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CLINICAL CASES

Case Report

Chairside TSLA workflow for same-day 3D printed *crown* restorations

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- Author of more than 40 articles in the last 5 years published in indexed international peer-reviewed journals, his clinical and research activity is mainly focused on fixed prosthodontics, implant, oral surgery and digital workflows.

INTRODUCTION

The integration of digital technologies across various dental specialties-from cone-beam computed tomography and orthodontic planning to guided implant surgery and advanced prosthodontics-has revolutionized the field. These innovations enable clinicians to streamline workflows, reduce treatment times, and maintain high standards of precision, function, and esthetics.

In particular, three-dimensional (3D) printing has become a viable alternative to traditional subtractive methods, especially in time-sensitive, in-office procedures. Systems like the Dfab TSLA 3D laser printer with Photoshade technology allow for the rapid fabrication of both functional and aesthetic restorations directly within the dental office. This technology, supported by both in vitro and clinical retrospective studies, offers exceptional speed and precision, making it particularly well-suited for immediate restoration in single-visit treatment protocols.

This clinical report describes a fully digital, chairside workflow for the immediate restoration of two teeth using 3D-printed crowns. The process encompasses diagnosis, digital impressions, crown design, and in-office fabrication, all completed in a single session. The approach demonstrates how digital tools and 3D printing technology can optimize clinical efficiency, meet patient expectations, and deliver high-quality prostheses on the same day.

CASE REPORT

A 65-year-old patient presented with the left first and second maxillary molars, which had undergone multiple treatments in the past and were currently restored with old crowns. These presented marginal leakage, secondary caries, and wear. The patient sought a more permanent solution and had no time to perform conventional prosthodontic treatment. He asked that the treatment be completed the fastest as we can. Digital radiographs were taken and a treatment plan was developed and discussed with the patient.

After the removal of the compromised crowns and caried tooth structure, endodontic treatments were performed. The tooth were restored by placing post inside the root canals when needed. Initially, a provisional restoration fixed partial denture covering two teeth was performed chairside. Then, when the endo and restorative treatment was finished, full coverage preparations were performed. (Figs. 1A, B). A tissue management procedure, using a retraction paste with hemostatic action, was then performed to ensure clean, visible preparation surfaces and provide margins visibility for precise digital impressions taking.

The digital workflow began with an intraoral scan of the maxillary and mandibular arches using the Trios 3 POD scanner (3Shape), employing the pre-preparation scan function with the provisional inside the patient's mouth. After the tooth preparations were finalized, the left first and second maxillary molars were scanned again.

FIG. 1A, B *Preparations of teeth 26 and 27, (A) occlusal and (B) side view.*

Once the digital impressions were acquired, they were transferred to the computer for prosthetic crown design (CAD). In this case, the Trios Design Studio (3Shape) software was employed to design the crowns. The emergence profiles, axial contours, and occlusion were finalized before saving the designs as a standard tessellation language file (.stl). This file (Fig. 2) was then transferred to the Dfab TSLA 3D laser printer (Fig. 3) for direct printing.

The Dfab printer, equipped with Photoshade technology, enables high-resolution reproduction with aesthetic color gradients that harmonize with the patient's natural dentition. The crowns were printed using a 42% ceramic-filled hybrid composite, Irix Max (RD Printing), a biocompatible material validated for intraoral applications. The printing process took approximately 22 minutes, allowing for the rapid fabrication of the desired high-strength hybrid polymer crowns.

FIG. 2 *The 3D computer aided designs saved as a standard tessellation language (.stl) file.*

FIG. 3 *Dfab desktop 3D TSLA laser printer and Irix Max Photoshade Dfab cartridge.*

“TSLA enhances printing speed and reduces the need for large support structures, improving both efficiency and print quality.”

TSLA PRINTING TECHNOLOGY INSIGHTS

The Dfab TSLA printer employs a unique tilted stereolithography (TSLA) technology designed for chairside manufacturing. Unlike traditional stereolithography, TSLA uses an inclined build platform and a moving high-viscosity resin, which creates a cascade effect that ensures even mixing of heavy fillers during printing (Fig. 4). This innovation enhances printing speed and reduces the need for large support structures, improving both efficiency and print quality. Once the CAD data is loaded into the Photoshade software, the crowns are auto-positioned for optimal accuracy and fit (Figs. 5A, B). The system allows the operator to adjust the color gradient to match the patient’s natural tooth transitions, with the cervical and incisal areas carefully defined to achieve the best esthetic results (Figs. 5 c, d). The print process begins with a UV laser selectively polymerizing the composite material layer by layer, building the crown from the base up (incisal/occlusal to cervical).

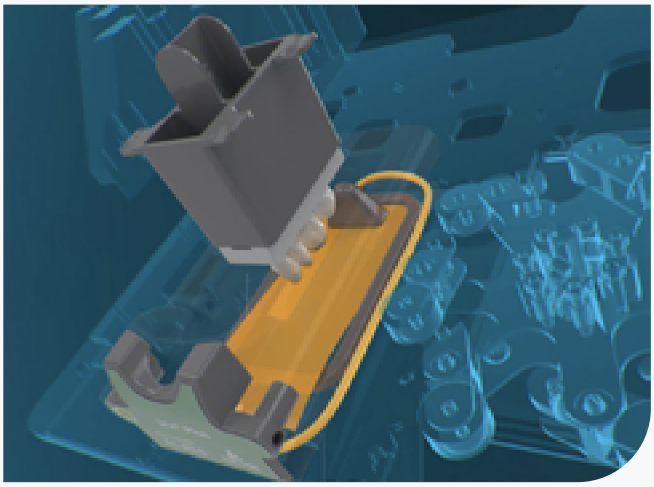


FIG. 4 *A videographics image of Dfab 3D TSLA technology.*

FIG. 5A *The .stl file loaded in the Dfab Photoshade software.*

FIG. 5B *The Photoshade software automatically orients the virtual restoration for optimal printing and color gradient results.*

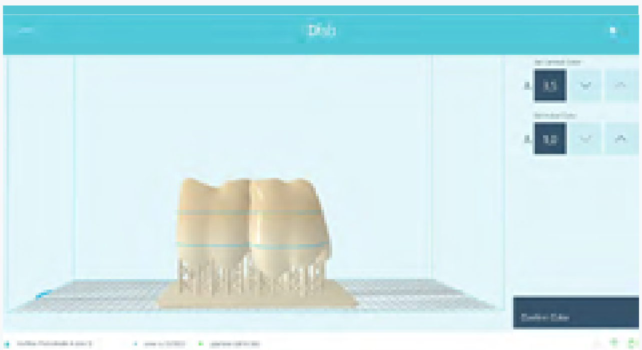


FIG. 5C *The restoration’s cervical and occlusal shade range is set in Photoshade.*

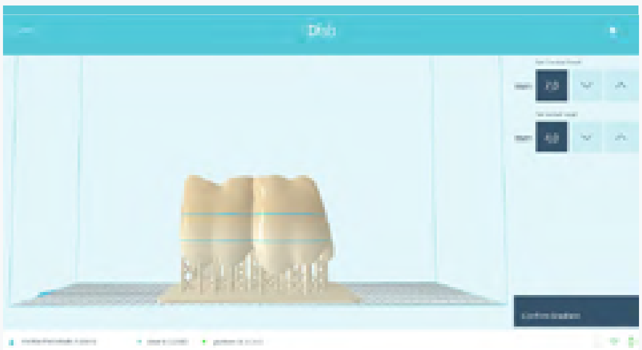


FIG. 5D *The color gradient boundaries of the restoration are set in Photoshade.*

FIG. 6 *Dfab restorations, as printed and still on the platform.*

POST-PROCESSING AND CEMENTATION

Post-printing (Fig. 6), the restoration underwent the standard finishing steps:

1. ***Washing***: The crown was washed with 95% ethanol (Figs. 7A-D) to remove residual composite material, ensuring accuracy and maintaining the precision of the print;
2. ***Support Removal***: The support structure was easily detached using a twisting motion, facilitated by the patented "easy break" system;
3. ***Post-Curing***: The restoration was then placed in a dual-energy (UV light and heat) curing unit (Dcure, RD-Printing) for a 9-minute cycle to maximize material conversion and mechanical properties (Figs. 8A, B);
4. ***Finishing and Polishing***: Margins were finished and polished using diamond-impregnated polishers (Diacomp, EVE, Germany) at low speed (≤ 8k rpm) to ensure smooth surfaces with better resistance to plaque adhesion (Fig. 9).

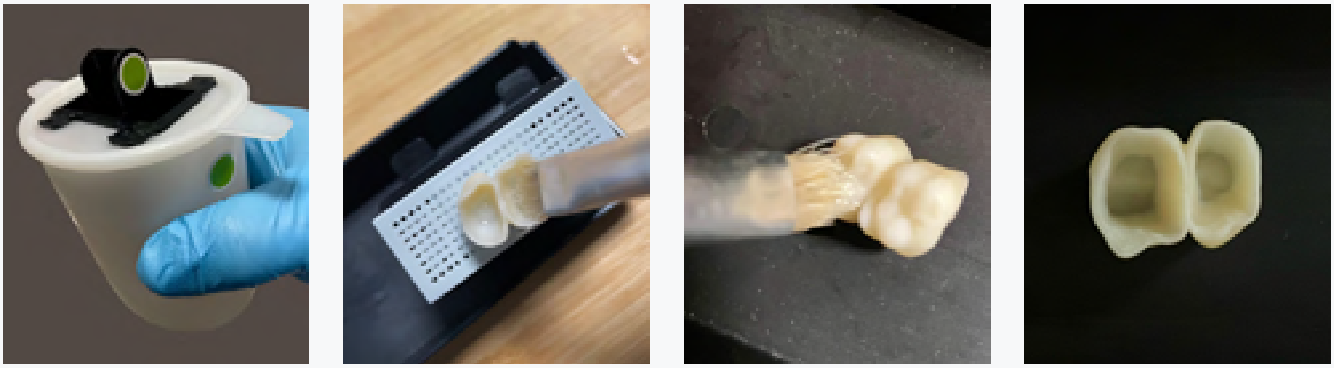


FIG. 7A-D *(A) Washing with 95% ethanol using a shaker for one to two minutes. (B) Scrubbing the intaglio surfaces with a brush wetted in 95% ethanol helps remove liquid composite residue. (C) Once the restoration has been separated from the platform, its occlusal surfaces are also scrubbed to remove any liquid composite traces. (D) An intaglio view of the restoration after washing and drying, ready for post-polymerization.*

"The restoration was then placed in a dual-energy curing unit for a 9-minute cycle to maximize material conversion and mechanical properties."

FIG. 8A, B *(A) The Dcure UV and heat post-polymerization unit containing the treated restoration. (B) Occlusal view of the post-polymerized restoration.*

FIG. 9 *Stained and glazed restoration, buccal-occlusal and lingual-occlusal view.*

Clinical try-in confirmed excellent marginal adaptation and passive fit, integrating seamlessly with adjacent teeth. The intaglio surfaces were sandblasted with 50 µm Al_2O_3 powder at 2.0 bar for 10 seconds to enhance the adhesion of the luting cement. The operative field was isolated, and after internal steam cleaning, the restoration was cemented using a dual-polymerized resin cement and corresponding adhesive bonding system, following the manufacturer's guidelines (Figs. 10 a, b.). Minimal occlusal adjustments were necessary, and final polishing was performed with diamond-impregnated wheels for an excellent finish without splattering. The patient was discharged with full functional restoration achieved in a single appointment. Post-treatment follow-up confirmed high satisfaction with both the comfort and esthetics of the restorations.

DISCUSSION AND CONCLUSION

Material and Print Performance

The Photoshade technology employed in the Dfab TSLA 3D laser printing system enabled high-quality, aesthetic reproduction with realistic color gradients. The rapid print and post-processing times make this system significantly faster than traditional milling or lab-based 3D printing, making it ideal for immediate chairside applications.

Clinical Relevance

This case report demonstrates that 3D printing technology can facilitate the delivery of high-precision, functional crowns in a single visit. Using the Dfab TSLA printer, which incorporates Photoshade technology, clinicians can produce prostheses that are both structurally stable and esthetically pleasing, reducing the traditional time required for prosthetic delivery. The case underscores the potential of chairside additive manufacturing to streamline workflows, enhance patient satisfaction, and improve the quality of care. As 3D printing technologies and materials continue to advance, single-visit prosthetic solutions are expected to become the new standard in modern dental practices, offering increased speed, precision, and personalization.

FIG. 10A, B *Completed restoration luted with a dual-cure resin cement: (A) occlusal view and (B) side view.*

Final Remarks

This report highlights the growing potential of 3D printing in modern dentistry, especially in providing same-day, high-quality restorations. The integration of the Dfab TSLA 3D printer into the chairside workflow not only improves clinical efficiency but also meets the rising patient demand for immediate, reliable dental care.

SOURCES

1) Alammar A, Att W, Beuer F. The Accuracy of 3D-Printed Fixed Dental Restorations. J Esthet Restor Dent 2024 Dec 8. doi: 10.1111/jerd.13365.

2) Dede, D.Ö., Zeller, D. K., Demirel, M., Al Johani, H., Schimmel, M., Çakmak, G., Yilmaz, B., & Donmez, M. B. (2025). Effect of manufacturing trinomial and preparation design on the fabrication and fit accuracy of additively and subtractively manufactured resin-based overlay restorations. Journal of Dentistry, 157, 105687.

3) Demirel, M., Donmez, M. B., Çakmak, G., Dede, D. Ö., Hinz, S., & Yilmaz, B. (2025). Effect of manufacturing trinomial and restoration thickness on the fabrication trueness, fit, and margin quality of additively manufactured resin-based ultrathin laminate veneers. Journal of Dentistry, 155, 105606.

4) Mangano, F. G., Mangano, C., Loktionova, M., Dudnik, O., Malanova, O., Elovskaya, A., Maltseva, A., & Dybov, A. (2025). Additively manufactured hybrid composite implant-supported restorations: A retrospective clinical study of 145 patients with up to 2 years of follow-up. Journal of Dentistry, Advance online publication, 105999.

5) Mangano, F. G., Yang, K. R., Lerner, H., Porrà, T., Khachatryan, L. G., Gordienko, I. D., & Admakin, O. (2024). 3D printed short-span hybrid composite implant-supported restorations fabricated through tilting stereolithography: A retrospective clinical study on 85 patients with 1 year of follow-up. Journal of Dentistry, 147, 105095.

3D-printed screw-retained single crown: A chairside single-visit workflow

Dr Antonino Cacioppo, Italy

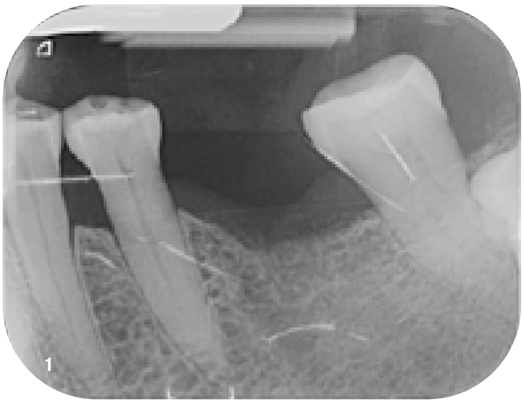


Fig. 1: Radiograph of the single edentulous site in the region of tooth #36 requiring restoration.

Introduction

The digital revolution in dentistry has introduced increasingly efficient and predictable workflows, enabling clinicians to drastically reduce treatment times while maintaining high standards of precision and functionality. In particular, the combination of guided surgery and chairside prosthetic manufacturing technologies is reshaping the approach to single-tooth implant restorations.

3D-printing technologies (additive methods) are now emerging as viable alternatives to subtractive methods (e.g. milling), particularly in scenarios where time efficiency and in-office production are critical. Resin-based additive manufacturing systems such as the Dfab tilting stereolithography (TSLA) laser printer with Photoshade technology enable clinicians to produce aesthetic and functional restorations directly in the dental office with unprecedented speed and accuracy.

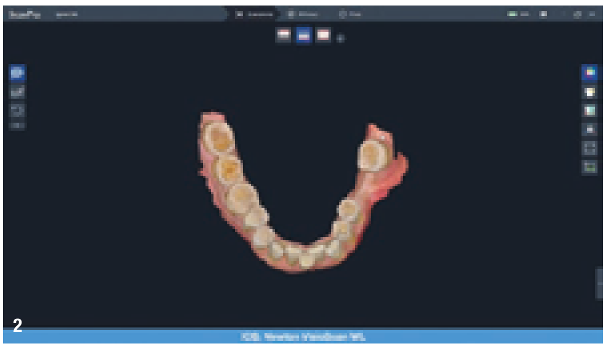
Screw-retained implant restorations are a widely accepted option owing to their retrievability, lack of cement-related complications and simplified maintenance. Their use in single-tooth cases, when combined with a fully digital workflow, offers the potential for same-day prosthesis delivery, improving patient comfort and reducing the number of clinical appointments.

This report presents the case of a patient with a single edentulous site in the mandibular posterior region. A fully digital chairside workflow was employed, including prosthetically guided planning, guided implant placement and immediate fabrication of a screw-retained crown using a 3D-printing resin. The definitive prosthesis was delivered in a single visit.

Case report

Patient assessment and initial situation

A 62-year-old female patient presented with a single edentulous site in the mandibular left first molar region (tooth #36; Fig. 1). The missing tooth had been extracted six months previously owing to a vertical root fracture. The patient was in good general health and expressed a desire for rapid and minimally invasive implant-supported rehabilitation. Clinical and radiographic evaluation confirmed sufficient bone volume and soft tissue to allow



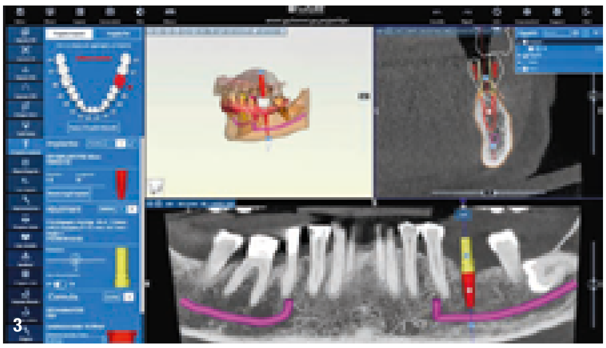


Fig. 2: Intra-oral scan of the mandibular arch. **Fig. 3:** RealGUIDE software showing the alignment of the STL files with the CBCT data for prosthetically guided planning of the implant position.

placement of a standard diameter implant without requiring regenerative procedures.

Digital planning and preoperative prosthesis fabrication
A digital workflow was started with the acquisition of intra-oral scans of the maxillary and mandibular arches using the ViSIOScan WL wireless scanner (Cefla; Fig. 2). The STL files were aligned with the CBCT data in RealGUIDE software (3DIEMME), which allowed prosthetically guided planning of the implant position (Fig. 3).

Based on the virtual implant position, a screw-retained crown was fully designed and fabricated prior to surgery without the need for an intra-oral scan after implant placement. The aim was to transfer the prosthetic plan to the surgical phase by ensuring perfect congruence between the digitally planned and clinically executed implant positions.

The crown was designed using digital prosthetic libraries (IPD Dental Group) to ensure compatibility with both the Oxy Implant PSK implant system (Biomec) and the selected titanium base (Ti-base). The emergence profile, occlusal morphology and screw access hole were designed to fit precisely on the Ti-base, assuming strict adherence to guided placement (Fig. 4).

The final design was then printed in-house using the Dfab TSLA printer with Photoshade technology (RD-Printing; Fig. 5), which allowed for high-resolution reproduction with aesthetic colour gradation. The printing time was 22 minutes, and post-processing included ultraviolet (UV) and heat photopolymerisation, finishing and cementation to the Ti-base.

Guided surgery and prosthesis delivery
A stereolithographic surgical guide generated from the RealGUIDE planning was used to perform fully guided implant placement under local anaesthesia. A PSK implant was inserted at the site of tooth #36 to a final torque of 50 Ncm, confirming sufficient primary stability for immediate restoration.

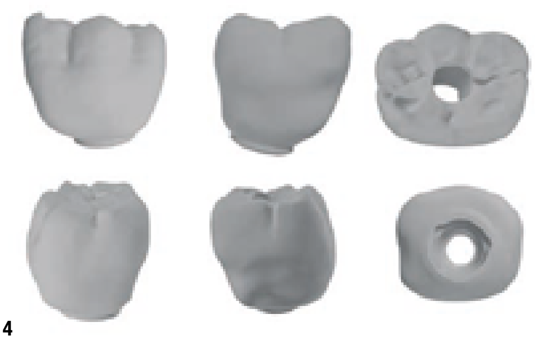

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Fig. 4: 3D CAD in STL format.

A straight Ti-base was placed according to the angulation designed in the prosthetic plan. The prefabricated screw-retained crown was seated immediately after implant placement without the need for modification or intra-oral scanning. Clinical verification confirmed excellent marginal adaptation and passive fit, both visually and radiographically. Minimal occlusal adjustment was required, and the crown was permanently screwed in place. The screw access hole was sealed with PTFE and composite resin. The patient was discharged with full function and aesthetics restored in the same session.

Prosthetic workflow

A unique aspect of this clinical protocol is the absence of a postoperative intra-oral scan for prosthetic purposes. Instead, the prosthesis was designed and fabricated prior to implant placement based on the virtual implant position generated during the planning phase in the RealGUIDE software. This approach requires meticulous attention to detail in both the surgical and prosthetic phases to minimise potential deviations between the virtual and actual implant positions.

Virtual implant planning and preoperative design of the prosthesis
The virtual implant position, aligned according to the prosthetic requirements, served as the definitive reference for the design of the definitive screw-retained crown. This concept of preoperative transfer of the prosthetic plan relies on a high degree of accuracy in surgical execution, supported by a fully guided protocol.


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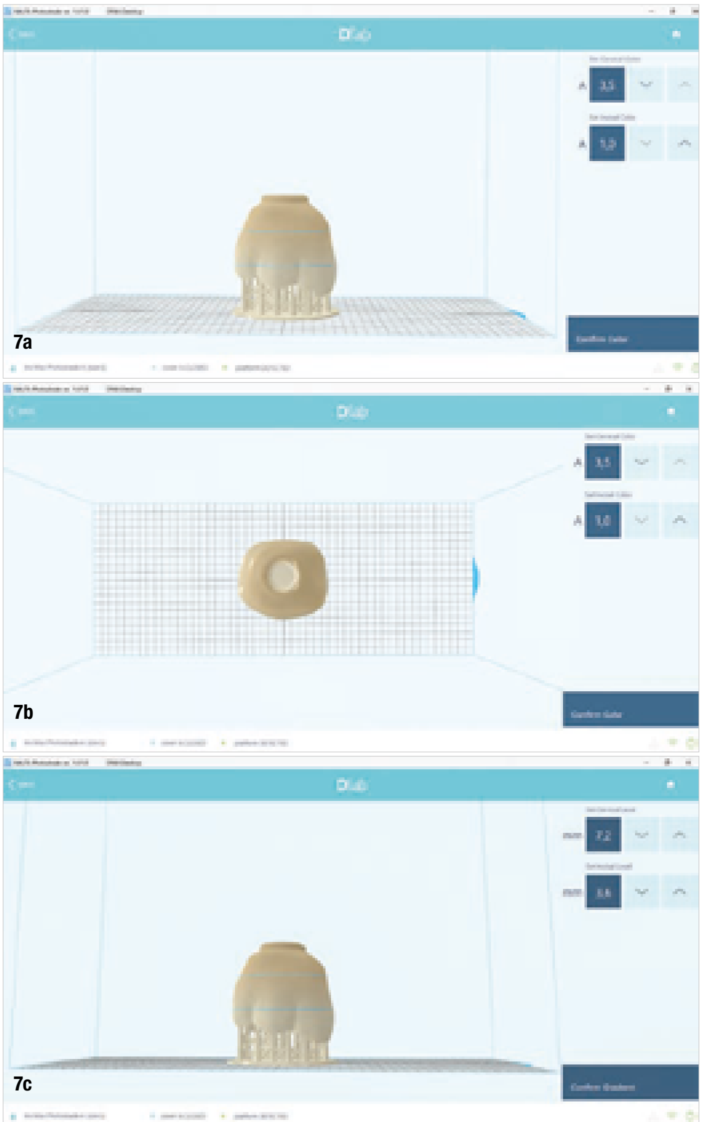
Fig. 5: Dfab desktop TSLA laser 3D printer. **Fig. 6:** Irix Max Photoshade Dfab cartridge.



Figs. 7a–c: Selecting the shade and the colour gradient in the Photoshade software.

CAD of the crown was performed using the IPD digital library, which offers extensive compatibility with various implant systems and Ti-base geometries. The crown was designed to sit on a Ti-base compatible with the Oxy Implant PSK system and with a screw access hole aligned and sized for retrievability. The emergence profile and occlusal morphology were designed with special attention to the spatial tolerance of the Ti-base interface and insertion axis to ensure passive fit of the prefabricated restoration.

Printing and post-processing

Once the design was complete, the file was sent to the Dfab printer for fabrication of the high-strength hybrid polymer crown. The chosen hybrid composite, Irix Max (DWS Systems; Fig. 6), is a biocompatible material for definitive restorations and has been validated for intra-oral applications. Direct printing assured:

– high accuracy without the need for retouching;
– a smooth surface and defined details; and
– a natural colour gradient owing to resin layering enabled by Photoshade technology.

The accuracy of 3D printing compared with conventional techniques is supported by clinical studies, which have demonstrated high reproducibility and prosthetic fit. Dfab employs TSLA technology, designed for chairside manufacture, and works with disposable cartridges, available in small, medium, and large according to the volume of material contained, allowing the workflow to be optimised according to the number and size of restorations to be printed. An evolution of stereolithography, TSLA uses an inclined build platform and a moving high-viscosity material to create a cascade effect that allows heavy fillers to be mixed evenly during printing. This technology increases printing speed and allows the size of the supporting structures to be reduced.

The process begins by loading the CAD restoration as an STL file into the Photoshade software, which automatically positions and correctly supports it for the best accuracy and fit with the occlusal surface facing the platform and the marginal and internal surfaces free of supports and facing the cartridge reservoir. The desired Photoshade colour gradient and positioning of the cervical and incisal colour boundaries are then selected, the width of the interspace resulting in a sharp (narrow) or gradual (wider) transition (Figs. 7a–c).

Once the appearance of the restoration has been approved, the printing process can begin. A Dfab cartridge of the selected material and size, incorporating the resin tub, is loaded into the top of Dfab, along with the printing block and disposable platform. The top of the printer is closed, tilting the cartridge at a 45° angle. Printing is initiated by the Nauta Photoshade Pro software, and a continuous flow of material is begun and maintained by gravity and a quiet peristaltic pump (Fig. 8).

At this stage, the software precisely controls the extrusion of material in two different shades to produce the desired colour gradient of the restoration. The blue UV laser beam is directed at the surface of the composite, selectively polymerising it to create the restoration. The build platform is gradually lowered into the resin tub, and the process is repeated layer by layer until the object is complete. The printer is then opened and the top section tilted to return the build platform and used cartridge to their original horizontal position, and they are removed, starting with the platform, to prevent unpolymerised liquid material from dripping into the printer.

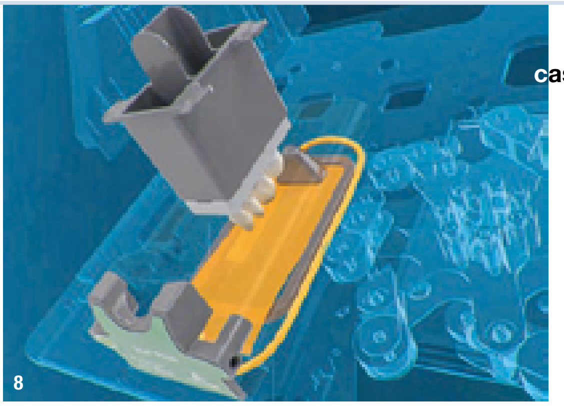


Fig. 8: Video graphics still image of a phase of the Dfab printing process.

After printing, the crown underwent standardised post-processing procedures. It was cleaned with 95% ethanol to remove all liquid composite from the restoration surfaces and maintain the high trueness of the TSLA printing process. This is accomplished by immersing the printing base and platform in a shaker containing 95% ethanol for 1–2 minutes, followed by scrubbing of all surfaces with a flat brush (Fig. 9). The supports were then removed, a simple manual procedure achieved by grasping the platform with one hand and the restoration with the other and twisting to safely separate the prosthesis without damage thanks to the patented easy break support configuration. Any unpolymerised composite residue in areas such as the occlusal and internal surfaces can now be removed with a flat brush dipped in 95% ethanol. Once dry, the restoration should appear opaque. Any shiny areas would indicate the presence of liquid composite residue that must be removed. Final post-polymerisation was then performed in the proprietary dual-energy (UV light and heat) unit (Dcure, RD-Printing; Fig. 10) with an automated, material-specific cycle that takes approximately 9 minutes to complete. This step is essential to obtain the best conversion rate for the material used and the best mechanical properties. Manual finishing and polishing of the margins were performed using a simplified and effective two-step sequential procedure with diamond-impregnated polishers of decreasing grit (Diacomp, EVE) performed at low speed (3,000–8,000 rpm). The crown was then cemented to the Ti-base using a dual-polymerising resin cement according to the manufacturer's protocol (Figs. 11 & 12).

Try-in and delivery of the definitive prosthesis

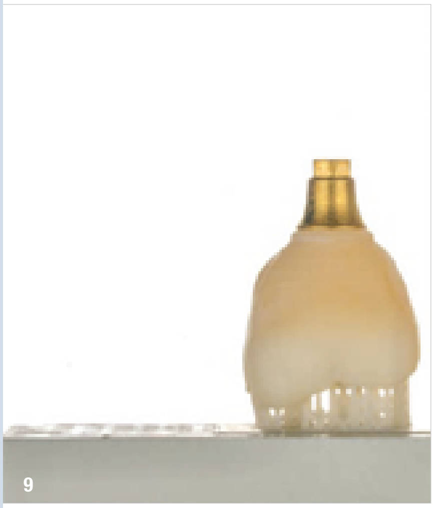
After implant placement and connection of the Ti-base, the prefabricated crown was directly seated without adjustment. The passive fit was verified clinically and radiographically. Occlusal contacts were evaluated and required minimal to no adjustment, confirming the accuracy of the virtual workflow.

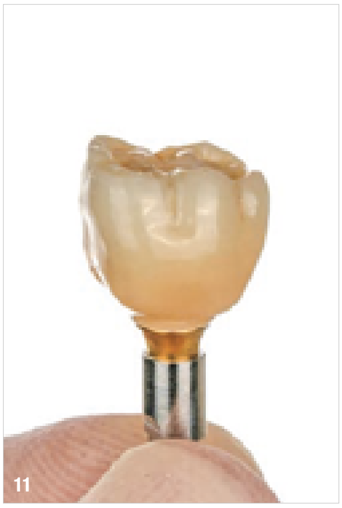
The prosthesis was permanently screwed into place using a calibrated torque wrench, and the screw access hole was sealed with PTFE tape and composite resin (Figs. 13 & 14). After a radiographic check of the treated area (Fig. 15), the patient was discharged with full function restored in a single session and reported high satisfaction with comfort and aesthetics.

Discussion

The integration of guided implant surgery with chairside additive manufacturing represents a significant evolution in digital implantology, enabling clinicians to deliver definitive restorations in a single clinical session. This case illustrates the feasibility of using a prefabricated, screw-retained crown designed on a virtual implant site and printed directly in the dental office for immediate delivery after implant placement.

The decision to forgo a postoperative intra-oral scan introduces a conceptual shift towards prosthetically driven backward planning, in which the accuracy of surgical execution is the key to the clinical success of





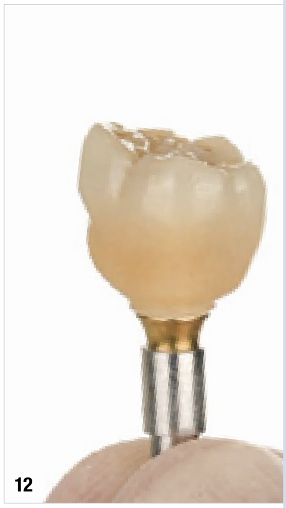


Fig. 9: Dfab-printed crown, still on the platform, after washing with 95% ethanol and drying. Fig. 10: Dcure post-polymerisation unit. Figs. 11 & 12: Finished crown cemented to the Ti-base with a dual-polymerising resin cement.

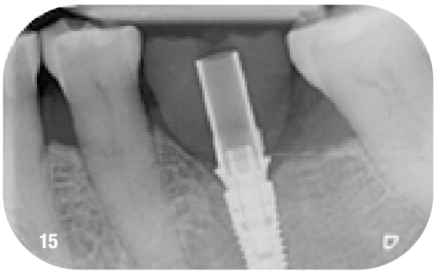


Fig. 13: Crown permanently screwed in place using a calibrated torque wrench. **Fig. 14:** Screw access hole sealed with PTFE tape and composite resin. **Fig. 15:** Radiographic evaluation of the restoration in place.

a prefabricated prosthesis. In this scenario, the use of a high-precision guided system (RealGUIDE) and validated implant components (Oxy Implant PSK implant system and IPD Ti-base libraries) was essential to reduce positional deviations that could have compromised the passive fit.

Several aspects deserve critical consideration:

– *Accuracy and fit:* The congruence between the virtually planned implant position and the actual clinical outcome was sufficient to allow precise seating of the prefabricated crown without occlusal or marginal discrepancies. This confirms the potential of guided surgery to achieve submillimetre precision when properly executed.
– *Material and printing performance:* The Photoshade technology used in the Dfab system enabled high-quality aesthetic reproduction with realistic colour transitions. The 22-minute total printing time is significantly faster than the fabrication time of milling or laboratory-based 3D-printing solutions, making it ideal for immediate chairside applications.
– *Workflow simplification:* Eliminating the postoperative impression phase reduces the number of clinical steps, potential contamination and patient discomfort while reducing chair time. This aligns with the principles of modern digital dentistry, in which minimal invasiveness and workflow efficiency are increasingly prioritised.
– *Limitations and risks:* Despite its success, this approach is sensitive to deviations between virtual and actual implant positions. Even small inaccuracies can lead to misfit, occlusal interference or screw access hole misalignment. Therefore, strict adherence to the guided protocol and the use of high-quality components are essential. In addition, long-term data on the mechanical behaviour and wear resistance of chairside-printed materials for definitive restorations remains limited, and these areas require further investigation.
– *Clinical relevance:* This case illustrates how digital workflows can be integrated for same-day delivery, improving the patient experience while maintaining precision. The strategy is particularly valuable in restoring single edentulous sites in non-aesthetically critical areas where implant stability is high and occlusal loading is moderate.

Conclusion

This clinical report demonstrates that the integration of guided implant surgery with high-speed chairside 3D printing enables the delivery of a definitive screw-retained crown in a single visit with high precision and patient satisfaction. Strategic use of the virtual implant position, combined with accurate planning and surgical execution, allowed the prefabrication of a definitive restoration that required no postoperative adjustment.

A key element of this workflow was the use of the Dfab TSLA printer with Photoshade technology, which provided aesthetic, functional and structurally stable results in just 22 minutes of fabrication time. This rapid printing capability transforms the traditional implant placement to restoration timeline, allowing clinicians to meet increasing patient demands for immediate, high-quality treatment solutions without compromising control or accuracy.

The success of this case confirms that chairside additive manufacturing is not only feasible but also highly effective when integrated into a rigorously planned digital workflow. As 3D-printing technologies and materials continue to evolve, their application to single-visit implant restorations is expected to become more widespread, bringing new standards of speed, personalisation and efficiency to modern dental practices.

about

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Il chairside nella Daily Digital Dentistry

Autori _ Dott. Luca Lepidi, MS, Dott. Byung Chan Kim

Le innovazioni tecnologiche introdotte nel corso degli ultimi anni hanno portato ad inevitabili cambiamenti al nostro modo di operare e di concepire la nostra pratica quotidiana. Grazie agli strumenti attualmente disponibili, oggi possiamo trasferire tutte le informazioni cliniche del paziente in un ambiente virtuale, con il potenziale vantaggio di ridurre significativamente i tempi operativi sia per il clinico che per il paziente. A tal proposito, nasce l'esigenza di testare nuovi protocolli.

Uno degli aspetti dell'odontoiatria maggiormente trasformati dalle innovazioni moderne è la produzione dei manufatti protesici, oggi progettati in ambiente virtuale e successivamente importati, tramite file digitali, in software dedicati alla produzione mediante dispositivi specifici. A tal proposito, in linea generale, ci si riferisce ai protocolli CAD/CAM (Computer-aided design/computer-aided manufacturing), che permettono di realizzare manufatti con alta precisione e accuratezza.

Grazie alla crescente diffusione e accessibilità dei protocolli CAD/CAM e alle sue declinazioni, l'odontoiatria *chairside* trova sempre maggiore consenso fra i clinici, perché consente di progettare e produrre manufatti protesici in poche ore direttamente in studio.

Il protocollo *chairside* mostrato in questo articolo per il disegno e la realizzazione di manufatti protesici prevede 5 fasi (Fig. 1):

1. Preparazione/posizionamento implantare.
2. Scansione intraorale.
3. CAD.
4. CAM.
5. Consegna del manufatto protesico.

_ 1. Preparazione/posizionamento implantare

La realizzazione di un restauro indiretto prevede la preparazione protesica di un elemento dentario o il posizionamento chirurgico di un impianto. Allo scopo di rendere il risultato predicibile, la pianificazione del posizionamento implantare e la ceratura di diagnosi virtuale rappresentano fasi molto interessanti per i vantaggi che possono dare al clinico.

_ 2. Scansione intraorale

Dopo la realizzazione della preparazione protesica dentale o il posizionamento della fixture implantare passiamo alle fasi di acquisizione dei dati intraorali e quindi alla digitalizzazione del flusso di lavoro con la scansione intraorale. Le arcate del paziente vengono scansionate e digitalizzate per mezzo dello scanner intraorale che produce una mesh in formato STL, ovvero un file formato da un insieme di triangoli e vertici che si traduce, in un ambiente virtuale, in una superficie che replica l'elemento scansionato. Durante questa fase è fondamentale produrre dati accurati, pertanto, è necessario conoscere la gestione dei diversi fattori da gestire che possono influenzare la qualità della nostra scansione[1, 2], così come è importante assicurarci che gli elementi da sottoporre alla protesizzazione abbiano una riproduzione nella mesh ad alta risoluzione, ovvero una elevata densità dei triangoli nella zona di nostro interesse (Fig. 2).

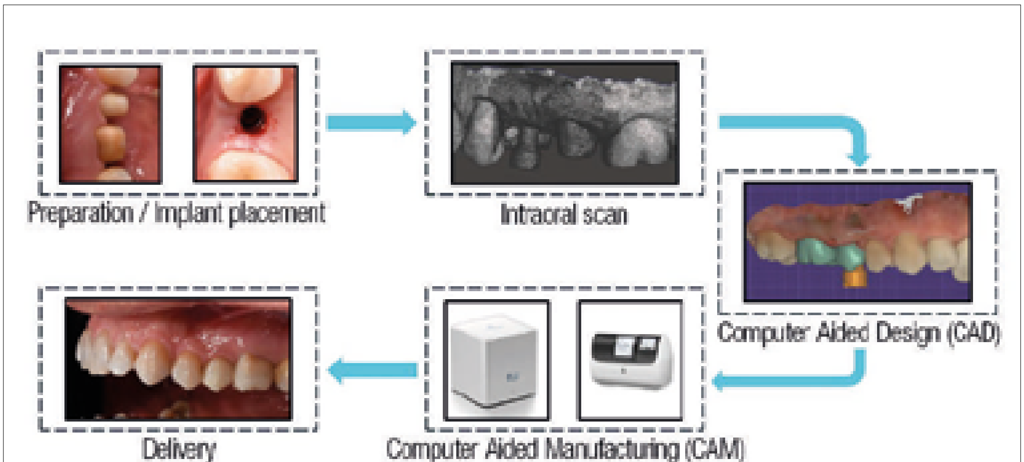

Fig. 1

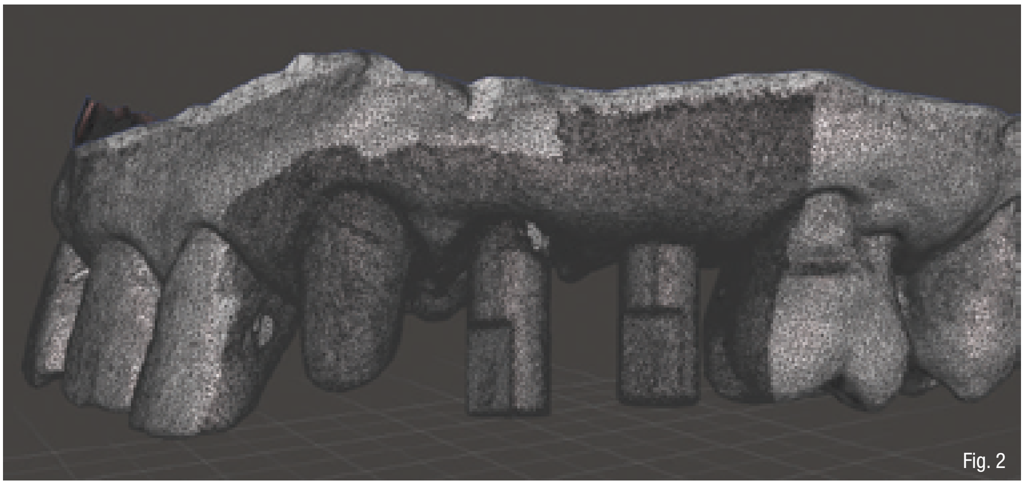

Fig. 2

_3. Computer-aided design

Realizzata la scansione dell'unità da protesizzare, il file in formato STL viene importato nel software CAD di specie. Sono presenti sul mercato diversi e numerosi software CAD, ma tutti seguono 4 passaggi predefiniti (Fig. 3):

1. Riconoscimento del margine di finitura della preparazione o matching dello scanbody.
2. Scelta della libreria e posizionamento dell'elemento da disegnare.
3. Modellazione del disegno tramite il "free forming tool".
4. Realizzazione del file STL da produrre nella fase CAM.

_ 4. Computer-aided manufacturing

Terminata la fase CAD, si passa alla fase CAM di produzione del manufatto. La produzione di manufatti protesici può avvenire tramite procedure sottrattive o additive, ed è la seconda fase cruciale, in quanto una gestione non allineata ai protocolli vigenti può portare alla realizzazione di un manufatto non accurato.

In questo articolo riportiamo la procedura additiva, ovvero mostreremo la realizzazione di manufatti protesici tramite stampante 3D Dfab (RD Printing, Thiene) (Fig. 4), in grado di produrre risultati altamente accurati[3, 4].

Dfab è una stampante 3D con tecnologia TSLA (Tilted stereolithography - stereolitografia inclinata), progettata per la tecnica additiva *chairside* (letteralmente, "alla poltrona"). Per TSLA si intende una tecnologia in grado di operare su un piano di costruzione inclinato (Fig. 5), sfruttando la forza di gravità per generare un effetto "a cascata" nella deposizione di un materiale ad alta viscosità. Questo "escamotage" consente ai riempitivi con peso specifico differente di miscelarsi in modo omogeneo durante la sessione di stampa. Questa tecnologia consente di aumentare la velocità di stampa e di ridurre la dimensione delle strutture di supporto, con vantaggi sul risultato finale facilmente apprezzabili clinicamente.

Fig. 1_Fasi del protocollo *chairside* per la produzione di manufatti protesici.

Fig. 2_Esame della qualità della mesh e della densità dei triangoli in Meshmixer. Si evidenzia la maggior concentrazione di triangoli a livello della preparazione e degli scanbody.

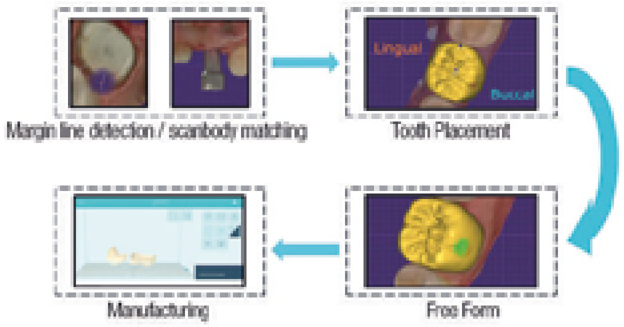

Fig. 3

Fig. 4

Fig. 5

Fig. 3_Fasi CAD/CAM per il disegno e la produzione di un manufatto protesico.

Fig. 4_Stampante Dfab nei modelli chairside e desktop (RD-Printing).

Fig. 5_ Una volta inserita la cartuccia contenente il materiale di stampa e posizionata la piattaforma, il piano di stampa viene inclinato di 45° rispetto al piano d'inserzione.

Il processo inizia con l'utilizzo di un software dedicato (Nauta Photoshade) che, in seguito a importazione del file STL elaborato al CAD di modellazione, posiziona automaticamente il modello di situazione virtuale con la superficie occlusale orientata verso la piattaforma[5].

In tutti quei casi in cui l'operatore dovesse ritenere utile modificare l'orientamento dei file, il posizionamento degli elementi può essere regolato manualmente. Approvata la posizione ideale, si può procedere con la stampa.

Uno dei vantaggi nell'utilizzo del software in dotazione alla stampante Dfab è la possibilità di selezionare un gradiente di colore variabile da A1 ad A3.5 all'interno dello stesso restauro. Il software permette il posizionamento dei limiti cromatici cervicali e incisali, con l'ampiezza dell'interspazio che determina una transizione netta (stretta) o graduale (più ampia) (Fig. 6).

Il processo di stampa prevede che un flusso continuo di materiale venga avviato e mantenuto costante sia dalla gravità che tramite una pompa peristaltica silenziosa. In questa fase, il software controlla l'estrusione di materiale dal carrier, ed un raggio laser UV blu viene diretto sulla superficie del composito, polimerizzandolo selettivamente per creare l'oggetto. La piattaforma di costruzione viene gradualmente immersa nella vasca della resina e il processo viene ripetuto strato per strato fino al completamento dell'oggetto (Fig. 7).

A stampa ultimata, l'operatore può rimuovere la piattaforma e posizionarla in uno shaker, con il quale si procede alla fase di washing (Fig. 8). Lo shaker viene riempito con alcol etilico al 95% che agirà per circa 2-3 minuti in modo da rimuovere quei residui di liquido non polimerizzato che, se non correttamente rimossi, possono inficiare l'accuratezza del manufatto.

Terminata la fase di washing, si rimuovono i manufatti dalla piattaforma con un semplice movimento di rotazione per separarli dai pins di stampa, e dopo averli completamente asciugati dai residui di alcol etilico, si procede alla fase di post-polimerizzazione allo scopo di migliorare le proprietà del materiale da restauro. Per questo scopo si utilizza il Dcure (RD-Printing), dispositivo a doppia energia (luce ultravioletta e calore) dotato di programmi automatici in base al materiale utilizzato (Fig. 9).

Terminata la post-polimerizzazione, il manufatto viene lucidato, colorato e glasato, ed è pronto per essere consegnato.

I passaggi critici che possono incidere sul risultato sono i seguenti: un cattivo orientamento sulla piattaforma del modello di situazione durante la fase CAM può portare a variazioni nella precisione e accuratezza del manufatto; un washing insufficiente può lasciare residui che possono portare a imprecisioni del "fitting" protesico; l'inosservanza del programma prescritto dal dispositivo di polimerizzazione Dcure può alterare le caratteristiche fisiche e discostarsi da quelle riportate nella scheda tecnica.

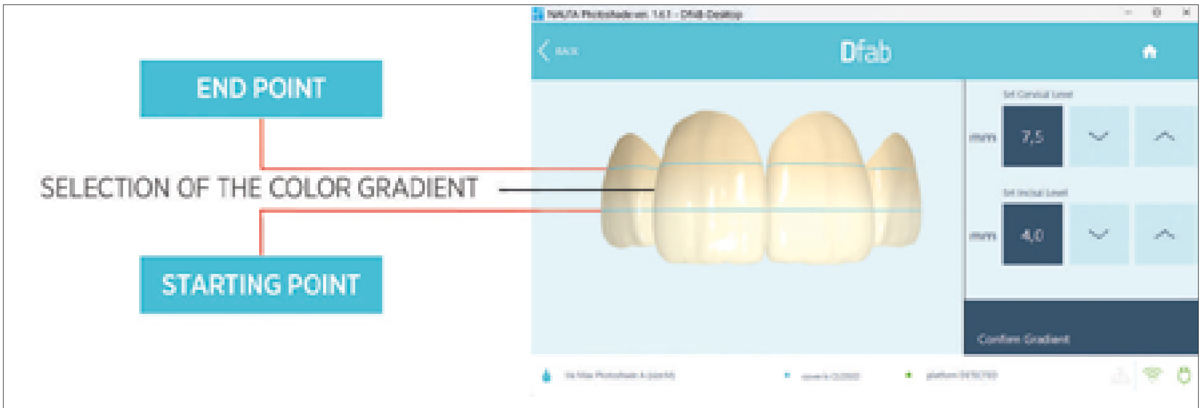

Fig. 6

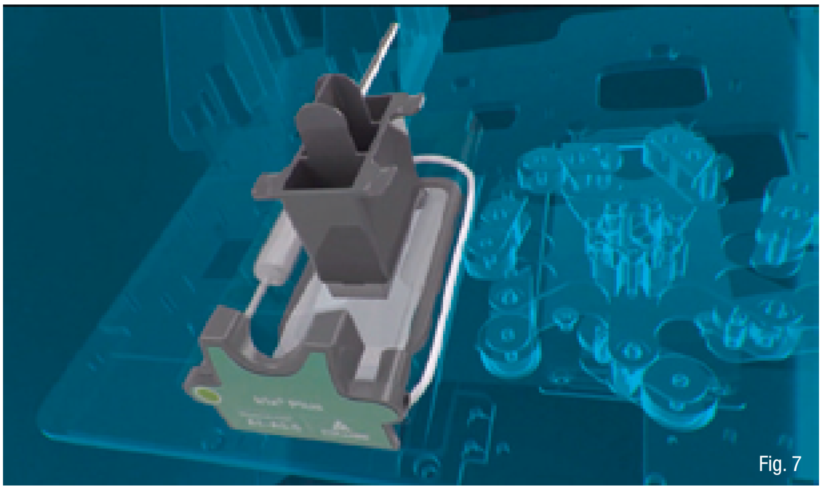
Fig. 7

Fig. 6_All'interno del software Nauta Photoshade è possibile selezionare i due estremi di colore del restauro ed il punto di inizio e di fine della transizione da un colore all'altro.

Fig. 7_La piattaforma di stampa viene immersa nella cartuccia dove viene costruito il manufatto protesico, strato per strato, con l'utilizzo di un raggio laser.

Fig. 8_ La piattaforma di stampa viene immersa in uno shaker contenente alcol etilico al 95% e agitata per 1-2 minuti, al fine di rimuovere eventuali residui di materiale.

Fig. 9_I restauri prodotti vengono posti in un contenitore di vetro e inseriti nel Dcure, dove termineranno la procedura di polimerizzazione.

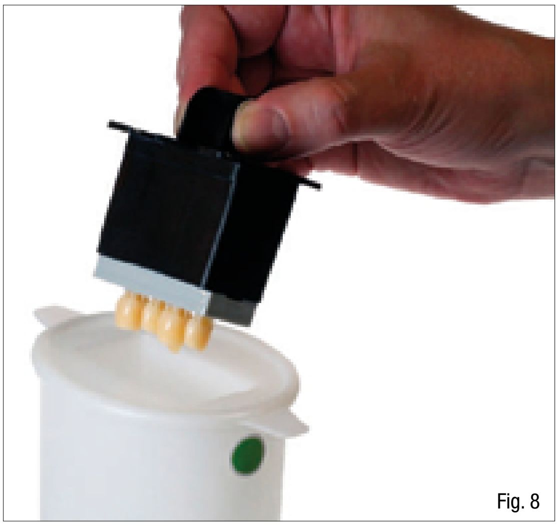
Fig. 8


Fig. 9

_Consegna

Riportiamo alcuni casi clinici realizzati utilizzando il protocollo *chairside* sopra descritto.

Come primo caso, riportiamo un paziente con un ponte protesico che aveva perso ritenzione a causa di una carie destruente a carico del pilastro distale (secondo premolare superiore di sinistra) (Fig. 10). In base alle richieste del paziente e con il suo consenso informato, si propone il posizionamento di impianti al fine di riabilitare la parte con singole unità protesiche. Nel rispetto delle condizioni biologiche e per assecondare una richiesta estetica immediata, si programma il posizionamento implantare computer guidato con carico immediato protesico.

Dopo avere realizzato la dima chirurgica (Fig. 11) si procedeva all'intervento chirurgico e successiva preparazione protesica dell'elemento 23. Dopo aver verificato la stabilità primaria degli impianti (Fig. 12), si procedeva alla acquisizione della scansione intraorale (Fig. 13).

Il file STL generato veniva importato nel software CAD, dove si procedeva al disegno della ceratura virtuale dei manufatti protesici da stampare (Fig. 14).

Terminato il disegno, si procedeva alla stampa, utilizzando il materiale prescritto per i restauri provvisori (Temporis, RD Printing, Thiene) (Figg. 15-22).

Poiché il protocollo *chairside* prevede la possibilità di stampare anche resine composite ibride, caricate con particelle di ceramica, si procedeva alla realizzazione dei definitivi.

Il secondo caso riportato riguardava un paziente con vecchi restauri conservativi in posizione secondo premolare e primo molare superiore di sinistra (Fig. 23). Come di routine, dopo la preparazione dei monconi, veniva eseguita una scansione intraorale (Fig. 24) e si procedeva al disegno delle protesi al software CAD (Fig. 25). I manufatti venivano stampati con materiale per restauri definitivi Irix Max (RD Printing, Thiene, Italia) (Fig. 26). Una volta terminata la produzione si passava per le fasi di washing, post polimerizzazione e lucidatura, con l'aggiunta, in questo caso, della fase di colorazione e caratterizzazione, eseguita con il kit Optiglaze color (Fig. 27), per rendere il restauro il più possibile simile agli altri elementi del paziente (Fig. 28).

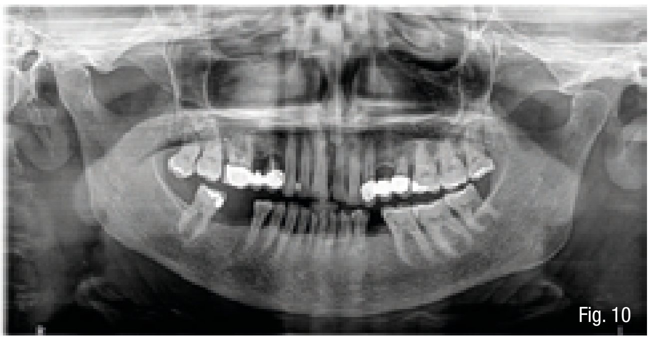
Fig. 10

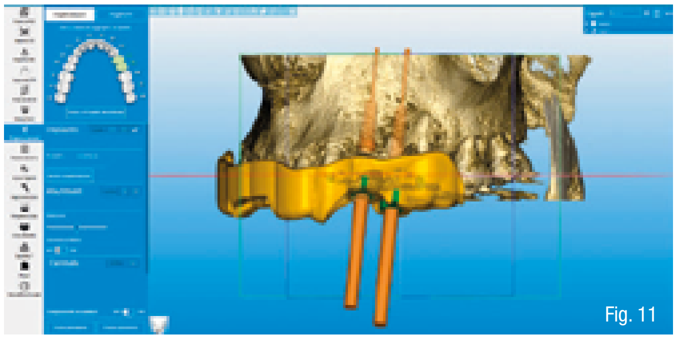
Fig. 11


Fig. 12


Fig. 13

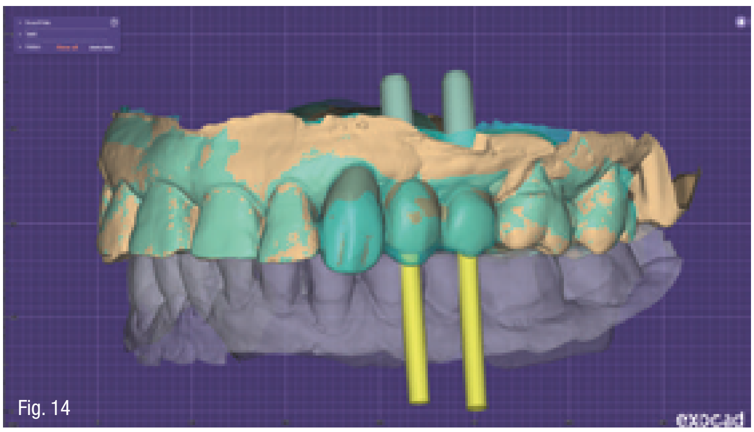

Fig. 14

Fig. 10_OPT iniziale del paziente.

Fig. 11_Progettazione della posizione implantare tramite software RealGuide.

Fig. 12_Valutazione della stabilità primaria post inserimento implantare.

Fig. 13_Scansione intraorale in seguito a preparazione protesica dell'elemento 23 e posizionamento degli scanbody in posizione 24-25.

Fig. 14_Disegno dei manufatti protesici da produrre con sovrapposizione della scansione pre-trattamento.

Fig. 15


Fig. 16


Fig. 17

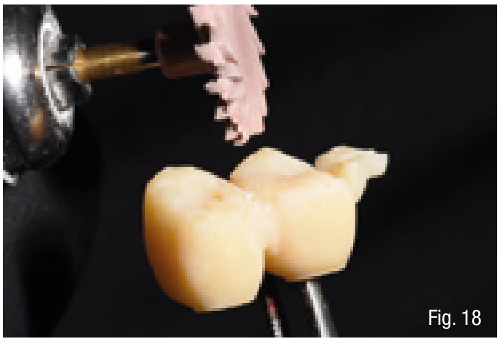
Fig. 18


Fig. 19


Fig. 20


Fig. 21


Fig. 22


Fig. 23

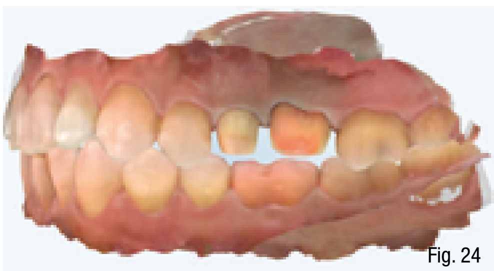
Fig. 24

Fig. 15_Cartuccia Temporis inserita nella stampante Dfab, materiale dedicato a restauri provvisori.

Fig. 16_Inserimento dei restauri in Dcure, fase di post-polimerizzazione.

Fig. 17_Rimozione dei supporti residui.

Fig. 18_Lucidatura delle superfici.

Fig. 19_Rx endorale per verificare il fit degli abutment.

Fig. 20_Foto al momento della consegna dei manufatti.

Fig. 21_Controllo tessuti a 10 giorni dalla consegna.

Fig. 22_Controllo al termine dei tempi di osteointegrazione (3 mesi).

Fig. 23_Preparazione protesica degli elementi 25-26.

Fig. 24_Scansione intraorale delle preparazioni protesiche.

Fig. 25_Disegno in exocad dei manufatti protesici da stampare.

Fig. 26_Cartuccia di Irix Max, materiale per la produzione di restauri definitivi.

Fig. 27_Kit OPTIGLAZE color per la colorazione, caratterizzazione e glasatura dei restauri stampati con Dfab.

Fig. 28_Consegna dei restauri definitivi 25-26 realizzati con Irix Max.

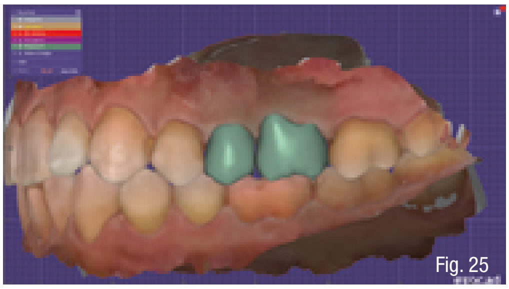
Fig. 25


Fig. 26


Fig. 27


Fig. 28

_bibliografia

CAD/CAM

1. Revilla-León M, Kois DE, Kois JC. A guide for maximizing the accuracy of intraoral digital scans. Part 1: Operator factors. J Esthet Restor Dent. 2023 Jan;35(1):230-240. doi: 10.1111/jerd.12985. Epub 2022 Dec 7. PMID: 36479807.
2. Revilla-León M, Kois DE, Kois JC. A guide for maximizing the accuracy of intraoral digital scans: Part 2-Patient factors. J Esthet Restor Dent. 2023 Jan;35(1):241-249. doi: 10.1111/jerd.12993. Epub 2023 Jan 13. PMID: 36639916.
3. Mangano FG, Cianci D, Pranno N, Lerner H, Zarone F, Admakin O. Trueness, precision, time-efficiency and cost analysis of chairside additive and subtractive versus lab-based workflows for manufacturing single crowns: An in vitro study. J Dent. 2024 Feb;141:104792. doi: 10.1016/j.jdent.2023.104792. Epub 2023 Nov 25. PMID: 38013004.
4. Zarone F, Ruggiero G, Soreca A, Lepidi L, De Stefano L, Sorrentino R. Marginal fit of nanocomposite 3D-printed crowns with horizontal and vertical preparation geometries: An in vitro comparative analysis. Digital Dentistry Journal, 2025, 100022, ISSN 2950-6433, https://doi.org/10.1016/j.ddj.2025.100022.
5. Revilla-León M, Supaphakorn A, Barmak AB, Rutkunas V, Kois JC. Influence of print orientation on the intaglio surface accuracy (trueness and precision) of tilting stereolithography definitive resin-ceramic crowns. J Prosthet Dent. 2025 Jan;133(1):246-251. doi: 10.1016/j.prosdent.2023.03.020. Epub 2023 Apr 25. Erratum in: J Prosthet Dent. 2025 Mar 30:S0022-3913(25)00207-0. doi: 10.1016/j.prosdent.2025.03.001. PMID: 37105822.

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Case Report

Chairside workflows in modern dentistry: Indirect *resin composite* restorations with advanced 3D-printing technology

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The evolution of digital dentistry has profoundly reshaped clinical practice over the last decade, introducing protocols that streamline workflows, improve patient outcomes, and significantly enhance clinical efficiency. Among these innovations, chairside procedures leveraging digital workflows have rapidly emerged as particularly transformative, offering clinicians the ability to deliver high-quality restorations in significantly reduced timeframes [1]. Traditional indirect restorative protocols typically require multiple appointments and laboratory involvement, resulting in extended treatment times, increased costs, and potential discomfort for patients. In contrast, chairside digital approaches drastically condense the treatment timeline, often allowing clinicians to perform all necessary procedures—from diagnosis and digital design to fabrication and cementation—within a single appointment.

A pivotal advancement supporting these chairside efficiencies is the rapid progression of 3-dimensional (3D) printing technologies. Initially perceived as primarily suited to prototyping and auxiliary applications, recent technological advancements in materials science and printer precision have significantly expanded the clinical applications of 3D printing in restorative dentistry[2]. The current generation of dental-specific 3D printers offers unprecedented accuracy, surface quality, and mechanical properties, making them suitable for definitive restorations. Particularly, 3D-printed composite resins have emerged as a viable alternative to conventional ceramic or composite materials used in computer-aided design (CAD) and manufacturing, exhibiting favorable esthetic properties, ease of fabrication, and mechanical characteristics suitable for a broad range of restorative indications [3].

The advantages offered by 3D-printed composite materials extend beyond convenience and chairside availability. They offer excellent adaptability and ease of intraoral adjustments, thereby contributing to clinical flexibility without compromising the quality of the final restoration. The workflow integration enabled by 3D printing technology also optimizes efficiency, reduces material waste, and promotes a more sustainable and patient-friendly clinical environment. Moreover, the adaptability of these technologies allows clinicians greater freedom to customize restorations precisely to patient-specific anatomical and functional requirements, enhancing both clinical and patient-reported outcomes [4].

Despite these significant benefits, comprehensive clinical documentation and literature supporting routine clinical integration of chairside 3D-printed composites remain relatively limited. Therefore, sharing detailed case experiences becomes vital for validating and further expanding the evidence base supporting these innovative techniques.

This case report presents a detailed clinical account of 2 indirect composite restorations fabricated chairside using state-of-the-art 3D printing technology. It highlights the efficiency, reliability, and practicality that can be achieved through modern digital workflows. Specifically, it highlights how leveraging these technologies can dramatically reduce treatment times while delivering restorations that meet high standards of function, aesthetics, and comfort. By illustrating the clinical steps, digital integration process, and final outcomes, this case report reinforces the role of advanced 3D printing techniques as a valuable tool in contemporary restorative dentistry, encouraging broader adoption and ongoing innovation in daily clinical practice.

CASE DESCRIPTION

The initial clinical examination revealed 2 aging restorations on teeth 26 and 27, as documented photographically (Fig. 1). Specifically, tooth 26 had an indirect composite restoration placed 12 years earlier, now requiring replacement due to recurrent caries localized primarily at the distal interproximal margin. Caries also affected the mesial surface of tooth 27, which further presented with mild masticatory sensitivity, likely attributable to microfractures affecting its distovestibular cusp. Despite the absence of evident parafunctional habits, the patient reported a recent traumatic biting incident involving a hard cherry pit a few months before, likely exacerbating the structural compromise.

The proposed treatment plan involved replacing these compromised restorations with 2 indirect composite restorations fabricated chairside utilizing advanced 3D printing technology. Initially, the operative field was isolated using a rubber dam to ensure optimal isolation of the operatory field (Fig. 2).

Next, the cavity was carefully prepared, adhering to minimally invasive principles tailored specifically for indirect restorative techniques. Preparation margins were meticulously refined after adequate caries removal and cuspal coverage (Fig. 3).

FIG. 1 *Two aging restorations, on teeth 26 and 27.*

FIG. 2 *Rubber dam isolation of the operatory field.*

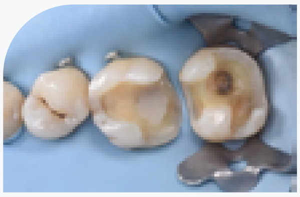


FIG. 3 *Minimally invasive preparations.*

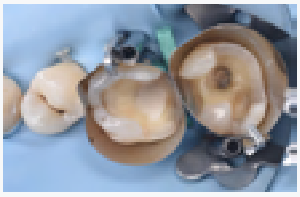


FIG. 4 *Margin elevation, adapted auto-matrices.*

FIG. 5 *Adhesive system and flowable composite.*

FIG. 6 *Cavity margins refinement.*

FIG. 7 *Accurate digital impression.*

Given the subgingival placement of certain cavity margins, a precise margin relocation technique was performed. Auto-matrices were adapted (Fig. 4) to facilitate margin elevation using a combination of a dental adhesive system (Optibond FL, Kerr) and flowable composite resin (Inspiro Bi2, Edelweiss; Fig. 5). After margin elevation, the cavity margins were meticulously refined to optimize the optical scanning phase (Fig. 6). Then, digital impressions were captured using an advanced intraoral scanner (IS 3800, Dexis), ensuring accurate and detailed reproduction (Fig. 7).

The scanned data was exported in standard tessellation language (STL) format and seamlessly integrated into dedicated chairside CAD software (Exocad Chairside). The indirect restorations were digitally designed in a streamlined chairside workflow (Fig. 8).

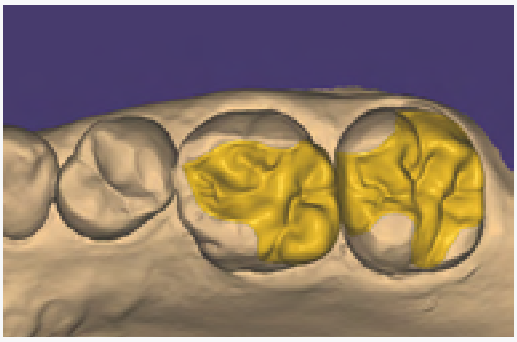


FIG. 7 *Computer Aided Design of the restorations.*

“3D-printed composite materials offer excellent adaptability and ease of intraoral adjustments, enhancing clinical flexibility without compromising the final restoration quality.”

Upon completion of the digital design, the restorations' STL files were re-exported and imported into specialized 3D printing software (Nauta Photoshade [version 1.6.1], Dfab). The restorations were strategically positioned on the printing platform to leverage the Photoshade technology, creating an optimal color gradient transitioning from shades A1 coronally to A3 cervically, closely mimicking natural tooth aesthetics (Fig. 9). The restorations were printed using a hybrid composite resin formulated explicitly for dental 3D printing applications (Irix Max Photoshade A Size S cartridge, DWS Systems). The printing process was completed efficiently within approximately 20 minutes (Fig. 10).

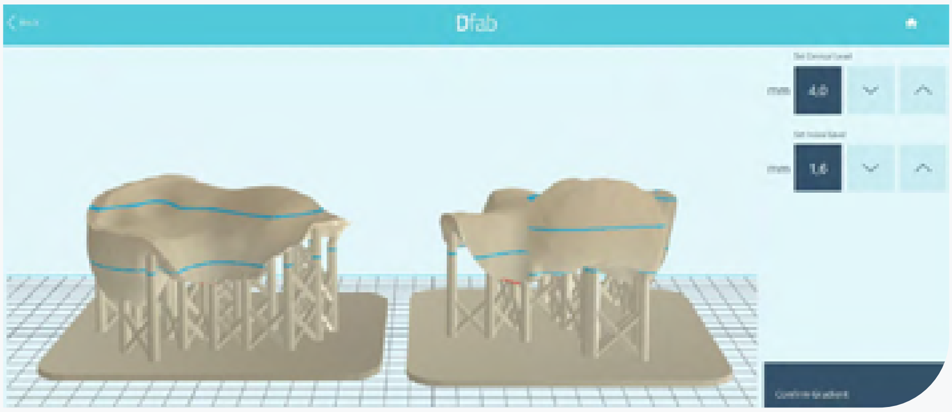


FIG. 9 *Supported restorations in the Dfab Photoshade printing software.*

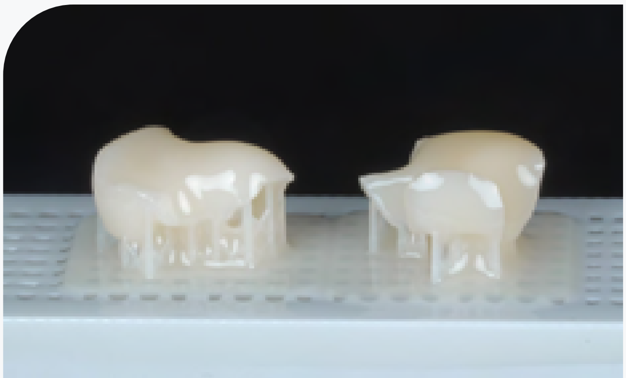


FIG. 10 *The Dfab printed restorations still on the platform.*

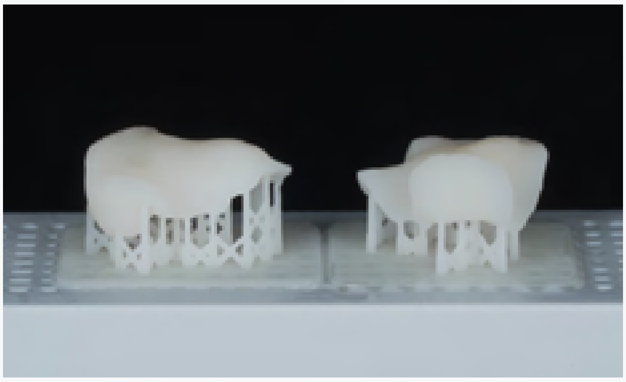


FIG. 11 *The restorations following ethanol washing, before separation and post-curing.*

FIG. 12 *A two-step diamond-impregnated polishing system is used to achieve the desired texture and lustre. First step: Use medium-grit tools to polish.*

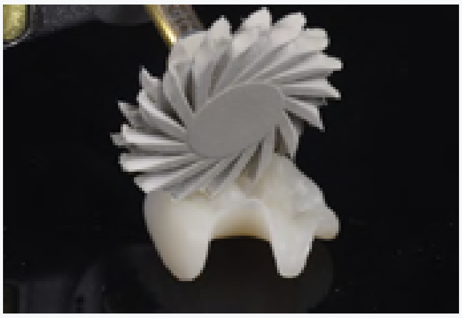


FIG. 13 *Second step: Fine grit tools are used for super-polishing.*

Post-printing procedures involved rigorous surface cleaning protocols recommended by the manufacturer. The restorations underwent an initial ethanol bath to remove residual uncured resin, followed by a secondary photo-thermal curing cycle in a dedicated polymerization unit for 10 minutes, ensuring optimal material properties and biocompatibility (Fig. 11). Then, they underwent an extensive polishing protocol using the manufacturer-provided finishing kit (Dfab 3D Course Kit, EVE), delivering restorations with an ideal surface texture (Figs. 12–14).

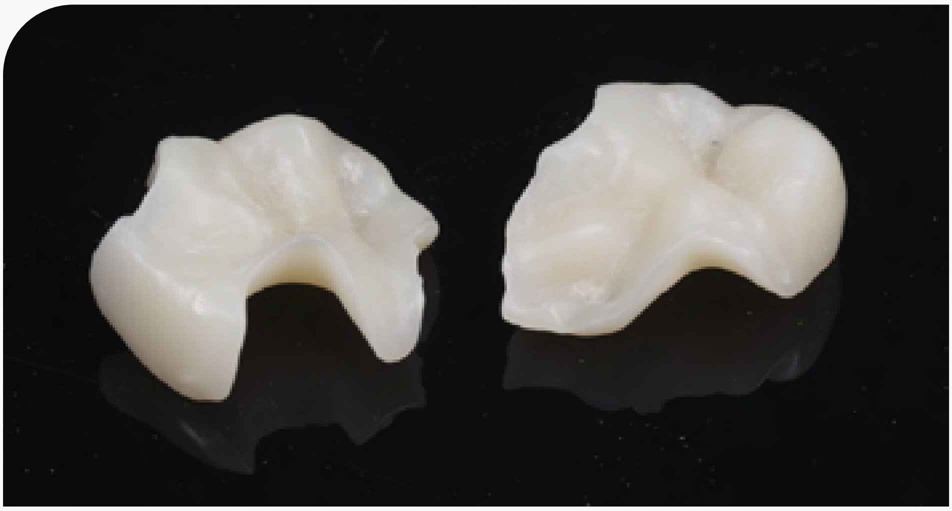


FIG. 14 *The ideal surface texture and lustre of the restorations.*

The cementation phase began by sandblasting the dental surfaces with 27-micron aluminum powder (Fig. 15) and then etching them with 37% orthophosphoric acid for 30 seconds, achieving ideal conditioning for adhesive bonding (Fig. 16). A 3-step adhesive system (Optibond FL, Kerr) was meticulously applied on the tooth preparations (Figs. 17–18).

Simultaneously, the internal surfaces of the indirect restorations were conditioned to optimize adhesive integration, which included sandblasting (Fig. 19), application of silane coupling agent (Fig. 20), and subsequent coating with the adhesive system (Fig. 21). For cementation, a preheated microhybrid composite resin (Inspiro Bi2, Edelweiss) was employed due to its favorable mechanical and aesthetic characteristics.

FIG. 15 *Sandblasting of dental surfaces with aluminium powder.*

FIG. 16 *Conditioning with orthophosphoric acid.*

FIG. 17 *Adhesive bonding in 3 steps.*

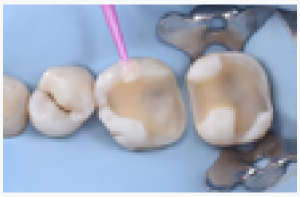


FIG. 18 *Adhesive bonding in 3 steps.*

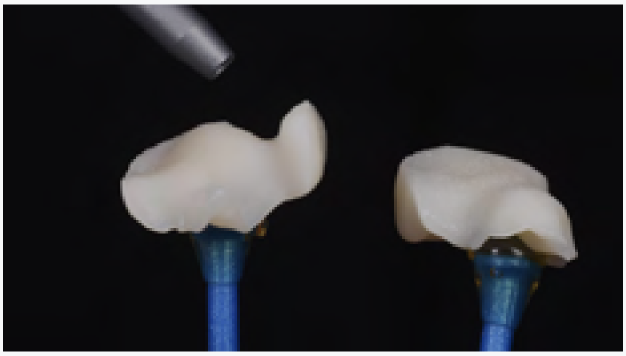


FIG. 19 *Sandblasting of the restorations' internal surfaces*

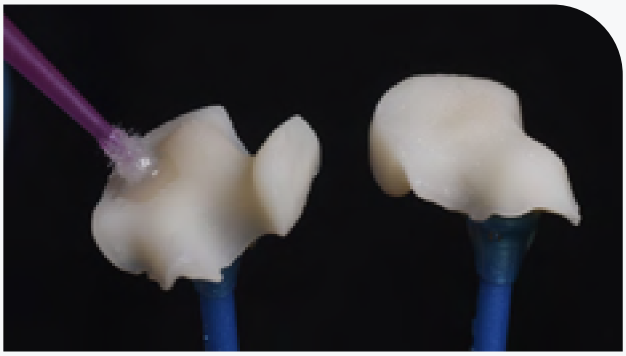


FIG. 20 *Application of silane.*

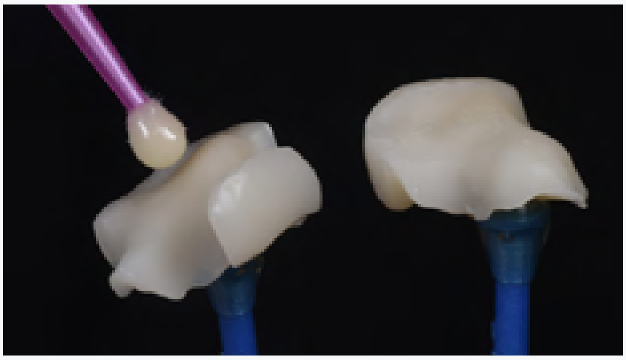


FIG. 21 *Coating with the adhesive system.*

FIG. 22 *Ultrasonically seaded restorations.*

The restorations were accurately seated onto their respective tooth preparations, aided by high-frequency ultrasonic tips to facilitate complete adaptation and displacement of excess luting material (Fig. 22). Excess material was meticulously removed using probes and dental floss to ensure clean margins. Then, the restorations were photopolymerized for 20 seconds per surface, ensuring complete polymerization and optimal bonding strength (Fig. 23).

Final polishing steps were performed under rubber dam isolation, which enhanced the restoration's smoothness and marginal integrity (Fig. 24).

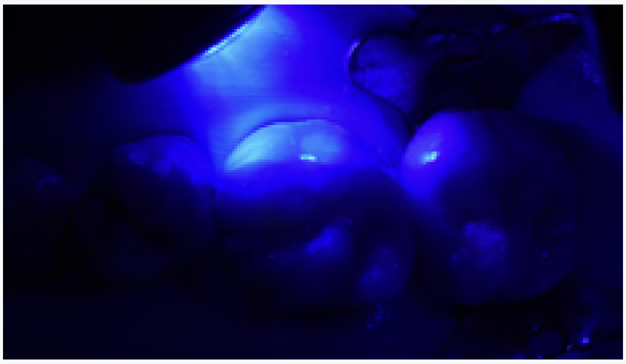


FIG. 23 *Light curing, 20 s per surface.*

Following the removal of the rubber dam, thorough occlusal evaluations were performed, adjusting the restorations to ensure perfect harmony with the patient's occlusal scheme, thereby ensuring functional comfort and long-term durability (Fig. 25).

DISCUSSION AND CONCLUSION

The integration of advanced chairside digital workflows, particularly those utilizing 3D printing technologies, represents a significant advancement in restorative dentistry, offering remarkable benefits in terms of efficiency, precision, and patient experience.

FIG. 24 *The restorations following final intraoral polishing.*

FIG. 25 *The finalised restorations.*

"3D-printed composite resins have emerged as a viable alternative to conventional CAD/CAM materials."

The presented clinical case effectively highlights these advantages, showing the successful chairside fabrication and delivery of 2 indirect composite restorations using the innovative Dfab 3D printer system.

One of the primary advantages of the chairside approach is the considerable reduction in treatment duration, which has traditionally been a major limitation in indirect restorative procedures. Conventionally, indirect restorations require multiple clinical visits and extensive laboratory involvement, inherently increasing time, cost, and inconvenience for patients. As illustrated in the presented case, the chairside workflow consolidates the entire restorative process—from cavity preparation and digital impression to restoration fabrication and cementation—into a single clinical session, significantly streamlining practice efficiency and patient convenience.

The use of 3D printing technology further amplifies these benefits. Modern dental-specific 3D printers, exemplified by the Dfab system used in the presented case, offer exceptional precision and reliability, which are essential for creating restorations with an accurate fit and excellent functional and aesthetic properties. The Dfab printer demonstrated high performance through its rapid printing capabilities and consistent production of restorations that accurately replicated the digitally designed anatomy. This precision not only facilitated an easier clinical integration phase but also ensured optimal restoration adaptation, minimizing chairside adjustments and enhancing overall treatment predictability. The Photoshade technology incorporated into the Dfab system also provided distinct aesthetic advantages, allowing the creation of restorations with a natural color gradient. Such capability is particularly beneficial in everyday clinical practice, offering clinicians enhanced control over aesthetic outcomes.

While further studies and long-term clinical observations remain necessary to reinforce and expand the evidence supporting the routine adoption of 3D-printed composite restorations, the outcomes documented in this case report are highly encouraging. The demonstrated clinical reliability, precision, and operational simplicity of the Dfab printer affirm its substantial potential in contemporary restorative dentistry. Continued advancements in 3D printing materials and technology will undoubtedly further extend these benefits, potentially establishing chairside 3D printing as a new standard in everyday dental practice.

FIG. X *Dr. Alireza Alipour Tehrany, co-author of this case.*

SOURCES

(1) F Del Curto, CM Saratti, I Krejci. CAD/CAM-based chairside restorative technique with composite resin for full-mouth adhesive rehabilitation of excessively worn dentition. Int J Esthet Dent 2018;13(1):50-64.

(2) CM Saratti, GT Rocca, I Krejci. The potential of three-dimensional printing technologies to unlock the development of new 'bio-inspired' dental materials: an overview and research roadmap. J Prosthodont Res 2019 Apr;63(2):131-139.

(3) FG Mangano, D Cianci, N Pranno, H Lerner, F Zarone, O Admakin. Trueness, precision, time-efficiency and cost analysis of chairside additive and subtractive versus lab-based workflows for manufacturing single crowns: An in vitro study. J Dent 2024 Feb:141:104792.

(4)A Alammar, W Att, F Beuer. The Accuracy of 3D-Printed Fixed Dental Restorations. J Esthet Res-tor Dent 2024 Dec 8. doi: 10.1111/jerd.13365.

Screw-retained implant bridge with multi-unit abutment connection: Digital workflow with intra-oral scanning, CAD and 3D printing

Dr Antonino Cacioppo, Italy

Fig. 1: Implant components.

Case history and treatment plan

A 72-year-old patient in good general health presented with partial edentulism in the maxillary posterior region. The main goal was to achieve a rapid fixed prosthetic rehabilitation. After clinical and radiographic (2D and 3D) analysis, it was decided to proceed with a screw-retained bridge on implants, using multi-unit abutment connections to compensate for angulation and z-axis discrepancies. After guided surgery to place two internal hexagonal/conical connection implants, osseointegration time was allowed before prosthetic loading. The patient was informed that the entire prosthetic treatment would be completed on one day, since there would be no need for an external laboratory.

Materials

The following implant components (IPD Dental Group; Fig. 1) were used:

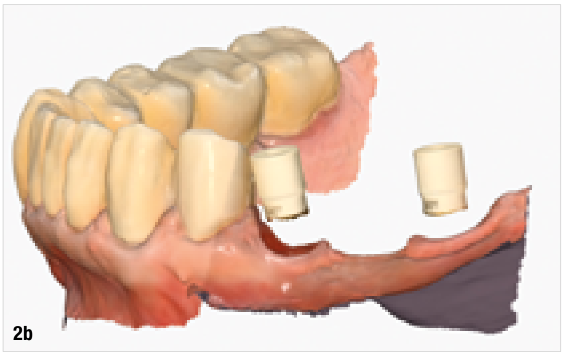
- multi-unit abutments, to ensure proper management of insertion and z-axis stresses;
- ProCam scan bodies, for accurate intra-oral scanning; and
- ProCam titanium bases (Ti-bases), to ensure a precise connection between the implants and prosthesis.

The use of compatible components optimised for a digital workflow resulted in a well-fitting and functional prosthesis.

Chairside workflow

Intra-oral scanning

After postoperative healing of the implants, multi-unit abutments and ProCam scan bodies were placed over the implants, and data was acquired with the Medit i700 wireless intra-oral scanner (Figs. 2a & b). The use of the intra-oral scanner allowed us to avoid physical impressions, thereby reducing patient discomfort. It also allowed for the capture of a detailed and accurate digital representation of the implant connections and enabled real-time evaluation of the scan quality.



Figs. 2a & b: Intra-oral scanning using ProCam scan bodies.

The use of intra-oral scanners to capture impressions has demonstrated high accuracy compared with conventional techniques.[1,2] The importance of ensuring a precise intra-oral scan is often under-estimated, and accurate intra-oral data capture is the true starting point for a successful restoration. Accurate transfer of the implant position is essential for achieving a perfect match between the digital design and clinical reality. Having an optimised geometry and being made of a highly readable scanning material, the ProCam scan bodies allowed the position of the implants and the profile of the peri-implant tissue to be captured with extreme fidelity (Fig. 3).

Design

Once the STL file of the scan had been obtained, the prosthesis was digitally designed in the RealGUIDE CAD+ software (3DIEMME), according to the following criteria:

- precise fit on the ProCam Ti-bases;
- passivity of the structure to reduce stress;
- occlusion optimisation; and
- natural aesthetics through advanced design.

The implant base was then fabricated using Ti-base custom interfaces. A key technical detail comes into play here: the ability to take advantage of a special 50 µm printing offset, designed to ensure the appropriate space for the cement and optimise the accuracy of fit between the 3D-printed part and the Ti-base. This seemingly minor detail turned out to be essential for achieving effective cementation, eliminating any tension and ensuring perfect adhesion of the anatomical part to the implant base. The ability to modify the design in real time made the design phase extremely efficient (Figs. 4a–c). The use of CAD/CAM technologies in fixed implant prosthetics has shown excellent results in terms of precision and fit.[3]

Dfab 3D printing

Once the modelling was complete, the file was sent to the Dfab 3D printer (RD-Printing; Fig. 5) for fabrication of the high-strength hybrid polymer prosthesis. The total printing time was 25 minutes. The material selected was Irix Max Photoshade (DWS Systems; Fig. 6), a ceramic-filled hybrid composite that is biocompatible, durable and highly aesthetic. Direct printing assured:

- high accuracy without the need for retouching;
- smooth surface and defined details; and
- natural colour gradient owing to resin layering enabled by Photoshade technology.


3

Fig. 3: Extreme fidelity of capture of the implant position and surrounding tissue profile using the ProCam scan bodies.

The accuracy of 3D printing compared with conventional techniques is supported by clinical studies, which have demonstrated high reproducibility and prosthetic fit.[4,5]

Dfab employs tilted stereolithography (TSLA) technology, designed for chairside manufacture, and works with disposable cartridges, available in small, medium and large versions depending on the volume of material contained, allowing the workflow to be optimised according to the number and size

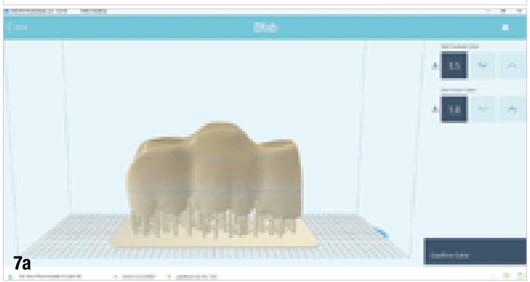

4a 4b 4c

Figs. 4a–c: Bridge design in RealGUIDE CAD+.

5

Fig. 5: Dfab 3D printer.


6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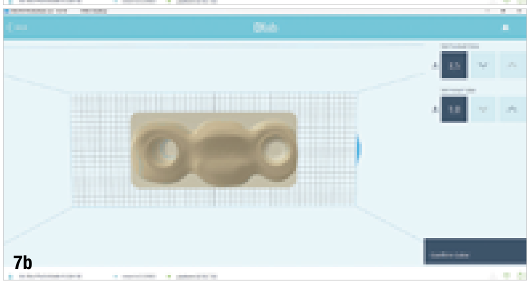
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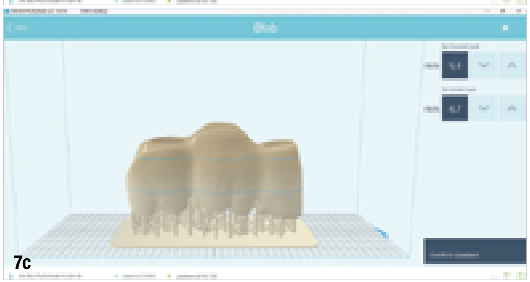
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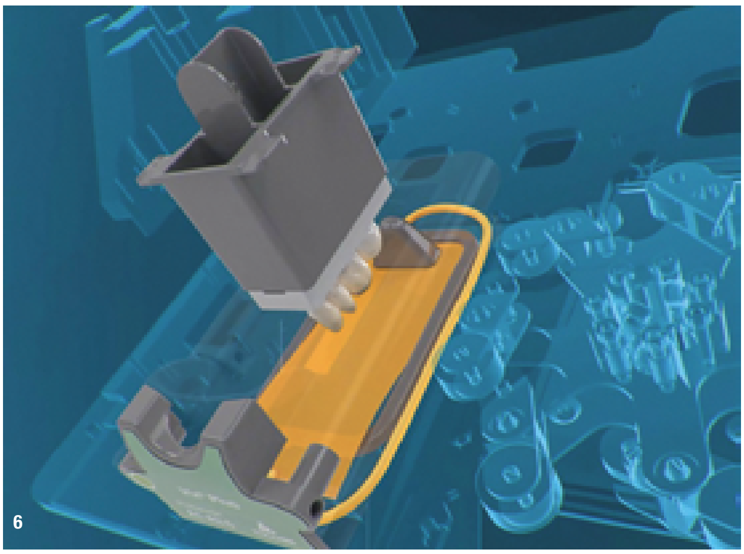
Fig. 6: Irix Max Photoshade Dfab cartridge. **Figs. 7a–c:** Selecting the shade and the colour gradient in the Photoshade software.

of restorations to be printed. An evolution of stereolithography, TSLA is a versatile technology that uses an inclined build platform and a moving high-viscosity material to create a cascade effect that allows heavy fillers to be mixed evenly during printing. This technology increases printing speed and allows the size of the supporting structures to be reduced.

The process begins by loading the CAD restoration as an STL file into the Photoshade software, which automatically positions and correctly supports it for the best accuracy and fit with the occlusal surface facing the platform and the marginal and internal surfaces free of support and facing the cartridge reservoir. The desired Photoshade colour gradient and positioning of the cervical and incisal colour boundaries are then selected, the width of the interspace resulting in a sharp (narrow) or gradual (wider) transition (Figs. 7a–c). Once the appearance of the restoration is approved, the printing process can begin. A disposable Dfab cartridge containing the printing reservoir of the selected material and size is loaded into the top of Dfab, along with the printing media and disposable platform. The top of Dfab is closed, and the cartridge is tilted at a 45° angle. Printing is initiated by the Photoshade Pro software, and a continuous flow of material is begun and maintained by gravity and a quiet peristaltic pump (Fig. 8).

At this stage, the software precisely controls the extrusion of material in two different gradations to produce the desired colour gradient of the restoration. The blue UV laser beam is directed at the surface of the composite, selectively polymerising it to create the object. The build platform is gradually lowered into the resin tank, part of the material's cartridge, and the process is repeated layer by layer until the object is complete. Dfab is then opened, and the top section tilted to return the build platform and used cartridge to their original horizontal position, and they are removed, starting with the platform, to prevent unpolymerised liquid material from dripping into the printer. To remove any residual unpolymerised liquid composite, the platform containing the restoration is washed with 95% ethanol for 1–2 minutes in a special shaker container. The restoration is then manually separated from the platform—without risking damage to adjacent surfaces—by grasping the restoration and using a twisting motion to break the very thin supports. Any unpolymerised composite residue in areas such as the occlusal and internal surfaces can be removed with a flat brush dipped in 95% ethanol. Finally, post-polymerisation is performed to improve the properties of the restorative material. A proprietary dual-energy (UV light and heat) unit (Dcure, RD-Printing) is used (Fig. 9) with an automated, material-specific cycle that takes approximately 9 minutes to complete.

Fig. 8: Video graphics still image of a phase of the Dfab printing process. **Fig. 9:** Dcure post-polymerisation unit.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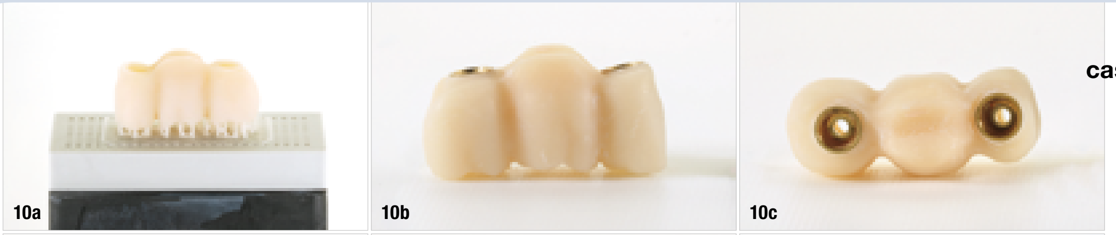

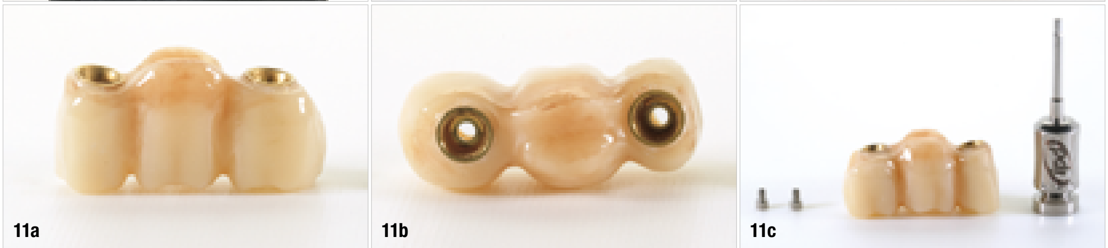

Figs. 10a–c: Bridge after washing, still on the build platform **(a)**, and after support removal and surface finishing **(b & c)**. **Figs. 11a–c:** Polished and glazed bridge.

Finishing and clinical evaluation

After printing, the bridge was washed with 94%–96% ethanol (food grade), post-polymerised and finished directly in the clinic (Figs. 10a–c) with the following procedures:

- polishing and characterisation with a glaze (DEI experience Seal Coat Fast, DEI Italia) to improve the aesthetics (Figs. 11a–c);
- verification of passive fit on the ProCam Ti-bases;
- extra-oral cementation on the ProCam Ti-bases using MultiLink Hybrid Abutment cement (Ivoclar Vivadent); and
- verification of occlusion and function.

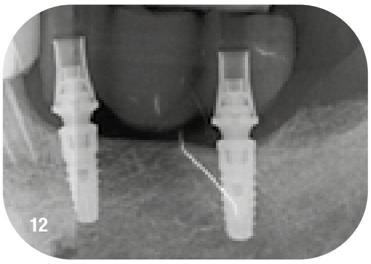

Fig. 12: Bridge in position on the implants, demonstrating seamless integration with the peri-implant bone.

Once screwed to the implants, the prosthesis demonstrated excellent stability and seamless integration with the peri-implant tissue (Fig. 12). No occlusal retouching was performed.

Outcome

The entire digital workflow was completed in one session, allowing the patient to receive a definitive prosthesis without a long wait. The chairside approach significantly reduced treatment time by eliminating the need to send the case to an outside laboratory. The main benefits achieved were:

- accurate fit to the implant sites;
- excellent aesthetics thanks to Irix Max Photoshade;
- minimal post-production retouching; and
- immediate patient comfort.

Discussion

The chairside 3D-printing workflow represents a revolution in implant prosthetics, enabling the clinician to:

- reduce treatment time;
- maintain complete control over the prosthesis; and
- eliminate the errors that can arise in data transfer to the laboratory.

The use of intra-oral scanners for data acquisition is now an established reality, and numerous studies have confirmed their accuracy and reliability in implant prosthetics.[6,7] Digital prostheses have demonstrated excellent accuracy of fit in comparative analyses with conventional methods.[8] The integration of digital technologies into the chairside workflow allows for optimisation of treatment management, reduction of treatment time and improvement of patient comfort.[9,10] The use of IPD components ensured a stable and predictable implant connection. In particular, the ProCam scan bodies enabled reliable and detailed scanning by correcting volumetric mesh distortions using advanced mathematical algorithms and precise offset adjustments, and the ProCam Ti-bases ensured excellent implant–prosthesis coupling accuracy. The combination of the Medit i700 wireless, RealGUIDE CAD+, Dfab and Irix Max Photoshade made the process extremely efficient and demonstrated how digital technologies can transform the approach to implant prostheses.

Conclusion

This clinical case demonstrates that the fabrication of a screw-retained bridge on implants using a chairside 3D-printing workflow is a clinically viable and efficient option. The dentist can manage all steps of the process independently, reducing time and cost without compromising quality and accuracy. Dfab's TSLA printing technology enables immediate, customised and highly predictable solutions that improve the patient experience and optimise practice operations.

Editorial note: Please scan the QR code for the list of references.

about

Dr Antonino Cacioppo graduated in dentistry from the University of Palermo in Italy and holds a master's degree in implantology and a PhD in dentistry. His expertise spans 2D and 3D radiographic diagnostics, CAD/CAM systems and guided implantology. He previously lectured at the University of Catania in Italy and currently holds a research fellowship at the University of Palermo, where he is associate professor of odontostomatological diseases. He is the author of 17 international publications and has contributed to specialist books and university textbooks. He can be reached at cacioppoantonino@gmail.com.

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Rehabilitation of the Anterior Mandibular Sextant with Chairside 3D Printed Hybrid Composite Restorations: a 7 years follow-up.

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_Description

In 2017, a patient presented to the clinic with extensive carious lesions affecting teeth 43, 42, 41, 31, 32 and 33. Additionally, the patient exhibited class V cervical lesions, root exposure, and significant generalized dental abrasion, particularly pronounced in the anterior frontal group. This condition was associated with reduced function in the posterior sectors of the dental arch. The patient expressed concerns regarding the cosmetic appearance of its dentition and reported a diminished ability to chew effectively. Notably, the patient emphasized its inability to attend multiple visits for prosthetic rehabilitation visits (Fig. 1).

Fig. 1_ Frontal picture of the arches: situation at first visit.

A comprehensive oral hygiene session, along with endoral radiographic examinations, and an intraoral scan, was conducted to meticulously document the patient's initial status. Following this assessment, carious lesions were removed from the affected teeth, which were severely compromised yet deemed recoverable (Fig. 2).

A chairside treatment plan was proposed to the patient, aimed at addressing both functional and aesthetic concerns within a few hours. This approach utilized minimally invasive preparations and the technique of printing restorations directly in the clinic. Upon the patient's acceptance of the treatment, minimally invasive preparations were carried out, followed by smoothing and polishing using medium to fine grit silicone abrasive instruments. Once the preparations were completed and the condition of the soft tissues, as well as the visibility of the cervical margins, were verified, intraoral scanning of the arches and occlusal relationships recordings were performed (Fig. 3).

_Materials and methods

Le The crowns were designed with ChairsideCAD dental CAD software (exocad) and connected with minimal-size connectors to ensure the stability of the prosthetic splint. The resulting design file was saved in .stl format and subsequently used for printing with a Dfab printer (DWS) equipped with TSLA (Tilted Stereolithography) technology.

The 3D Dfab printer is specifically designed for chairside additive manufacturing and operates with disposable cartridges available in various sizes (S, M, L) to accommodate different material volumes. This technology represents an evolution of traditional stereolithography, utilizing an inclined build plane and high-viscosity materials to create a "waterfall" effect. This innovative approach allows for the homogeneous mixing of heavy fillers during the printing process, significantly increasing printing speed while reducing the need for support structures.

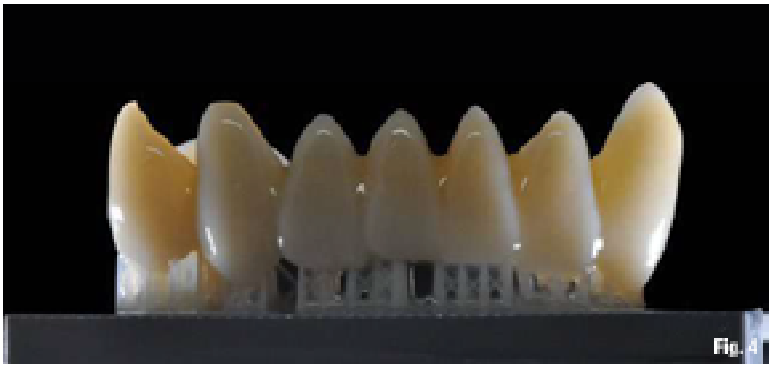
_Il metodo additivo TSLA

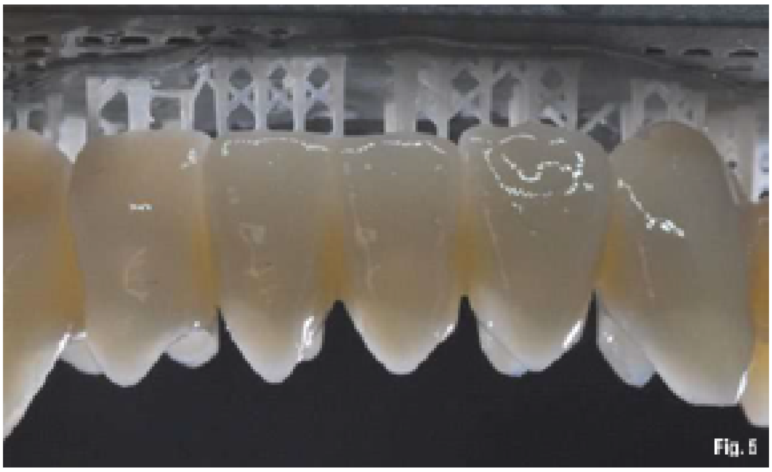
In dentistry, TSLA is employed in the Dfab printer using Photoshade color gradient cartridges (DWS). The process begins by loading the .stl file into Photoshade software, which optimally positions and supports the restoration to ensure accuracy and fit. The desired Photoshade gradient is selected and the cervical and incisal color boundaries are defined. Once the visual appearance of the restoration is approved, the printing process commences. The disposable Dfab cartridge is loaded into the top of the printer along with a print platform holder with a disposable platform attached. The top of the Dfab is closed and the cartridge tilted at a 45-degree angle. Printing is initiated via Photoshade Pro software, with a continuous flow of material maintained by gravity and a silent peristaltic pump. A blue UV laser beam selectively cures the composite, building the object layer by layer. Upon completion of the printing process, the Dfab is opened, and the build platform is returned to a horizontal position. To remove uncured composite residue, the platform containing the restorations is washed for 1-2 minutes in a shaker with 95% ethyl alcohol. The restorations are then manually separated from the platform by breaking the thin supports with a rotary motion. Any remaining small fragments of uncured composite are removed by scrubbing with a flat brush dipped in 95% ethyl alcohol. Finally, post-polymerization is performed using a dual-energy device (Dcure, DWS) that utilizes ultraviolet light and heat, with an automatic cycle lasting about nine minutes. (Figs. 4, 5).

Figs. 2, 3_ Preparation of the frontal group, teeth 33 to 43.


Fig. 2


Fig. 3





_Post-processing

The printed prosthetic restorations are then finished and polished. Surface morphology and texture are enhanced using abrasive burs, followed by mechanical polishing. This effective method ensures color stability over time and helps resist the accumulation of plaque and staining agents such as red wine and coffee. Polishing is performed meticulously, using diamond-impregnated polishers of fine and superfine grit (e.g., Twist spiral discs and Occluflex cups, Diacomp, EVE) (Fig. 6).

_Follow-up

The patient is regularly monitored with biannual checkups and hygiene sessions to maintain oral health and prevent secondary caries and periodontal issues. He has expressed full satisfaction with the treatment received and remains cooperative throughout the follow-up process. During the most recent visit, the Irix hybrid composite restorations appeared intact and functional. Only a new polishing was required, which was performed following the oral hygiene session using the modern polishing technique previously described. The patient will continue to be monitored, and we plan to document mid- and long-term follow-up assessments. (Fig. 7).

Figs. 4, 5_Restoration printed with TSLA technology.

Fig. 6_Cemented restoration in the oral cavity.

Fig. 7_Restoration after 7 years.

Case Report

Additive hybrid composite *restorations*: a simple case

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- President (2024- 25), Digital Dentistry Society (DDS);
- Scientific Editor, DDS MAG, DentalTech, Infodent;
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- Author of 145 publications on international Pubmed indexed journals and high impact factor;
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- He works as a freelance in Gravedona (Como), devoting himself exclusively to Digital Dentistry.

THE CLINICAL CASE

Today, implant-supported prostheses have changed thanks to the advent of 3D printing, which allows the manufacture of certified definitive restorations in hybrid composites filled with ceramic, even chairside.

Here, we present a rehabilitation case of a patient with two single implants, one in the maxilla (#26) and the other in the mandible (#46), managed through a fully digital and model-free workflow and finalised with two hybrid composite crowns (filled with 42% ceramic particles).

The first step was intraoral scanning of the implants (Anyridge®; Megagen, South Korea; Figs. 1–4).

FIG. 1 *Intraoral scan with iTERO Element 5D Plus® (Align).*

The scan was captured with a powerful intraoral scanner (iTERO Element 5D Plus®; Align, USA) according to a consolidated protocol, which included:

- Scanning of the master model after removing the healing abutment;
- Scanning the opposing arch;
- Scanning of the bite on the left and right;
- High-resolution scanning of the scan body (IPD Pro CAM®; Matarò, Spain) and adjacent teeth for the best definition of the contact points;
- Scanning the master model with the scan body in position.

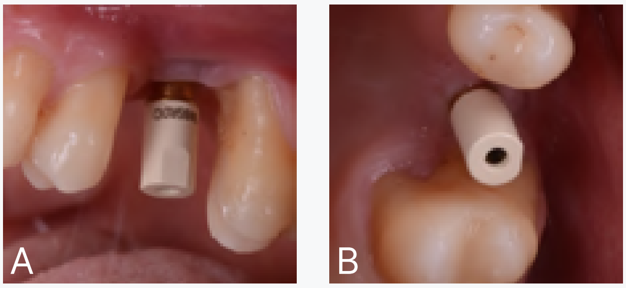

FIG. 2A, B *Details of the scanbody in position #26.*

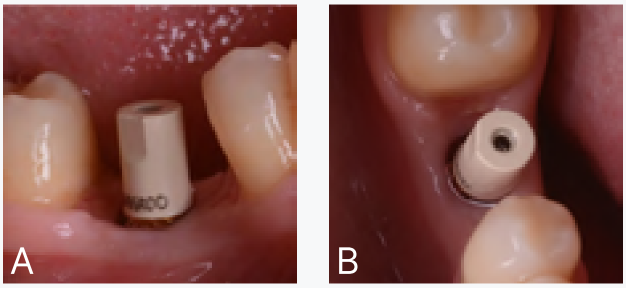

FIG. 3A, B *Details of the scanbody in position #46.*

The intraoral scanner choice was motivated by the high accuracy of the iTERO Element 5D Plus®, as unequivocally demonstrated in the scientific literature [1]. We opted for IPD Pro CAM® compatible scan bodies since this is one of the very few companies able to provide incremental libraries (i.e. equipped with multiple files of the same scan body at different magnifications), which helps to compensate for the possible (and probable, given that it is an optical scan) mesh growth during scanning. This library allows the dental technician to significantly improve the quality of the superimposition of the library file on the scan body mesh, minimising all errors. It eliminates the risk of shifting the implant platform from real to virtual.

FIG. 4 *High-resolution scan of the scanbodies in position #26 and #46.*

After receiving the scan file in the cloud, the dental technician modelled an individual abutment for each implant, to be fabricated by milling in zirconia, and a single crown, to be 3D printed in hybrid composite loaded with ceramic particles (Galway®; exocad, Germany; Figs. 5–8).

"Having received the scan file in the cloud, the dental technician modeled for each implant an individual abutment and a single crown."

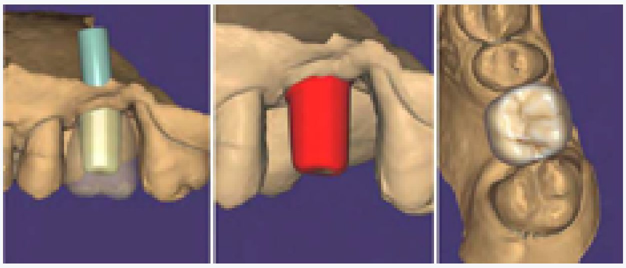

FIG. 5 *CAD modelling, implant #26.*

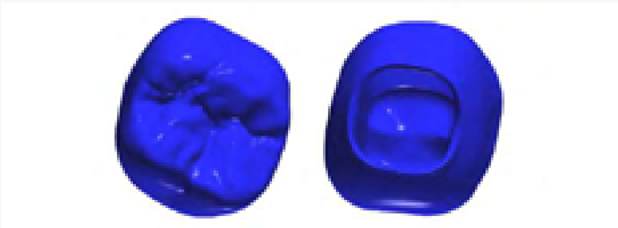

FIG. 6 *Crown #26 modelled in CAD.*

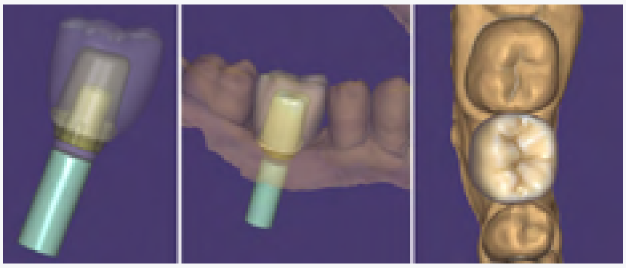

FIG. 7 *CAD modelling, implant #46.*

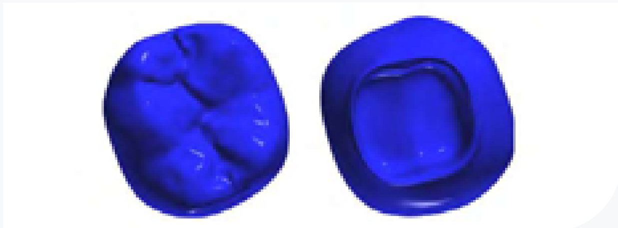

FIG. 8 *Crown #46 modelled in CAD.*

The files were reshared with me, and I put them into production. The individual abutments were milled in zirconia with a powerful five-axis milling machine (DGSHAPE DWX-52D®; Roland Company, Japan), sintered in a dedicated oven and adhesively cemented onto TiBase IPD ProCam®, appropriately sectioned to identify the best possible height, through a specific cutting template. The prosthetic crowns were instead 3D-printed using a tilted stereolithography technique with a Dfab® printer (DWS Systems, Italy) in hybrid composite material (filled with 42% ceramic particles) Irix Max® (DWS Systems; Thiene, Italy; Figs. 9–12).

The workflow involved loading the STL file of the restorations into the proprietary Nauta Photoshade® software (DWS Systems, Italy), which automatically generates the supports and print bases. The operator must only set the colour levels because the printer can print restorations with a colour gradient (three different colours) for a better aesthetic adaptation, all completed in under 15 minutes. After printing, the restorations were further characterised and cured for five minutes in a dedicated unit (Dcure®; DWS Systems, Italy) before delivery.

"The prosthetic crowns were instead printed using a tilted stereolithography technique."

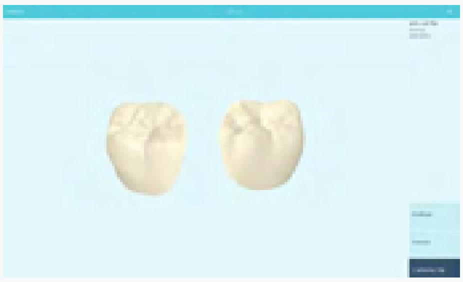

FIG. 9 *The STL of the restorations are uploaded in the Nauta Photoshade®.*

FIG. 10 *Automated orientation of the .STL files.*

FIG. 11 *Automated support and print bases.*

FIG. 12 *Colour gradient selection.*

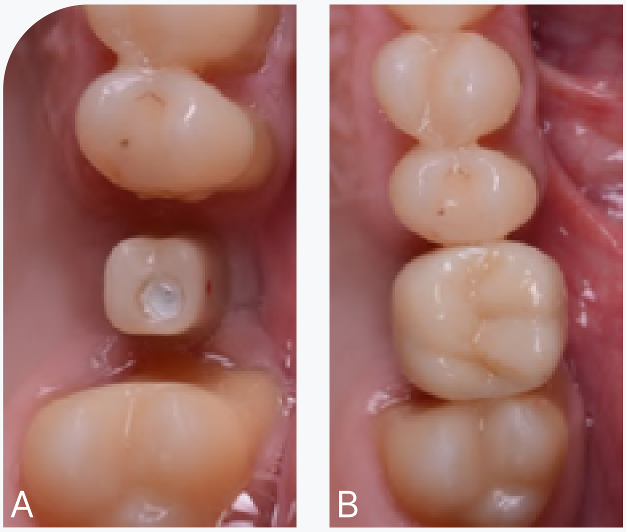

FIG. 13A, B *Delivery of the final #26 crown.*

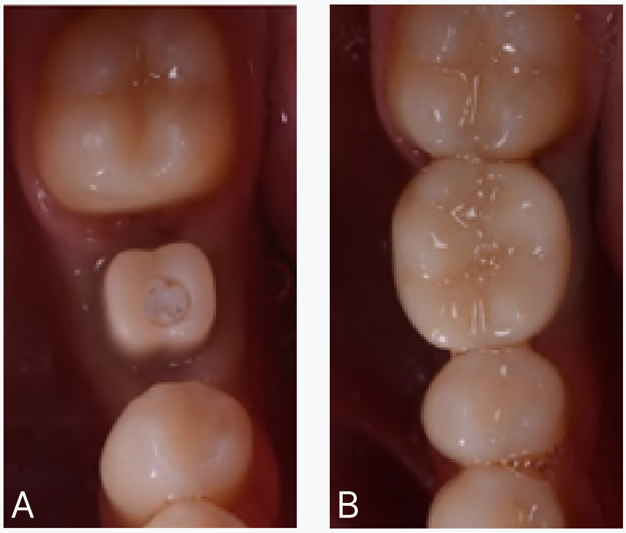

FIG. 14A, B *Delivery of the final #46 crown.*

The definitive hybrid-composite restorations were delivered at the second appointment. The healing abutments were unscrewed, the individual hybrid abutments were screwed, and the monolithic crowns in hybrid composite loaded with ceramic were cemented on top of them (Figs. 13–14).

The precision of these crowns, obtained by 3D printing, is relatively high, as demonstrated in a recent in vitro study [2]. From a clinical perspective, these restorations proved reliable in a recent retrospective study involving 85 patients rehabilitated with 95 restorations (70 single crowns and 25 bridges with up to three elements) [3].

SOURCES

(1) Mangano FG, Admakin O, Bonacina M, Lerner H, Rutkunas V, Mangano C. Trueness of 12 intraoral scanners in the full-arch implant impression: a comparative in vitro study. BMC Oral Health. 2020 Sep 22;20(1):263

(2) Mangano FG, Cianci D, Pranno N, Lerner H, Zarone F, Admakin O. Trueness, precision, time-efficiency and cost analysis of chairside additive and subtractive versus lab-based workflows for manufacturing single crowns: An in vitro study. J Dent. 2024 Feb;141:104792.

(3) Mangano FG, Yang KR, Lerner H, Porrà T, Khachatryan LG, Gordienko ID, Admakin O. 3D-printed Short-span Hybrid Composite Implant-supported Restorations Fabricated Through Tilting Stereolithography: A Retrospective Clinical Study on 85 Patients with 1 Year of Follow-up. J Dent. 2024 May 22:105095.

THE CLINICAL CASE
Simple implant-prosthetic rehabilitation in the era of 3D printing

Dr. Francesco Mangano
DDS, PhD

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#fulldigital #modelfree

Digital the beautiful, indeed wonderful

Dear Colleagues,
in this June 2024 issue of DentalTech we talk about ***#fulldigital #modelfree*** for the rehabilitation of single or partial edentulism with implant-borne restorations. Here we show you an example of simple and accurate digital, beautiful indeed because it is affordable: democratic! We discuss intraoral scanning with the i-Physio® protocol from Lyra ETK and 3D printing with Dfab® from DWS Systems. Why i-Physio®? Because it is a scan-healing abutment that is in immediately placed with the implant (even better if the implant is a post-extraction, to take full advantage of the healing potential of the surgical site) and is never removed, until the final restoration is delivered. i-Physio® is available in different shapes and heights, making it ideal for preparing the tissues for the delivery of the final abutment, which will be seamless. With i-Physio® scanning is simplified: nothing needs to be unscrewed, you simply capture the master model with the scan healing abutment in situ, the antagonist and the bite. For scanners with a High Resolution (HR) option such as the iTERO Element 5D Plus®, an additional scan of the scan-healing abutment in HR can always be integrated. The scan is sent to the technician who models in CAD from a high-quality mesh/ library overlay. The modelling can be done as a chairside additive solution with the Dfab® printer, printing a superstructure in Irix Max®, a hybrid composite material certified as definitive (because it is filled with 42% ceramic), to be cemented extraorally on ti-bases provided by the implant company, and applied immediately (screw-retained prosthetic solution); or, as in the case presented here, the CAD files of the individual abutments are sent to the implant company for fabrication of the customised abutments, and the prosthetic framework is printed in the dental practice in Irix Max®, with Dfab® (cemented prosthetic solution, which we always prefer, even if it is not chairside). The choice is yours! Finally, I would like to take this opportunity to invite you all to the **International Congress of the Digital Dentistry Society (DDS)** (https://conference.digital-dentistry.org/) **that I am organizing in Florence**, **18-19 October 2024**. We will present many interesting things and at least two atomic innovations that will disrupt the world of implant dentistry. The congress will consist of a series of discussions between the best researchers and clinicians on the international scene, on the topic of digital technologies in clinical practice. An extraordinary event, of the highest scientific level, in Italy. I look forward to seeing you all in Florence!

Francesco Mangano

#fulldigital #modelfree

Simple implant-prosthetic rehabilitation in the era of 3D printing

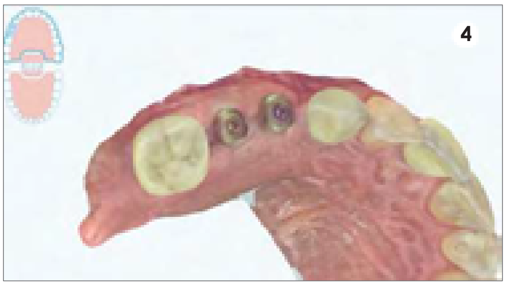
Prof. Carlo Mangano

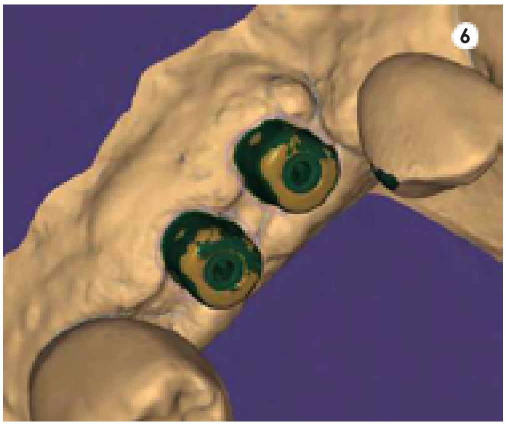
Medical Surgeon, Specialist in Anesthesia and Resuscitation and in Dentistry. Founding Member and Past President of the Digital Dentistry Society (DDS).

We present a case of partial edentulous rehabilitation achieved by a simple, ***#fulldigital #model-free*** procedure. This was an implant-supported bridge printed in hybrid composite material (with 42% ceramic fillers), certified as a definitive restoration, using modern TSLA (tilted stereolithography) technology with a Dfab® printer (DWS Systems, Thiene, Vicenza, Italy). The restoration was cemented onto customised abutments milled by the implant manufacturer.
The patient, a 65-year-old male with no general health problems and good oral hygiene, came to us for the solution of a multiple edentulous problem, involving elements #14 and #15 (first and second maxillary right premolars). The implants chosen for prosthetic rehabilitation were NATURACTIS® (LYRA ETK, Sallanches, France). At the same time as the implants were placed, the most appropriate scan-healing abutments from the i-PHYSIO® range (LYRA ETK), carefully selected according to the type of tooth to be replaced and the thickness and height of the available peri-implant soft tissue, were screwed onto the implants. These abutments have the dual function of custom healing screws to shape the tissues for the final restoration, and scanbodies to capture the implant position through optical impressions. Therefore, once placed, they should not be removed until the final prosthetic restorations are delivered.
Therefore, after the two-month period required to complete osseointegration, the position of the implants was recorded by optical impression using a powerful intraoral scanner (iTERO Element 5D Plus®, Align Technologies, San Jose, USA). As mentioned above, no special scanbody

Fig. 1. i-Physio® in position #14 e #15, occlusal view.
Fig. 2. i-Physio® in position #14 e #15, lateral view.
Fig.3. Intraoral scan made with iTERO Element 5D Plus®, lateral view.

was required as the scan-healing abutments served the dual function of custom healing screws and implant position transfer devices in CAD. Therefore, scanning was simplified and consisted of capturing the master model with i-PHYSIO® (LYRA ETK) *in situ*, the antagonist model, and the bite. The scan was sent to the dental laboratory, which modelled the customised abutments and the final bridge (cemented prosthesis) using computer-aided design (CAD) software (Galway®, Exocad, Darmstadt, Germany). The customised abutments were sent to the implant company for milling, in this- case in titanium, while the bridge was fabricated in-house using the TSLA printing with the Dfab® laser printer (DWS Systems). The material chosen for printing was a hybrid composite (Irix Max® indeed, also from DWS), filled with 42% ceramic, and therefore certified for printing definitive restorations. Using the proprietary Photoshade® technology (DWS srl), the operator was able to print the restoration in the desired shade, by choosing from several natural colour gradients. The bridge was cured in the Dcure® unit (DWS srl) and was ready for delivery. The patient was then called in for the third and final appointment, following those for implant placement (first appointment) and intraoral scanning (second appointment): the delivery of the final restoration. The dentist unscrewed the i-Physio® scan-healing abutments (LYRA ETK) and without any difficulty (with the soft tissue already "prepared" for the insertion of the final customised abutments, the lower part of which was "copied" from that of the coded abutments),.screwed on the





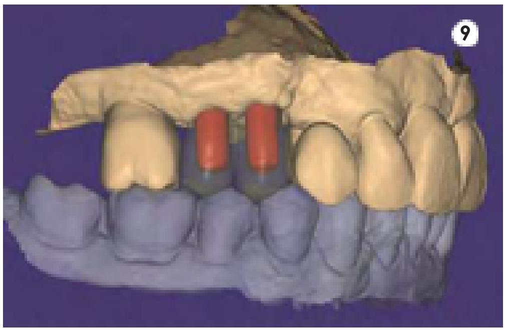
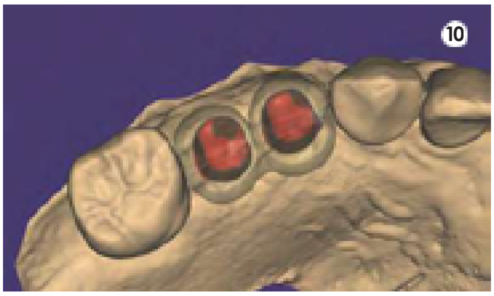
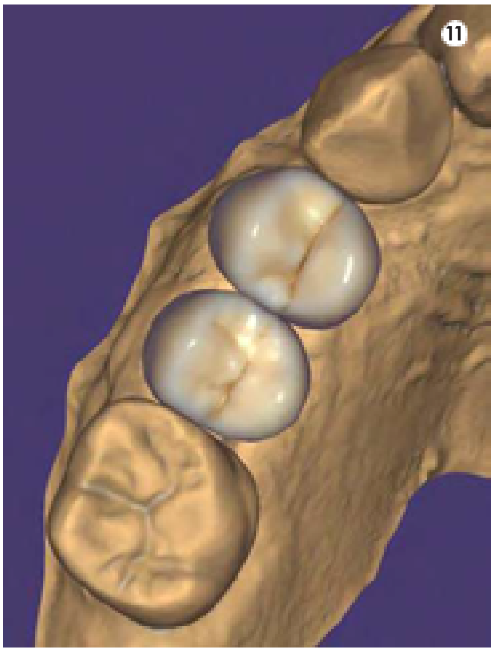


Fig. 4. Intraoral scan msde with iTERO Element 5D Plus®, occlusal view.
Fig. 5. Detail of the i-Physio's captured in the intraoral scan of the master model.
Fig. 6. Occlusal detail of the i-Physio's in the CAD software.
Fig. 7. The i-Physio's in the CAD software, lateral view.
Fig. 8. Detail of the bridge and customized abutments CAD modelling.
Fig. 9. Modeling placed in the context of the virtual patient's mouth in CAD.

custom titanium abutments. On them, he would finally cement the definitive restoration. Clinical precision was absolute, given by the high quality of the intraoral scan (iTERO Element 5D Plus®, Align) combined with the high quality of the custom milled and 3D printed hybrid composite restoration (Irix Max®, DWS). Digital can be really simple and affordable if you choose the best solutions!

There is no reason why everything should not be done *additive chairside* if a screw-retained superstructure is chosen: theoretically, with the patient in the chair, the technician could be alerted, the scan sent and the CAD design (screw-retained superstructure) returned in 5-10 minutes, time for a coffee. After receiving the design, all that would be required is to print the final hybrid composite bridge using DWS's Dfab®





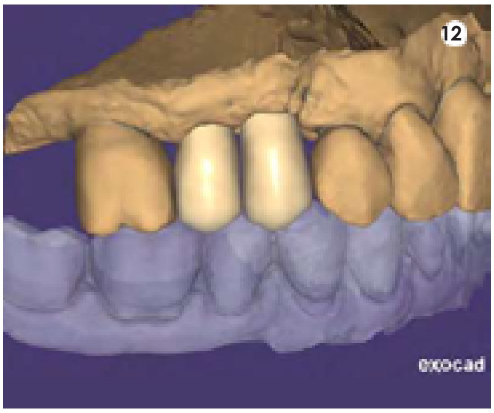
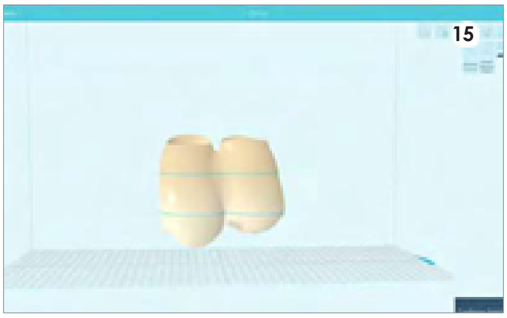
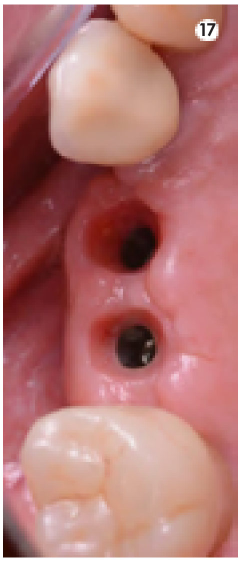


Fig. 10. Occlusal view. Note the support that individual abutments provide to the restoration.
Fig. 11. Exocad's Truesmile® photorealistic rendering of the modeling of the restoration, occlusal view.
Fig. 12. Exocad's Truesmile® photorealistic rendering of the modeling of the restoration, lateral view.
Fig. 13. The definitive restoration file is ready for printing.

printer, procedure that takes a maximum of 10-15 minutes, including curing in its proprietary device. At this point, all that would need to be done is to extraorally cement the printed restoration onto the appropriate ti-bases, and screw it onto the patient. This would be a chairside prosthesis of absolute quality, as evidenced by recent in vitro and in vivo scientific work, elegant and economically sustainable.
But we love cemented restorations and we won't change our minds, because we believe that the support of the restoration by one or more customised abutments, whether all titanium or hybrid (titanium and zirconia), is essential, and we don't like restorations with occlusal screw holes.





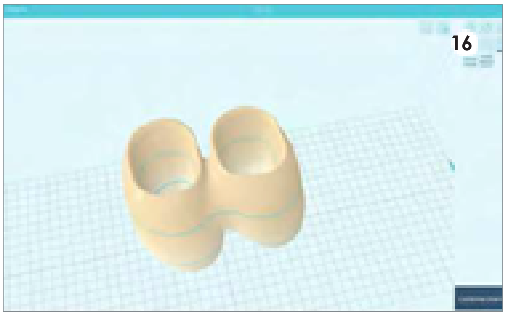


Fig. 14. Loading the STL file of the restoration into the proprietary software Nauta Photoshade® from DWS Systems.
Fig. 15. Setting the color levels in Nauta Photoshade®. The software allows the setting by the operator of three color levels, corresponding to the contents of the disposable cartridge loaded inside the Dfab® printer for the required printing session.
Fig. 16. Detail of the restoration ready for automatic support generation in Nauta Photoshade®.
Fig. 17. Excellent tissue health after removal of i-Physio® scan healing abutments.
Fig. 18. Placement of the individual abutments milled by Lyra Etk.
Fig. 19. The tilted stereolithography (TSLA) restoration produced with the Dfab® printer (DWS Systems) in 42% ceramic-filled hybrid composite (Irix Max®) is delivered to the patient, cemented onto the individual abutments.

Solution of a case of frontal agenesis with 3D navigation surgery and color 3D printing in Dfab with TSLA technology

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** Specialist in Oral&Facial 3D Design.

** Specialist in Oral&Facial 3D Design..

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_Case Presentation

The 16-year-old patient has an agenesis of tooth 12 (US 7) and a Maryland bridge cemented on teeth 11-13 (US 8-6) (Figs. 1, 2).

Instrumental examinations, facial and dental arches photographs (Figs. 3-5), CBCT (Fig. 6), and intraoral impressions with the Primescan intraoral scanner (Dentsply Sirona) were performed. The morphology of teeth 11-12 (US 8-7) was planned and integrated into the 3D radiographic volume. The guided surgery was planned using the X-Nav 3D navigation technique (X-Nav Technologies).

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Translated from: Fazioni M, Surico N, Consolaro R, Orio S. Soluzione di un caso di agenesia frontale con chirurgia a navigazione 3D e stampa 3D del colore in DFAB a tecnologia TSLA. CAD/CAM IT 2023:2 24-30

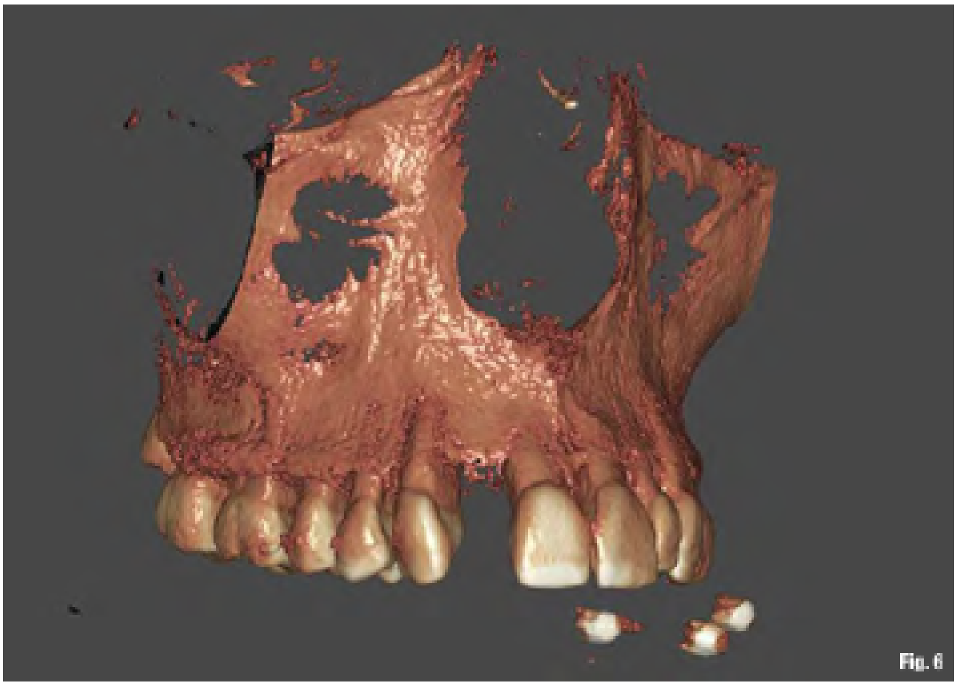

Fig. 1_Patient's face.
Fig. 2_Cemented Maryland bridge.
Figs. 3-5_Photos of the arches.
Fig. 6_CBCT.

_Materials and methods

The planning of the transmucosal pathway in a subject with a thin biotype and complex gingival architecture becomes strategic to obtain good stability of the soft tissues, marginal gingiva and interdental papillae. Prosthetic guidance is a procedure always performed at our Center in all cases of tooth replacement or restoration of the partially compromised tooth.

The morphologically obtained data becomes a surgical guide to the robotized approach without a surgical guide. This procedure guarantees a very high level of precision and reduces the need to make a physical template with consequent lower costs. The surgical act involves a series of calibration steps of the instrument, also using a marker during the 3D volume recording phase (Fig. 7).

Fig. 7_Placement Marker.

Fig. 8_Geo-localion of the handpiece.

Figs. 9-11_Placement of the handpiece during surgery.

Fig. 12_Fixture placed in the bone.

Fig. 13_Suture.

The geolocation of the handpiece guarantees the correct position in all phases from the insertion of the drills to the positioning of the fixture in the bone, with a very high predictability of the result. (Figs. 8-13).

A scanning body (Fig. 14) is used to record the position of the system after inserting the fixture, which is done using conventional techniques. This position of the implant is integrated into the initial preoperative impression, with the aim of reducing the scanning time during surgery and making the operating session more comfortable for the patient (Fig. 15).

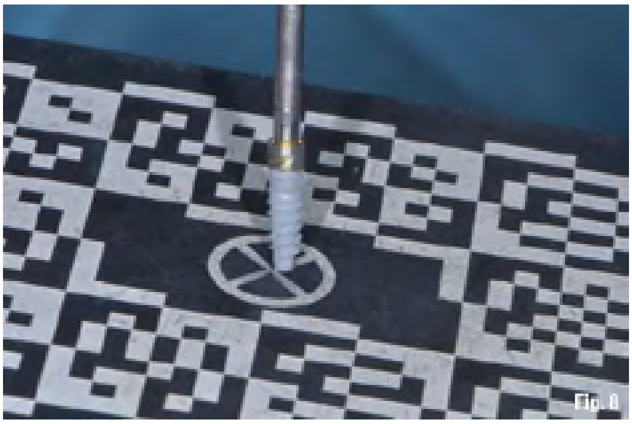
Fig. 8

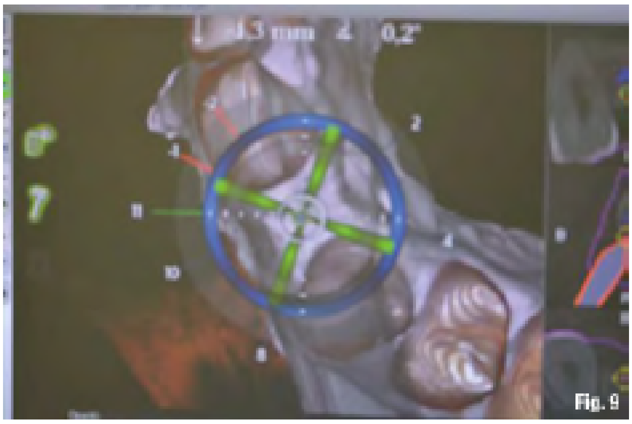
Fig. 9

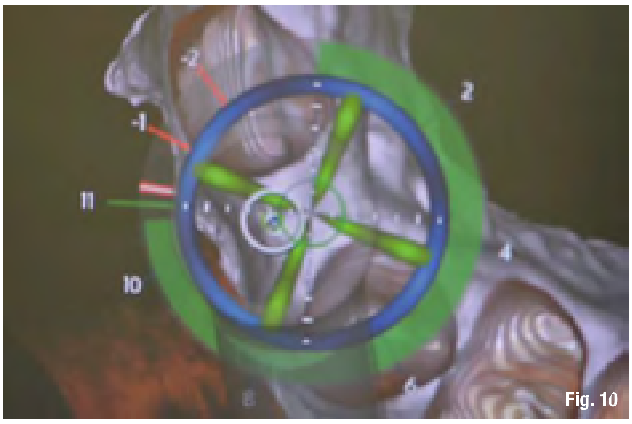
Fig. 10


Fig. 11


Fig. 12


Fig. 13

Fig. 14

Fig. 15

Following this survey, the file is sent to the laboratory which designs in real time (Figs. 16, 17) and prints the provisional restoration (Dfab 3D laser printer by DWS) using Temporis, a Class IIa, CE Certified hybrid composite.

The literature indicates that the restoration should be cemented to a metal mesostructure that contains all the information of the implant connection manufactured by the company in order to guarantee a positive result over time..

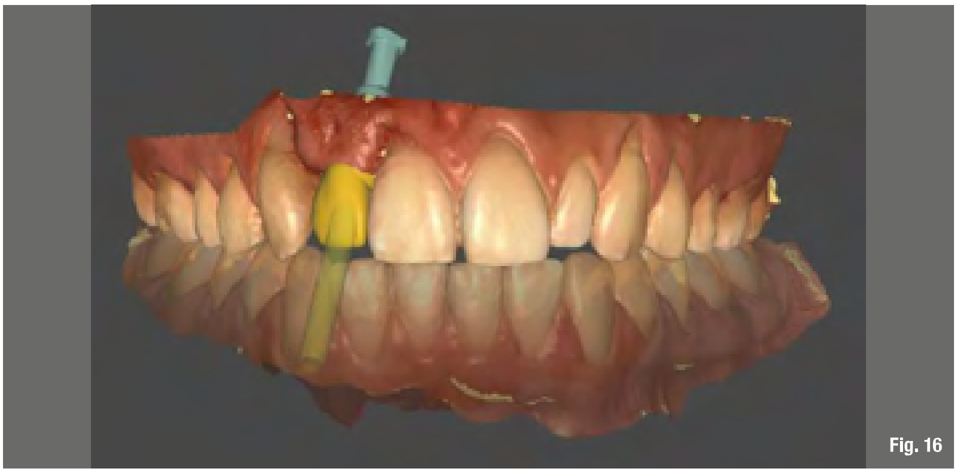

Fig. 16

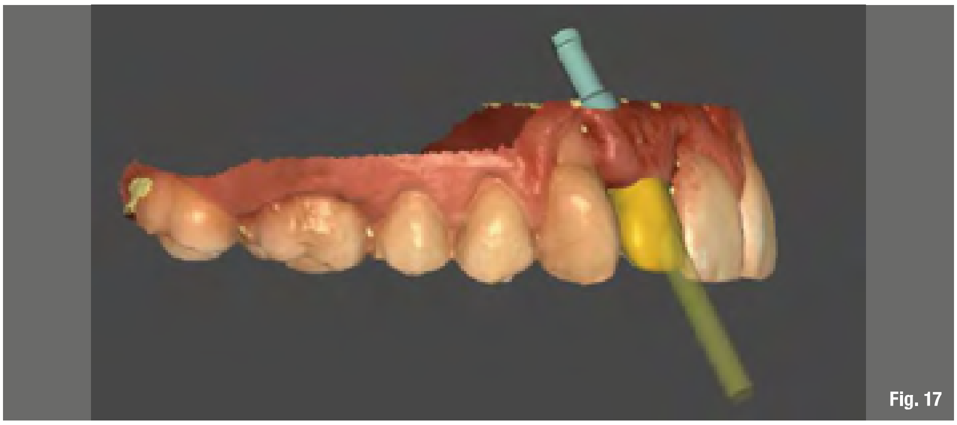

Fig. 17

Fig. 14_Insert the scan body.

Fig. 15_Intraoral scan with scan body.

Figg. 16, 17_Design of the provisional restoration.

Direct 3D printing made with DWS's DFAB uses TSLA (Tilting Stereolithography) technology (Fig. 18). This technology guarantees the use of state-of-the-art materials, hybrid composites with a high ceramic content that would be extremely complex to produce with conventional techniques due to their high viscosity. The TSLA technology guarantees the flow and continuous mixing of the hybrid composite material in the cartridge's vat and therefore an extremely homogeneous quality result. SLA printing enhances and guarantees extreme detail refinement thanks to the laser that makes the size of the curing light spot infinitesimal. The TSLA technology applied to restorative dentistry guarantees very refined levels of detail and, thanks to the peculiar shape of the cartridges (equipped with two small tanks filled with composite in A1 and A3.5 shades), it is possible to obtain a chroma saturation gradient that reduces time and improves the aesthetic result even in the case of provisional restorations.

In our case, due to the significant bone resorption, we decided to fabricate a screw-retained crown cemented to a metal mesostructure (Fig. 19). The inclination of the restoration is managed by the transmucosal path of the emergence profile. The side effect of the presence of the passage hole on the vestibular surface is easily managed with camouflage through a mini restoration. This complexity further facilitates and ensures that there is no boundary between crown and abutment.

The effect over time will be a better esthetic stability for a thin biotype profile, a reduction in all complications due to the emptying of the through screw and the possibility of reintervention, disassembling the crown to make the appropriate evaluations over time of the transmucosal path (Fig. 20). The intraoral images of the transmucosal path after the healing phase, which in our case was defined as four months, clearly show the stability of the healing of the connective tissue, thanks to the special attention paid to the morphology of this structure on the screw-retained crown (Figs. 21, 22). After this period, we proceeded with the esthetic finalization by placing a final restoration in Irix Max (hybrid composite material enriched with 42% ceramic, class IIa, CE certified) fabricated with a DWS Dfab 3D printer using TSLA technology (Figs. 23, 24).

Fig. 18_DWS DFAB printer with TSLA technology.

Fig. 19_Screw-down crown cemented on metal meso-structure.


Fig. 20


Fig. 21


Fig. 22

Fig. 23


Fig. 24

Fig. 20_Placement of the provisional restoration.

Figs. 21, 22_Tissue healing conditioned by the mesostructure.

Fig. 23_Aesthetic finalization.

Fig. 24_The permanent restoration.

_Discussion

The hybrid composites used in this procedure are now an option depending on the type of restoration. Cost containment, significant reduction in processing steps and time are just some of the benefits found with this technology.

The DWS Dfab method is now a unique process capable of planning and implementing a color gradient by discovering a very wide range of chromatic variability within the same restoration, simply by programming the concentration in the different parts of the restoration during the printing phase. It also offers easier integration and camouflage of the restoration, all to the benefit of the patient and the timing of the operative procedures.

_Conclusions

At our IRCS Sacro Cuore Hospital in Negrar, a simulation of the restoration of the compromised element is always performed during the first visit. From the partial restoration of a single element to the cases of complete restoration of all the teeth in the oral cavity, we carry out the virtual planning of the restored morphology of the crown and the position of the implant. This procedure, which is always shared with the patient, becomes the basis of the subsequent clinical process and helps to correctly define the surgical procedures, sharing each step with all the specialists.

Intraoral scans, facial and intraoral photos, CBCT when replacement surgery is required, even with implants, are always procedures that help the clinician from planning to design. The use of state-of-the-art design software allows for a simplified approach, whereas in the past their application was extremely complex. Today, they are much easier to integrate and allow the clinician and patient to visualize the restoration in advance. The use of state-of-the-art materials, such as hybrid composites, is revolutionizing the future of these therapies. Additive technology overcomes the limitations of undercuts and the potential inaccessibility of rotary tools. SLA laser technology allows for levels of detail not possible with subtractive technologies, and DFab technology allows for 3D printed restorations with details and thicknesses not possible with machine tools, in addition to the aesthetic chromaticity essential to the proper prosthetic rehabilitation of our patient.

At the Dental Center of the Sacred Heart Hospital of Verona, these techniques have been applied daily for some years, with extremely comforting, predictable and stable results over time, which pave the way for new future applications of three-dimensional reconstruction methods with 3D navigation and three-dimensional reconstruction of tooth morphology and color without introducing complexities that would make these methodologies not very applicable and widespread.

Case Report

Implant restoration through a *full digital* additive chairside workflow: a simple case

Dr. Francesco **Mangano**

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- Associate Professor, Digital Dentistry, Sechenov First State Medical University, Moscow, Russian Federation; Lecturer, University of Hong Kong, China;
- Editor-in Chief, Digital Dentistry Section, Journal of Dentistry (Q1, Impact Factor 4.4; Citescore 7.0);
- Member of the Board of Directors (2022- 23) and President Elect (2024- 25), Digital Dentistry Society (DDS) International;
- Scientific Editor, DDS MAG;
- Scientific Editor, DentalTech, Infodent;
- Director of the Mangano Digital Academy (MDA);
- Author of 135 publications on international Pubmed indexed journals and high impact factor;
- He works as a freelance in Gravedona (Como), devoting himself exclusively to Digital Dentistry.

THREE MONTHS AFTER the placement of an Anyridge® (Megagen, South Korea) single implant in position 36, the patient was ready for prosthetic rehabilitation.

The intraoral scan was performed with an iTero™ Element 5D Plus (Align Technologies, USA), an intraoral scanner with high trueness as demonstrated in a recent scientific study [1] and thus ideal for clinical application in not only orthodontics but also prosthetic dentistry (Fig. 1A–D).

In this case, an IPD® scanbody (IPD PRO CAM, Spain) was used.

The choice of a compatible scanbody was dictated by the quality of the implant libraries that IPD makes available to the dental technician in CAD. IPD PRO CAM offers a library with different solutions (or, rather, different enlargements of the same object), very useful in compensating for any errors or positional discrepancies due to the transition from mesh to library file [2], in the early stages of CAD modelling. The transfer of the correct position of the implant from the real to the virtual is thus granted, and modelling in CAD is possible without any error.

FIG. 1A-D *Intraoral scan with iTero™ Element 5D Plus (Align Technologies, USA). (A) Master model after removal of the healing abutment; (B) master and antagonist models in occlusion with the scanbody IPD PRO CAM in position; (C) detail of the high-definition scan of the scanbody; (D) the master model only with the scanbody.*

“The printing model with a double-fixation screw represents a valid solution [...] for the precise transfer of the implant position from the virtual to the real”

We opted for a crown cemented on a personalised abutment [3]: therefore, the dental technician modelled a monolithic crown to be cemented on an individual hybrid abutment (Fig. 2A–C). The model for 3D printing was also prepared in CAD (Fig. 3A–D). The printing model with a double-fixation screw represents a valid solution offered by IPD PRO CAM for the precise transfer of the implant position from the virtual to the real.

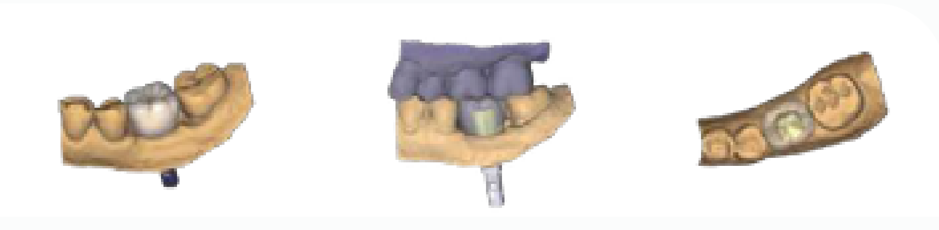

FIG. 2A-C *CAD modelling of the individual hybrid abutment and the final crown. (A) photorealistic rendering of the implant crown; (B) the monolithic crown in transparency with the individual abutment supporting it; (C) occlusal view.*

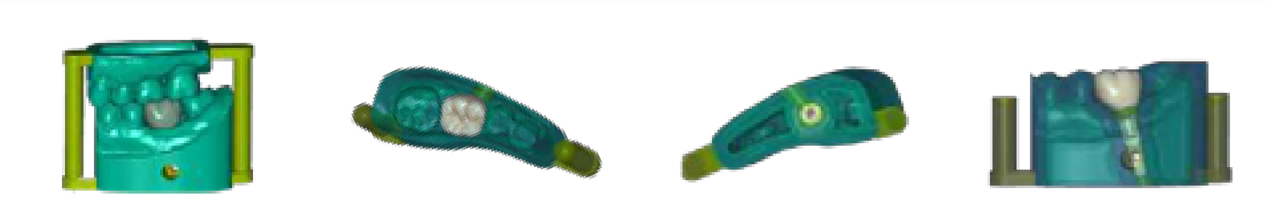

FIG. 3A-D *CAD modelling of the models. (A) the IPD PRO CAM models feature two holes for fixation screws, in order to replicate the virtual implant position in real; (B) top view of the model; (C) bottom view of the model with the first hole for the fixation of the implant analog in the correct position; (D) lateral view of the model with the second hole for the fixation of the implant analog in the correct position.*

The monolithic crown was printed with additive technology using a modern 3D SLA printer, the DFAB® (DWS Systems, Italy), in the proprietary hybrid composite material Irix Max® (DWS Systems, Italy; Fig. 4A–E).
The DFAB printer, a small jewel of Italian technology, can print in 10–15 minutes up to five single crowns in a definitive material, in a colour gradient, thanks to the proprietary tilted stereolithography technology. Basically, the printer allows for obtaining restorations with three different colours because the operator can intuitively set the colour levels in the software (Fig. 5 A–D).

All the CAD/CAM is automated, which results in considerable time saving.

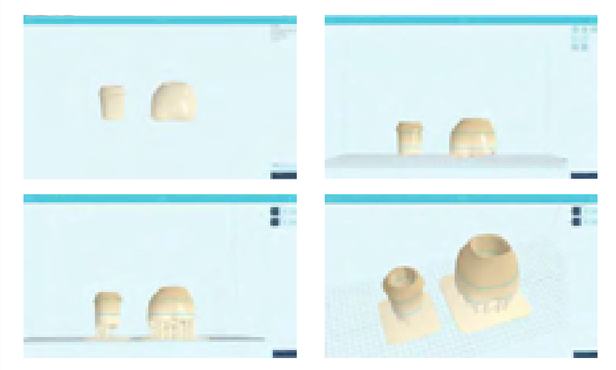

FIG. 4A-E *The stereolithographic printer (DFAB®, DWS Systems, Italy) used in this case report. (A) The material used for manufacturing the crown and the abutment was an hybrid composite (Irix Max®, DWS Systems, Italy). This material is certified in Europe and US as definitive material; (B) the Irix Max® cartridge; (C) the material used here has three layers of colours thanks to the tilted stereolithography concept and the proprietary Photoshade® technology; (D) the cartridge and the printing plate in position; (E) the printer is ready for use.*

FIG. 5A-D *Details from the Nauta Photoshade® (DWS Systems, Italy) software. (A) the restorations are imported in the software; (B) the software automatically place them in the best position thanks to artificial intelligence; (C) the software automatically creates supports and bases for the printing process; (D) the operator can confirm the colour gradients and adapt the colour layers according to the specific clinical indications.*

Besides the monolithic crown, the dental technician also modelled a customised abutment in CAD, printed with the same additive technology in hybrid material, in a chairside procedure (Fig. 6A–E).

As an alternative, the abutment could be milled in zirconia after nesting in CAM with Millbox® (Cimsystem, Italy), using a powerful five-axis milling machine (DWX-52D®; DGSHAPE, Japan). In the case of zirconia abutments, sintering in the Tabeo® furnace (Mihm Vogt, Germany) is required; if the full chairside additive procedure is instead opted for, both the monolithic hybrid composite crown and the abutment need to be polymerised in the proprietary DCURE® oven (DWS Systems, Italy; Fig. 7A–C).

The accuracy of the printing is very high, as demonstrated by the quality of the occlusal features and marginal closure of the restorations obtained with DFAB® (Fig. 8A, B).

The customised abutment was subsequently adhesively cemented on an IPD® titanium bonding base (IPD PRO CAM, Spain). This individual hybrid abutment served as a support for the cementation of the final monolithic single crown, which could be further characterised.

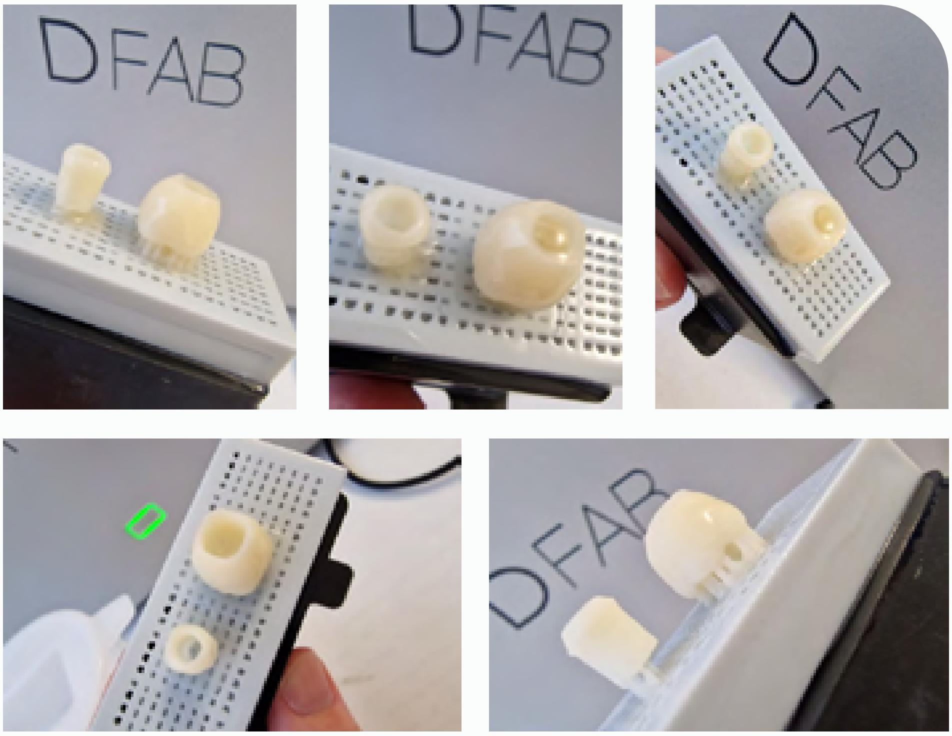

FIG. 6A-E *The monolithic crown and the hybrid abutment have been printed. (A) Prospective view; (B) lateral view; (C) immediately after removed from the printer, the samples must be washed in alchool for about 4-5 minutes in order to eliminate the exceeding material; (D) the samples have been cleaned in alchool; (E) the supports must be removed and the crown and the abutments are ready for polymerization.*

FIG. 7A-C *Polymerization in DCURE® (DWS Systems, Italy) oven. (A) View of the DCURE®; (B) the restorations are placed inside the DCURE® unit; (C) top view of the restorations after the curing process. The whole process takes only 5-8 minutes.*

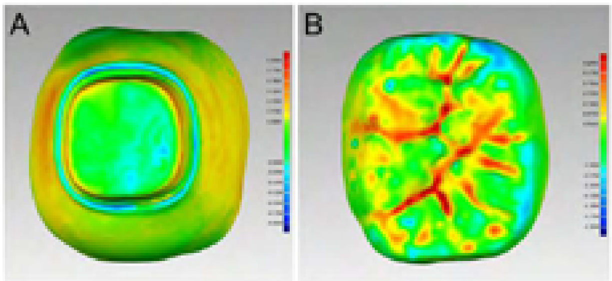

FIG. 8A, B *Quality control of the 3D printed restoration with iTero™ Elements 5D Plus (Align Technologies, USA) and Geomagics Studio® (Autodesk, USA). It is possible to scan the actual monolithic crown in high-definition, and compare the quality of this STL file with the original CAD modelling, using a reverse engineering software. (A) Note the high quality of the marginal closure; (B) the occlusal surface is also well represented.*

FIG. 9A-D *3D printed IPD PRO CAM model. This model grants the perfect transfer of the position of the analog, from the virtual to the real. (A) Lateral view with the final monolithic Irix Max® (DWS Systems, Italy) crown in position; (B) top view of the occlusal surface; (C) the individual hybrid abutment in position. The analog is screwed in position through two fixation screws (one is lateral, the other apical); (D) bottom view of the model with the fixation screw.*

The result was a certified crown for definitive use, aesthetically pleasing, with remarkable clinical precision [4] and ideal mechanical characteristics. Its function was guaranteed in the medium and long term [5].

The quality and accuracy of the restoration were verified on a model with a double-fixation screw (IPD PRO CAM, Spain) 3D printed on the XFAB 3500PD® desktop SLA printer (DWS Systems, Italy; Fig. 9A–D).

In a second session, the patient was recalled for delivery of the final restoration. Once the healing abutment was removed, the individual hybrid abutment was screwed into the correct position dictated by the index (hexagon). Subsequently, once the screw hole of the individual abutment was closed with Teflon, the final crown in the hybrid composite material was cemented onto the abutment with TempBond® temporary cement (Kerr, USA; Fig. 10A–E).

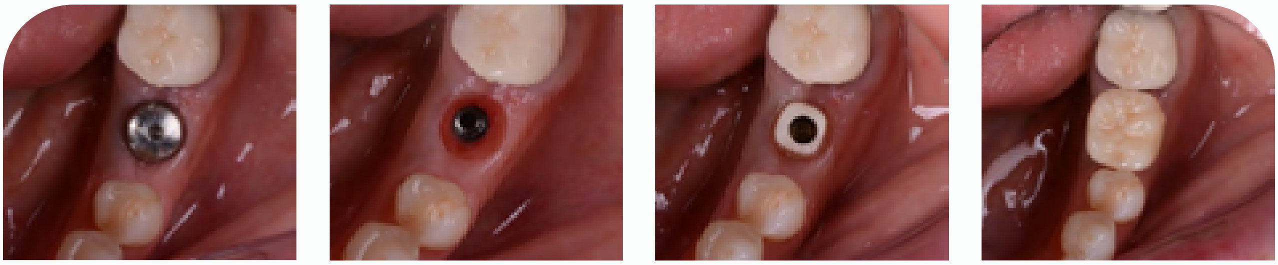

FIG. 10A-D *Delivery of the final restoration. (A) The patient before the removal of the healing abutment; (B) the tissues after the removal of the healing abutment; (C) the individual hybrid abutment screwed in position; (D) occlusal view of the Irix Max® crown; (E) lateral view of the Irix Max® crown.*

SOURCES

*1) Mangano FG, Admakin O, Bonacina M, Lerner H, Rutkunas V, Mangano C.
Trueness of 12 intraoral scanners in the full-arch implant impression: a comparative in vitro study.
BMC Oral Health. 2020 Sep 22;20(1):263. doi: 10.1186/s12903-020-01254-9.*

*2) Mangano F, Lerner H, Margiani B, Solop I, Latuta N, Admakin O.
Congruence between Meshes and Library Files of Implant Scanbodies: An In Vitro Study Comparing Five Intraoral Scanners.
J Clin Med. 2020 Jul 9;9(7):2174. doi: 10.3390/jcm9072174.*

*3) Lerner H, Mouhyi J, Admakin O, Mangano F.
Artificial intelligence in fixed implant prosthodontics: a retrospective study of 106 implant-supported monolithic zirconia crowns inserted in the posterior jaws of 90 patients.
BMC Oral Health. 2020 Mar 19;20(1):80. doi: 10.1186/s12903-020-1062-4.*

*4) Revilla-León M, Supaphakorn A, Barmak AB, Rutkunas V, Kois JC.
Influence of print orientation on the intaglio surface accuracy (trueness and precision) of tilting stereolithography definitive resin-ceramic crowns.
J Prosthet Dent. 2023 Apr 25:S0022-3913(23)00186-5. doi: 10.1016/j.prosdent.2023.03.020.
Online ahead of print.*

*5) Corbani K, Hardan L, Eid R, Skienhe H, Alharbi N, Ozcan M, Salameh Z.
Fracture Resistance of Three-unit Fixed Dental Prostheses Fabricated with Milled and 3D Printed Composite-based Materials.
J Contemp Dent Pract. 2021 Sep 1;22(9):985-990.*

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The **chairside** of 2023

Dr Francesco Mangano, Dr Claudio Gattelli

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The chairside of 2023

Dr. Francesco Mangano
DDS, PhD

** 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 Digital Dentistry Society (DDS) International. Director of 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 139 publications in Pubmed indexed international journals with a high impact factor, with an h-index of 47 (Google Scholar) and 36 (Scopus). He practices in Gravedona (Como, Italy), devoting himself exclusively to Digital Dentistry, and to the development and application of innovative technologies in Dentistry, such as artificial intelligence, augmented reality, and robotics.*

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

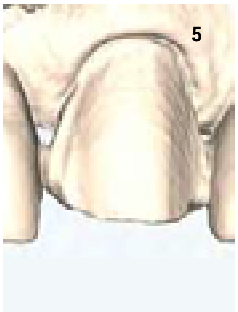
Here are two simple prosthetic cases solved in the same session with the patients in the chair, by using additive technology and direct digital flow based on the following ***#chairside*** procedure:

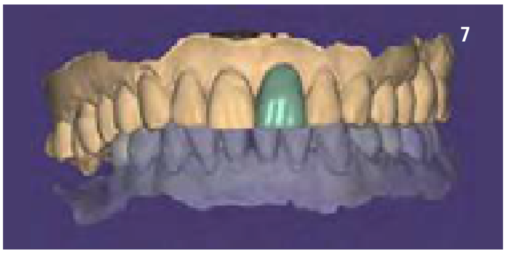
1 intraoral scanning (iTero Element 5D Plus®, Align Technologies);
2 CAD modeling (Galway®, Exocad) of the prosthetic restoration;
3 3D printing (Dfab®, DWS) of the ceramic filled hybrid composite prosthetic restoration (Irix Max®, DWS Srl), washing, curing and characterization;
4 clinical application.

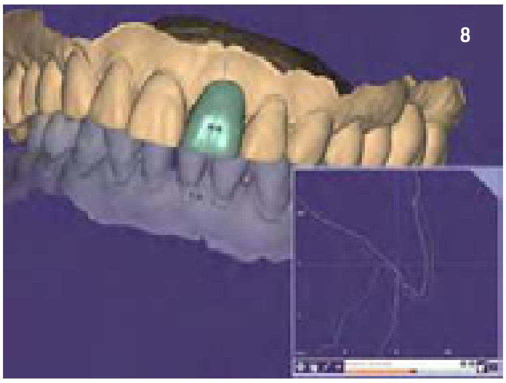
FIRST CLINICAL CASE

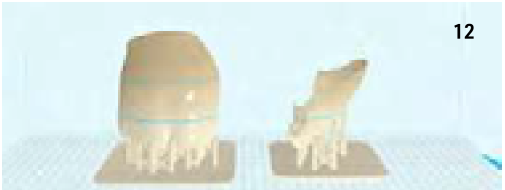
The patient presented with the need to replace an old, pre-existing veneer on tooth #21, which had fractured (**Figs. 1, 2**). The old, cracked restoration was removed and the tooth was re-prepared (**Fig. 3**), a shade was selected, and an intraoral scan (**Figs. 4**-**6**) was taken in the same session 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.









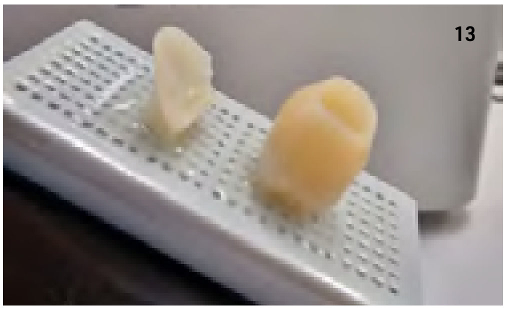


Fig. 5. Detail of HD acquisition (iTero Element 5D Plus®, Align) of the prepared tooth.
Fig. 6. Lateral view of the preparation of tooth #21.
Fig. 7. Modeling of the new veneer in CAD software (Galway®, Exocad): frontal view.
Fig. 8. Detail of modeling in CAD in 2D section.
Fig. 9. Photorealistic rendering 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.

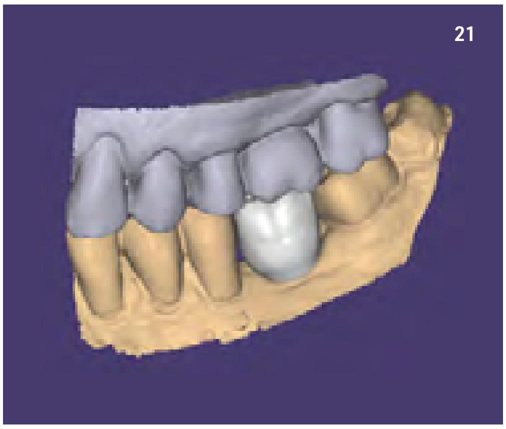
SECOND CLINICAL CASE

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.



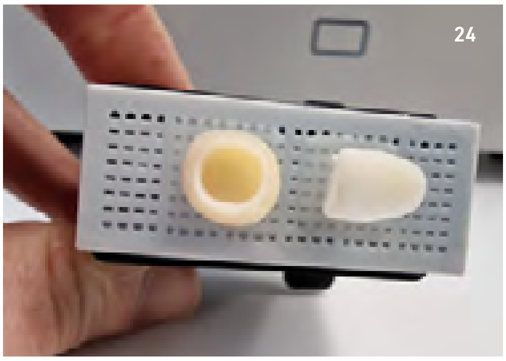


Fig. 20. The arches in occlusion with the scan body in place.
Fig. 21. CAD modeling of the monolithic restoration (Galway®, Exocad).
Fig. 22. Photorealistic rendering of the crown modeling.
Fig. 23. Detail of the occlusal surface of the restoration modeling.
Fig. 24. 3D printing of monolithic restoration 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.

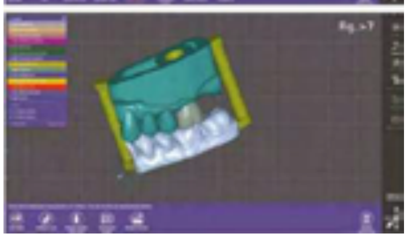
Fig. 2 - Intraoral scanner.

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.

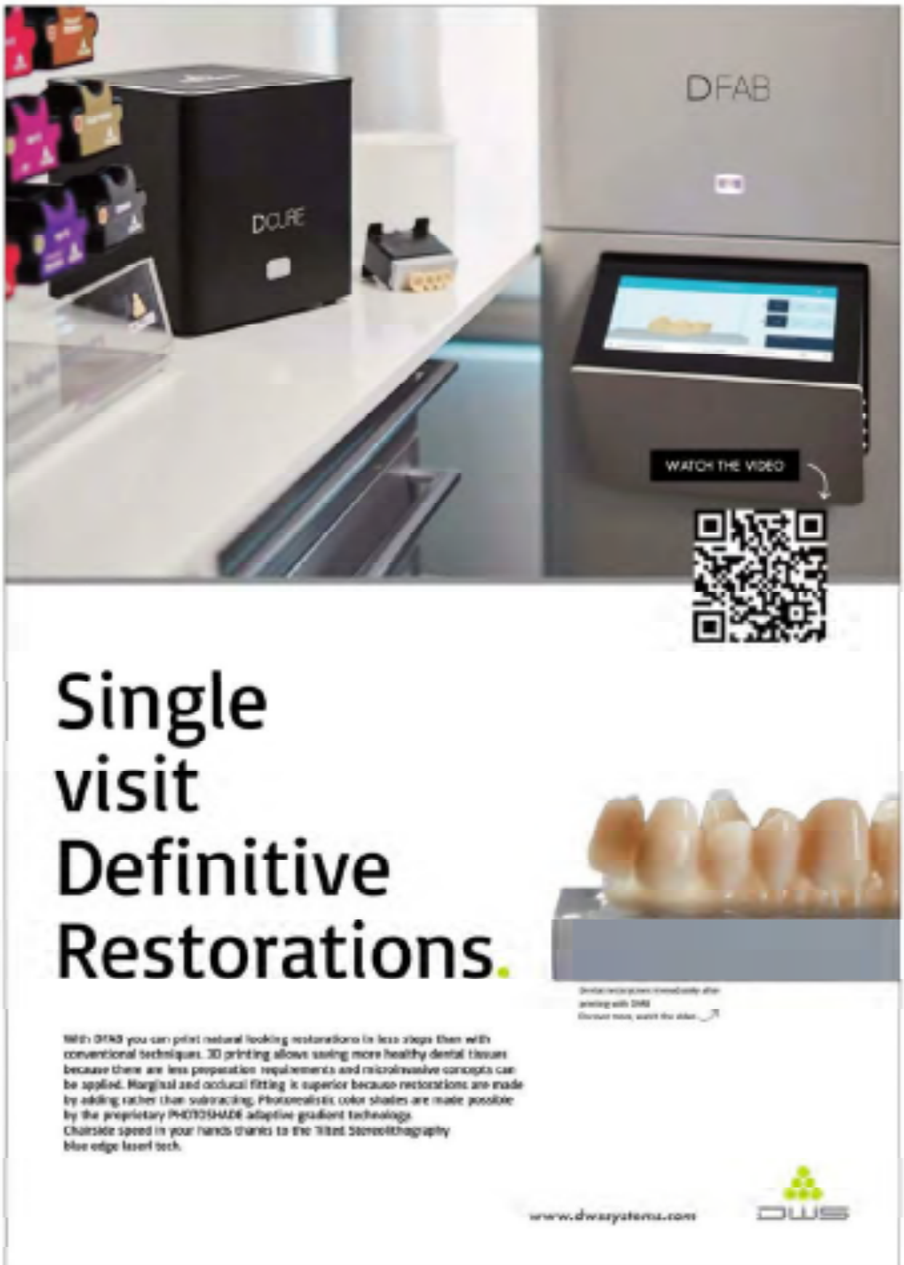
Figs. 6, 7 - Model Builder design with digital analog and screw-retained provisional.



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

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**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

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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),

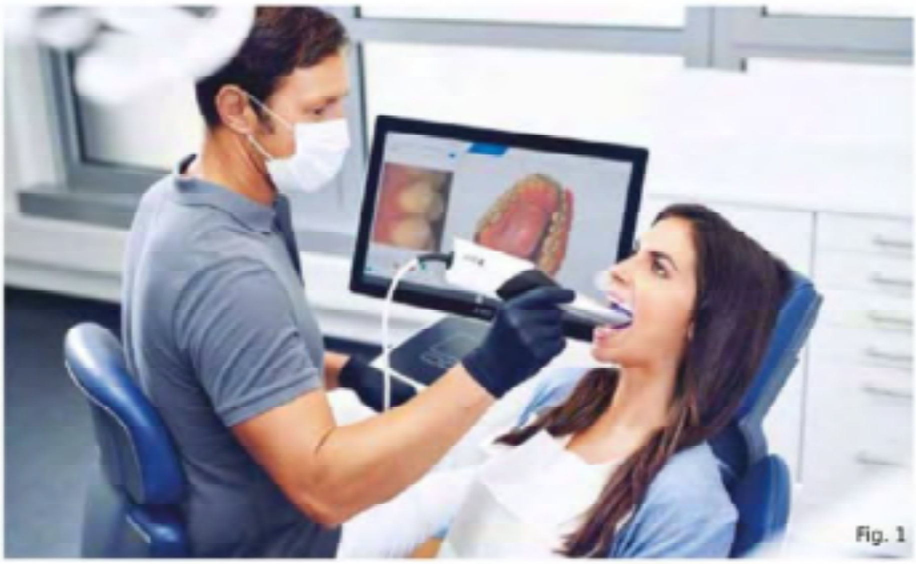


Fig. 1

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.

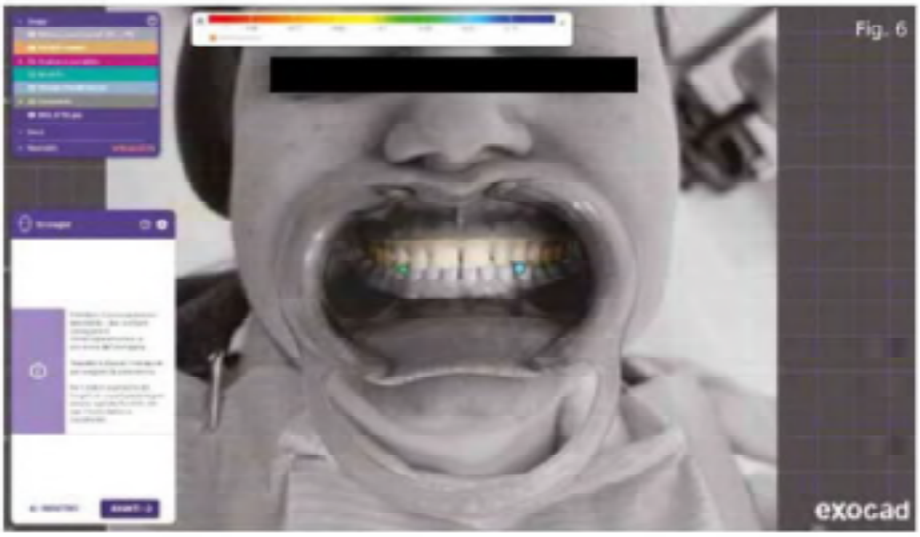
Fig. 4_The patient's face.


Fig. 2


Fig. 3


Fig. 4

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.

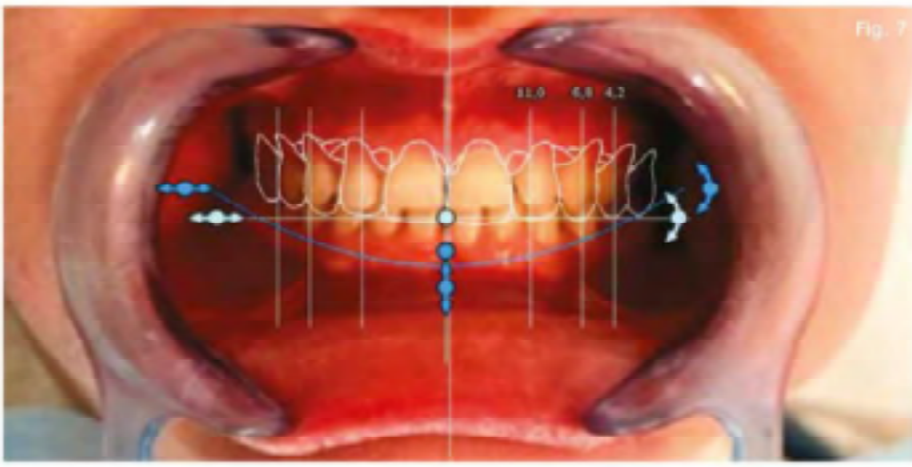


Fig. 5_The .stl file imported in the Exocad software.

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.

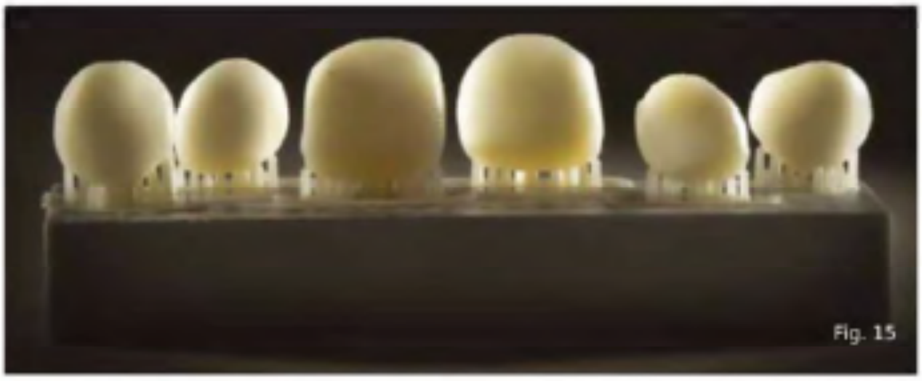


Fig. 15


Fig. 16

_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.

Fig 15_The veneers printed with PHOTOSHADE technology.

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

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

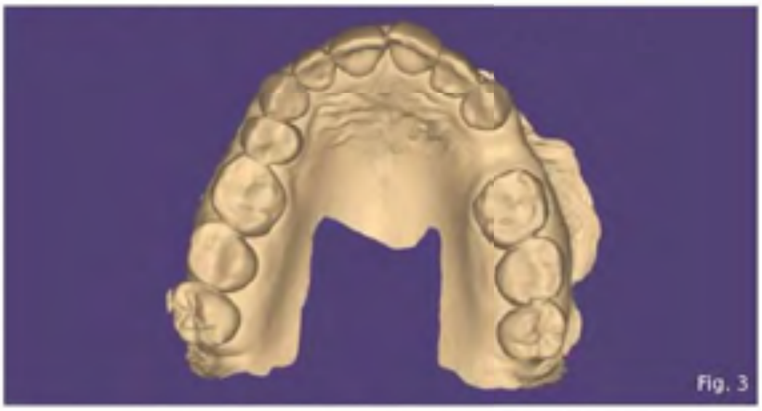
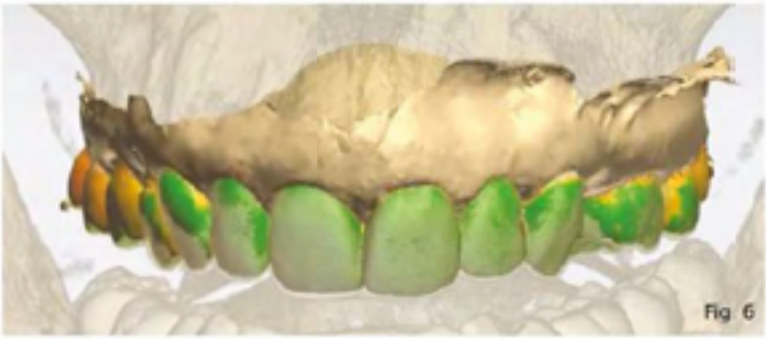
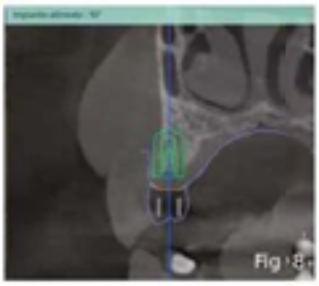


Fig. 3

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).





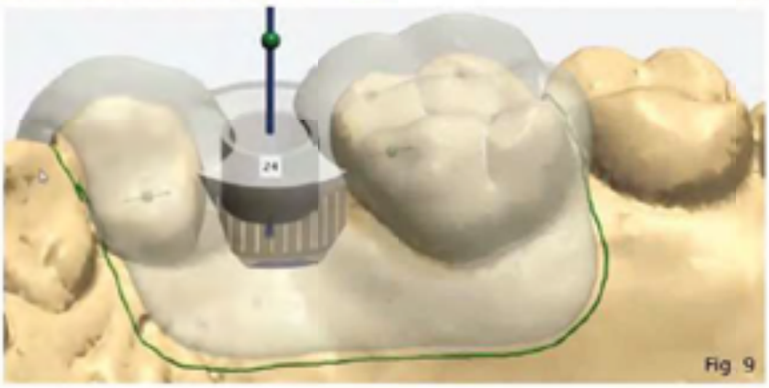


Fig. 4_The edentulous saddle.

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.

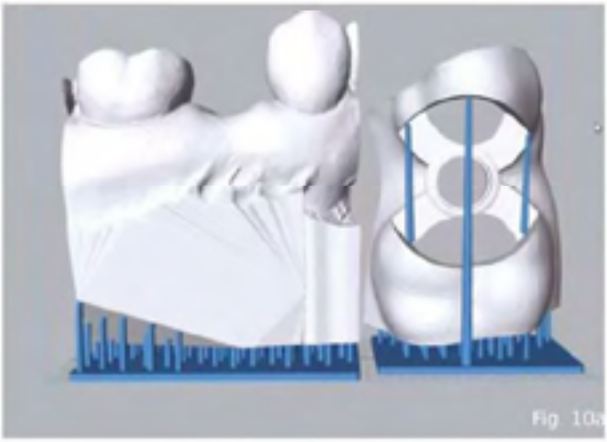


Fig. 10a

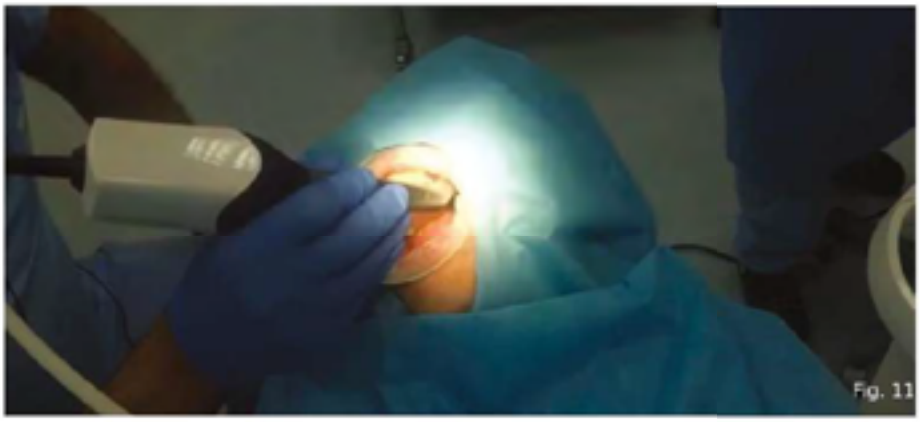

Fig. 10b

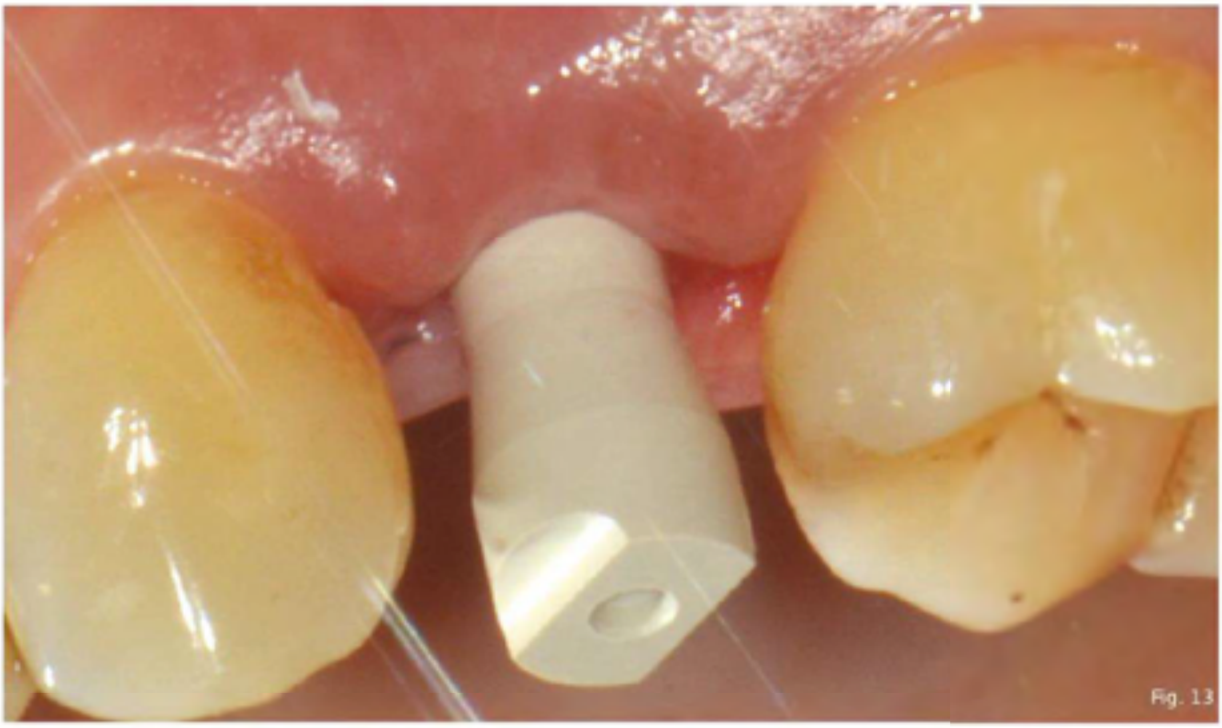
Fig. 10c

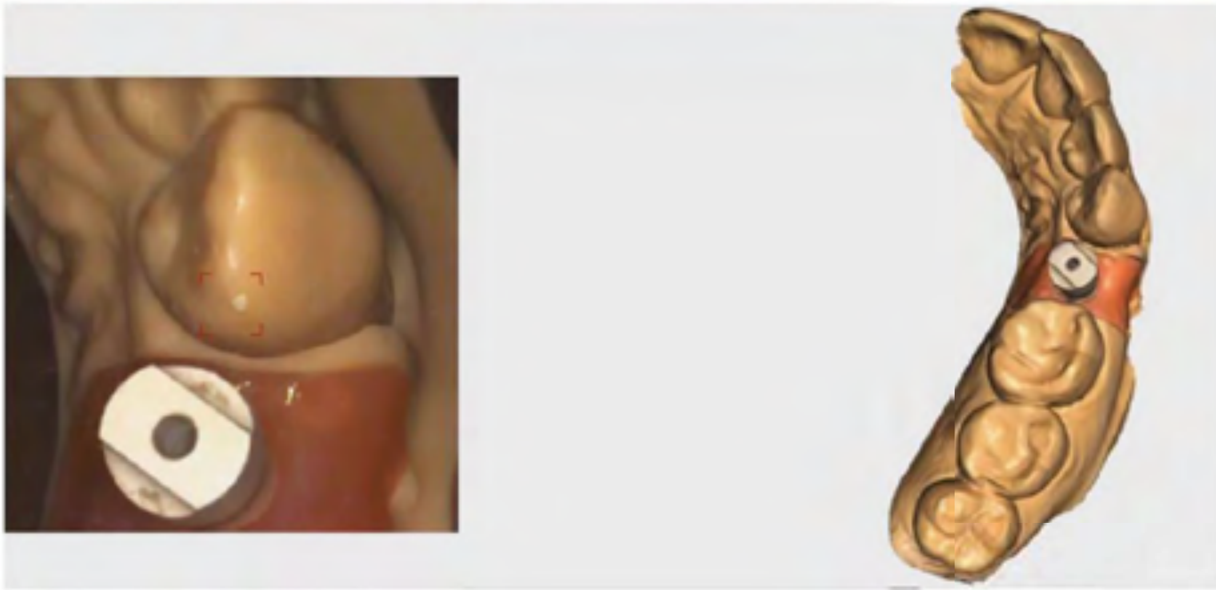

Fig. 10d

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.

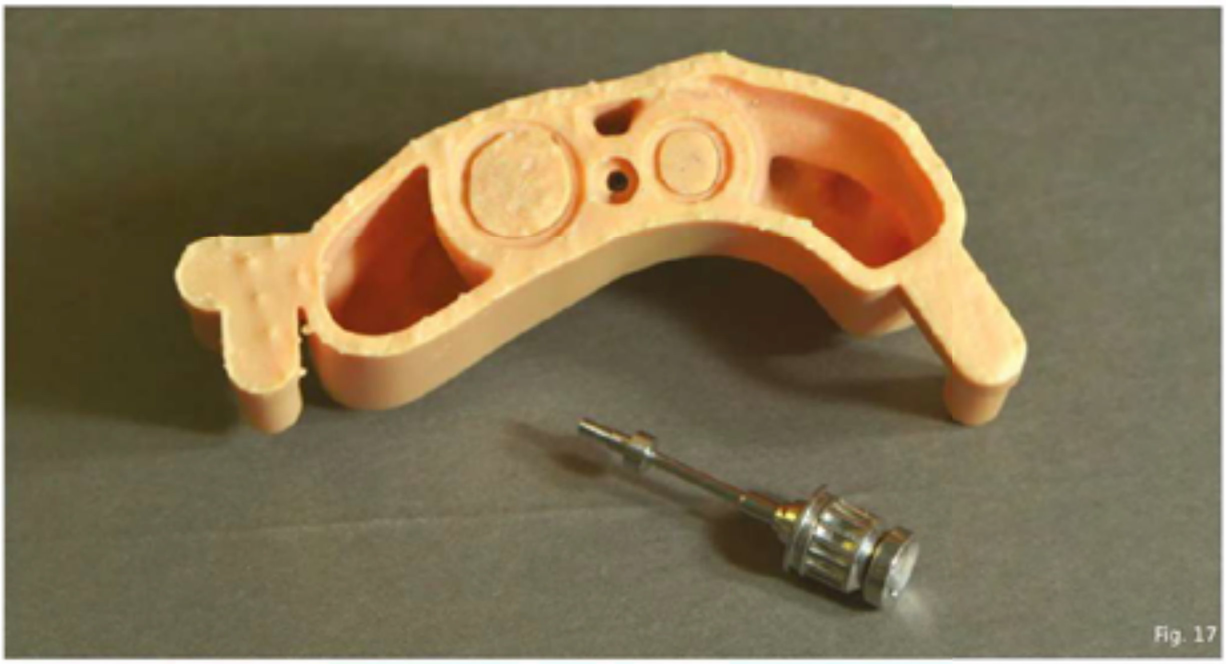


Fig. 17

Fig. 18

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.

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Dr Francesco Mangano

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CHAIRSIDE RESTORATIONS WITH DFAB®

Dr. Francesco Mangano, DDS, PhD, FICD*

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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).

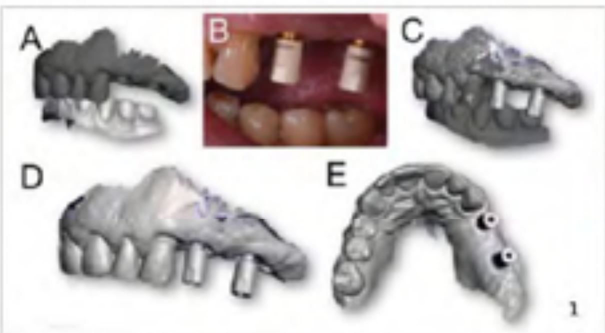

Fig. 1. Clinical case number 1: two implants in the left posterior maxilla. (A) Scan of the master arch after removal of the healing screws, and of the antagonist arch, in occlusion (CS 3800®, Envista, Brea, California, USA); (B) IPD ProCam® scanbodies from AbutmentCompatibili.com (IPD Dental Group, 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

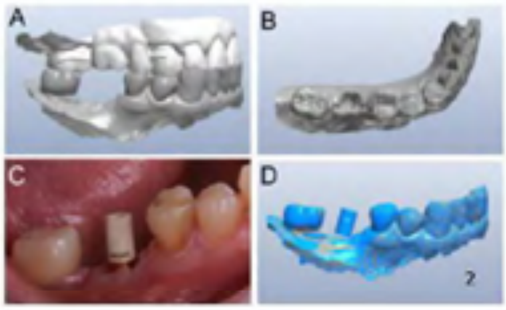

Fig. 2. Clinical case number 2: An implant in the right posterior mandible. (A) Scan of the master arch after removal of the healing screws, and of the antagonist arch, in occlusion (CS 3800®, Envista, Brea, California, USA); (B) the master model in occlusal view; (C) the IPD ProCam® scanbody from AbutmentCompatibles.com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

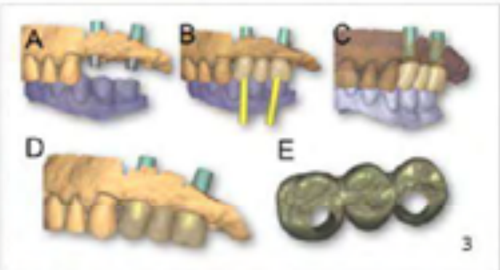

Fig. 3. Clinical case number 1: two implants in the left posterior maxilla. (A) The arches in occlusion with the bonding bases in focus (Galway®, Exocad, Darmstadt, Germany); (B) modeling of the screw-retained superstructure with indication of the screw holes; (C) perspective view of the modeling in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

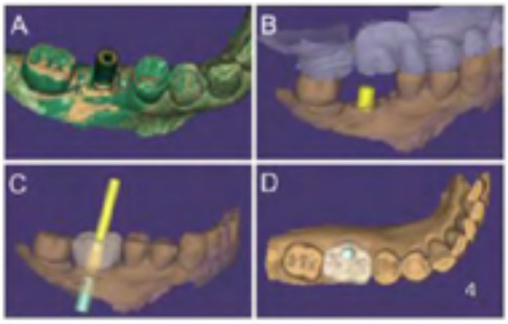

Fig. 4. Clinical case number 2: an implant in the right posterior mandible. (A) Master model with the scanbody in place (Galway®, Exocad, Darmstadt, Germany); (B) The arches in occlusion with the bonding base in focus; (C) Perspective view of the restoration with the screw hole and analog in focus; (D)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

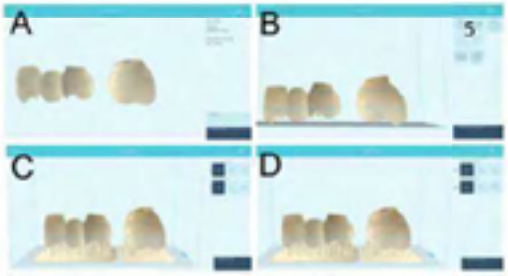

Fig. 5. Color selection in NAUTA PHOTOSHADE® software (DWS Srl, Thiene, Vicenza, Italy). (A) Restorations are loaded within the software; (B) placement of restorations; (C) print base and media are automatically generated; (D) color levels are finely adjusted using NAUTA PHOTOSHADE® software.

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,

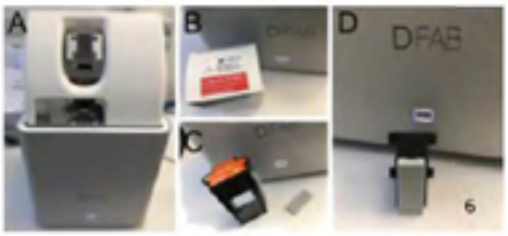

Fig. 6. 3D printing of restorations. (A) The DFAB® printer (DWS Srl, Thiene, Vicenza, Italy); (B) the material chosen for the restorations was highly esthetic Irix® Max (DWS Srl, Thiene, Vicenza, Italy); (C) the cartridge ready to be loaded; (D) platform and print base ready for insertion.

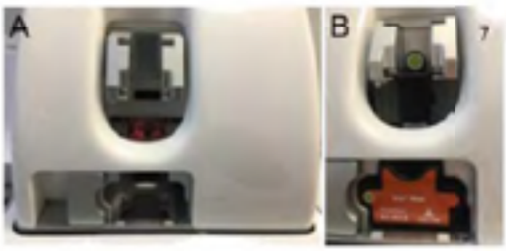

Fig. 7. 3D printing of restorations with DFAB® (DWS Srl, Thiene, Vicenza, Italy). (A) Detail of the guides for inserting the printing platform and cartridge; (B) the printing platform and cartridge inserted.

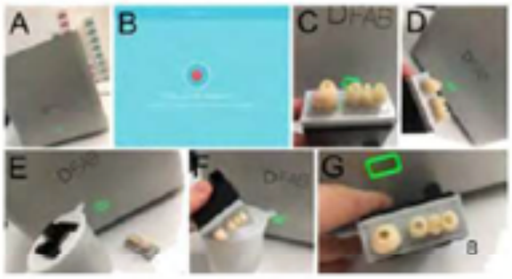

Fig. 8. 3D printing of restorations with DFAB® (DWS Srl, Thiene, Vicenza, Italy). (A) The attractive and compact design of the desktop version of DFAB®; (B) in just 25 minutes, the printing session is completed; (C) the restorations in Irix® Max (DWS Srl, Thiene, Vicenza, Italy) just out of the printer; (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. 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. 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.

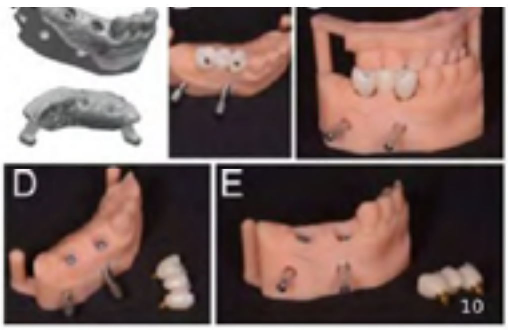

Fig. 10. Clinical case number 1: Check of the bridge fitting on the 3D printed model (XFAB 3500PD®, DWS Srl, Thiene, Vicenza, Italy) before clinical application. (A) CAD design of master and opposing partial models: models used are from AbutmentCompatibili.com (IPD Dental Group, Matarò, Barcelona, Spain), 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.

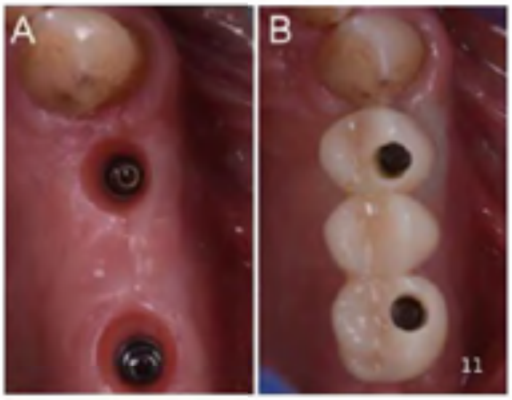

Fig. 11. Clinical case number 1: delivery of restoration in Irix® Max (DWS Srl, Thiene, Vicenza, Italy). (A) Detail of the mucosal collars. Note the excellent health of the peri-implant mucosal tissues, upon removal of the healing screws; (B) Delivery of the definitive bridge: clinical accuracy (defined 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.

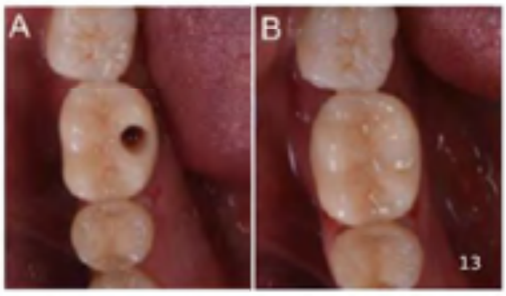

Fig. 13. Clinical case number 2: delivery of the restoration in Irix® Max (DWS Srl, Thiene, Vicenza, Italy). (A) Clinically, the crown fits perfectly, showing high precision, and integrates into the oral cavity both functionally and aesthetically; (B) screw hole closure with Teflon and composite.

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

Dr Francesco Mangano

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THE CLINICAL CASE

#3Dprinting

3D PRINTING WITH DFAB IN A FULL DIGITAL CASE

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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.

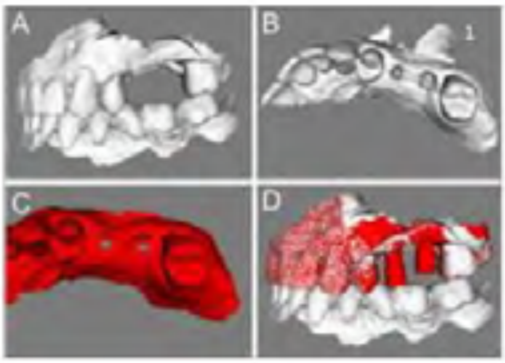

Fig. 1. Intraoral scan. (A) Master and antagonist models in occlusion; (B) view of the open mucosal collars in the master model; (C) the scanbodies in place on the master model; (D) The master and antagonist models with the scanbodies screwed on.

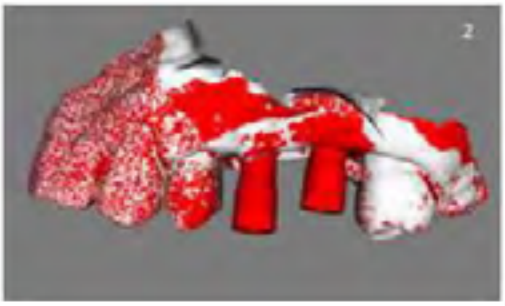

Fig. 2. Detail of the master model with and without the implant scanbodies.

Fig. 3. CAD modeling of the restorations.

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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)**.

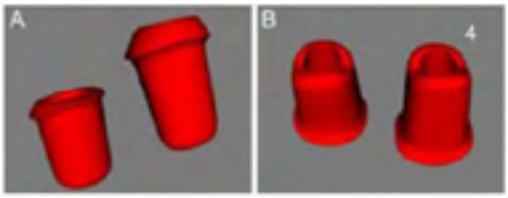

Fig. 4. Details related to the individual abutments. (A) View of the transmucosal part (B) view of the screw holes.

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.

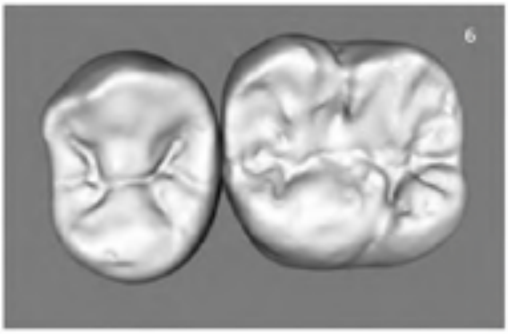

Fig. 6. Detail of the modeling of the occlusal planking of the prosthetic crowns.

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.

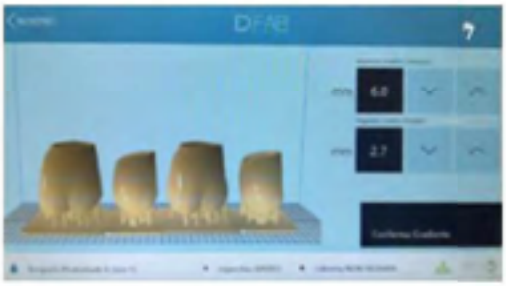

Fig. 7. Screenshot of DFAB® Photoshade software for setting color gradients.

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.

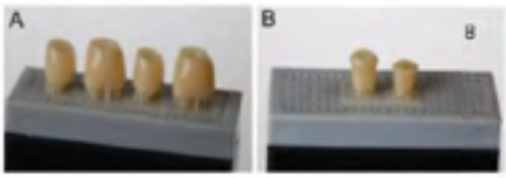

Fig. 8. Printing with DFAB®. (A) Prosthetic crowns (B) individual abutments.

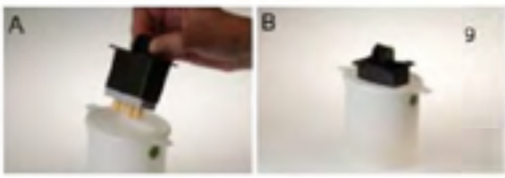

Fig. 9. Washing of restorations in special box with ethyl alcohol. (A) The printing block is inserted inside the box (B) the box is closed and shaken so that resin residues can be washed off the restorations and abutments.

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.

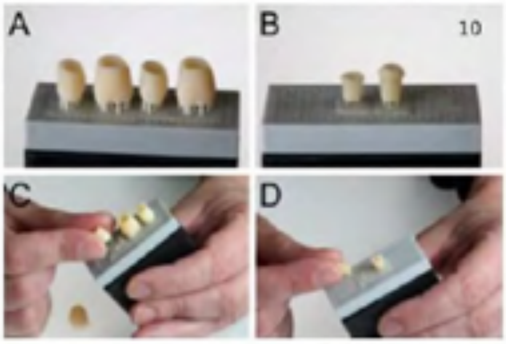

Fig. 10. Removal of the supports. (A) Prosthetic crowns with their supports on the printing platform; (B) individual abutments with their supports on the printing platform; (C) removal of crowns from their supports; (D) removal of individual abutments from the printing platform.

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

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

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*** 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

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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

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

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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

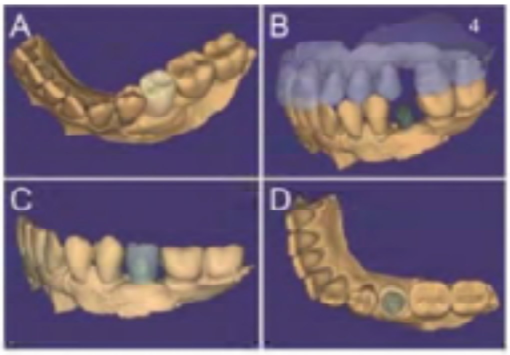

Fig. 4. CAD modeling with exocad™.
(A) Master model with restoration; (B) models in occlusion with custom abutment; (C) the final crown in transparency and the individual abutment, side view; (D) the definitive crown in transparency and the custom abutment, occlusal view.

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;

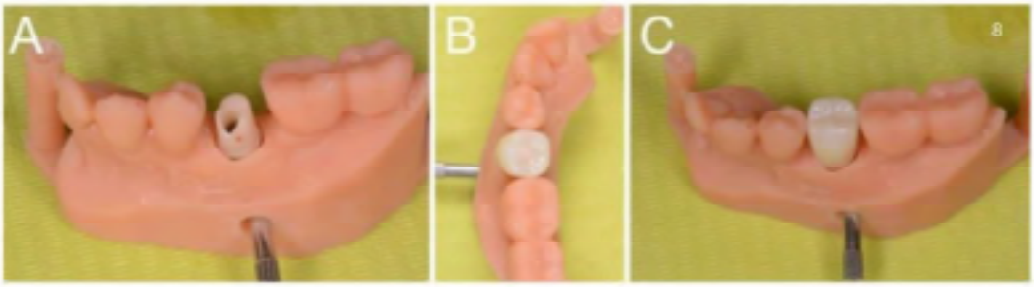

Fig. 8. The restoration on the type IPD Pro Cam model. (A) The 3D model, made with a SLA printer (XFAB 3500PD®) with the custom zirconia abutment in place; (B) occlusal view of the prosthetic restoration in Irix Max® resting on the custom abutment; (C) lateral view of the restoration.

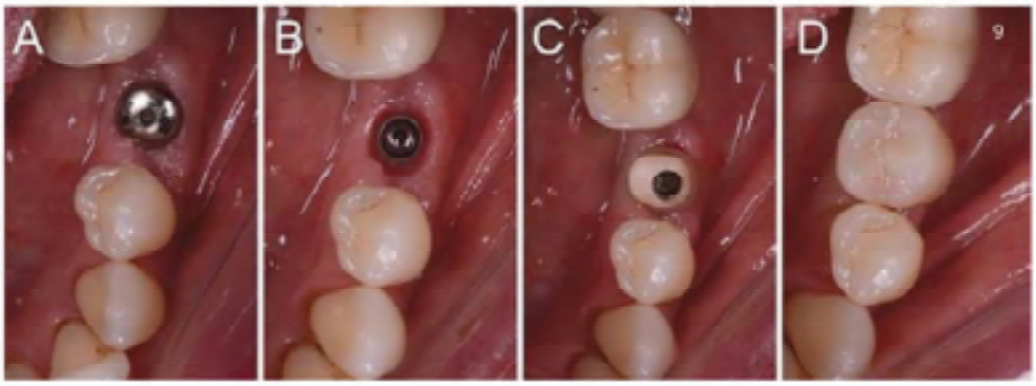

Fig. 9. Delivery of the prosthetic restoration. (A) Occlusal view with healing abutment in place; (B) mucosal collar; (C) custom zirconia abutment screwed in place; (D) the cemented prosthetic restoration.

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.

BIBLIOGRAPHY

1. Mangano FG, Admakin O, Bonacina M, Lerner H, Rutkunas V, Mangano C. Trueness of 12 intraoral scanners in the full-arch implant impression: a comparative in vitro study. BMC Oral Health. 2020 Sep 22; 20 (1): 263. doi: 10.1186/s12903-020-01254-9.

2. Nedelcu R, Olsson P, Nyström I, Thor A. Finish line distinctness and accuracy in 7 intraoral scanners versus conventional impression: an in vitro descriptive comparison. BMC Oral Health. 2018 Feb 23; 18 (1): 27. doi: 10.1186/s12903-018-0489-3.

3. Metzger Z, Colson DG, Bown P, Weihard T, Baresel I, Nolting T. Reflected near-infrared light versus bite-wing radiography for the detection of proximal caries: A multicenter prospective clinical study conducted in private practices. J Dent. 2022 Jan; 116: 103861. doi: 10.1016/j.jdent.2021.103861. Epub 2021 Oct 24.

THE CLINICAL CASE

#MAKE!

3D PRINTERS

Operative protocols in Dentistry and Dental Technology

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1. *Dentist in private practice in Verona, author of several publications in national and international journals on implant prosthodontics, three-dimensional radiological diagnostics and direct esthetic restorations with CAD/CAM methods. Speaker at many conferences and congresses in Italy and abroad.*
2. *As an independent dentist in Mantua, he has been involved in scientific work for many years and has actively participated as a speaker and organizer in many courses in Italy and abroad on the subject of esthetic prosthetics and implantology. He gives courses to dentists on the correct and effective use of CAD/CAM techniques on natural teeth and implants.*
3. *Dental technician, specialized in aesthetics and digital methods.*

Digital methods in dentistry and dental technology are the basis for the most important innovations in clinical and laboratory protocols. Scanning of plaster casts is a fundamental daily practice for prosthetic design with today's increasingly advanced and powerful software. Intraoral scanning, now a consolidated method, paves the way for fully digital protocols in all specialties. Digital Orthodontics, Prosthetic Planning, Surgical Planning, Restorative. The dental office and the dental laboratory are and will be increasingly connected, integrated and, thanks to modern software, will have more and more useful tools for diagnosis, clinical decision making and qualitative production methods. Until recently, subtractive methods (milling) were the basis of production tools. Milling machines of all types are capable of providing restorations in all materials. Metal, zirconia, glass-ceramics and ceramic-based composites are the main materials that can be used with these milling machines. The manufacturing process by milling guarantees a standardized quality process, which ensures high mechanical and technological properties of the produced restoration. The limitations of subtractive methods (milling machines), such as the dependence on the definition of the insertion axes and the milling itself, as well as lengthy and complex post-processing, have recently led to the introduction of additive methods (3D printing), which overcome these limitations by not being constrained by the use of tools (milling cutters) in the production phase. Today, 3D printers represent an advanced technology, useful for the dental technician and the clinician, to amplify even morphologically complex production processes, without geometric limits, guaranteeing the achievement of high precision without long and complex adjustments. Stereolithographic 3D printers (SLA) are today the reference in terms of precision, generating smooth surfaces with very high resolution, extremely accurate even in complex morphologies, obtained through a point-to-point polymerization process. In addition, this feature allows color definition that is not limited to pre-determined layers and the realization of complex restorations even with planned color gradients (Photoshade™ technology). Below is a proposed clinical protocol where additive methods (3D printing SLA) combined with software design represented a simplification of a complex esthetic rehabilitation.

CLINICAL CASE

The 45-year-old patient presented to us with the results of improper anterior and posterior reconstructions on enamel affected by amelogenesis imperfecta. We performed an objective assessment and the following instrumental examinations:

- Intraoral scan with Dentsply Sirona Primescan® scanner (Fig. 1)
- CBCT Orthophos SL 3D.

Following the intraoral scan, a preliminary morphologic evaluation of the achievable results was performed using smile design software (Figs. 2,3), which was then incorporated into the prosthetic reconstruction modeling software (Fig. 4). After this simulation, a treatment plan was selected that included the use of aligners to reconfigure the arch morphology, followed by conservative preparation of the teeth guided by the mock-up printed in the mouth. 3D printing with the XFAB 2500® from DWS (Fig. 5) provided a useful interface where the intraoral impression with the diagnostic wax-up provided an integrated mock-up in a short time (Fig. 6). In this way, in a single session and with only a few steps to produce the digital mock-up, we were able to propose the prototype model printed in DWS Precisa RD097® resin and DWS Temporis® resin for restorations on the patient's teeth (Fig. 7).

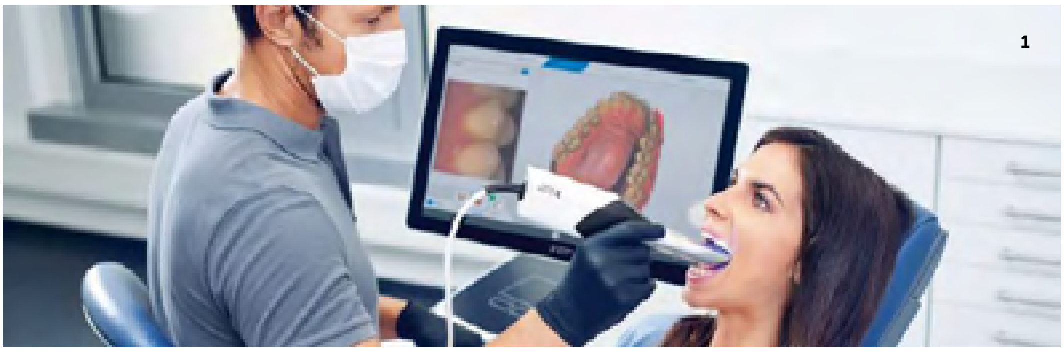

Fig.1. Intraoral scan with Dentsply Sirona's Primescan® scanner.

Fig. 2. Photographs of the initial situation. Using smile design prosthetic planning software, a preliminary morphological assessment of the achievable results was made.

Fig. 5. DWS's powerful 3D printers, the XFAB 2500 PD® and XFAB 3500 PD®, respectively.

Fig. 3. Detail of preliminary morphological assessment with smile design software.

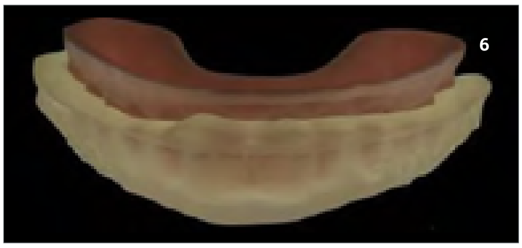

Fig. 6. 3D printing of the model and printed silicone mock-up.

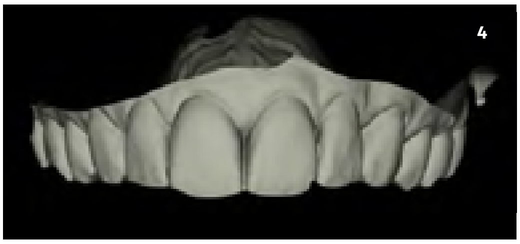

Fig. 4. The data from the preliminary assessment were imported into prosthetic modeling software.

Fig. 7. The printing of the prosthetic project in the mouth.

This step allows the vertical dimension to be assessed and gives the patient a preview of the proposed morphology. Aditionally, the printed model becomes a guide for conservative tooth preparation (Fig. 8) by helping to minimize the removal of enamel or dentin.

Finally, the intraoral impression with printed preparations (Fig. 9) provides the technician with a useful tool for fabricating the final restorations (Fig. 10) and finishing them esthetically (Figs. 11, 12).

Fig. 8. The intraoral use of mock-up.

Fig. 10. The adjusted restorations on the prototyped models.

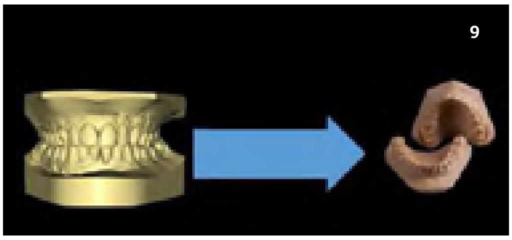

Fig. 9. Intraoral impression with printed preparations.

Fig. 11. The completed restorations.

Fig. 12. he final aesthetic result is fully satisfactory.