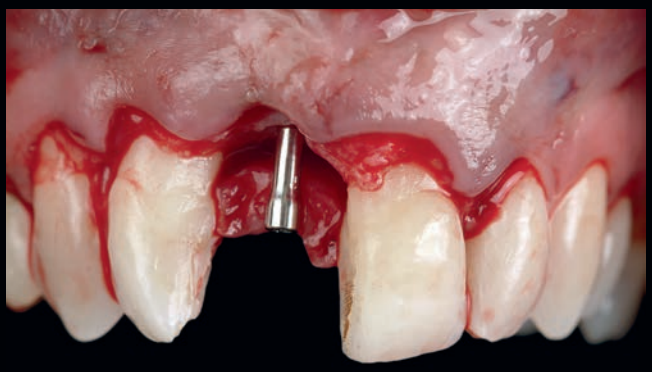
In recent years, single anterior implants have become a predictable treatment option when a tooth is missing or in need for extraction. The situation becomes more challenging when a veneer restoration has to be fabricated next to an anterior implant crown. Blending the color and especially the translucency of a veneer restoration with an adjacent crown is always difficult. To match both restorations in a simple manner, a screw-retained implant crown is the restoration of choice to allow shade matching of the zirconia abutment to the color of the prepared veneer abutment tooth. When the shade of the zirconia abutment is the same as the shade of the abutment tooth, the dental technician can build up both restorations in the same manner and create an optimal result. Key details are explained and depicted with two select clinical cases.

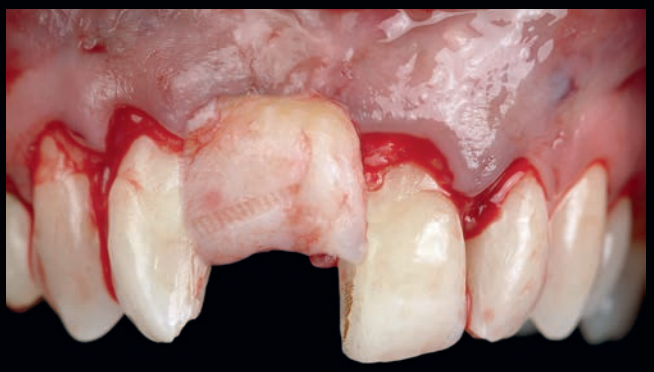
CASE 1

3 years postoperative

Preoperative



Slim healing abutment



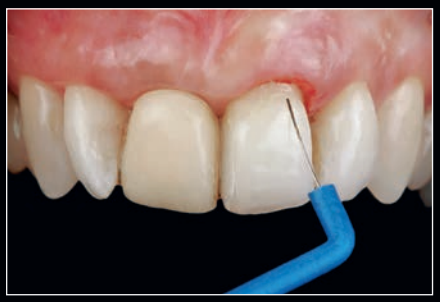
Connective tissue graft from tuberosity

- Final result 3 years after delivery of a single-tooth screw-retained implant restoration. A 3.0-mm NobelActive implant (Nobel Biocare) was placed in the area of the maxillary right central incisor and a feldspathic veneer on the left central incisor.
- Initial situation reveals a vertical and horizontal ridge defect in the area of the right central incisor.
- Implant placement with a Slim healing abutment in a one-stage surgery.
- Subepithelial connective tissue graft (CTG) was harvested from the tuberosity and sutured crestally on the ridge to minimize the tissue defect.

Provisional implant restoration with a flat tissue scallop allows for shaping of the ideal scallop with gingivectomy.

Zirconia abutment selection and shade communication.

Final implant impression was made to design and fabricate the zirconia implant abutment before the veneer preparation.



Gingival recontouring through gingivectomy to recreate ideal gingival scallop and align gingival levels.

Intracrevicular margin location for optimal tissue volume support and scallop.

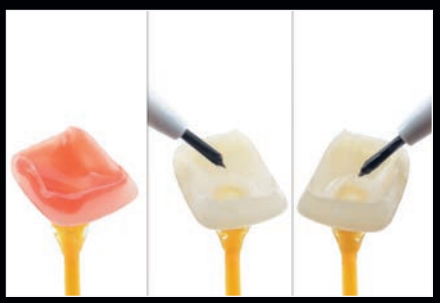
Try-in of the zirconia abutment: Light-cure stain was applied to accurately communicate abutment shade to the technician.

Abutment shade was reproduced in the laboratory with corresponding chroma and value.

Second try-in of the zirconia abutment to verify base shade of preparations before final delivery of the restorations.

The two veneers were layered and completed at the same time and in the exact same manner.

The veneer on the natural tooth was tried in before cementation with glycerin gel to assess shade, value, and color match of the two restorations.



The feldspathic veneer was then acid etched, silanated, and bonded to the abutment tooth.

Bonding only one veneer next to the implant restoration decreases bonding difficulty.

The zirconia abutment was bonded to a titanium post with resin cement due to the lack of metal connection for the NobelActive 3.0 implant.

Palatal view of both restorations with splinted teeth (with fibers) adjacent to the implant restoration to avoid extrusion.

3 years

Initial

3 years

Restorations: Screw-retained implant restoration to replace maxillary right central incisor and porcelain laminate veneer on left central incisor.

Materials used: Maxillary right central incisor—white color ZR NobelProcera, bonded with HO0 Multilink Hybrid abutment (Ivoclar Vivadent) to titanium abutment, engaging. Maxillary left central incisor—laminate veneer bonded with translucent resin cement G-CEM LinkAce (GC). Creation ZI-CT porcelain used for both restorations.

CASE 2

2 years

Initial

Final

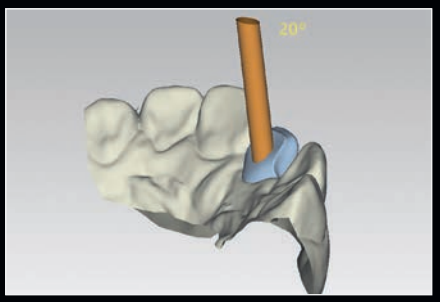
Initial

Provisional restoration on maxillary left central incisor and composite resin restoration on right central incisor were made to adequately support the soft tissues.

Two weeks after tooth extraction, immediate implant placement with NobelActive 5 × 13 mm and CTG.

Situation 3 months after surgery indicates ideal tissue contour and support.

Final impression was made with a customized impression coping to support emergence profile in the same manner as the provisional restoration.

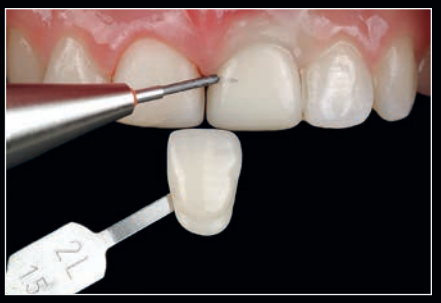


Design and fabrication of the screw-retained final zirconia abutment restoration with angulated screw channel (ASC, Nobel Biocare).

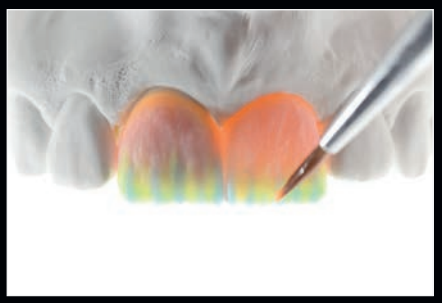
Veneer preparation and ASC zirconia abutment in situ.

Shade communication of the zirconia on day of veneer preparation with light curing (Optiglaze, GC).

Base color abutment is fired on top of the zirconia to match the shade of the natural abutment tooth.



Second try-in of the zirconia abutment is necessary after adjustment to verify color match of both abutments.



Porcelain veneering is completed in the same manner for both restorations.

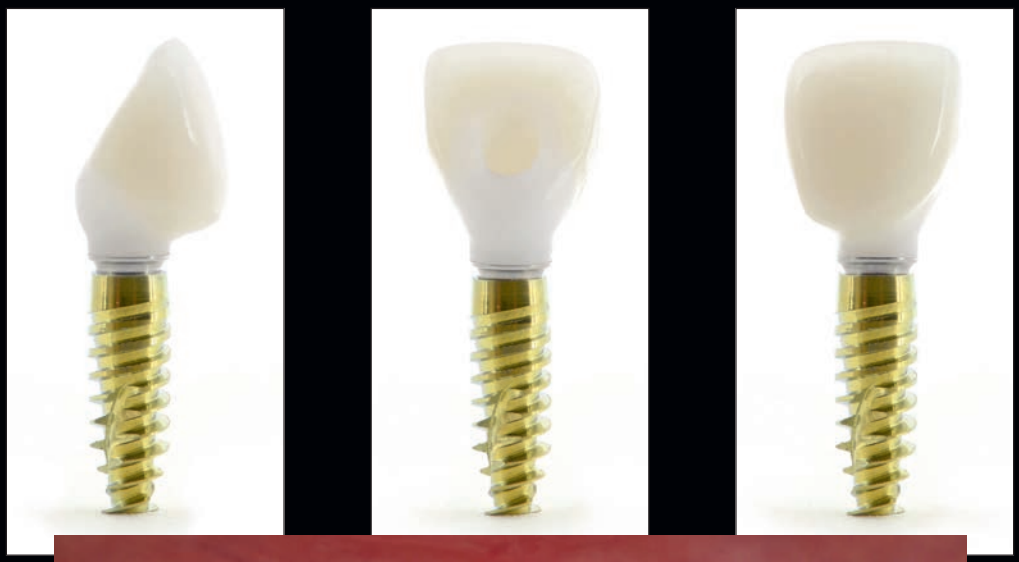
Laminate veneer on the natural tooth is bonded first to ensure accurate adaptation, followed by the screw-retained implant restoration to control interproximal contact areas.

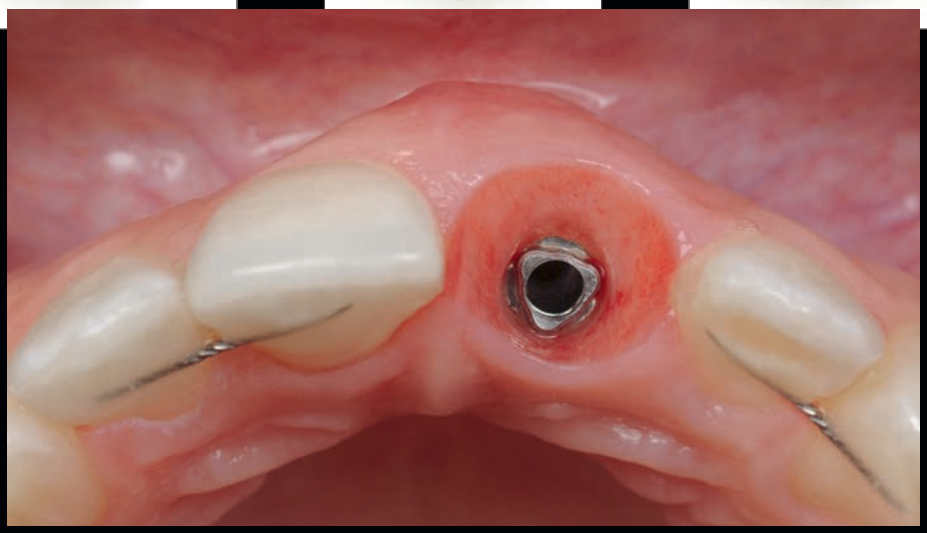
Final restorations on the master cast with the same veneer layering.

2 years

Restorations: Screw-retained implant restoration to replace maxillary left central incisor and porcelain laminate veneer restoration on the right central incisor.

Materials used: Maxillary left central incisor—white color ZR NobelProcera, with ASC abutment, 20-degree angulation. Maxillary right central incisor—feldspathic veneer cemented with translucent resin cement G-CEM LinkAce (GC). Creation ZI-CT porcelain used for both restorations.





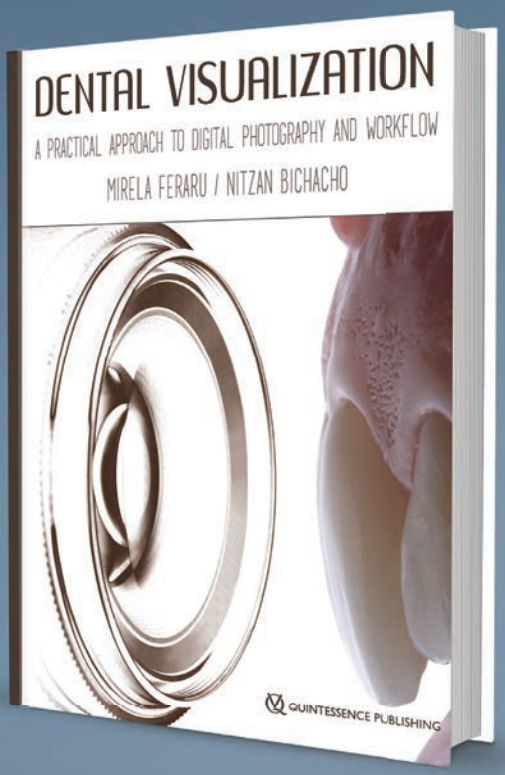
In all of our patients restored with a single implant, the teeth adjacent to the implant are splinted to avoid continuous extrusion of the teeth, especially in Class II malocclusion cases.

Benefits of this Protocol:

- Designing a screw-retained implant restoration allows the clinician to try in the zirconia abutment and match it to the shade of the natural abutment tooth after veneer preparation. The angulated screw channel (ASC, Nobel Biocare) can be angulated more than 25 degrees and thereby increases the possibility to fabricate screw-retained implant restorations by approximately 40%.
- The bonding procedure is simplified since only one veneer is bonded. The screw-retained restoration veneer is built up in the same manner as the laminate veneer.
- There is improved accuracy and adjustment of the veneer cementation as well as the interproximal contacts between the veneer and the implant restoration. The veneer is bonded first to ensure optimal marginal adaptation. Then, the screw-retained implant restoration is torqued down and interproximal contact areas are adjusted until ideal pressure is achieved.
- The shade match between both materials is better since the veneer porcelain layering is performed in the same manner on a verified base color abutment. The intention is always to cement the veneer with a translucent cement to not interfere with the overall value of the restoration and match of both restorations.

One disadvantage of this technique is that a second try-in appointment is necessary to verify the base shade of the prepared veneer and the zirconia abutment color to achieve the results illustrated in the cases presented.

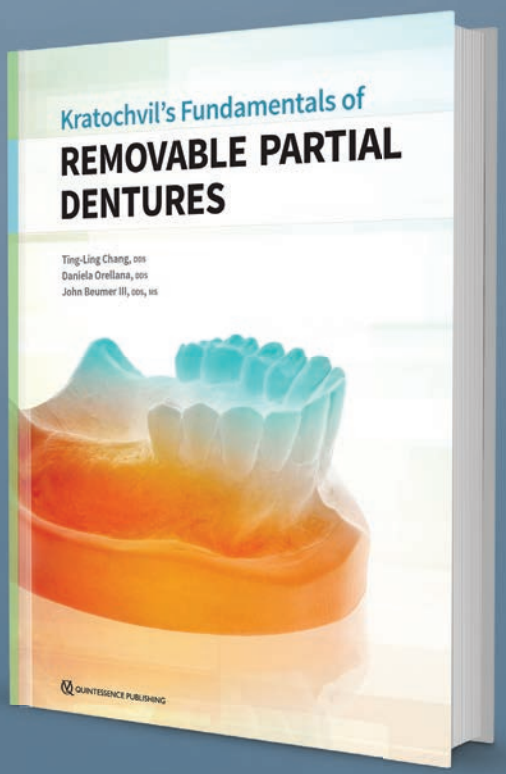
NEW TITLES FROM QUINTESSENCE



By Mirela Feraru and Nitzan Bichacho

This book provides the practicing clinician with a clear and concise guide to dental photography and its role in modern dentistry. The main aspects are broken down into easy-to-follow chapters, all lavishly illustrated with detailed images. Aspects such as the importance of digital documentation, camera components, and photographic equipment as well as simplified protocols for high-end results, different dental specialties, and troubleshooting are all covered within the book's pages. The authors have condensed their extensive knowledge and expertise into a book that will prove invaluable to all those looking to incorporate dental photography into their practice.

248 pages, 556 illus; ©2018; ISBN 978-1-78698-004-5 (B9104)
US $158



By Ting-Ling Chang, Daniela Orellana, and John Beumer III

This textbook provides an overview of the removable partial denture (RPD) design philosophy developed by Professor F. J. Kratochvil more than 50 years ago that is still used today. Topics include RPD components and functions, design sequences for maxillary and mandibular RPDs, and techniques for surveying and determining the most advantageous treatment position. A chapter dedicated to digital design and manufacturing of RPD frameworks highlights new technology in this emerging field. The authors provide illustrations of clinical cases throughout the book as well as an illustrated glossary of prosthodontic terminology. This book will prepare students and general practitioners to design and fabricate a biomechanically sound RPD framework for just about any dental configuration they encounter.

240 pp; 748 illus; ©2019; ISBN 978-0-86715-790-1 (B7901); **US $108**

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Integration of Digital Technology, Implants, and Adhesive Dentistry for Predictable Esthetic Results in Complex Anterior Rehabilitations

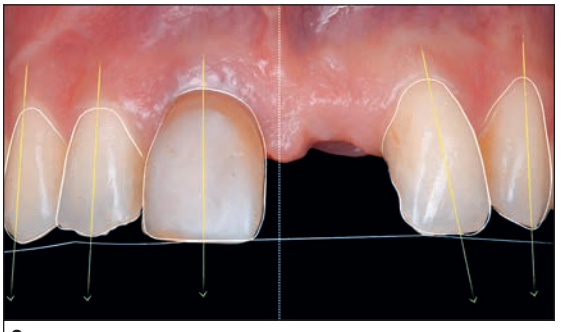
The increased demand for high-quality, functional, and natural-looking restorations has driven the development of new restorative materials, technologies, and techniques. Esthetic rehabilitation that combines the advantages of implant-supported prostheses to restore missing dentition and bonding procedures to restore adjacent teeth using minimally invasive approaches allows clinicians to significantly improve esthetics and correct altered teeth shape ultraconservatively.

In the past, the main objective of an implant treatment was to ensure osteointegration,[1] which might not always presuppose a successful esthetic outcome.[2] With the development of bone grafting materials, guided bone regeneration techniques, and digital treatment planning, the concept of implant treatment has changed to "restoration-driven implant placement."[3] Consequently, there has been an increased demand for esthetic and functional restorations with healthy peri-implant soft tissue.[4] Nowadays, one of the biggest challenges in dentistry is to restore a single anterior tooth with an implant-supported restoration that mimics all lost structures as closely as possible to those of the contralateral or original tooth.[5]

The advancements in dental ceramics and adhesive technology allow ultraconservative treatments to improve esthetics and function by modifying the morphology and/or shade of anterior teeth. The main advantage of using ultrathin ceramic restorations is maximum enamel preservation, which ensures the long-term success of the restorative treatment.[6] However, some situations, such as tooth discoloration and/or malposition, may require a large amount of dentin to be exposed during tooth preparation. In such situations, the clinician should be aware that the adhesive bonding protocol must be modified to create a reliable long-term resin-dentin interface.

1a

1b



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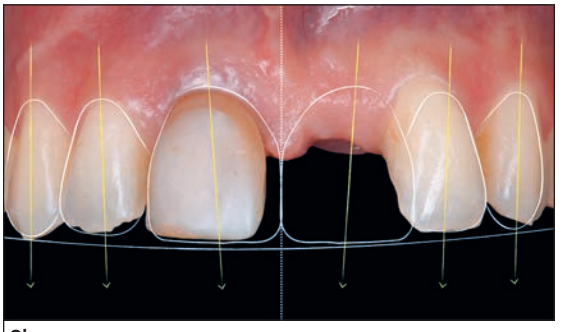


2b

Figs 1a and 1b Preoperative intraoral views. The patient is missing the maxillary left central incisor due to dental trauma, and the right central is discolored due to endodontic therapy.

Fig 2a Preoperative analysis of teeth outline and inclination. Note the flare of the teeth and inadequate relationship with the proposed midline.

Fig 2b Digital design depicting the ideal teeth proportions (width/length ratio) and inclination toward the midline. Digital analysis was used to explain the advantages and limitations of the esthetic treatment proposed.

Therefore, the aim of this article is to describe ultraconservative procedures to restore the esthetics and function of patients exhibiting discolored, missing, and misaligned anterior teeth while ensuring the appropriate longevity of the restorations.

CASE PRESENTATION

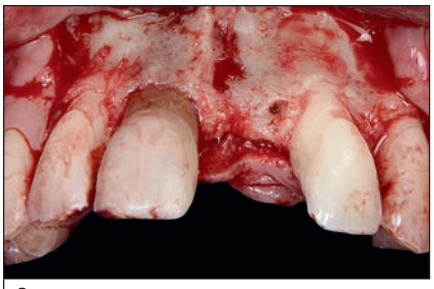
Initial Diagnosis and Treatment Planning

A 34-year-old systemically healthy nonsmoking male presented to the Advanced Operative & Adhesive Dentistry Program, Herman Ostrow School of Dentistry of University of Southern California, for esthetic treatment of his anterior teeth. The patient was missing the maxillary left central incisor due to trauma, and the right central was discolored due to endodontic therapy.

The success of esthetic and functional treatment of the anterior teeth depends on an adequate treatment plan. Photographs were taken of the patient's face with the lips in resting position as well as smiling to evaluate the lip competence and lip line position. Intraoral photographs were taken to evaluate the dental arrangement, smile line, gingiva position, occlusal planes, teeth color and shape, as well as emergence profile of the teeth (Figs 1a and 1b). A two-dimensional digital treatment planning was done using presentation software (Keynote, Apple) to facilitate interdisciplinary communication, as well as to discuss treatment options and limitations with the patient (Figs 2a and 2b).

Guided Bone Regeneration

Tooth extraction initiates various soft and hard tissue alterations that lead to a reduced alveolar ridge contour,[7] which is exacerbated if the tooth is traumatically removed.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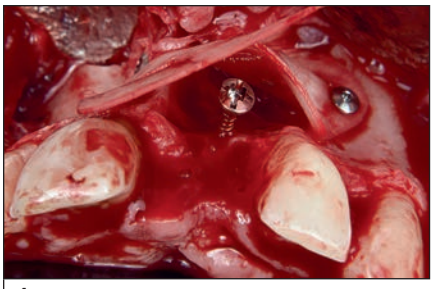
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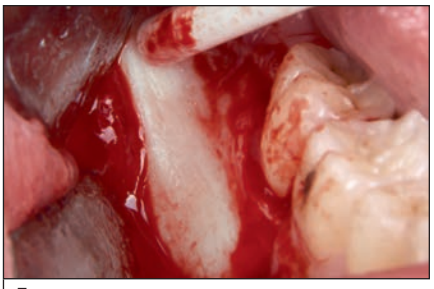
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Fig 3 Crestal incision with vertical releases and full-thickness mucoperiosteal flap elevation to expose the alveolar ridge deficiency site.

Fig 4 Tenting titanium screws positioned strategically in the alveolar ridge deficiency to create the potential threshold for horizontal bone gain of approximately 4 mm.

Fig 5 Autogenous bone graft harvested from the retromolar area with a bone scraper.

Fig 6 Autograft bone mixed with deproteinized bovine bone mineral applied on the alveolar ridge deficiency to cover the screw heads.

Fig 7 Resorbable membrane placed over the screws and grafted site, stabilized by two tacks in the apical portion.

Fig 8 Surgical site sutured, achieving tension-free primary closure.

In order to place an implant in the correct position for a screw-retained restoration, as well as have adequate gingival architecture and esthetics, the alveolar ridge deficiency must be corrected.[8,9] Reconstruction of the alveolar bone can be achieved through many regenerative surgical procedures, including guided bone regeneration; onlay grafting; combinations of onlay, veneer, and interpositional inlay grafting; distraction osteogenesis; ridge splitting; as well as a multidisciplinary approach utilizing forced eruption.[10]

The tent screw pole technique is a safe and effective method for augmentation of bone height and width in severely resorbed ridges.[10] During the healing period, the tenting screws maintain the volume and the geometry of the space. This allows for the stabilization of the blood clot and undisturbed healing. The tenting effect facilitates successful bone augmentation with a high predictability, low risk of complications, and reduced healing period.[10] This helps prevent the soft tissues from contracting around the graft material and subsequently displacing it or causing physiologic resorption.[9]

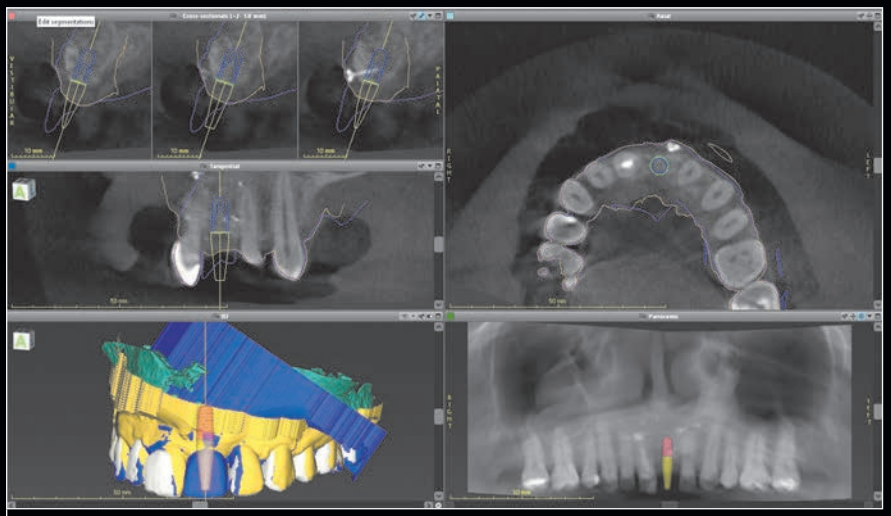
A crestal incision with vertical releases was made and a full-thickness mucoperiosteal flap was elevated (Fig 3). Two 12-mm-long titanium screws (Trutent Tenting Screw, ACE Surgical Supply) were placed in the alveolar ridge deficiency area with approximately 4 mm of the screw exposed above the alveolus, maintaining space for the graft (Fig 4). Autologous bone was harvested from the retromolar area with a bone scraper (Fig 5). The autogenous bone chips were mixed with deproteinized bovine bone mineral (Bio-Oss, Geistlich Pharma) at a ratio of 1:1. The graft material was placed into the site until only the surface of the screws was visible (Fig 6). Then, a resorbable membrane (OsseoGuard, Zimmer Biomet) was placed over the screws and grafted site. Additional stabilization of the resorbable membrane was achieved using two tacks in the apical portion (Fig 7). The surgical site was sutured using 5/0 polytetrafluoroethylene (Cytoplast PTFE suture, Biohorizons) and 5/0 polypropylene sutures (Perma Sharp Suture, Hu-Friedy) to achieve tension-free primary closure (Fig 8).

9

10

Fig 9 Postoperative view after 6 months of healing.

Fig 10 Anterior esthetic and functional wax-up based on the two-dimensional digital treatment planning (compare to Fig 2b).



11

Fig 11 Diagnostic wax-up digitalized and combined with the patient's maxillary impression and CBCT file to plan the implant placement position and angulation.

12

13

Fig 12 Surgical guide printed with the selected implant sleeve.

Fig 13 Intraoral evaluation of the surgical guide fit.

Digital Treatment Planning for Implant Placement

After 6 months of healing (Fig 9), a cone beam computed tomography (CBCT) scan was taken to evaluate the augmented bone site. A maxillary esthetic and functional wax-up (Fig 10) was digitalized using CAD/CAM software (PlanScan, Planmeca) and merged with the CBCT scan (Fig 11) using implant planning software (coDiagnostiX, Dental Wings). The implant position and angulation were digitally determined, and a surgical guide for the implant placement was fabricated. The guide was printed and a sleeve designed for the Straumann Implant System to be used was placed on the implant access hole (Fig 12). The surgical guide fit was then intraorally verified to confirm the adaptation before the surgical implant placement (Fig 13).

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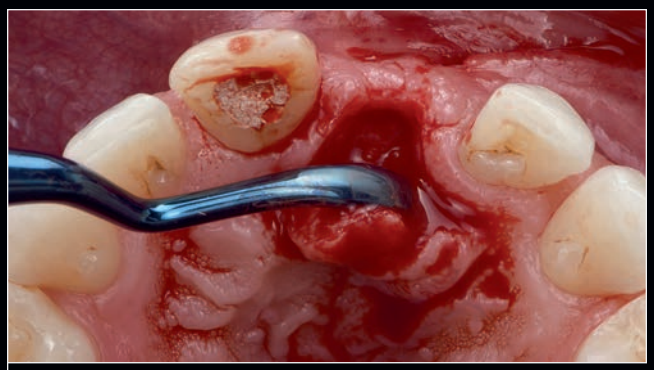

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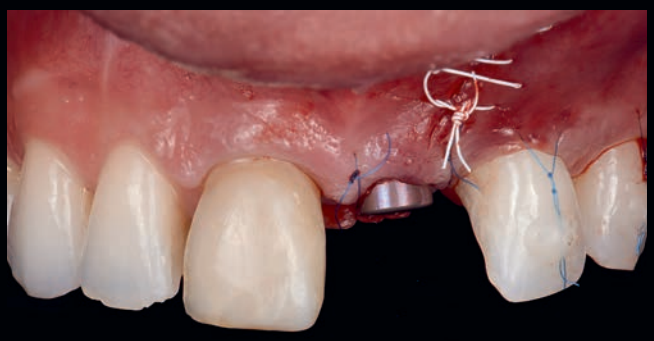

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Fig 14 Vestibular incision subperiosteal tunnel access (VISTA technique) to retrieve the tenting screws.

Fig 15 Sigmoidal incision on the palatal side to gain access to the bone crest.

Fig 16 Drilling sequence for the implant placement according to the digital treatment planning.

Fig 17 Implant placed subcrestally.

Fig 18 VISTA technique of coronal gingival advancement to correct the gingival level on maxillary left side.

Implant Guided Surgery and Coronal Advancement

To minimize the surgical trauma, a vestibular incision subperiosteal tunnel access (VISTA) was used to retrieve the tenting screws.[11] Through this incision, a subperiosteal tunnel was created using a series of specially designed elevators, extending toward the vestibular depth, as well as the ridge crest (Fig 14).

After removal of the tenting screws, a sigmoidal incision was made on the palatal side to gain access to the bone crest (Fig 15). The drilling sequence was done according to the digital planning using the surgical guide and the corresponding sleeves and drill handles (Fig 16). After the implant bed preparation, a Straumann Bone Level 4.1 × 12-mm implant was inserted subcrestally with a torque of 35 Ncm (Fig 17) and a 4-mm-long RC healing abutment was placed. Lastly, using the VISTA technique, a coronal advancement was done for the adjacent lateral incisor and canine using 5/0 polypropylene suture (Perma Sharp Suture, Hu-Friedy) bonded to correct the gingival level. The vestibular incision was sutured with 5/0 PTFE suture (Cytoplast PTFE suture, Biohorizons) (Fig 18).

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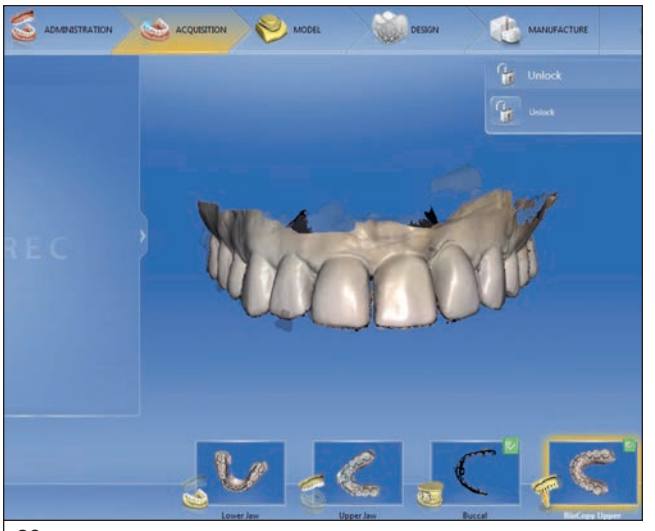

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21b

Fig 19 Clinical aspect 4 months after implant placement and coronal gingival advancement.

Fig 20 Virtual 3D models imported into CAD/CAM designing software to fabricate the provisional screw-retained implant restoration.

Figs 21a and 21b Interim restoration milled, polished, and connected to the titanium base.

CAD/CAM Provisional Restoration Fabrication

Adequately restoring function and esthetics for implant restorations in the esthetic zone is a challenge.[12] In addition to surgical modification, soft tissue management with provisional restoration plays a crucial role in the esthetic outcome.[1] In other words, the final esthetic results of single implant restorations are influenced by the shape and position of the implant, soft tissue management during the surgery, design of the provisional restoration, type of abutment, and characteristics of the definitive restoration.[5] Therefore, to create a satisfactory esthetic treatment it is important to mimic all lost structures as closely as possible to those of the contralateral tooth.[13]

Four months after the implant placement (Fig 19), the healing abutment was removed and immediately replaced by a digital scan-post. A radiograph was taken to confirm the scan-post position, a scan-body was then placed on the scan-post, and the maxilla was scanned using an intraoral scanner (CEREC, Dentsply Sirona). The virtual 3D models of the scan-post, diagnostic wax-up, mandible, and patient's occlusion were imported into the CAD/CAM designing software to fabricate an interim implant-supported restoration (Fig 20).

The aim of a provisional implant-supported restoration is to restore the masticatory function and the contour of the peri-implant soft tissue to create an optimum emergence profile for the final restoration. The provisional restoration was designed, based on the morphology of the diagnostic wax-up, and milled in a block of microfiller-reinforced polyacrylic (CAD-temp Multicolor, VITA Zahnfabrik) (Fig 21a). The screw-retained provisional restoration was polished and bonded to the titanium base (TiBase, Dentsply Sirona) using dual-cure resin cement (Fig 21b).

Direct Gingival Recontouring

The provisional implant restoration was connected to the implant and the subgingival contours were gradually recontoured to modify the soft tissue profile around the im-

Fig 22 Interim restoration connected to the implant before subgingival recontouring.

Fig 23 Facial view of the interim restoration connected to the implant after correction of the subgingival contours.

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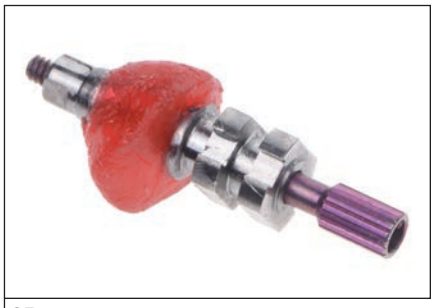

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Fig 24 Aspects of the completed interim screw-retained restoration used to modify the soft tissue profile around the implant.

Fig 25 Customized impression coping fabricated to transfer the emergence profile contours and position of the gingiva from the interim to the final implant-supported restoration.

plant (Fig 22). The direct contouring technique allows the clinician to gradually modify the restoration while gauging the effect on the peri-implant tissues to optimize the esthetic results. Areas of residual gingival blanching that were present after 15 minutes were reduced; in areas with a lack of peri-implant tissues, pressure flowable nanofilled composite resin (Filtek Supreme Ultra, 3M ESPE) was added.[14] The modified areas of the emergence profile of the provisional restoration were then properly polished for precise soft tissue management. This approach allows the tissues to gradually adapt to the pressure, without overstressing the elasticity of the gingival tissue,[15] as well as allows soft tissue maturation and a chance for the patient to try the esthetics and function of the restoration before the final inpression.[16]

The provisional restoration was relined and reshaped three times, so that the soft tissue was managed and guided to achieve the desired emergence profile (Fig 23). Ideally, the modified emergence profile of the provisional restoration should contain two specific areas: *(1)* a concave area, about 1 mm subgingival and continuing for 360 degrees around all margins of the provisional restoration, to provide a nonsurgical increase in tissue thickness and long-term stability, and *(2)* an interproximal subgingival area that should be convex to support the papillae (Fig 24).[5] After 6 weeks, a customized impression coping was fabricated to transfer the emergence profile contours and position of the gingiva from the provisional restoration to the definitive prosthesis (Fig 25).

Shade Correction and Restoration Prototypes Try-in

Bleaching procedures should be performed before the tooth preparations to balance the shade among different teeth. The teeth were bleached using a combination of in-office and at-home techniques,[17] as well as nonvital tooth bleaching on the endodontically treated tooth. Two weeks after completion of the bleaching treatment, shade matching was done visually and with the aid of a spectrophotometer (Easy Shade, Vita), and dental photographs were taken to register the color of the hydrated teeth.

The morphology of the restoration prototypes were transferred from the waxed diagnostic cast to the patient's mouth using a polyvinyl siloxane impression filled with a chemical-cure multifunctional methacrylic ester resin (Integrity, Dentsply Sirona).[6] After the resin polymerization,