issn 1616-7390 • Vol. 11 • Issue 1/2020

1/20

CAD/CAM

international magazine of dental laboratories

interview
Advantages of a digital workflow

industry report
New paradigm in aesthetic restoration

education
CAD/CAM can be an incredible teaching tool

dti] Dental Tribune International

Magda Wojtkiewicz

Managing Editor

Dear readers,

I have the great pleasure of introducing our new CAD/CAM *international magazine of dental laboratories*, which aims to be one of the primary sources of information for dental laboratory owners and dental technicians. This is the first publication in Dental Tribune International's portfolio focused mostly on dental technicians and their needs.

In the era of rapid changes and transition from a conventional to a digital workflow in dental offices and laboratories, it is crucial to stay updated with the latest technologies. Nowadays, dental technicians need to be more involved in what dentists are doing. Whether managing an in-house laboratory working intimately with the dentist and patient or owning a larger laboratory organisation and consulting over the phone or in person, the dental technician's role is now, more than ever, that of an integral partner with the dentist to achieve the best results for the patient.

As the role of the dental technician continues to change, so too does the need to acquire specific knowledge and skills. Dental technicians need to broaden their knowledge. Owing to omnipresent digital technology, many technicians are involved in treatment planning and procedures such as guided surgery, implantology and full-mouth rehabilitation. Digital technology has helped to break down the separation of dental offices and dental laboratories by involving technicians in all aspects of the dental treatment workflow.

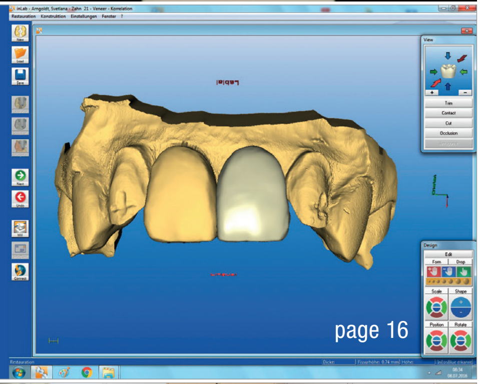
This rapid change in the dental field will continue and will have an increasing impact on the industry and its structure. Soon, CAD/CAM will be supporting every single department within the laboratory and digital technology will create even more collaboration with dentists.

Inside this issue of CAD/CAM, you will find articles about advantages of the digital workflow, computer-aided treatment planning, matching the CBCT scan and virtual wax-up, the latest CAD/CAM software developments and much more. I hope you will find our magazine informative and that it will encourage you to continue to learn about and embrace the digital reality.

Sincerely,

Magda Wojtkiewicz
Managing Editor


page 08


page 16


page 58

Cover image courtesy of sunlight19/Shutterstock.com

Advantages of a digital workflow

An interview with Germen Versteeg, DTL Mediaan founder. By Brendan Day, DTI

Germen Versteeg

Germen Versteeg is the founder of DTL Mediaan, a dental laboratory in Heerhugowaard in the Netherlands. In this interview, he talks about the advantages of having adopted a digital workflow in his laboratory and the advice he has for other laboratories that are planning to do the same.

Mr Versteeg, could you tell us a little bit about yourself.
I'm a denturist and the owner of DTL Mediaan. We work with a team of eight dental technicians, and as a completely digital dental lab, we provide all kinds of services—implant cases, dental crowns and bridges, dentures, orthodontic solutions, and more.

Do you find that a digital workflow saves time compared with an analogue workflow?
Yes, it can take a lot of time to produce something with an analogue workflow. For example, it would take up to one whole working day to produce a set of dentures from beginning to end. Since going digital, we have saved a lot of time and can now make a set of dentures in 2 to 2.5 hours.

We can achieve a really high standard of quality because of the accuracy of 3Shape's scanners. At every step of the workflow, we can refer to the design or the manufacturing process, and we can reproduce or conduct a correction for any case.

What percentage of your cases use intra-oral scans?
About 30 to 40 per cent of our cases involve intra-oral scans, which is also a big benefit of working digitally.

What has your experience using the 3Shape Dental System been like?
Our experience with the 3Shape Dental System has been really great. There are a lot of automated and guided workflows in the software, but you also have the possibility of being creative in your approach. For example, we can use a 2D or 3D image in the software for the design in such a way that we are able to copy the patient's dentition and transfer it to the dentures.

When you become familiar with the system and get to know the ideas behind it, you will be amazed at what you can do with this powerful software.

Has going digital led to an increase in productivity for DTL Mediaan?
Yes, we really are more productive. Our labour costs were around 50 per cent of our total costs when we were an analogue-focused lab. Now, thanks to the 3Shape Dental System, our labour costs have dropped down to 20 per cent of our total costs.

What advice do you have for dental labs planning to go digital?
My advice for dental labs that want to begin working according to a digital workflow is that they should go fully digital and start implementing it immediately.

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straumann

New paradigm in aesthetic restoration

Francesco Ferretti & Dr Marco Nicastro, Italy


Fig. 1


Fig. 2

This article presents a case of aesthetic restoration of anterior teeth using KATANA Zirconia Ultra Translucent Multi Layered (UTML; Kuraray Noritake Dental) complete anatomical crowns, with vestibular stratification, and the biologically oriented preparation technique (BOPT).

The patient requested a solution for an aesthetic problem due to the unnatural look of her old restorations and black triangles from a past history of periodontitis. The resulting retraction of the tissue had left the margins of the prostheses clearly visible, and the loss of the papilla peaks, together with the numerous black spaces between the crowns, required a complex therapeutic approach (Fig. 1).

The treatment plan for the periodontal problems consisted of a non-surgical approach, with scaling and root planing, and the replacement of the old fixed prostheses to recondition the marginal tissue and facilitate the restoration of a new, aesthetically pleasing gingival architecture (Fig. 2).

From a functional point of view, we decided to reduce the deep frontal bite to restore a correct overjet–overbite ratio. This reduction was also important from an aesthetic point of view, as it allowed us to shape the teeth correctly (Fig. 3).

We usually remove old prostheses before beginning a periodontal treatment and make a provisional restoration to create an environment in which the soft tissue can heal. If we have to work beyond the cementoenamel junction, we prefer a vertical preparation for abutments, and the purpose of the provisional restoration


Fig. 3


Fig. 4


Fig. 5


Fig. 6


Fig. 7

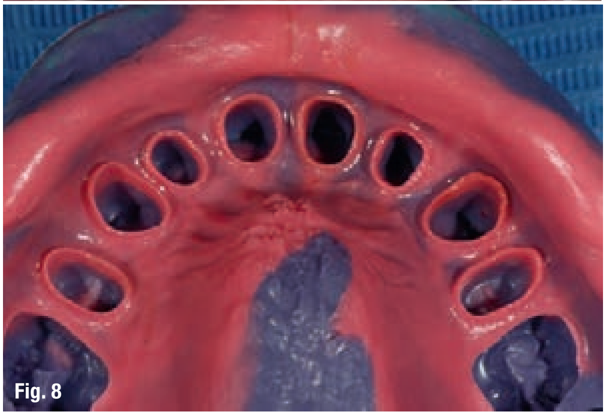


Fig. 8

is to condition the marginal tissue using the BOPT by Dr Ignazio Loi (Fig. 4).

For the BOPT, the vertical preparation of the abutment has a finishing line that extends into the gingival sulcus. The temporary conditioning of the tissue induced by the provisional prosthesis allows us to modify the level of the gingival parabolas to a certain extent (Fig. 5).

Healing of the tissue one month after the initial periodontal treatment was significant (Fig. 6). The role of the provisional restoration, appropriately realigned, is crucial for obtaining healthy soft tissue around future restorations. The conditioning of the tissue was achieved by means of the provisional restoration, which modified the level and shape of the marginal tissue. Once filled with correctly fitted crowns, the interproximal spaces would be further reduced after the definitive restoration.

The correct management of the provisional restoration is crucial for the healing of the tissue. The placement of a provisional restoration before the periodontal therapy allowed us to create the right environment for complete healing. At the same time, the vertical preparation allowed us to gradually condition the marginal gingival tissue by shortening or lengthening the provisional restoration as necessary (Fig. 7).

One of the advantages of a vertical preparation is that taking the final impression is easy, because the absence of a horizontal finishing line greatly simplifies the procedure (Fig. 8). However, the BOPT also requires the taking of an

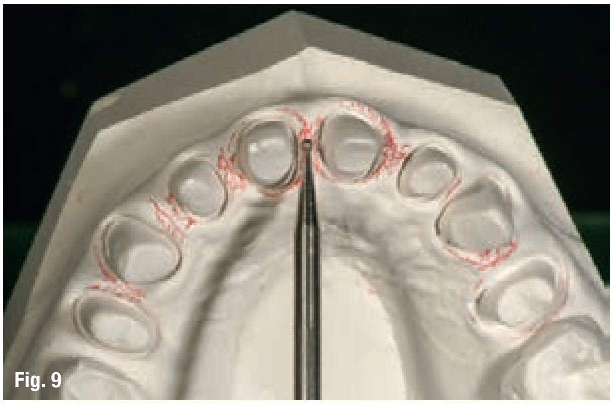


Fig. 9


Fig. 10

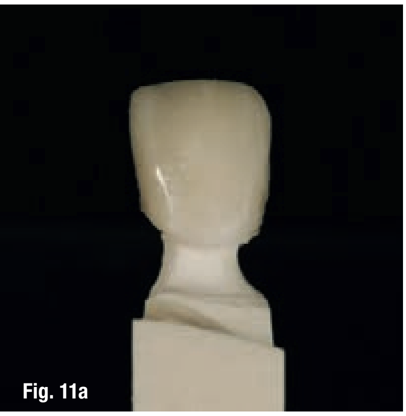


Fig. 11a


Fig. 11b

Fig. 12

impression of the subgingival portion of the preparation. The dental technician will have to decide on the marginal shape of restorations according to the position of the gingival marginal in consultation with the clinician and based on the tests conducted with the provisional restoration.

After the casting of the model, we prepared the gingival area to accommodate an ideal configuration of the gingival parabolas (Fig. 9).

After making a wax model, we assessed whether the height of the gingival zenith could be further corrected. Figure 10 shows that the gingival level of tooth #21 was not yet ideal, so we stretched it distally.

Once the wax model was complete, we extracted the tooth from the model and evaluated its protrusion. It was only after joining the gingival protrusion to the arbitrary margin of the preparation that we proceeded to a scan and milled the crowns (Fig. 11).

The restoration was carried out with KATANA Zirconia UTML based on the new formulation of cubic zirconium oxide. This ultra-translucent material was chosen because we were working with light and non-discoloured abutments (Fig. 12).

We finished the crowns on a positional impression to help to improve the gingival adaptation; we had some dispersion of the tissue in the first precision impression due to the use of retractors. We finished the crowns with CERABIEN ZR FC Paste Stain colours and glaze (Kuraray Noritake Dental; Fig. 13).

The surface colours and the slight contrast created are highlighted in this black and white image taken with a blue filter (Fig. 14).

In Figure 15, we can see the natural translucent effect of KATANA Zirconia UTML and the invisible fusion between the abutments and crowns.


Fig. 13


Fig. 14


Fig. 15


Fig. 16


Fig. 17


Fig. 18

Figure 16 shows the clinical situation one year after cementation, performed with PANAVIA V5 (Kuraray Noritake Dental): the marginal tissue was in a good clinical condition, with no signs of inflammation or bleeding. The BOPT allowed us to optimise the level of the gingiva without resorting to periodontal surgery, while the shape of the new crowns made it possible to close all the interproximal spaces for an optimally aesthetic result.

The brightness of the restorations (thanks to the use of a particularly translucent zirconia) combined with the shape of the incisors, greatly improved the aesthetics of the restoration, even though the initial situation appeared to be particularly unfavourable (Fig. 17).

Compared with the previous prostheses, the incisal reduction allowed not only for the optimisation of the functional phase by reducing the overbite, but also made it possible to achieve more natural aesthetics, the contour of the incisal margins following that of the lower lip.

Figure 18 demonstrates the excellent aesthetic properties of KATANA Zirconia UTML and the perfect integration of the prostheses in harmony with the pink tissue.

about

Francesco Ferretti received his dental technician degree from L'istituto E. De Amicis in Rome in Italy. In 1992, he began working with Prof. Mario Martignoni and a year later with the Oral Design centre founded in Rome by master ceramist Willi Geller and became a partner. In 1999, he returned to working on his own and enrolled at the University of Rome Tor Vergata. In 2001, he founded Estech Dental Studios, in cooperation with Pentron for technical training and consulting. He taught prosthetics at the Gabriele d'Annunzio University of Chieti–Pescara from 2002 to 2005, has taught the perfection of prostheses at the University of Naples Federico II since 2006 and is a consultant to the San Raffaele hospital in Milan, all three in Italy. He is interested in metal-free prosthetics, has published articles in Italian and American journals and has participated as a speaker at numerous conferences in Italy. He is a member of the European Society of Cosmetic Dentistry, Associazione Nazionale Titolari di Laboratorio Odontotecnico [Italian national association of dental laboratory owners] and Gruppo Italiano per la Ricerca Applicata in Scienze Biomediche [Italian group for applied research in the biomedical sciences].

Dr Marco Nicastro obtained his degree in dentistry and dental prosthetics from the Sapienza University of Rome in 1989. Since the beginning, he has been interested in prosthetic restorative dentistry and treating aesthetic problems. From 1990 to 1996, he attended Prof. Martignoni's studio, where he developed his prosthetic knowledge. From 1993 to 1998, he cooperated as a lecturer with the Oral Design centre in Rome, giving lectures and courses on aesthetic restoration either in Italy or in other countries. In the same period, he expanded his experience in aesthetics, attending training courses at the University of Geneva in Switzerland. Since 1993, he has been cooperating with Ferretti in the organisation of courses and conferences, paying particular attention to metal-free methodology. He practises prosthetic and aesthetic restorative dentistry in Rome. He has published his work in Italy and other countries and given national and international lectures on aesthetic restorations. He is one of the founders and an active member of the Gymnasium Interdisciplinare CAD/CAM, a certified member and vice president of the European Society of Cosmetic Dentistry, an active member of the Società Italiana di Odontoiatria Conservatrice [Italian society of conservative dentistry] and a partner of the Italian Academy of Prosthetic Dentistry.

Mill, polish, seat! Indirect procedures in the dental workflow

Dr Johannes Beiter, Germany

In addition to the primary wishes of the patient regarding prosthetic treatment, namely safety, comfort and aesthetics, are the need for an efficient treatment process, high cost-effectiveness and a minimal number of therapy sessions. Owing to the possibilities offered by CAD/CAM, these desires can in many cases be fulfilled. While a dental technician is indispensable for complex and aesthetically demanding restorations (e.g. in the anterior region), single-tooth restorations (e.g. inlays, partial crowns and complete crowns) can in many situations be realised within the dental practice. For the patient, this has the great advantage, among others, that only one therapy session is needed. Various materials are suitable for such an indication. Mainly, these are materials from the large family of glass-ceramics, which in combination with the adhesive technique optimally fulfil the requirements for conservation of dental hard tissue, biocompatibility, stability and aesthetics.

Overview of dental ceramics in everyday clinical practice

The diversity of materials in everyday prosthetic practice is constantly increasing, especially regarding dental

Fig. 1: Different n!ce milling blanks.

ceramics. For the practitioner, it is important to maintain an overview in order to select the optimal material for the indication. Dental ceramics can be broadly divided into ceramics with a glass phase (e.g. silicate ceramics and glass-infiltrated ceramics) and ceramics without a glass phase, the oxide ceramics (e.g. zirconium dioxide). Differences exist in, among other things, the materials' photo-optical properties and characteristics (e.g. flexural strength and fracture toughness). To perform single-tooth restorations chairside, a high-strength glass-ceramic is often used, such as lithium disilicate ceramic or lithium silicate ceramic. To obtain the final strength level of 360–400 MPa, these ceramics are crystallised after milling. There are also pre-crystallised blanks available that only need to be polished. However, in this case, the strength is greatly reduced. For several months, the family of CAD/CAM glass-ceramics has been augmented with a further class of materials: lithium aluminosilicate ceramics (n!ce, Straumann).

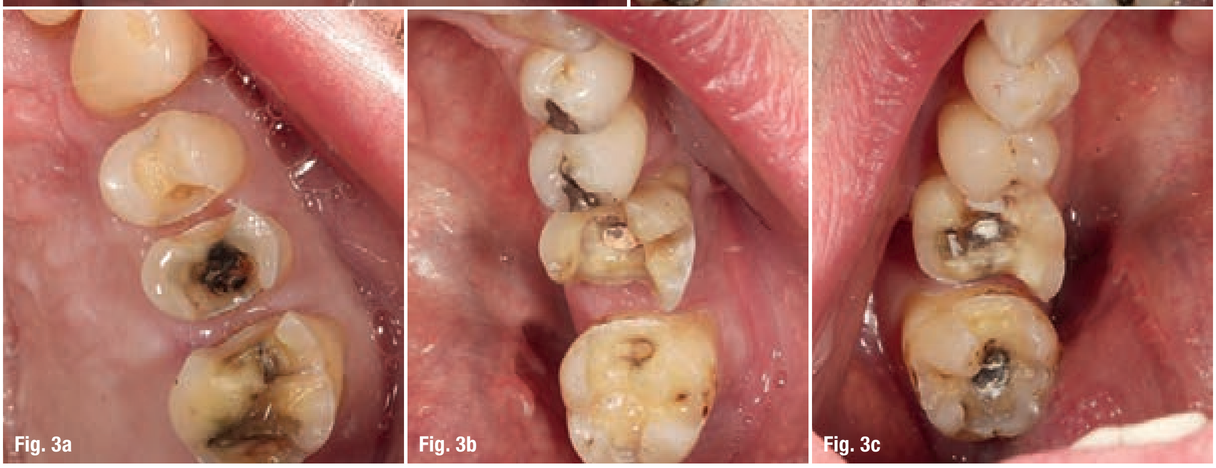
Pre-crystallised and high strength

In terms of materials science, the n!ce fully crystallised glass-ceramic is a lithium disilicate reinforced with lithium aluminosilicate. Its flexural strength is 350 MPa (± 50). Its great advantage is its easy and efficient processing. The range contains blanks in two translucency levels: HT (high translucency) and LT (low translucency). Both translucency levels are available in different shades (Bleach, A1, A2, A3, B2 and B4 of the VITA classical shade guides) and cover a large number of restorative indications in everyday clinical practice. The fully crystallised milling blocks were developed specially to fabricate complete crowns, partial crowns, inlays, onlays and veneers. The blanks are compatible with different block holders for different milling machines (Fig. 1). The glass-ceramic blocks can therefore be processed with conventional milling machines and require no investments in additional hardware or software. The material can be milled, polished and seated without crystallisation firing. This saves time and effort in daily practice. Individual characterisation is possible if required.

Case report

Initial situation

The patient wished to have the large-surface amalgam fillings in the upper and lower jaw (Figs. 2a & b) removed



Figs. 2a & b: The patient desired replacement of the large-surface amalgam fillings in the upper **(a)** and lower jaw **(b)** with full-ceramic restorations. **Figs. 3a–c:** The prepared teeth are readied for intra-oral digitalisation (intra-oral scanning).

Fig. 4a

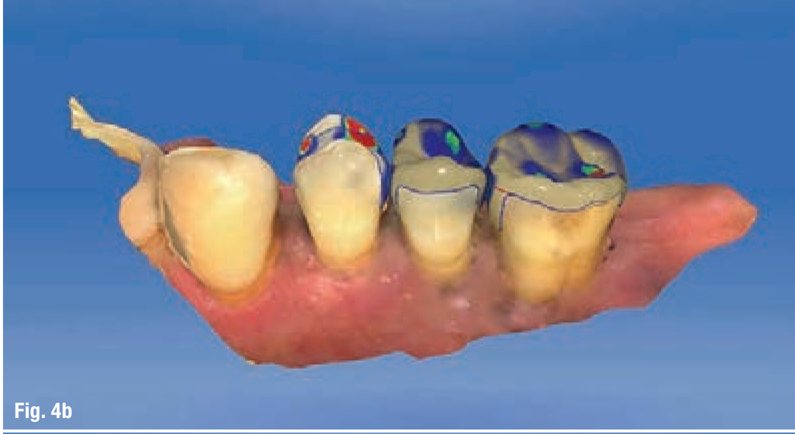


Fig. 4b

Fig. 5a

Fig. 5b

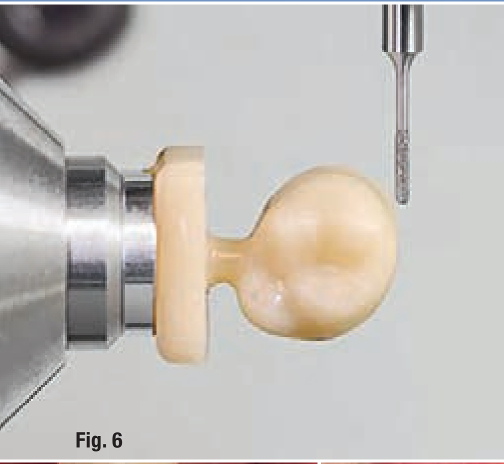


Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10a

Fig. 10b

Figs. 4a & b: Illustrative image of the CAD construction in the posterior segment of the maxilla. **Figs. 5a & b:** CAD construction in the mandible. **Fig. 6:** Milling of a n!ce restoration. **Fig. 7:** Polishing of a n!ce restoration. **Fig. 8:** The teeth are conditioned for adhesive bonding of the glass-ceramic restorations. **Fig. 9:** Restorations inserted in the mandible. **Figs. 10a & b:** Occlusal view after the treatment: glass-ceramic crowns **(a)**, composite fillings and a bridge of lithium disilicate **(b)**.

and replaced with full-ceramic restorations created with the least possible effort. These were single-tooth restorations (partial crowns). In the maxillary posterior region, a bridge restoration was indicated, which was produced from lithium disilicate ceramic. All other indirect single-tooth restorations were to be fabricated from n!ce. The material is biocompatible and relatively strong without additional crystallisation firing, while featuring natural photo-optical properties.

Preparation

The aim was a new minimally invasive treatment performed within the dental practice. No functional disorders were present and no periodontal abnormalities were identified either. A vitality test was performed on all of the teeth and a positive result was found up to tooth #46. This tooth had undergone root canal therapy.

After anaesthesia and fitting of the rubber dam, the amalgam fillings were removed and the teeth were prepared in a minimally invasive way for full-ceramic restorations (Figs. 3a–c). The restoration guidelines for n!ce are a rounded design, with no angles or sharp edges, and a shoulder preparation with rounded inner edges and/or chamfer. The manufacturer specifies 1 mm as the minimum layer thickness for complete crowns and partial crowns, which was complied with in the preparation.

Construction and milling

Digital impressions of the situation were captured with an intra-oral scanner. To prevent mirror images or undesired reflections, the teeth were first dried to the maximum extent. This was followed by bite registration (scan) and importation of the data into the CAD software.

The scans were checked and artefacts were removed. After the virtual model calculation and assignment of the jaws with the bite register, the preparation boundary could easily be marked and the insertion axis defined with a few clicks. The automated, biogeneric initial suggestion of the software was a valuable aid in constructing the restorations. Only minor changes were made to the initial suggestion. The restorations were constructed within a short time (Figs. 4 & 5) and the data was transferred to the CAM machine. In the milling preview, the design was finally checked, for example for values below the minimum wall thickness. The n!ce blocks were then secured and the restorations were milled (Fig. 6). Milling was performed in the fine mode and took about 25 minutes.

Completion

After removing the milled restorations from the machine, the milling pins of the blank were removed with a fine-grain arkansas stone. The restorations milled from n!ce showed finely tapered margins and a 1:1 reproduction of the construction. On trial placement in the mouth, the fit was judged as very good. At some sites, the approximal contact points were adjusted as required. Final polishing of the restorations outside the mouth produced a high-gloss finish. For a natural appearance, the n!ce restorations can be polished with a standard polishing set for lithium disilicate glass-ceramic. A classical polishing protocol was used in this case—coarse burs, ceramic polisher, zirconium oxide polishing paste (FEGUPOL ZIRKOPOL, Feguramed) and brushes (Fig. 7)—and the restorations were then cleaned in an ultrasonic bath. The complete crowns and partial crowns were then ready to be fitted. An additional crystallisation firing as for comparable materials is not necessary for n!ce.

Insertion

The insertion of restorations in the mouth was performed with an adhesive under rubber dam isolation. The same adhesive cements used for lithium disilicate can be used for n!ce. Before insertion, the ceramic restorations were cleaned with phosphoric acid (30 seconds). Conditioning of the bonding surface was performed according to the protocol, with 20-second etching with a 5 % hydrofluoric acid gel. After cleaning and conditioning the teeth, final insertion of the restorations was performed (Figs. 8 & 9), and the functional criteria underwent a final check. The two small amalgam fillings in teeth #34 and 35 were replaced with direct composite fillings.

Conclusion

In combination with the intra-oral scanner and the chairside CAM machine, n!ce glass-ceramic offers the possibility of fabricating indirect single-tooth restorations easily, safely and comfortably within the dental practice. The lithium aluminosilicate ceramic is supplied in the fully crystallised state; thus, no crystallisation firing is necessary. Mill, polish, seat—the procedure described offers high comfort for the patient and high productivity in everyday practice.

about

Dr Johannes Beiter holds a Master of Science in Periodontology and Implant Therapy and specialises in these fields. Since 2012, he has been a dentist specialising in oral surgery.

Anterior restoration with CAD/CAM veneers made of VITABLOCS TriLuxe forte

Dr David Jäger, Dr Martin Hammer & Carmen Scheibling, Germany

Fig. 1

Fig. 1: Initial situation with severe tetracycline discoloration of teeth #11 and 21.

Prosthetic restoration of the maxillary incisors is a challenging task for dentists and dental technicians. In the following case report, the authors describe step by step how they treated a complex initial clinical situation with CAD/CAM feldspathic ceramic VITABLOCS TriLuxe forte (VITA Zahnfabrik).

Case report

A patient presented in the dental practice with severe discoloration caused by a course of tetracycline during childhood. The psychological strain on the 38-year-old patient was increased by the palatal inclination of teeth #11 and 21 (Fig. 1). She was looking for a quick and efficient solution which would meet her expectations in terms of aesthetics without undergoing orthodontic pre-treatment. The practitioners, the dental technician and the patient therefore decided on a digital workflow with the feldspathic ceramic VITA TriLuxe forte. The material imparts a natural appearance to the anterior teeth thanks to its integrated shade gradient.

Mock-up phase

A wax-up was made using dental impressions and was used as the foundation to discuss the treatment goals with the patient. Using a silicone index and composites, mock-ups were produced similarly in the laboratory.

Fig. 2

Fig. 3

Fig. 2: Mock-up on teeth #11 and 21 for defining the goal with the patient. **Fig. 3:** Mock-ups on all the incisors for levelling the gradient of the incisal edges. **Fig. 4:** Preparation was as minimally invasive as possible and limited to the enamel, and retention grooves were created for the best adhesive bond possible. **Fig. 5:** Targeted reduction to harmonise the dental arch. **Fig. 6:** The removal of sufficient tooth substance ensured that the discoloration could be covered. **Fig. 7:** Plaster model for digitalisation similar to the intra-oral mock-ups. **Fig. 8:** CAD of the veneer on tooth #21 using mock-up data. **Fig. 9:** CAD of the veneer on tooth #11 using mock-up data. **Fig. 10:** Virtual position of the restoration in a VITA TriLuxe forte block. **Fig. 11:** View of the virtual veneer restoration.


Fig. 4


Fig. 5


Fig. 6


Fig. 7

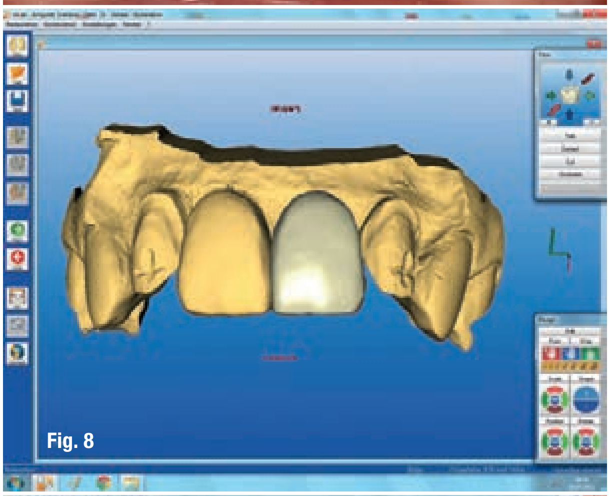


Fig. 8

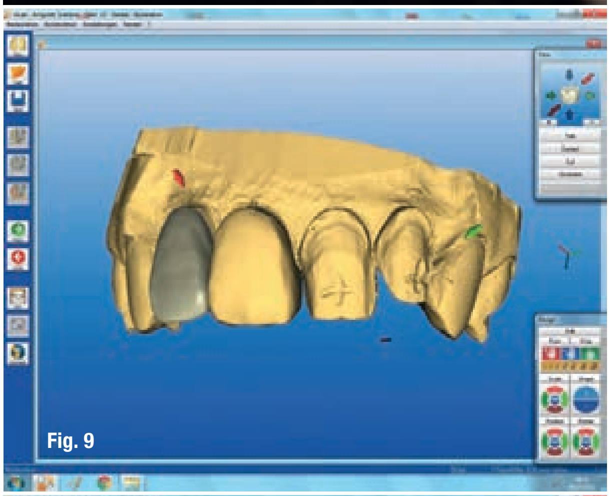


Fig. 9

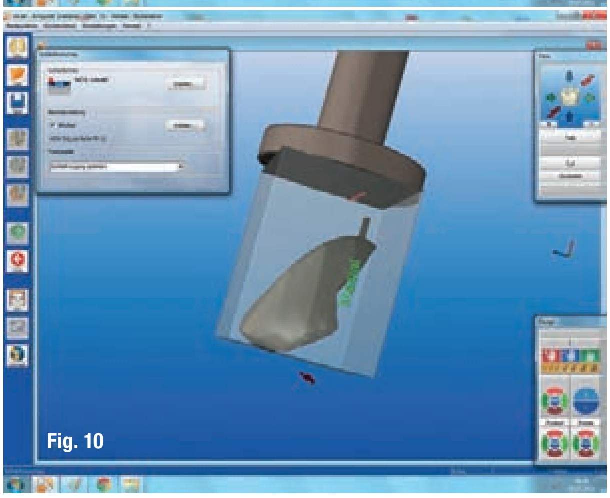


Fig. 10

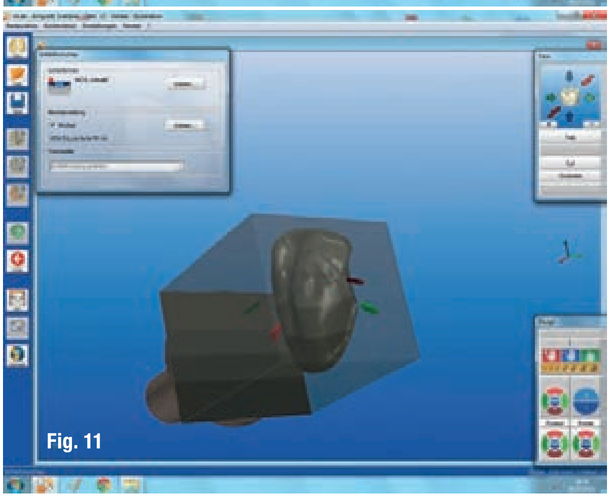


Fig. 11

Fig. 12: Try-in of the completed restorations with glycerine gel. **Fig. 13:** The aesthetic results after adhesive integration.

The severely discoloured central incisors were modified (Fig. 2), as were the length and gradient of the incisal edges of teeth #12 and 22 (Fig. 3). During the try-in, the patient was quickly convinced of the potential positive results and decided on four veneers. This was followed by a minimally invasive preparation of the teeth and impression taking (Figs. 4–6).

CAD/CAM process

The dental technician corrected and duplicated the mock-up and scanned in the plaster model in the laboratory. The master model made during the preparation was also digitalised (Fig. 7). In order to cover the severe discoloration, we decided on the multi-chromatic VITABLOCS TriLuxe forte blank, owing to its integrated harmonic shade gradient. Thanks to the mock-up data set, the restorations could be created in the laboratory using CEREC SW 3.8 design software (Figs. 8–11) and milled using the CEREC MC XL milling system (Dentsply Sirona).

Individualisation and integration

To deepen the chroma in the cervical area even more, the dental technician worked with a well-balanced mixture of VITA VM 9 CHROMA Plus 2 and 3 (VITA Zahnfabrik) during the individualisation. She was able to achieve more light dynamics on the distal and mesial edges with EFFECT OPAL 2 (VITA Zahnfabrik) in the formative and shading individualisation steps. After the try-in (Fig. 12), minor corrections and glaze firing, the final adhesive integration was performed (Fig. 13). The result was a happy and satisfied patient.

Editorial note: This article originally appeared in German in das dental labor 2/2018, *published by Verlag Neuer Merkur. Its edited version has been reproduced here in English with permission.*

about

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The complete digital implant workflow

Drs Kirill Kostin, Mikhail Erohin, Oleg Ponomarev & Maxim Kozhevin, Russia

Figs. 1 & 2: The patient's upper teeth before treatment.

Planmeca is known for high-tech innovations and continuous product development. The company's powerful Planmeca Romexis software platform allows all stages of the dental implant and aesthetic prosthodontic treatment to be completed using one piece of software, from the computer-assisted design of patients' smiles to the fabrication of surgical guides.

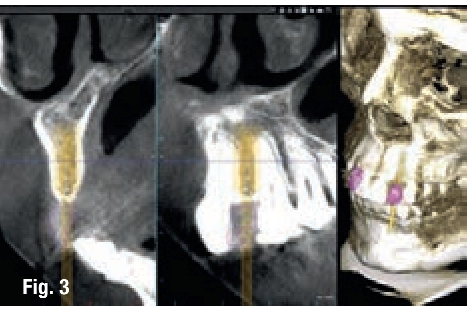
The following clinical case, which I performed together with my colleagues Dr Ponomarev, Dr Kozhevin and Dr Yarokhin, illustrates how digital solutions can be used in prosthodontic treatment, implant placement and restoration design. According to our experiences, digital CAD/CAM technologies enable maximal functional and aesthetic results compared to traditional methods.

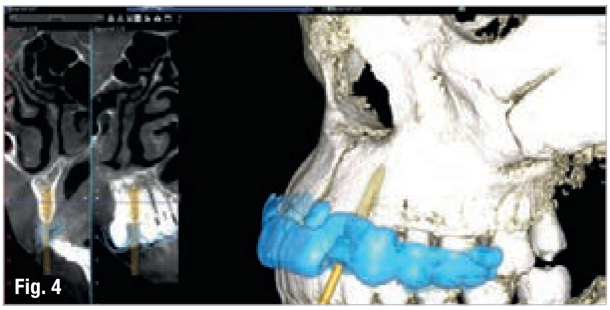
Clinical case report

The clinical case illustrates the advantages of using Planmeca CAD/CAM solutions in the digital planning of an implant placement and surgical guide, as well as in the fabrication of a ceramic restoration. This article presents a clinical case in which the treatment was completed using the Planmeca Romexis 3D Implant Guide software, Planmeca PlanCAD Premium software and Planmeca PlanMill 40 milling unit.

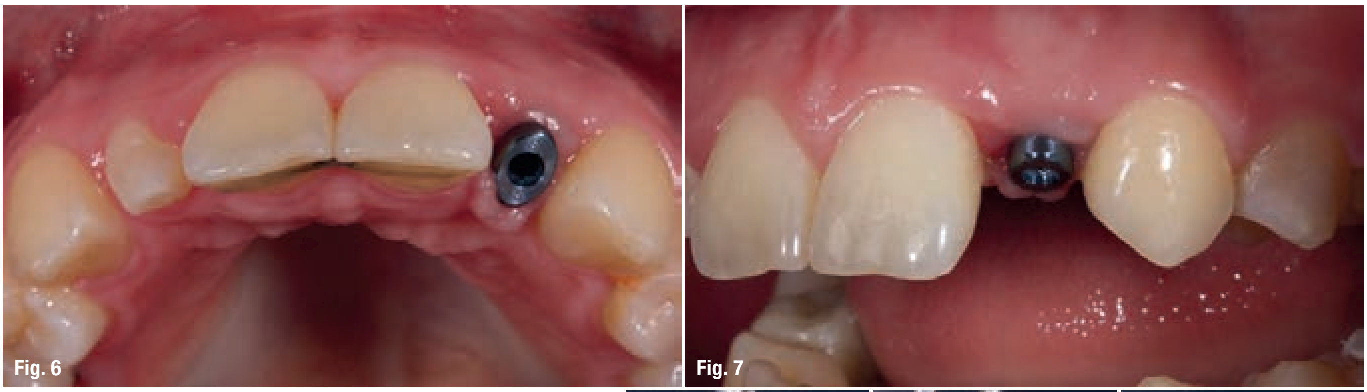
The clinical case features a female patient, who complained about missing tooth #22, as well as the shield-like shape of tooth #12 (Figs. 1 & 2). During the initial examination, the area around the missing tooth was estimated to be quite narrow for an implant. However, the patient declined orthodontic preparation, as she had already previously had orthodontic treatment with orthodontic surgery.

In this particular case, we started with an aesthetic analysis of the patient's CBCT data and concluded that a Straumann implant with a 2.9 mm diameter would fit in the area of tooth 22, if we used a surgical guide





Figs. 3 & 4: Digital implant and surgical guide planning in Planmeca Romexis software. **Fig. 5:** Surgical guide was fabricated for maximum precision.



Figs. 6 & 7: Successful placement of the implant.

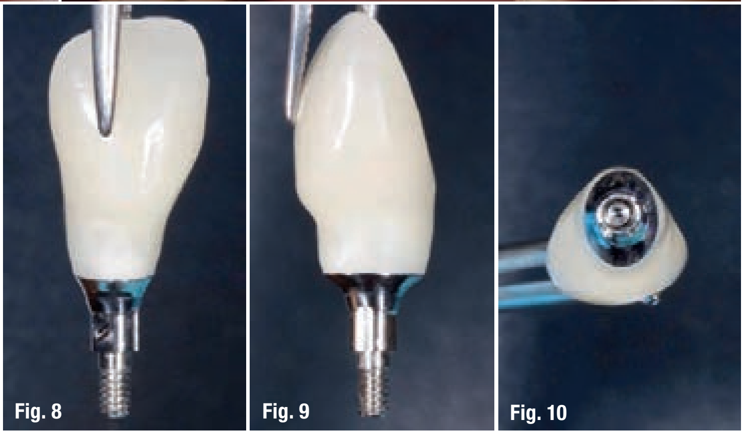
for maximum precision (Figs. 3–5). For tooth #12, we decided to fabricate a thin-walled IPS e.max ceramic restoration (Ivoclar Vivadent).

Thanks to digital planning and a carefully fabricated surgical guide, the implant was placed successfully, even though the anatomical conditions appeared to be less than advantageous. We achieved a torque of 30 Ncm and attached a healing abutment to the implant (Figs. 6 & 7).

Three months after the implant placement operation, the osseointegration of the implant fixture was completed. A temporary crown was fabricated on the implant from a VITA ENAMIC multiColor block to support the formation of soft tissues (Figs. 8–10). We improved the original design on the Straumann superstructure with gum contouring. On tooth #12, crown lengthening was performed with an electrocoagulator (Figs. 11–13).

Once the formation of the soft tissues was complete, tooth #12 was minimally prepared for the ceramic crown with the help of a surgical microscope. After the preparation, the teeth were scanned in order to digitally design a custom abutment and crowns (Figs. 14–19).

The final smile design was planned digitally together with the patient. For the implant structure, we chose an individual zirconium abutment screw with a ceramic facing and a fully anatomical Empress crown (Figs. 20 & 21).



Figs. 8–10: Temporary crown was installed to support the formation of soft tissues.

The ceramic facing concealed the excessive brightness of the zirconium, and we were able to achieve the desired colour. Thanks to the digital workflow, we managed to fulfil the wishes of the patient. (Figs. 22–24).

Conclusion

With digital technologies, the entire implant workflow can be completed in the dental clinic, from planning to fabrication of the restorations. Digital planning increases the reliability of the implant treatment and helps the dentist to succeed in the operation. Digital tools allow achieving the maximum functional and aesthetic result even in combined operations in which an implant placement and ceramic restoration are performed simultaneously.

Figs. 11–13: Crown lengthening was performed on tooth #12.

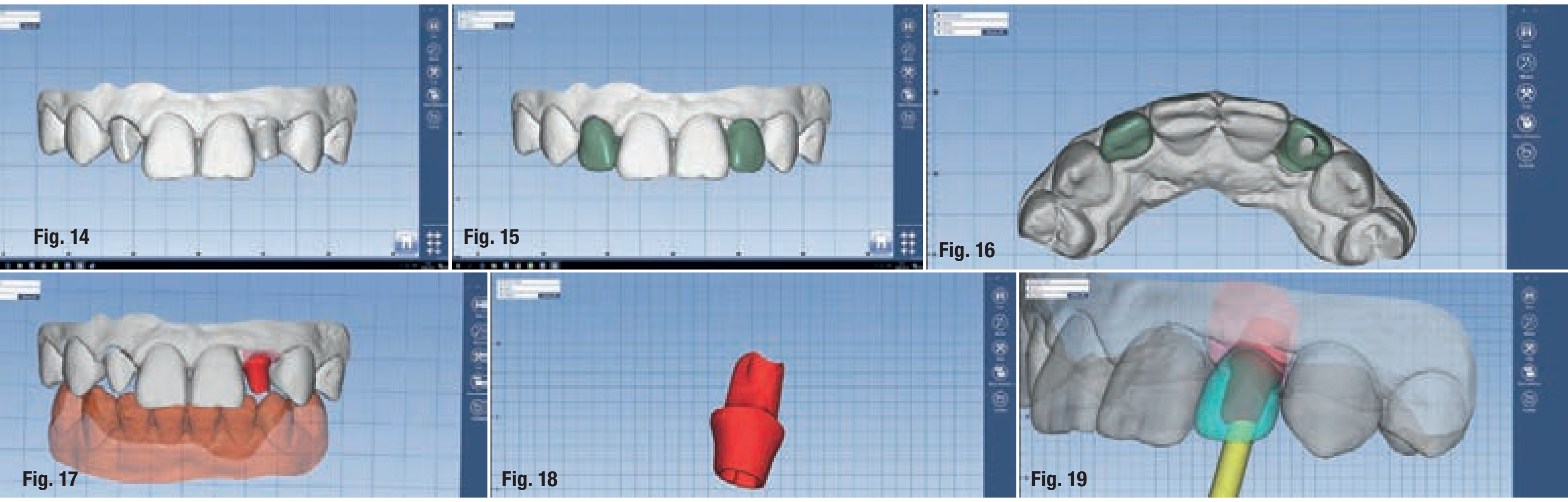


Fig. 14 Fig. 15 Fig. 16 Fig. 17 Fig. 18 Fig. 19

Figs. 14–19: The final restorations were designed in Planmeca PlanCAD Premium.

Thanks to the development of modern technologies, a 3D model of a patient's set of teeth can now be acquired in only a few minutes, without infringing on the comfort of the patient. At the same time, combining a CBCT image with an intra-oral scan enables the dentist to plan the implant placement and surgical guide accurately and with just a few mouse clicks.

Finally, digital technologies also enable visualising the treatment outcome for the patient. Clear visualisations of the end result facilitate communication with the patient, which, in turn, can increase case acceptance.

about

Dr Kirill Kostin graduated from Saint Petersburg State Medical University in Russia in 2004. He became the co-founder of the PerfectSmile dental clinic and dental study centre in 2014. At his clinic in Saint Petersburg, Dr Kostin runs a private practice concentrating on the aesthetic and functional rehabilitation of natural dentition and implants, applying various digital instruments as part of restorative procedures (digital smile design, intra-oral scanning, CAD/CAM milling, 3D printing, and guided surgical procedures). Using a dental microscope on a daily basis, Dr Kostin focuses on minimally invasive restorative procedures with direct and indirect restorations. This particular case Kostin performed together with his colleagues Drs Mikhail Erohin, Oleg Ponomarev and Maxim Kozhevin.

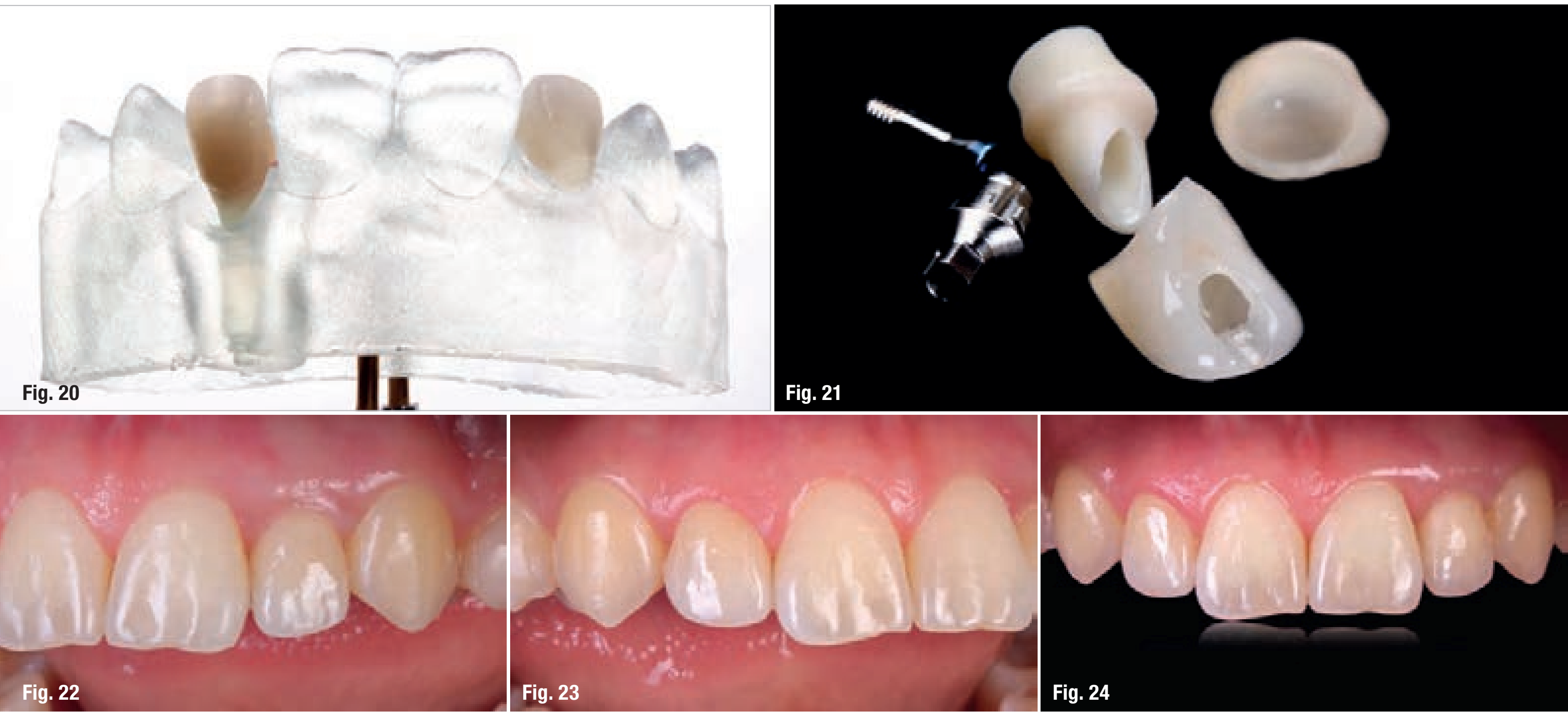


Fig. 20 Fig. 21 Fig. 22 Fig. 23 Fig. 24

Figs. 20 & 21: Final restorations: Zirconium abutment screw with a ceramic facing and a fully anatomical Empress crown. **Figs. 22–24:** Final outcome after the completion of the treatment.

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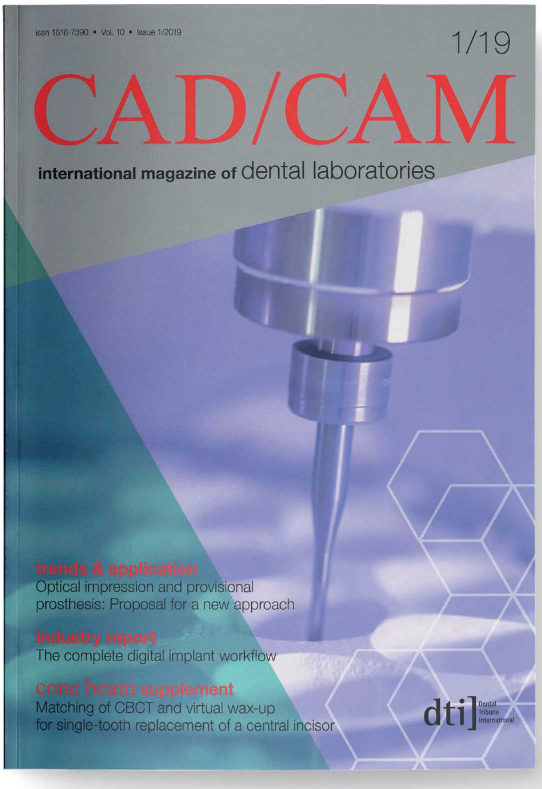

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Matching of CBCT and virtual wax-up for single-tooth replacement of a central incisor

Dr Jakob Zwaan & Vito Minutolo, Italy

Although many smile design programmes offer us solutions for rendering of multiple-tooth replacements, very often in our daily practice we encounter major challenges when just a single tooth needs to be substituted. In order to estimate the risk of an unacceptable aesthetic final result of our treatment and to determine the most effective and predictable treatment plan, it is necessary, also in these cases, to perform an analysis of the desired tooth shape, the soft tissue architecture and the bone volume necessary to stabilise an implant in the optimal position and support the soft tissue. This analysis can be done using several means. In the traditional workflows, we asked our dental technician, after taking impressions of the dental arches and registering the occlusion, to perform a wax-up to obtain information about tissue volume available and needed. It was difficult to get from this hard model information about the lip line and gingival exposure, and before the era of 3D scanning, it was impossible to interface the teeth with the deeper anatomy. With the arrival of digital photography, video, intra-oral scanners[1] and CBCT scanners, our possibilities have grown enormously, thus raising the accuracy and predictability of our treatments.

In the following case report, the author will describe how he and his team approach cases in which a single tooth needs to be replaced by an implant-supported crown. Most of the procedures can be applied to more extensive cases, since the basic rules of implant dentistry are universal. After an anamnestic interview in which patient

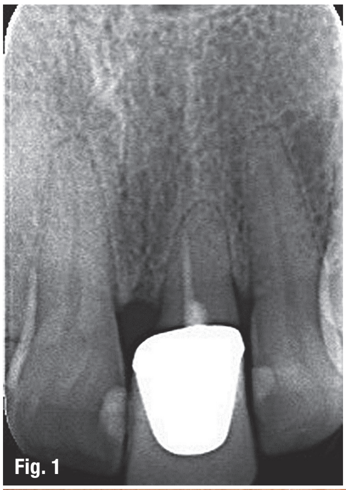


Fig. 1


Fig. 2


Fig. 3


Fig. 4

expectations play a fundamental role, we proceed with the intra-oral examination. Hygiene and periodontal health are checked, and if required, a session for calculus debridement, motivation and instruction is scheduled. Normally, the first radiographic examination performed is an intra-oral radiograph for a single tooth (Fig. 1) or a dental panoramic tomogram if the need for a more extensive treatment is suspected. In the same session, both dental arches are scanned with an intra-oral scanner and the bite is registered. A simple photographic sequence is followed:

1. Full frontal view intra-oral photograph (Fig. 2).
2. Detailed photograph of the single arch, possibly with a black mirror to contrast the teeth (Fig. 3).
3. Photograph of laterolateral detail of the tooth and gingival profile (Fig. 4).
4. Full-face photograph with maximum gingival exposure (Fig. 5).
5. Full-face photograph of a spontaneous smile (Fig. 6).
6. Photograph of the full face at rest.

This sequence allows one to view immediately the presence of orthognathic and periodontal issues (Figs. 1 & 2), to evaluate the biotype (Figs. 2 & 3) and to estimate aesthetic challenges, like tooth colour, tooth texture, soft tissue/lip exposure and position of the incisal edge/lip (Figs. 2 & 4–6). The 3D intra-oral scan is extremely helpful for determining orthodontic alignment of the teeth and in our protocol replaces an occlusal and/or 12 o'clock photograph in most cases.

"There can be different ways of treating a disease, but there can be only one correct diagnosis." Dr Morton Amsterdam, 1974. When anamnesis, intra-oral examination and preliminary radiographs are sufficient to conclude that the tooth in question cannot be preserved, it needs to be decided what the optimal timing for extraction and a CBCT scan is and how to provide for a temporary tooth replacement. Also, the timing of implant placement is essential and the operator must choose between immediate, early or delayed placement in the fresh extraction socket. Will there be a (potential) need for bone augmentation and/or a soft tissue graft? In short, our policy is the following: in case of acute inflammation that cannot be effectively treated in a way that an infection of the future implant site will be prevented, we will proceed with extraction. A temporary fixed etch and bond or removable prosthesis can be used to guarantee acceptable aesthetic comfort to the patient. In these cases, a CBCT scan will be taken after extraction so that the most detailed image of the socket anatomy can be obtained. Since a provisional solution has been provided for, there is no need for very early implant placement. Timing is now based on the expected period needed for the infection to be eliminated and the risk of loss of volume by the collapse of tissue. Normally, the implant is placed four to six weeks after the extraction. Another reason for delayed implant placement can be the need for healed soft tissue in order to facilitate proper wound closure to protect, for example, bone substitutes and membranes when bone augmentation is necessary. Additionally, if the patient is suffering


Fig. 5


Fig. 6

owing to the tooth that is to be extracted, it can be a reason to proceed quickly with the extraction, thus gaining time for adequate treatment planning and preparing for surgery and eventual immediate temporary crowns. If the anatomy and biological conditions are favourable, one can decide to proceed with implant surgery at an early stage after extraction, such as one week. Only in those cases in which there is no acute inflammation or infection, and sufficient bone and soft tissue quantity and quality are present is it recommendable to place the implant in the fresh extraction socket. Obviously, in such a case, the CBCT scan would be performed before proceeding. Minor bone augmentation and/or connective tissue grafting can be performed contemporaneously. The decision to place an immediate provisional crown on the implant is strongly related to the expected primary stability of the implant, as well as the opportunity to manage the position of biomaterials in such way that undisturbed and uncontaminated healing is guaranteed. After healing, good aesthetics and sufficient protection of the underlying implant and implant–prosthesis connection are requisite if we wish to treat our patients in the best possible way and earn their long-term trust.

Risk evaluation

First aesthetic risk evaluation

A very simple tool to start with can be a render of a 2D photograph. We use the macro intra-oral shot with the black background behind the teeth (Fig. 3). With Adobe Photoshop, GIMP, Microsoft PowerPoint or Keynote, for example, it is possible, with little time invested and no expense, to cut out the shape of the contralateral tooth that will not be extracted, copy it, flip it horizontally and paste it in the position of the tooth that needs replacement. It will be clear immediately whether this shape, which provides for symmetry, supports the papillae sufficiently or whether there is a lack of volume that needs to be compensated for (Fig. 7). Another trick is to use this image with the flipped contralateral tooth and align it with the original photograph and then draw a horizontal line across both images that coincides with the same gingival reference points. This will demonstrate whether there is a vertical component that indicates a lack or abundance of soft tissue (Fig. 8). This can be easily quantified in a metric system if an intra-oral reference is measured with a calliper. We can now inform the patient whether an additional procedure like guided bone regeneration (GBR) or a connective tissue graft will be needed, which can be helpful for informed consent and financial planning.

Second risk evaluation

The intra-oral scan is imported into CAD software and transformed into a virtual master model without the tooth to be extracted and a separate STL shape of the ideal CAD-designed tooth (Fig. 9). Now there is the opportunity for 3D evaluation of the dimensional relation between the new tooth and the soft tissue before extraction. In the current case, the tooth involved had not been extracted and a CBCT scan was performed (X-Mind trium, ACTEON; 110 x 80 mm field of view; 0.15 mm voxel size) for further investigation and treatment planning. In the AIS 3D App

Fig. 7

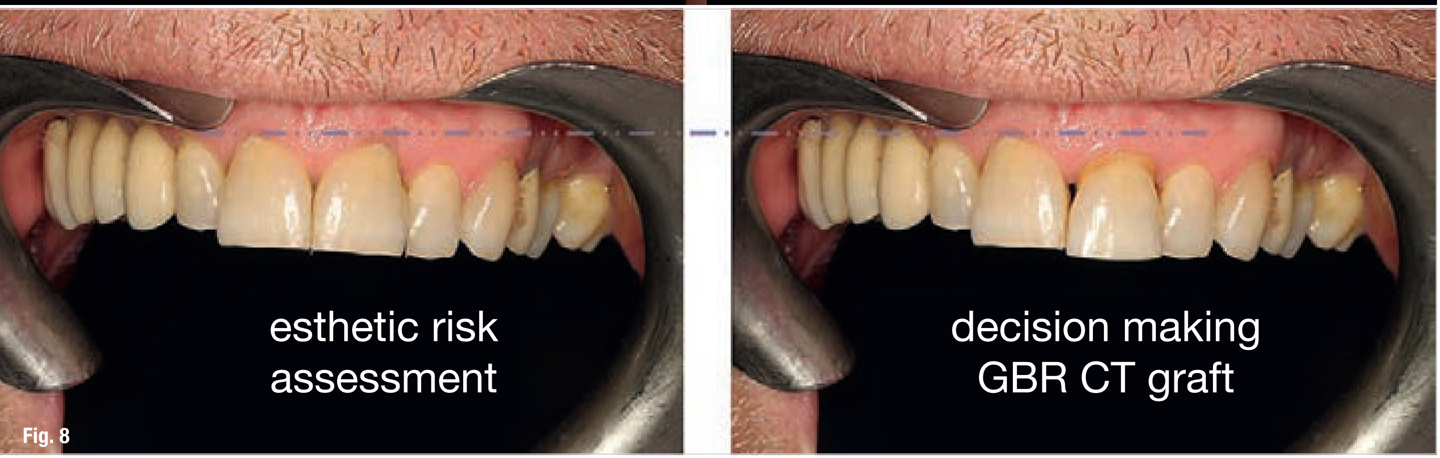


Fig. 8

software that comes with the CBCT X-Mind trium device, STL files can be matched and aligned with the 3D bone volume, thus giving the opportunity to plan the future implant position taking into account the shape and position of the future crown (Figs. 10a & b). In accordance with the prosthetic procedure preferred, cemented versus screw-retained, CAD/CAM-fabricated versus manual layering and the type of material to be used, all the information for the final treatment plan is available, on which decisions can be made regarding GBR, connective tissue graft and timing of implant loading.

Case report

The female patient, aged 47 and a non-smoker, was in good general health. She performed regular oral hygiene and had good periodontal health. The patient experienced increasing mobility of the maxillary left central incisor and complained about compromised aesthetics due to the extrusion and progressive migration of the tooth in a buccal direction. The incisor had been treated with a crown at a preadolescent age after a violent trauma. The intra-oral radiograph showed incomplete root development and evidence of a root canal therapy suggesting a strip perforation though no signs of periapical lesions were present. The shape of the crown was not symmetrical in relation to the triangular shape of the maxillary right central incisor, but had a wider and rectangular profile. Minor general gingival recession had led to the presence of a tiny inter-dental space. The marginal gingiva was reddened, and the central papilla was not symmetrical.

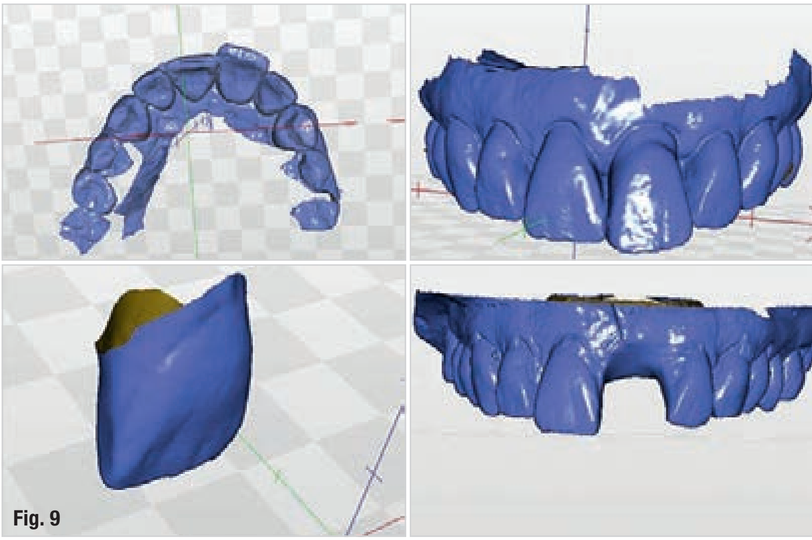


Fig. 9

Probing depths were within 2 mm for both the right and left central incisors and the radiographic mesial and distal bone peaks were of a regular height.

The photographic aesthetic evaluation showed that it would be very difficult to obtain symmetry in tooth shape and have good-looking and healthy soft tissue support at the same time. The patient's maximum smile exposed the gingival contours. In such cases, it may be wise to consider also the possibility of altering the anatomy of the contralateral tooth with, for example, a ceramic veneer and discuss outcomes with the patient before finalising


Fig. 10a

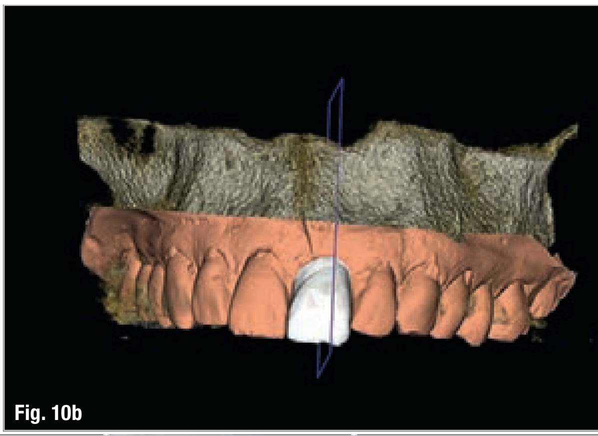


Fig. 10b

Fig. 10c b c d

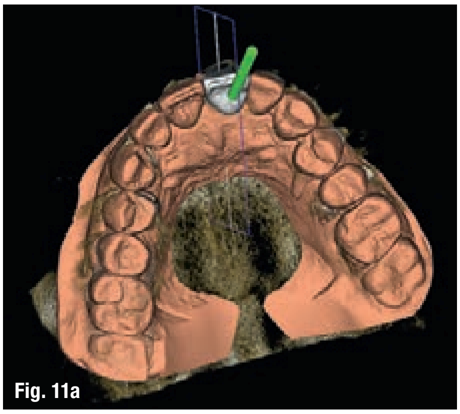


Fig. 11a

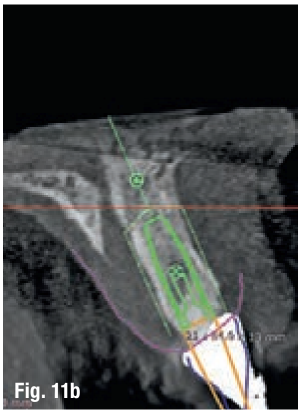


Fig. 11b

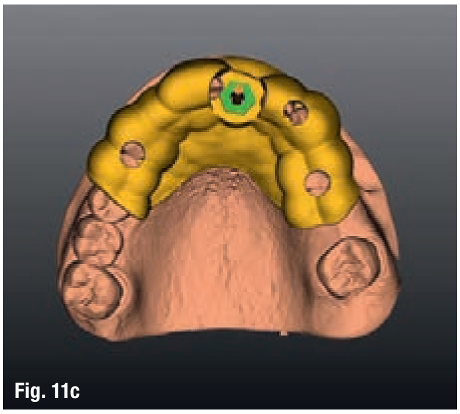


Fig. 11c

the treatment plan. This can be evaluated by performing the cut/copy/flip/paste sequence in reverse (Fig. 7). Together with the patient, it was decided to start performing the best possible replacement of the maxillary left central incisor and evaluate at an advanced stage with a temporary crown on the implant and mature, conditioned tissue whether to add a veneer to the maxillary right central incisor.

Analysing the CBCT scan

It became evident that the short-rooted tooth could be extracted without compromising the buccal bone, and that there was sufficient bone volume and quality to obtain good primary stability of the implant. Thanks to the AIS 3D App software, this information can be visualised using the bone density tool and linear measures tool (Fig. 10c) and represented in a graphic or according to a coloured scale. The presence of the nasopalatine duct prohibited ideal palatal positioning of the implant, and if the implant were to be placed flush with the palatal alveolar bone, this would have resulted in a 1.5–2.0 mm high exposure of the implant collar on the buccal aspect (Fig. 11a). This information, combined with the aesthetic analysis, led to the decision to place the implant in that position and to augment the buccal bone volume with a contemporaneous GBR procedure, thus also providing for major soft tissue support. As often described in the literature, it is to be expected that in some measure the implant will deviate buccally[2–4] from the original planning because of the major mechanical resistance of the palatal plate. The author's team prefers whenever possible screw-retained solutions. Several production centres are capable of milling angulated screw access holes in cobalt-chromium abutments of up to 25°,[5] which is a range that covers most cases in daily practice. It can be easily checked in the implant planning software whether the future access hole will exit on the palatal aspect of the tooth, either by angulating the implant extension tool or by choosing a virtual abutment from the library. Confirming being in the safety range from this point of view allowed for an approach that foresaw the implant in native bone without the necessity for major GBR on the apical aspect of the implant. Knowing that a flap needed to be raised to facilitate the marginal tissue augmentation, it was decided to use a surgical guide (Figs. 11a & b) for only the first drill to determine with precision the position and angulation of the osteotomy that would be performed freehand thereafter. In order to limit


Fig. 12

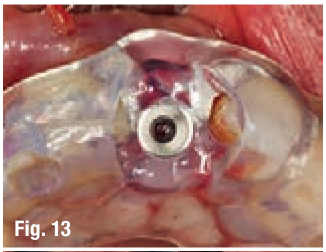
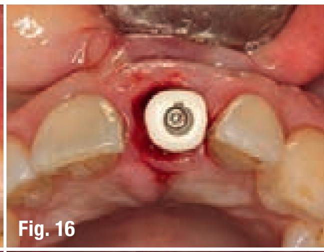


Fig. 13


Fig. 14


Fig. 15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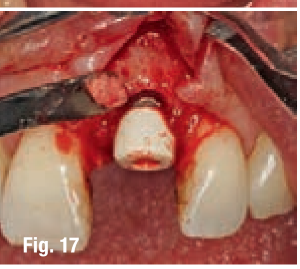
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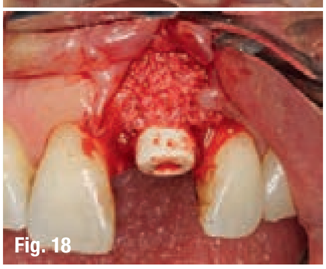


Fig. 18

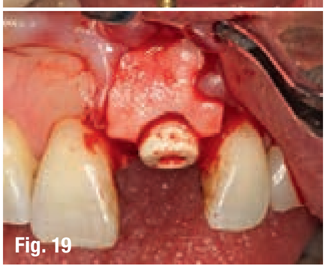


Fig. 19


Fig. 20


Fig. 21

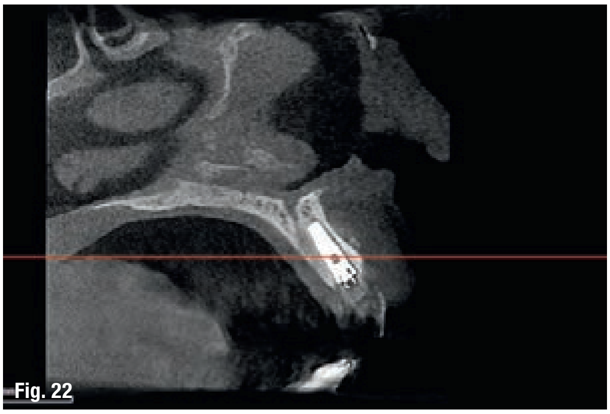


Fig. 22

Fig. 23

surgery time and eliminate unpredictable factors inherent in immediate loading, a removable temporary prosthetic tooth was produced in advance.

Surgery

Local anaesthesia was performed with 2% mepivacaine with 1:100,000 adrenaline. Preventative antibiotic therapy with amoxicillin (1g, b.d. for five days) was prescribed, aided by use of a 0.2% chlorhexidine mouthrinse three times a day for one minute. The tooth was extracted and the sulcular epithelium removed with diamond burs. The milled surgical template (Figs. 12 & 13) served as a guide for the first 2mm diameter pilot drill (Fig. 14). Thus, the planned depth, position and angulation of the osteotomy were obtained. The drill sequence was completed freehand, using tapered 3.0 and 3.4mm drills. A Neoss ProActive Tapered Implant of 4mm in diameter and 13mm in length was inserted flush with the mesial/palatal/distal bone, motor driven up to a torque of 50Ncm and then with a manual wrench (Fig. 15). The correct position of the internal hex was verified by checking the references on the implant driver, which ideally points in the buccal direction. Resonance frequency analysis with Penguin-RFA (Integration Diagnostics Sweden) determined an ISQ value of 73/76. At this stage, a Neoss Esthetic Healing Abutment with a ScanPeg was connected to the implant (Fig. 16). A flap was then raised after a vertical incision of the frenulum and the expected buccal exposure of the implant neck was evident. Autogenous bone harvested from the drills was positioned directly on the implant surface (Fig. 17), followed by a bone substitute on top of it and on the buccal cortical bone (Fig. 18). This material was covered with a resorbable membrane (Fig. 19). The mobilised flap was then repositioned by rotating it coronally and fixed with single sutures (Fig. 20). The removable partial denture was adapted and delivered (Fig. 21). An immediate postoperative CBCT scan of 60 x 60mm was performed, and it confirmed a perfectly centered implant position (Figs. 22 & 23).

Intra-oral scan

Eight days after surgery, the patient reported that healing was uneventful and the prosthodontist removed the stitches. It has become the author's standard protocol to perform an intra-oral scan for implant position in this same session (Figs. 24 & 25). The specific and

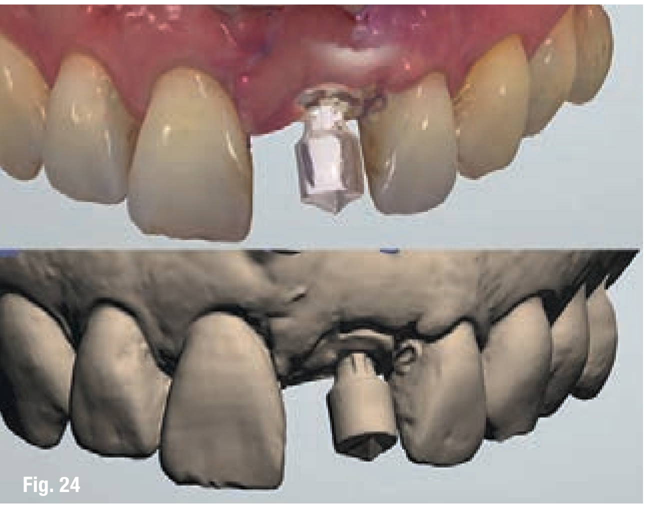


Fig. 24

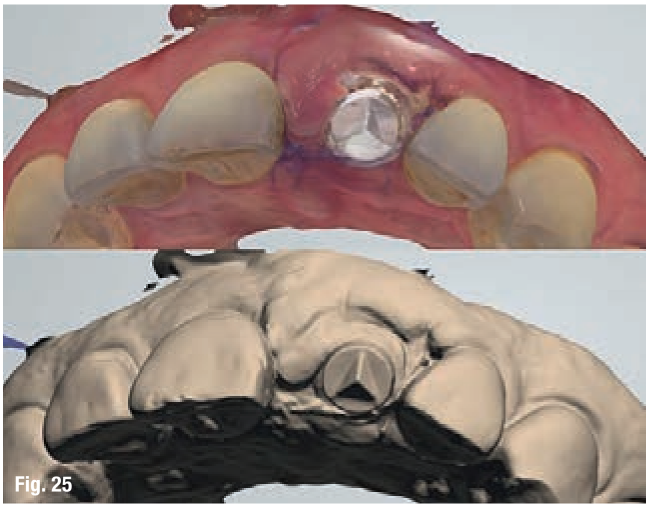


Fig. 25

Fig. 26

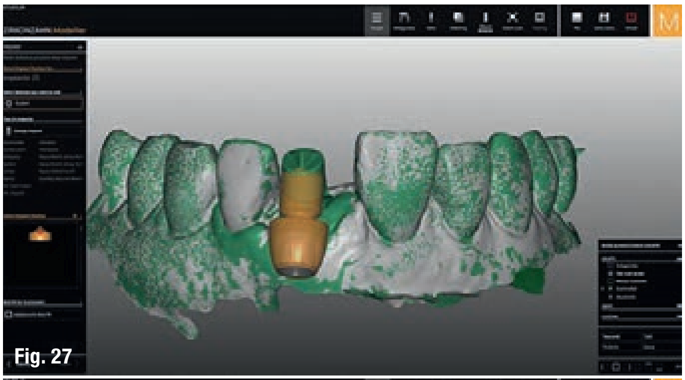


Fig. 27

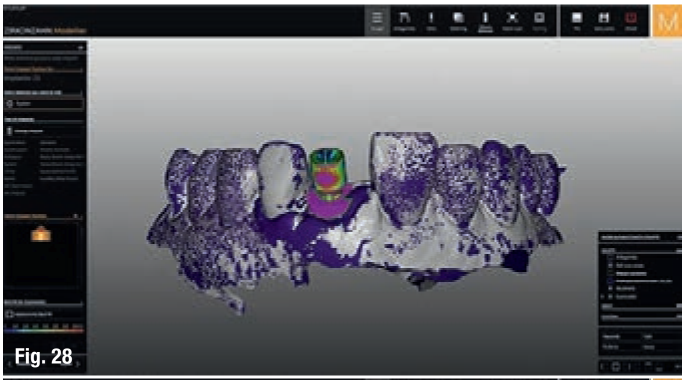
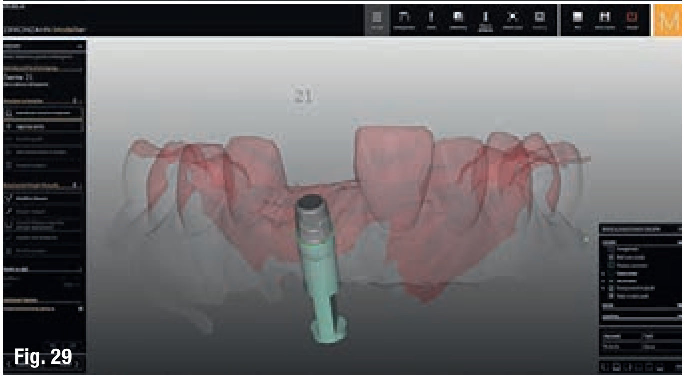


Fig. 28



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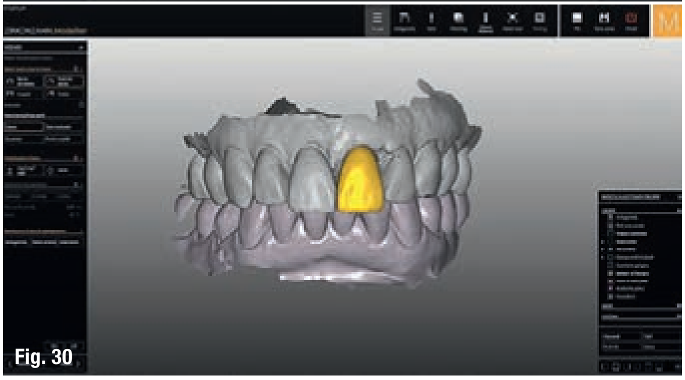

Fig. 30

unique PEEK healing abutment used has an internal circular channel and on one side, normally positioned on the buccal aspect, a vertical rectangular slot (Fig. 26). After removing the PTFE tape used to plug this area during surgery, a ScanPeg can be positioned inside the healing abutment. This allows for a unique scanning procedure without removing the healing abutment, thus avoiding disturbing healing tissue or dislocating recently placed biomaterials. The producer provides libraries for STL files of the five different anatomical shapes—wide incisor, narrow incisor, canine, premolar and molar—that determine the basic profile of the gingival tunnel during healing.

Temporary crown

The surgeon indicated that the healing abutment may be removed after four weeks. By then, the temporary screw-retained crown had already been fabricated by the technician, who had prepared a CAD/CAM-milled acrylic tooth glued on to a Neoss NeoLink abutment (Figs. 27–30).

As a result of the decision to place the implant entirely in native bone, the angulation was such as to locate the screw access hole of the provisional on the buccal aspect. This can be easily camouflaged by a simple composite filling after plugging the channel with PTFE tape. The gingival profile copies in this first stage of loading the central incisor anatomy of the Neoss Esthetic Healing Abutment (Fig. 31).

Tissue conditioning

As evidenced by the aesthetic analysis before treatment, it was clear that symmetry with the contralateral incisor would be impossible. The implant was placed slightly distal because the distal papilla normally has a narrower mesiodistal basis than the central papilla. The tissue volume augmentation helped to obtain the necessary quantity of gingiva to shape nice papillae, leaving a minimal gap. The soft tissue architecture was conditioned (Fig. 32) by adding composite to the temporary crown and grinding

Fig. 31

Fig. 32

Fig. 33

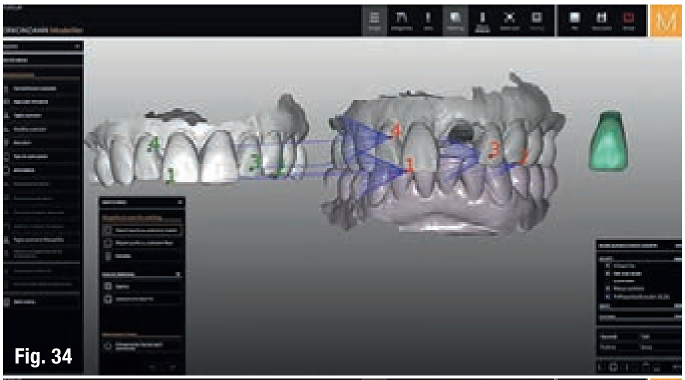
Fig. 34

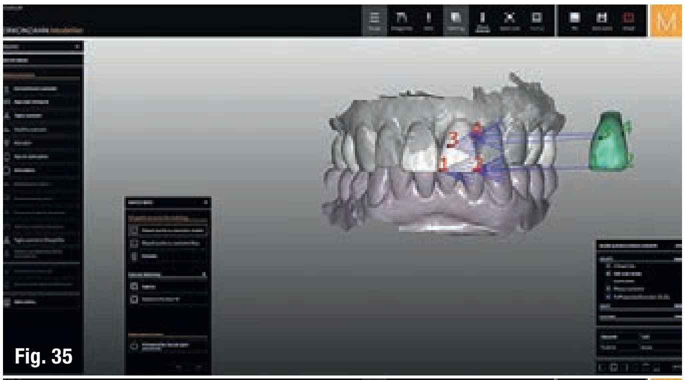
Fig. 35

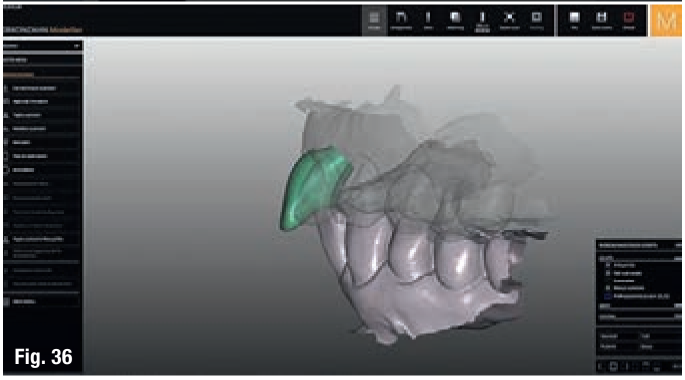
Fig. 36

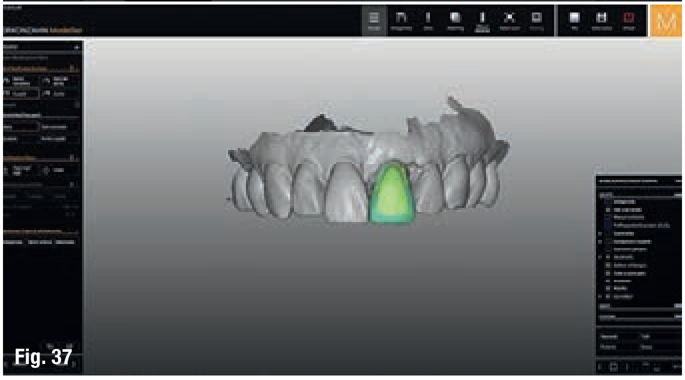
Fig. 37

material where necessary until the prosthodontist and the patient felt an optimal result had been achieved.

Transfer of the profile

A new intra-oral scan sequence was performed. First was the scan of the full arch with the temporary crown in place. The provisional was then removed from the mouth and screwed on to an implant replica fixed to a stable support with wax. The second scan revealed in 360° the modified shape of the temporary crown, including the gingival profile (Fig. 33). These files can be easily matched in the CAD software when the technician designs the definitive crown (Figs. 34–36). If a monolithic material is used, the technician may copy the entire shape of the temporary. When a support is needed that will be layered with ceramic afterwards, at least the gingival profile can be duplicated in a reliable way.


Fig. 38


Fig. 39


Fig. 40

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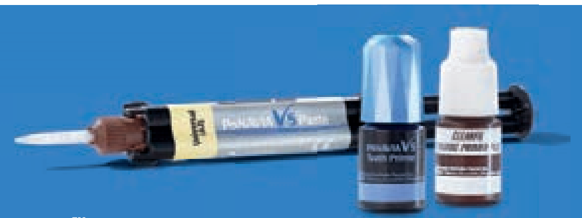

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Fig. 41


Fig. 42


Fig. 43

Definitive crown

The author strongly prefers screw-retained devices. Owing to the angulation of the implant, it was necessary to relocate the screw access hole. In CAD, the design for a cobalt-chromium support that copied the gingival profile of the temporary was prepared, and the screw access was brought to the palatal aspect (Fig. 37). The file was sent to the Arc solutions milling centre in Helsingborg in Sweden. High-quality material and CAM production guarantee an excellent outcome in terms of connection and smooth surfaces (Figs. 38–40). The technician layered feldspathic ceramics to obtain the final anatomy and texture. The patient was totally satisfied with the result and did not wish for intervention for the maxillary right central incisor. Minor gingival asymmetries, though evident at high magnification in photography, are not really disturbing when viewed at social distance if all other parameters, like colour, incisal edge, tooth texture, correct proportion of the incisal two-thirds of the tooth and transitions, are respected (Figs. 41–43).

Conclusion

Innovative technologies enable extremely accurate diagnosis and treatment planning. Affordable high-quality CBCT has profoundly changed our profession. In the current case, the detailed X-Mind trium 3D images allowed for planning and performing implant placement in the optimal mesiodistal position. Correct distances to the lateral incisor and the nasopalatine duct were obtained. Final choices will always remain related to the experience, skills and equipment of the performing team. After collecting all of the necessary information and knowing what technology can provide, it is possible that one team will opt for GBR and monolithic crowns, where another might try to minimise the invasiveness of surgery and employ innovative milling strategies to deliver a predictable, beautiful solution. In the actual challenging buccopalatal dimension, the implant was perfectly planned and guided into the centre of the native bone. Guided bone regeneration was limited to the minimum and minor buccal exposure of the implant was predicted. Reviewing the case described above, the fact that bone volume could be matched with the dental preoperative situation and the CAD virtual wax-up made the whole procedure, from extraction to final restoration, highly predictable. Bone volume, bone quality, extent of GBR indicated and the type of prosthodontic solution were all known before starting treatment thanks to the implant planning with the AIS 3D App software. Both the clinician and patient were well informed and prepared, avoiding surprises, improvisations and unnecessary stress. New developments like smart, scannable healing abutments will help to continue creating treatment outcome and comfort improvements.

Editorial note: A list of references is available from the author.

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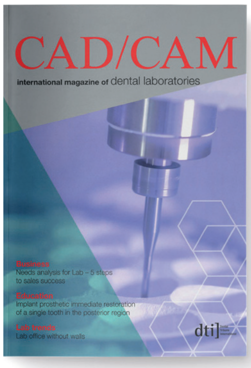

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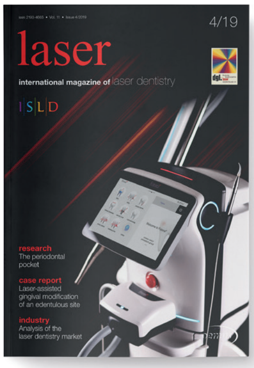

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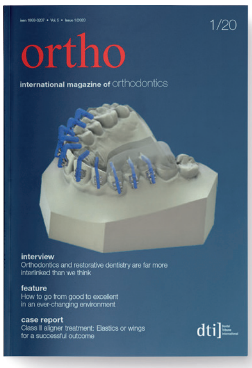

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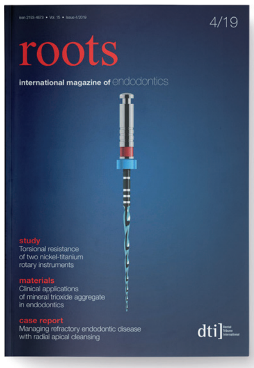

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Computer-aided, template-guided immediate implant placement and loading in the mandible

Dr Thomas Spielau, Uli Hauschild, Germany & Dr Joannis Katsoulis, Switzerland

Background

Computer-aided implantology (CAI) was introduced more than 25 years ago with the aim of facilitating implant planning and avoiding intra-operative complications such as mandibular nerve damage, sinus perforation, fenestration and dehiscence.[1–4] Based on a computed tomography (CT) scan and a digitised tooth set-up, the prosthetically ideal implant positions can be planned virtually with the help of guided surgery software, allowing for 3D visualisation prior to implant surgery.[2,5,6]

Furthermore, the possibility of transferring the virtually planned implant position to the real clinical situation is provided by a stereolithographically fabricated surgical template.[3,7] While only few guided implant placement systems were available at the time, today, multiple CAI programmes are available on the market. Several *in vitro*, cadaver and clinical studies have reported on the accuracy of guided implant placement.[8–10] Although the current state of software and hardware technology has improved, inaccuracies in implant placement may occur and these depend on different factors, such as the template support (bone, mucosa, teeth, implants), intrinsic factors of the surgical guide (tolerance in diameter between the drill and the guide sleeve, fabrication accuracy of the guide)[11,12] and human-related factors during the workflow of virtual planning and guided surgery.[7,13] The guided surgery approach is still a matter of controversy,[14–16] even though the procedure may be performed in a safe and predictable way.[17,18] However, a systematic and concise approach to performing the single steps in the treatment sequence may allow for more accurate implant positioning, as the type of guide and fixation have an important influence.[19,20] Additionally, the use of multiple templates with different supports, that is teeth and implant support, combined in a sequenced order is believed to improve accuracy compared with a mucosa-supported approach alone.[21]

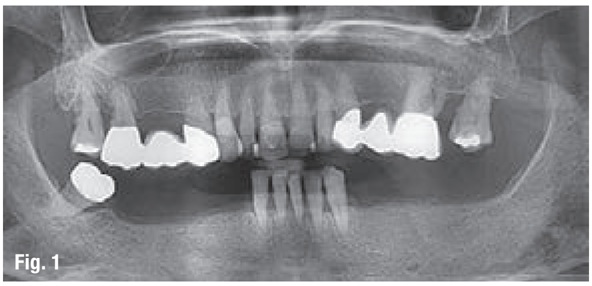
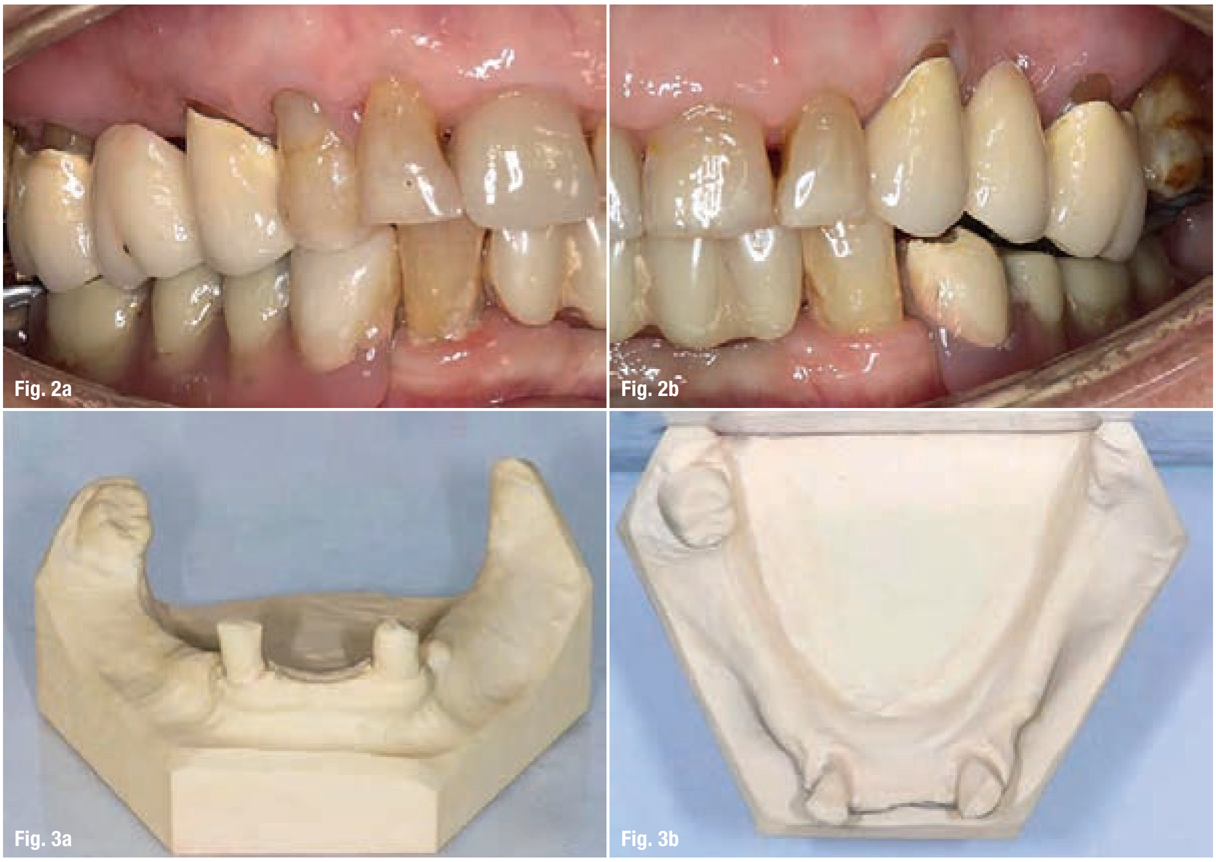


Fig. 1: Panoramic radiograph of the initial dental status.

While some patients wish to be informed in detail about the specific treatment steps, most want to know whether they would have to leave the dental office without teeth at some point of the treatment. In this context, immediate implant placement after tooth extraction and immediate implant loading with a fixed provisional restoration may help the patient, as the time after extraction and osseointegration is consolidated. In guided surgery protocols, minimally invasive placement and immediate loading have been possible treatment steps from the beginning.[3,4] Postoperative morbidity after flapless surgery is significantly reduced compared with the traditional open approach, especially in edentulous patients.[17,22,23] Later during the treatment, restorations fabricated with the help of computer-aided design/computer-aided manufacture (CAD/CAM) provide high-quality and aesthetic materials. Although CAI and CAD/CAM procedures have facilitated a straightforward workflow in the rehabilitation of edentulous patients, immediate implant placement and immediate loading protocols combined are complex and required a high level of organisation between the implantologist, the technician and the patient. The aim of the present case report was to illustrate the feasibility of a combined immediate implant placement and loading approach using CAI in the rehabilitation of a patient with a partially dentate mandible and who requested a comprehensive treatment and, specifically, one that would not leave her edentulous at any point.

Initial status and treatment concept

The partially dentate 74-year-old patient presented with masticatory problems due a removable partial den-



Figs. 2a & b: Initial dental status: right side **(a)** and left side **(b)**. **Figs. 3a & b:** Frontal **(a)** and occlusal view **(b)** of the study models after extraction of teeth #41, 31 and 32.

ture (RPD) with insufficient stability, in combination with chronic pain affecting the mandibular anterior teeth area. She asked for a comprehensive treatment and was not prepared to accept being edentulous at any stage of the treatment. The patient was a non-smoker and—with the help of antihypertensive (Candecor comp. 32 mg/12.5 mg, TAD Pharma) and anti-coagulant medication (quick 30, Marcoumar)—in good general health.

The dental status showed acceptable oral hygiene and some teeth with Grade III mobility (teeth #41, 31, 32, 18 and 28) and local periodontal problems, including horizontal bone loss (teeth #42, 41, 31, 32, 33, 18, 17, 27 and 28). Teeth #42 and 33 were healthy and not mobile. The alveolar crest in the lateral mandible area showed clinically a wide shape with thick keratinised mucosa. The initial panoramic radiograph revealed stable crestal bone

Treatment step	Product	Manufacturer
CBCT	**PaX-Uni3D**	**VATECH**
Virtual implant planning	3Diagnosys	3DIEMME
Implants	ELEMENT RC (4.5 x 9.5 mm)	Thommen Medical
CAD	exocad	exocad
CAM	M1 Wet	Zirkonzahn
Provisional FDP	Prefabricated titanium abutments CAD/CAM cobalt–chromium framework Composite veneering and teeth	Thommen Medical Sintermetall (Zirkonzahn) SR Nexco Paste (Ivoclar Vivadent)
Final FDP	CAD/CAM cobalt–chromium framework Composite veneering and teeth	Sintermetall (Zirkonzahn) SR Nexco Paste (Ivoclar Vivadent)

Table 1: Material and software used for the planning and realisation of the treatment.

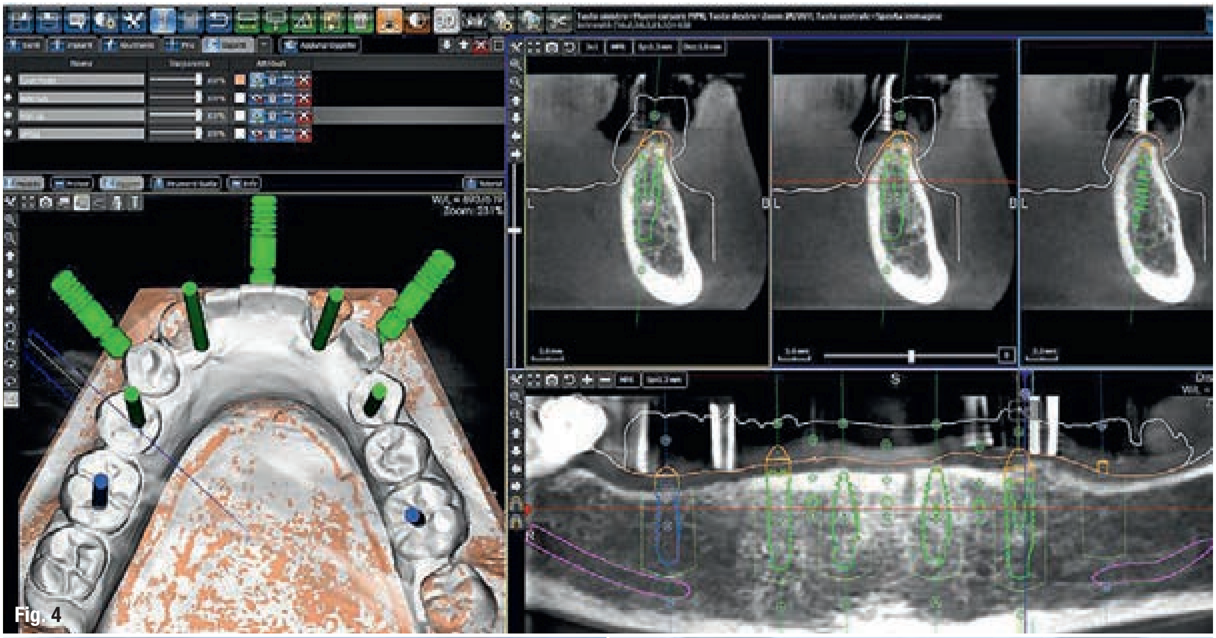


Fig. 4

Fig. 5a

Fig. 5b

Fig. 4: Screenshot of the virtual implant planning for positions #36, 35, 33, 42 and 46, showing occlusal, sectional and panoramic views. **Figs. 5a & b:** CAD/CAM-fabricated surgical guides: tooth- and mucosa-supported **(a)** and implant- and mucosa-supported **(b)**.

in the lateral mandibular area (Figs. 1–3). Thus, in the lower jaw, the single-tooth prognosis was fair for teeth #47, 42 and 33, and hopeless for teeth #41, 31 and 32.[24]

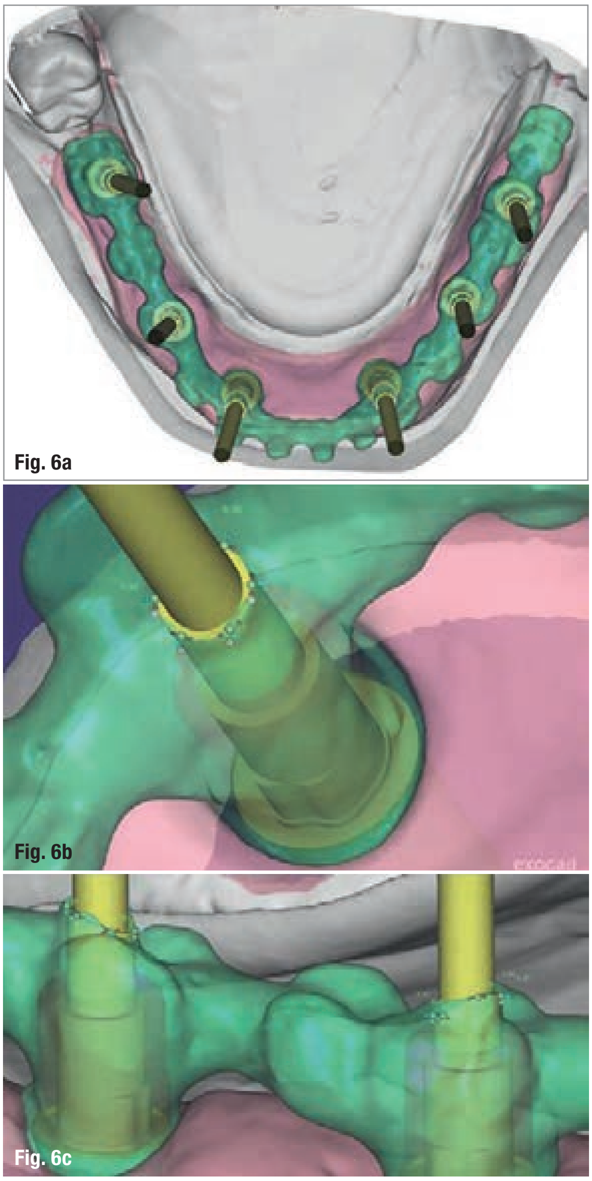
During decision-making for the final treatment plan, various treatment options, including a removable dental prosthesis, were discussed with the patient. To fulfil the patient's wish for a fixed restoration and to never be edentulous in any treatment phase and considering the prognosis of the remaining mandibular teeth, the decision was made to prepare a provisional fixed prosthesis with an immediate loading approach and to extract teeth #42 and 33 for prosthodontic reasons but to maintain tooth #47.

Digital implant planning (Table 1)

After extraction of the painful and extremely mobile teeth #41, 31 and 32 and adaptation of the existing RPD, a cone beam computed tomography scan (PaX-Uni3D, VATECH) with a 5 x 8 cm field of view, 85 kVp generator voltage, 5.5 mA generator current and 0.2 mm voxel size was performed to proceed with the detailed implant planning (Fig. 4). Based on the anatomical conditions and prosthetic planning (i.e. tooth set-up for the provisional RPD), six implants were virtually planned (3Diagnosys, 3DIEMME) in positions #46, 44, 42, 33, 35 and 36. As the implant positions #42 and 33 interfered with teeth #43 and 33, a two-step procedure with two surgical templates was planned for the guided implant placement (Figs. 5a & b). The templates were fabricated stereolithographically (DS3000 and XFAB, DWS) according to the virtual implant planning. Based on the same digital file (Figs. 6a–c), a provisional fixed dental prosthesis (FDP) was prepared preoperatively, allowing for an intra-oral adaptation between the abutments and the framework in order to achieve a passive fit (Figs. 7a–d).

Immediate implant placement

On the day of surgery, a single dose of antibiotic (2 g of amoxicillin and clavulanic acid) was administered pro-



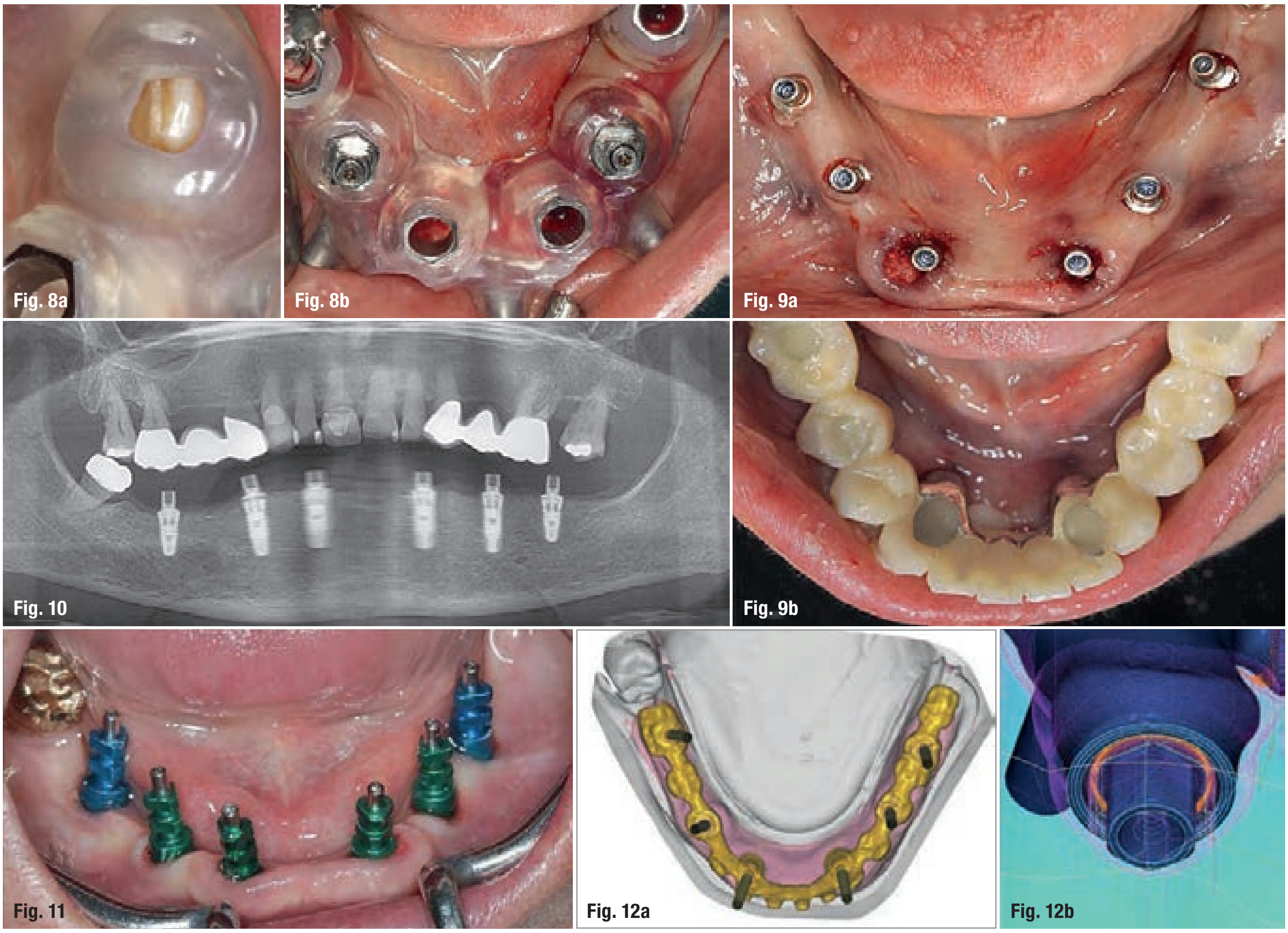
Figs. 6a–c: Occlusal view showing CAD of the provisional FDP framework **(a)** and close-up views from the interface between the CAD framework and the prefabricated titanium abutments **(b & c)**.

phylactically one hour prior to surgery. This treatment continued for five days (1 g of amoxicillin and clavulanic acid twice a day). Prior to the start of surgery, the patient rinsed with 0.2 % chlorhexidine for one minute. Local anaesthesia was induced using a 4 % articaine solution with 1:100,000 adrenaline.

The two-step approach entailed the flapless, guided insertion of four posterior implants (ELEMENT RC, 4.5 x 9.5 mm; Thommen Medical), using the first surgical template, which was tooth- and mucosa-supported (Fig. 8a). The template was then removed and teeth #42 and 33, which had supported the guide, were extracted. Thereafter, the second surgical template was positioned and stabilised on the four poste-

Figs. 7a–d: CAD/CAM model with the prefabricated titanium abutments **(a)**, CAD/CAM cobalt–chromium framework **(b)** and composite veneered provisional FDP **(c & d)** before bonding to the abutments.

rior implants with the help of specific abutments and the same anchor pins (Fig. 8b), thus allowing guided placement of implants (ELEMENT RC, 4.5 x 9.5 mm) in positions #42 and 33 immediately after the extractions. All the implants were inserted at a torque of 35 Ncm and had good primary stability.



Figs. 8a & b: Close-up view of the first CAD/CAM guide *in situ* (tooth- and mucosa-supported) showing the perfect fit on tooth #33 **(a)**. Occlusal view of the second CAD/CAM guide (implant- and mucosa-supported) after extraction of teeth #42 and 33 and placement of implants in positions #44 and 35 **(b)**. **Figs. 9a & b:** Occlusal views of the abutments **(a)** and of the immediate provisional restoration that were passively bonded *in situ* **(b)**. **Fig. 10:** Post-op panoramic radiograph. **Fig. 11:** Frontal view showing the screw-retained posts at impression taking 24 weeks after implant placement. **Figs. 12a & b:** Occlusal view showing CAD of the final FDP **(a)** and detailed screenshot of the interface geometry **(b)**.

Immediate loading

After removal of the second surgical template, the standard titanium abutments were mounted on to the implants at a torque of 15Ncm (Fig. 9a). The gaps between the abutments and the FDP were filled with a dual-curing composite material and the screw-retained immediate provisional FDP delivered. The occlusion required only minor adaptations owing to the accurate digital preoperative planning (Fig. 9b). The postoperative panoramic radiograph showed the parallel axes of the six implants (Fig. 10).

Final fixed prosthesis

All six implants osseointegrated successfully without complications. After six months of the patient wearing the provisional FDP, a conventional impression was taken (screw-retained impression copings, open-tray technique, polyether material) to fabricate the final FDP on a new, precise cast (Fig. 11), which was then digitised with a laboratory scanner (Deluxe scanner, Open Technologies). The final framework was designed with straight connection to the implant platforms and with a cutback allowing for the veneering material (Figs. 12a & b). While the cobalt–chromium framework was fabricated using CAD/CAM technology (exocad, exocad; M1 Wet, Zirkonzahn), the veneering was performed manually, allowing for individual characterisation of the teeth (Figs. 13a–d). The models were fabricated with a laser stereolithography printer (XFAB) using an ABS-like polymer (Precisa RD096B, DWS). Healthy mucosal conditions were present at the delivery of the final CAD/CAM restoration, made from cobalt–chromium and composite veneering material (Figs. 14a–e). The accurately fitting FDP was attached with screws at 25Ncm and the screw access area covered with composite material. The panoramic radiograph on the day of delivery showed optimal prosthetic and osseous conditions (Fig. 15). The patient followed a regular maintenance programme at the dental hygienist twice a year.

At the one-year follow-up appointment, healthy mucosal and stable crestal peri-implant conditions were observed (Fig. 16). The patient was very pleased with the aesthetic and functional outcome. Thus, the performed treatment was successful, and it showed stable results without complications or the need for maintenance service after the first year.

Discussion

The use of CAI software in the preoperative virtual 3D implant planning allowed for guided and immediate implant placement, and proved to be especially beneficial in the mandibular full-arch case presented. While there are some studies that have investigated outcomes of immediately loaded implants placed in edentulous patients using computer-aided, template-guided surgery to support an FDP,[25] only few case reports are available in the literature that describe the entire workflow, the patient's state in detail and the usage of guided surgery templates with subsequent immediate loading.[3,4] The considerably more complex combination of immediate implant placement and immediate loading required a high level of organisation between the implantologist and technician, minimising the required compliance of the patient. Pozzi et al. reported excellent results with CAD/CAM cross-arch zirconia bridges on immediately loaded implants placed with computer-aided, template-guided surgery.[26] Several investigators have presented analyses of recent studies in this context, elaborating on the factors that influence accurate implant placement but also the comparable outcome of the restorations after guided implant placement.[15,20,21,27–31] In the present case report, two CAD/CAM surgical templates were combined in this partially dentate patient, with extraction of teeth #42 and 33 and immediate implants performed in a sequenced order. The first scanner-based template was tooth- and mucosa-supported, enabling a higher template stability and thus more accurate guided osteotomies and implant placement. Four posterior implants were placed with this approach, allowing support of the second surgical template after extraction of teeth #42 and 33. The stability on these four points was high, as the implants in positions #42 and 33 showed a torque value of 35–40 Ncm each. The placement of the subsequent two anterior immediate implants was thus perfectly guided.


Fig. 13a


Fig. 13b


Fig. 13c


Fig. 13d

Figs. 13a–d: CAD/CAM-fabricated one-piece cobalt–chromium framework before **(a & b)** and after veneering with composite (SR Nexco Paste, Ivoclar Vivadent), that is the final FDP **(c & d)**.

Different factors contributed to this insertion torque, such as the depth of the planned implant position in a more apical area than the extraction site, the minimally invasive tooth extraction, the macroscopic implant geometry and the osteotomy protocol with a smaller drilling diameter compared with the implant diameter (as proposed by the company), the accurate performance of the single steps in the pre- and intra-operative phases, and the bone density in the anterior mandibular area. The prefabricated provisional FDP was prepared to connect the abutments to the FDP intra-orally, which was easily performed, given the accurate implant positions. With this approach, the passive fit of the FDP was maximised, the clinical chairside efforts (in terms of abutment connection and occlusal adaptations) were minimal and the predictability was very high compared with the various limitations and problems reported in a recent review.[32]

The preoperative communication between the dentist and the technician during the decision-making and planning phase was essential for concise timing in the clinic, ensuring the highest surgical and prosthodontic performance accuracy in this particular case. Therefore, up-to-date software and hardware, as well as the knowledge of how to apply the specific products, were required. This

Figs. 14a–e: Occlusal, frontal and lateral views on the day of delivery, showing healthy peri-implant mucosal conditions **(a)** and the final CAD/CAM restoration *in situ* **(b–e)**.

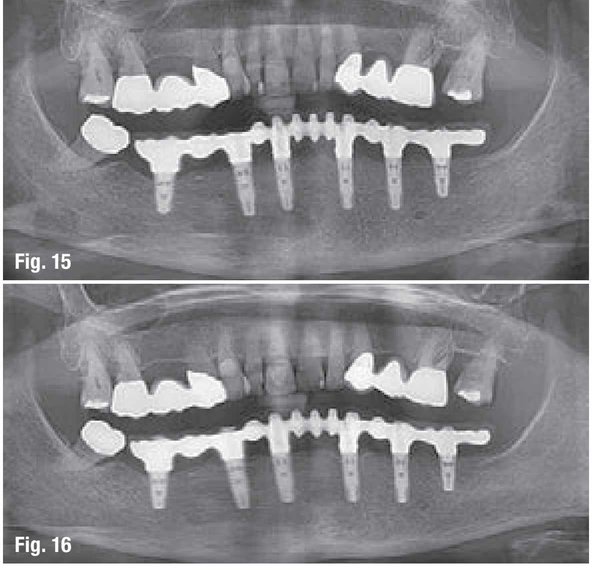


Fig. 15: Panoramic radiograph at delivery of the final CAD/CAM FDP. **Fig. 16:** Panoramic radiograph at the 12-month recall appointment.

case report supports the need for minimally traumatic or flapless surgery, optimal implant positioning and immediate loading, as summarised in a recent review on randomised controlled trials.[33]

Conclusion

The present case report has emphasised the efficient workflow and the predictable outcome using CAI. The fabrication of an immediate provisional FDP and, subsequently, the final CAD/CAM restoration was facilitated by CAI, fulfilling the patient's wish to being continuously restored throughout the complete treatment.

Editorial note: A list of references is available from the publisher. This article was first published online in BMC Oral Health *on 11 April 2019.*

Acknowledgements
Thommen Medical is acknowledged for its logistical and administrative help during the treatment.

Funding
No funding body was involved in the design of the study, in the collection, analysis or interpretation of data, or in the writing of the manuscript.

Competing interests
The authors declare that they have no competing interests related to this case report.

about

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Making a perfect ceramic crown on a titanium abutment in the aesthetic zone

Overcoming a challenging situation step by step

Patrick Rutten, Belgium


Fig. 1

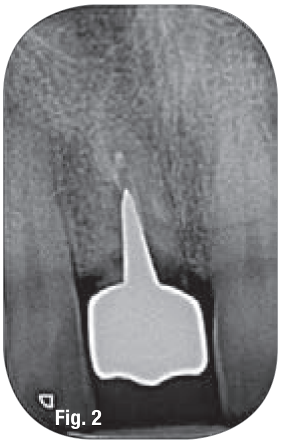


Fig. 2

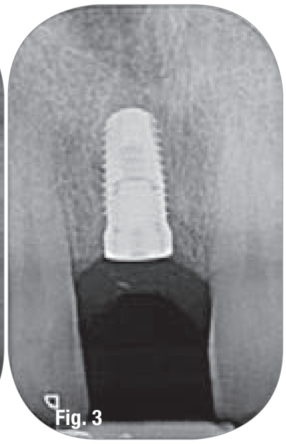


Fig. 3

Figs. 1 & 2: Initial situation, clinically and radiographically, before extraction of the right maxillary central incisor. **Fig. 3:** Radiograph after implant placement.

For reasons of strength, a titanium abutment may be required in the aesthetic zone. However, masking the dark metal to achieve a natural-looking outcome presents a challenge. A ceramic crown with a zirconia coping should be used to mask the metal abutment. A layering protocol is used to create natural light and colour and avoid greyish-looking gingival tissue in the cervical area. In the following clinical report, the author demonstrates how to handle such a challenging situation and obtain predictable white and pink aesthetics.

Clinical situation

More than 40 years after a sports injury, extensive caries was detected radiographically under a post and core crown on the maxillary right central incisor (Figs. 1 & 2). The tooth was determined to be unrestorable and was extracted. After a healing period of eight weeks, an implant was placed (Fig. 3) and allogenic bone augmentation and soft-tissue regeneration with a free connective tissue graft harvested from the palate were performed simultaneously. A healing abutment was screwed on to the implant and a removable provisional denture provided. For reasons of strength, a custom CAD/CAM-fabricated titanium abutment was chosen (Fig. 4). I prefer to avoid using titanium in the anterior if possible, but in this case, function was more important than aesthetics. The challenge was to veneer a zirconia coping with the fine-structured feldspathic ceramic VITA VM 9 (VITA Zahnfabrik) to reproduce the natural appearance of the adjacent teeth and to support and sculpt the soft tissue for optimal gingival management. Working with a titanium abutment is very difficult because the gingiva can look greyish, and we have to mask the greyish cervical part. Precise shade determination was the first requirement for success. To guarantee a perfect shade match, the VITA Linearguide 3D-MASTER (VITA Zahnfabrik) was used to cover the whole 3D tooth shade spectrum and to allow shade determination in three defined steps (Fig. 5). In the first step, the shade value was verified, followed systematically by chroma and hue. The basic shade of the adjacent teeth was measured digitally with the VITA Easyshade V spectrophotometer (VITA Zahnfabrik). The expert independently determined the tooth shade to be 3M2, and this was confirmed with the digital device. To achieve a shade match between the natural teeth and the restorations, the correct basic shade is highly important.

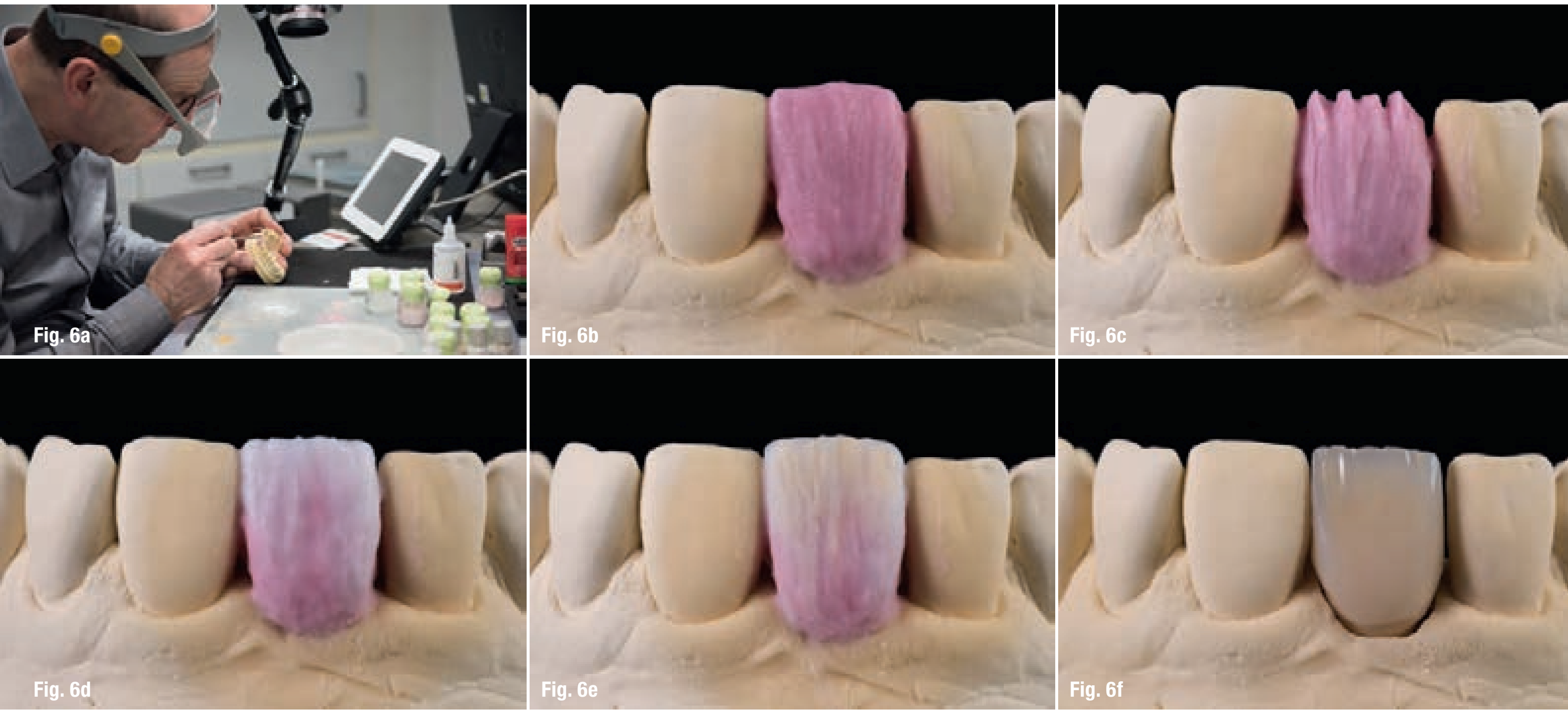
Fig. 4: Titanium abutment screwed on to the implant. **Fig. 5:** Determination of the basic shade with the VITA Linearguide 3D-MASTER.

Layering procedure

The zirconia coping was virtually designed, milled, sintered and fitted. An initial wash firing with VITA VM 9 EFFECT LINER (VITA Zahnfabrik) was a crucial step in adding a fluorescent layer to the non-fluorescent zirconia coping. The liner also provided reliable bonding to the framework. The firing temperature should be 50° higher than that of normal dentine firing. VITA VM 9 BASE DENTINE 3M3 (VITA Zahnfabrik) with a higher chroma was used in the cervical area to mask this critical area and to mask the lifeless and greyish appearance of the titanium abutment. EFFECT CHROMA 4 (yellow; VITA Zahnfabrik) was then applied with a deeper orange in the interdental areas with a mixture of EFFECT CHROMA 5 (golden rod) and 6 (sunflower; VITA Zahnfabrik) to enhance the masking effect. For the incisal third area, a higher value was selected with 3M2.

To create the ridges, the bluish EFFECT ENAMEL 9 mixed with ENAMEL LIGHT (VITA Zahnfabrik) was chosen (Figs. 6a–f). The synergy of these three basic components is essential for the incisal edge: colour, enamel and translucency.

VITA VM 9 ENAMEL LIGHT and EFFECT ENAMEL 9 were layered to create a bluish accentuation and replicate natural aesthetics. In addition, VITA INTERNO 2 (sand) and 4 (orange; VITA Zahnfabrik) were added to replicate the characteristics of the contralateral tooth. VITA INTERNO ceramics played an important role in increasing fluorescence and natural warm colour effects with internal characterisation. These characterisations should always be arranged irregularly for a natural appearance. To achieve a contrast, BASE DENTINE was layered on to the palatal side of the incisal edge. During contouring, the ceramic mixture must remain creamy and stable to achieve an efficient and



Figs. 6a–f: Master dental technician Patrick Rutten at work **(a)**. Layering of the dentine core **(b)**. Creation of the mamelons **(c)**. Layering of the enamel **(d)**. Characterisation with INTERNO **(e)**. Result after the first dentine firing **(f)**.

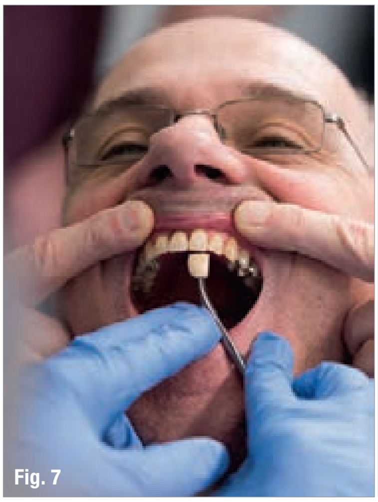


Fig. 7: Shade assessment after the first dentine firing. **Fig. 8:** Final layering and contouring.

successful layering procedure. This layer was increased slightly to allow for intra-oral adjustment. An implant crown should be adjusted so that functional loading is minimised.

Be careful with translucency!

If the crown contour needs to be increased, translucent porcelain should never be added, since the addition will always reduce value and chroma. Using too much translucent enamel is a common mistake and will automatically lead to a greyish-looking tooth. BASE DENTINE should be applied again to correct the deficient contour (Figs. 7 & 8). If the value has to be changed, the technician should go back two steps and correct the basic value. The basic value is the most important thing for me, and the technician should play around with it. The palatal side was layered with EFFECT CHROMA 4 (lemon drop) and BASE DENTINE to mask the transition between the coping and layering in these areas. My general advice for finding the correct ceramic shade combination is that, because getting the right mixture will sometimes take more time than the layering itself, the technician should not start mixing thousands of powders.

Finishing the restoration

Maintaining adequate healthy pink-coloured gingiva is challenging for the dentist, especially around implant restorations. To accomplish optimal gingival architecture, the shape of the neighbouring lateral incisor was replicated and the gingival papilla supported to avoid creating black triangles. The distal and mesial marginal ridges

Fig. 9: Clinical evaluation.


Fig. 10


Fig. 11

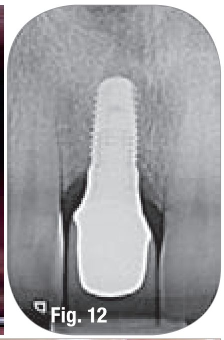


Fig. 12


Fig. 13


Fig. 14

Fig. 10: Evaluation before glaze firing. **Figs. 11 & 12:** Cemented maxillary right central incisor crown intra-orally and periapical radiograph. **Fig. 13:** Natural and aesthetic smile. **Fig. 14:** Close-up lateral view of the maxillary incisors.

were created with a fine diamond instrument to produce a fluent curvature toward the apex. After the fine-structured feldspathic ceramic had been fired, the subgingival areas were contoured and polished with a rubber wheel to create a smooth and compatible environment for the surrounding soft tissue. The chipped adjacent tooth was matched in the restoration, although in a different location for a more natural outcome. A vertical crack line was accomplished with a fine tungsten carbide bur. The technician can place the cracks 2 or 3 mm away from the position on the corresponding neighbouring tooth, since the crack line should be irregular. Final characterisation was achieved with VITA AKZENT Plus EFFECT STAINS (VITA Zahnfabrik) and then fired. I try to create something soft without overdoing it.

Make the best, but keep it simple!

The goal should be to keep the technique straightforward and to know when a restoration is finished so that time is not wasted and cost goals are met. Consequently, every veneering procedure should be consistently ended at some point. The crown was clinically evaluated before the final glaze firing (Figs. 9 & 10). After evaluation of the aesthetics, function and occlusion, the restoration was finalised in the dental laboratory and definitively cemented (Figs. 11–14). The restoration looked exceptionally natural and integrated harmoniously in the aesthetic zone. Texture and ceramic layering created a highly aesthetic combination of contour and colour. The crown supported the gingival architecture and was thereby able to accomplish pink aesthetics. The patient was delighted with his new restoration and appreciated the outcome.

Thanks to expertise, technical skills, interdisciplinary teamwork, and outstanding ceramics, a challenging clinical case was solved in a highly aesthetic manner.

Editorial note: This article originally appeared in dental dialogue 5/2016*, published by teamwork media. Its edited version has been reproduced here with permission.*

about

Patrick Rutten graduated in dental technology from the Anneessens dental technology school in Brussels in Belgium. After completing his training, he moved to Cologne in Germany to specialise in different milling and ceramic layering techniques. Together with his brother, Luc, he has lectured regularly all over Europe and in Australia, India, Israel, Japan, South Africa, Saudi Arabia, and the US. In addition to regularly writing numerous articles published in international dental journals in the field of aesthetic implantology, he has co-authored several textbooks and the books *Implantat Ästhetik* (teamwork media, 1999) and *Crown—Bridge and Implants: The Art of Harmony* (teamwork media, 2006). Together with his brother, he maintains a dental laboratory in Tessenderlo in Belgium dedicated to ceramic restorations and aesthetic implantology. He is an active member of the European Academy of Aesthetic Dentistry and of the International Academy for Digital Dental Medicine.

"We are in the forefront of CAD/CAM software development"

An interview with Tillmann Steinbrecher, CEO and co-founder of exocad. By Monique Mehler, DTI

The exocad management remains on board. "We will continue our way as before and remain independent," stated Tillmann Steinbrecher, CEO and co-founder of exocad.

For ten years now exocad's dedicated team of engineers and researchers has consistently delivered state-of-the-art innovations to the dental industry. At the exocad press conference in Darmstadt, Germany, on 12 March, Dental Tribune International met with the company's CEO, Tillmann Steinbrecher, to discuss the partnership with Align Technology, evaluate what impact the collaboration could have and consider the future of digital dentistry.

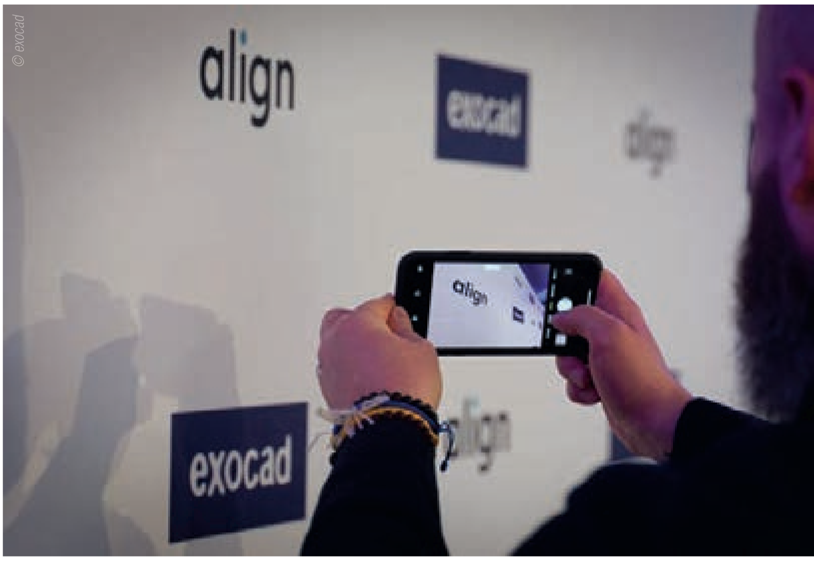
Mr Steinbrecher, what prompted exocad to sell to Align Technology?

It is the second time that the company has sold shares. The first time was in 2016 when a private equity investor of the Carlyle Group came on board and became the majority shareholder, acquiring all of Fraunhofer's shares [exocad was originally founded in 2010 as a spin-off of the world-renowned Fraunhofer Institute]. During that investment period, we basically transformed exocad from a startup to a well-structured global company. I think the two companies complement each other, because there is very little overlap in the customer base and the technologies, which creates potential synergies. We are at the forefront of CAD/CAM software development, and in implantology, we have the best-in-class products. Align Technology offers best-in-class digital solutions—so it is an ideal fit. We will work together to further enable digital transformation in the dental industry and for our customers.

The deal is set to close in the second quarter of 2020. What are your expectations for the near future?

We will continue to operate as we exist today to maintain our open approach and support a broad ecosystem of partners and users and continue to deliver hardware-independent software solutions.

“We will continue to support all the partnerships we have throughout the industry.”



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How has the announcement of the acquisition been received by the industry so far, and how will it affect your business?
Overall, we have received a great deal of positive feedback from our customers and from the users as well. However, there have also been some mixed reactions. The thing that people wondered about most was whether they would be able to continue to purchase our products and whether we would remain as open as we are today. We would like to give everyone who has similar concerns full assurance that we will continue to support all the partnerships we have throughout the industry and that we will still have independence within the Align collaboration to do that.

Market research forecasts that the global CAD/CAM market is expected to grow continuously. Do you hope that this will give your company preferential development?
In past years, exocad grew faster than the market, and I expect that to continue in the future. There are some parts of the world where, by comparison, we are still a bit under-represented, and I think that, by being acquired by a larger company, we will be able to have more impact.

How will the exocad users benefit from the collaboration?
Even though some dentists use our software solutions, most of our users are laboratory technicians. Among other things, they will benefit from further improvements and integration with the installed base of iTero intra-oral scanners. As far as dentists are concerned, there will be extremely interesting solutions for orthodontic restorative purposes, although it is still too early to comment on details in this area.

This year, exocad will be celebrating its tenth anniversary. In the past, what were the biggest milestones for exocad? And what are you hoping to achieve in the next ten years?
The first milestones were the ones we mastered while we were still employees at the Fraunhofer Institute. These included finding major partners from the industry who would sell CAD/CAM systems based on our CAD technology. So far, we have all been very successful with that, and everyone benefited from working together. The next big challenge was geographic expansion. We still are a much smaller company than our competitors, and getting a foot in the door in Asia or the US was not that easy. But I am very happy with what we have achieved in that respect. In the US, we have a great team and a significant market share, and in Asia, we are the market leader; we consider these achievements to be major milestones. In assessing the future, I think that, today, even though there are various integrative approaches, we still find a dominance of isolated and non-connected solutions in digital dentistry. So, we have CAD/CAM software, software for guided surgery, an orthodontics solution and so on. And they are not optimally linked, as the cross-disciplinary workflows are quite cumbersome. I think that, in the future, there will be very few platforms across the disciplines that will allow more holistic and digitally supported treatments. This idea is something that fascinates me and could greatly benefit our customers, and this is something we want to build together with Align in the future.

“I am very happy with what we have achieved.”

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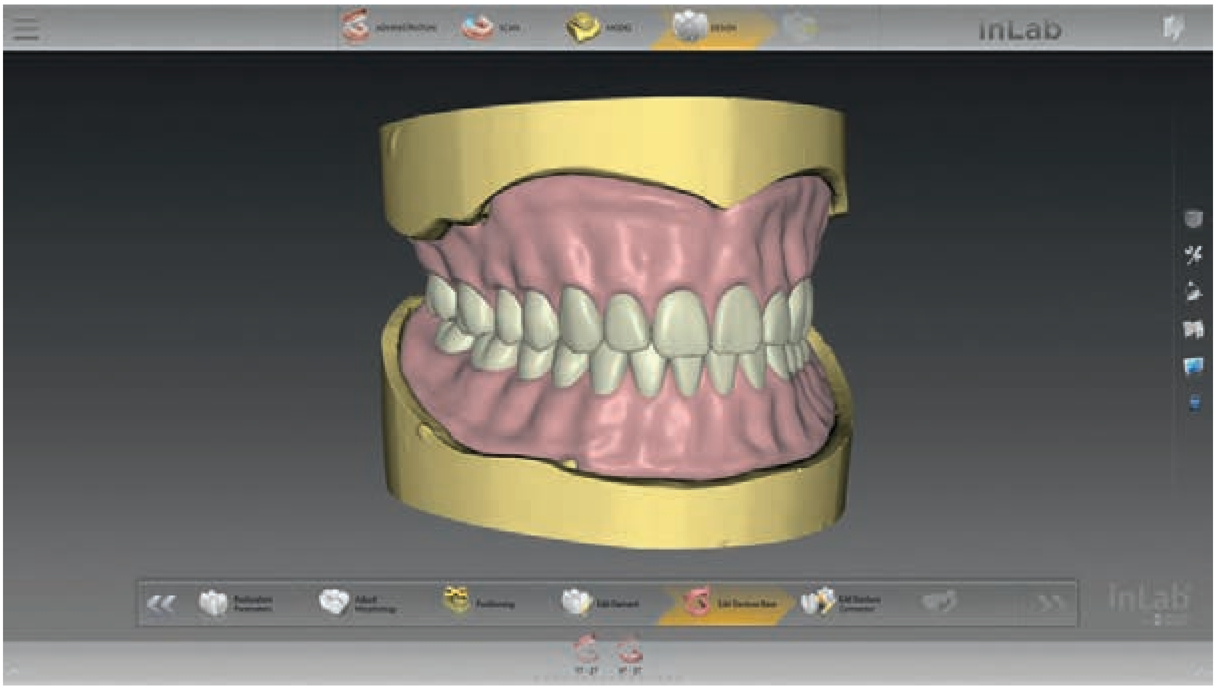
Simply digital

Complete dentures with inLab SW 20.0



The conventional production of dentures is one of the most complex manual activities in the dental laboratory, requiring high expenditure of time and intensive use of work materials, as well as specific dental technical qualifications and experience. The manufacture of a digital denture places correspondingly high demands on the CAD/CAM-supported manufacturing process. With inLab SW 20.0, Dentsply Sirona has expanded the software's range of dental indications to include the fabrication of digital dentures and is offering a laboratory-oriented and economically compelling introduction to this field of application. The digital production of dentures accelerates the manufacturing process in the laboratory, offers confidence in accuracy, reproducibility and material quality and has a positive influence on the cost aspects in general.

Digital workflow simplifies complex processes

The new inLab software now has an extended field of application to dentures and provides the dental laboratory with optimum digital support for all relevant process steps—from accurate imaging of the maxillomandibular relationship record with the inEos X5 extra-oral scanner from Dentsply Sirona, covering automated and careful model analysis, to the initial proposal of a possible tooth set-up and the design of the denture base. Familiar and proven procedures regarding functional impressions and maxillomandibular relationship record taking can be retained. The laboratory decides on the further digital processing.

High usability and intuitive operation are central components of this new application of inLab software. The software guides the dental technician step by step safely through the entire digital process without the user having to forego individual design requirements. The intelligent model analysis supports the definition of the required anatomical features. Users of the inEos X5 extra-oral scanner also benefit from the latest software update. An easy-to-use interface, a new menu of options for each step and interactive help via the object list guide users through the scanning process for every indication. Especially for the digital denture, a uniquely developed denture holder positions the maxillomandibular relationship record for safe and steady scanning in just one step. The denture-optimised software also enables a new and fast scanning workflow for the exact correlation of the upper and lower jaws—the optimal basis for the subsequent design.

Tooth arrangement of user's choice

InLab SW 20.0 offers two options for tooth placement: the use of digitised denture teeth that are stored in a tooth library or of an individual tooth set-up. Both are based on the unique biogeneric algorithm through which the software adapts the pre-occluded teeth to the given jaw situation.

In the case of denture teeth from the dental library, the new prefabricated IPN 3D Digital Denture Teeth from Dentsply Sirona are used; these have been especially developed for the digital process. They are uniquely designed to prevent penetration through the intaglio surface of the denture base. After the teeth have been placed in the inLab software, the denture base is designed with the corresponding tooth pockets. A special positioning system is used, which facilitates the subsequent attachment of the acrylic teeth and thus accelerates the positioning and bonding of the teeth.

For the individual tooth set-up morphology, shape and occlusion can be individually designed after the positioning. This allows specific patient situations to be taken into account or individual tooth shapes to be created. The complete tooth arch can be completely fabricated or, depending on requirements, divided into several segments down to the individual tooth. After the denture has been designed, a monolithic try-in can be fabricated.

Staying flexible in production

The subsequent manufacturing process can be carried out using various methods; for example, the denture base can be milled out of a blank, such as Lucitone 199 Denture Base Disc from Dentsply Sirona, or manufactured in 3D printing material, such as Lucitone Digital Print 3D Denture Resin. Depending on the tooth set-up selected, the tooth arch or segments are milled out of a disc, or the prefabricated IPN 3D Digital Denture Teeth are used.

The inLab system continues to follow the principle of seamless, validated and open connection to suitable manufacturing processes, whether with inLab MC X5 from Dentsply Sirona or via the optional interface with other suitable production units using the milling or 3D printing processes.

Digital dentures with inLab—an option for any preference

InLab software offers a fast, simple and reasonably economical entry into digital fabrication and opens up the digital path that suits the dental laboratory best.

The new application is integrated into the inLab SW 20.0 removables module. More information can be found at:

dentsplysirona.com/digital-denture

Owing to various certification and registration periods, not all products are immediately available in all countries.

CediTEC and V-Print dentbase from VOCO

CAD/CAM system for individual prostheses

It is a familiar situation: time is in short supply and yet the dentist, dental technician and patient all want dentures which satisfy the highest requirements. CediTEC and V-Print dentbase are now being offered by VOCO as a system which unites denture bases, prosthetic teeth and luting materials. This means that the entire prosthesis can be produced quickly and simply in just a few steps.

While CediTEC DT provides the material for the prosthetic teeth as well as the luting material, the denture base is being launched on the market as dentbase, part of the V-Print range. The combination of milling and 3D printing technology not only simplifies the process, but also offers the technician performing the work the option of reproducing the prosthesis at any time—and far quicker than with the classic method.

CediTEC DT:

CAD/CAM composite for prosthetic teeth

From individual prosthetic teeth right up to complete dental arches for removable dentures, CediTEC DT allows the quick and very precise production of customised prosthetic teeth using the CAD/CAM milling technique. The four shades (A1, A2, A3 and BL), the additional option of customising the shade and the translucent colouring ensure appealing aesthetics. The innovative material can be polished effortlessly, delivering a natural sheen. The already polymerised composite is offered as a disc with a diameter of 98 mm and a height of 20 mm and fits all universal disc holders of milling devices conventionally available on the market.

CediTEC:

System for luting prosthetic teeth in denture bases

The prosthetic tooth luting system comprises CediTEC Adhesive and CediTEC Primer. CediTEC Adhesive is mixed in a practical cartridge that avoids mixing errors or air bubbles. Thanks to the convenient mixing tip, the product can be applied to the base directly from the cartridge using a dispenser. This means that only as much material is mixed as is actually required.

CediTEC Primer creates the bond between the base or tooth and the adhesive. It is poured on to a mixing tray directly from the dropper bottle and applied to the base and tooth with a brush. After an air-drying period of only 30 seconds, CediTEC Adhesive can be applied and the tooth inserted.

When used as a system together with V-Print dentbase, it is therefore possible to produce high-quality dentures quickly and efficiently. However, CediTEC is of course also compatible with other systems currently available on the market.

www.voco.dental/en/home.aspx

Burs designed for laboratory applications

SS White's Great White carbide lab burs provide excellent value

For increased performance and durability in laboratories, SS White developed its Great White Lab Series carbide burs, which feature a patented proprietary zirconium nitride coating.

When choosing a dental bur, the options seem endless, even for specialty burs like those designed for laboratory applications. The needs and requirements of dental laboratories have changed significantly over the past ten years, and today's laboratories cut everything from plaster to titanium and require a product that offers great efficiency.

For increased performance and durability in laboratories, SS White developed its Great White Lab Series carbide burs, featuring a patented proprietary zirconium nitride coating to increase the surface hardness of the bur and create an extremely efficient cutting instrument. According to Brant Miles, vice president of business development at SS White, the Great White laboratory burs offer up to ten times increased durability and longevity compared with products not coated with zirconium nitride.

With a tungsten carbide head, the burs cut a multitude of different dental substrates, and a stainless-steel shank reduces unnecessary wear to the handpiece. The burs are abrasion-resistant, reducing surface heat and vibration for a cooler and more consistent surface finish.

With the versatility to cut all types of materials, the Great White laboratory burs are available in cross-cut and spiral-fluted blade configurations in a variety of shapes, sizes and grits. Dental professionals can choose the correct instrument for all applications, whether for bulk reduction, adjusting or fine finishing on all dental materials, including stone, acrylic, precious and non-precious metal, and any other material used in the dental laboratory.

"The Great White Lab Series burs offer excellent value owing to their industry-leading cutting efficiency, which leads to increased service life and lower instrument cost. With optimal material reduction, the laboratory cutters produce a high-quality surface finish, which helps reduce remakes," reported Miles.

SS White invites anyone interested in adding Great White carbide laboratory burs to their SS White product line or becoming an SS White dealer to contact Michael Schwartz at mschwartz@sswhitedental.com.

By partnering with SS White and representing the 175-year-old brand, dealers will benefit from:

- a differentiated full product line for restorative dentistry and endodontics,
- world-class quality (ISO 13485:2003),
- preferred pricing commitment,
- industry-leading delivery times,
- full sales and marketing support.

More information can be found at **www.sswhitedental.com.**

"Excellence made easy" through speed, user friendliness and precision

An interview with Dr Alexander Völcker, Dentsply Sirona. By Claudia Duschek, DTI

Dr Alexander Völcker, group vice president of the dental product group CAD/CAM and orthodontics, in conversation with Dental Tribune International.

Dentsply Sirona recently introduced its new grinding and milling unit—CEREC Primemill—to the world. More than 200 international key opinion leaders and press representatives attended the exclusive product launch in Berlin, Germany. Dental Tribune International had the opportunity to speak with Dr Alexander Völcker, group vice president of the dental product group CAD/CAM and orthodontics.

Dr Völcker, the well-proven CEREC system has reached a new level with the introduction of CEREC Primemill. What led you to develop the unit and what exactly sets it apart from previous models?
Owing to the intensive contact that we maintain with our customers, we always know exactly what questions and topics concern them. In addition, our engineers are always coming up with new ideas as to how products and solutions can be improved. Of course, CEREC MC XL was and still is a great grinding and milling unit, but about four and a half years ago, the time had come to bring these new ideas to life and invest again in developing a completely new machine. We were convinced that the market would respond well to the numerous new features.

At first glance, the CEREC Primemill does not appear to differ that much from its predecessors, however and yet, it is quite different. We have deliberately given the new system the tag line "Excellence made easy". This statement is founded on the key principles of speed, precision and user friendliness. The speed at which restorations can now be manufactured represents an economic and a structural value—for dental practices and, above all, for patients. For treatment durations of more than 75 to 90 minutes, renewing anaesthesia is almost always necessary. With the new CEREC workflow, a patient can be treated in only one session without having to receive another local anaesthetic. In terms of accuracy, the newly developed fine tools ensure that fissure details can be very precisely drilled out. Furthermore, when combined with the easy-to-use touch interface, the technology practically eliminates minor errors, such as those that can occur when choosing tools or materials. That's what "made easy" means to us.

After the successful introduction of the Primescan intra-oral scanner last year and now the CEREC Primemill, Dentsply Sirona is staying focused on innovations in chairside dentistry. Is this the area in which you see the greatest development potential?
We were pioneers in this area. Today, we are clearly the market leader and will continue to drive chairside technologies forward. In this respect, we adapt to the varying needs of our customers. Many of them don't want to plunge straight into single-visit dentistry, but would rather get to know the digital process first and continue working with their laboratory. This is why, for instance, we entered into an extensive collaboration with exocad in the area of digital dental workflows last year.

Despite the steadily growing range of digital products on the market, many dentists remain on the threshold of digitalisation. What is Dentsply Sirona doing to advance the level of digitalisation in dentistry, and what role do you think dental education plays in this regard?
The penetration of digital technologies in dental practices is growing noticeably. Dentistry is currently going through a crucial transition period. We have recently become very strong in this area also, owing to the successful launch of Primescan. However, there is no question of the market being saturated yet. From our perspective, the CEREC system that we have today is more attractive than ever before. Hence our slogan "Now is the time—the all-new CEREC". We believe that the system has reached a level of maturity that enables an interested user to change his or her practice in a commercially effective way over a relatively short period.

Education is of huge importance in this regard. Dentists and dental technicians are people who work with their hands, and they want and need to experience the products themselves. Presenting something exclusively on screen can certainly arouse interest. However, we are convinced that it is only through personal experience that interest turns into enthusiasm. That is why events and continuing education courses at which our products can be experienced first-hand are an important building block for us in winning over customers.

> "From our perspective, the CEREC system that we have today is more attractive than ever before."

Dentsply Sirona sees itself as a full-service provider. How important is the CEREC system in your product portfolio?
CEREC is extremely important. The digitalisation of dental practices will influence and advance many other developments in the group as a whole. Our technological advantage helps us to tie in other technologies and improve them further. The entry into the CEREC workflow also impacts upon other areas of our work, for example that of materials. Here too, we are constantly making new developments so that the customer can get everything under one roof.

What role will CEREC play in the dental practice of the future?
This touches on the question of the clinical gold standard of the future. Nowadays, the traditional workflow using conventional impression and laboratory production is essentially the clinically established workflow. However, I believe that this will have to be reassessed in the years to come, especially in light of technological progress. The purely manual workflow can often bring about excellent results, but this is not always true and, above all, does not always happen consistently. The results depend heavily on the practitioner, his or her skills and the way he or she feels on the day. With a digital workflow, these factors only play a minor role. Digitalisation offers great advantages in terms of excellent, predictable results. The establishment of a new gold standard must come from clinical practice, however. We are aware that many clinicians are already investigating this.

> "The purely manual workflow can often bring about excellent results, but this is not always true and, above all, does not always happen consistently."

CAD/CAM can be an incredible teaching tool

An interview with Dr Gary Hack, associate professor at the University of Maryland School of Dentistry.
By Brendan Day, DTI

Dr Gary Hack

Dr Gary Hack is an associate professor at the University of Maryland School of Dentistry, where he teaches in the Department of Advanced Oral Sciences and Therapeutics. In this interview, he outlines how he integrated dental CAD/CAM technology into his teaching methods and how his students have responded to this.

Dr Hack, you've been in dental education for more than three decades. When did you first introduce CAD/CAM tools into your teaching?
Let me give you a little background. In the early 2000s, there were some representatives from Sirona who came to conduct a demonstration at our dental school. At that time, they had the CEREC Red Cam. I had been teaching in the crown and bridge course for many years at that point, but when I saw this technology firsthand, I was overwhelmed. I knew that this was the future of dentistry. I knew that this would introduce an incredible level of excitement for the dental students. And I knew about the students' passion for computers and technology.

In 2006, the University of Maryland School of Dentistry moved into a new building. Our dean at that time was a visionary. He wanted to teach to the future, not to the past. I said to him, "The future is digital dentistry." We were still making impressions while working under a light, just as I did when I was a student back in the 1970s. With his permission, I arranged for a gift from Sirona of ten Red Cams and ten compact milling machines, personally driving them back myself in a truck from Sirona's headquarters and setting them up in our so-called Dream Room. That was the beginning.

How did you incorporate CAD/CAM into your teaching methods at that time?
I began trying to integrate digital dentistry into everything we were teaching from that point onward. At that time, I was teaching a freshman course on amalgams and composites, and the general thinking was that you couldn't gain any value from scanning amalgam and composite preparations because they have undercuts. What I quickly learned, however, was that it was very easy to scan these. Instead of ten or 15 students gathered around you and a typodont, failing to really see anything while you try and explain the walls of an intracoronal preparation, a single scan allowed for me to show everybody all the different elements in a way that was much easier for them to understand.

I soon became aware that, not only was this CAD/CAM equipment good for same-day dentistry in a private practice setting, but it could also be utilised as an incredible teaching tool. I saw that it wasn't just useful for crown and bridge preparations but intracoronal preparations as well.

Now, with the software that is available on certain CAD/CAM devices, the students have the ability to evaluate their own preparations and get feedback from the computer. After 35 years of teaching, I can tell you that it's almost impossible to get ten dentists to look at the same dental preparation and each come up with the same grade. Everyone has his or her own bias, his or her own way of looking at things. However, the computer has no bias.

At the school, we're using digital dentistry solutions for crowns, bridges, veneers, implants and so on, but we now have to integrate it into CBCT imaging and surgical guide printing. I think the current students are getting into dentistry at one of the most exciting times in dental history. I'm passionate about this and want Maryland to be at the forefront of dentistry.

Is the learning curve greater for students now that they have to learn these digital technologies?
There really is no learning curve. These students pick it up within minutes, to a point where they understand it better than I do! They grew up with computers and are naturally drawn to this technology, are passionate about it and are excited to bring it into their future dental practices.

Many of our graduates who apply for jobs working under older, more experienced dentists are also already ahead of the rest of the pack as a result of their familiarity with digital dentistry. The older dentists might be a little nervous about integrating CAD/CAM technology into their dental practices, but realise that CAD/CAM is nonetheless the future of dentistry.

Do you think that the price of investing in CAD/CAM tools and technologies can be prohibitive?
Let me begin with the private practice. The return on investment is clear: If you buy this technology, it can often pay for itself within a few years as a result of savings. If you mill in-house or simply digitally scan at your practice and still send away to a dental laboratory for fabrication, you will be saving money over using conventional techniques.

In my opinion, all dental schools are, to some degree, struggling with this decision. Clearly, they know that they have to do this, that it is incumbent on them that they teach their students this technology, since if they don't, they are not properly preparing them for their future practice. Yes, the financial cost can be a barrier,

> "I soon became aware that, not only was this CAD/CAM equipment good for same-day dentistry in a private practice setting, but it could also be utilised as an incredible teaching tool."

but this is clearly outweighed by the benefits that come with integrating CAD/CAM devices into current methods of teaching.

Is there a role for industry to play in supplementing this classroom learning?
My thinking is that, yes, it can play a role. As teachers, we can go back to the manufacturers and tell them what we would like to see in their evaluation software and they will work on it. There is a collaboration between dental school education and the manufacturers that becomes a win-win situation. The manufacturers know that, if the students are being taught digital dentistry, then chances are, when they get into private practice, they'll move in that direction.

How to send us your work

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- the complete article;
- all the image (tables, charts, photographs, etc.) captions;
- the complete list of sources consulted and
- the author or contact information (biographical sketch, mailing address, e-mail address, etc.).

In addition, images must not be embedded into the MS Word document. All images must be submitted separately, and details about such submission follow below under image requirements.

Text length

Article lengths can vary greatly—from 1,500 to 5,500 words—depending on the subject matter. Our approach is that if you need more or fewer words to do the topic justice, then please make the article as long or as short as necessary.

We can run an unusually long article in multiple parts, but this usually entails a topic for which each part can stand alone because it contains so much information.

In short, we do not want to limit you in terms of article length, so please use the word count above as a general guideline and if you have specific questions, please do not hesitate to contact us.

Text formatting

We also ask that you forego any special formatting beyond the use of italics and boldface. If you would like to emphasise certain words within the text, please only use italics (do not use underlining or a larger font size). Boldface is reserved for article headers. Please do not use underlining.

Please use single spacing and make sure that the text is left justified. Please do not centre text on the page. Do not indent paragraphs, rather place a blank line between paragraphs. Please do not add tab stops.

Should you require a special layout, please let the word processing programme you are using help you do this formatting automatically. Similarly, should you need to make a list, or add footnotes or endnotes, please let the word processing programme do it for you automatically. There are menus in every programme that will enable you to do so. The fact is that no matter how carefully done, errors can creep in when you try to number footnotes yourself.

Any formatting contrary to stated above will require us to remove such formatting before layout, which is very time-consuming. Please consider this when formatting your document.

Image requirements

Please number images consecutively throughout the article by using a new number for each image. If it is imperative that certain images are grouped together, then use lowercase letters to designate these in a group (for example, 2a, 2b, 2c).

Please place image references in your article wherever they are appropriate, whether in the middle or at the end of a sentence. If you do not directly refer to the image, place the reference at the end of the sentence to which it relates enclosed within brackets and before the period.

In addition, please note:

- We require images in TIF or JPEG format.
- These images must be no smaller than 6 x 6 cm in size at 300 DPI.
- These image files must be no smaller than 80 KB in size (or they will print the size of a postage stamp!).

Larger image files are always better, and those approximately the size of 1 MB are best. Thus, do not size large image files down to meet our requirements but send us the largest files available. (The larger the starting image is in terms of bytes, the more leeway the designer has for resizing the image in order to fill up more space should there be room available.)

Also, please remember that images must not be embedded into the body of the article submitted. Images must be submitted separately to the textual submission.

You may submit images via e-mail, via our FTP server or post a CD containing your images directly to us (please contact us for the mailing address, as this will depend upon the country from which you will be mailing).

Please also send us a head shot of yourself that is in accordance with the requirements stated above so that it can be printed with your article.

Abstracts

An abstract of your article is not required.

Author or contact information

The author's contact information and a head shot of the author are included at the end of every article. Please note the exact information you would like to appear in this section and format it according to the requirements stated above. A short biographical sketch may precede the contact information if you provide us with the necessary information (60 words or less).

Questions?

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CAD/CAM

international magazine of digital dentistry

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Printed by
Löhnert Druck
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04420 Markranstädt, Germany

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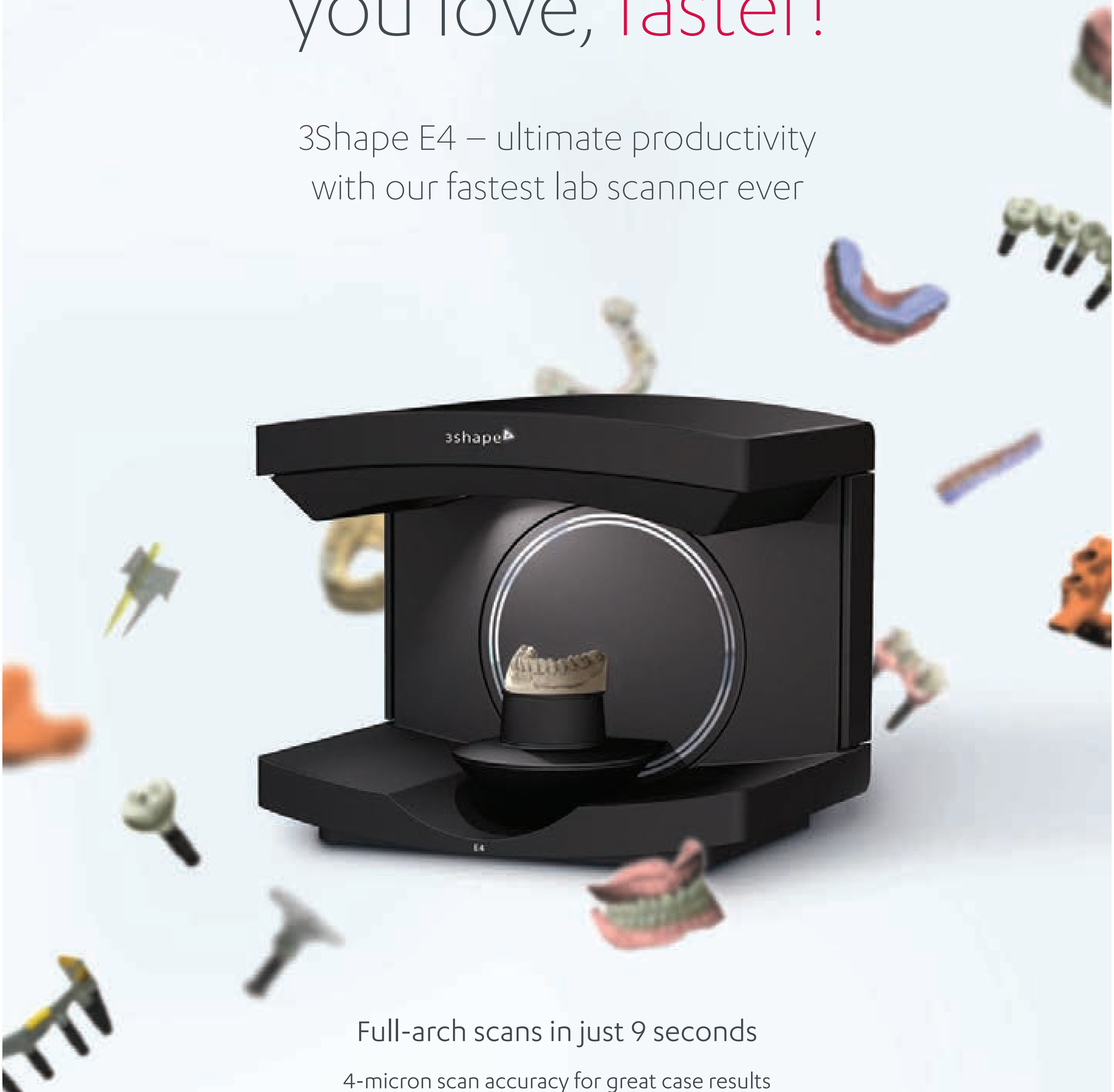

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