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CLINICAL CASES

DWS

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DENTAL TECH

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The **chairside** of 2023

Dr Francesco Mangano, Dr Claudio Gattelli

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Digital Dentistry Society

Edited by the Digital Dentistry Society

chairside

The chairside of 2023

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DDS, PhD

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Dear colleagues,
welcome back to DentalTech, the column that Infodent devotes to the world of digital in Dentistry. In this April 2023 issue, we return to talk about ***#chairside*** and the digital workflow in prosthodontics and restorative dentistry. Today, chairside is a clinical reality, because it is possible to produce in a matter of minutes, through additive technology, color gradient restorations that are certified as definitive. In other words, it is possible to 3D print prosthetic restorations (single crowns, inlays/onlays, veneers and bridges up to 3-4 units) in ceramic filled hybrid composite materials, certified for definitive use, in three different shades. These restorations are fabricated with a powerful dedicated chairside printer (Dfab®, DWS Srl) which uses stereolithographic laser technology (SLA) and can be further customized with dedicated kits (for the purpose we are using Optiglaze™ color, GC Corporation). After characterization, the restorations are delivered to the patient in the same visit as the scan or at a later appointment, depending on the convenience of the case. We have been using the Dfab® in our clinic for 3 years now and I must say that the restorations made using "tilted stereolithography", the technology on which the machine operates, are extremely accurate, durable (we have not recorded any prosthetic issues in over two hundred restorations delivered) and beautiful to look at. They are so beautiful, once characterized, that they rival translucent monolithic zirconia! Obviously, these are completely different materials, but I believe that products like Irix Max® will make their way in the coming years because ceramic filled hybrid composites are easier to process compared to zirconia; and they could be a viable alternative in some cases, not only for printing long-lasting provisionals, but also for producing definitive restorations.
Enjoy reading!

Francesco Mangano

#chairside

3D PRINTING OF CERAMIC FILLED HYBRID COMPOSITES

Accuracy, mechanical reliability, and aesthetics for everyday prosthetics

Dr. Francesco Mangano
Associate Professor

INTRODUCTION

Here are two simple prosthetic cases solved in the same session with the patients in the chair, by using additive technology and direct digital flow based on the following ***#chairside*** procedure:

1 intraoral scanning (iTero Element 5D Plus®, Align Technologies);
2 CAD modeling (Galway®, Exocad) of the prosthetic restoration;
3 3D printing (Dfab®, DWS) of the ceramic filled hybrid composite prosthetic restoration (Irix Max®, DWS Srl), washing, curing and characterization;
4 clinical application.

FIRST CLINICAL CASE

The patient presented with the need to replace an old, pre-existing veneer on tooth #21, which had fractured (**Figs. 1, 2**). The old, cracked restoration was removed and the tooth was re-prepared (**Fig. 3**), a shade was selected, and an intraoral scan (**Figs. 4-6**) was taken in the same session with a powerful scanner (iTero Element 5D Plus®, Align Technologies). The scan was immediately sent via cloud to the laboratory and the tech modeled the veneer restoration (**Figs. 7-9**) with a dedicated CAD software (Galway®, Exocad). The modeling file was then transferred by e-mail to the clinic, where the restoration was immediately printed in a color gradient with a 3D printer (Dfab®, DWS Srl) based on the "Tilted Stereolithography" laser technology. The material chosen was a ceramic filled hybrid composite (Irix Max®, DWS Srl), certified for permanent use (**Figs. 10-13**). The restoration was then washed in 95% ethyl alcohol before being removed from the printing plate and cured in a dedicated device (DCure®, DWS Srl) (**Fig. 14**). The 3D printing and curing process took only 15-20 minutes. After curing, the restoration was characterized (Optiglaze™ shade, GC Corporation) before being cemented in the patient's mouth (**Fig. 15**). The hybrid material restoration had a perfect fit on the preparation and demonstrated a high degree of accuracy as well as good esthetic integration. The entire procedure was performed chairside with the patient in the chair and took just over an hour.

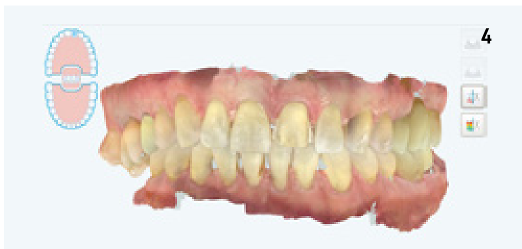
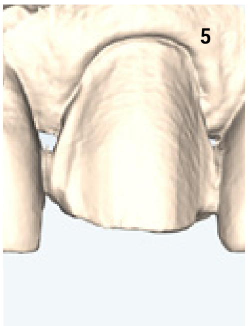
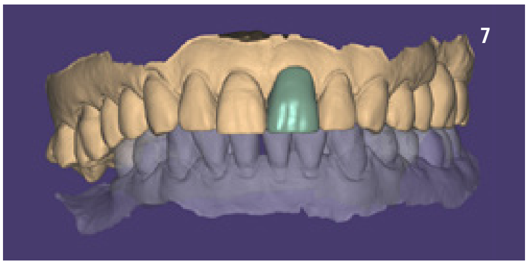
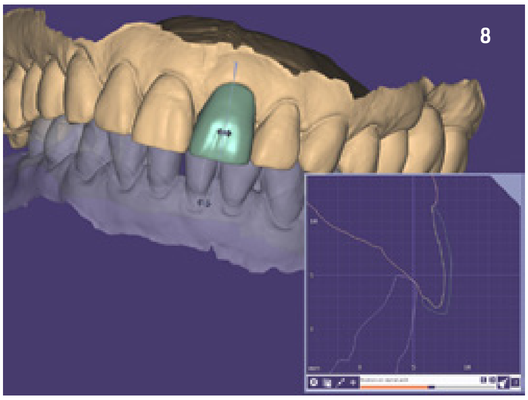
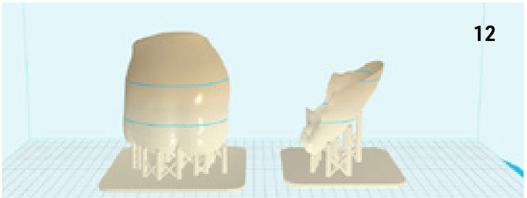


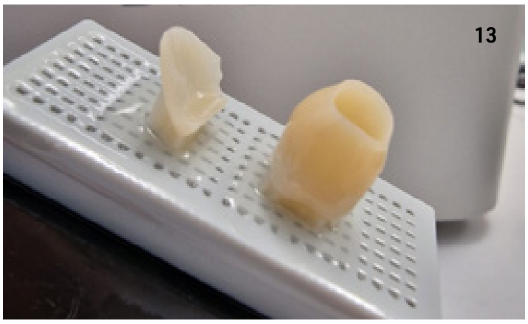
Fig. 1. Intraoral scan (iTero Element 5D Plus®, Align) of the old pre-existing fractured veneer on tooth #21.
Fig. 2. Note the vertical fracture rhyme on #21, evident from the intraoral scan.
Fig.3. Preparation of the left upper central incisor #21.
Fig. 4. Intraoral scan (iTero Element 5D Plus®, Align) after the new preparation of tooth #21: frontal view of the arches.











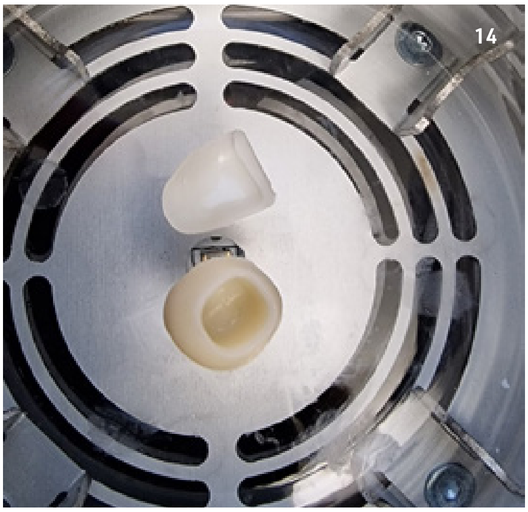


Fig. 5. Detail of HD acquisition (iTero Element 5D Plus®, Align) of the prepared tooth.
Fig. 6. Lateral view of the preparation of tooth #21.
Fig. 7. Modeling of the new veneer in CAD software (Galway®, Exocad): frontal view.
Fig. 8. Detail of modeling in CAD in 2D section.
Fig. 9. Photorealistic rendering of the modeling of the new veneer in CAD (Galway®, Exocad).
Fig. 10. The Dfab® printer (DWS Srl).
Fig. 11. The material used in this case was a ceramic filled hybrid composite: Irix Max® (DWS Srl).
Fig. 12. Detail of the proprietary print preparation software (Nauta Photoshade®, DWS Srl): the choice of color levels is the key step in the process. In this case, the restoration was printed using a small cartridge.
Fig. 13. The freshly printed veneer before being removed from the printing table.
Fig. 14. The restoration in the dedicated DCure® curing device (DWS Srl).
Fig. 15. The freshly cemented restoration.

SECOND CLINICAL CASE

The patient required an implant-supported restoration (Anyridge®, Megagen) in the #36 tooth position and therefore underwent an intraoral scan (iTero Element 5D Plus®, Align Technologies) (**Figs. 16**-**20**). The scan was sent to the laboratory for immediate monolithic single crown modeling (**Figs. 21**-**23**) using specialized CAD software (Galway®, Exocad) while the patient waited in the chair. The modeling file was then sent to the clinic, where the restoration was immediately printed in color gradient using a 3D printer (Dfab®, DWS Srl) in ceramic filled hybrid composite (Irix Max®, DWS Srl) certified for final use (**Figs. 12, 13, 24**). Following a two-minute wash in 95% ethyl alcohol, the restoration was from the printing plate and cured in a dedicated device (DCure®, DWS Srl) (**Fig. 14**). It took only 15-20 minutes to 3D print and cure the restoration. After curing, the restoration was characterized (Optiglaze™ color, GC Corporation) before being cemented in the patient's mouth (**Fig. 25**). The restoration was accurate and showed excellent esthetic-functional integration. Again, the ***#chairside*** procedure was performed with the patient in the chair.

ACKNOWLEDGEMENTS

We thank Dr. Sergio Montini and CDT Roberto Cavagna, for their clinical and technical contributions to the completion of these cases.

Fig. 16. Intraoral scan of master arch (iTero Element 5D Plus®, Align) for implant in position #36 (Anyridge®, Megagen): mucosal collar visible after healing abutment removal.
Fig. 17. An IPD ProCam scan body (Abutmentcompatibili®, BiagginiMedicalDevices) was used for the intraoral scan.
Fig.18. Detail of the master model scan with the scan body in place (Abutmentcompatibili®, BiagginiMedicalDevices).
Fig. 19. Detail of the high-resolution scan body. The scanner (iTero Element 5D Plus®, Align) has adaptive resolution.

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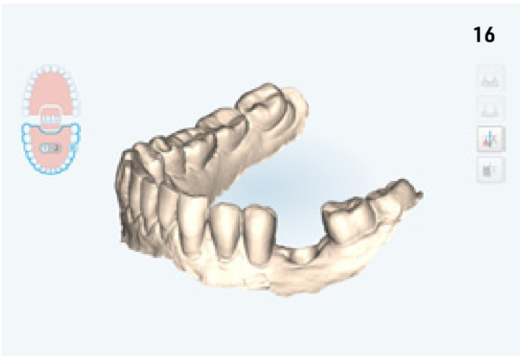

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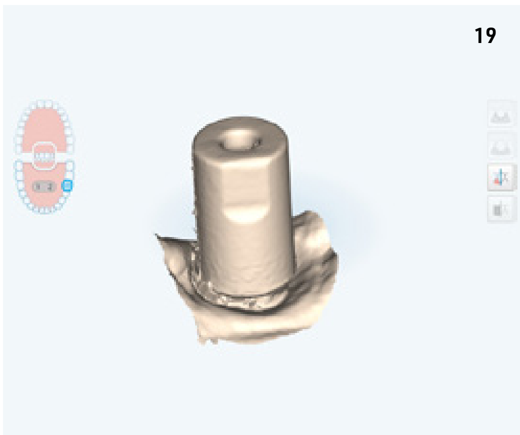
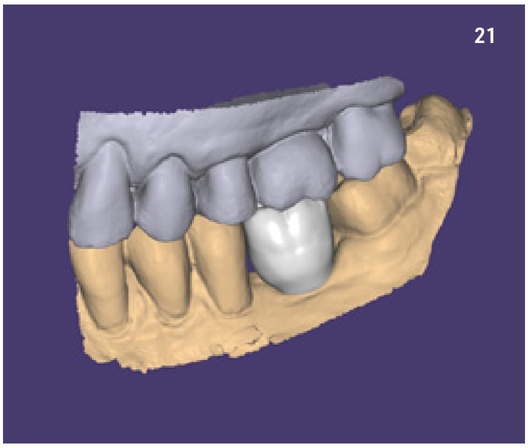




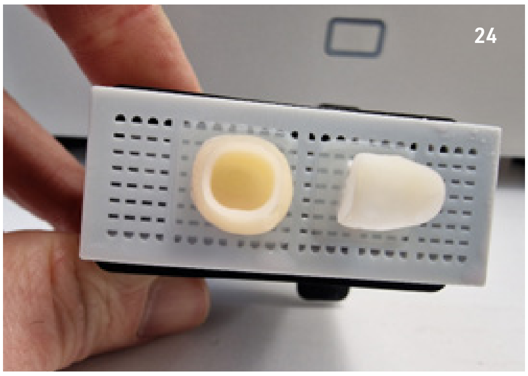


Fig. 20. The arches in occlusion with the scan body in place.
Fig. 21. CAD modeling of the monolithic restoration (Galway®, Exocad).
Fig. 22. Photorealistic rendering of the crown modeling.
Fig. 23. Detail of the occlusal surface of the restoration modeling.
Fig. 24. 3D printing of monolithic restoration with SLA printer (Dfab®, DWS Srl).
Fig. 25. Delivery of the 3D printed restoration after further customized staining.

#chairside

DFAB®: THE PRINTER FOR **QUALITY CHAIRSIDE**

DFAB® is the printer designed and manufactured by DWS Srl for the modern dental practice that wants to offer its patients a #chairside of absolute quality.

Fig. 1. *The DFAB® printer from DWS.*

The DFAB® system can be used to print provisional composite restorations as well as definitive composite or ceramic filled hybrid composite restorations (single and implant-borne crowns, bridges, inlays, and veneers) of up to 6-10 units. Such restorations are clinically accurate, durable, and aesthetically pleasing because they exhibit the color gradient. This is possible thanks to stereolithographic laser technology, with a printing process that takes less than 15-20 minutes. It is a process that is dust-free, silent and requires no maintenance, tools, or tool changes: simple, intuitive and within everyone's reach. The combination of the revolutionary Tilting Stereolithography (TSLA®) technology and the intuitive NAUTA PHOTOSHADE® software allows the reproduction of the natural tooth color gradient.
It also enables the use of an exceptionally wide range of certified biocompatible materials, available in disposable cartridges. The result of 8 years of research and development, TSLA® (Tilting Stereolithography) is the ultimate expression of DWS innovation. Introduced as a world first in the DFAB® range, this patented technology enables high speed 3D printing of high viscosity materials such as ceramic filled hybrid composites and hybrid composites. With DFAB®, the digital workflow steps are simple. It starts with intraoral scanning, which can be done with any commercially available intraoral scanner. It then continues with CAD

modeling, which results in an STL file that is ready for printing in DFAB®. Using the proprietary NAUTA PHOTOSHADE® 3D printing software, the operator can quickly and easily set the position and extent of the desired color shade. PHOTOSHADE® makes it possible to reproduce the specific color of the patient's teeth, giving the restoration an aesthetically pleasing appearance. The user selects the extremes of the required color gradient and the exact position and amplitude of the adaptive gradient he or she wishes to achieve in the restoration. At the end of printing, after a simple wash in ethyl alcohol, the restoration can be easily separated from the supports thanks to the patented break points and placed in the DCURE® device for the final stabilization of the restorations. DCURE®, through the combined action of UV light and heat, completes the perfect solidification of the restoration in just 5-7 minutes, while preserving its shade and gradient. At the end of the cycle, the lid of DCURE® opens automatically, and the restoration is ready for further characterization, or directly for application with adhesive cementation on the patient.

The DFAB® range currently includes three versions of printers and a DCURE® curing device:

1) **LFAB®** is the entry-level printer designed for dental laboratories and clinics that want the full functionality of a monochrome printer at a sustainable investment level;
2) **DFAB® Desktop** is a compact, ready-to-use printer supplied with NAUTA PHOTOSHADE® color gradient software loaded on an external PC;
3) **DFAB® Chairside** is the wheeled "all-in-one" version; it is completely self-contained; in the elegant aluminum turret it integrates all the hardware (PC and 3D printer) and software necessary for its operation. The integrated touchscreen PC allows all controls to be set up in a practical and intuitive manner, and the convenient wheeled structure allows it to be moved easily even between multiple rooms.

All DFAB® / LFAB® versions, thanks to the cloud-based internet connection, guarantee total tracking of interventions, materials used and cartridges. In addition, they can be connected to an external display, allowing the patient a true immersive experience in the world of digital dentistry. To complement the digital flow with vertical integration of hardware, software, and materials, DWS also introduced DCURE®, a hybrid technology post-treatment device designed for finalizing the curing of materials.

Evenly distributed UV light and heat inside the curing chamber ensure that objects are cured optimally while preserving their aesthetics. As for proprietary materials that can be used for 3D printing of fixed prosthetic restorations, DFAB® allows for ceramic filled hybrid composite, hybrid composite, and composite restorations.

chairside
is a clinical reality
achievable in
minutes

Irix Max® ceramic filled hybrid composite is the revolutionary Class IIa-certified medical device for fabricating esthetic definitive restorations that stand out for their translucency, high strength, and precise fit. The material has excellent mechanical resistance to fracture and wear in occlusion. Irix Max® allows minimally invasive rehabilitations on the natural tooth and implant. Another material in the DFAB® range is Irix Plus® hybrid composite, a Class IIa certified medical device with high elastic properties. It allows producing restorations in different monochromatic shades and with PHOTOSHADE® adaptive gradient. Restorations made with Irix Plus® are distinguished by esthetics and high compressive strength values. It is an ideal material for the clinician, which can be characterized with commercially available composite colors (stains) and glaze. Temporis® is the ideal Class IIa composite material for long-term, natural-looking provisional restorations. The esthetic qualities of Temporis® mimic the authentic color of teeth. DFAB® cartridges are available in three sizes: Small (suitable for printing up to two units), Medium (up to four units) and Large (up to six units). Having three sizes makes it possible to optimize printing and reduce waste. The manufacturer is producing several monochromatic shades while, for the time being, Photoshade cartridges cover the A1 to A3.5 range.

#chairside

DFAB: THE PRESENT AND THE FUTURE OF CHAIRSIDE?

Dott. Claudio Gattelli

Business Unit Manager
Dental DWS Systems

Francesco Mangano interviews Claudio Gattelli, Dental Business Unit Manager at DWS® srl, for INFODENT® about DFAB®, the printer for the digital dentist who wants to offer his patients a quality ***#chairside***.

Mangano
Dear Claudio, it is indeed a pleasure for me to interview you for DentalTech. Can you briefly explain why a dentist should focus on DFAB®?

Gattelli
DFAB® Dfab® is a printer designed specifically for chairside use. It is easy to use. It is plug-and-play, maintenance-free, quiet, and clean. DFAB® prints definitive, gradient-colored restorations with exclusive Photoshade technology, and polishing is quick and easy. This allows the clinician to create minimally invasive restorations and provide the patient with a permanent restoration in less than two hours. With DFAB®, the clinician has access to an innovative technology that allows them to provide an efficient and personalized service to their patients.

Mangano
What are the key features that differentiate DFAB® from other printers on the market today?

Gattelli
Unlike other printers, it does not have a tank where copious amounts of resin are left, which does not facilitate its use in the clinic, but it works with special vat equipped cartridges that retain all the excess materials. DFAB® is a laser printer, and its high accuracy gives the dentist more freedom to perform minimally invasive digital restorations. DFAB® prints polychromatic permanent restorations. Using the Photoshade software, you can choose how you want the color transition to occur according to the AD Guide, from the cervical area to the occlusal area. All other printers on the market today are monochrome. Washing the restoration is quick and easy, with 95% ethyl alcohol, there are no chemicals to be kept under a hood or dangerous to the clinician and patient, and no ultrasonic steps are involved.

Mangano
I have been using the DFAB® for 3 years now and I am very enthusiastic about it because it allows me to achieve a high-quality chairside treatment with restorations that are extremely accurate, durable, and beautiful to look at. Of course, the machine goes far beyond the chairside. Can you briefly summarize the types of prints that can be made with the printer and the materials that can be used?

Gattelli
DFAB® can produce inlays, onlays, tabletops, single crowns, partial crowns, crowns with a through-hole for the implant screw, bridges, veneers, small surgical guides, and quadrant models. There are composite-filled cartridges for long-term provisionals, hybrid composite and ceramic filled composite material for permanent restorations.

Mangano
In your opinion, can the investment in DFAB® also be an economic plus for the practice? Can you give us some figures?

Gattelli
DFAB® represents a plus at the economic level, with a cartridge costing € 140, eighteen veneers can be printed, in 30 minutes, in composite with ceramic matrix.

Mangano
What are the next developments for DFAB®? Do you have any plans for the release of new materials?

Gattelli
We are working on a printable product based on zirconium and a series of monochrome cartridges with translucency gradients. The dentist will be able to vary translucency by brightening the incisal area.

The Model Builder in rapid prototyping in implant prosthetics

Why it is important to print an optical impression with an embedded digital analogue

Dr. Mauro Fazioni, Dr. Stefano Orio, Nicolò Surico, Rita Consolaro

In recent years, digital technologies are becoming increasingly prevalent in dental practices and laboratories, leading to a radical transformation of computer-aided design (CAD), computer-aided manufacturing (CAM) and additive manufacturing (3D printers) software workflows.
The digital revolution paves the way toward the patient being fully aware of therapeutic value and able to access many clinical procedures that have so far remained in the background due to their complexity of application and dependence on the experienced specialist practitioner. One of the fundamental goals of implant-prosthetic treatment is the patient's full approval through the knowledge that the final result will meet his or her expectation of improved aesthetics and function, through pre-visualization of the prosthetic restoration. With this in mind, in this article, we will try to understand why 3D printing will play a crucial role today and in our future.

Why is it important to print an optical impression with the implant position after surgery? The importance of developing a prosthetic master model by intraoral scanning allows the dental technician to be able to fabricate a restoration taking into account the morphology of adjacent teeth and soft tissue structures. The existence of a plaster model has always been a limitation to the application of pure digital methods, and the advent of 3D printers has radically altered this type of approach, providing the laboratory with suitable media for the production and aesthetic finalization of a high-level restoration. In the case of implant prosthetics, the 3D-printed prototype model initially presents complications on the implant connection: for a long time this type of connection has been 3D printed directly, but it has been seen from countless studies in the literature that the precision achieved through this protocol is not up to the standard of a high-level result. Then, thanks to the detection of the exact geometric position of the implant connection, guaranteed by the presence of the scanbody, we are in a position to define three-dimensionally the position of a commercially available digital analogue, which reproduces a connection identical to the implant connection. In the design phase, the software recognizes, through the scanbody present in the optical impression, the position of the implant, and once the library associated with that particular scanbody and software type is loaded, the prosthetic master model and restoration can be designed. At this point, the 3D printer ensures rapid fabrication of the model with the digital analog inserted within it. Below we will present a step-by-step protocol of prototyping an implant model in the case of a single element. Multiple elements behave in the same way by simply changing the number of implants to be placed. The cornerstones of this procedure are:

- The scan body or scan flag;
- The intraoral scanning of the implant with scanbody;
- Model Builder with digital analog;
- The 3D printer.

The use of scanbodies (Fig. 1) is currently the most accurate method of detecting the position and angle of the implant. Digital scanning by intraoral scanner (Fig. 2) of these markers, screwed into the implant after surgery, allows the clinician to obtain a real-time digital case setup and faster and easier workflow (Fig. 3). By exporting the .stl file, this information can be immediately shared with the design laboratory. Each implant is associated with a scanbody with different geometries, which in turn is associated with certain libraries that the digital designer (the dental digital modeling specialist) will upload to the design software. Once all the necessary information has been acquired, the lab will easily perform the design of a high-definition prototype model with digital analog and screw-retained temporary (Figs. 4-7).

Fig. 1 - Scanbody.

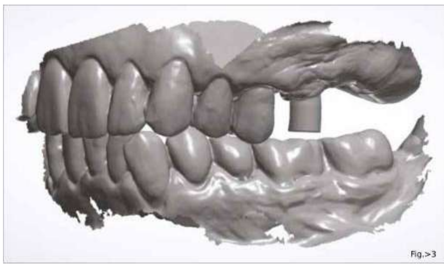
Fig. 2 - Intraoral scanner.

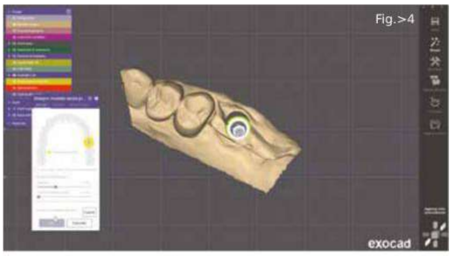
Fig. 3 - Optical impression with Scanbody.

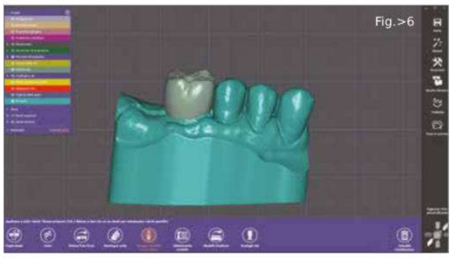
Fig. 4 - Model Builder design with digital analogue.

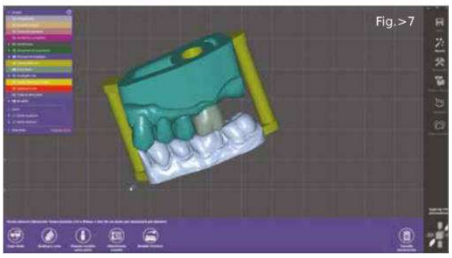
Fig. 5 - Provisional screw-retained crown made with exocad DentalCAD software.

Figs. 6, 7 - Model Builder design with digital analog and screw-retained provisional.









Translated from: Fazioni M, Orio S, Surico N, Consolaro R. Il Model Builder nella prototipizzazione rapida in implantoprotesi. Dental Tribune 2022: XVIII (5) 14-15

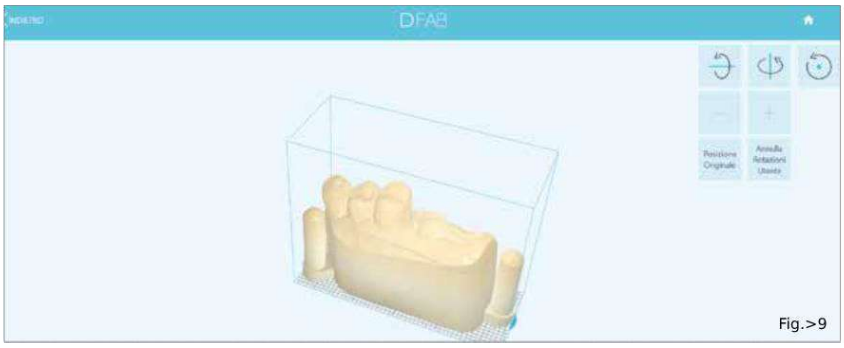


Fig. 8 - The DFAB printer from DWS.
Fig. 9 - The creation of the print file.
Fig. 10 - The printing of the model.
Fig. 11 - The printed model with the screw-retained crown.

Thanks to the state-of-the-art 3D printer, with DWS's DFAB high-speed tilting stereolithography (TSLA) technology (Fig. 8), this model can be printed quickly (about 15 minutes) and allows both clinician and patient to visualize the final result with extreme precision even in a single session, reducing the timing of treatment (Figs. 9-11). It is therefore clear that such a digital protocol, from intraoral scanning with scanbody to 3D printing of the restoration and prototype model, has revolutionized the standard of implant-prosthetics, providing the clinician with extreme precision of treatment, aiding visual communication and patient involvement during the prosthetic rehabilitation process thereby increasing patient awareness and case acceptance.

The first dental examination: an event revolutionized by modern digital technology

Authors_ Dr. Mauro Fazioni*, Dr. Stefano Orio*, Nicolò Surico*, Rita Consolaro*

**Centro Odontostomatologico Ospedale Sacro Cuore di Verona, Italy*

Today, the first dental examination can make use of instrumental examinations such as X-rays, CT scans, MRIs, intraoral scans, and software that can process the information obtained from the instrumental investigations and integrate them with each other. In addition, modern dentistry offers advanced output tools such as ultrafast 3D printing capable of prototyping anatomical models in real time, useful for therapy, but also for diagnosis, clinical decision-making and discussion with the patient. The latter must be the center of attention of the clinician and the team involved in the case solution, as he or she has important expectations that during the first visit can, and must, be met to intercept every need:

- morphologic and aesthetic previewing;
- simulated surgical planning in real time.

The team of specialists, today, can therefore interact in real time. The scope of this article is to present the possibilities available to the clinician and the laboratory for diagnosis and real-time clinical operative decision making. Objective examination of the oral cavity and perioral tissues, intraoral scanning, and ultra-low-dose 3D CBCT are now widespread methods available to the clinician. Simplified advanced software interfaces, allow specialists to share information useful in deciding the most appropriate treatment plan to solve the case. The type of disease faced by the modern dental practice today dictates fast treatment approaches that are predictable in results, functional, and resolvable with conservative and minimally invasive aesthetic techniques.

_The objective examination of the oral cavity

Huge importance has always to be given to this stage, for which we refer to in-depth discussions in the literature. However, the need to focus on new technologies, such as intraoral scanning, which allows the instantaneous recording of the three-dimensional state of tissues, mucosal and tooth color (according to the chosen color guide), and the extent of lesions, should be emphasized. It is also possible, thanks to some simple software, to pre-visualize tooth reconstruction, virtually place an implant and then a restoration, and move and align teeth. Smile planning is also added to these: by interfacing the direct mock-up with the intraoral impression, the patient can pre-visualize the result and the clinician is able to plan the operative steps and decide on the most suitable type of restoration.

_CBCT Radiology

Low-dose 3D CBCT radiology has for many years provided the clinician with useful information in the field of oral and maxillofacial surgery. The progressive lowering of the administered dose opens the application of this information to orthodontics and aesthetic implant-prosthetic planning. Same-day dentistry once commonly known as the "chairside approach" now takes on greater value, completely surpassing the direct therapeutic focus of

Translated from: Fazioni M, Orio S, Surico N, Consolaro R. La prima visita odontostomatologica: un evento rivoluzionato dalla moderna tecnologia digitale. CAD/CAM 2022: 1 20-25

chairside methods. Today, the use of tools such as intraoral scanners, analysis and design software, milling machines, and 3D printers for every stage of treatment, from diagnosis to case resolution, is the norm, even in the "less than three (units)" situations that currently account for most treatments.

_Clinical Case

A 38-year-old female patient; she presents with worn dentition syndrome with an altered incisal morphology of the anterior group. During the first visit, intraoral scanning of the full arches was performed with the Primescan scanner (Dentsply Sirona), (Fig. 1).The scan of the arches revealed a essentially normal morphology of the gingival architecture and structures, mild-to-moderate gingival inflammation (the optical impression can be compared with previous impressions and it is, therefore, possible to assess changes in volume), and the presence of altered dentinal sensitivity to cold stimulus, consistent with small gingival recessions, revealed by the scan. The intraoral scan (Figs. 2, 3) was processed with TRIOS Design Studio software (3Shape),

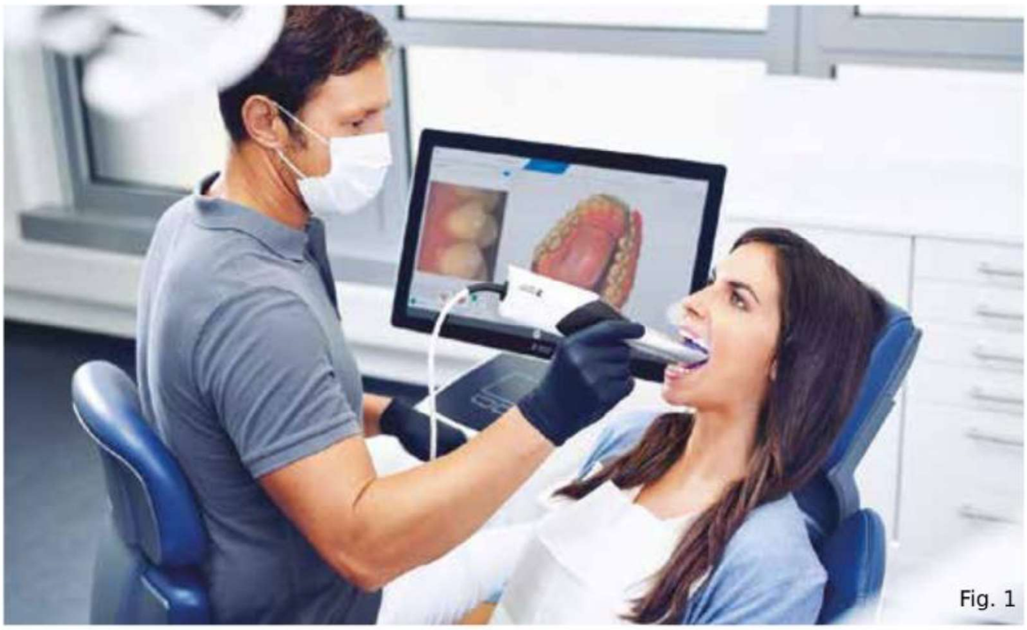
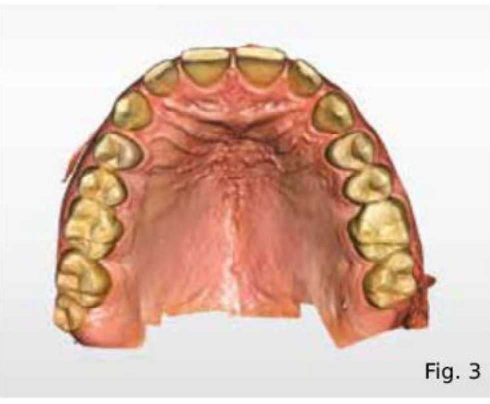


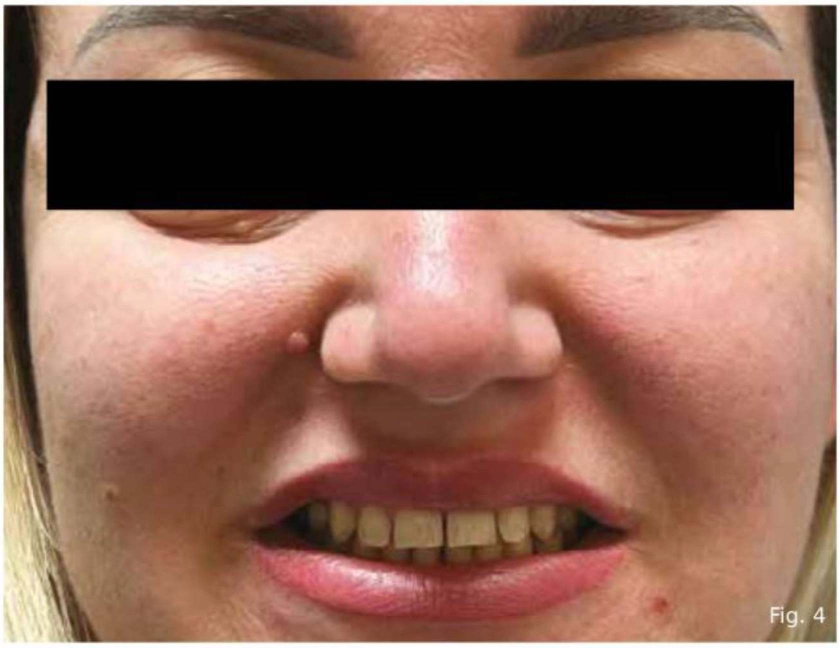
Fig. 1_Intraoral scan, a key event in first-visit diagnostics.

Fig. 2_The optical impression, frontal view.

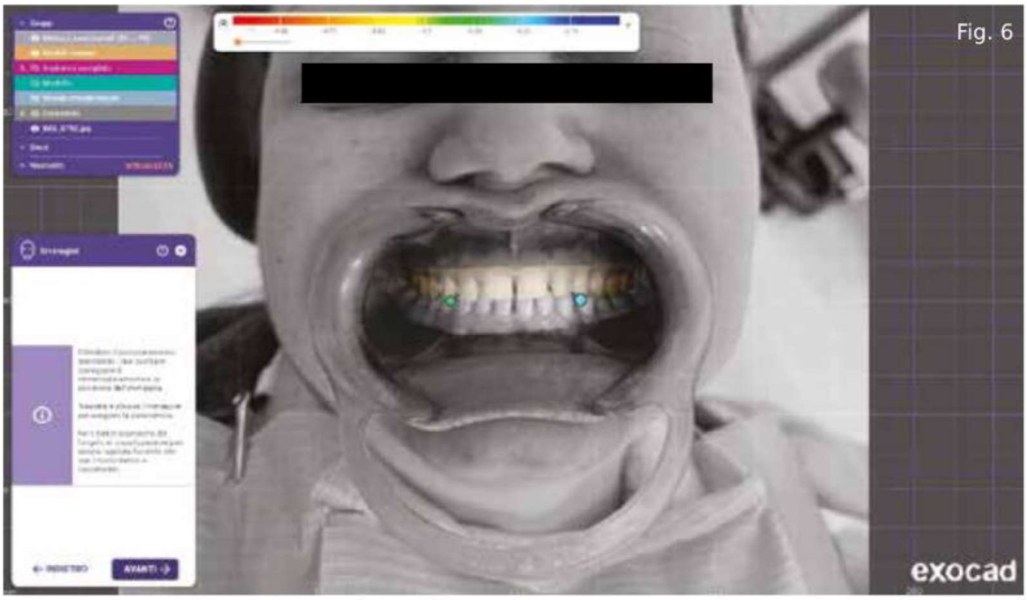
Fig. 3_The optical impression, occlusal view.

Fig. 4_The patient's face.





integrated with photographs of the patient's face with a closed mouth (Fig. 4), with a natural smile, and with an oral retractor, to assess the morphology of the perioral soft tissues of the lower lip and the type of anatomy of the frontal group. Photographs of the face were integrated in real-time with an optical impression for an immediate preview of the amount of dental tissue lost due to wear syndrome.



Then, for further evaluation, .stl files of the lower and upper arches were imported within DentalCAD 3.0 Galway software (exocad; Fig. 5) where, along with photographs of the patient's face (Fig. 6), actual planning was performed on the 3D digital model. On this basis, tooth substance loss of approximately 10-15% was revealed.

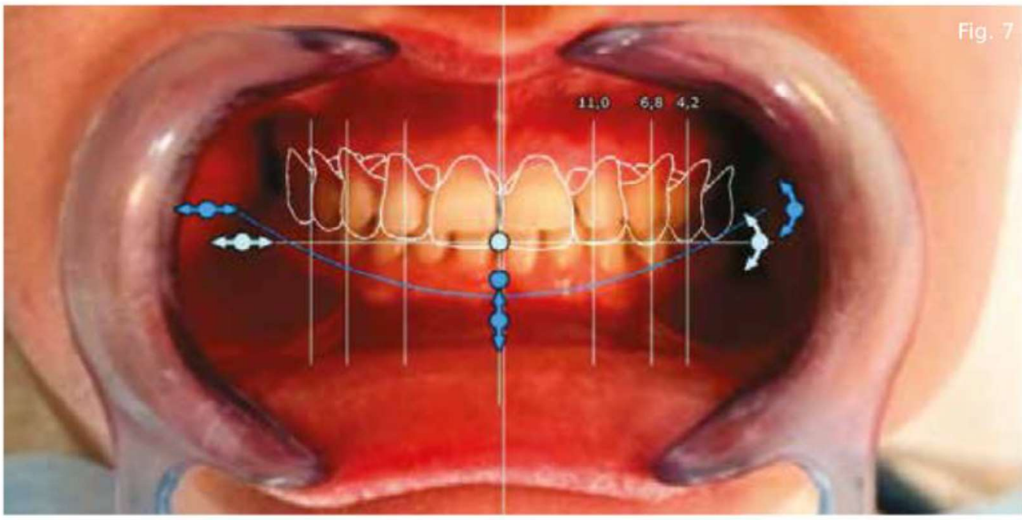


Fig. 5_The .stl file imported in the Exocad software.

Fig. 6_Integration between 3D optical impression and photographs of the patient.

Fig. 7_Occlusal interferences.

On the apico-coronal projection, occlusal interferences were evaluated (Fig. 7) by simulating chewing movements - recorded by the integrated digital axiograph - and the lateral displacement in protrusion as a function of maximum intercuspation.

Evaluation of the prosthetic proposal was performed by direct digital wax-up technique designed with exocad software (Fig. 8). This simulation (Fig. 9), carried out in real time by the remotely connected laboratory, was presented to the patient, and an immediate prototype of the rough evaluation was made as early as the first visit.

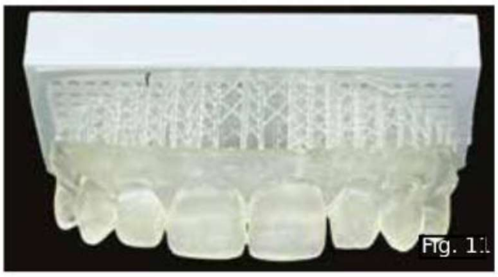


Fig. 8_The choice of the library.

Fig. 9_Simulation.

Fig. 10_Starting the 3D printing.

Fig. 11_After 15 minutes, the prototype model is ready.

Fig. 12_The DFAB DWS printer allows rapid smile prototyping.

In order to carry out this procedure, it was necessary to use a 3D printer with high-speed TSLA tilting stereolithography technology (DFAB, DWS), capable of making the model of the patient's arch (Figs. 10, 11) with the prosthetic layer fitted, on which, subsequently, a silicone base was taken over according to the mock-up technique. DWS's DFAB printer (Fig. 12) with TSLA tilting stereolithography technology allows for extremely precise printing in the short time available to the dentist. It is clear that such a technique would have required higher processing times and laboratory costs (at a stage when the patient

has not yet accepted the treatment plan). The availability of such a 3D printer within the dental office makes it possible, with a small economic investment, to produce the direct mock-up, which is useful to provide a rough indication to the patient and define the goal to be achieved as early as the first visit. The mock-up was printed in the mouth with the conventional analog technique (Fig. 13) to give more precision to the details, especially in the frontal group festoons.

Fig. 13_ The printed mock-up in the mouth.

Fig. 14_ The prototype in immediate view.

Direct printing in the mouth also allows immediate evaluation from the patient's point of view (Fig. 14), who is thus able to see what level of rehabilitation and goal is achievable through these procedures. In this case, it was also possible to evaluate some minor tooth displacement through a digital orthodontic planning software that allows us to program aligners with the aim of minimizing the amount of dental tissue to be removed through IPR (interproximal enamel reduction/stripping) in the preparation stages.

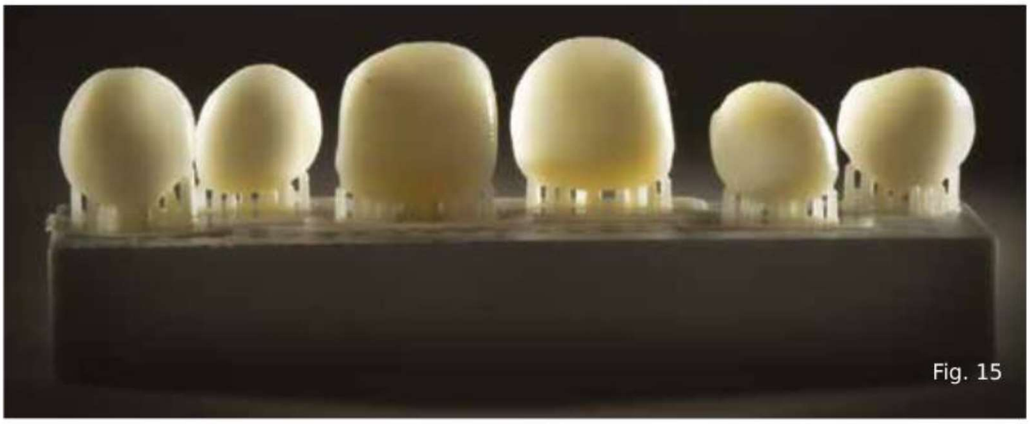


Fig. 15

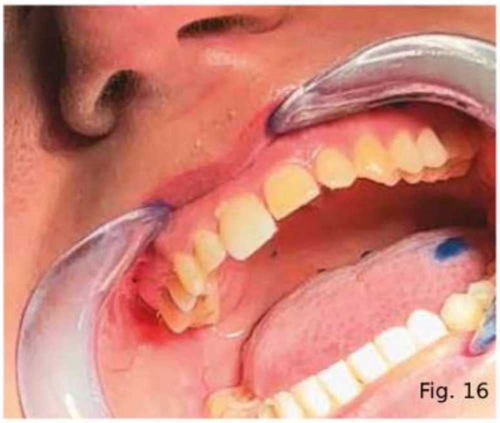


Fig. 16

Fig 15_ The veneers printed with PHOTOSHADE technology.

Fig 16_ Testing of the veneers, 3D printed with DFAB in Irix Max (DWS).

_The accuracy of the model, printed in 3D with high-speed TSLA technology (DFAB, DWS)

Today, the technique of minimally invasive additive veneers is as modern as it gets. Thanks to the use of the latest generation of hybrid materials containing glass-ceramic (Irix Max, DWS) (Figs. 15, 16) that allow an optimal level of esthetics, and the maneuverability allowed to the clinician during the fabrication phase of the prosthetic restoration, this technique is usable even by non-specialists of additive techniques State-of-the-art materials are the key turning point in the success of ultra-conservative therapies. Meeting the needs of the patient with simplified operative procedures is the goal of a therapy available to all with predictable results and true functional esthetic value. The evaluation of the mock-up by the patient is valuable for aesthetics and perception of the type of restorations that will be made. For the clinician, the immediate mock-up, printed directly in the mouth, offers an assessment of the restorations' thicknesses to be used, the preparation technique, and the efficiency of the adhesive cementation method, which is an essential requirement for successful medium- to long-term therapy.

_Objective examination, patient assessment, clinician-patient dialogue.

The clinician must be able to intercept the real needs of the patient, in addition to the objective finding of pathological syndromes within the oral cavity.

State-of-the-art instrumental examinations, such as intraoral scanning, cone beam computed tomography, prosthetic pre-visualization software, dental displacement planning, and guided surgical planning, ensure predictability of outcome, especially through integration with each other. The patient must be involved within the diagnostic process, always in real time, in order to have all the information immediately available and to consciously accept the proposed therapy. The latter, will then be representative of the modern standard of dentistry, characterized by a minimally invasive, functional, conservative approach, with high aesthetic perception by the patient.

All these therapies, until recently delegated to specialists, are now applicable to all patients directly by the generalist dentist, who coordinates a team of specialists involved in the clinical process, thanks to technologies and the choice of modern dental materials.

The single tooth implant prosthesis in the esthetic area: proposal of a simplified clinical protocol

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_Abstract

The digital methods available to the clinician and dental technician today provide useful information for aesthetic and functional planning of the restoration in implant prosthetics from the very first visit. Optical impression, low-dose 3D radiological source, and prosthetic planning software are key tools that the team has at its disposal for clinical decision making. The following is a proposed clinical protocol where these integrated tools simplify the procedures and make them usable in a short time even in the same first visit session. The single tooth implant prosthesis in the esthetic area: proposal of a simplified clinical protocol

_Introduction.

Single-unit and multiple-unit implant prosthetics (Less Than Three Prosthetic Implantology) now account for more than 75 percent of cases in an average dental practice. It is clear from this figure that economic issues alone cannot be the explanation for the sharp reduction in these procedures. Increased awareness of oral health, more minimally invasive approach by dentists in treatment plans, overtreatment no longer perceived by patients as success, are the factors that are most pushing in this direction. Today, patients perceive esthetic-functional stability and minimally invasive approach as value. Prosthetic planning, prosthetically guided surgery, use of customized abutments, and metal free prostheses are the undisputed cornerstones for the success and stability of the aforementioned results.

The analog method is often complicated and characterized by long timelines, while digital technology has enabled major improvements in the management of patients in need of implant surgery: specific software can simulate the procedure, integrating data obtained from a CT scan with those from a digital impression in the same session as the first visit. The new workflows make it possible to combine the diagnostic, surgical and prosthetic parts in a high-performance manner and in optimized time, providing high precision of implant placement and offering more predictable results than unguided implantology: CAD/CAM guides have been shown to provide an excellent level of precision in dental implant placement, better than both freehand techniques and those relying on model-derived guides. The purpose of this paper is to present a proposed clinical protocol where, starting from the first visit, the patient is involved in all decision-making processes. Involving the patient in prosthetic, surgical and esthetic planning represents a valuable concept and effective clinical decision-making. The digital workflow is characterized by the following steps:

- Intraoral scanning and diagnostic wax-up or digital prosthetic mock-up;
- Virtual placement of the prosthetically guided implant;
- Fabrication of a prosthetic-guided surgical template;
- Digital postoperative impression;
- Fabrication of a custom healing screw and an immediate screw-retained provisional cast using TSLA DWS DFAB technology.

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_The TSLA Technology

Stereolithography Apparatus (SLA) is a technique that allows individual three-dimensional objects to be made directly from digital data processed by CAD/CAM software by employing special photosensitive resins solidified through a UV source.

A tank contains a liquid resin that can polymerize when exposed to light from a Laser (photo-polymerization). Just below the fluid level is a perforated plate. A laser beam is projected from a system of mirrors in such a way as to scan the surface of the liquid and at the same time modulated so as to reconstruct a raster image of the first section of the object to be built.

When the first scan is finished, the plate is lowered slightly and a subsequent laser scan generates a second section. The process is repeated until the object is completed. When creation is complete, the object is removed from the liquid resin and placed in an ultraviolet light oven to complete surface curing.

In traditional printing technologies, the material is single, one color, and the tray or container of the printing material is placed flat. With that material, the substrate, base and pattern are created.

In Tilting Stereolithography, the material is unique, but it flows into a continuous flow pumping circuit as the cartridge is placed on a 45-degree inclined plane.

Because of this flow, different types of pigments can be used: a very sophisticated software algorithm causes a vertical gradient of coloration to be created, picking up the recognized pigment at the right time.

The resin is circulated and flowed downward, thanks to the inclined plane, and then it is recirculated, that is, brought upward again by a pump. This continuous circulation of resin allows dark color to be added with each pass, thus reconstructing the actual original color. In contrast, this procedure is not possible in traditional methods, where the resin is placed at level 0 and thus flat.

_Clinical case, materials and methods

A 55-year-old female patient presented to observation with a longitudinal root fracture at tooth 24, which was untreatable. Therefore, a therapy involving extraction of the tooth and placement of an implant was opted for (Figs. 1, 2).

We performed an intraoral scan of the dental arches with the Primescan scanner (Dentsply Sirona) (Fig. 3). We then planned a diagnostic wax-up of tooth 24 with exocad Galway software.

Fig. 1_The initial case.

Fig. 2_Element 24 is to be replaced with an implant.

Fig. 3_Intraoral optical impression, the tooth is virtually removed.

Fig. 1

Fig. 2

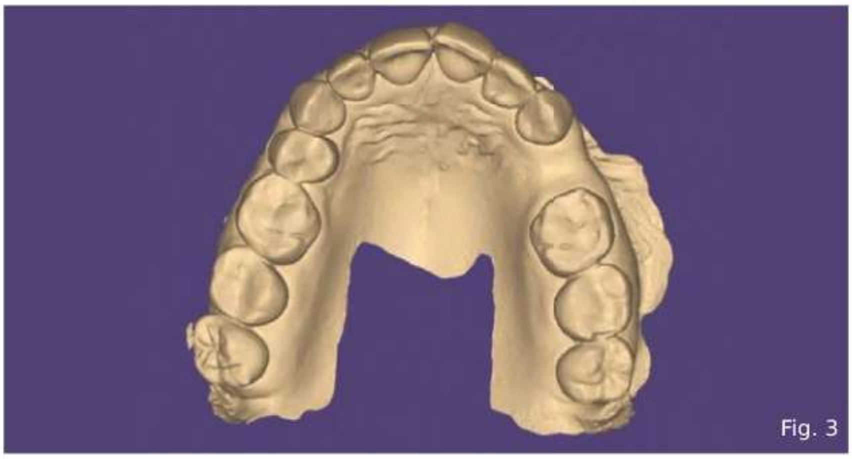
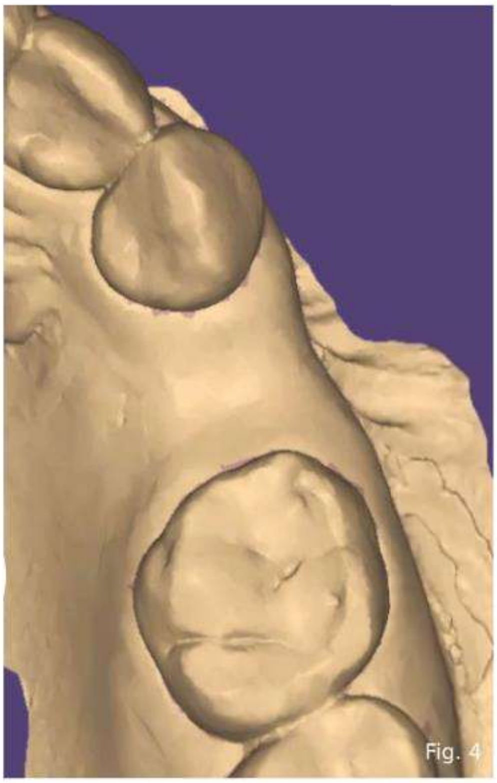
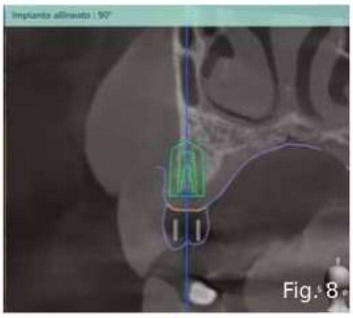


Fig. 3

The resulting prosthetic design, based on esthetic and functional parameters, was imported into the 3Shape Implant System software, where the implant position was programmed according to bone and prosthetic guidance.

The 3Shape Implant System software used for implant programming allows exporting the surgical template and prosthetic model with the position geometries of the digital analogue in place (Figs. 4-9).





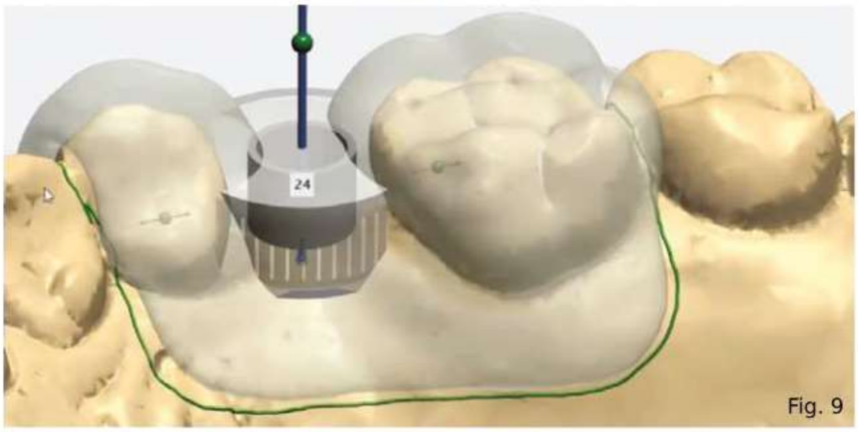


Fig. 4_The edentulous saddle.

Fig. 5_The digital wax-up prosthetic proposal.

Fig. 6_The alignment between intraoral impression and low-dose Dicom.

Fig. 7_The prosthetic design integrated into the radiological volume.

Fig. 8_The implant placement in the 3Shape Implant Studio software.

Fig. 9_The planned surgical template.

The resulting STL files were printed using a TSLA technology proprietary to DWS's DFAB printer. The STL file for the surgical template was imported into NautaPlus software used to prepare models for 3D printing. We added support points exclusively for the occlusal surfaces to achieve a perfect fit of the surgical template. Printing was performed using DS3000 resin in DFAB cartridges from DWS. The support points were carefully examined and manually removed from the surfaces of the template to facilitate post-processing.

After printing, the template was removed from the build platform and rinsed with a 80% vol. grade hydroalcoholic mixture and finally sterilized by preparing it for the surgical procedure. The maximum printing time was 45 minutes (Figs. 10a-10d).

Next, the surgical act allowed guided implant placement. We placed a scan-body, acquired the optical impression of the scan-body to which the initially designed wax-up is aligned, and the custom abutment design.

The custom design of the transmucosal pathway is important because it is able to support the soft tissues, thereby increasing the aesthetic quality of the healing tissues, keeping the papillae intact and a gingival profile in harmony with the contours of the adjacent teeth.

Cylindrical titanium healing abutments, while effective, cannot handle the numerous gingival topographies found intraorally (Figs. 11-14).

Fig. 10a_The prosthetic model and the surgical template ready for printing with DFAB.

Fig. 10b_The template before the surgical procedure.

Fig. 10c_The DFAB system in the Desktop version.

Fig. 10d_The custom healing screw programming derived from the wax-up copy.

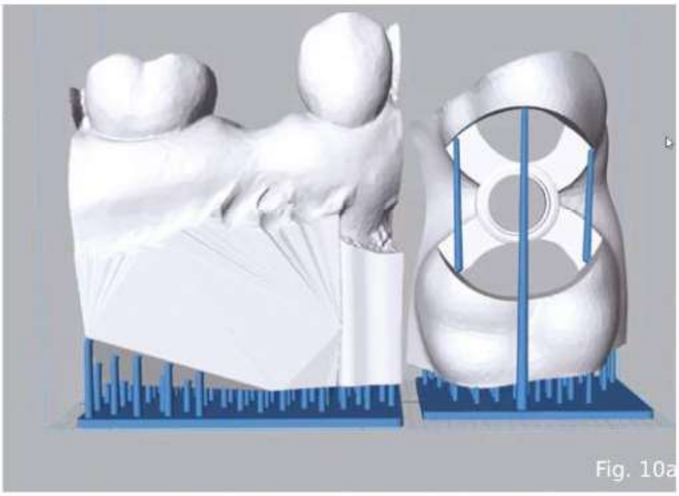


Fig. 10a

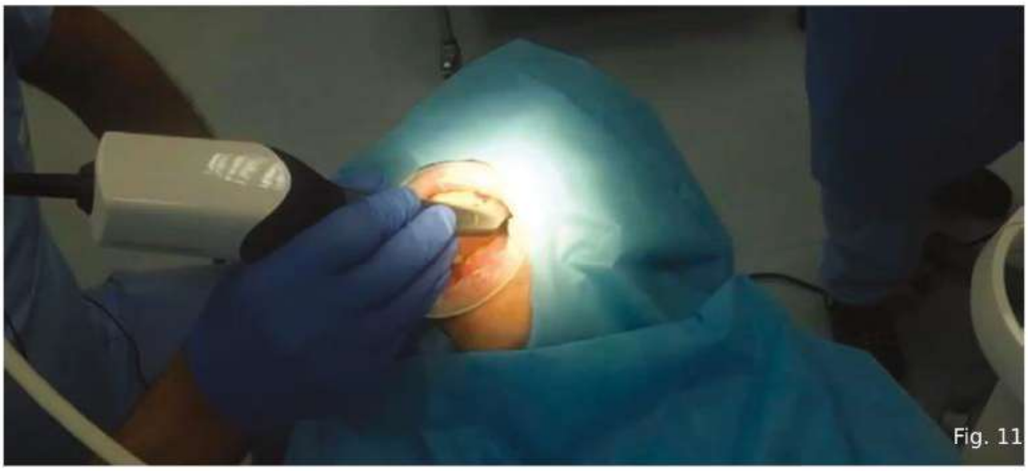
Fig. 10b

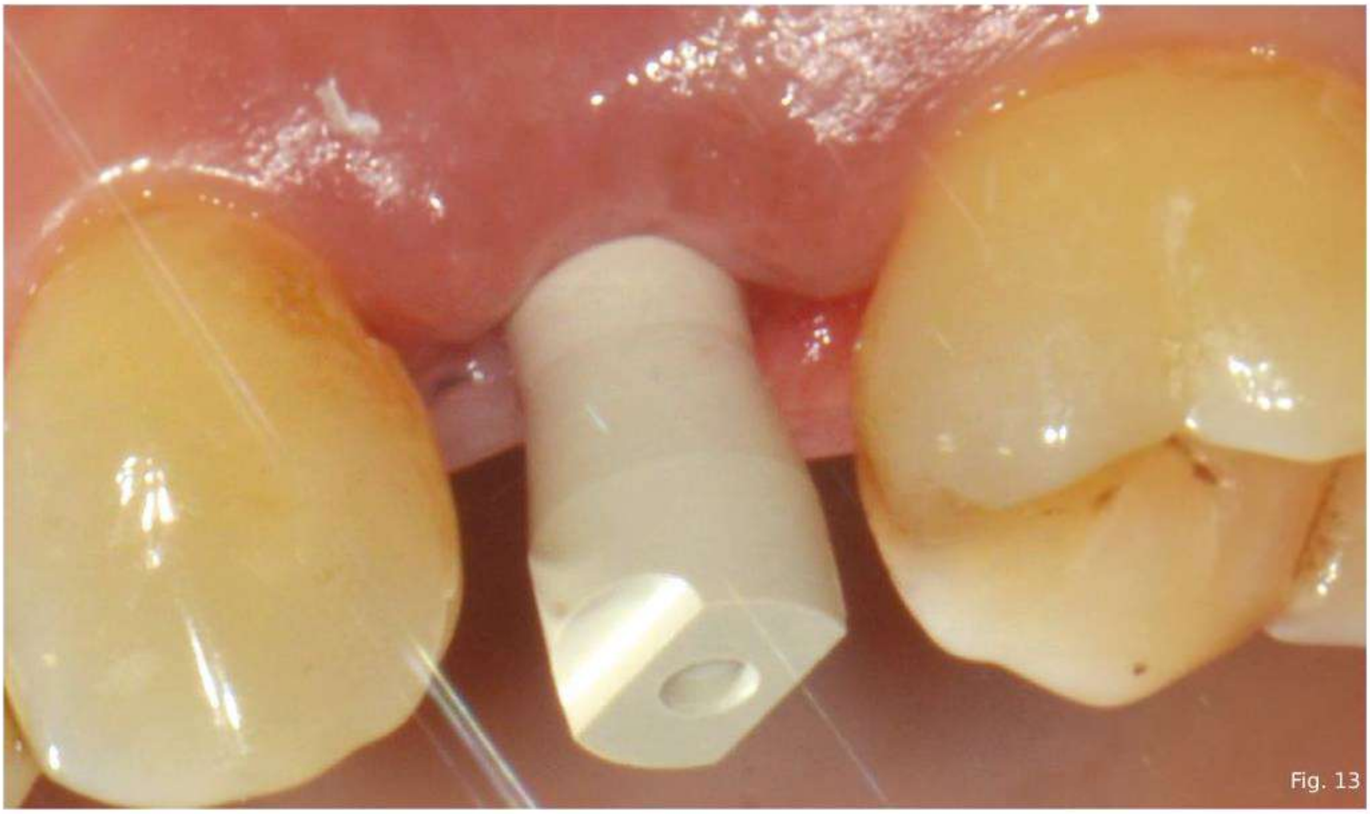
Fig. 10c

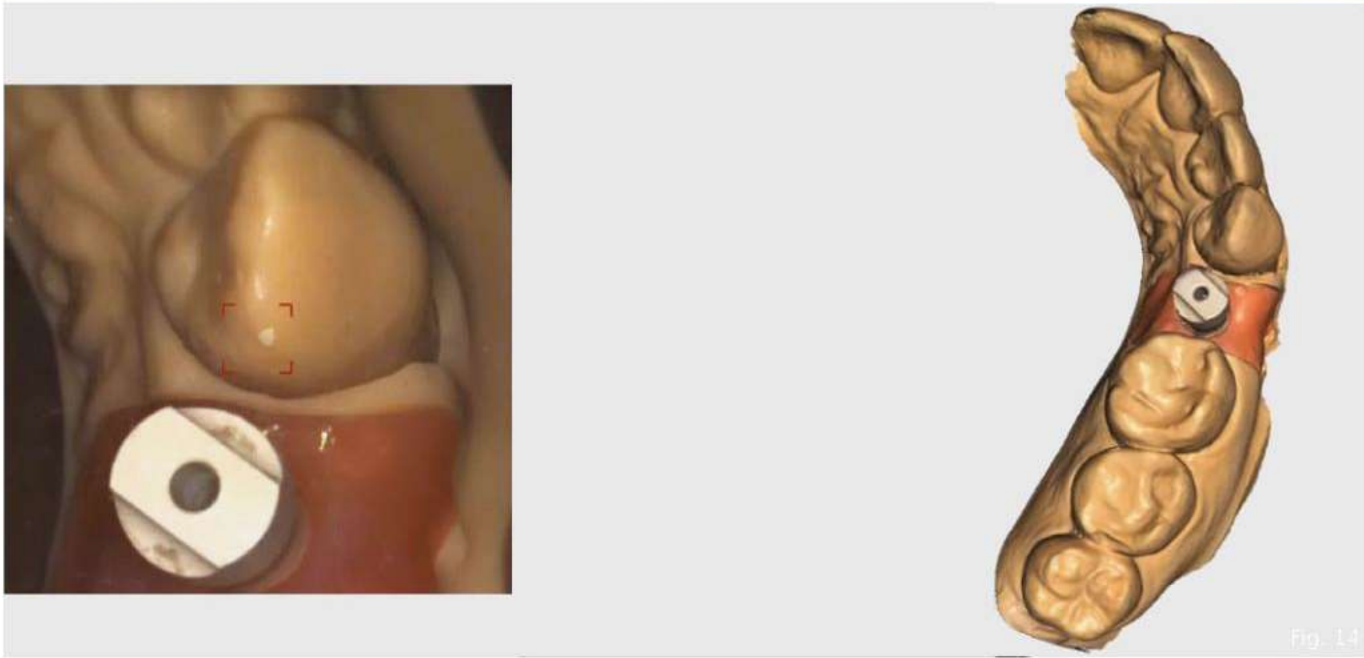
Fig. 10d

Fig. 11_ The surgical procedure.

Fig. 12a_ The postoperatively tightened custom screw.







From the optical impression of the scanbody, we printed the 3D model with an XFAB 2500PD printer using PRECISA RD097 resin to later allow the laboratory to finalize the case. Upon surgical re-entry, a custom healing screw was attached to the emergency profile of the designed crown.
The custom healing screw can also be available to the clinician post-operatively.

It is the surgeon's choice whether to use the submerged technique, insert the custom healing screw, or prefer immediate loading with the final crown.
The laboratory can confidently fabricate a hyper-aesthetic definitive restoration later, using the high-definition 3D-printed master model without needing a stone cast (Figs. 15-19).

Fig. 13_ The scanbody in position in the second prosthetic stage.

Fig. 14_ Intraoperative impression with the Primescan intraoral scanner (Dentsply Sirona).

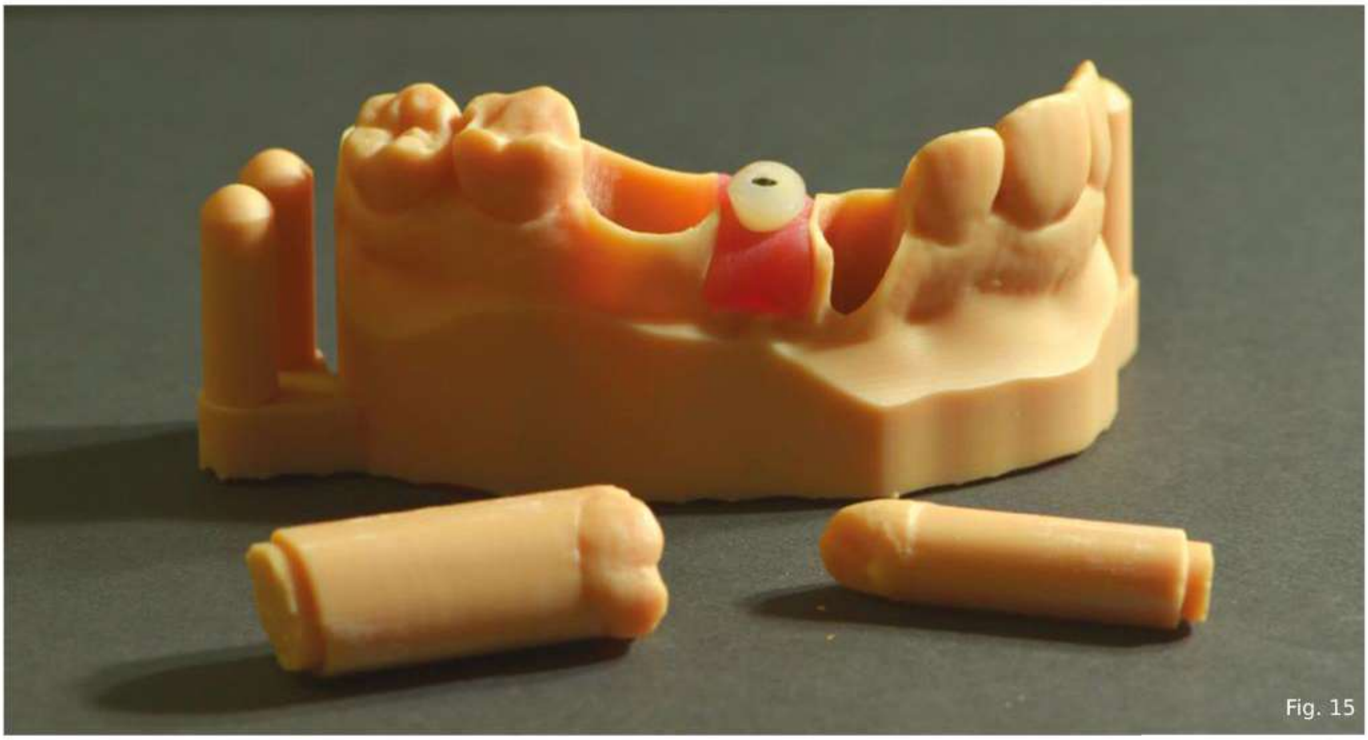


Fig. 15_The prototyped master model printed with the XFAB 2500PD and the digital analog in place.

Fig. 16_The screw-retained provisional printed with DFAB TSLA technique in Irix Plus material.

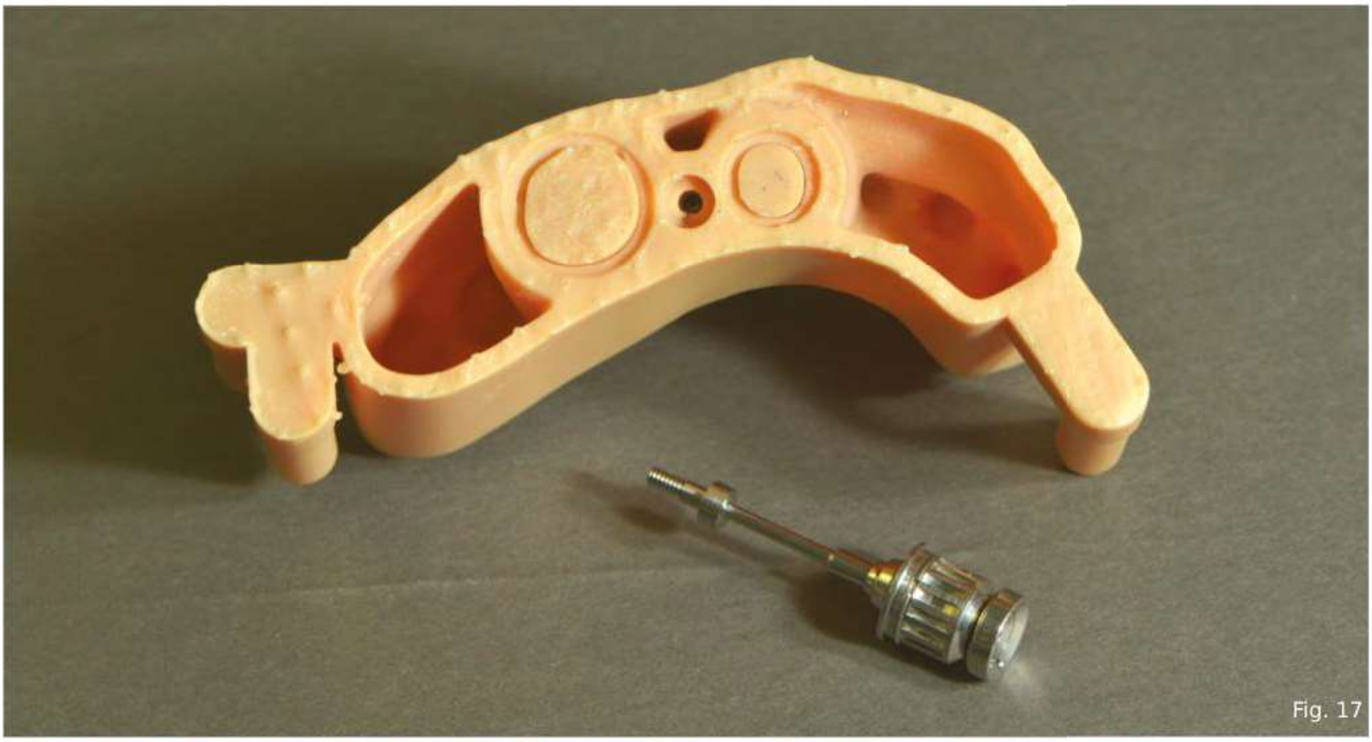


Fig. 15_The prototyped master model printed with the XFAB 2500PD and the digital analog in place.

Fig. 16_The screw-retained temporary printed with DFAB TSLA technique in Irix Plus material.

Fig. 19_Detail of the prosthetic design in DWS Irix Plus.

_Conclusions.

Single or multiple implants represent a daily challenge for the clinician and the laboratory. When esthetic-functional goals become a priority, it is important for the patient to grasp the value of certain steps that have been neglected in the past at the expense of predictable results. Diagnostic wax-up, fabrication of a prosthetic-guided template, postoperative impression, fabrication of a custom healing screw and screw-retained temporary are the cornerstones of successful therapy. All these steps are now possible thanks to a state-of-the-art scanner with software that integrates prosthetic, surgical and print programming and DFAB's high-speed TSLA technology capable of fabricating surgical template, custom healing screw and screw-retained provisional in less than 30 minutes.

MENSILE D'INFORMAZIONE MERCEOLOGICA DENTALE

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Chairside restorations with DFAB®

Dr Francesco Mangano

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CHAIRSIDE RESTORATIONS WITH DFAB®

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INTRODUCTION

We see below two clinical cases of simple rehabilitations on implants, solved in a single appointment, thanks to a single 3D printing session with DFAB® (DWS Srl, Thiene, Vicenza, Italy). Specifically, these are a bridge on two implants in the maxillary left quadrant, and a single crown on implant in the mandibular right quadrant.

THE CLINICAL CASE

The two patients were seated in an dental chair, simultaneously. The procedure began with intraoral scanning to capture the spatial position of the implants (**Figs. 1,2**). A powerful structured light scanner was employed (CS 3800®, Envista, Brea, California, USA). The scanbodies used were from the IPD ProCam® system from AbutmentCompatibles.com (IPD Dental Group, Mataro, Barcelona, Spain).

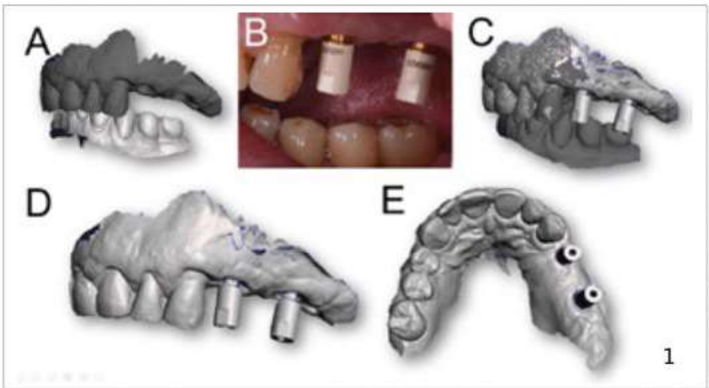

Fig. 1. Clinical case number 1: two implants in the left posterior maxilla. (A) Scan of the master arch after removal of the healing screws, and of the antagonist arch, in occlusion (CS 3800®, Envista, Brea, California, USA); (B) IPD ProCam® scanbodies from AbutmentCompatibili.com (IPD Dental Group, Mataro, Barcelona, Spain) screwed in place; (C) the scan with the scanbodies screwed in place; (D) Detail of the master model with the scanbodies in place, lateral view; (E) Detail of the master model with the scanbodies in place, occlusal view.

The choice to use scanbodies from AbutmentCompatibili.com was justified by the high accuracy and quality of the components, and the intelligent design of the transfer devices, which allows the Iterative Closest Point (ICP) overlay algorithms to work best. However, the greatest advantage of using IPD ProCam® from AbutmentCompatibili.com (IPD Dental Group, Matarò, Barcelona, Spain) lies in the richness of the CAD library (Galway®, Exocad, Darmstadt, Germany). The IPD ProCam® libraries from AbutmentCompatibles.com (IPD Dental Group, Matarò, Barcelona, Spain) are among the few that give the dental technician the option of choosing between different enlargements of the scanbody library file when

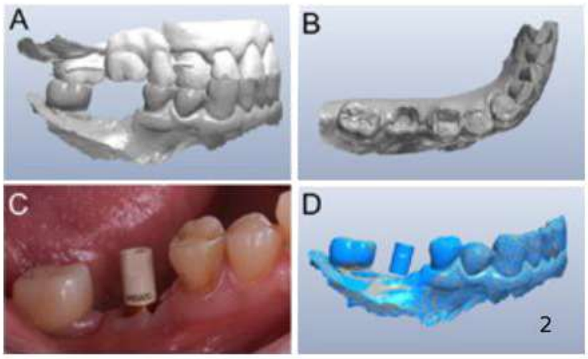

Fig. 2. Clinical case number 2: An implant in the right posterior mandible. (A) Scan of the master arch after removal of the healing screws, and of the antagonist arch, in occlusion (CS 3800®, Envista, Brea, California, USA); (B) the master model in occlusal view; (C) the IPD ProCam® scanbody from AbutmentCompatibles.com (IPD Dental Group, Mataró,

substituting it for the scan abutment mesh or surface reconstruction. This is critical and allows to reduce the error given by mismatch between mesh and scanbody library, always present unfortunately, both in intraoral and desktop scanning.

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Being able to compensate for this congruence error makes it possible to significantly reduce the error in the transfer of the real implant position to the virtual design: this is crucial to achieve adequate clinical accuracy of the restorations. The first scan was that of the master arch, immediately after removal of the healing screws; this was followed by capture of the antagonist arch and bite. Then, the scanbodies were screwed onto the implants, and the operator captured their entire anatomy; this was done without insisting too much on details, to avoid oversizing the mesh reconstruction of the object. Once the scans were finished, they were sent electronically to the laboratory, in .STL format. While patients were offered coffee, the dental technician proceeded to model the restorations as screw-retained superstructures **(Figs. 3,4)**. The IPD ProCam® library from AbutmentCompatibles.com (IPD Dental Group, Matarò, Barcelona, Spain) allowed the

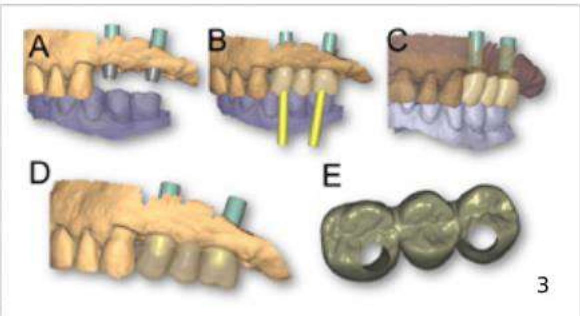

Fig. 3. Clinical case number 1: two implants in the left posterior maxilla. (A) The arches in occlusion with the bonding bases in focus (Galway®, Exocad, Darmstadt, Germany); (B) modeling of the screw-retained superstructure with indication of the screw holes; (C) perspective view of the modeling in occlusion; (D) lateral view of the modeling in transparency with view of the Ti-bases; (E) final modeling.

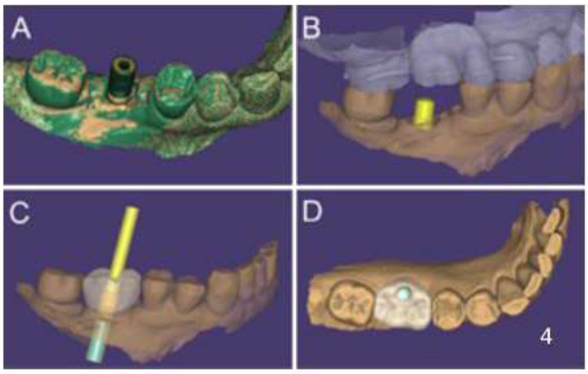

Fig. 4. Clinical case number 2: an implant in the right posterior mandible. (A) Master model with the scanbody in place (Galway®, Exocad, Darmstadt, Germany); (B) The arches in occlusion with the bonding base in focus; (C) Perspective view of the restoration with the screw hole and analog in focus; (D) Occlusal view of the restoration with the screw hole in focus.

dental technician to compensate for mesh growth errors, using an enlarged library file: this ensured an ideal transfer of implant positions to virtual planning.

Once the modeling was finished in CAD (Galway®, Exocad, Darmstadt, Germany), the dental technician sent files of the modeled bridge and screw-retained crown to the dental office. These files were uploaded within the NAUTA PHOTOSHADE® software (DWS Srl, Thiene, Vicenza, Italy), which prepared the restorations for printing; the operator was asked to choose and place the three levels of color, within the restorations (**Fig. 5**). Once this procedure was completed, the operator would load the cartridge and place the printing platform inside the printer; then, the printing project could be launched (**Figs. 6,7,8**). The printing session lasted 25 minutes; meanwhile,

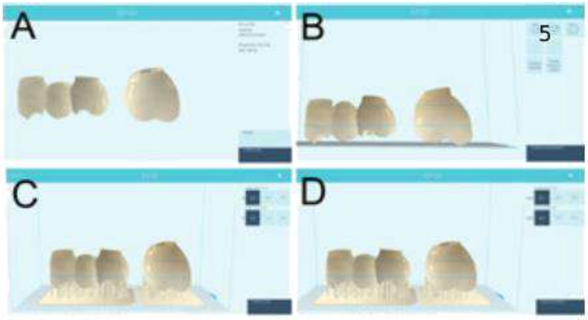

Fig. 5. Color selection in NAUTA PHOTOSHADE® software (DWS Srl, Thiene, Vicenza, Italy). (A) Restorations are loaded within the software; (B) placement of restorations; (C) print base and media are automatically generated; (D) color levels are finely adjusted using NAUTA PHOTOSHADE® software.

the clinician would customize the titanium bonding base chosen by the dental technician, cutting it to height with special template provided by IPD ProCam® from AbutmentCompatibili.com (IPD Dental Group, Matarò, Barcelona, Spain). After the printing session was over,

Fig. 6. 3D printing of restorations. (A) The DFAB® printer (DWS Srl, Thiene, Vicenza, Italy); (B) the material chosen for the restorations was highly esthetic Irix® Max (DWS Srl, Thiene, Vicenza, Italy); (C) the cartridge ready to be loaded; (D) platform and print base ready for insertion.

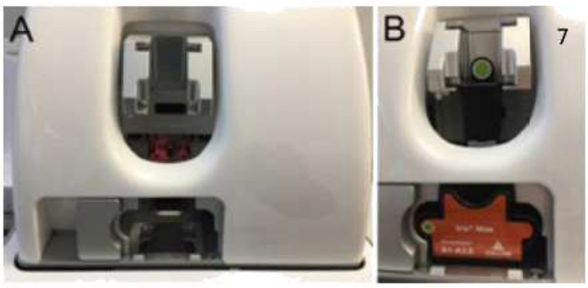

Fig. 7. 3D printing of restorations with DFAB® (DWS Srl, Thiene, Vicenza, Italy). (A) Detail of the guides for inserting the printing platform and cartridge; (B) the printing platform and cartridge inserted.

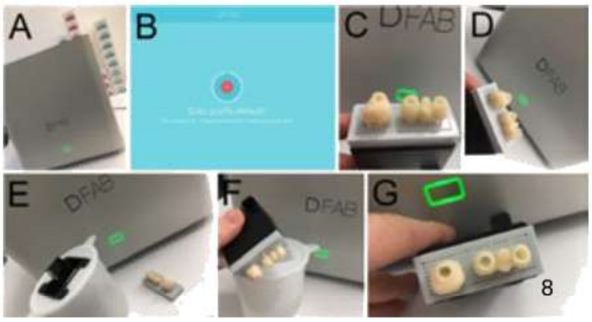

Fig. 8. 3D printing of restorations with DFAB® (DWS Srl, Thiene, Vicenza, Italy). (A) The attractive and compact design of the desktop version of DFAB®; (B) in just 25 minutes, the printing session is completed; (C) the restorations in Irix® Max (DWS Srl, Thiene, Vicenza, Italy) just out of the printer; (D) the restorations still on the base of the printing platform; (E) washing in 95% ethyl alcohol; (F) the restorations after washing in alcohol; (G) the restorations ready for post-curing.

The restorations where rinsed in ethyl alcohol for 2-3 minutes, removed from the printing platform, dried, characterized if necessary and cured in the dedicated hybrid cure device, DCURE® (DWS Srl, Thiene, Vicenza, Italy). Polymerization took place in a few minutes **(Fig. 9)**. Restorations were extracted from DCURE® and cemented to the chosen bonding base. Before the restorations could be applied, they were polished further. Upon delivery, the restorations were clinically accurate with an optimal fit, and ideal interproximal and occlusal contact points (**Figs.**

Fig. 9. Polymerization of restorations with DCURE® (DWS Srl, Thiene, Vicenza, Italy). (A) The dry restorations ready for polymerization; (B) the DCURE® polymerization device in action; (C) the restorations inserted for polymerization; (D) Once the polymerization is complete, the restorations are ready to be applied clinically.

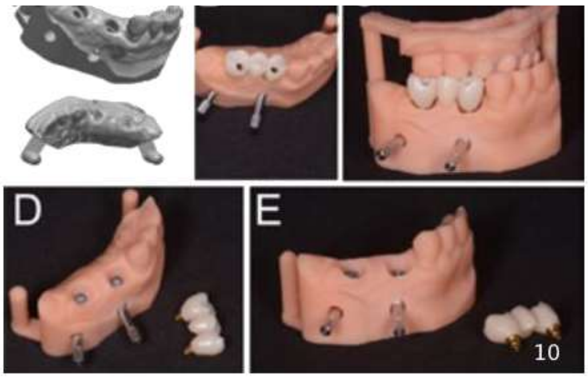

Fig. 10. Clinical case number 1: Check of the bridge fitting on the 3D printed model (XFAB 3500PD®, DWS Srl, Thiene, Vicenza, Italy) before clinical application. (A) CAD design of master and opposing partial models: models used are from AbutmentCompatibili.com (IPD Dental Group, Matarò, Barcelona, Spain), featuring double fixation screws to control the positions of the analogs within the master model; (B) 3D master model printed with proprietary resin (PRECISA® RD097, DWS Srl, Thiene, Vicenza, Italy) featuring very high precision; (C) the models in occlusion with the Irix® Max restoration (DWS Srl, Thiene, Vicenza, Italy) screwed in; (D) perspective view of the model with the restoration on the side; (E) detail of model and restoration.

10, 11, 12, 13). Aesthetic integration was good. Screw holes were sealed with Teflon, over which composite resin was cured. A final polishing in the mouth, and patients were discharged with new implant-supported restorations. The entire procedure took less than 2 hours.

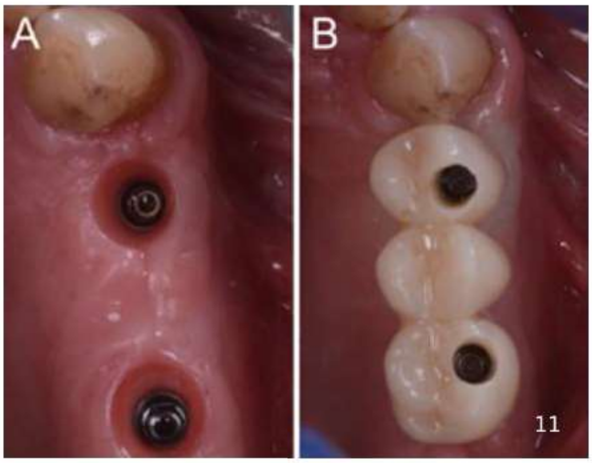

Fig. 11. Clinical case number 1: delivery of restoration in Irix® Max (DWS Srl, Thiene, Vicenza, Italy). (A) Detail of the mucosal collars. Note the excellent health of the peri-implant mucosal tissues, upon removal of the healing screws; (B) Delivery of the definitive bridge: clinical accuracy (defined by fit or adaptation, and occlusal and interproximal contact points) is optimal. The screw holes will be closed with Teflon and composite material, and the patient will be discharged, less than 2 hours after entering the dental office.

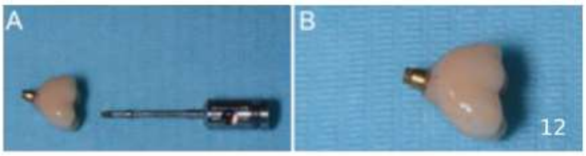

Fig. 12. Clinical case number 2: Delivery of the restoration in Irix® Max (DWS Srl, Thiene, Vicenza, Italy). (A) Detail of the screw-retained superstructure with fixing screw and driver from AbutmentCompatibles.com (IPD Dental Group, Mataró, Barcelona, Spain); (B) detail of the 3D printed restoration.

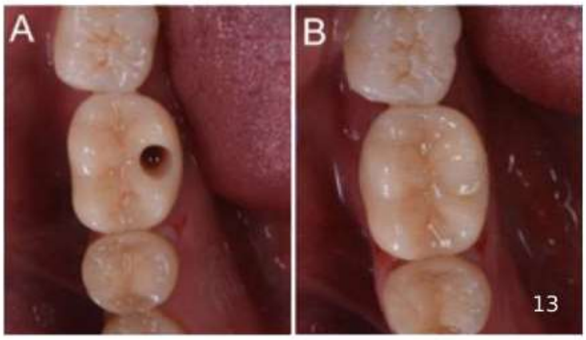

Fig. 13. Clinical case number 2: delivery of the restoration in Irix® Max (DWS Srl, Thiene, Vicenza, Italy). (A) Clinically, the crown fits perfectly, showing high precision, and integrates into the oral cavity both functionally and aesthetically; (B) screw hole closure with Teflon and composite.

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3D Printing with DFAB in a **full digital case**

Dr Francesco Mangano

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3D PRINTING WITH DFAB IN A FULL DIGITAL CASE

Dr. Francesco Mangano, DDS, PhD, FICD*

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INTRODUCTION

3D printing is revolutionizing the world of dentistry, but to date only a few dental practices have invested in purchasing a 3D printer. However, the recent introduction of new, compact and easy-to-use desktop and chairside machines could radically change the outlook. In this December issue of DentalTech, we present a prosthetic workflow for implant-based rehabilitation achieved with the new DFAB® machine from DWS Systems.

THE CLINICAL CASE

The patient, who had been previously treated through the placement of 2 implants (BTSafeR, BTK, Povolaro di Dueville, Vicenza, Italy) in area #25 and #26, underwent direct intraoral scanning with CS 3700® scanner (Carestream Dental, Atlanta, USA) **(Fig. 1).** The scan involved capturing the opposing arch, the master model with the mucosal collars in evidence (after unscrewing the healing screws) and the splint; then, scanbodies were inserted and screwed in, which were in turn scanned. The scanbodies were captured in their entirety **(Fig. 2)**, and the scan was sent to the dental technician who modeled in CAD software (Valletta®, Exocad, Darmstadt, Germany) two single crowns **(Fig. 3)**. These crowns were supported by two individual hybrid abutments consisting of a CAD-modeled portion **(Fig. 4)** to be cemented extraorally on a titanium bonding base.

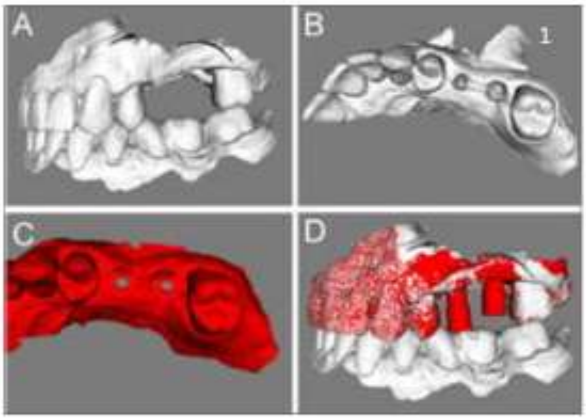

Fig. 1. Intraoral scan. (A) Master and antagonist models in occlusion; (B) view of the open mucosal collars in the master model; (C) the scanbodies in place on the master model; (D) The master and antagonist models with the scanbodies screwed on.

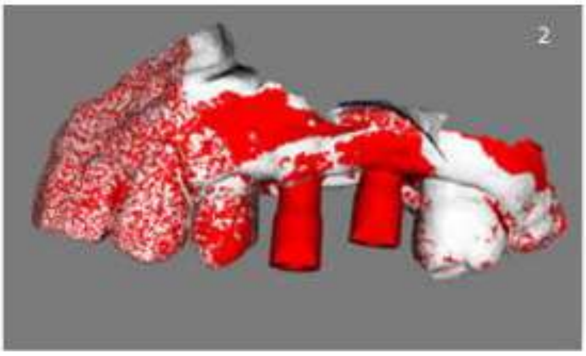

Fig. 2. Detail of the master model with and without the implant scanbodies.

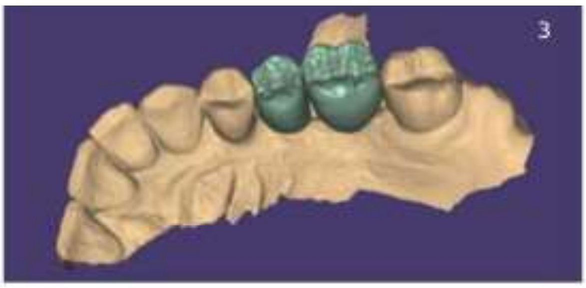

Fig. 3. CAD modeling of the restorations.

Translated from: Mangano F – La stampa 3D con D-FAB in un caso full digital. Infodent Dentaltech 2021: 12 12-14

Modeling of the individual abutments and single crowns was done in CAD **(Fig. 5)** with the possibility of setting different cement spaces, depending on the material chosen. The technician paid attention to modeling the occlusal board of the restorations **(Fig. 6)**.

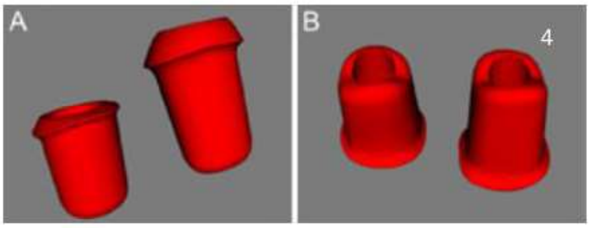

Fig. 4. Details related to the individual abutments. (A) View of the transmucosal part (B) view of the screw holes.

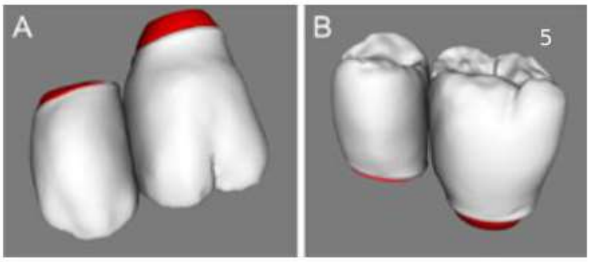

Fig. 5. The individual abutments and prosthetic crowns. (A) Top-down view (B) bottom-up view.

Crown and abutment files were then imported within the DFAB® chairside System. For the crowns, we opted for printing in translucent hybrid ceramic material, Irix Max® for permanent restorations, in "M" cartridge (3-4 elements) in the Photoshade version.

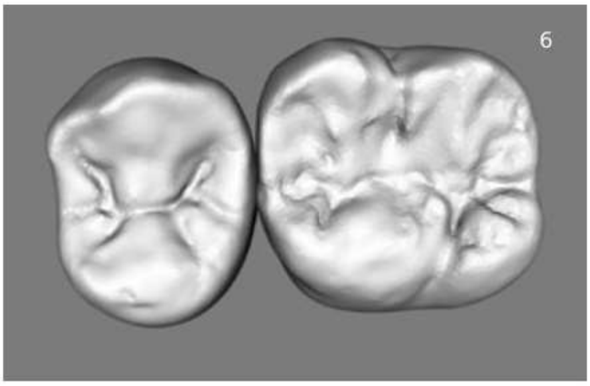

Fig. 6. Detail of the modeling of the occlusal planking of the prosthetic crowns.

Irix Max® is a hybrid ceramic material for translucent permanent restorations with adhesive cementation. It combines excellent aesthetic characteristics with excellent mechanical fracture resistance, enabling reliable and repeatable rehabilitations and has high wear resistance in occlusion. It allows the production of single and/or implant-supported crowns, inlays and veneers even with the smallest thicknesses, restorations faithful in detail, thanks to Photoshade technology and photo reproduction of the natural tooth.

It is a CE-marked Class IIa medical device. The adaptive gradient chosen was A3.5- A2 in this case. The color bands were set at 6.0 (cervical) - 2.7 (incisal) mm with Photoshade cartridge **(Fig. 7)**. The total printing time was 27 minutes.

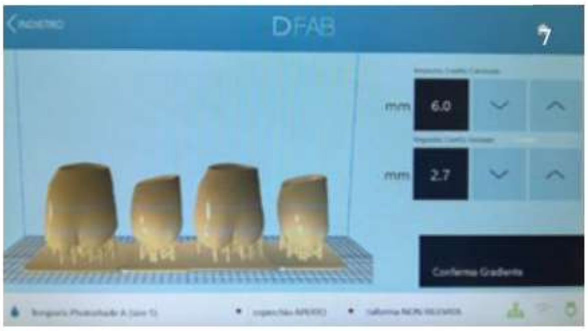

Fig. 7. Screenshot of DFAB® Photoshade software for setting color gradients.

For the abutments, we opted for Irix Max® monochrome A3.5 in "S" cartridge (mechanically more suitable when paired with Irix Max crown) for which the printing time was 13 minutes. Once the two printing processes were completed, the blocks with the newly printed platforms **(Fig. 8)** were placed in a special wash shaker, identified with a green sticker (for Class IIa compatible materials), containing 95% ethyl alcohol **(Fig. 9)**. The shaker was shaken for one minute (first wash) to remove residual material on the surface of the restorations and abutments.

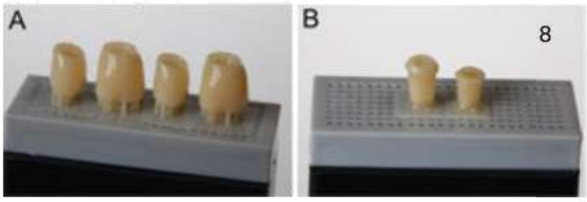

Fig. 8. Printing with DFAB®. (A) Prosthetic crowns (B) individual abutments.

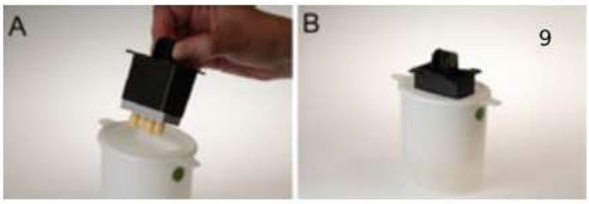

Fig. 9. Washing of restorations in special box with ethyl alcohol. (A) The printing block is inserted inside the box (B) the box is closed and shaken so that resin residues can be washed off the restorations and abutments.

If needed, the operation can be repeated with new alcohol in order to achieve optimal cleaning of the restorations. The alcohol was then blown off with compressed air. Removal of the supports was easy, thanks to DWS's patented "Easy Break" generation system. In fact, removal is facilitated at the point of breakage (a bottleneck is created between the head of the support and the ball built above, which half penetrates the artifact, while the other half remains joined to the support) **(Fig. 10).** No cutters or other tools are needed; the sprues are thin and are easily removed with fingers alone. The crowns underwent an initial finishing: with the help of an ultrasonic cutter, the protruding hemispheres (remnant of the supports) were removed. Then a second washing with an airbrush with 95% ethyl alcohol and compressed air was carried out to remove any remaining material (liquid or powdered) from the grooves of the crowns.

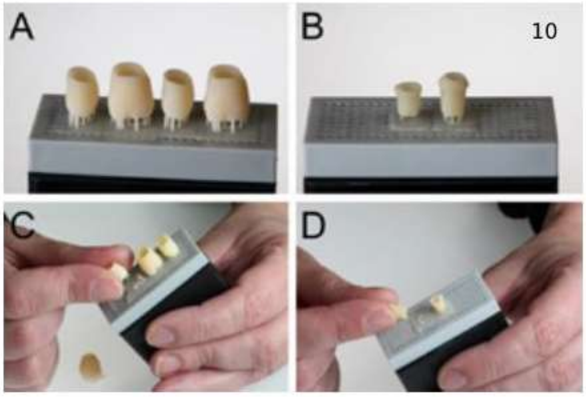

Fig. 10. Removal of the supports. (A) Prosthetic crowns with their supports on the printing platform; (B) individual abutments with their supports on the printing platform; (C) removal of crowns from their supports; (D) removal of individual abutments from the printing platform.

The crowns were customized by employing composite tints (stains), before final polymerization in the DCURE device (Fig. 11). Restorations and abutments were placed in the DCURE® which is specific for restorations in Temporis® and Irix® series materials. The device stabilizes the materials with a hybrid cycle - combining heat and UV light - of 7 minutes for optimal curing. At the end of the cycle, the device opens automatically.

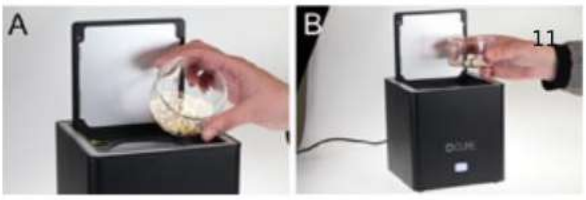

Fig. 11. Insertion of restorations into the DCURE® device. (A) Restorations and abutments are placed in the DCURE®; (B) once the restorations are cured, the device opens automatically.

For finishing and glazing, a rotating brush with goat hair was used to lightly polish the restorations, taking care to quickly rewash them with 95 percent ethyl alcohol and compressed air. Once crowns were well cleaned, Shofu glaze was applied in thin layers with a small brush until complete covering. Finally, the restorations were cured with a power lamp and ready to be delivered to the patient **(Fig. 12)**.

Fig. 12. The restorations are ready for delivery. (A,B) The glazed crowns; (C) crowns and abutments; (D) Delivery of the final restorations.

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Additive manufacturing in the **esthetic reconstruction of anterior teeth**: new possibilities for the clinician and the dental technician

Dr Roberto Molinari, Dr Mauro Fazioni, Camilla Vesentini

DENTAL TECH is an **INFODENT® italian magazine** column.

THE CLINICAL CASE

#3Dprinting

ADDITIVE MANUFACTURING IN THE ESTHETIC RECONSTRUCTION OF ANTERIOR TEETH: NEW POSSIBILITIES FOR THE CLINICIAN AND THE DENTAL TECHNICIAN

Dr. Roberto Molinari*, Dr. Mauro Fazioni**, Camilla Vesentini***

** Private practice, Mantua, Italy. Scientific disseminator for years. Organizer and lecturer of events and workshops in Italy and abroad, on the topics of esthetic restorations and implantology. Holds training courses for dentists on the best use of CAD/CAM techniques on natural teeth and implants.*
*** Private practice, Verona, Italy. Has published extensively in national and international journals on topics ranging from implant-prosthetics and three-dimensional radiological diagnostics to direct esthetic restorative with CAD/CAM methods. Lectures in Italy and abroad.*
**** Designer, specialized in aesthetics and digital techniques.*

In restorative dentistry, esthetics and appearance, especially in the anterior dental areas, are increasingly perceived values only when associated with a minimally invasive approach. On the other hand, when the approach is totally noninvasive, it is received consistently. In clinical dentistry, there is still a great demand for the more common restorative procedures, such as the placement (and replacement) of restorations. In terms of time spent, they account for a significant part of dentists' work. No-prep (prep-less) veneers, although ideally considered the best option for maximum preservation of tooth structure, have often been criticized for some potential limitations including esthetic outcomes and periodontal complications. Since their introduction, hybrid composites have gained popularity as restorative materials, mainly because of their esthetic properties but also because of the possibility to work them at ultra-thin thicknesses, thereby reducing the removal of healthy tissue while maintaining properties properties compatible with clinical application. Recent decades have seen a continuous development of composite technology and adhesive techniques. Currently, hybrid ceramic is the material of choice for anterior and posterior tooth restoration. Since there is a wide variety of dental ceramics and a large selection of composite resin materials on the market, one wonders why there is a need for a new material. The advantages of ceramics are high flexural strength and color stability, while the disadvantages are high antagonist tooth wear and loss of tooth structure due to a minimum thickness of 1.5 - 2.0 mm. These two parameters are better for composite resins, but the wear of the material itself is generally higher. Thus, Young's modulus should be close to dentin's and hardness values should be between those of dentin and enamel. Minimum wear of both the material itself and the opposing teeth would be desirable. In order to preserve healthy tooth structure, the most important requirement for new materials would be a very low

Translated from: Molinari R. Fazioni M. Vesentini C. Uso del metodo additivo nella ricostruzione estetica del gruppo frontale: nuove potenzialità per il clinico e per l'odontotecnico; Infodent Dentaltech 2021:12 15-17

Fig. 1. Initial photograph of the patient.

Fig. 2. Smile design.

Fig. 3. Mockup.

Figs. 4,5. Minimally invasive preparations.

Fig. 6. CAD restorations planning.

minimum thickness. High-quality veneers on unprepared or minimally prepared teeth can be more challenging to fabricate than conventional veneers, and their success depends on a combination of good case selection, margin placement, sound adhesive principles, and clinical and laboratory experience. Besides, 3D printing offers some additional advantages: it does not depend on the size of a tool and on a software-designed path of insertion, since the fabrication of restorations does not depend on these parameters. In fact, laser additive technology allows for better management of undercuts than subtractive techniques and, consequently, greater accuracy in prosthetic restoration. The prerogative of the DWS' DFAB method is to create a restoration with an adaptive gradient of value and chroma, making the use of surface tints (staining) unnecessary. In fact, staining limits the restoration's esthetics over time since it's subject to the normal wear phenomena of the oral cavity. The patient, 35 years old, in good psycho-physical health, presented to our observation lamenting an esthetic discomfort due to the appearance of her front teeth. The objective examination highlighted small signs of wear in substantially healthy tooth structure. Intraoral scanning was performed with Primescan (DentsplySirona) and the scan was imported into Smile Creator 3.0 Galway (Exocad) esthetic analysis software. The analysis showed an inconsistency of proportion between the length and width of the front teeth, with a minus of about 1.5 mm. A software project was made according to the indications of the esthetic analysis with Cerec 4.6 software (DentsplySirona). From the software project, a prototype was made that, once placed in the mouth, provided useful information on the minimally invasive preparation technique. Minimally invasive preparations were then performed on the maxillary front teeth. Next, intraoral scanning of the preparations was performed, associated by

Fig. 7. The DFAB printer from DWS Systems.

Fig. 9. The printed restorations.

Fig. 8. The DFAB's Photoshade system.

Fig. 10. The restorations following cementation.

Fig. 11. The patient's new smile.

subtraction with the Digital Wax-Up. The restorations were printed by the DFAB method (DWS) using Irix Max®, DWS glass-ceramic filled hybrid composite. The resulting restorations were adjusted and finished according to the "Polishing Technique"* for the preservation of the surface quality.

The restorations were then cemented with Calibra® Veneer (DentsplySirona) adhesive cementation technique, employing light-curing esthetic resin cement.

The photo sequence (Figs. 1- 11), fully documents the clinical case.

** A technique involving only finishing and polishing, without resorting to the use of surface colors and/or glazing*

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iTero ElementTM 5D Plus meets DFAB®: excellence in Digital Dentistry

Dr Francesco Mangano

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THE CLINICAL CASE

digitalimplantprosthodontics

iTero Element™ 5D Plus meets DFAB®: excellence in Digital Dentistry

Dr. Francesco Mangano, DDS, PhD, FICD*

** Associate Professor, Digital Dentistry, Sechenov University, Moscow, Russia. Editor of the Digital Dentistry Section of the Journal of Dentistry (Elsevier) Q1 journal with impact factor 4.9 and citescore 6.8. Founding Member, Active Member, Board of Directors Member and President-Elect (2024-2025) of the international Digital Dentistry Society (DDS). Director of the Mangano Digital Academy (MDA), an academy that aims to promote education in Digital Dentistry. Creator of the Course "#ZEROMICRONS: Precision in Digital Dentistry." Author of 136 publications in Pubmed indexed international journals with a high impact factor, and h-index of 46 (Google Scholar) and 36 (Scopus). He practices in Gravedona (Como), devoting himself exclusively to Dentistry Digital, and to the development and application of innovative technologies in Dentistry, such as artificial intelligence and augmented reality*

INTRODUCTION

A simple clinical case of a mandibular implant supported (Anyridge®, Megagen) premolar crown, resolved in just 2 sessions thanks to the use of:

1. Intraoral scan (iTero Element™ 5D Plus, Align Technology) **(Figs. 1-3)**;
2. CAD modeling (Galway®, exocad™) **(Figs. 4,5)**;
3. 3D printing (DFAB®, DWS) of hybrid ceramic crowns. (Irix Max®, DWS) **(Figs. 6,7)**;
4. 5-axis milling (DWX-52D®, DGSHAPE) of a zirconium customized abutment to be bonded on a titanium base (AbutmentCompatibles.com, IPD ProCam) and 3D printing of models (XFAB 3500PD®, DWS) implants according to the IPD ProCam concept **(Fig. 8)**;
5. delivery of the hybrid ceramic restoration, cemented on the customized zirconia abutment **(Fig. 9)**.

THE CLINICAL CASE

The prosthetic phase begins with an intraoral scan, performed with a powerful device (iTero Element™ 5D Plus, Align Technology). The scanning sequence involves capture of the implant site quadrant with the mucosal collar highlighted (after removal of the healing abutment), then of the opposing quadrant, and of 1-2 occlusal records. Next, the scanbody (AbutmentCompatibles.com, IPD ProCam) on the implant, and a scan of just the scan abutment at very high resolution. At this stage the software requires to report, via a green dot, the scanbody head in order to optimize the portion of the scan that is actually in HD. Finally, the scanning process is completed by capturing of the entire master quadrant, with the scanbody in place. The features that make iTero Element™ 5D Plus an outstanding machine in prosthetics on tooth natural and implant are basically 6:

Fig. 1. Intraoral scan of implant position. (A) Master model with mucosal collar highlighted; (B) opposing quadrant; (C) interocclusal relation; (D) the models in occlusion with the scanbody in place

Fig. 2. The scanbody with index in place.

Fig. 3. Detail of the scanbody' scan.
(A) Master model with the scanbody in place;
(B) high-definition detail of the scanbody

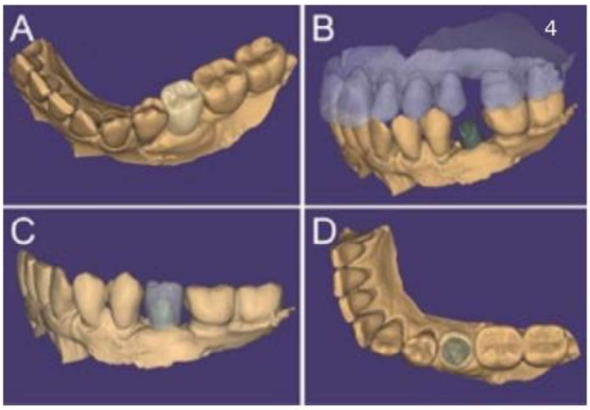

Fig. 4. CAD modeling with exocad™.
(A) Master model with restoration; (B) models in occlusion with custom abutment; (C) the final crown in transparency and the individual abutment, side view; (D) the definitive crown in transparency and the custom abutment, occlusal view.

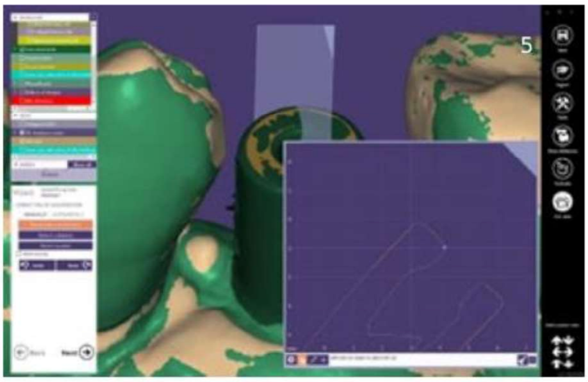

Fig. 5. CAD modeling with exocadTM.
2D evaluation of superimposition quality between mesh and library.

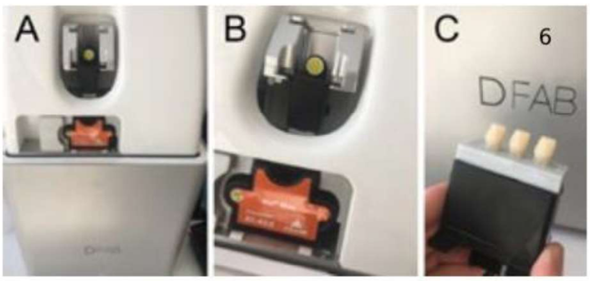

Fig. 6. 3D printing of the prosthetic restoration in hybrid ceramic material (Irix Max®). (A) The DFAB® printer with its printing plate and vat inclusive cartridge in place: (B) Detail of the Irix Max® cartridge with PHOTOSHADE®; (C) the newly fabricated restorations, before removal of the printing plate and washing in alcohol.

Fig. 7. Polymerization of restorations in the DCURE® device.
(A) Polymerization cycle is automatic and takes a few minutes;
(B) restorations cured and ready for delivery.

1. *Very high accuracy*, as demonstrated in a recent study[1], which showed how this scanner can also be considered an ideal solution for optical impression capture for fabrication of full arch (global error in nurbs/ nurbs < 20 μm in arch). The high accuracy is determined by the capture technology and the machine's proprietary algorithms for reconstructing the scanned object surface, but also by the size of the tip, with a large mirror that can reduce the stitching error;

2. *Extremely reliable bite capture*. Many scanners are unable to capture or represent occlusion in a predictable manner. This is a problem that can result in precontacts at the time of delivery of restorations, resulting in difficulties for the dental technician in modeling and for the dentist upon delivery. The occlusal record captured by iTero Element™ 5D Plus is absolutely accurate, exactly as it is in the mouth, thanks to advanced software that is able to to handle this complex phase of the scanning.

3. *Adaptive resolution*. iTero Element™ 5D Plus is one of the few machines on the market equipped with resolution adaptive: that is, it is able to create a contrast between areas of very high triangle density (e.g, at the scanbody to be captured, or of the natural tooth stump and thus the margin of preparation) and areas of medium/high density. This allows for the best visualization and reproduction of the critical areas for scanning: the implant scanbody precisely or, even more importantly, the natural abutment with the margin line in evidence. A recent study[2] showed how the sharpness of the margin line of the prosthetic preparation is strongly correlated to the acquisition resolution, and indeed to the contrast between areas of high triangle density and areas with lower density. In this sense, iTero ElementTM 5D Plus is one of only two scanners currently on the market that guarantees the capture of a scan with adaptive resolution. This is an important advantage in the prosthetic workflow, because it reduces potential errors in CAD;

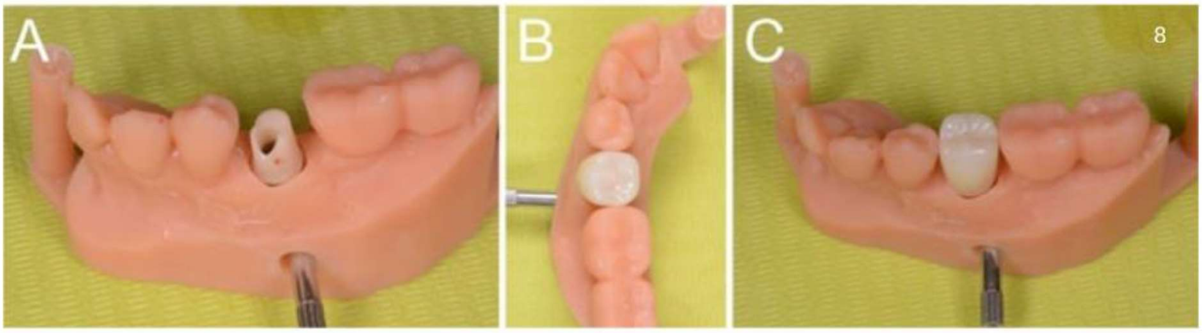

Fig. 8. The restoration on the type IPD Pro Cam model. (A) The 3D model, made with a SLA printer (XFAB 3500PD®) with the custom zirconia abutment in place; (B) occlusal view of the prosthetic restoration in Irix Max® resting on the custom abutment; (C) lateral view of the restoration.

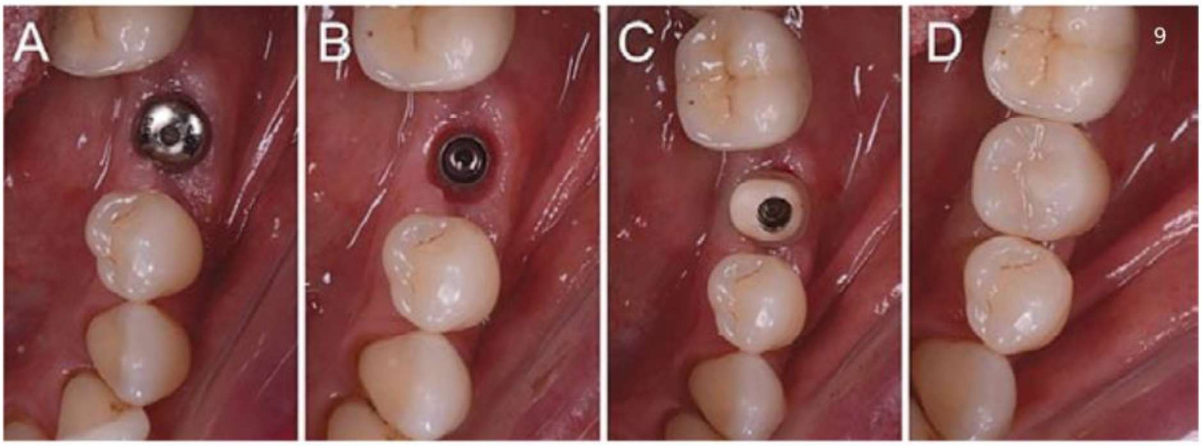

Fig. 9. Delivery of the prosthetic restoration. (A) Occlusal view with healing abutment in place; (B) mucosal collar; (C) custom zirconia abutment screwed in place; (D) the cemented prosthetic restoration.

4. *Disposable tips* that ensure very high quality of scanning. In most other commercially available systems, the tips are made of plastic and contain the mirror that is used for image capture. Such tips tend to be reused several times, due to cost, but sterilization and/or disinfection damages them, making it more difficult to obtain a quality scan. With iTero Element™ 5D Plus, the tips are disposable and do not contain the mirror: they serve only to isolate and protect the mirror, which is in the machine. Being soft, they can be placed on the patient's teeth without creating any discomfort, and being disposable, they guarantee the scanning quality, since the mirror is in the camera body, and not on the tip;
5. *Technology for caries detection*, including interproximal caries (NIRI)[3] useful when scanning natural teeth;
6. Direct communication with dental CAD's leading platform (Galway®, exocad™), which belongs to the same company that produces the scanner (Align Technology).

Once the scan is completed, its refinement is started , after which it is possible to refine further, through simple and intuitive tools available in the software, the adaptive resolution. The scan is then automatically sent through the MyItero® portal to the certified laboratory, which can immediately view the files. The integration with exocad™ is certainly a plus for this scanner, which with the CAD software is now a powerful prosthetic platform. The technician models the restoration to be cemented onto a custom zirconia abutment. Such custom abutment is milled from zirconia with a powerful 5-axis machine (DWX-52D®, DGSHAPE), sintered and then bonded in the laboratory on the chosen bonding base (AbutmentCompatibles.com, IPD ProCam). The technician also prints a precision model of the implant's position with a SLA printer (XFAB 3500PD ®, DWS).

The use of the AbutmentCompatibles.com system has two outstanding advantages over competitors on the market, which make it possible to significantly increase clinical accuracy:

1. intelligent library in CAD, capable of compensating for any dimensional discrepancies or inconsistencies between the scanbody mesh (3D reconstruction of the surface of the acquired scanbody, by the scanner software) and the original file of the scanbody found in the implant library. Such compensation is achieved by the presence of several dimensional increments (T0 to T6) of the same file library: the technician can then realize the matching between mesh and library, check it dimensionally in 2D and 3D, and then "choose" the solution with the lowest error. This is an essential aspect, since an inconsistency at this stage can determinate a "slippage" of the implant platform from the real to the virtual position, causing a clinical inaccuracy;

2. models with “intelligent” analog fixation system. The analog is not simply inserted "by pressure" into the model, but is locked in the exact spatial position it must have by a system of screws. This allows zero error in the transfer of the implant position from the CAD to the 3D printed model.

The prosthetic restoration file, designed by the dental technician, is printed directly in the dental office, thanks to the DFAB® printer from DWS. Such a printer allows up to 5-6 restorations to be made in 10-15 minutes. color gradient, hybrid ceramic prosthetic restorations, thanks to the proprietary PHOTOSHADE® technology.

We have already talked about this revolutionary 3D printer in the June issue of DentalTech, and in the Editorial in this November issue. The main advantages of printing with DFAB® are summarized below:

1. hybrid ceramic material printing, for high accuracy and high esthetic performance. The accuracy of these restorations is high, because they are made through proprietary SLA technology certified by DWS. Accuracy is also guaranteed by the process of integration into exocad™. Within the exocad™ ChairsideCAD software DWS materials can be found, with preset cement spaces and predefined offsets; the latter aspect is particularly important when printing superstructures to be bonded to titanium bases (screw-retained prosthesis). At the same time, aesthetics are high, as determined by the presence of hybrid ceramics and the possibility of color gradient printing with PHOTOSHADE®;
2. absolute simplicity. All that needs to be done is to load the STL file resulting from the CAD modeling into the proprietary Nauta's PHOTOSHADE® software: the software automatically provides for the correct orientation of the restorations, preparation of printing base and supports. All the operator has to do is choose where to place the color layers, and insert the cartridge of the selected material and the printing platform into the machine;
3. speed: after launching the print, in 10 minutes the restorations will be ready to be washed in ethyl alcohol, and cured in the dedicated DCURE® device. Polymerization will only take 6-7 minutes;
4. zero maintenance. DFAB® works with cartridges that are removed at the end of printing. There is no need to clean any printing vats, since the vat in incorporated in the cartridge incorporates. Once a printing session is completed, a second one can be started immediately: just change the disposable cartridge and print platform. In fact nothing needs to be cleaned except for the restorations.

Once printed, the restoration is cured in the dedicated device and is ready for delivery. The patient is called back, the healing abutment is removed and the custom zirconia abutment is screwed in and checked. Teflon is placed to seal the screw hole and the hybrid ceramic restoration in then fixed on top of it with temporary cement. Occlusion is carefully checked and the patient is discharged with the new restoration cemented in place. The hybrid ceramic crown is in fact a definitive restoration, but it can also be replaced later by monolithic milled zirconia restoration, depending on clinical and patient needs.

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