2017 QDT

QUINTESSENCE OF DENTAL TECHNOLOGY

40th Anniversary Issue

Sillas Duarte, Jr, DDS, MS, PhD
Editor-in-Chief

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Celebrating the *Quintessence of Dental Technology*

Recent data from the American Dental Association Health Policy Institute has revealed that dental care is at the highest rate ever for children but continues to decline for working-age adults. It was noted that only a third of working-age adults seek regular visits to the dentist, the cost to obtain dental care being their main concern. Unfortunately, despite several years of economic recovery, overall spending in dental care has leveled off. To complicate the scenario, the number of new dentists and dental technicians entering the market has grown significantly, and their education debt exponentially. As a consequence, substantial pressure is now placed on newcomers—solo or small-group business owners—to have their practices succeed. The competition that a dental health service provider faces has reached a new and distinct level of complexity. Those that can offer the highest quality of care customized to each individual patient's personal needs, while also providing education and motivation for their customers, will thrive in today's insensitive business environment. Professionals must therefore constantly update their knowledge of innovative concepts, trends, techniques, and biomaterials to ensure a dynamic practice allied to long-term success.

Reliable sources of knowledge and information that can excite, nurture, and inspire while being scientifically trustworthy are essential for our professional growth. In 1976, just such a publication was born. For 40 years, *Quintessence of Dental Technology (QDT)* has reliably instituted what is considered the state of the art in restorative dentistry and has in many ways revolutionized the way it is practiced today. This has been possible over the last four decades because of *QDT*'s legacy of addressing common and newer clinical challenges unconventionally, and yet scientifically.

It is remarkable to note that many of the renowned worldwide experts and lecturers in our field initiated their careers with articles in *QDT*. Moreover, many of them are still actively working to be part of this essential publication in dentistry. Every year, I receive numerous requests and submissions from authors vying for space in the book. The vast majority of those submissions strive for the highest standards and reveal beautiful work, but only those that can truly move our profession forward can be accepted. Once a manuscript has been accepted, a team of amazing professionals devotes their time (including nights, weekends, and holidays) and expertise to carefully revise each sentence within the text, while another team inspects each single image for resolution, quality, sharpness, and color. Each article is then crafted as a piece of art, and the layout—including the location of each image and the position of the text within the layout—is reviewed numerous times until its final approval. The world is changing fast and we are moving faster to promote and foster excellence in our profession.

This commemorative edition is dedicated to all our mentors, teachers, and family members who supported us to achieve our dreams. My dear friends, please join me in celebrating the 40th anniversary of *Quintessence of Dental Technology*.

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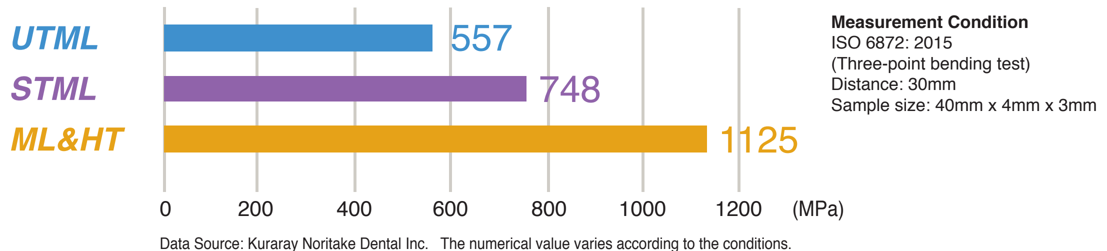

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Volume 40

QUINTESSENCE OF DENTAL TECHNOLOGY

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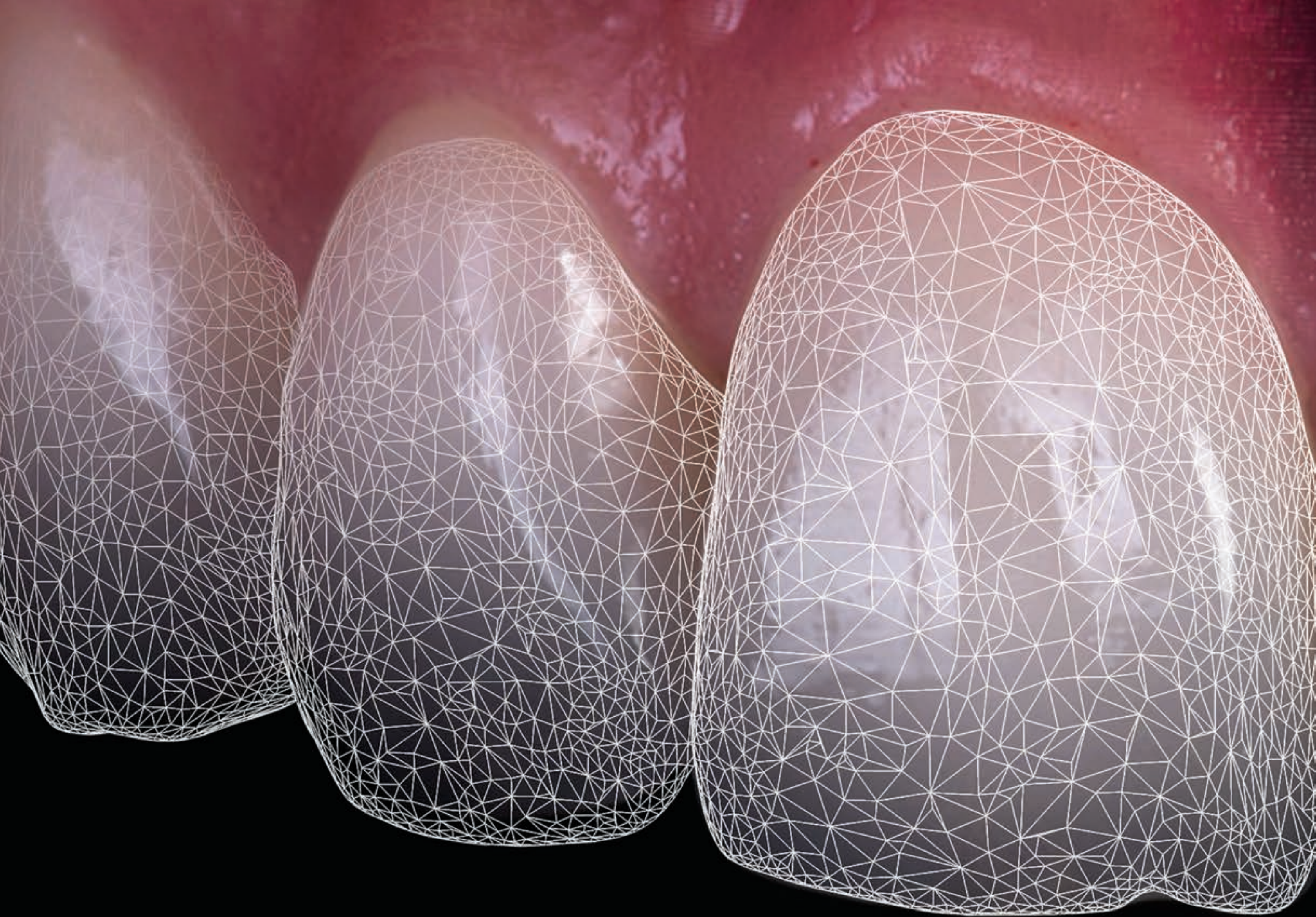
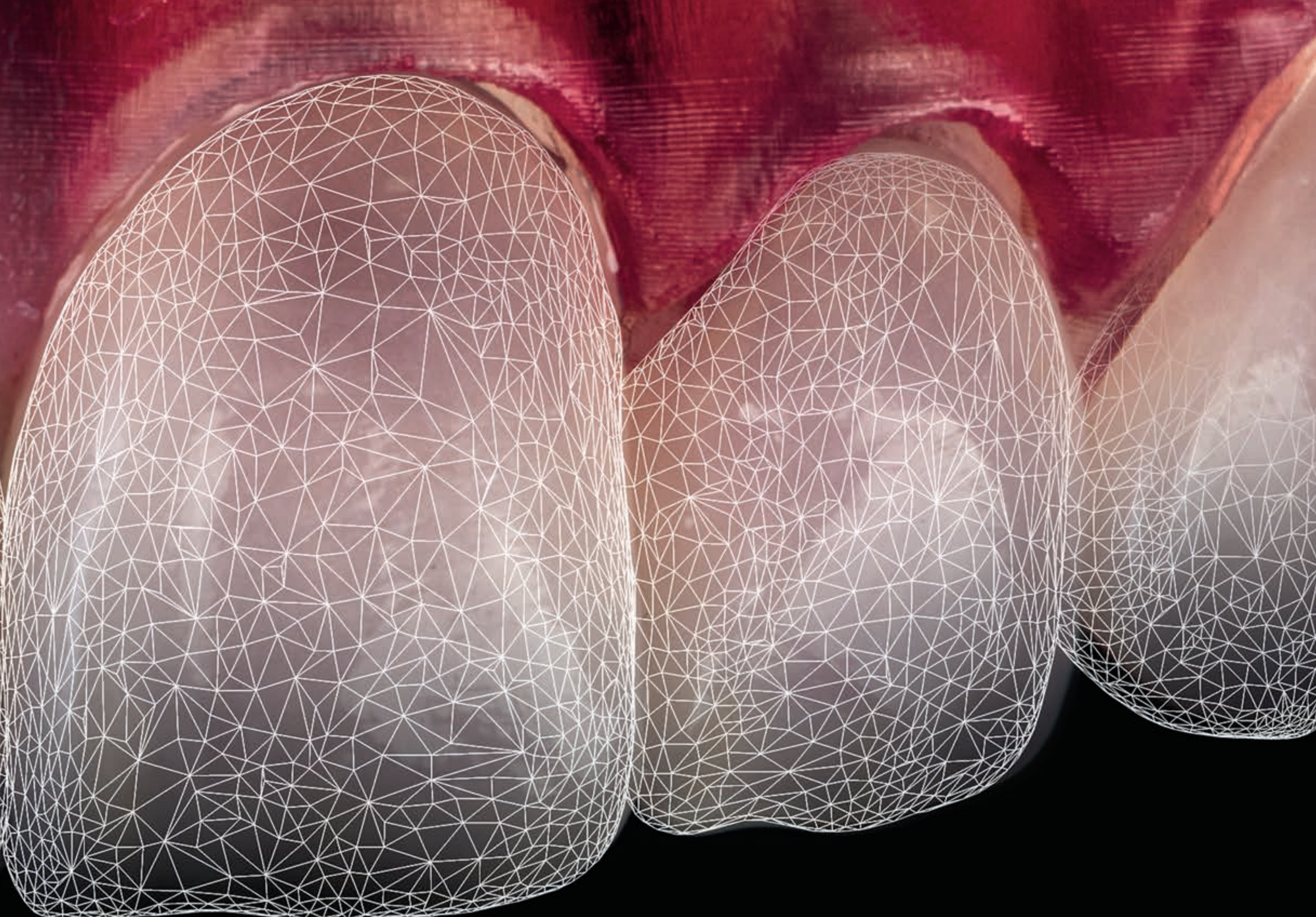


State of the Art

RAW

A Digital Workflow



Florin Cofar, DDS[1]
Ioan Cofar, DDS, CDT[1]
Lorant Stumpf, CDT[2]
Ioana Popp, CDT[1]
Alejandro Pineda, DDS[3]
Eric Van Dooren, DDS[4]

[1]DENTCOF, Timisoara, Romania.
[2]CDC Dental Laboratory, Carlow, Ireland.
[3]Private Practice, Lhasa, Uruguay.
[4]Private practice limited to prosthodontics, implants, and periodontal plastic surgery, Antwerpen, Belgium.

Correspondence to: Dr Florin Cofar, DENTCOF, 62 Simion Barnutiu Street, Timisoara 300302, Romania. Email: florin.cofar@dentcof.ro

Fig 1 The digital clone.

RAW is a digital Skyn workflow that aims to copy intact teeth and transfer this information to dental restorations simply by using digital technology. During this digital workflow, the intricate dental morphology observed on an intact tooth is digitally acquired, duplicated, exported to a tooth to be restored, and preserved throughout the entire oral rehabilitation—from the diagnostic mock-up to the final restoration.

In digital design, the dental morphology and tooth shape seen by the dentist and technician are interpreted by the computer as a three-dimensional geometric mathematical model. Controlling the geometry provides freedom for the practitioner to develop a restorative digital plan that can be followed throughout the treatment of the patient. This article describes the novel concepts for treatment planning and execution in the digital era.

THE PATIENT DIGITAL CLONE

(Fig 1)

Traditionally it takes several in-person patient appointments for the dentist to collect all the information needed to proceed with an esthetic treatment plan. These consultations require a significant amount of time and effort by the entire restorative team, which includes laborious hours spent developing wax-ups and putting together the treatment plan.

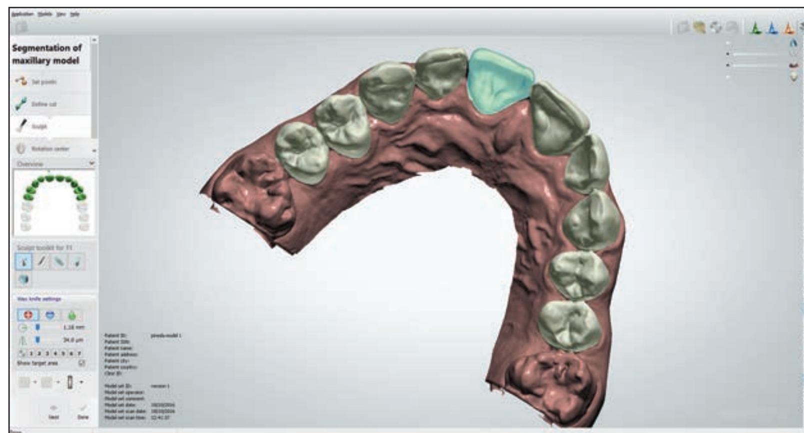
The “digital clone” is a modern version of the consultation appointments, in which all data collected are synthesized and assembled digitally for treatment planning. Thus, digital medical and dental records are obtained, STL (STereo Lithography) files are generated by digitally scanning both dental arches, DICOM (Digital Imaging and Communication in Medicine) files are acquired through cone beam computed tomography (CBCT), and a photo-video protocol is produced. This combination of data produces the “patient digital clone,” which eliminates the need for the patient to be present during multiple treatment planning sessions, and multiple appointments among different specialists, which would otherwise delay the treatment planning process.

The patient digital clone can be shared digitally among the restorative team, and all those involved are able to assist in real time to create a collaborative and ideal treatment plan. No boundaries exist among restorative dentist, dental technician, and all other specialtists (periodontist, orofacial pain specialist, endodontist, orthodontist), so treatment planning and delivery can be carried out more efficiently.

CREATING A SMILE LIBRARY

(Figs 2 and 3)

If shape is geometry, dental morphology is also geometry. Evaluating natural dentition provides an unlimited library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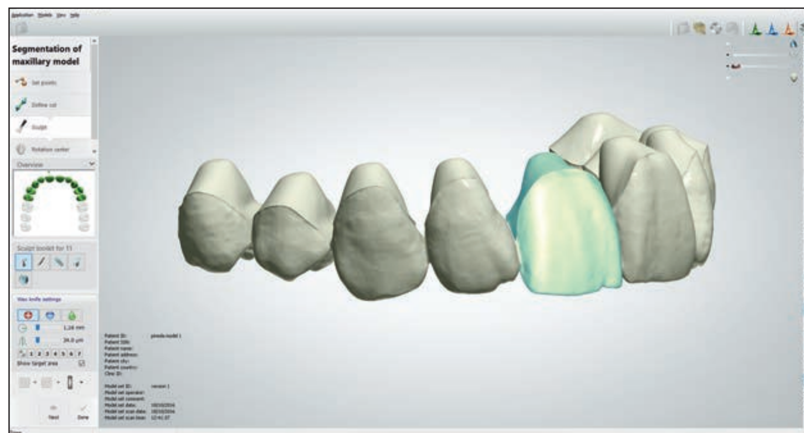
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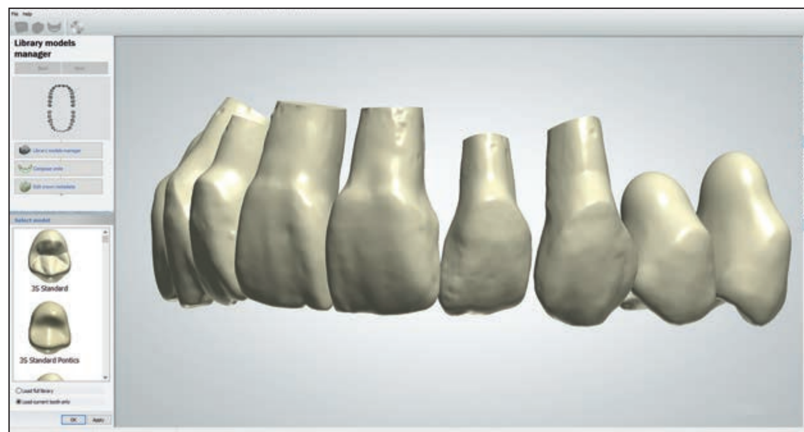
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Figs 2a and 2b Extracting morphology by segmenting with Ortho Analyzer.

Fig 3 Natural morphology library created using ScanIt library.

of possible tooth designs and teeth arrangements. Every tooth design created by nature is unique. The use of digital scanners (ie, TRIOS 3, 3Shape) allows us to create our own library of tooth designs. Once a patient is scanned, the arch scan can be segmented into individual STL files of each tooth to be restored using tools such as Ortho Analyzer (3Shape). The individual STL files can then be organized into smile libraries, using ScanIt library (3Shape).

4a

4b

Figs 4a and 4b Designing using natural morphology with RealView Function.

USING THE LIBRARY TO DESIGN *(Fig 4)*

With the RealView function (3Shape Dental Designer), the digital model (STL of the arch) can be aligned with the photographs of the patient. The initial design is made from a facially driven perspective, allowing real-time feedback from the team. Individual STL files are then imported from the digital library and positioned on the area to be restored, and the smile is designed using Smile Composer (3Shape). At any time it is possible to render a preview using the RealView function. Once the diagnostic design of the definitive restorations is finalized, it is added to the scan of the arch and the final STL file is exported for 3D printing to produce the digital mock-up.

3D-PRINTED DIAGNOSTIC MOCK-UP *(Figs 5 to 8)*

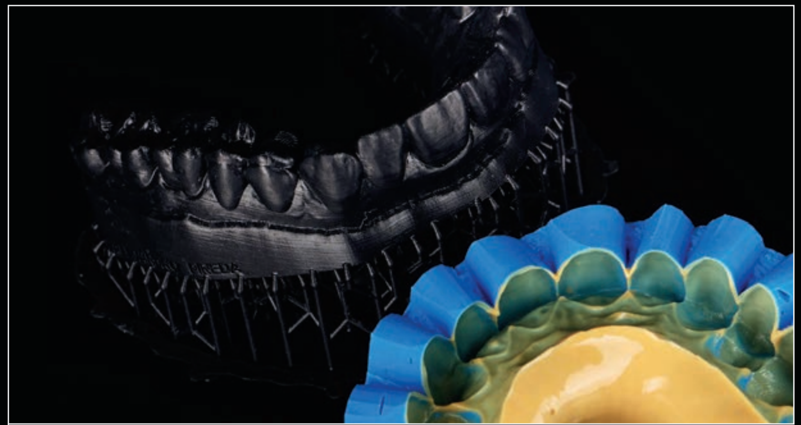
The 3D-printed diagnostic mock-up is an essential step that allows the patient to evaluate the esthetics and give consent for the proposed treatment. However, the diagnostic

Fig 5 Transfer of 3D-printed design with silicone index and bis-acryl.

Fig 6 Painting the areas that will be removed. Diagnostic mock-up is used to get consent for the reduction that will follow.

Fig 7 Patient with diagnostic mock-up in place.

Fig 8 Intraoral view of diagnostic mock-up.



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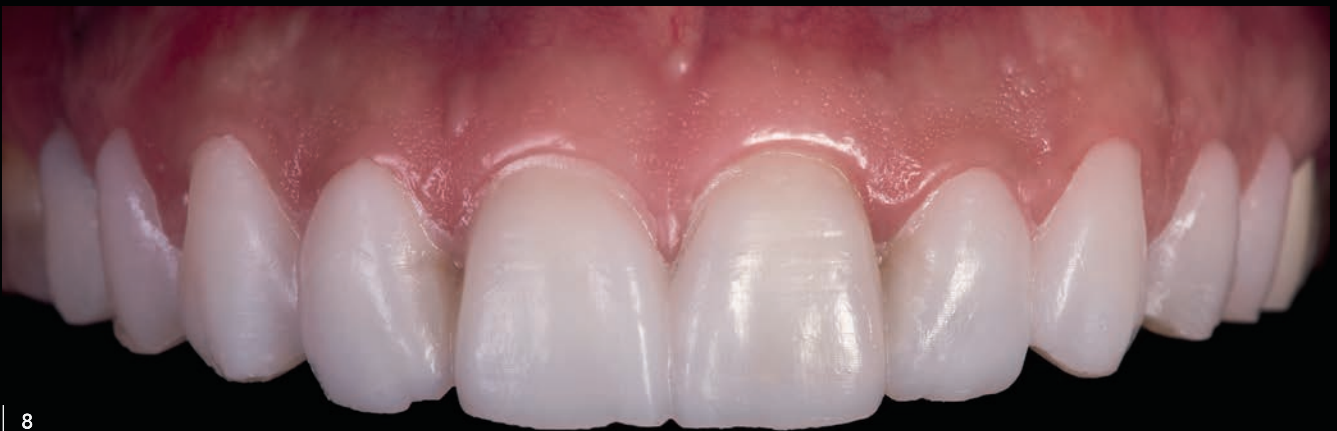

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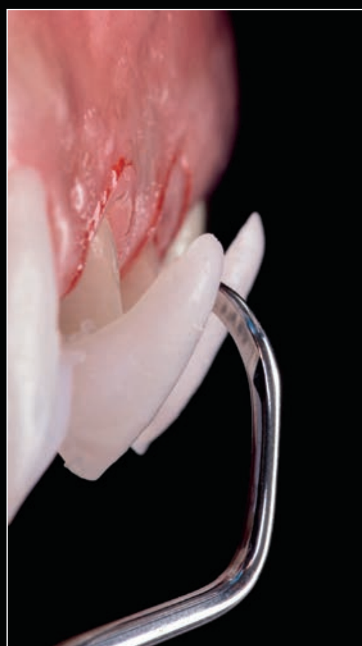
esthetic design of the smile is generated over the existing dental conditions of the patient. Thus, patients should be informed that the mock-up might feel slightly bulky since it is placed buccally from the existing teeth. Once the patient understands this, the clinicians should videotape the patient before and after placement of the 3D mock-up in the mouth. Since in most cases the design is additive and may be perceived as slightly bulkier than the final restorations, it is always advised to present the patient using frontal photographs or videos. Only after the patient has accepted the diagnostic mock-up and formally agreed to the treatment plan should the restorative team be allowed to surgically intervene.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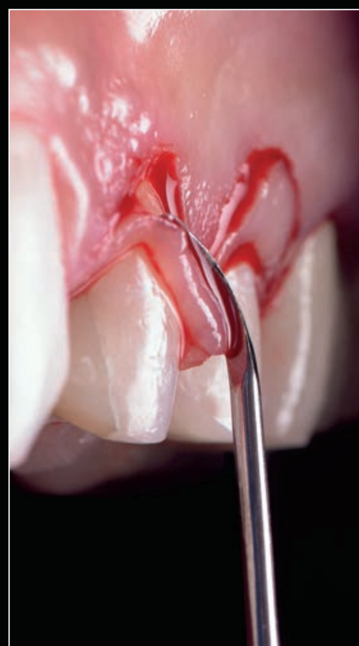
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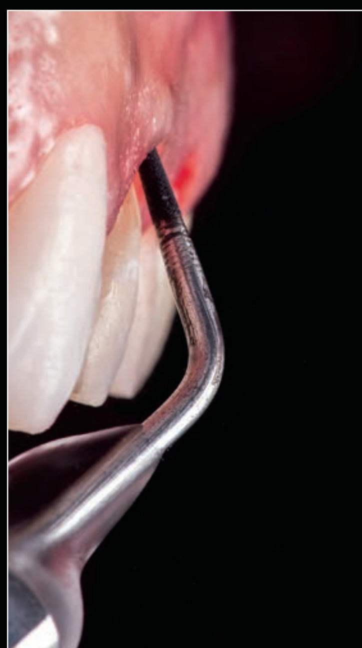
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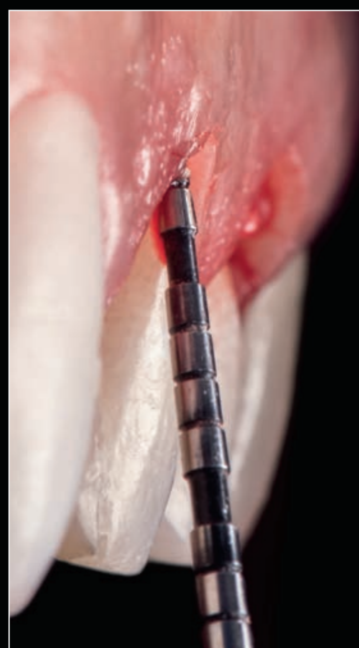
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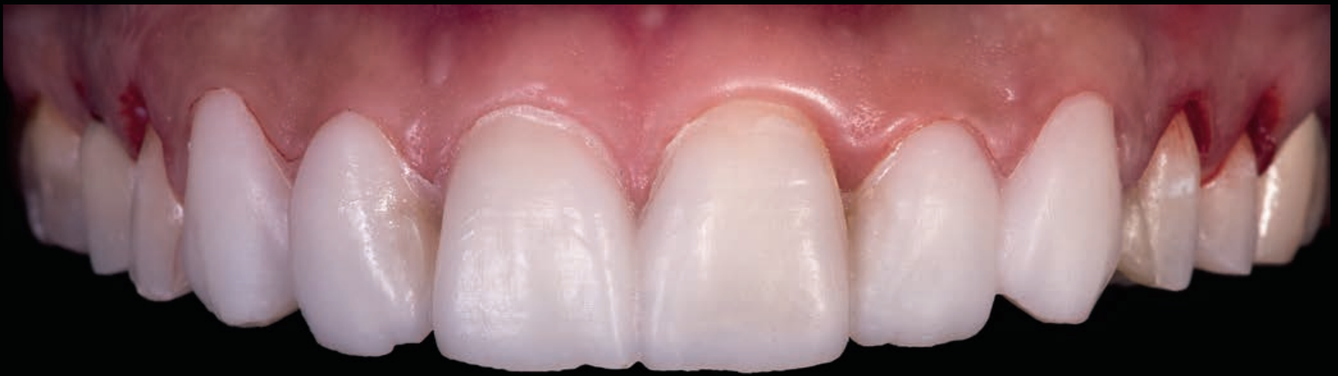
DIAGNOSTIC MOCK-UP AS A SURGICAL GUIDE *(Figs 9 to 11)*

The 3D diagnostic mock-up can be also used as a surgical template for esthetic gingivectomy or crown lengthening. In the clinical case shown, the mock-up ensures proper placement of the gingival zenith. Once the soft tissue is recontoured, as guided by the mock-up, the biologic width is modified using an ultrasonic diamond tip with a flat surface (CV Dentus) under copious water-cooling. The flat surface of the diamond tip allows, in some cases, flapless bone reduction without damaging the soft tissue. In this type of procedure, which is indicated for cases with thin buccal bone, the enamel preparation and scanning can be performed on the same day.



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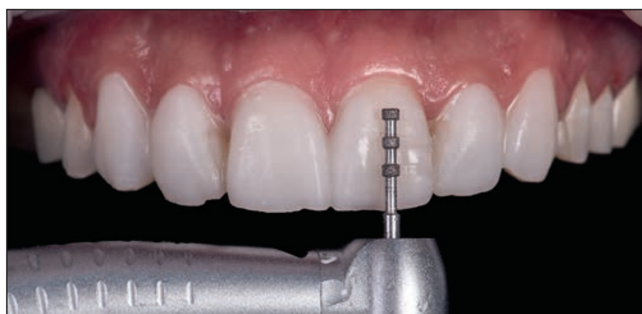
11a

11b

Figs 9a to 9d Soft tissue recontouring sequence. *(a)* Gingivectomy using diagnostic mock-up as guide. *(b)* Soft tissue removed. *(c)* Bone reduction. *(d)* Biologic width checked.

Fig 10 Situation after crown lengthening.

Figs 11a and 11b Rescanning the area of crown lengthening in a standard copy of the original scan.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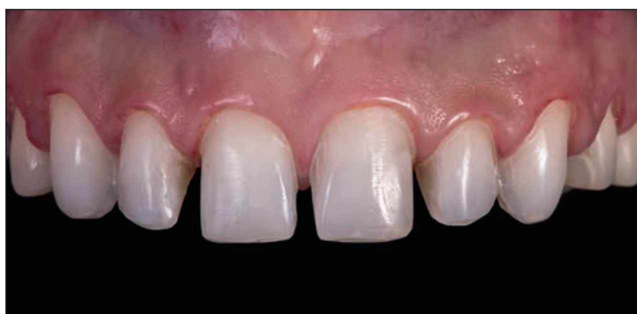
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14a

14b

Fig 12 Using the design as a preparation guide (Aesthetic Pre-evaluative Temporaries, APT).

Fig 13 Final preparations.

Figs 14a and 14b Rescanning the preparations in a standard copy of the original scan.

FINAL MOCK-UP: PRESERVING THE GEOMETRY

The final digital design of the restorations should maintain the same geometry as the 3D diagnostic mock-up. The only difference is that the geometry of the final design is then revised over the prepared teeth. Thus, only the sagittal axis differs from the diagnostic design, since after soft and hard tissue recontouring and tooth preparation, the final digital design can be repositioned slightly more lingually and the emergence profile revised. At this stage, if the patient is videotaped from the front, the two designs (digital diagnostic and final designs) should look alike, since the geometry used is identical. The variation in sagittal axis between the diagnostic and final designs is translated into an increase in interproximal space and a proper emergence profile. These details are usually not perceived when the patient is photographed or filmed from the front.

FINAL MOCK-UP AS PREPARATION GUIDE

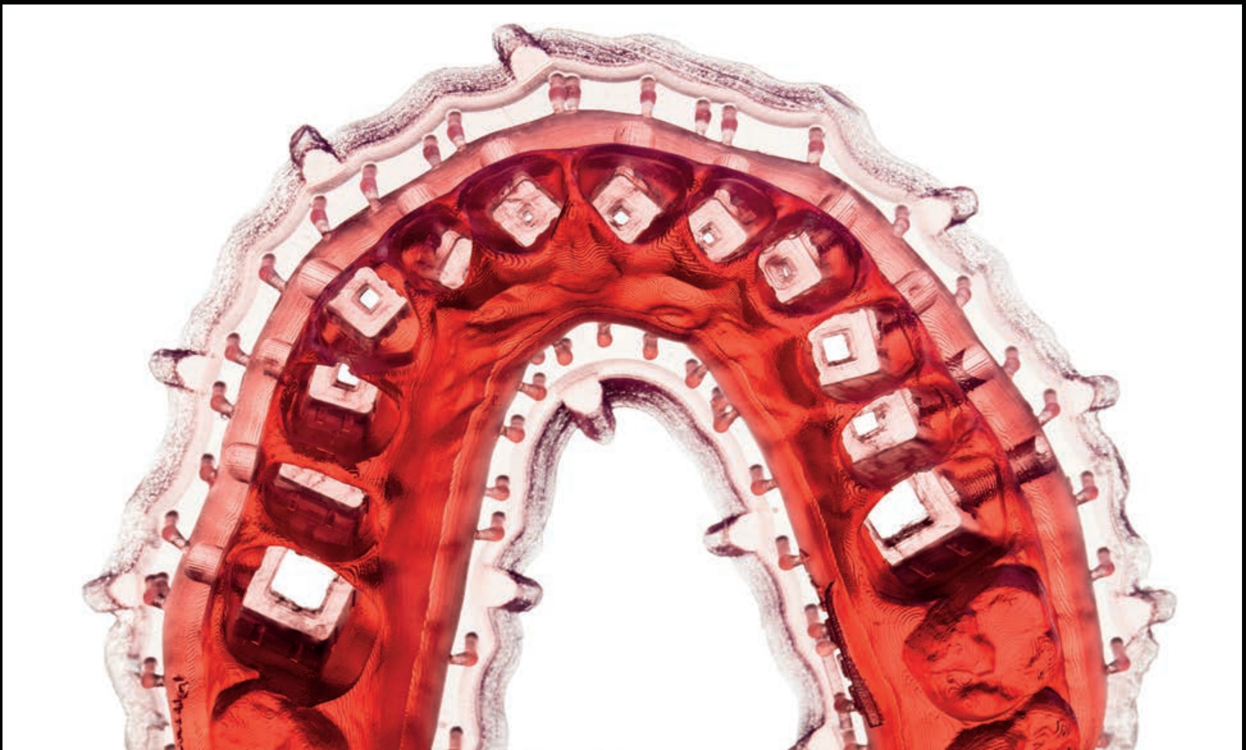
(Figs 12 and 13)

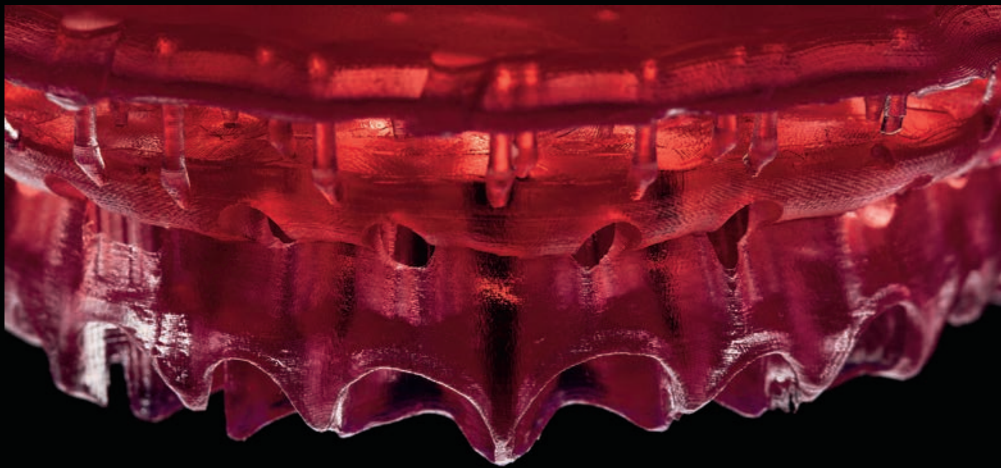
While the diagnostic mock-up can serve as a tool for getting the patient's consent for treatment and as the surgical template, the replication of the ideal design intraorally is extremely important for tooth preparation. Ultraconservative preparations are made over the mock-up to ensure maximum preservation of dental tissues.

3D-PRINTED ALVEOLAR MODEL

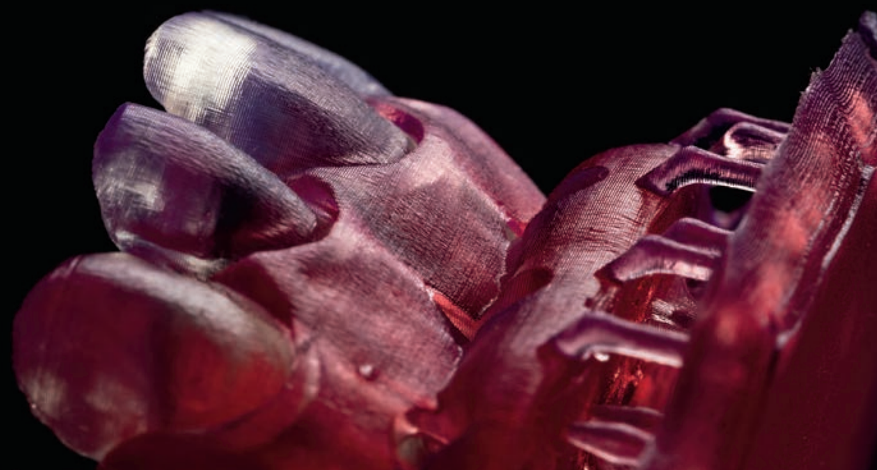
(Figs 14 and 15)

The digital alveolar model is created from the preparation scan using 3Shape Model Builder. Separate colors can be used for the dies and for the base. Models are printed with a digital 3D printer (Formlabs 2 Desktop Printer). The precision observed in the 3D printing averages 25 microns and can serve definitively as a working model.





Figs 15a to 15c 3D-printed alveolar model.



DESIGNING THE RESTORATIONS: SCAN ALIGNMENT

One of the major challenges in the digital workflow is scan alignment. Lack of alignment can produce error factors that make the process more cumbersome and complex. Manual alignment can also be highly complicated and the results inadequate. In order to achieve perfect alignment among the images and design, the scanner must first be calibrated with guidance from the manufacturer. The initial scan is performed at the very start of the case, as a part of the digital clone. Whatever change is done to the clinical situation, a standard copy of the original scan is created and the area (tooth or region) modified is deleted and the same area rescanned. For instance, after crown lengthening, the gingival levels are rescanned and the original levels deleted in order to correct to the new emergence profiles. In the digital workflow it is common to have multiple different scans of the same region of a patient (ie, an initial scan, one after periodontal surgery, and another of tooth preparations). By staging the scanning in different moments, the STL files can be aligned and the reference for design is maintained. Therefore, the most important scan and design of the entire digital workflow is the first one, since it will be needed for some fine tuning and adapting the guided changes to the current clinical situation.

DIGITALLY DESIGNED PROVISIONALS

(Figs 16 to 18)

Polymethyl methacrylate (PMMA) milled restorations are a perfect alternative to bis-acryl provisionals. Bis-acryl tends to flow in areas of undercuts, masking irregularities of the preparation that may generate problems during final delivery. In contrast, milled PMMA restorations based on the digital design produce superior marginal fit and longevity, in addition to allowing the patient the opportunity to evaluate the final outcome. If the patient demands any correction, it can be produced and replicated on the final restoration. Furthermore, this technique is an inexpensive solution that accurately simulates the process of ceramic manufacturing (milling).

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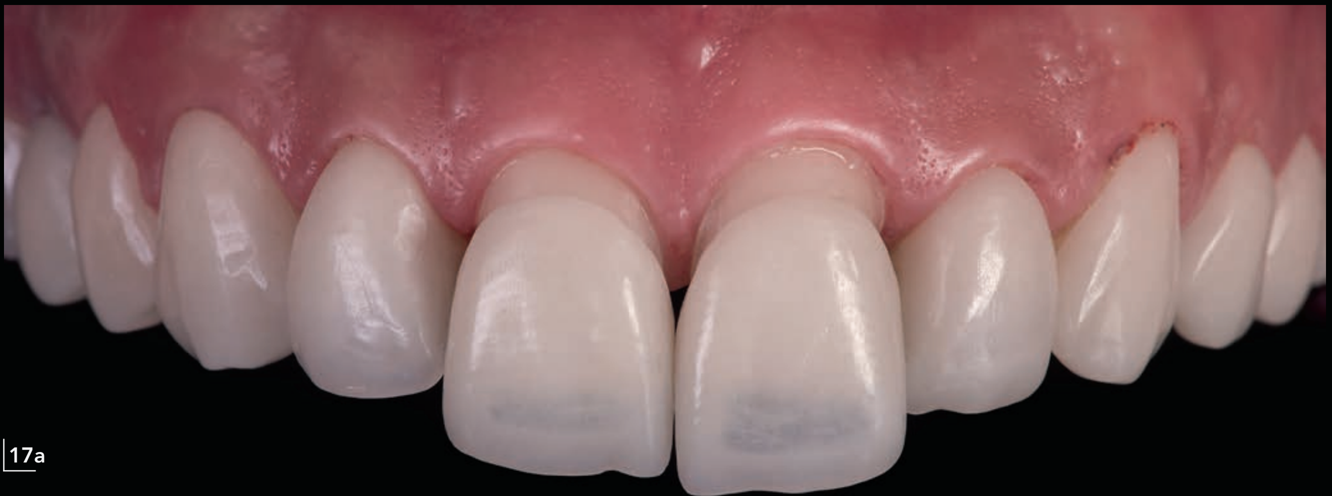
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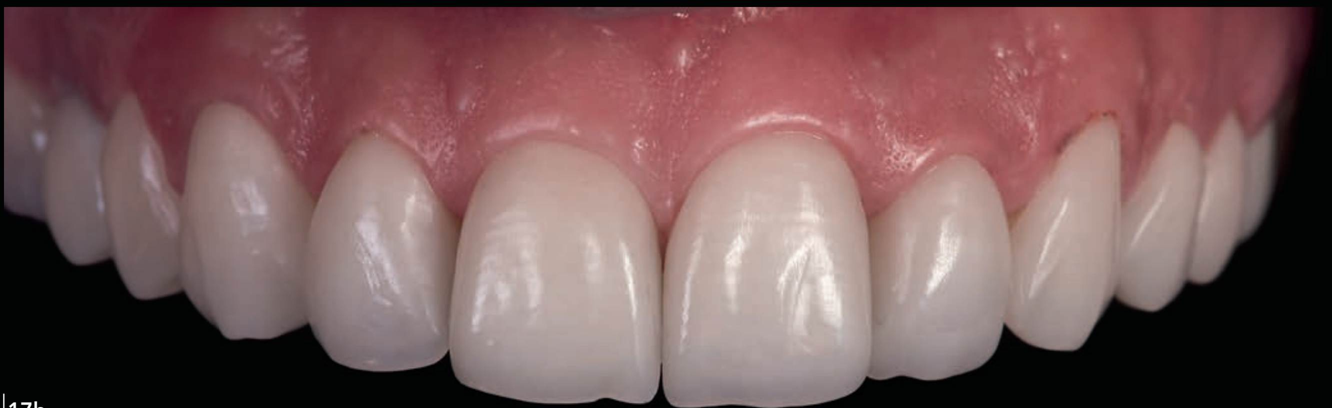
17b

Fig 16 PMMA milled provisionals on 3D-printed alveolar model.

Figs 17a and 17b Intraoral photographs of PMMA milled provisionals at try-in.

Figs 18a to 18c Patient try-in portraits with PMMA milled provisionals.

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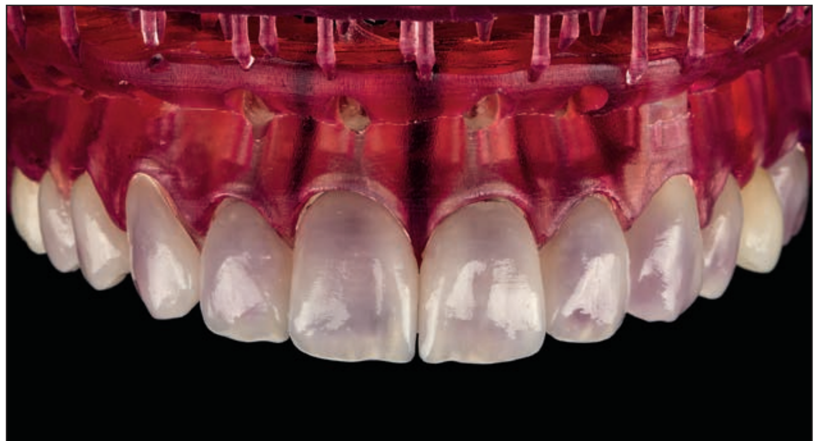
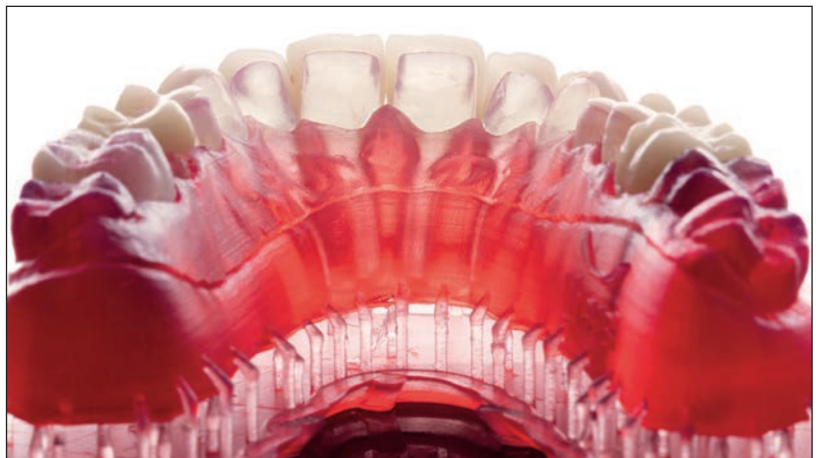


20a



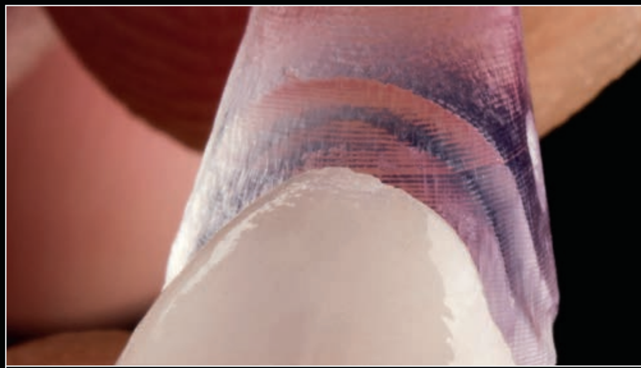
20b

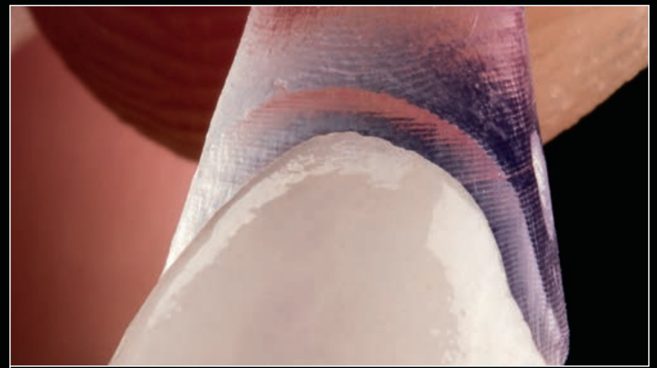
Fig 19 Milled final ceramics (Empress CAD Multi block / Wieland Zenotec Select Hybrid; Ivoclar Vivadent).

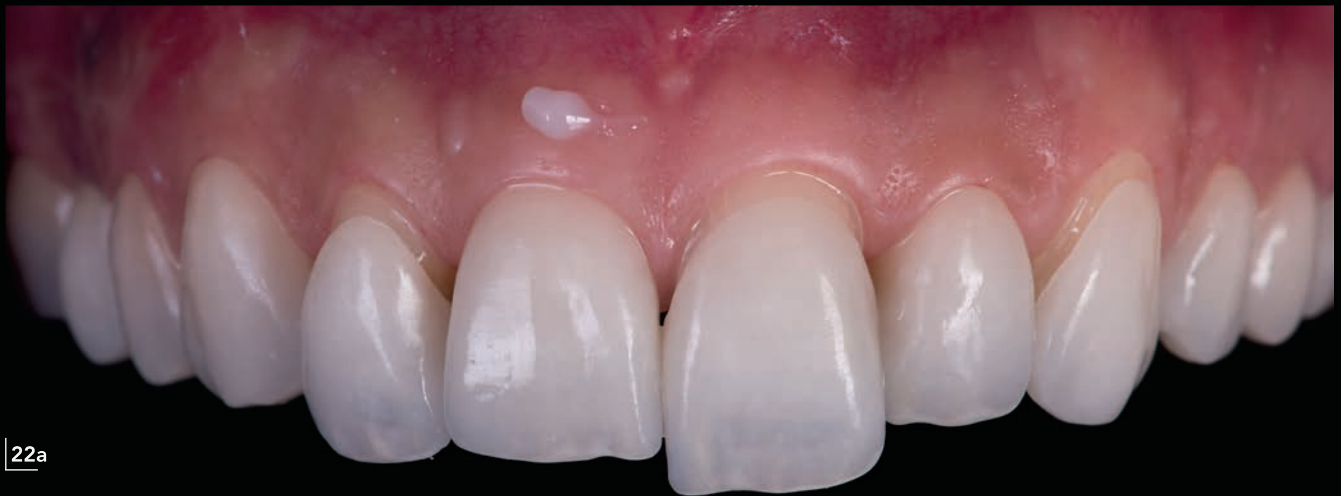
Figs 20a and 20b Milled final ceramics on 3D-printed control model.

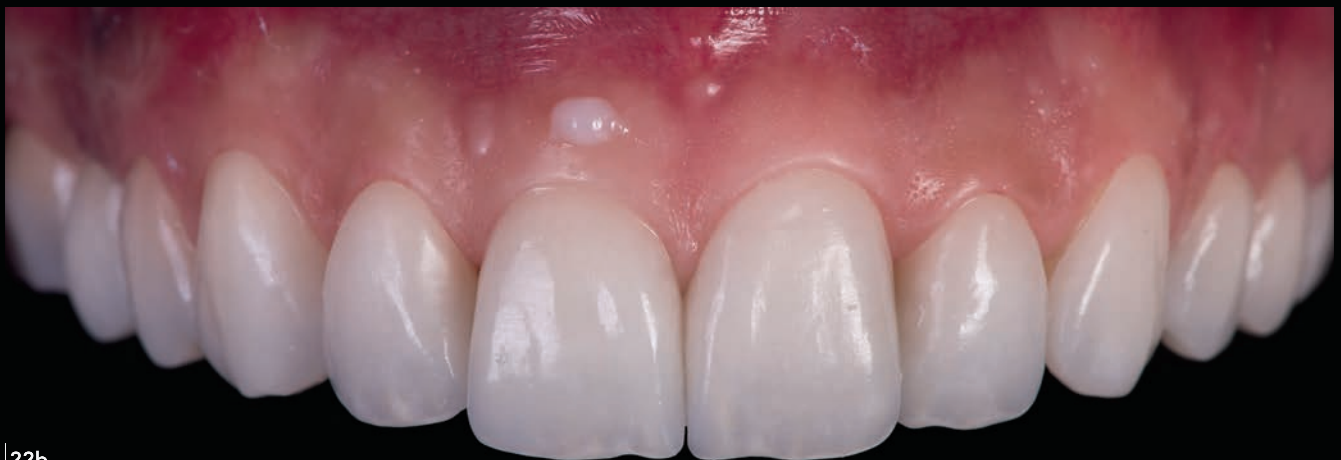
FINAL CERAMICS *(Figs 19 to 27)*

To finalize the case—once the patient has formally accepted the esthetics—the proposed digital design tested with the PMMA milled restorations is replicated using ceramics. In the present case, a leucite-reinforced glass-ceramic was used (Empress CAD Multi block, Ivoclar Vivadent).


21a

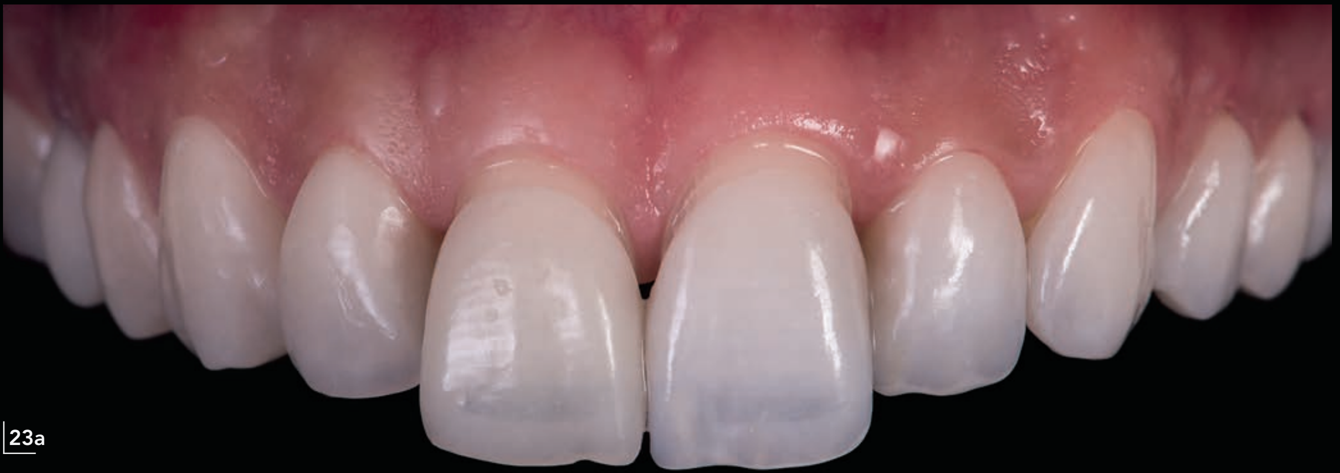

21b


22a

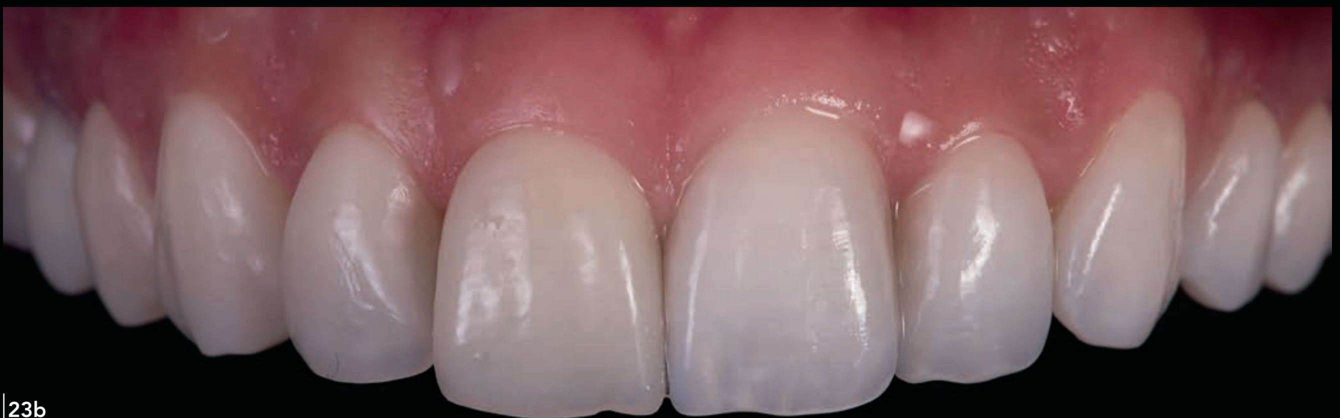

22b

Figs 21a and 21b Precision check of 0.2-mm chamfer; milled monolithic ceramic restoration on 3D-printed die.

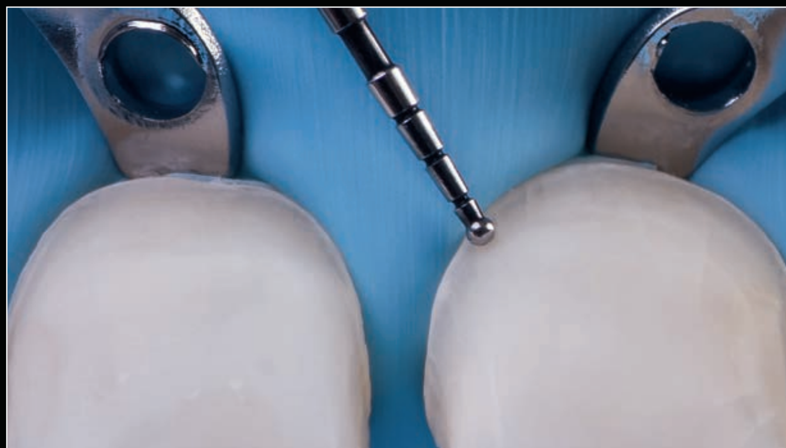
Figs 22a and 22b Try-in of ceramic restoration after staining and glazing.



23a



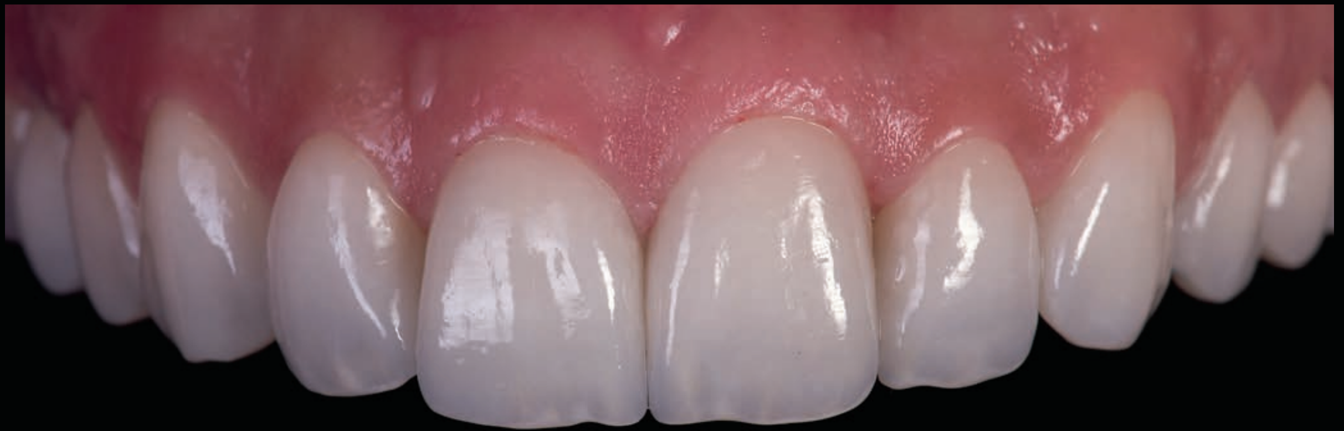
23b



24

Figs 23a and 23b PMMA provisional and ceramic final restorations at the same try-in. Note that the geometry is the same.

Fig 24 Isolation and emphasizing the minimal preparations.



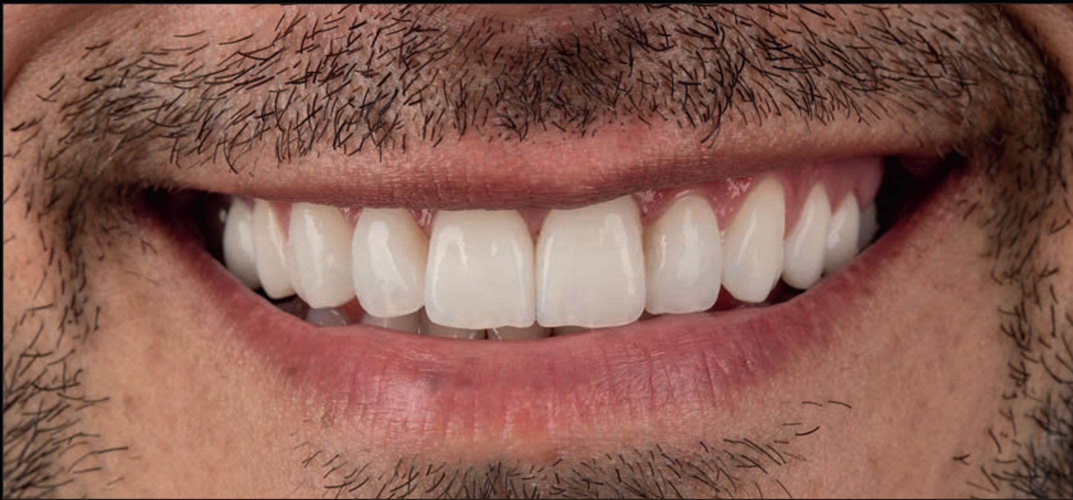
25

Fig 25 Final intraoral view on the day of cementation.

Fig 26 Before and after photographs.

Figs 27a to 27c Close-up of final smile.

26



SAME GEOMETRY, DIFFERENT MATERIALS, OUTSTANDING OUTCOME

A machine can never design by itself. Design implies creativity, and creativity means connecting the unconnected—asking a question that has never been asked before. This will always be a human trait. A machine can run the existing connections and can copy better than human beings. To unleash the true power of CAD/CAM, we need to teach ourselves to see design in a different way when working digitally.

Henri Cartier-Bresson, one of the greatest photographers of all time, said that he took up photography once he understood that photos capture eternity in an instant. In a similar way, this is what CAD/CAM can do. As DNA runs through time, in the form of unique beauty, of morphology and shapes that never repeat themselves, we can now capture beauty, store it, and with the power of mathematics, reproduce this beauty in an unlimited number of materials and designs.

View a video of the RAW digital workflow at:
www.dentcof.net/game-over-raw

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