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digital

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case report
Digital approach in the anterior area

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Study finds differences in intra-oral scanners

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Dr Scott D. Ganz

Editor-in-Chief

per·ma·nent

/'pərmənənt/ *adjective*

1. lasting or intended to last or remain unchanged indefinitely

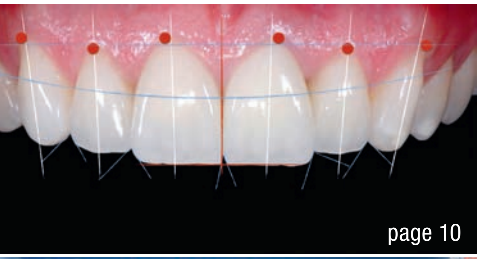
Dentistry is dedicated to understanding the workings of the oral cavity, the maxillomandibular relationship, the repair of tooth decay, the reconstruction of partially or completely fractured teeth, the replacement of missing teeth, aesthetics, smile design, the creation of proper tooth alignment, the fixing of bite discrepancies, and much, much more. Regardless of what we as clinicians do for our patients, are there any solutions that should necessarily be described as being permanent?

We are all aware that the oral cavity is constantly under attack from the foods we eat, the liquids we drink, abrasive toothbrushes, parafunctional habits, accidental trauma, etc. Therefore, why do we often see dental professionals advertising services that are permanent? In the world of dental implants, the concept that dental implants are a permanent replacement for missing teeth is a common one that has inhabited print media, social media, television commercials, websites and radio advertising. A simple online Google search for dental implants using the word "permanent" will reveal an almost endless list of entities who promote this concept. While we all know that dental implants are perhaps the most predictable biological replacement in all of medicine, they are not truly permanent replacements. In today's world of misinformation, is the dental industry being prudent when promoting services that are permanent? This is some food for thought.

On another note, however, the use of technology and our digital workflow have created methods which can aid clinicians in providing an extended timeline for the care delivered to their patients. Digital dentures are an example. Once the digital STL file has been designed and finalised, it can be stored on a local or remote computer server to fabricate the definitive prosthesis that will be provided to the patient. In the past, we would need to start over again if the patient accidentally dropped the denture and it fractured or lost the prosthesis, as the analogue process often destroyed the working cast used for the fabrication of the denture. Using today's digital workflow, we can retrieve the STL file and fabricate a new prosthesis without the need for additional impressions or many office visits. The same can be stated for implant-supported restorations fabricated with an intraoral scanner and designed using CAD software and milled with CAM technology. If we can maintain the digital files, when unforeseen events happen, we can recreate a lost implant crown with a few clicks of a mouse, instead of many patient visits.

Therefore, as the profession of dentistry has been highly successful in providing long-lasting treatment to our patients, the digital workflow has provided new and exciting opportunities to extend the true lifetime of restorations, saving both time and money for the clinician and the patient. While still not permanent, digital technology does give us additional and important solutions to the potential lifespan of the restorations we provide to our patients. Please enjoy the most excellent state-of-the-art information contained in this latest issue of digital.

Dr Scott D. Ganz
Editor-in-Chief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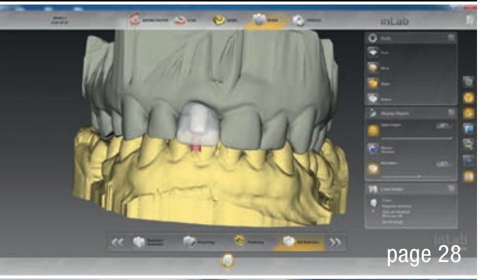
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The COVID-19 practice manager 2021: Four steps to confidence

Chris Barrow, UK

Introduction

It was American politician Adlai Stevenson (1835–1914) who observed that “it’s hard to lead a cavalry charge when you think you look funny on a horse”. I have spoken to many practice managers in the last 12 months who have shared with me their sense of imposter syndrome, as team members, clinicians, owners and family members have looked to them for guidance in the ever-changing pandemic landscape. In this four-part series, I am going to suggest a step-by-step approach to overcoming any feelings you may harbour that you are not good enough and, I hope, provide you with a framework on which to grow your self-confidence.

I will be talking about the following in steps:

1. Leadership—why you do not have to be a Marvel superhero to be a good leader;
2. Management—a checklist of all the systems you need in place to reduce your stress levels (and remain compliant);
3. Teamwork—the psychology of teams and how to create environments in which morale improves;
4. Extreme self-care—making sure that the best possible version of you turns up for work (and arrives home again).

Leadership

Let us begin our journey atop that horse, the cavalry regiment waiting for you to give the orders and you (just maybe) wondering how the devil you ended up there. “C’est magnifique, mais ce n’est pas la guerre: c’est de la folie.” [It is magnificent, but it is not war: it is madness.] Thus spoke Pierre François Joseph Bosquet, distinguished French army general, as he watched Lord Cardigan lead the British light cavalry to their doom at the ill-fated Charge of the Light Brigade on 25 October 1854, during the Crimean War. One hundred and eighteen men were killed, 127 wounded and 60 taken prisoner after the carnage created by the misinterpretation of an order. The good news is that you are unlikely to experience such devastation in a dental practice, but there has never been a time when so many orders have been flying around in the heat of battle (nor so many people asking questions)—and there are plenty of times when everybody is looking at you.

Let me define “everybody” a little more specifically. When you are a practice manager, you have a leadership responsibility to multiple communities. These may be your employer, patients, team, self-employed clinicians, referring general dental practitioners, suppliers, lenders, local community or family. They are all looking to *you* for guidance, and you dare not have a bad day, because your emotion is contagious.

As soon as the UK lockdown started, the first important message to my practice managers was to keep communicating with all these communities. The quality and the quantity of that communication have clearly differentiated the winners and losers in the pandemic period.

> “Whether it is silence or noise, good or bad, people will not forget how you showed up.”

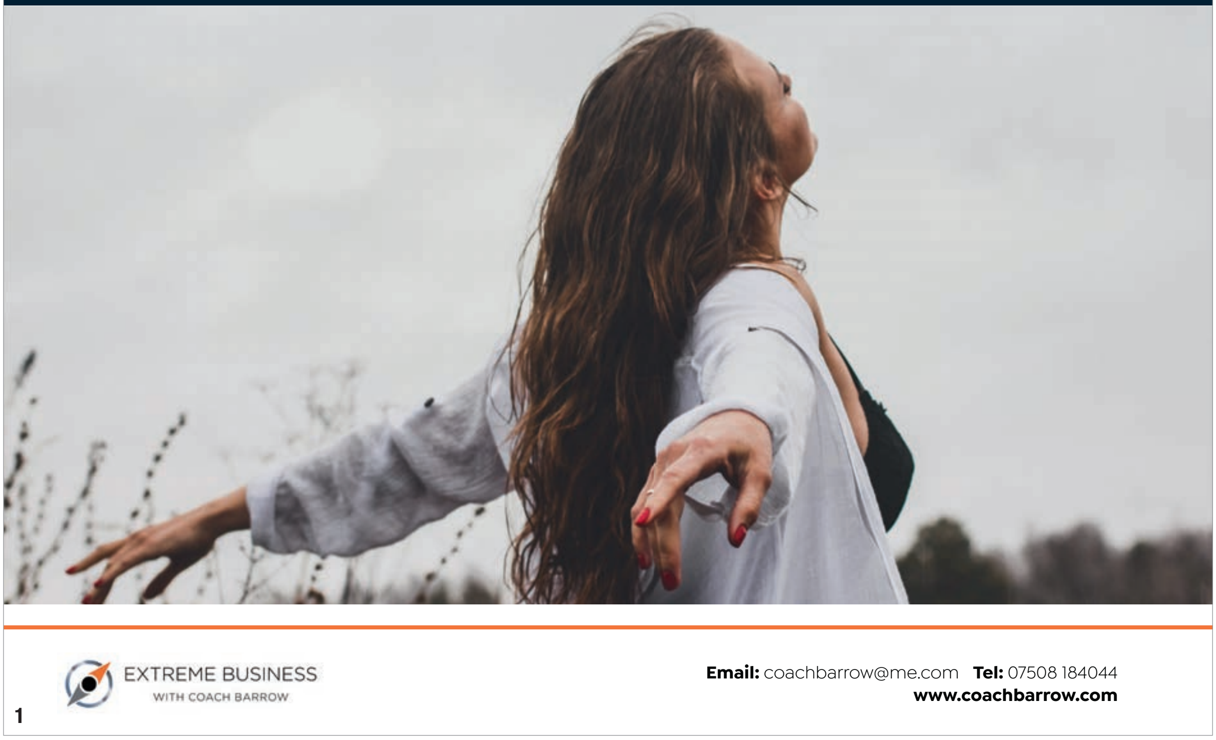
My second message was that people will remember the things you did and the way that you did them. Whether it is silence or noise, good or bad, people will not forget how you showed up.

My third message was to keep your message confident—no matter how difficult things become.

I define leadership as the combination of the following attributes:

- communicating a clear vision: knowing where we are going, why we are going there and how we intend to do it;
- listening regularly to feedback on how your people are feeling;
- being an example of the standards of performance and behaviour that you expect from those around you—people will follow your lead and that is a constant burden that the leader must bear;

The February Manifesto



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- creating environments in which people can choose to become self-motivated;
- understanding what makes people tick and being prepared to walk the floor;
- being an effective delegator, focusing on your own unique abilities and learning to delegate, automate or eliminate everything else.

The challenge for the practice manager can arise from a sense that some of the attributes mentioned may feel out of their control.

How can I share a clear vision when the owner has not or will not tell me where we are going?

It is essential that you bring to the owner's attention that teams cannot function in the current landscape unless they have a sense of direction and destination—the groundhog days will burn them out. Sometimes, it might be impossible to draw a finish line in an uncertain landscape, but it remains important to commit that you have their backs so that people feel reassured that you care about them and know where the team is going so that people can follow your lead.

How can I listen when I am chasing my tail every day?

It is essential that protected time is booked out in your day to allow for your own planning and preparation—and to facilitate conversations with all team members in which you do the listening and gather in what is working and what is not, what is good and what is bad, and how the team can improve.

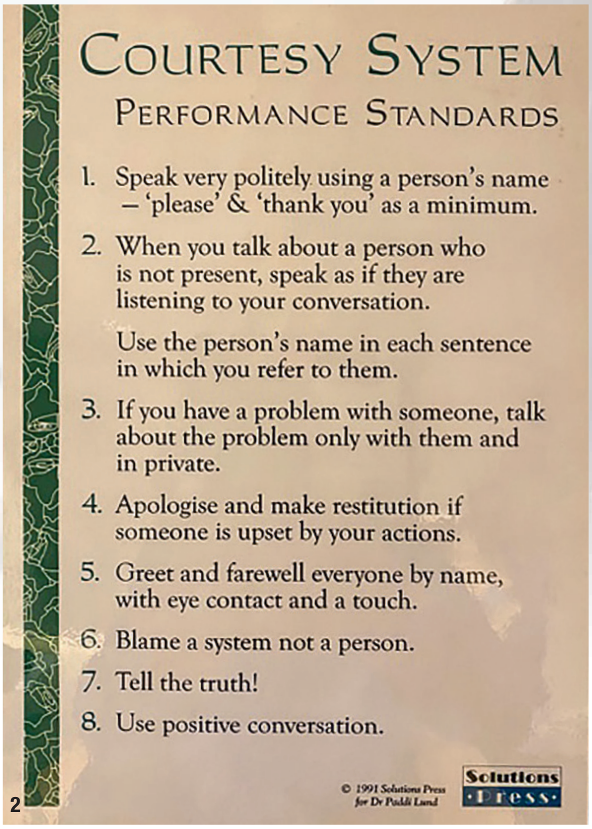
Why must I set the example when I am exhausted?

After spending much of January listening to myself moaning and realising that I was depressing the people around me, I recently wrote out for myself a February manifesto (Fig. 1):

1. There are 28 days in February 2021, and I am going to read this manifesto out loud to myself at the beginning of every day.
2. I am not going to complain—about lockdown 3.0, about the economy, about other people's performance and/or behaviour, or about my life.
3. I am going to become the beacon of light and assume the role of leader to all those around me.
4. I am going to make a list of my three most important tasks every day—and get them done.
5. I am going to take time, every day, to practise extreme self-care and ensure that I have adequate sleep, nutrition, exercise and fun.

How can I create environments in which people become self-motivated?

Please remember that you cannot motivate people; you can only create environments and then people choose to become self-motivated, or not, and that will largely depend upon their own personal circumstances. I have seen too many practice managers burned by the mistaken belief that they carry everyone else's motivation on their shoulders. Not true. Your job is to create the kind of environment in which people can do their best work, described many years ago by dentist and author Dr Paddi Lund as his Courtesy System, which has taken pride of place on my office wall for over 20 years (Fig. 2).


Courtesy System
Performance Standards

1. Speak very politely using a person's name – 'please' & 'thank you' as a minimum.
2. When you talk about a person who is not present, speak as if they are listening to your conversation.

   Use the person's name in each sentence in which you refer to them.
3. If you have a problem with someone, talk about the problem only with them and in private.
4. Apologise and make restitution if someone is upset by your actions.
5. Greet and farewell everyone by name, with eye contact and a touch.
6. Blame a system not a person.
7. Tell the truth!
8. Use positive conversation.

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2

What resources are available to me to help me to understand what makes people tick?

Frankly, the list is endless, and a few moments on any search engine will reveal countless resources to assist with your leadership role. The best teacher is, of course, your own personal experience of dealing with people over many years of interaction.

For the beginners, I strongly recommend any reading on simple psychology. One of the most revealing lessons I have learned on understanding the behaviour of other people is the *Karpman Drama Triangle*. Dr Stephen Karpman conducted research in the 1960s into three modes of behaviour adopted by those who are emotionally charged (and what to do or say in response). There is never a week that passes without my discussing this with managers. To read more, go to *https://karpmandramatriangle.com* (a rather dated website) or take a look at *The Karpman Drama Triangle Explained: A Guide for Coaches, Managers, Trainers, Therapists—and Everybody Else by Chris West.*

How do I delegate when I do not trust the people that I am delegating to?

This is, perhaps, one of the greatest challenges the practice manager faces, and it is all too easy (especially in a pandemic landscape) for the practice manager to argue that it is easier just to do it himself or herself. That, of course, is no use as a long-term solution. Business author Harry Beckwith suggests that "there is no performance without accountability and no accountability without measurement".

To delegate, follow the simple rules:

1. Be specific about what you want to be done.
2. Be specific about who you want to do it.
3. Agree on a deadline.
4. Agree on how you want to be informed of completion.
5. Walk away and do not micromanage.

To begin, people will make mistakes. Then you will train them. If the mistakes are repeated, you have the wrong person. If you have the right person, the mistakes will not reoccur. Finding the sweet spot between abdication and micromanagement is a skill of a true leader.

Finally, let us deal with the Chimp. *The Chimp Paradox* is the 2012 groundbreaking book by psychiatrist and sports performance coach Dr Steve Peters. The Chimp in question is the limbic (emotional) brain. The paradox is that the Chimp can be our best friend or our worst enemy. The book is about dealing with what happens when the Chimp whispers in our ear that we are not good enough, that our plans will fail, that we are the imposter; when we start comparing our inside with everybody else's outside.

My Chimp attacks me every September, when we begin marketing our coaching programmes for the following year. My team will tell you that I repeat the same behaviour every year, fantasising that I will have no clients and I will be out of work—being revealed as the imposter coach. My business coach Rachel Turner will also confirm that we have the same coaching session every year, during which she asks me to grab pen and paper and make a list of the top ten reasons that the Chimp is wrong—you might say, the top ten reasons that you look just great up there on that horse. I keep my list with me at all times—and refer to it when I feel those moments of uncertainty.

Leaders are quiet and confident, firm and fair, inspiring and vulnerable, above all else, that beacon of light I referred to in my manifesto. You *are* a leader.

about

Chris Barrow has been active as a consultant, trainer and coach to the UK dental profession for over 24 years. His main professional focus now is through his Extreme Business company, providing coaching and mentorship to independent dentistry around the world via face-to-face meetings, a workshop programme and an online learning platform.

Digital approach in the anterior area: Management of surgical and prosthetic cases

Dr Roberto Molinari, Italy

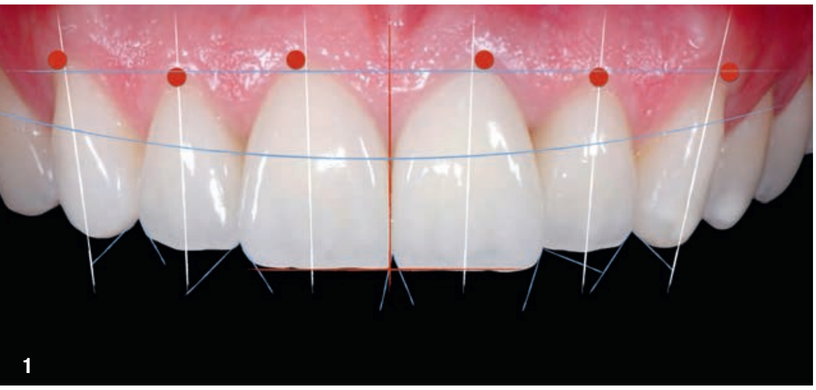

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Fig. 1: Ideal anterior aesthetic composition.

Introduction

In this article, I would like to propose a new approach to digital dentistry regarding new surgical and prosthetic work processes on the subject of complex aesthetic rehabilitation in the anterior area, with particular reference to gummy smile patients. More precisely, I would like to introduce the digital process that I apply when I need to preserve the original morphology of the soft tissue (gingival margin and papillae) in the anterior areas, a protocol that involves the use of a customisable collagen matrix and provisional devices created by a digital method.

As is already known, to achieve an optimal result in aesthetic cases, it is necessary for a certain harmony between the soft tissue and prosthetic devices; this means that the interdental papillae, the gingival margin, the dental axes and the dominance of the central incisors must be well balanced (Fig. 1). The digital management of aesthetic cases in which it is essential to perform a surgical procedure in the anterior area, such as the insertion of an implant, requires greater attention to detail, especially if the patient has a gummy smile.

In order to keep the position and thickness of the gingival margin and papillae stable, it is recommended to perform a connective tissue graft in the vestibular area of the implant. The insertion of the connective tissue graft in this area is essential from an aesthetic point of view and in order to maintain the long-term health of the implant.

The most commonly used method is to extract the connective tissue for the graft from the palate or maxillary tuberosity. This type of conventional approach presents some risks, such as the following:

1. bleeding from the donor area;
2. necrosis of the connective tissue graft;
3. neurological damage;
4. aesthetic damage; and
5. pain, swelling and paraesthesia.

2a

2b

Fig. 2a: Initial extra-oral situation. **Fig. 2b:** Initial intra-oral situation.

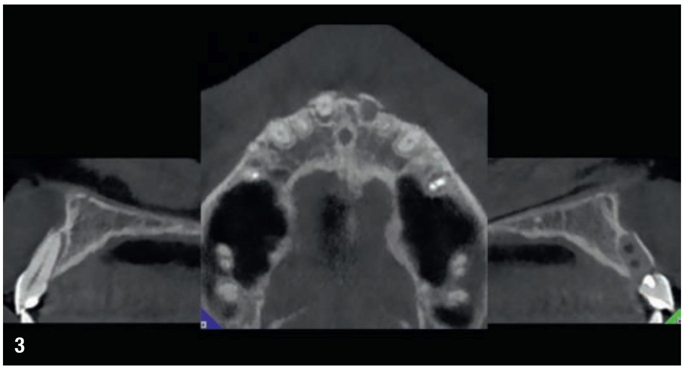


Fig. 3: CBCT scan after the trauma. **Fig. 4:** Emergence solution.

The use of a collagen matrix, as highlighted in the following clinical case, can be a valid alternative to the present gold standard approach.

Case presentation

After an anterior trauma, a 24-year-old gummy smile patient lost tooth #21. Tooth #11 was palatally dislocated, and tooth #12 sustained slight damage to the incisal edge (Figs. 2a & b). The CBCT scan showed a fracture in both buccal bone plates in relation to the two maxillary central incisors (Fig. 3).

Immediate therapy

Because I saw the patient for the first time three days after the trauma, it was not possible to reimplant tooth #21. In order to support the soft tissue of this area (papillae

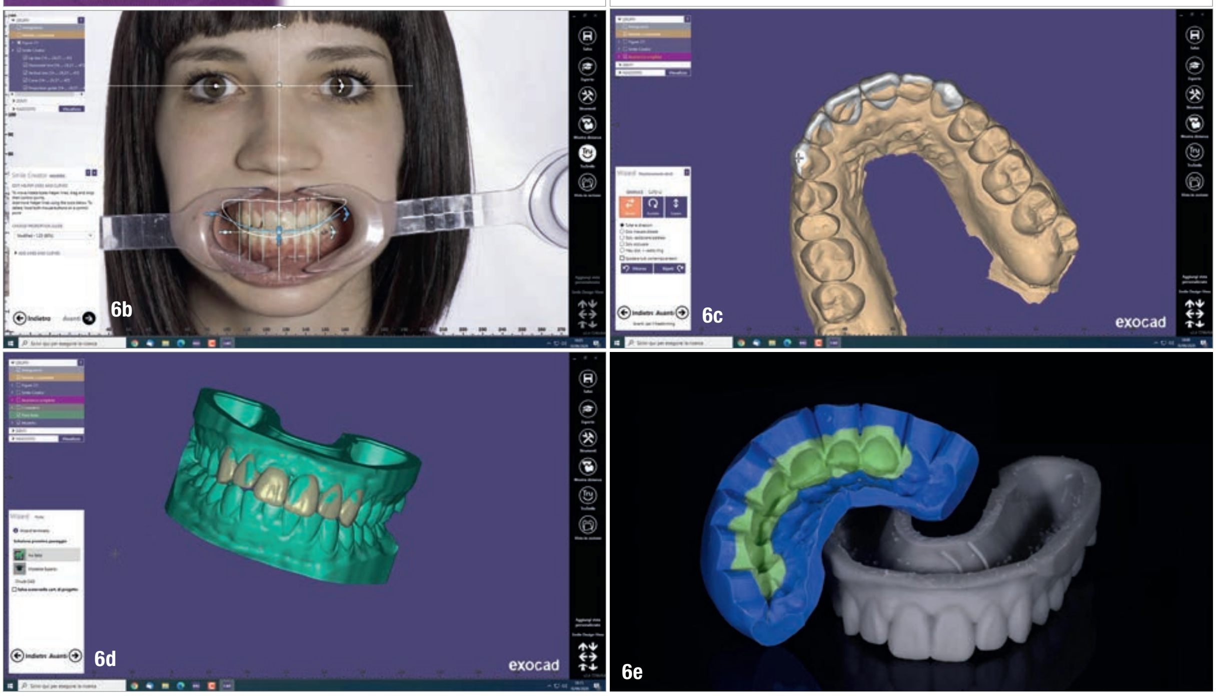


Fig. 5: Digital Smile Design. **Fig. 6a:** Initial STL model scanned. **Fig. 6b:** Smile Creator (exocad). **Fig. 6c:** Digital wax-up. **Fig. 6d:** STL model with the new morphology. **Fig. 6e:** Prototyped model and silicone index.

Fig. 7: Mock-up of the future restoration and its aesthetic impact on the patient's face.

and gingival margin), as a temporary solution, I removed the root of the lost tooth with a bur and I made a pontic, modifying the crown with some composite on the cervical third. I then bonded the avulsed tooth to the adjacent teeth using a metal wire and flow resin (Fig. 4).

Case analysis and treatment plan

In all cases in which aesthetics is involved, I always carry out an aesthetic analysis of the smile following the Digital Smile Design concept in order to optimise the harmony between the patient's teeth and face (Fig. 5). In this case, in order to test the aesthetic potential of the project, I created a mock-up of the intended final result. In order to reduce treatment time, I used a digital method of prototyping a resin model with the new morphology and creating a silicone index to carry out testing directly in the patient's mouth (Figs. 6a–e). After simulating the patient's new smile and verifying its harmony and proportion-

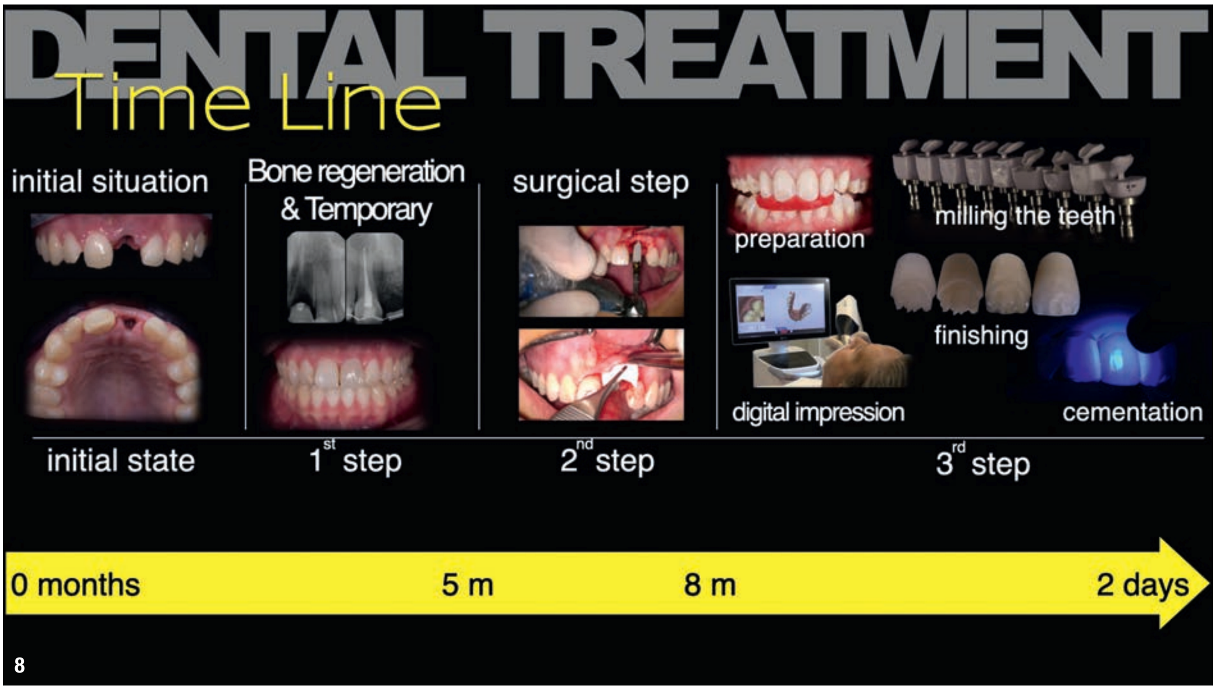


Fig. 8: Definitive treatment plan overview.

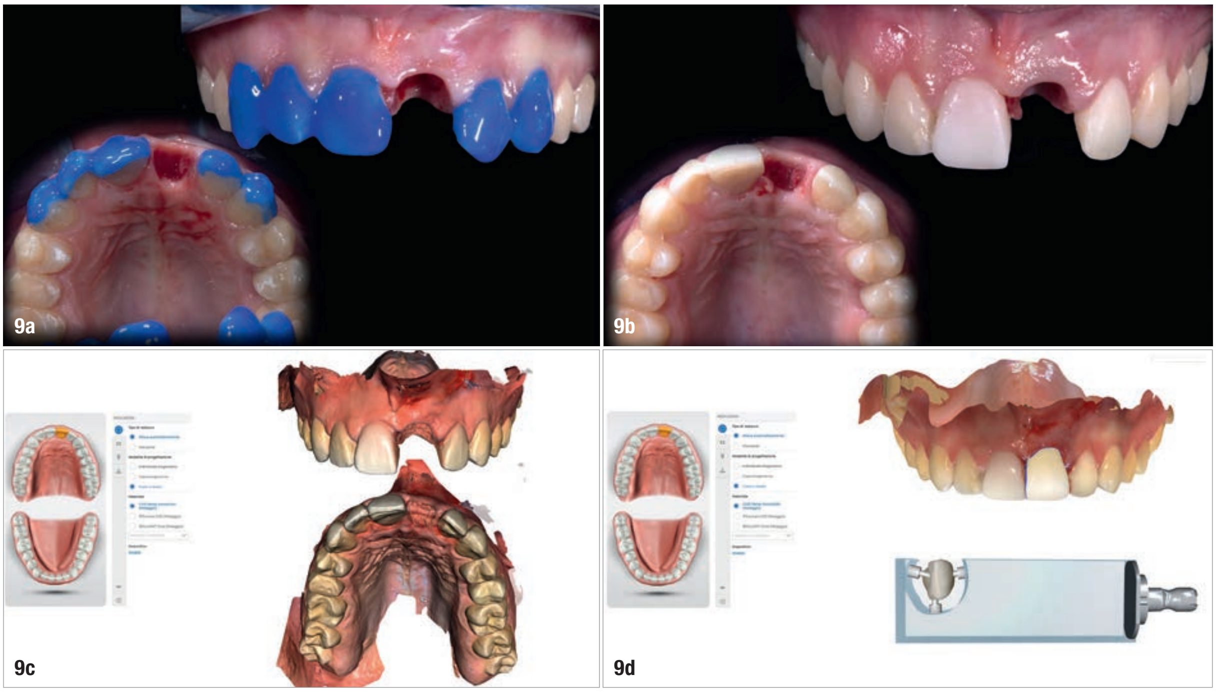


Fig. 9a: Etching of the anterior teeth. **Fig. 9b:** Definitive bonding of the mock-up. **Fig. 9c:** Initial scan and use of the CEREC software to create the first provisional crown. **Fig. 9d:** Digital project of tooth #21.

ality (Fig. 7), it was possible to define a four-step definitive treatment plan lasting eight months (Fig. 8).

The work process

Step 1

Five days after the trauma, the goal was to regenerate the bone volume in area #21. The key to success in this phase is to create a provisional restoration to condition the soft tissue while holding the biomaterial in the socket.

It should be emphasised that the immediate insertion of an implant at this stage in this specific case was not possible, as it would not have allowed optimal primary stability. To obtain the provisional crown, following a digital path, I proceeded as follows:

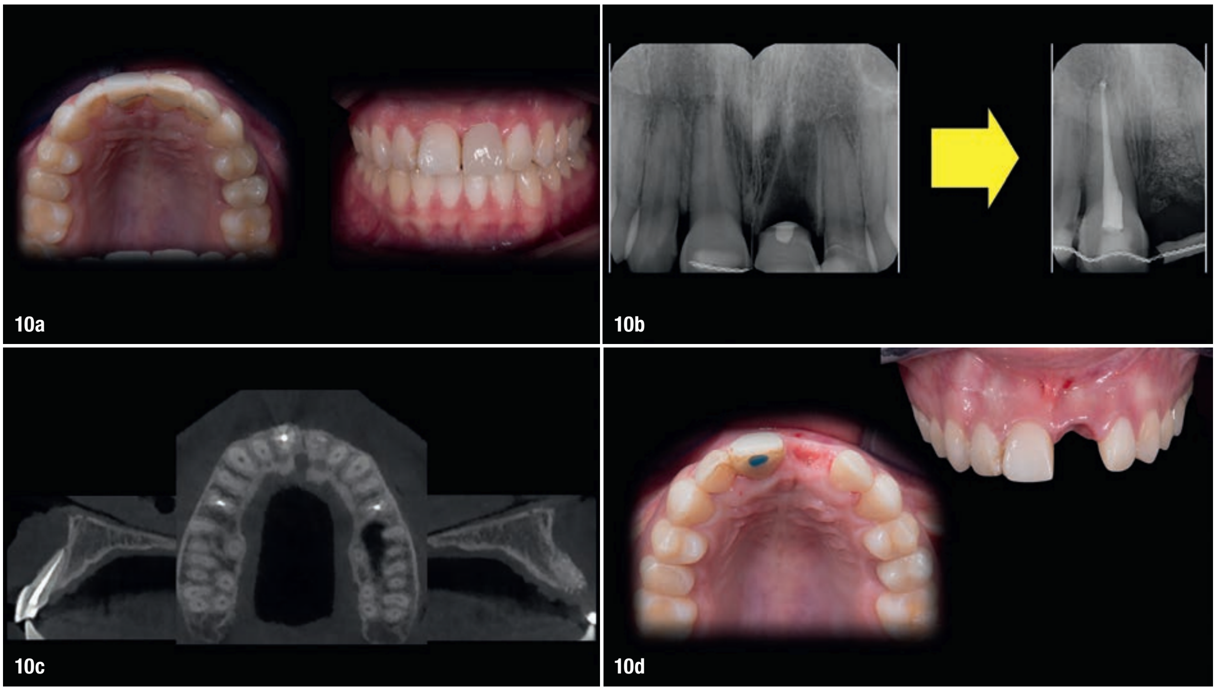


Fig. 10a: Aesthetic result of the first step. **Fig. 10b:** Bone regeneration. **Fig. 10c:** CBCT scan after five months. **Fig. 10d:** Preliminary soft-tissue conditioning.

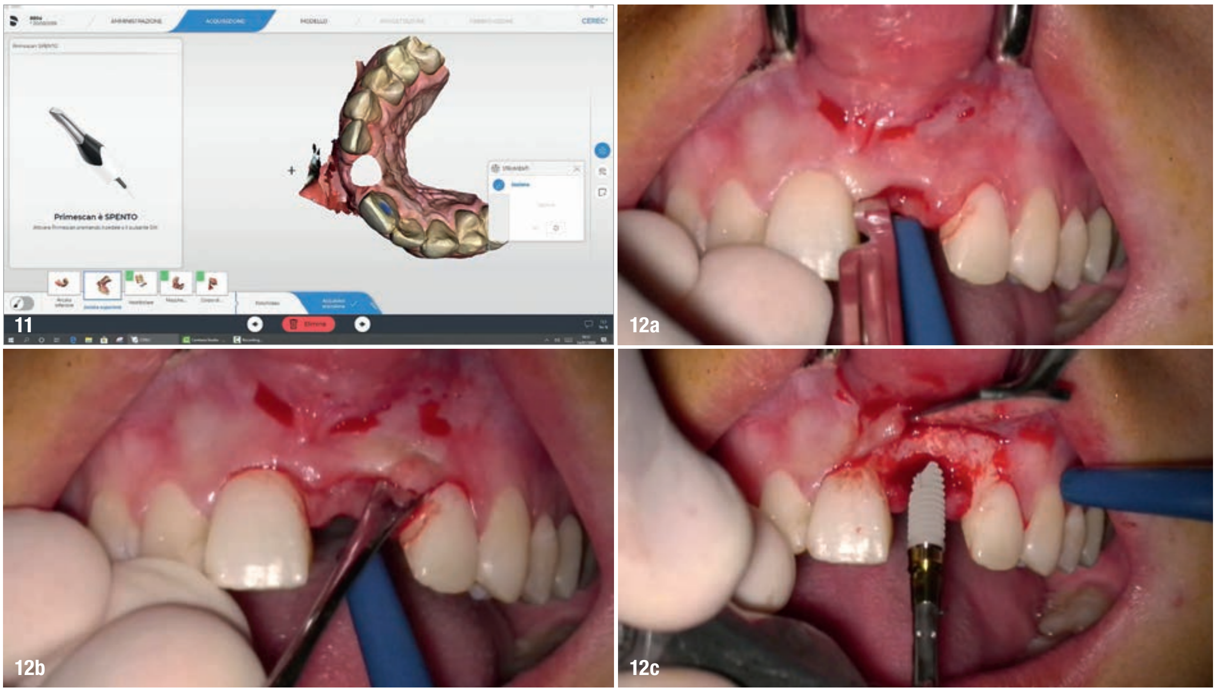


Fig. 11: Digital impression necessary to create the second provisional crown screwed into the implant. **Fig. 12a:** First incision. **Fig. 12b:** Full-thickness flap detachment by 3 mm. **Fig. 13:** Implant placement.

1. I etched teeth #13–23 in order to bond the previously tested mock-up using the adhesive technique. This decision was decisive, as it allowed me to virtually design a provisional crown for area #21 with an adequate cervical shape by copying it with the scanner and then mirroring the new tooth #11 morphology with the CEREC design software (Dentsply Sirona; Figs. 9a–d).

2. I performed bone regeneration of socket #21 using Geistlich Bio-Oss and Geistlich Mucograft (Geistlich Pharma). In this phase, the previously milled provisional crown was bonded to the adjacent teeth with a metal wire and flow resin after etching and applying the adhesive on their palatal surfaces. An adequate compression of the provisional crown protected the biomaterial

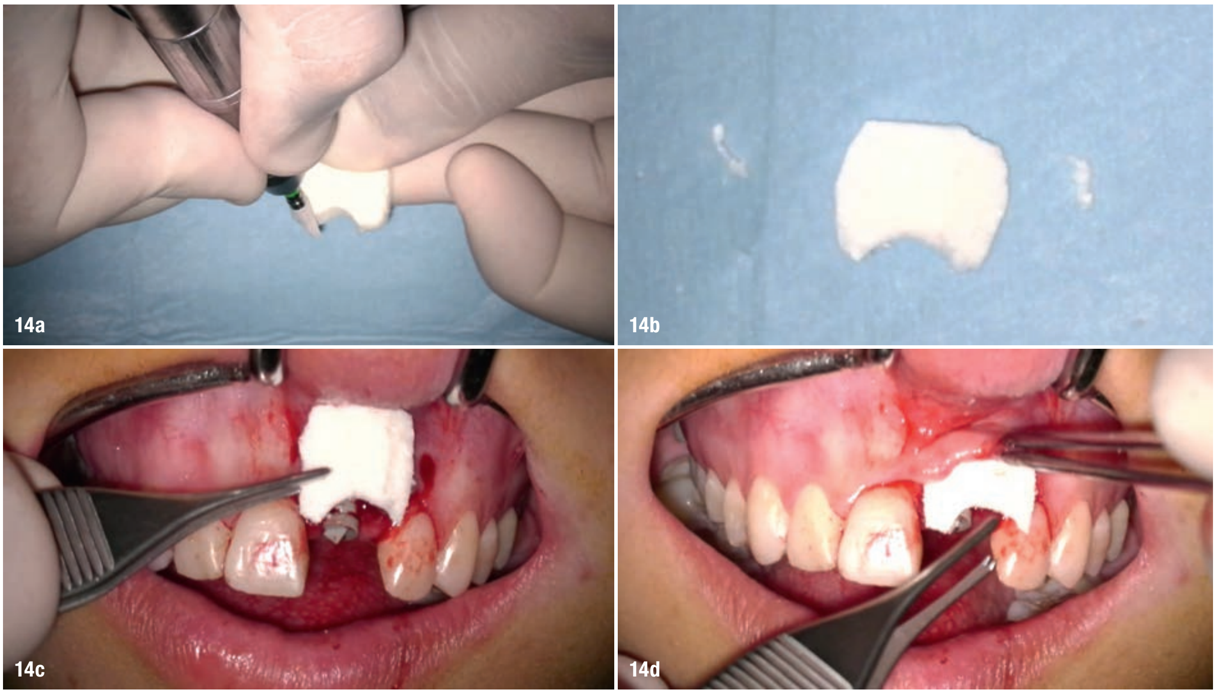


Fig. 14a: Customisation of the collagen matrix with a zirconia bur. **Fig. 14b:** Customised collagen matrix. **Fig. 14c:** Collagen matrix positioning. **Fig. 14d:** Collagen matrix insertion.

graft in the following months, keeping the papillae stable. After five months, I obtained the necessary bone volume to be able to place an implant in the anterior edentulous area (Figs. 10a–d).

Step 2

The objective of this second step was to insert an implant in the regenerated bone ridge and to restore the volume of the keratinised gingival tissue in the vestibular area around it and thus recreate an adequate vestibular gingival profile in harmony with the gingival profile of the adjacent teeth. Even at this stage, the aim was to create a second provisional crown with an appropriate emergence profile in order to further stabilise the soft tissue by conditioning it completely. I performed the following procedures:

1. Taking of a digital impression with an intra-oral scanner. The most important aspect during this first scan was the creation of the gingival mask, which entailed copying the previously conditioned soft tissue. This scan would guide us during the design phase of the emergence profile of the provisional crown. A proper emergence profile was certainly the key to success, and it would allow us to achieve, in a predictable way, correct conditioning of the tissue around the cervical third of the crown screwed into the implant. The maxillary master model would then be digitally cut in the centre of area #21 using a cutter tool (Fig. 11).

2. Design of the flap. The incision did not involve the coronal part of the papillae, as an incision of the bone peaks would inevitably have led to the loss of 1.0–1.5 mm of bone

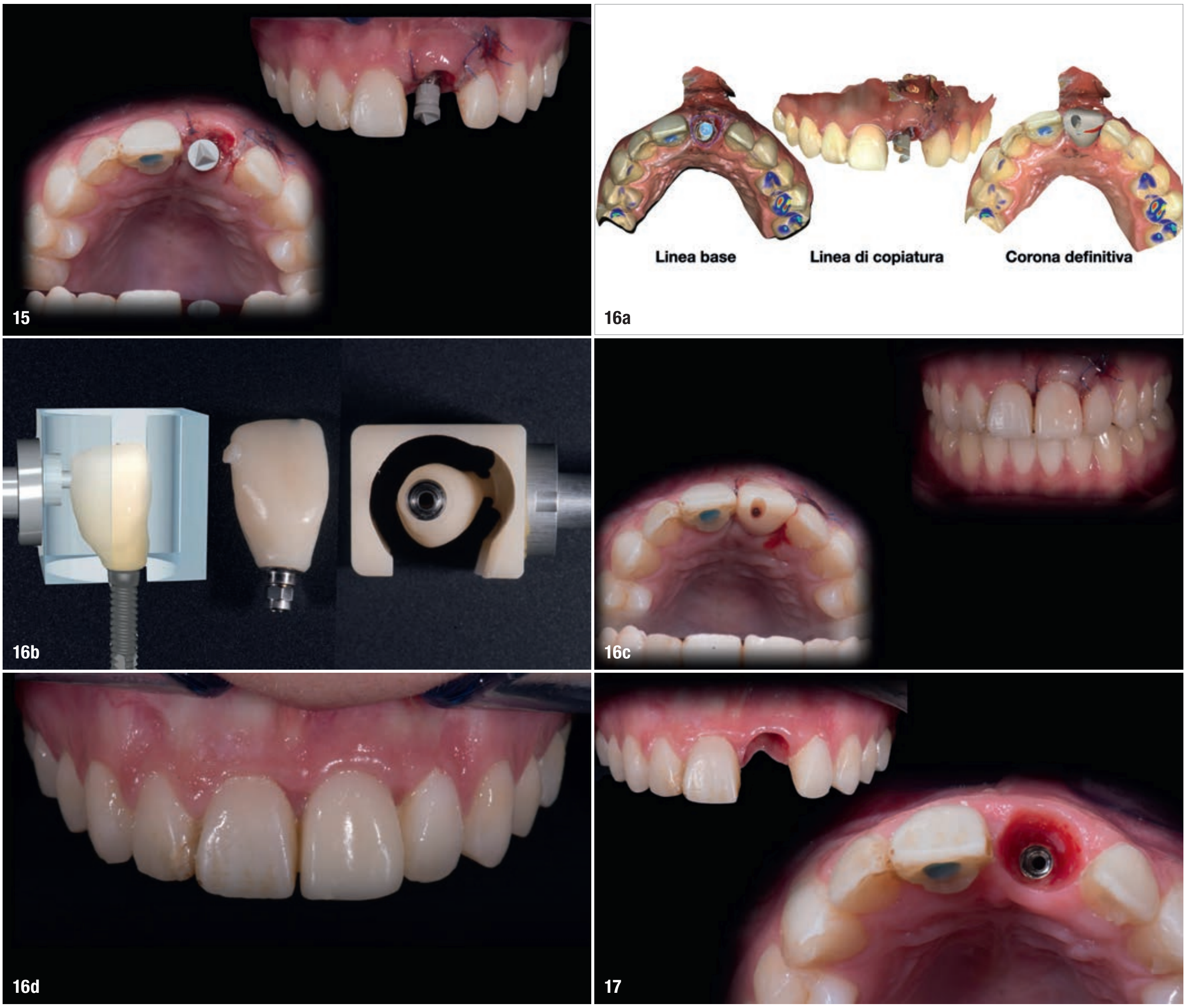
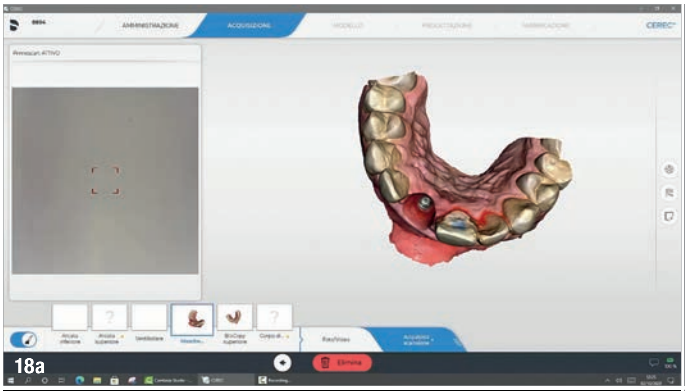
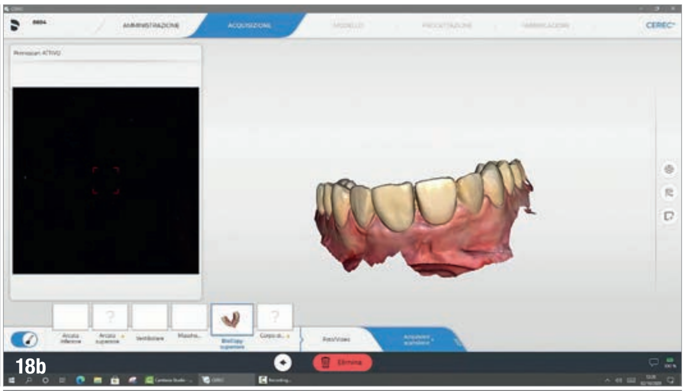


Fig. 15: Suture. **Fig. 16a:** Digital planning of the second provisional crown screwed into the implant. Baseline (left), copy line (middle) and crown (right). **Fig. 16b:** Crown milled in PMMA. **Fig. 16c:** The second provisional crown screwed in. **Fig. 16d:** Healing at three months. **Fig. 17:** Soft-tissue appearance after removal of the provisional crown.





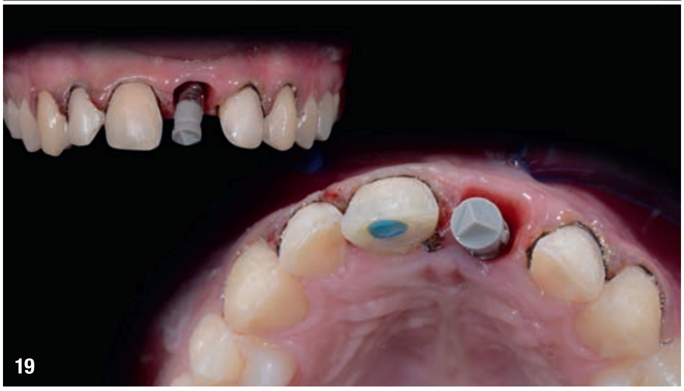


Fig. 18a: Soft-tissue digital impression gingival mask. **Fig. 18b:** Biogeneric copy of the mock-up and the screwed-in provisional crown. **Fig. 19:** Prepared teeth. **Fig. 20:** Definitive digital impression of the prepared teeth.

and thus an impairment of the final aesthetics. Therefore, an intra-sulcular vestibular incision was performed by creating a small mucosa pocket obtained through a further partial-thickness incision of the soft tissue in correspondence with the buccal portion of the edentulous area (Figs. 12a & b).

3. Placement of the implant. The implant was positioned centrally with a palatal inclination in order to prevent the screw access hole from affecting the incisal edge of the provisional crown or its vestibular surface (Fig. 13).

4. Customisation of a Geistlich Fibro-Gide matrix (Geistlich). Fibro-Gide is a porous, resorbable and volumetrically stable collagen matrix of porcine origin, specifically designed for the regeneration of soft tissue in order to avoid removal of autologous connective tissue. This matrix promotes angiogenesis, the formation of new connective tissue and the stability of the collagen network in submerged healing. In an aesthetic case like this, however, the matrix must be customised and adapted to the recipient site. It would then be very stable and maintain its volume in the healing phase, and it would not be oversized, avoiding traction of the flap and/or excessive volume of the soft tissue after healing. As it is a particularly resistant matrix, I always find it difficult to shape it with a scalpel blade. Instead, I suggest the use of a zirconia bur at low speed. In this way, overheating and denaturation of the collagen will be avoided and the structural characteristics will be maintained (Figs. 14a–d).

5. Placement of the collagen matrix and suturing. The collagen matrix was placed in the previously created mucosa pocket. The soft tissue must be hermetically sutured over the matrix so that it is completely submerged (Fig. 15).

6. Taking of final digital impressions to fabricate the immediate provisional crown. Once the previously cut impression had been achieved, along with the completion of the 3D position of the implant, the emergence profile was drawn (baseline) on the gingival mask. Subsequently, on selection of the anatomical portion of tooth #11 (copy line), crown #21 was automatically created thanks to the design software. The restoration of tooth #21 milled in PMMA was cemented to the TBase and then screwed into the implant at 20 Ncm. The real advantage of this technique is that the provisional crown would not have to be relined with acrylic resin in the patient’s mouth, avoiding the risk of contaminating the collagen matrix. The provisional crown properly designed thanks to a personalised emergence profile would favour the conditioning of the soft tissue by supporting it and, furthermore, by sealing the margins of the surgical gap. This would protect the underlying collagen matrix, ensuring a successful final result (Figs. 16a–d).

Step 3
In this final phase, the case was prosthetically finalised following a chairside digital method. The key to this step is the biogeneric copy function that the prosthetic software makes available and through which it is possible to copy the morphology of the previously bonded mock-up and of the provisional crown screwed into the implant. With this approach, we share with the design software the shapes previously tested in order to create the definitive prosthetic restoration.

1. Creation of the gingival mask and biogeneric copy of the anterior teeth. Proper implant osseointegration was obtained after three months, and the conditioning of the soft tissue appeared to be optimal both in terms of tissue quality and in terms of reconstructed volume. In Figure 17, it is possible to see that the gingival profiles were perfectly harmonious and natural thanks to the provisional crown.

At this point, I performed the biogeneric copy of the anterior teeth, and after having unscrewed the provisional crown from the implant, I scanned the position of the papillae and gingival margin with an intra-oral scanner. And so doing, I created the gingival mask, at the same time, sharing the morphological information of the soft tissue with the CEREC design software which would go to creating the definitive prosthetic devices (Figs. 18a & b).

2. Preparation of the anterior teeth. In the treatment plan, I had planned to create five veneers from tooth #13 to tooth #23, with the exception of area #21, for which I had planned to make a crown to be screwed into the implant (Fig. 19).

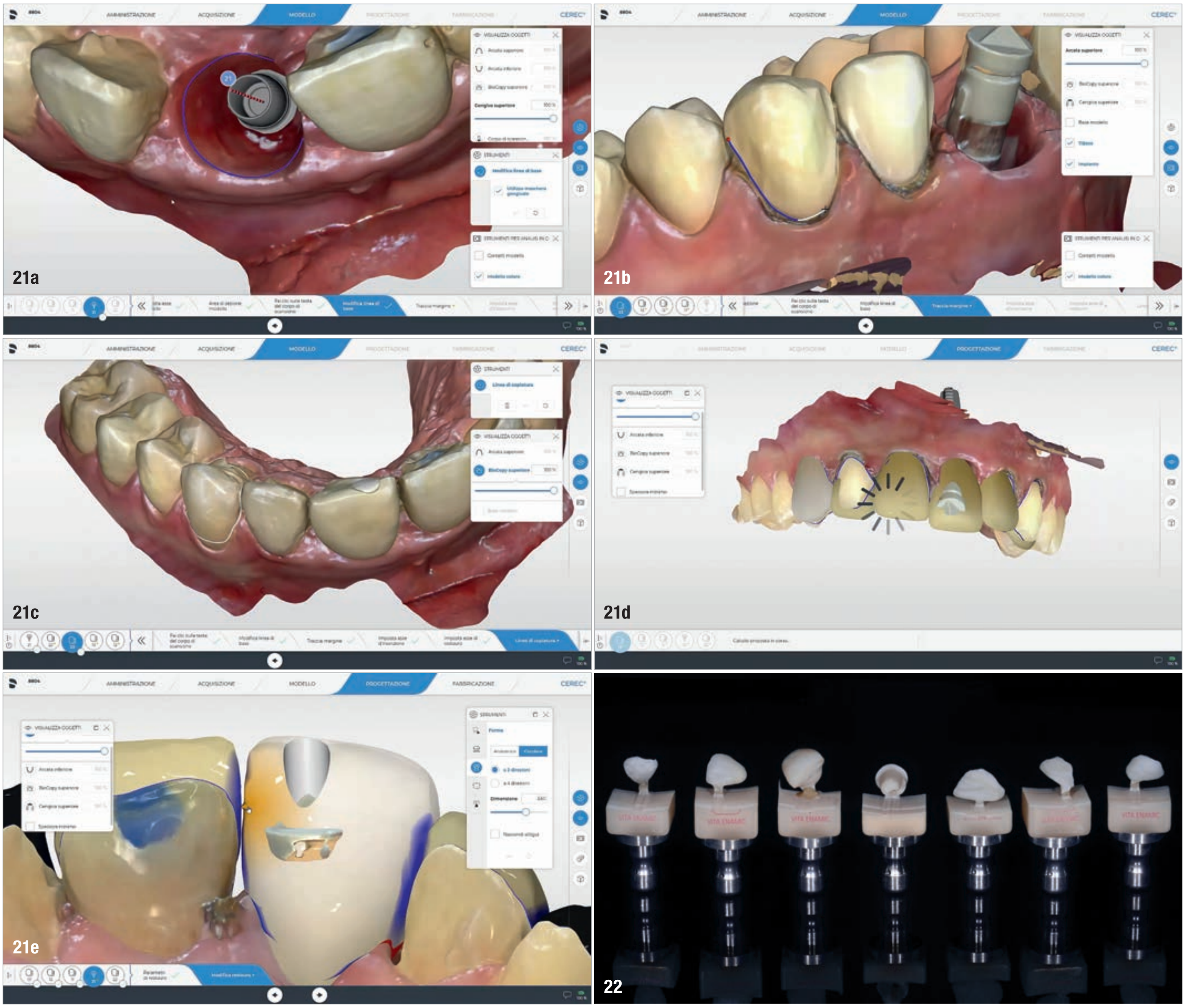


Fig. 21a: Gingival mask and emergence profile crown on implant #21 definition. **Fig. 21b:** Drawing of the baseline, highlighting the finishing line preparation. **Fig. 21c:** Drawing of the copy line. **Fig. 21d:** Automatic project of the definitive restorations by the CEREC software. **Fig. 21e:** Morphological improvement with the digital tools. **Fig. 22:** Definitive prosthetic restorations milled.

Figs. 23a & b: Polished restorations.

3. Taking of final impressions of the prepared teeth. With a scan post positioned on the implant, the prepared maxillary arch was scanned with the intra-oral scanner, capturing every single anatomical detail not only of the prepared teeth but also of the teeth not involved in the preparation. This operation is necessary to match the virtual models, a prerequisite in order to obtain definitive prosthetic devices with the same shape as the mock-up (Fig. 20).

4. Development of the master models and digital design. Once the impression phase had been completed, we would rely on the software in order to design the definitive prosthetic teeth. To begin with, it is necessary to draw the baseline on the soft-tissue profile, highlighting the area within which the software will detect and create a prosthetic crown with a proper emergence profile that will support the previously conditioned papillae and gingival margin. Subsequently, the baseline for each of the prepared teeth must be drawn, highlighting the finishing line preparation. In the following step, the copy line will be drawn, selecting the same teeth from the master model created by copying the mock-up. With this information, the software will create the final virtual prosthetic teeth.

The digital tools that the software makes available are an excellent aid in perfecting the shape of the prosthetic teeth (Figs. 21a–e).

5. Choice of material and milling of prosthetic teeth. The choice of material is another important key point. A dentist who decides to take the digital path must have a good knowledge of the chemical and physical characteristics of materials on the market because they are directly linked to the aesthetic and functional result that will be obtained.

If it is clear to us how natural teeth react to light, considering aspects such as fluorescence, opalescence and translucency, then our goal will be to select the most suitable CAD/CAM block. In general, my first choice is feldspathic ceramics, as they allow me to obtain results that are closest to the aesthetic characteristics of natural teeth. However, in the case that it is necessary to mill prosthetic restorations to a very thin thickness (0.2–0.3 mm), it is necessary to choose a hybrid ceramic containing a variable percentage of resin, which gives greater elasticity and thus avoids fractures during milling and obtains accurate margins.

In addition to chroma and value, it is important to consider translucency when choosing the material to create prosthetic restorations for the anterior area. The multicoloured blocks, or so-called multilayer blocks, have a stratification that goes from opaque to translucent. In the design phase, it is recommended to allocate the translucent area to the incisal edge of the anterior teeth. In this case, having the need to make very thin veneers, I selected a hybrid ceramic. As mentioned, it is a more elastic material than feldspathic ceramic and offers the advantage of being available in industrially drilled CAD/CAM blocks for the production of screw-retained crowns on implants. More specifically in the case described in this article, I milled five multicoloured hybrid ceramic veneers, a multicoloured hybrid ceramic crown for implant #21 and a single-colour hybrid ceramic abutment to mask the grey titanium of the TBase (Fig. 22).

6. Finalisation of the prosthetic teeth. This point is very important, as it will define the final appearance of the prosthetic teeth. In my opinion, we erroneously rely too much on products such as glazes or stains to perform the surface characterisation. The goal we should aim for at this step should not be the creation of mirrors that reflect light evenly, but the creation of a surface texture capable of reflecting light in a different way that gives the prosthetic teeth a more natural appearance. The micro- and macro-texture of each tooth should be sculpted by inserting all the micro-defects that are typical of natural teeth and that help us to camouflage the prostheses. When I use ceramic materials, I do not use stains or glazes, but after sculpting the texture, I just polish them with a series of polishers in order to enhance the anatomy of each individual tooth.

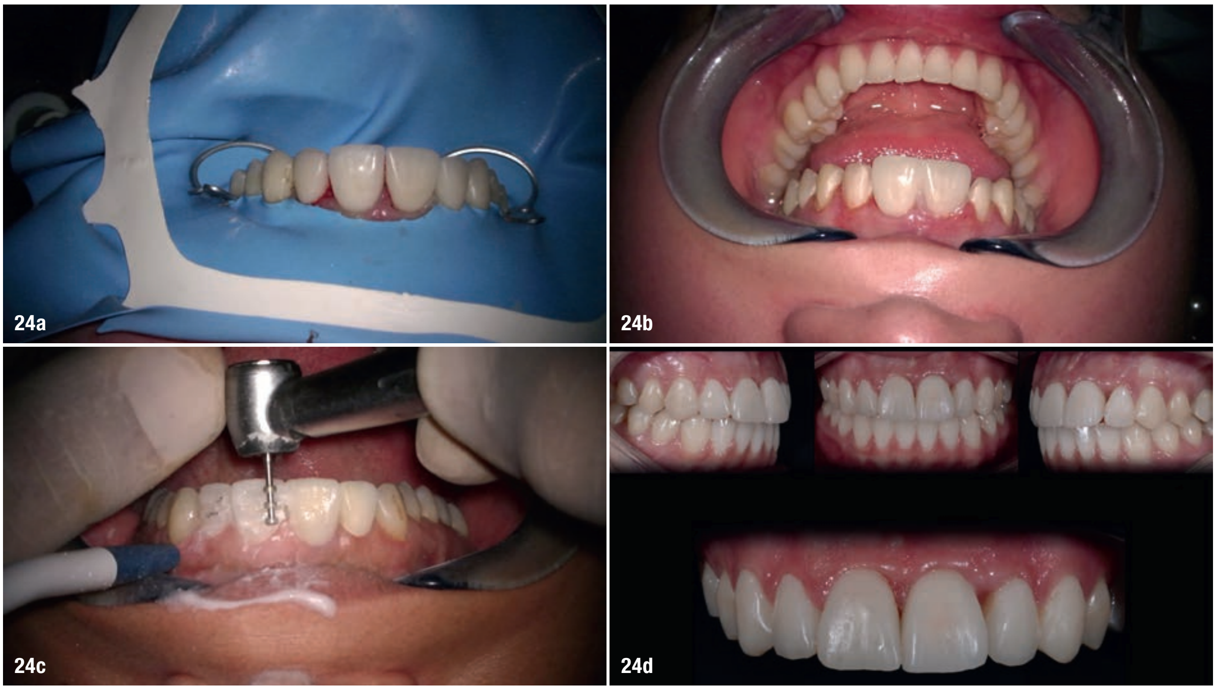


Fig. 24a: Definitive cementation. **Fig. 24b:** Try in paste. **Fig. 24c:** Preparation starting from the mock-up. **Fig. 24d:** Definitive restorations in the patient's mouth.

Another aspect to consider is the fact that the thinner areas, such as the cervical third, after adhesive cementation, transfer the natural colour of the prepared tooth to the surface which, for example in this area of the thinnest enamel, is more chromatic. To remedy this, coloured cements are available on the market with which it is possible to modulate the final colour after cementation (Fig. 23).

7. Adhesive cementation. This last step is very delicate, as if not managed properly, it could nullify the final result from both an aesthetic and functional point of view. Avoiding going into details of the various phases that characterise this step, it is important to remember that the main aspects to be considered in order to obtain optimal stability of the prosthetic devices over time after their cementation are the following:

Fig. 24e: Impact of the new smile on the patient's face.

25a

25b

Figs. 25a–c: Final outcome.

- isolation of the operative site by dental dam (I will not discuss the importance of the dental dam here, as we clinicians know that adhesive cementation must be performed under isolation of the operating site);
- conservative preparation; and
- evaluation of the final colour.

25c

I believe it is essential to emphasise how important conservative preparation of the teeth involved in the treatment is: leaving enamel on the surfaces of the prepared teeth will allow for greater adhesion than would be obtained on dentine. For this reason, I advise you to start the preparation already from the mock-up, creating the guide grooves of 0.5 mm deep with a calibrated bur that allows conservation of the enamel. We must not forget that the dentine must be hybridised immediately if it is uncovered because in this way, by engaging the newly uncovered collagen fibres, the strength of the adhesive bond will also be increased on this tissue. Delay in these cases would lead to deterioration of the fibres, consequently lowering strength of the adhesive bond.

Equally decisive for the final aesthetic result is the third point. Today, there are coloured cements on the market that allow us to modulate the final colour of prosthetic devices by mitigating the possible discoloration of a devitalised tooth or highly chromatic dentine, or to slightly modify the value of the ceramic. These products are sold with the respective full-colour test glycerines, through which it is possible to select the most suitable cement colour for the case (Figs. 24a–e).

Conclusion

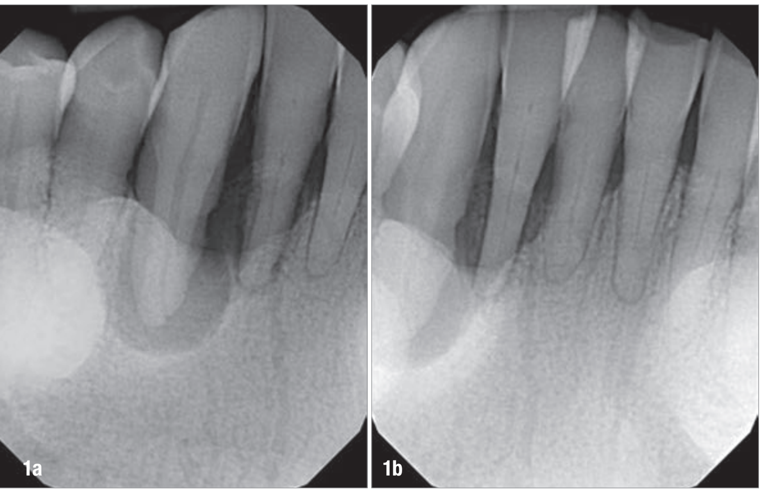
I hope that reading this article will be an incentive to see your work differently. Over the years, my vision has led me to change my approach and my work process continuously and to look at what I am doing with a critical eye, in order to improve. After so many years of navigating the digital sea, I must admit that today, compared with 20 years ago, procedures have been simplified and what was considered pioneering at the time is now part of the accepted clinical protocols. Technological innovations and the development of increasingly high-performing materials have allowed me to reduce therapy times and discomfort for my patients and, moreover, to increase my profit margin (Figs. 25a–c).

about

Dr Roberto Molinari obtained his diploma in dental technology in 1986 and his degree in dentistry and dental prosthetics with honours from the University of Bologna in Italy in 1993. After having trained with the most notable experts in modern dentistry, he specialised in periodontics, implantology and aesthetic prosthetics. He holds courses for dentists on the correct use of CAD/CAM techniques for natural teeth and implants. He is an active member of the board of PEERS (the Platform for Exchange of Experience, Research and Science, founded by Dentsply Sirona) and a founder member of the Accademia Italiana di Odontostomatologia Digitale (Italian academy of digital odontostomatology). He is an international key opinion leader for Dentsply Sirona and Zeiss on CAD/CAM and micro-dentistry, respectively. He lives in Mantua in Italy, where he runs his own dental clinic. He can be contacted at r.molinari@sanitasservizi.it.

An in-office-fabricated implant surgical guide corrected using CBCT

Drs Sean W. Meitner & Gregori M. Kurtzman, USA

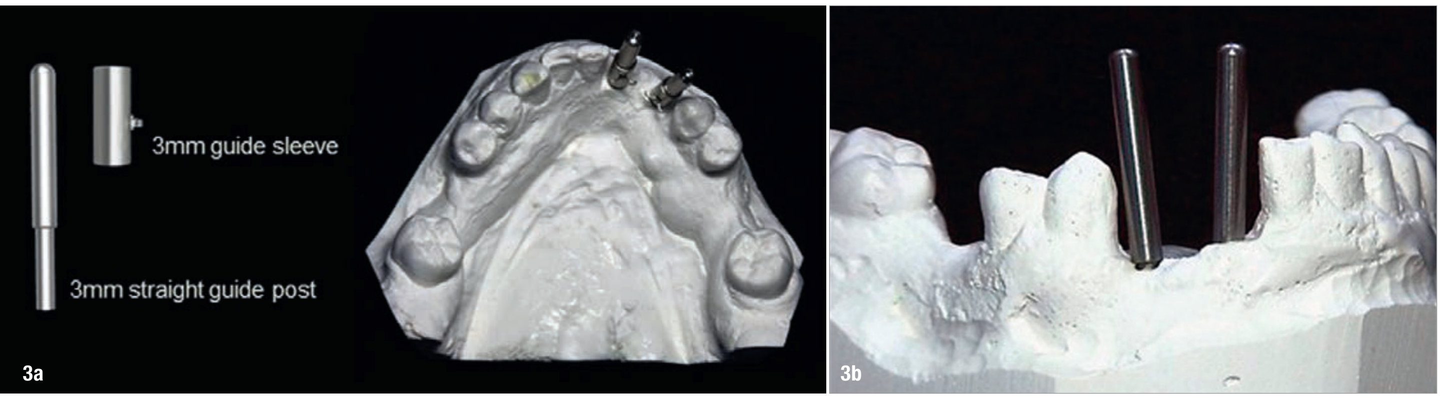


Figs. 1a & b: Pretreatment radiograph demonstrating significant bone loss associated with the mandibular right central incisor, lateral incisor and canine. **Fig. 2:** A 3/32 in. drill was used to make a pilot hole in the edentulous area of the cast where implants were planned and guide posts inserted.

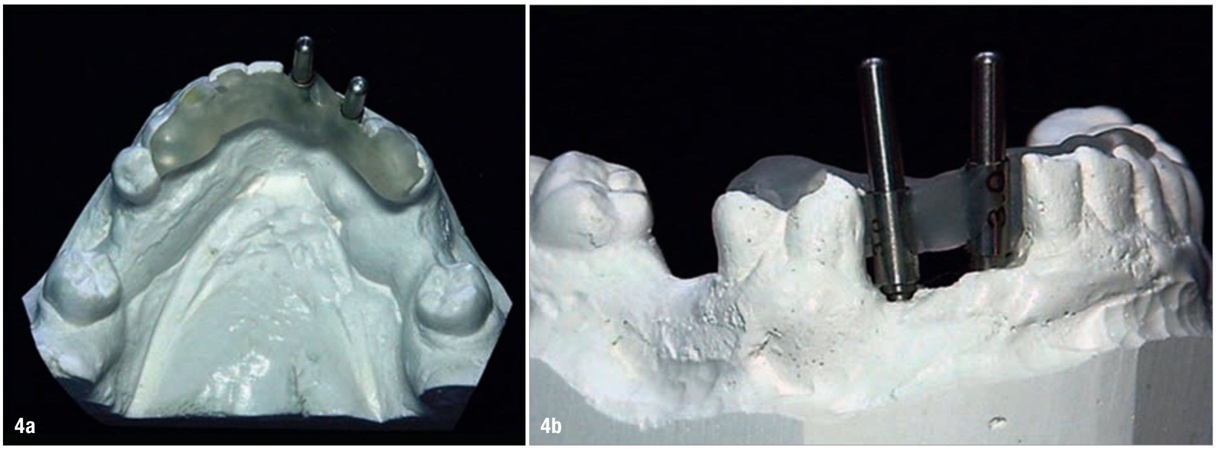
Introduction

Geometry of the bone present can make implant placement challenging. This can be especially true in the anterior, where the angle of the ridge requires a different trajectory than that of the prosthetic axis that will be used during restoration.[1] Both the maxillary and mandibular ridge tip to the facial aspect, requiring implant placement that is not vertical in position. This can become more complicated in a site that is either edentulous or undergoing significant periodontal changes to the bone present, as the facial aspect is lost first, shifting the trajectory of the available bone present.

Periapical and panoramic radiographs only provide a 2D view of the 3D anatomy practitioners operate within. Therefore, information regarding the inclination of the triangle of bone is not available. Attempts at a flapless approach surgically in those cases can lead to perforation of the lingual plate or dehiscence on the facial aspect of the ridge. This implant placement requires a flapped approach to fully view the facial plate to aid in osteotomy preparation during implant placement.[2,3] Even under those circumstances, the surgeon must centre the drills in the space for the implant to be properly positioned in the mesiodistal orientation.[4] This becomes more complex, with greater potential error, when placing two implants adjacent to each other



Figs. 3a & b: Guide sleeves were placed over the guide posts with the retentive cleats at the lingual aspect.



Figs. 4a & b: Triad gel was added to create a diagnostic stent that used the adjacent teeth for stability and locked to the guide sleeves' cleats.

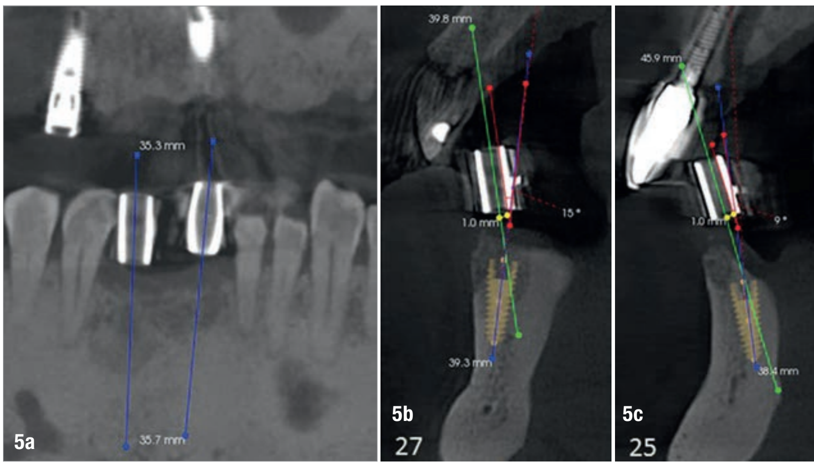
and increases as more adjacent implants are planned. Angulation errors in the facio-lingual dimension can still occur with freehand placement, leading to prosthetic complications during the restorative phase.[5]

Simple surgical guides have been in use for a guided approach that is prosthetically driven.[6] Those have ranged from guides created with denture teeth on the cast[7] with guide holes to position the initial drills to metal sleeves[8] that can, with appropriate inserts in the sleeve incorporated in the guide, allow guidance of each drill and implant insertion into the site. Unfortunately, those do not consider the 3D anatomy when fabricated and are created using a cast and viewing traditional radiographs to guide a hole drilled into that cast to position the sleeve and make the guide to that. Depending on the design of the guide and position in the arch, those may allow a flapless surgical approach or may still require a flap to verify orientation of the osteotomy in relation to the anatomy present. These factors can be challenging in a partially edentulous arch.[9]

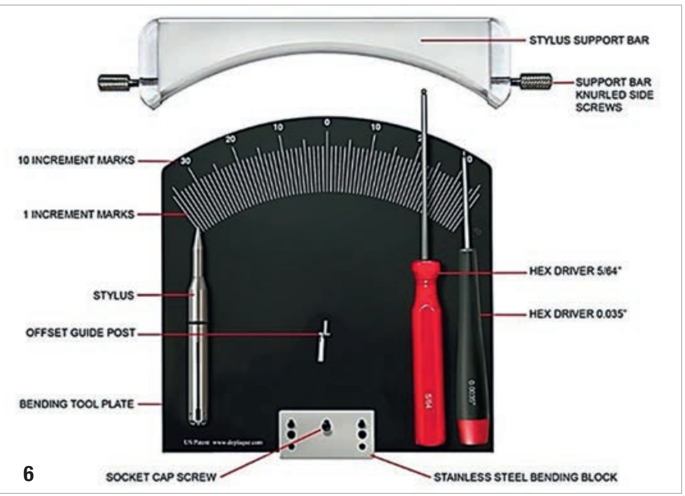
Cone beam computed tomography (CBCT) has assisted in eliminating the lack of information provided by traditional radiographs by allowing analysis of the surgical area in 3D.[10, 11] This technology has expanded on this improved information by permitting virtual planning of the implants and fabrication of CAD/CAM surgical stents to better guide the drills to create osteotomies that are anatomically and prosthetically guided. The benefit of this approach is that a flapless surgery can be performed if chosen during implant placement. Those guides are typically created by a laboratory after transmission of a virtually planned implant placement in CBCT using various software packages on the market. The laboratory then creates the surgical guide and returns it to the surgeon, and implant placement is performed.

Laboratory-fabricated surgical guides have some negatives to their use. Typically, there is the two- to three-week turnaround time between submission of the virtual planning and receipt of the CAD/CAM surgical guide. Additionally, there is a laboratory fee associated with that laboratory-fabricated guide. This may be cost prohibitive for the patient when a single implant is planned and adds to the treatment fee when multiple implants are planned in the same arch.

A simpler approach has been developed that uses a surgical guide fabricated in-office that does not require laboratory involvement. The guide is worn during a CBCT scan, and that data is imported into the implant planning software, where corrections to the planned trajectory and 3D position are made to the final in-office guide to be created. The result is a cost-effective surgical guide that can be quickly created in-office and that is guided based on the 3D anatomy, allowing a flap-free surgical approach that eliminates potential prosthetic complications if bone is adequate based on the desired implant position. A case demonstrating this tech-



Figs. 5a–c: CBCT views showing orientation of the diagnostic guide sleeves in relation to the bone present (green line), indicating correction required on both planned sites to have implants placed within the arch. The red line indicates the angle correction, and the yellow line indicates the offset measurement to the facial and lingual aspects. The blue line indicates the newly planned axis of the implant.



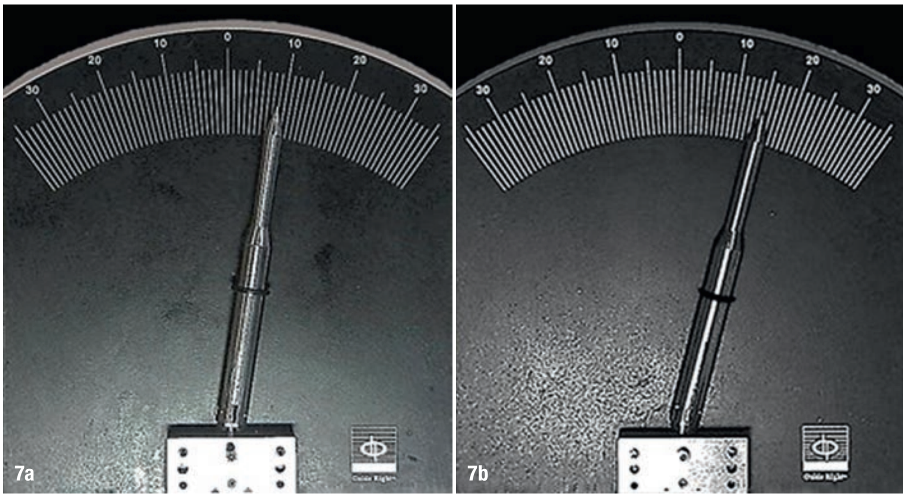


Fig. 6: Guide Right Bending Tool and stylus. **Figs. 7a & b:** A 1 mm offset post was bent to 9° for the central incisor site **(a)** and a 1 mm offset post was bent to 15° for the canine site **(b)**.

nique and application with regard to adjacent implants to be placed, each requiring a different orientation with regard to the osseous anatomy, is presented.

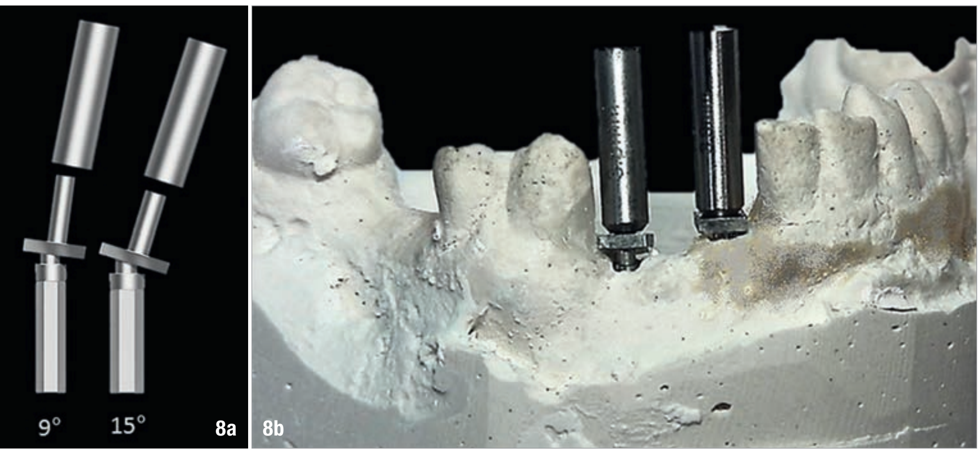
Clinical case

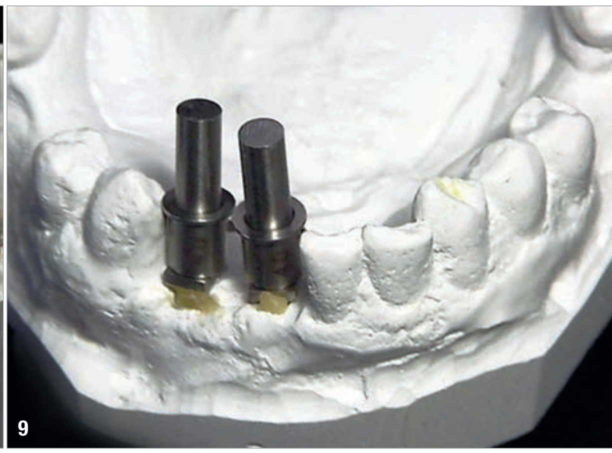
A 76-year-old male patient presented with mobility and pain in the right mandible. Review of the medical history of the patient informed that he had controlled diabetes and high blood pressure, for which he was on medication with regular supervision by his physician. Examination noted that the mandibular right central incisor and lateral incisor had Grade II mobility and that the right canine presented with Grade III mobility.

Periapical radiographs were taken to access the conditions present (Figs. 1a & b). A large area of bone loss was noted around the entire root of the canine, which had no osseous support. The lateral incisor presented with 90% bone loss and the central incisor 75% bone loss. The patient was informed that, owing to the amount of bone loss, extraction of the three teeth was the recommended treatment that could be performed on those teeth.

Treatment options to replace the teeth, which included a removable partial denture or placement of two implants and restoration with a three-unit fixed prosthesis, were discussed. The patient decided on the implant-retained fixed prosthesis as the treatment he wished to proceed with. Review of the steps necessary to follow this treatment option were discussed and the patient was informed that osseous grafting would be necessary at the time of extraction and, after a healing period, implants would be placed. The implants would then require a healing period to osseointegrate before restoration could be initiated. During the healing periods, the patient would wear a provisional partial denture. The patient was scheduled for surgery.

The patient presented, and informed consent forms were reviewed and signed by him. Local anaesthetic (4% art-





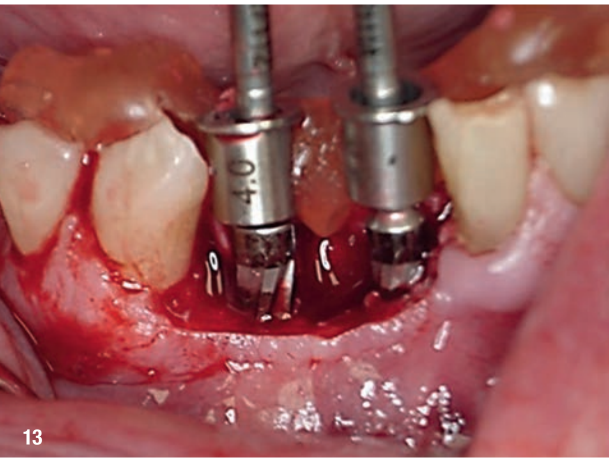
Figs. 8a & b: Corrected 1.0 mm offset guide posts with 3.9 mm upper parts for alignment of 4.0 mm guide sleeves placed into the post holes on the cast. **Fig. 9:** Guide sleeves were placed on the upper removable parts of the corrected guide posts.

Fig. 10: The cleats on the guide sleeves were orientated to maximise retention in the resin to be placed to fabricate the surgical guide. **Fig. 11:** Triad gel was placed, completing the corrected Guide Right surgical guide.

icaine with 1:200,000 adrenaline) was administered in the buccal vestibule and lingual aspect for infiltration. The central incisor and lateral incisor and canine were extracted atraumatically with a forceps after detachment of the periodontal ligament with a periotome. The extraction sockets were curetted to remove any residual tissue related to the periodontal lesions present. In preparation for implant placement after site healing, osseous grafting was performed to create a bed to accommodate the planned implants. The material used was INFUSE® Bone Graft (Medtronic), which contains a recombinant human bone morphogenetic protein-2, known to be upregulated in the bone healing process and thus assisting in bone regeneration. It stimulates the recruitment and differentiation of bone-forming cells, inducing new bone formation and healing existing bone. The solution was added to Puros (Zimmer Biomet Dental) and an absorbable collagen sponge. A resorbable non-ceramic bioactive bone graft was selected to aid in filling the sockets' missing volume (OsteoGen, Impladent). These materials convert over time and are replaced with host bone. The grafting material mixture was placed into the extraction sockets and gently tamped down to eliminate any voids present between the grafting material and socket walls. The patient was dismissed and scheduled for a follow-up appointment to check site healing.

At two weeks post-extraction and socket grafting, the patient presented and sutures were removed. The flap had healed uneventfully with primary closure. The patient was scheduled for an appointment at three months post-grafting to initiate the next phase of treatment. An impression was taken of the arch to fabricate the diagnostic guide. The impression was poured in stone to create a cast. A 3/32 in. drill was used in a laboratory handpiece to create a pilot hole in the cast at the estimated position and angulation at the central incisor and canine sites on the edentulous area, and guide posts (DePlaque) were inserted into the holes (Fig. 2). Owing to the different anatomical shapes of the two sites, the pilot holes were placed based on the cast's anatomy and parallelism was not attempted. A guide sleeve (DePlaque) was placed over each of the two guide posts and the retentive cleats were positioned at the lingual

Figs. 12a & b: The corrected Guide Right surgical guide was tried into the mouth to verify fit and stability **(a)**. A 2.3 mm insert and a 3.0–4.0 mm insert were placed in the 4.0 mm guide sleeve before the 2.2 mm drill was used to start the osteotomy **(b)**.



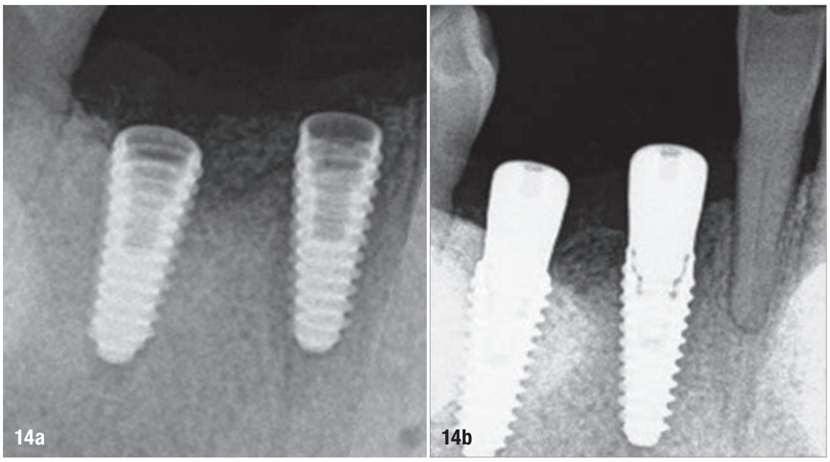
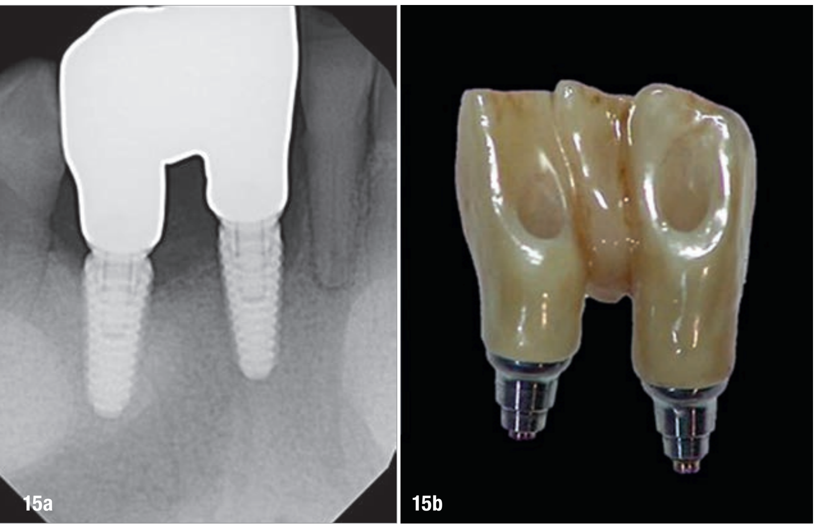


Fig. 13: Densah osseodensification drills used through the Guide Right surgical guide to create the osteotomies for the implants to be placed. **Figs. 14a & b:** Periapical radiographs of the implant placement **(a)** and healing abutments placed **(b)**.

aspect (Figs. 3a & b). Triad gel (Dentsply Sirona) was placed over the retentive cleats on the sleeves and over the lubricated surfaces of the adjacent teeth on the cast and light-polymerised to create the diagnostic guide (Figs. 4a & b). A CBCT scan was taken with the diagnostic guide worn intra-orally. The data was imported into CS 3D implant planning software (Carestream Dental), and the position of the two sleeves were analysed with regard to orientation to the underlying ridge and its angulation.

A virtual implant was placed at each site in the software. It was determined that, based on the trajectory of the guide sleeves, that both implant sites were angled to the facial aspect. This would create lingual perforation when the osteotomies were prepared, and a correction would be necessary with the surgical guide that would be fabricated. Additionally, both planned implants would need to be shifted and angled lingually to allow the definitive restoration to have lingual access openings for the abutment



Figs. 15a & b: Radiograph of the definitive restoration **(a)** and the definitive restoration displaying the lingual access openings **(b)**.

screws. Analysis determined that the implant at the central incisor would need to be angled 9° to the lingual aspect and offset to the facial aspect at the crest by 1 mm and the canine angled 15° to the lingual aspect and offset to the facial aspect by 1 mm (Figs. 5a–c).

The corrections to the guide posts would be made using the Guide Right Bending Tool (DePlaque; Fig. 6) and the appropriate offset guide posts. As planned in the virtual software, for the central incisor site, a 1 mm offset post (DePlaque) was bent using the bending tool previously mentioned to achieve the desired 9° correction to the pilot hole in the cast (Fig. 7a). This was repeated for the canine site using a 1 mm offset post which was bent to 15° (Fig. 7b). The corrected offset guide posts were inserted into the cast at the appropriate pilot holes, and 3.9 mm upper removable parts were placed over the top portion of the offset guide posts (Figs. 8a & b). Guide sleeves (4 mm) were placed over the upper removable parts with the cleats at the lingual aspect and oriented to maximise resin retention to them (Figs. 9 & 10) Triad gel was flowed over the cleats and adjacent lubricated portions of the cast and light-polymerised to create the corrected surgical guide (Fig. 11).

The surgical stent was soaked in povidone-iodine prior to use surgically. Chlorhexidine may be used as an alternative liquid to disinfect the guide. Local anaesthetic was administered, and the surgical guide verified for fit and stability intra-orally (Figs. 12a & b). A crestal incision was made with a scalpel, and a full-thickness flap was reflected to expose the crest. The Guide Right surgical guide with 4 mm guide sleeves was inserted. The osteotomies were initiated with a 2.2 mm drill in a 2.3 mm insert and completed with Densah osseodensification burs (Versah), starting at 2.5 mm and continuing to 3.5 mm in diameter to a depth of 11.5 mm at both sites through the surgical guide (Fig. 13). A 3.5 × 11.5 mm implant was placed into the central incisor site and a 4.0 × 11.5 mm implant was inserted into the canine site (AnyRidge, MegaGen). A post-insertion

Figs. 16a & b: Completed prosthesis with a three-unit screw-retained bridge on the implants, labial **(a)** and palatal **(b)** view.

radiograph was taken (Fig. 14a). Cover screws were placed on both implants, and the flap was secured with sutures.

Owing to the pandemic and shutdown, a delay in the return of the patient to initiate the prosthetic stage of treatment resulted. When the patient returned, the implants were exposed with a split-thickness flap. An implant stability quotient value of 80 was recorded for the central incisor implant and of 84 for the canine implant, and healing abutments were placed. A radiograph was taken to check the status of the implants (Fig. 14b). An open-tray impression was captured, opposing impressions taken and a maxillomandibular relationship record taken. Healing abutments were replaced, and the impressions were sent to the laboratory for fabrication of the prosthesis.

Two weeks later, the laboratory work was returned, and the patient presented for insertion. The healing abutments were removed, and the screw-retained three-unit bridge was tried in, and the fixation screws hand-tightened. A periapical radiograph was taken to verify mating of the prosthesis to the implants (Figs. 15a & b). The screws were tightened with a torque wrench to the manufacturer's recommended torque, and the screw access channels sealed with PTFE tape and flowable composite (Figs. 16a & b). The occlusion was checked, and no adjustment was indicated.

Conclusion

Implant placement can be challenging owing to the position and angulation of the available bone present. This is particularly true in the anterior maxilla and in the case of poor placement, especially when surgery is performed in a flapless manner. Poor placement can result in insufficient bone on the facial aspect of the implant, leading to eventual failure, as occurred with the initial implant the patient presented with. Evaluation of available bone is difficult with traditional 2D radiographs, as the facio-lingual dimension is lost for evaluation and can only be assessed with a CBCT scan. Software is then able to allow virtual planning and fabrication of a surgical guide to replicate placement based on the anatomy present and virtual positioning. A simplified process using the Guide Right system permits in-office fabrication of a simple guide that is used as a diagnostic guide worn during the CBCT scan and permits references during virtual planning and then fabrication of a corrected surgical guide, thus reducing both the cost of the surgical guide and the time required to have the guide ready for the implant placement appointment—an ideal option in the partially edentulous arch.

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

about

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He has been in private practice in periodontics for over 30 years in Pittsford in Rochester and is the developer of the Guide Right protocol. He can be reached at swmeit4@gmail.com.

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The use of new technologies and digital implant solutions in a one-stage surgical procedure

Dr Michał Nawrocki, Poland

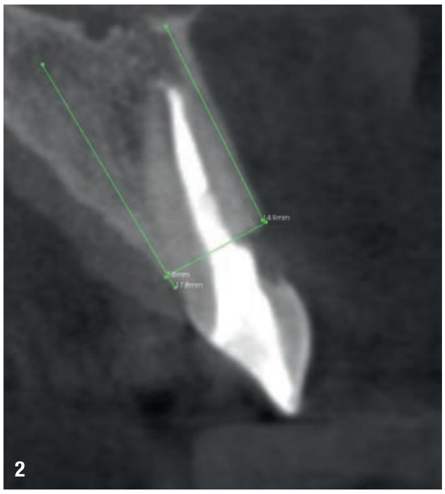
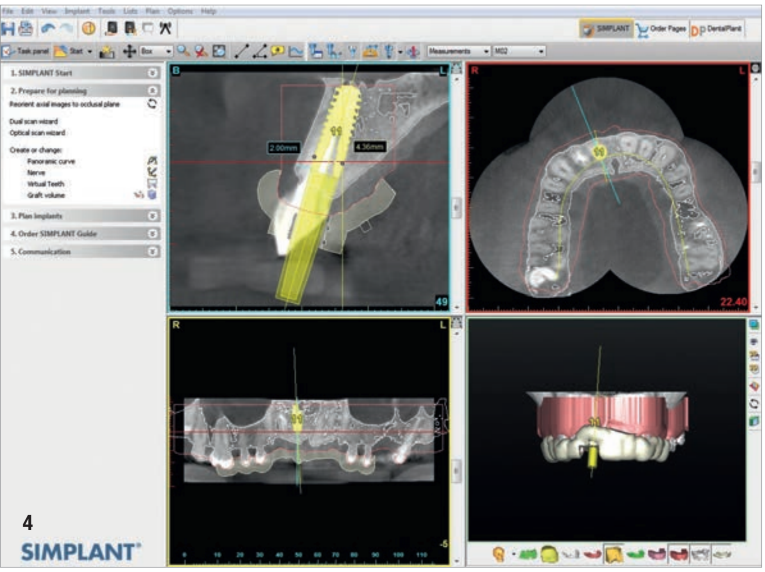


Fig. 1: Situation before treatment, which led to the decision to extract tooth #11. **Fig. 2:** CBCT scan: the root of the tooth was visibly fractured, and there was clear external resorption of the root from the vestibular side.

The aim of this article is to present a case of single-tooth prosthetic restoration in the aesthetic zone step by step. The patient was referred to our clinic with a fractured root of tooth #11 (Fig. 1). The cone beam computed tomography (CBCT) analysis confirmed the fracture and revealed external resorption of the root

Fig. 3: Buccal scan: information on the positioning of the maxilla relative to the mandible. This is absolutely necessary for designing a crown.



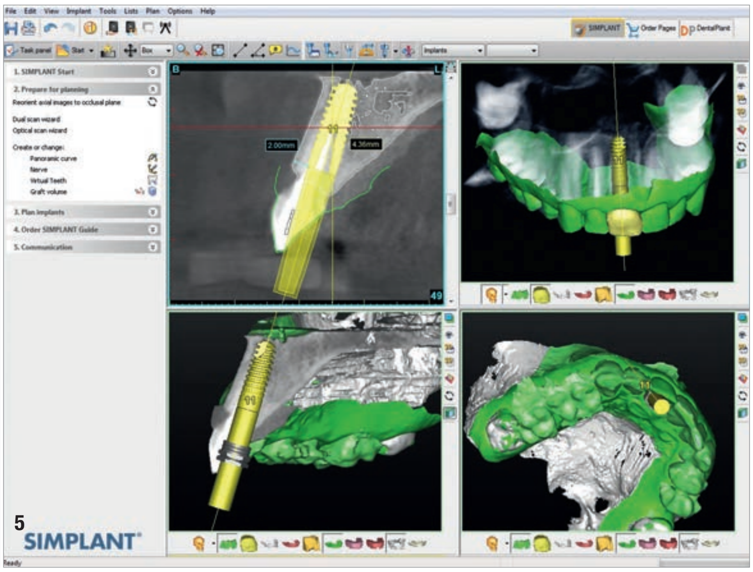
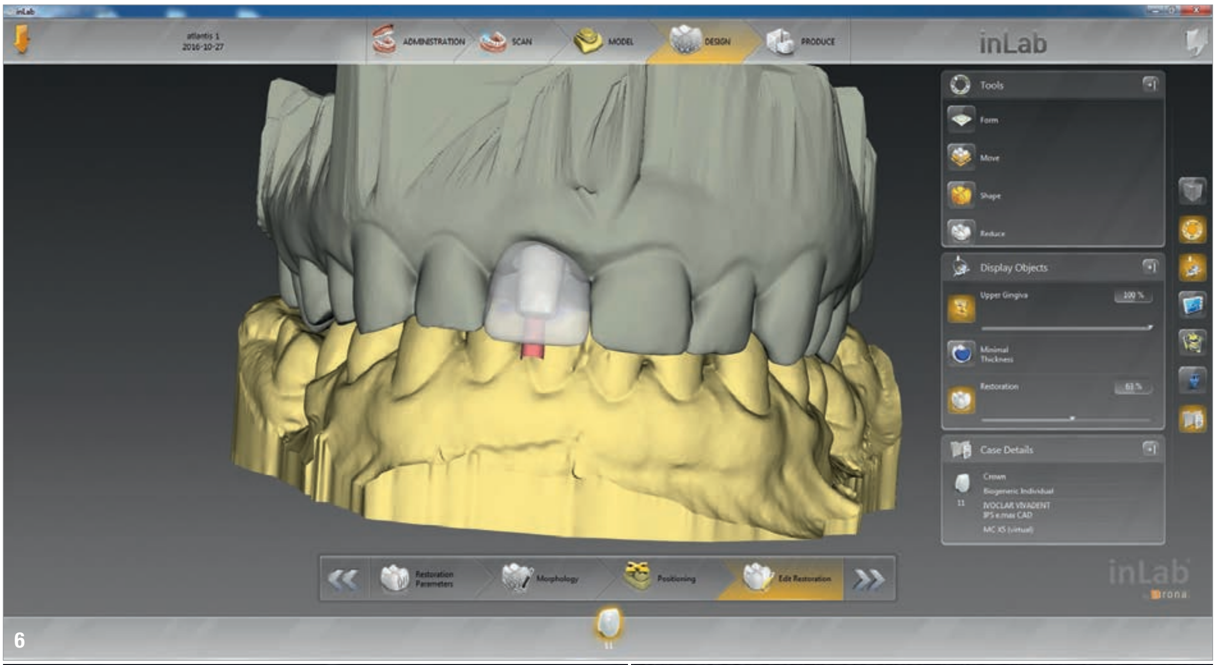


Fig. 4: Designing the guide in the Simplant software based on the planned implant position. **Fig. 5:** Overlaying the CBCT and CEREC intra-oral scans, as well as the planned implant position, in the Simplant software.



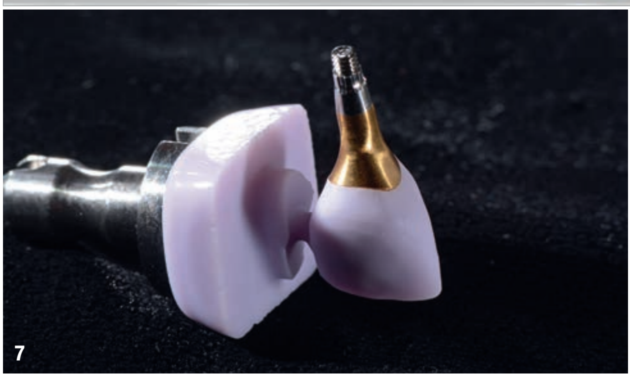


Fig. 6: Planning the shape and size of the future CAD/CAM full ceramic crown in cut-back technique in the inLab software (Dentsply Sirona) based on the Atlantis Core File received. **Fig. 7:** Full ceramic crown milled in the CEREC CAD/CAM system before sintering. As can be seen in the image, the Atlantis abutment and the crown would fit perfectly together. **Fig. 8:** The completed screw-retained IPS e.max crown ready to be cemented extra-orally with the Atlantis abutment (titanium nitride abutment surface).

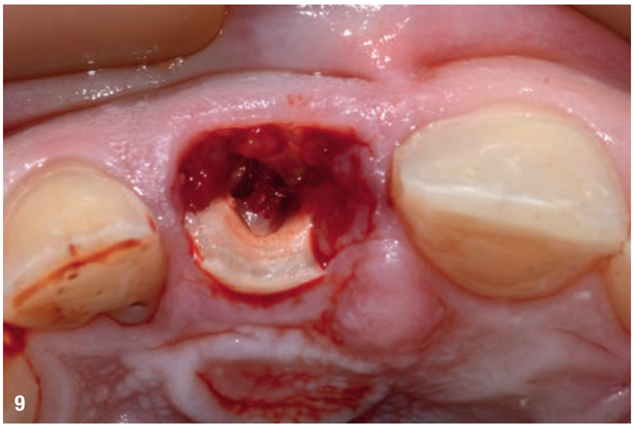
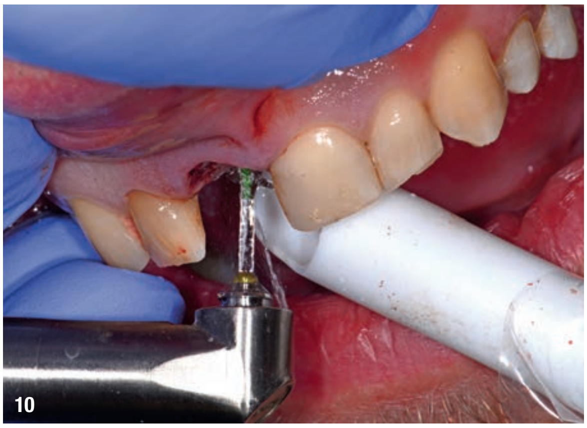



Fig. 9: Visible granulation tissue at the resorption and fracture area of tooth #11. **Fig. 10:** Removal of the granulation tissue with an Er:YAG laser.

from the vestibular side (Fig. 2). The tooth had to be extracted, and it was decided to follow immediate implant placement with a temporary aesthetic implant restoration. The immediate implant placement was planned with short-term non-occlusal loading.

With the use of the CEREC Omnicam scanner (Dentsply Sirona), scans were taken of both the maxillary and the mandibular full arches along with a buccal scan (Fig. 3). The scans, together with the DICOM files, were uploaded to the Simplant software (Dentsply Sirona; Figs. 4 & 5).

The optimal position was planned for an Ankylos C/X B 14 implant (Dentsply Sirona) in line with the 3A–2B rule.[1] Using the Simplant software, a Simplant Guide, along with a patient-specific Atlantis CustomBase Solution (with a titanium nitride abutment surface; Dentsply Sirona) and digital files, were ordered using Atlantis Core File (Dentsply Sirona).

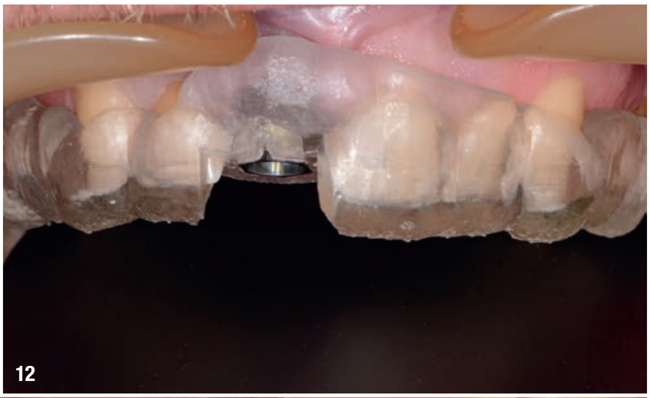
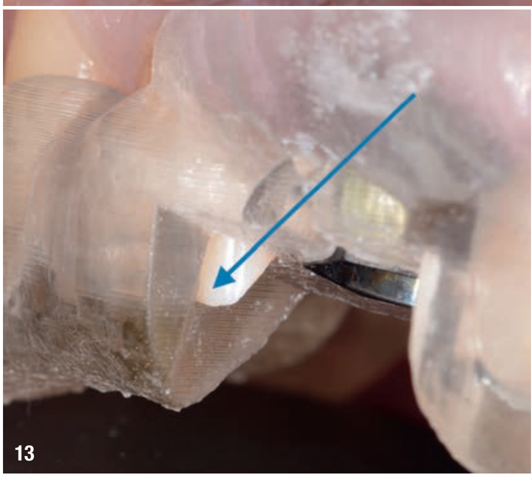





Fig. 11: Clean socket after atraumatic extraction of tooth #11. **Fig. 12:** Tooth-supported Simplant Guide. **Fig. 13:** The guide fitted flawlessly on the patient's teeth. **Fig. 14:** A sequence of implant drills with specific guide sleeves were used.

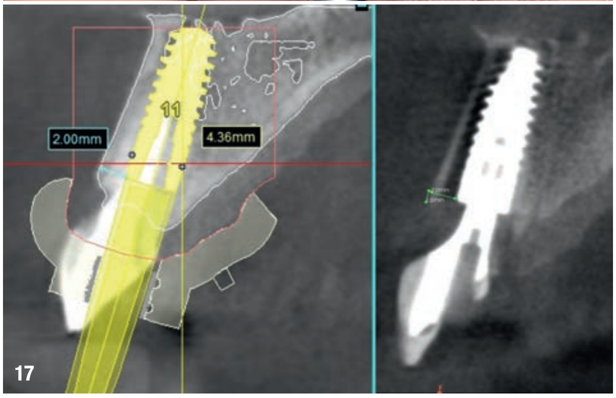


Fig. 15: Placement of the Ankylos implant using the Simplant Guide. **Fig. 16:** Sub-crestal placement of the Ankylos implant. Attachment of the screw-retained IPS e.max crown on to the Atlantis abutment (non-functional restoration). **Fig. 17:** A follow-up CBCT scan demonstrated the perfectly executed positioning of the implant as it had been planned. **Fig. 18:** There was perfect adaptation of the soft tissue around the implant restoration. In addition, a ceramic crown was placed on tooth #12 (after root canal therapy) and ceramic veneers on teeth #21 and 22. Three years follow up shows stability of soft and hard tissue.

The digital files were used to design and manufacture a screw-retained Atlantis crown for implant #11 in the CEREC CAD/CAM system (Dentsply Sirona). All the components, the Simplant Guide, the Atlantis abutment and the temporary crown, using CEREC, were manufactured and delivered prior to the surgical procedure (Figs. 6–8).

After precise planning, the tooth was extracted. At the resorption and fracture area of tooth #11, granulation tissue was clearly visible (Fig. 9). The granulation tissue was removed with an Er:YAG laser (H14 handpiece, Fotona; Fig. 10). The extraction was atraumatic and the socket clean and ready for implant placement (Fig. 11).

The implant was placed sub-crestally using the Simplant Guide (Figs. 12–15), which assures precision and safety. The screw-retained full ceramic crown on the Atlantis abutment (non-functional restoration) was placed immediately after implantation (Fig. 16). A follow-up CBCT scan demonstrated the perfectly executed positioning of the implant as it had been planned in the Simplant software (Fig. 17).

The treatment was successful, and the final outcome was very satisfying. After three years, the soft tissue around the implant was well adapted and healthy (Fig. 18). In addition, a ceramic crown was placed on tooth #12 (after root canal therapy) and ceramic veneers on teeth #21 and 22.

1. Rojas-Vizcaya F. Biological aspects as a rule for single implant placement. The 3A-2B rule: a clinical report. J Prosthodont 2013;22(7):575-80.

about

Dr Michał Nawrocki is an experienced implantologist. In 2009, he obtained a dental implantology certificate from Goethe University in Frankfurt am Main in Germany. In 2015 and 2016, he participated in the Implant Prosthodontics Program at the Mediterranean Prosthodontic Institute in Castellon in Spain. Dr Nawrocki also obtained an implantology certificate from the University of North Carolina at Chapel Hill in the US in 2016 and earned an MSc in lasers in dentistry from RWTH Aachen University in Germany. He is a member of the Polska Akademia Stomatologii Estetycznej (Polish academy of aesthetic dentistry) and Polish Society for Laser Dentistry. Dr Nawrocki runs a private practice in Gdańsk in Poland.
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Bimaxillary prosthetic reconstruction with implant-supported overdentures using novel materials and digital technology

Dr Said Sánchez, Mexico

Figs. 1–3: Baseline situation, extra-oral aspect. **Figs. 4–6:** Baseline situation, intra-oral view.

Introduction

The prosthetic rehabilitation of the fully edentulous patient with implant-supported overdentures has many advantages in comparison with conventional tissue-supported dentures in terms of retention, stability and masticatory efficiency, resulting in high patient satisfaction. Nevertheless, a proper diagnosis identifying the aetiology of edentulism, appropriate treatment planning according to the patient's profile, and the incorporation of novel technologies and materials in combination with evidence-based concepts are critical for obtaining highly successful results for the benefit of our patients.

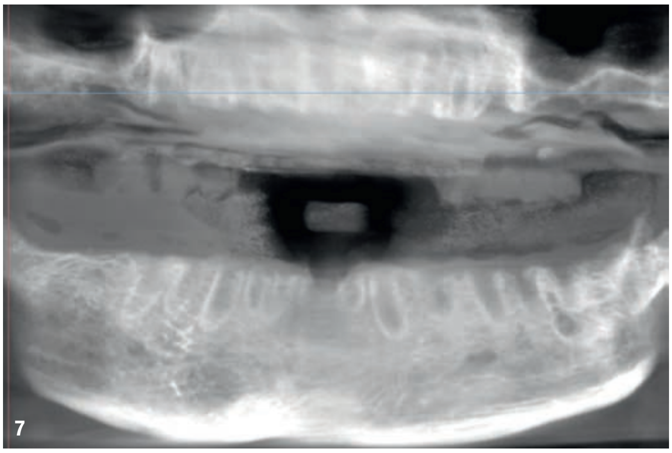


Fig. 7: Baseline situation, panoramic aspect obtained by CBCT.

This clinical report describes the surgical and prosthetic management in the rehabilitation of a fully edentulous patient, using narrow-diameter Roxolid implants (Straumann), allowing us to exploit the alveolar bone available and thereby avoid augmentation procedures. We applied the Novaloc retention system (Straumann) to restore the edentulous mandible in combination with advanced digital technology. Together, this allowed us to perform accurate full-mouth implant restorations with highly aesthetic and functional results.

Fig. 8: Transitional complete dentures, extra-oral frontal view. **Fig. 9:** Transitional complete dentures, extra-oral three-quarter view showing the adequate lip support provided by the buccal flange of the denture. **Fig. 10:** CBCT panoramic view showing gutta-percha points in the sites of interest.

Clinical case

Initial situation

A 65-year-old female patient with a medical history of Type 2 diabetes controlled with medication presented to the clinic with severe aesthetic and functional problems due to complete edentulism as a result of generalised Stage IV periodontitis (Figs. 1–3).

Her chief complaint concerned impaired mastication of all types of food and a compromised aesthetic appearance. Clinical examination and CBCT digital analysis revealed alveolar ridge deficiency attributed to extraction of the remaining teeth several months before (Figs. 4–7).

Treatment planning

Based on the initial intra-oral and extra-oral clinical assessment, CBCT digital analysis, the patient's functional and aesthetic requirements, and financial aspects, a definitive treatment plan was created. The proposed treatment plan was the prosthetic reconstruction of both the maxilla and mandible with prostheses that the patient would be able to remove and easily maintain and that would simultaneously fulfil the high functional and aes-

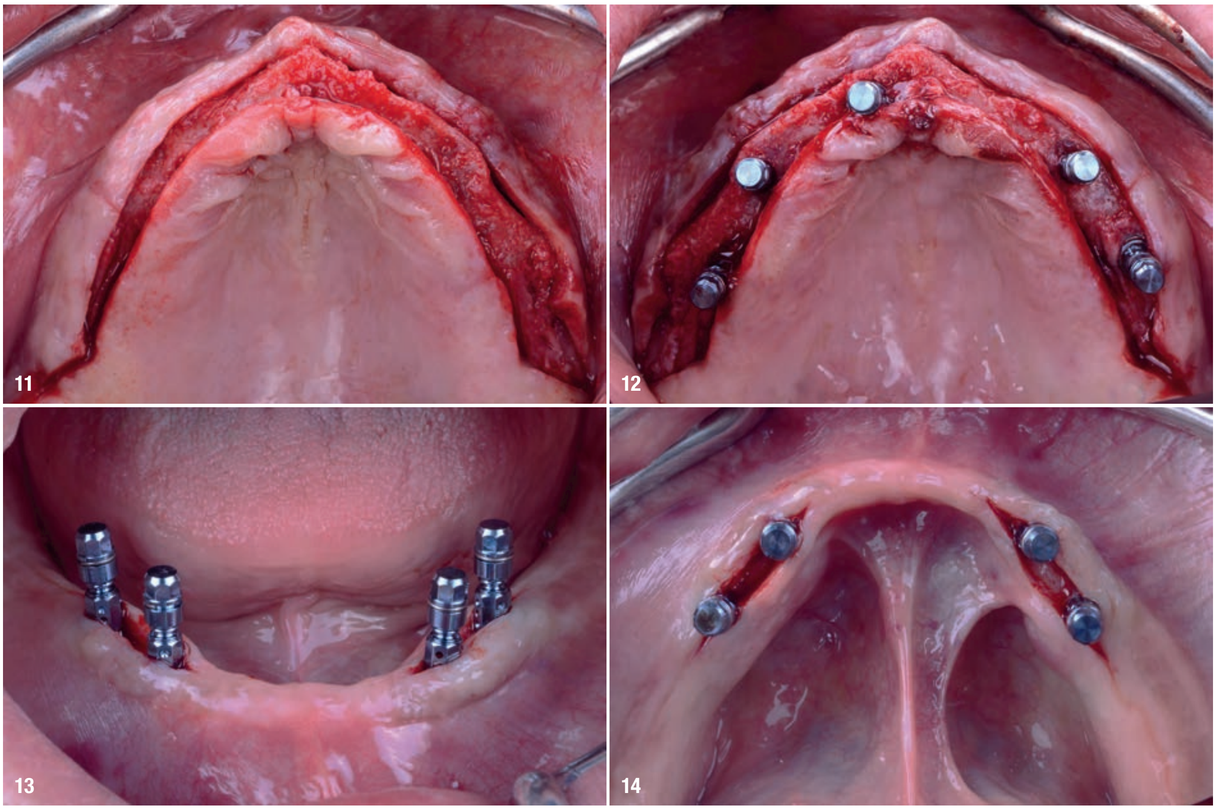


Fig. 11: Maxillary implant surgery. Occlusal view of the alveolar ridge before implant placement. **Fig. 12:** Maxillary implant surgery. Occlusal view of the implants placed, one in the position of the right central incisor, two in the positions of the right and left canines, and two in the positions of the second premolar sites. **Fig. 13:** Mandibular implant surgery. Frontal view of the four implants placed. **Fig. 14:** Mandibular implant surgery. Occlusal view of the four implants placed.

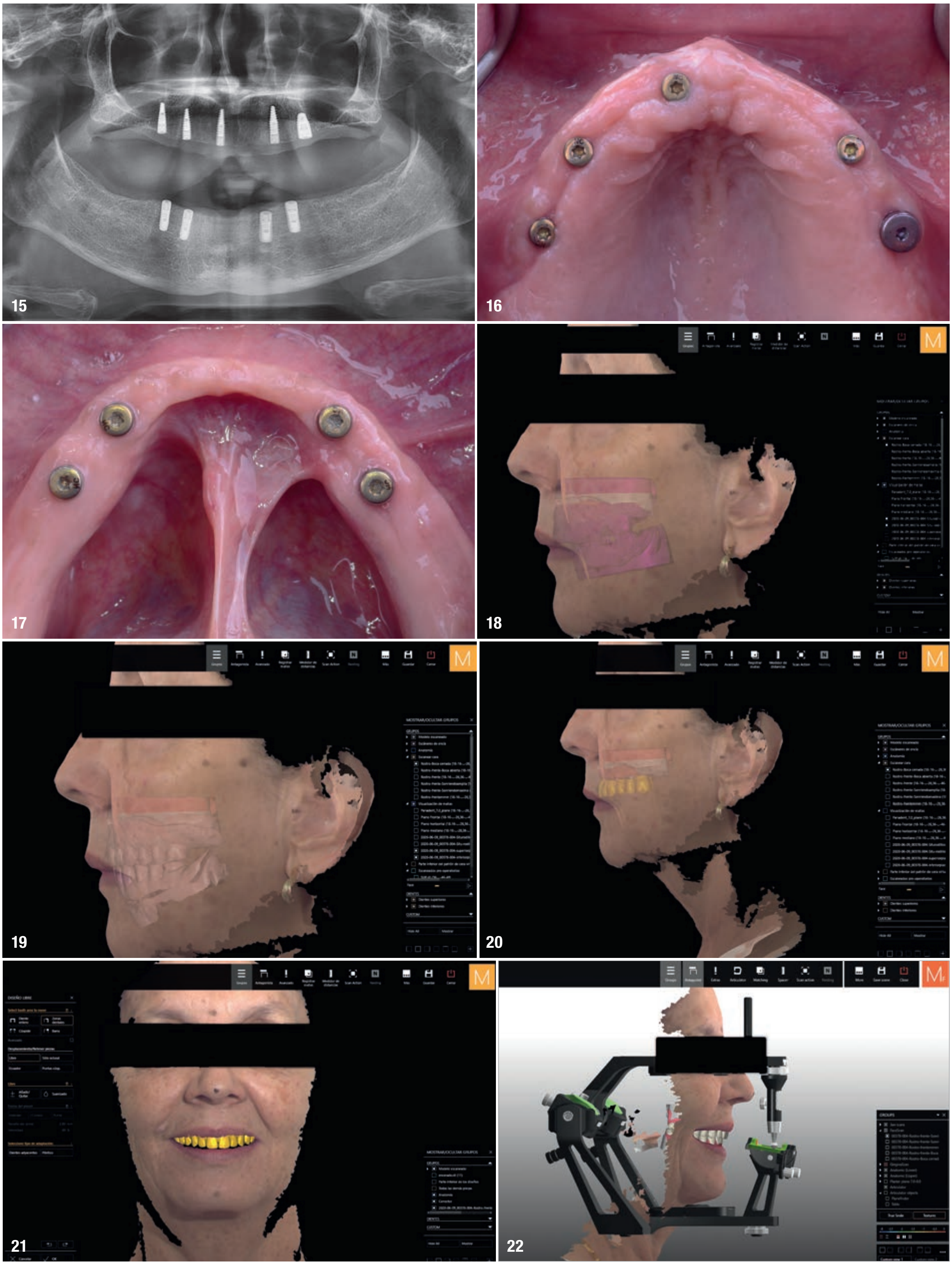
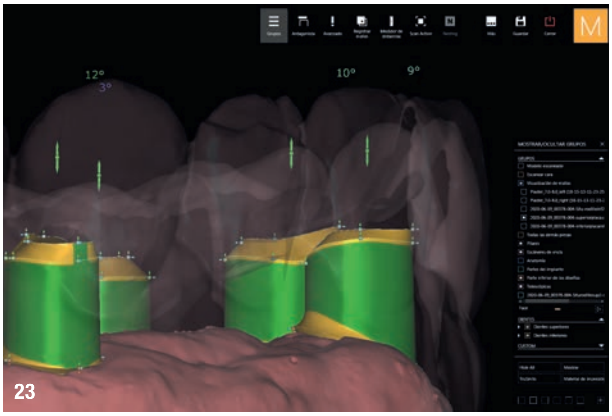
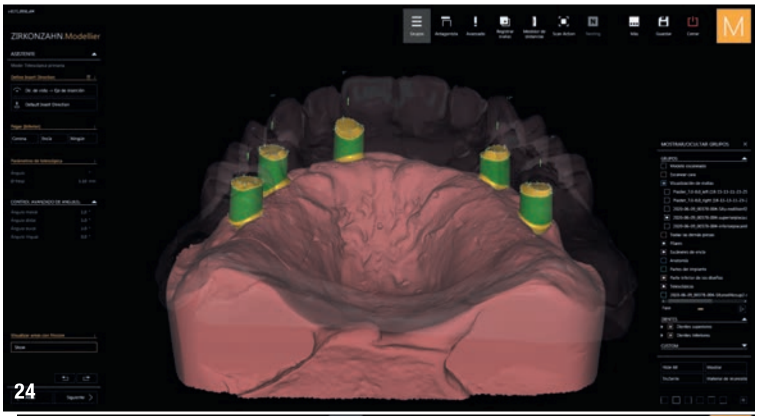
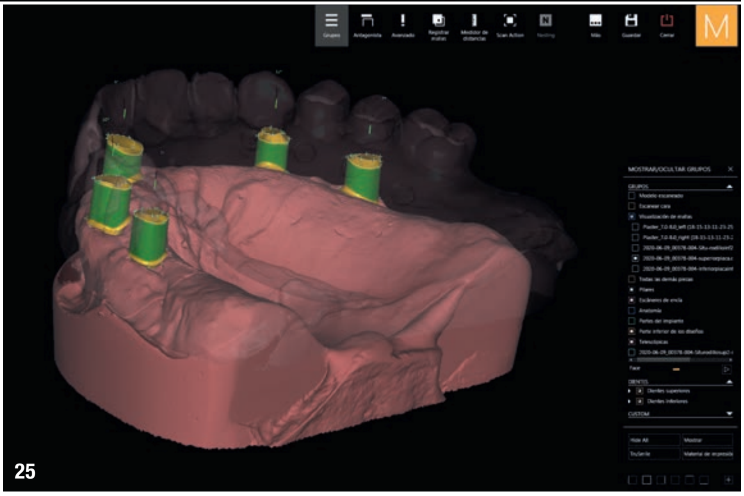


Fig. 15: Panoramic radiograph after the eight-week post-op healing period. **Fig. 16:** Occlusal view of the five uncovered maxillary implants. **Fig. 17:** Occlusal view of the four uncovered mandibular implants. **Fig. 18:** 3D digitisation of the patient's face in the natural head position with maxillary and mandibular baseplates and wax rims with the correct intermaxillary parameters. **Fig. 19:** Facial data integrated into the virtual articulator with final virtual design of the restorations. **Fig. 20:** Facial data integrated into the virtual articulator with final virtual design of the maxillary restoration. **Fig. 21:** Facial data integrated into the virtual articulator with final virtual design of the maxillary restoration. **Fig. 22:** Facial data integrated into the virtual articulator with final virtual design of the maxillary and mandibular restorations.







Figs. 23–25: Virtual design of the maxillary telescopic crowns.

thetic expectations. Therefore, an implant-supported fixed/detachable maxillary overdenture with a palate-less design and an implant-supported overdenture employing the Novaloc system were selected as definitive restorations.

The fabrication of transitional acrylic complete dentures (Figs. 8 & 9) with customised teeth and the proposed functional and aesthetic parameters was carried out in order to set the final tooth position before implant placement. This restoration-driven concept aims to optimise implant planning and placement according to the desired prosthetic reconstruction. The transitional dentures were duplicated in clear radiographic guides with gutta-percha points. These were placed in the potential areas of interest and served as surgical templates as well (Fig. 10).

Surgical procedure

After local anaesthesia, a crestal incision in the maxilla was performed slightly palatally in order to preserve the attached gingiva, and a full-thickness flap was raised with the purpose of reducing the alveolar ridge to create an adequate platform, assuring the vertical space required for the definitive prostheses (Fig. 11). After the osteotomy, five implants (four Straumann Bone Level Tapered, Roxolid SLActive; diameter: 3.3 mm; length: 12.0 mm; and one Straumann Bone Level Tapered, Roxolid SLActive; diameter: 4.1 mm; length: 8.0 mm) were placed in a straight position well distributed across the arch (Fig. 12).

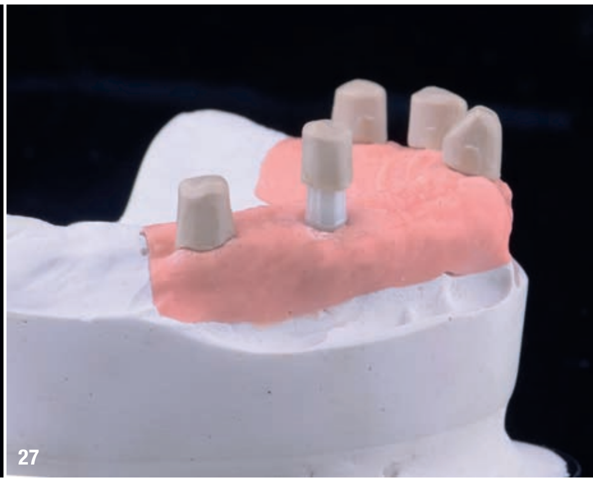
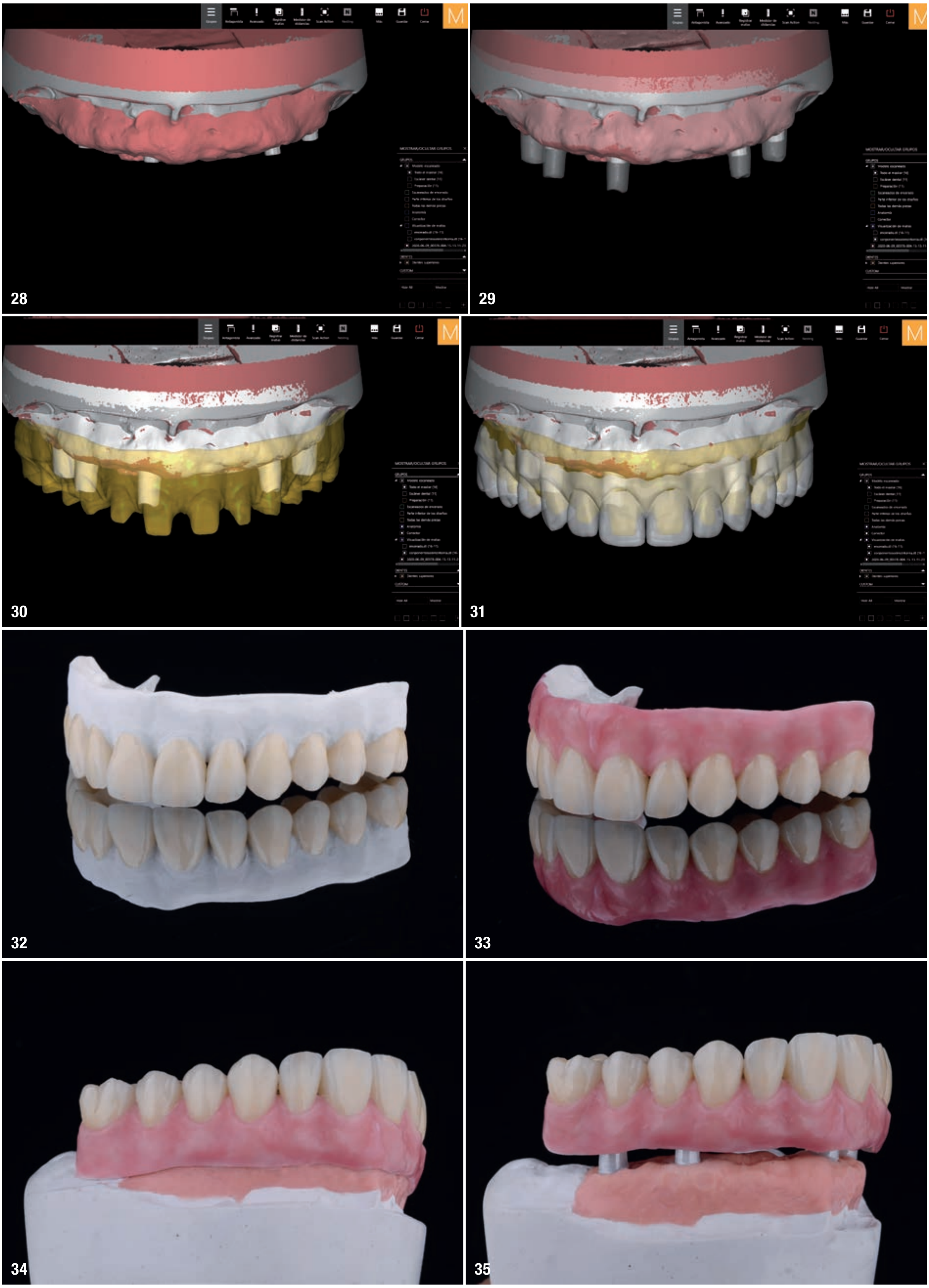


Fig. 26: Polished maxillary telescopic zirconia crowns cemented on to Variobase abutments (Straumann). **Fig. 27:** Secondary friction elements milled in PEEK material, ultimately cemented on to the final denture base structure.



Figs. 28–31: Final virtual design in the CAD software of the maxillary overdenture before the CAM procedure. **Fig. 32:** Maxillary overdenture base material milled in reinforced PEEK. The customised ceramic denture teeth were milled in lithium disilicate glass ceramic and finally were bonded to the reinforced denture base structure. **Fig. 33:** Final characterisation with pink veneering composite. **Figs. 34 & 35:** Final telescopic maxillary complete overdenture customised with pink veneering composite.

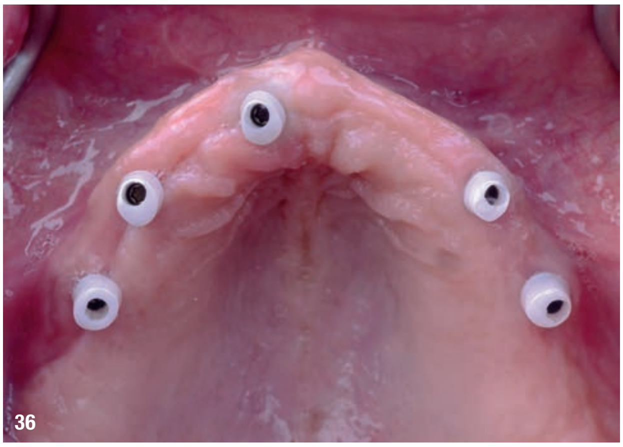
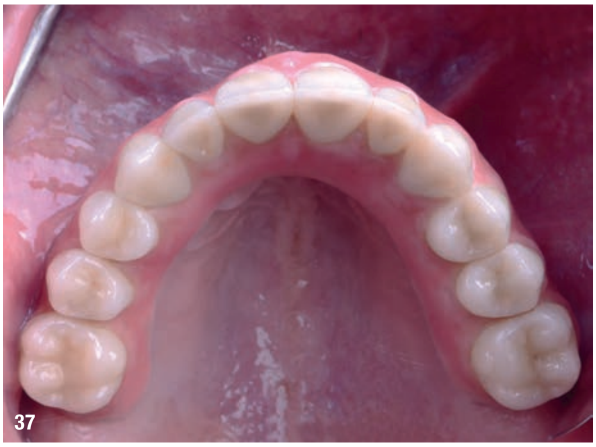



Fig. 36: Intra-oral occlusal view of the five telescopic abutments screwed in and torqued to 35 Ncm. **Fig. 37:** Intra-oral occlusal view of the maxillary implant overdenture incorporated.

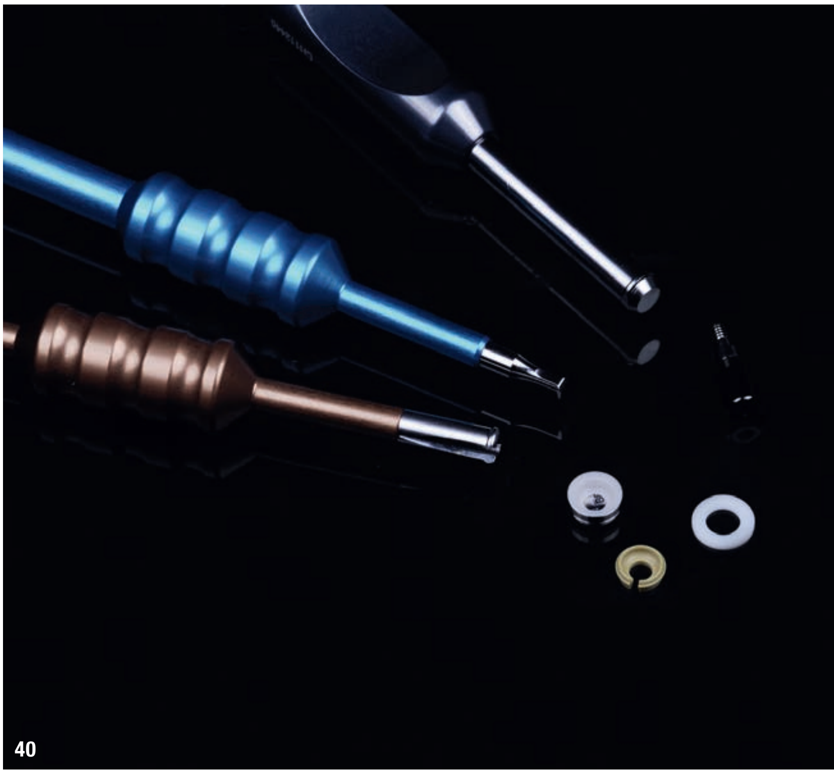
The primary wound closure was performed with a modified continuous sling suture using non-resorbable PTFE monofilament suture material.

After four weeks, in the second implant surgery, four narrow-diameter implants (Straumann Bone Level Tapered, Roxolid SLActive; diameter: 3.3 mm; length: 10.0 mm) were placed in a straight position in the mandible in interforaminal distribution (canine and second premolar), avoiding important anatomical structures in the molar sites and the severely reabsorbed anterior mandible (Figs. 13 & 14).

The implants were left with closure screws for two-phase submucosal healing (Fig. 15), and a conventional loading protocol was selected for both the maxilla and the mandible according to the International Team for Implantology consensus statement on loading protocols for implant-supported overdentures in edentulous jaws.

After eight weeks of healing, a second surgery was performed to uncover the implants and place healing abutments to preserve the attached gingiva (Figs. 16 & 17).





Figs. 38 & 39: Novaloc abutments (Straumann) presented in the model with artificial soft tissue showing the correct abutment gingival height. **Fig. 40:** Novaloc retention system.

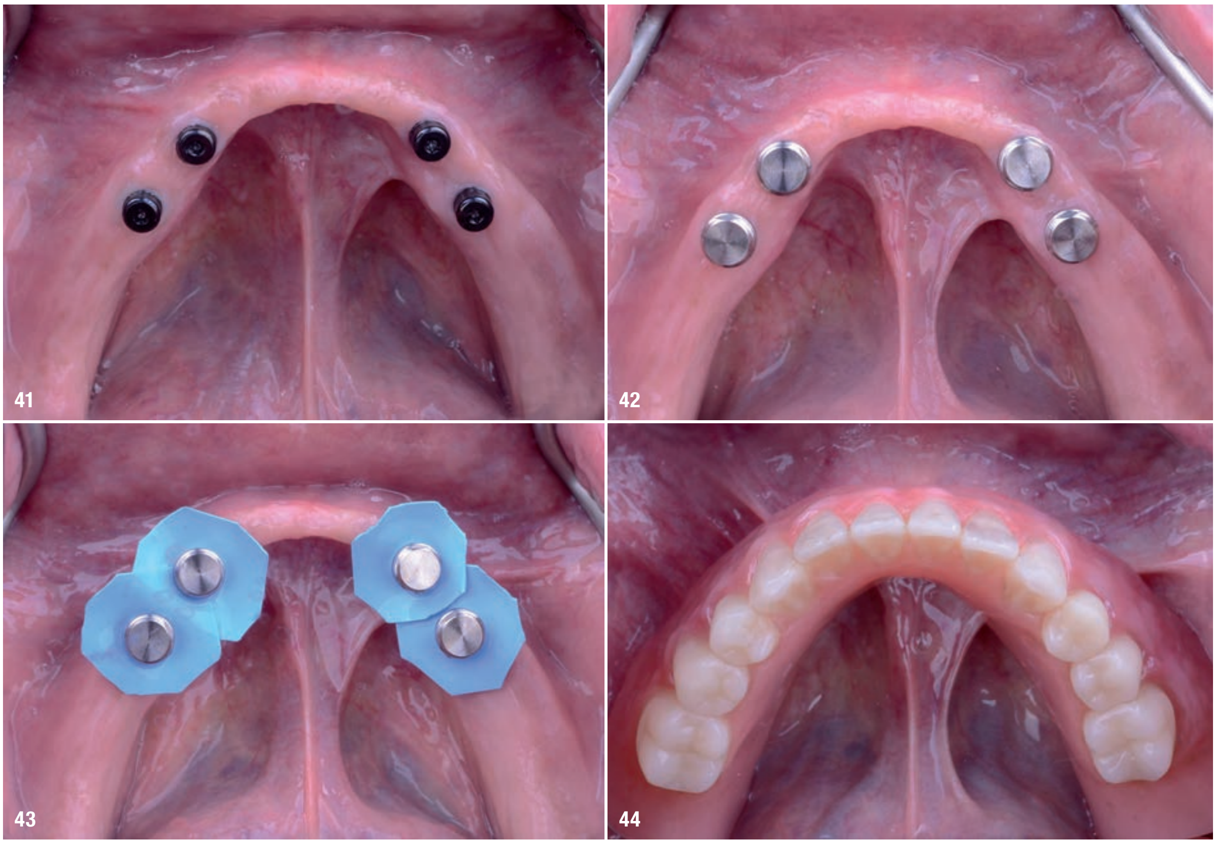


Fig. 41: Intra-oral occlusal view of Novaloc abutments screwed in and torqued to 35 Ncm. **Fig. 42:** Intra-oral direct pick-up procedure. Titanium matrix housings *in situ*. **Fig. 43:** Intra-oral direct pick-up procedure. Block-out rings placed over the abutments to prevent excess dual-polymerising resin processing material below the matrix housings. **Fig. 44:** Intra-oral direct pick-up procedure. After adequate passive seating of the definitive prosthesis had been checked, the final pick-up was performed with finger pressure using dual-polymerising self-adhesive resin material.

Prosthetic procedure

The first step was to accurately transfer the implant 3D position to the laboratory through conventional impressions with the open-tray technique using polyvinylsiloxane and customised trays. Cast models with implant analogues were obtained, scanned and digitised. From this point, a completely digital workflow for the production of the definitive restorations was employed. Posteriorly, the craniomandibular jaw relation was registered using a specific system (PlaneSystem by Udo Plaster, Zirkonzahn), which is based on the patient's natural head position and the ala-tragal line allowing an accurate transfer of this information to the physical and virtual articulator.

Eventually, the patient's facial 3D recording was taken using an optical face scanner with a bite plate for image merging and 3D patient analysis (Fig. 18). The application of a 3D face scanner is an important tool that provides the clinician and laboratory with valuable patient information and better communication with the patient.

Figs. 45 & 46: Final intra-oral aspect of the bimaxillary implant rehabilitation after six months.

Figs. 47–50: Final extra-oral view. A very pleasant and natural smile was achieved with the implant-supported prosthesis.

After data acquisition (with a laboratory scanner) and merging in the CAD software, the digital design process of the definitive restorations was initiated. The CAD software allows full control of the prosthesis with 3D data of the aesthetic and functional parameters, verifying occlusal contacts and excursive movements in the virtual articulator (Figs. 19–22).

For the maxillary arch, five monolithic zirconia telescopic crowns were designed and milled according to the previous digital set-up (Figs. 23–27) and cemented on to Straumann Variobase abutments (four Narrow CrossFit; diameter: 3.8 mm; height: 3.5 mm; gingiva height: 1.0 mm; and one Regular CrossFit; diameter: 4.5 mm; height: 3.5 mm; gingiva height: 1.0 mm). The definitive prosthesis consisted of an overdenture CAD/CAM base material milled in ceramic-reinforced PEEK with anatomical reduction to receive customised monolithic ceramic denture teeth (Figs. 28–31). Lastly, indirect pink veneering composite was used to reproduce the gingival anatomy (Figs. 32–35). The telescopic crowns were screwed on and torqued to 35 Ncm, the access holes were blocked with PTFE and the definitive prosthesis was incorporated (Figs. 36 & 37).

The fabrication of the definitive restoration for the mandible included a milled implant-supported overdenture in pink PMMA denture base material with CAD/CAM polymer denture teeth customised with layering composite. Four straight Straumann Narrow CrossFit Novaloc abutments (diameter: 3.8 mm; height: 3.0 mm) were selected as the retention system for definitive prosthesis (Figs. 38–40). These abutments have the advantage of requiring minimal vertical prosthetic space, have high patient satisfaction owing to excellent and long-lasting retention properties, and have significantly higher wear resistance in comparison with other stud-type attachments.

The intra-oral pick-up process of the abutments was performed using dual-polymerising self-adhesive pink composite (Figs. 41–44). Subsequently, finishing and polishing were done, and PEEK Novaloc retention inserts with light retention force (white colour) were placed.

Treatment outcomes

Final intra-oral and extra-oral views six months postoperatively illustrated the very pleasant and natural result achieved (Figs. 45–50). The patient was very satisfied with the aesthetic outcome and, more importantly, the functional outcome and reported her ability to chew different types of food, describing it as a life-changing experience.

about

Dr Said Sánchez is a dentist specialised in prosthodontics and oral implantology. His areas of focus are implant dentistry, aesthetic dentistry, digital technology and adhesive oral rehabilitation. He is a lecturer in the postgraduate department of prosthodontics and implant dentistry of the University of De La Salle Bajío in León in Mexico and is in private practice limited to prosthodontics and implant dentistry in León. He is a fellow of the International Team for Implantology (ITI), joint director of the ITI study club in León, an ITI speaker, and communications officer of the ITI Mexican, Central America and Caribbean section.

Full-mouth restoration with Zolid FX—a successful concept for sophisticated prostheses

Joachim Maier, Germany

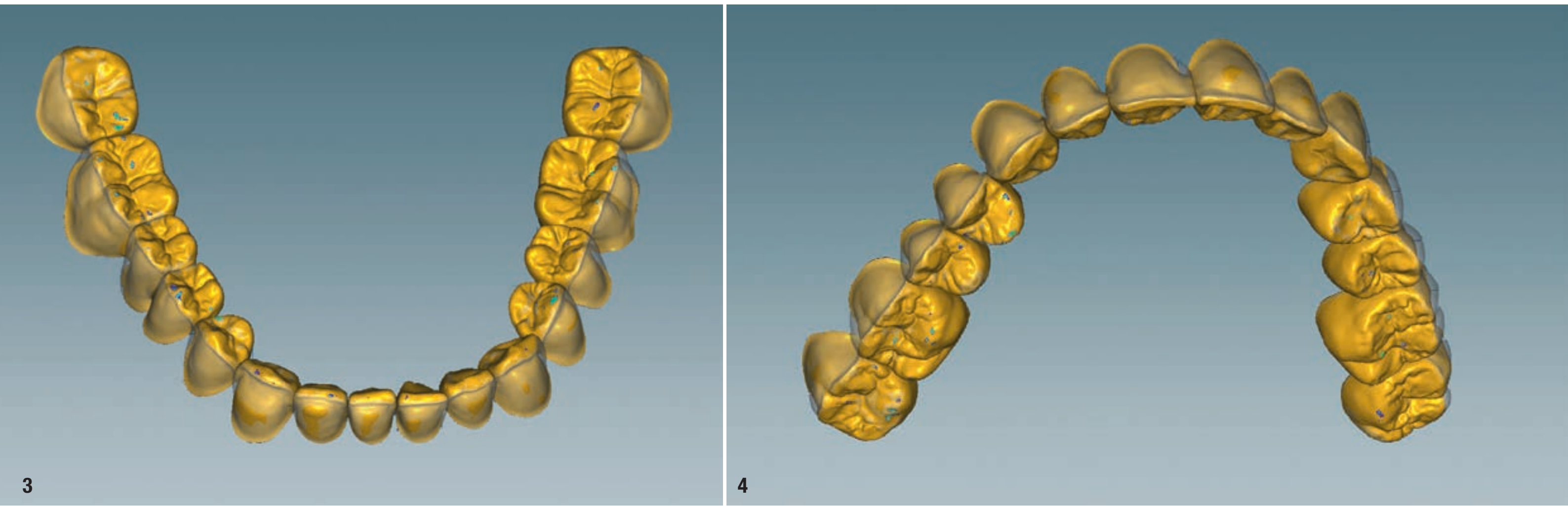
Figs. 1 & 2: Pronounced abrasion due to bruxism, resulting in significant loss of the vertical dimension.

Case description

The patient case outlined here describes the challenges that prostheses have to meet under high stress. The patient presented to the practice with pronounced abrasion and asked to have his natural dental appearance restored. Full-mouth restorations have their own challenges, and this was particularly so for this patient, who tended to relieve his daytime stress by grinding his teeth at night. After completion of pretreatment and splint therapy, the patient presented to us with the status shown in Figures 1 and 2.

Goal definition

Our task was to fabricate prostheses which, in addition to their natural aesthetics, could withstand high mechani-



Figs. 3 & 4: The occlusal design was created, and the contacts placed on unveneered zirconia. These should not be positioned directly on the veneer interface.


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Fig. 5: Tools for surface characterisation before sintering. **Figs. 6–8:** Stones and sandpaper cones were drawn over the surface by hand without rotation.

cal stress and offer corresponding durability. The patient and clinician wanted all-ceramic restorations consisting of single crowns in the maxillary and mandibular regions, except for a three-unit bridge in the fourth quadrant. The restorations were to be fabricated at the occlusal height specified during splint therapy. This was specified to us via a corresponding occlusion registration record.

Choice of materials and design

We always attempt to use only a single material for each case or restoration. Different ceramics have different light properties, which can be an optical disadvantage. For restorations consisting exclusively of single crowns, we usually choose veneered zirconia and in exceptional cases also lithium disilicate. The bond between lithium disilicate and veneering ceramics demonstrates higher strength than between zirconia and corresponding veneering ceramic. However, we appreciate the concentration of zirconia as a universally applicable material for frames. With a limited choice of materials, we can gain maximum experience and thus achieve a very high level of production reliability and predictability of the results.

Depending on the mechanical stress, we select a different thickness for the veneering ceramic on zirconia. In the case of extreme stress, we also dispense with a glaze in the functional area of the contact points.[1] For bruxism patients, however, we choose unveneered lithium disilicate for individual crowns in the posterior region, as the natural abrasion and associated loss of height observed for this material are similar to that


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Fig. 9: Interim status of the surface treatment before partial smoothing.

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Figs. 10 & 11: If required, the fissures can be recontoured with a pointed carbide cutter. **Fig. 12:** After sintering, diamond silicone polishers are recommended for refining the zirconia surface. For example, the Zolid Sinter-State Polishing Kit (Amann Girrbach) is well suited here. **Fig. 13:** Stone and diamond polishers from EVE-Diacera HP Set for zirconia.

of natural teeth. Unveneered, smooth-polished zirconia would exhibit less loss of height over the years and would result in uneven abrasion of the teeth, having unforeseeable consequences. Our standard solution is thinly veneered zirconia if only a few teeth are to be restored, for example in the case of isolated gaps.

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Figs. 14 & 15: Silicone brushes with diamond grains do not change the shape of the surface, but smooth it. Contact with the workpiece should be made at a slight angle so that the bristles can deflect better and do not kink.

In this case, we decided to partially veneer the crowns and the bridge owing to the exceptional mechanical stress on the prostheses.

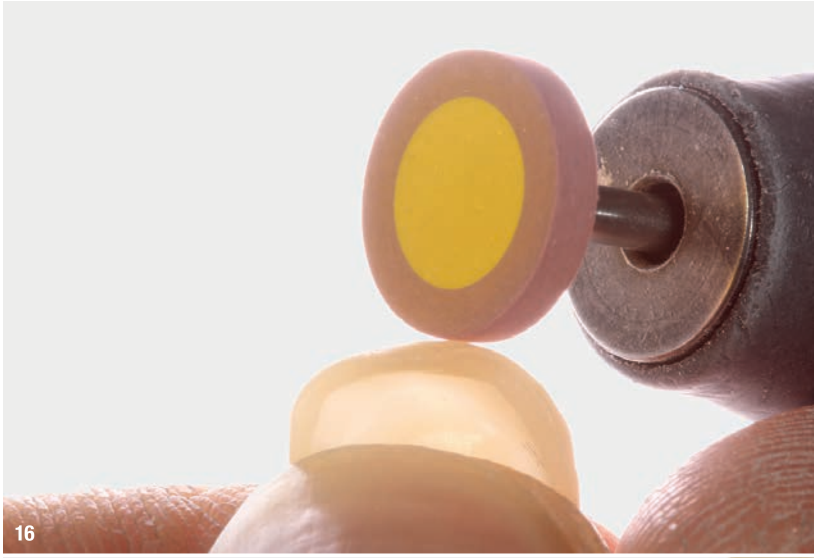
The visible vestibular parts were to be veneered with the Creation CT veneering ceramics. We wished to place the transition to the unveneered area outside the heavily stressed functional paths and static contact zones. At the time of fabrication, we had ZI, Zolid and Zolid FX (Amann Girrbach) at our disposal. Owing to the small bridge span, we selected the super-high-translucency material Zolid FX Multilayer (Amann Girrbach) for the full-mouth restorations, including the bridge from tooth #45 to tooth #47. The tooth stumps were not significantly discoloured. This allowed us to make full use of the optical advantages of the translucent material. To achieve maximum individuality, the Zolid FX multilayer crowns were partially stained with liquids before sintering. It is recommended to use a pre-stained blank that is slightly lighter than the tooth shade to be achieved in order to avoid a restoration that is too dark.

Design of the functional areas

In virtual design, we try to create as few occlusal contact points as possible. We consider this to be sufficient if the tooth can be loaded axially. A reduced number of occlusal contacts helps us to keep the dynamic function under control. This is absolutely necessary in the case of extremely hard zirconia, as defects in this area can lead to unforeseeable consequences for the softer components of the masticatory organ. Our occlusal design can be viewed as an example in Figures 3 and 4. The areas to be veneered are defined with some distance to the contact paths and surfaces. Normally, we extend the cut-back to such an extent that small optical optimisations of the incisal cutting edge are possible through the individual layering technique of the veneer, particularly in the anterior region. The anterior teeth are therefore often given a cut-back that runs approximately in the middle of the incisal edge in a mesiodistal direction. However, in patients where extreme functional loading can be expected, this boundary line runs all the way along the outer buccal edge of the abrasive surface to prevent chipping under these particular conditions.

The surface quality of zirconia

In this case, the unveneered areas of zirconia were provided with a surface structure prior to sintering. Figures 5 to 9 show the tools, work steps and results of surface characterisation prior to sintering. The powerful characterisations can only be performed by hand with a coarse stone, for example, without the use of a motor. These structures are subsequently smoothed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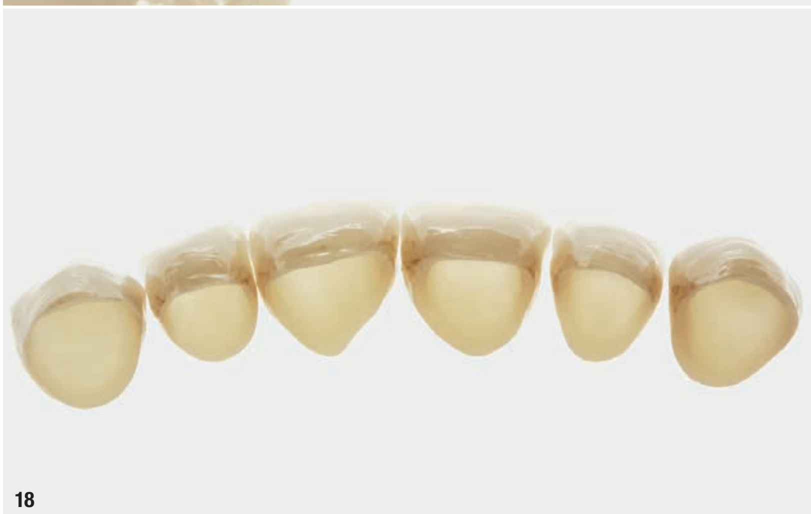
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Fig. 16: Low-structure, smoother areas, such as those found at the exposed tooth equator, are partially polished with silicone wheels. **Fig. 17:** The objective is a high-quality surface with a matt finish. Only the small occlusal contact or functional surfaces are polished to a high gloss. **Fig. 18:** The nature-like translucency of Zolid FX makes it possible to dispense with part of the dentine layering with veneering ceramics.

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Figs. 19 & 20: The combination of areas with monolithic zirconia and areas with buccal veneering combines the entirely different advantages of two ceramics.

again slightly at the raised areas with mostly smoother surfaces. It is important that these structures are not applied to bridges in tensile stress areas, to prevent any possible initial formation of cracks. Finally, the fissures are reworked if necessary. Figures 10 and 11 demonstrate this final processing step before cleaning, infiltration and sintering. The small contact and guide surfaces on zirconia must be polished to a high gloss after sintering and grinding to prevent mutual abrasion and early failure of the restoration. The analysis of an internal study by our laboratory showed that polishing with a diamond polisher or the finest diamond grinder largely removes the deep surface damage caused by a Rotring diamond bur. The success of this approach has been confirmed by Coldea et al.[2]: if final sintered Y-TZP is processed with coarse abrasives, subsequent polishing is absolutely necessary. It is recommended to grind or polish gradually with increasingly finer grinders or polishers. The surfaces are smoothed with suitable diamond silicone polishers, that is, the spikes are removed without causing any further surface damage. This can be facilitated quite easily, for example, with the polishing sets in Figures 12 and 13.

In contrast to veneering ceramics or lithium disilicate, our polished zirconia samples have very low roughness depths. The smooth surface of final sintered zirconia that can be achieved by polishing also has advantages in abrasion behaviour compared with veneering ceramics. Preis et al. came to this conclusion in a comparison of the abrasion behaviour of zirconia and veneering ceramics on natural enamel.[3] Abrasion caused by zirconia was considerably less than that of veneering ceramics. Owing to the veneering ceramics, the antagonist exhibited a roughened surface and partially also cracks and fractures in the enamel. The contact surfaces with zirconia were polished.[3] In an *in vitro* study, Sripetchdanond and Leevailoj showed that monolithic zirconia had a lower wear depth on human enamel than glass-ceramic and human enamel did.[4] The best result of our laboratory test regarding the lowest roughness depth was obtained with an epoxy resin-bonded, diamond-

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Figs. 21 & 22: New teeth with abrasion facets and cracks that suit bruxism patients. Stability, function and inconspicuous integration of the restorations were the objectives of our work.

containing stone. The remaining surface structures were efficiently polished with two-stage diamond polishers as shown in Figure 13. The surface quality can be further increased with a subsequent glaze layer. However, one must allow for abrasion of the glazing material in the functional area. A meticulously smoothed surface is therefore a prerequisite for long-term success. Nevertheless, we now avoid the use of glazing material as far as possible, as solubility and a surface that tends to roughness in an acidic environment in the long term have been observed and discussed critically in the literature.

After sintering, the surface was again smoothed with diamond silicone polishers in wheel and brush form (Figs. 14–16). High-gloss polished zirconia tends to have a mother-of-pearl-like shine, which does not really resemble a natural tooth. We therefore try to polish only those parts which are in direct contact to a high gloss. All other areas receive a rather matt finish, easily visible at the crowns of this patient case as shown in Figure 17. The nature-like translucency of Zolid FX (Fig. 18) makes it possible to manage it with a reduced veneer thickness. The Zolid FX frame material with its dentine-coloured shade assumes parts of the optical dentine core. The fluorescence is applied with a fluorescent liner before veneering.

Goal achieved?

The work was tried in as an intermediate step in the mouth. The shade and natural appearance with incisal facets and enamel cracks both suited and pleased the patient. The occlusal contacts were checked by the dentist with shimstock and, where necessary, discreetly optimised with a Rotring diamond burr and subsequent polishing in analogy to the laboratory procedure. Back in the laboratory, we finished the work with glaze firing without glazing material (Fig. 19). The cemented restorations looked authentic and inconspicuous in the mouth (Figs. 20–23). The patient and our dental partner were both very satisfied with the restorations. The near-natural appearance exceeded the expectations of the patient. He considered the reconstructed occlusal height and function to be very comfortable.

Acknowledgement: Our thanks go to Dr Cornell Lischka for the excellent cooperation.

Editorial note: This article first appeared in BYT—Another Dental Magazine *in March, 2019, and an edited version is provided here with permission from Amann Girrbach. A list of references is available from the publisher.*

Fig. 23: The patient was very satisfied with the restorations.

“The near-natural appearance exceeded the expectations of the patient.”

about

After completing an apprenticeship in dental technology in the 1990s, master dental technician **Joachim Maier** worked as a dental technician at the school for dental medicine in Tübingen in Germany. This was followed by five years at a renowned laboratory in Stuttgart in Germany and then by a collaboration with Dr Kenneth A. Malament in Boston in the US and support as a visiting lecturer of the postgraduate programme in prosthodontics at Tufts University School of Dental Medicine and Harvard School of Dental Medicine in Boston.

In 1999, he achieved his master’s degree and was co-founder and part owner of Bodensee Dentaltechnik in Meersburg in Germany. Today, he runs the Bodensee Oral Design Center in Überlingen in Germany. The laboratory specialises in fixed prostheses with all-ceramic systems. He gives presentations and courses in Europe, the US and Asia on all-ceramic, minimally invasive restorations, implant-borne prostheses and CAD/CAM technology and reports on his 15 years’ experience with veneering zirconia and more than 10,000 workpieces.

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Zygomatic dynamic navigation: New challenges and possibilities

Drs Fernando Duarte, Carina Ramos, João Neves Silva & Luis Pinheiro, Portugal

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Fig. 1: StealthStation S8 system (Medtronic) equipment.

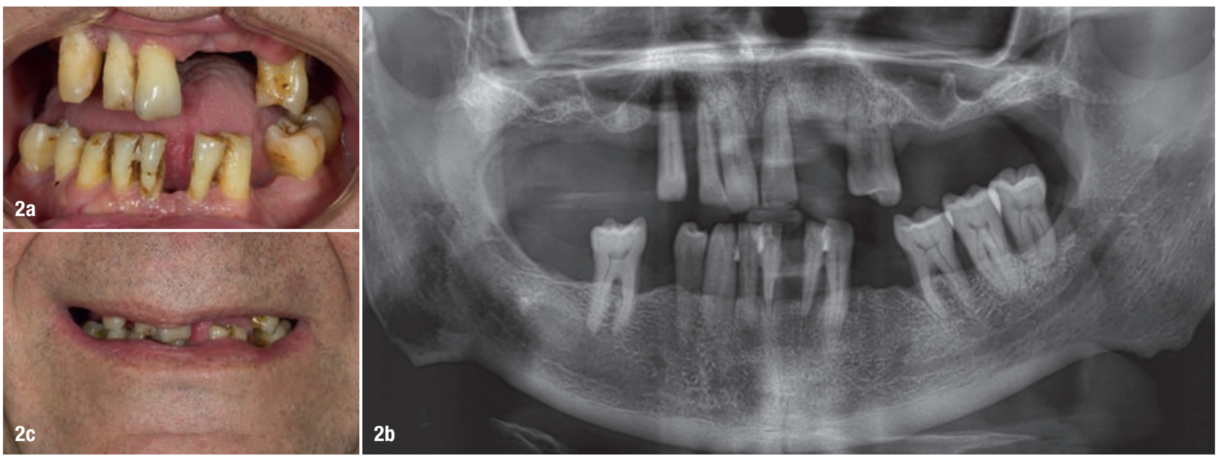
Introduction

The presence of sufficient bone volume is one of the most important criteria for successful osseointegration of implants,[1] wherefore restoration of atrophied edentulous maxillae poses a great dilemma for the surgeon and restorative dentist. Sinus bone grafting to build new bone for implant anchorage in atrophied jaws entails multiple surgical interventions and has varying implant success rates, high potential for donor site morbidity and increased surgical costs.[2,3] A major breakthrough came when Brånemark first used custom-designed, longer implants inserted into the zygomatic bone in support of a craniofacial prosthesis in the 1980s.[4] When used in the treatment of maxillary atrophy,[5,6] zygomatic implants present a graftless alternative.

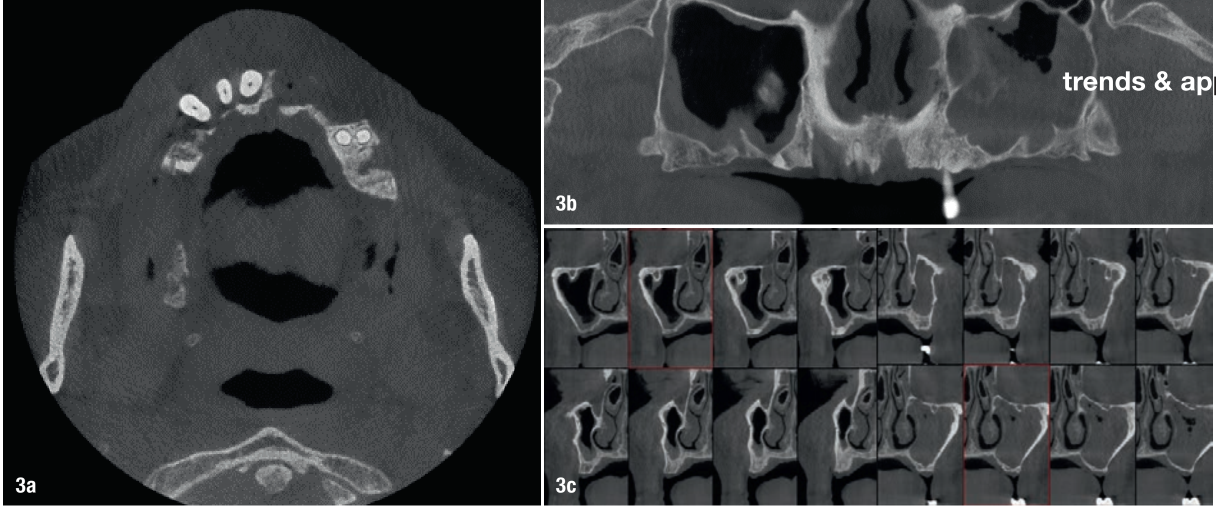
Zygomatic implant concept

The zygomatic implant design and placement protocols have been extensively described.[6–17] In short, the implant, ranging from 30.0mm to 62.5mm, is introduced into the second premolar area, traversing the maxillary sinus, and is anchored in the zygomatic bone. In addition to two zygomatic implants, two to four conventional implants are required in the anterior maxilla to support the prosthesis.[18,19] Zygomatic implants have shown good clinical success rates in clinical studies, most often close to 100% success in follow-up periods of up to five years.[20–23] Sinuscopy performed in patients with zygomatic implants has shown absence of infection or inflammation in the surrounding mucosa.[24] Furthermore, placement of multiple (two to four) zygomatic implants in the same zygomatic bone has been reported to be a clinically successful treatment and to have similar complications to those experienced with the original technique.[25–29]

Immediate function, a well-documented concept associated with the immediate loading of implants upon insertion,[30–33] has shown high success rates, provided that there is high


2a
2c
2b

Figs. 2a–c: Pre-op evaluation: dental occlusion **(a)**; dental panoramic tomograph **(b)**; and appearance of the contour of the lips and orbicularis oris muscle of the mouth **(c)**.



Figs. 3a–c: Initial CT scan with cross-sectional **(a)**, coronal **(b)** and sagittal **(c)** views.

initial stability. Histological analysis of the zygomatic bone shows a regular trabecular structure and a larger compact bone density (up to 98%).[34] Owing to the high osseous density of zygomatic bone[34] and the high clinical survival rates associated with zygomatic implants,[20–23] this tissue–implant interface is particularly suitable for immediate function.

Dynamic navigation

3D implant planning and mapping are two important steps in implant rehabilitation,[35,36] in the sense that they represent a preliminary stage to actual surgery. Misplaced implants can create difficult aesthetics and functional and biological problems and may result in implant loss.[37–39] There are three ways to transfer a planned implant's position into the actual patient's jawbone: (a) mental navigation, called freehand navigation; (b) static navigation using surgical templates;[40] and (c) dynamic navigation.[41,42]

The freehand approach is totally dependent on the surgeon's experience, skills and mindset during treatment and creates the highest deviations compared with the other approaches.[36] The use of surgical templates provides a higher accuracy compared with freehand surgery, but has several limitations, such as the inability to modify the plan once the surgical template has been manufactured. Surgical templates require longer drills, which can make their use difficult in patients with limitations in terms of mouth opening. Other concerns are irrigation issues and incompatibility with advanced surgical protocols. Dynamic navigation is, at present, the most effective way to transfer the planned implant's position to the actual patient, as it guides the surgeon's motions using real-time feedback. It is especially useful for reducing flapped procedures and offers the advantage of improved soft-tissue healing and patient comfort and reduction in bone resorption. Dynamic navigation allows modification planning at any time, even during treatment, and can be used in cases with limited mouth opening or in combination with osseodensification drills.

StealthStation S8 system

The StealthStation S8 surgical navigation system (Medronic) enables precise tracking of the location of technical instruments throughout a surgical procedure. The system introduces a combination of hardware, software, tracking algorithms, image data merging and specialised instruments to help guide the surgeon during surgical procedures.[43,44] The StealthStation S8 system is intended as an aid for precisely locating anatomical structures in either open or percutaneous procedures. The system is indicated for any medical condition in which the use of stereotactic surgery may be appropriate and where reference to a rigid anatomical structure, such as the skull, a long bone or a vertebra,

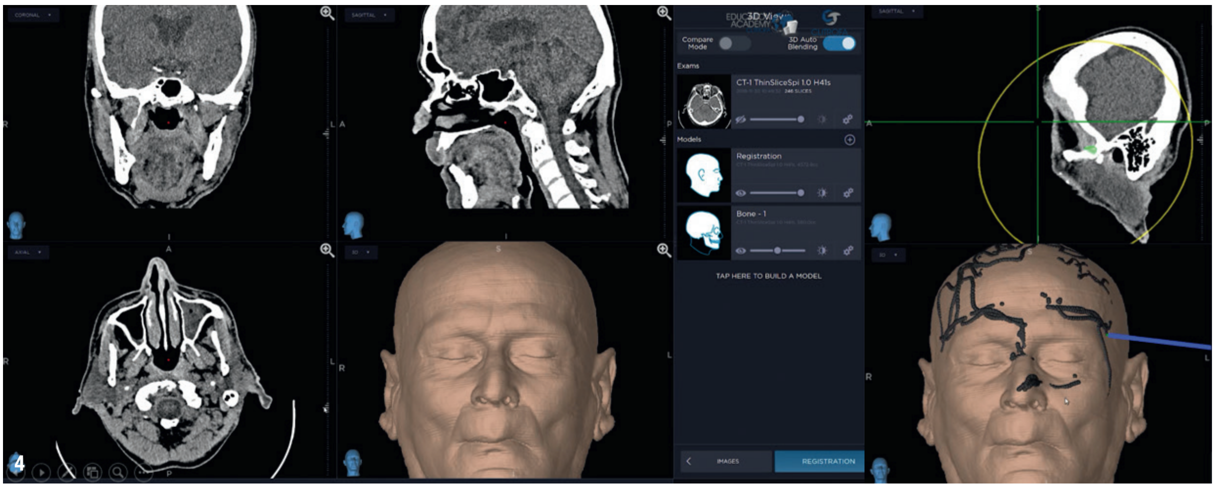


Fig. 4: StealthStation S8 matches the CT imaging with the patient's actual anatomy.

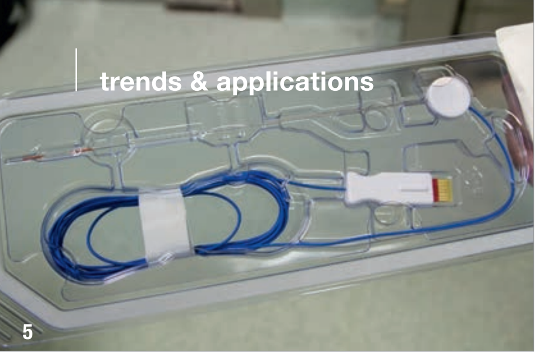
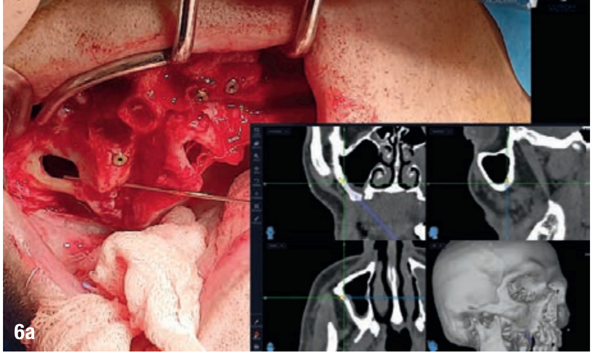
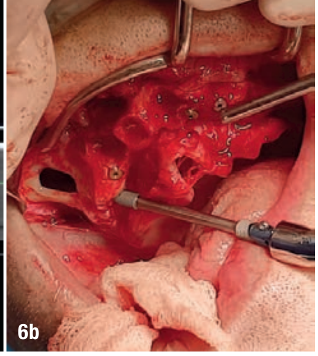
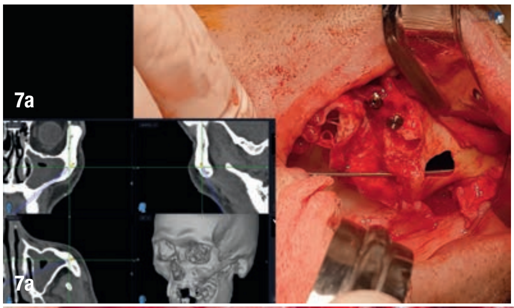




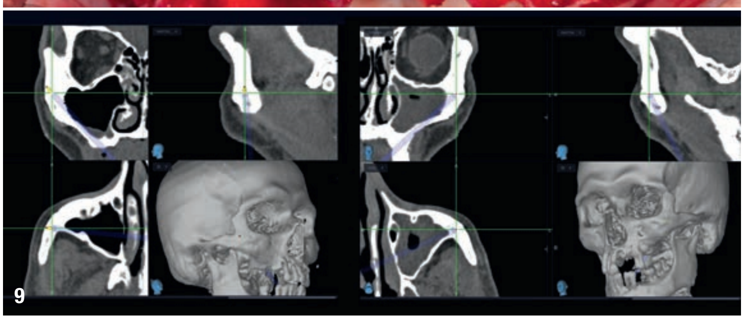
Fig. 5: The navigation instrument. **Figs. 6a & b:** Placement of the first-quadrant zygomatic implant with the help of the navigation instrument.

can be identified relative to a tomography- or magnetic resonance-based model, fluoroscopic images or digitised landmarks of the anatomy.[43,44]

For the software to display the instrument's location in relation to the patient's images, the software must create a map between the points on the patient and the points on the images. This process is called registration. Upon completion of registration, whenever the operator touches a point on the patient using a special tracked instrument, the computer will use the map to identify the corresponding point on the images. This identification is called navigation. A navigated point is identified on the system screen in various patient image planes and other anatomical renderings.

The surgical navigation system offers both optical and electromagnetic tracking capabilities, integration with external devices like microscopes and ultrasonic devices, a broad array of instrument offerings, and core software applications for neurosurgery, spine procedures and maxillofacial surgery.[43,44] During navigation, the system identifies the location of the tip and the trajectory of the tracked instrument in images and models that the user has selected for viewing. The surgeon may also create and store one or more surgical plane trajectories prior to surgery and simulate the progression along these trajectories. In surgery, the software can show the actual position at the tip of the instrument and its trajectory, relating them to the preoperative plane.[43,44]



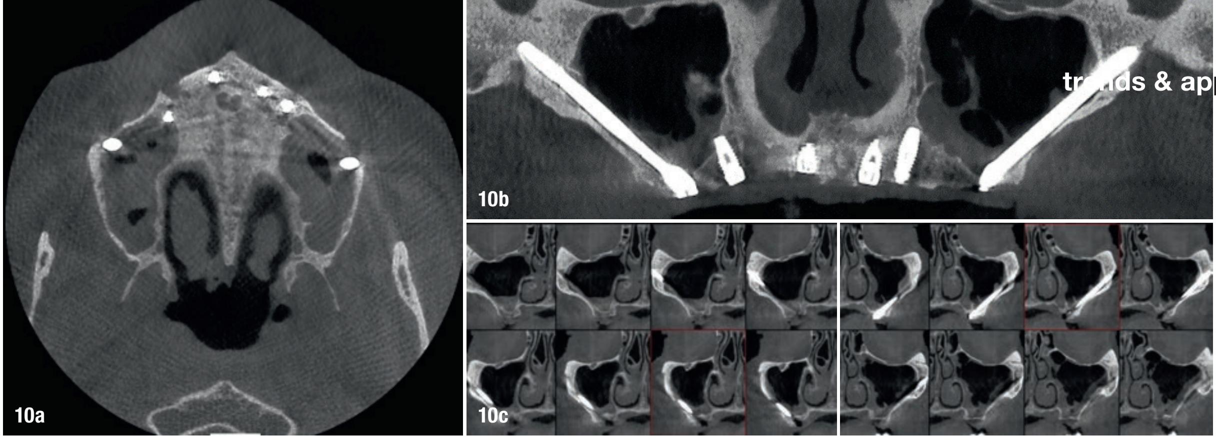
Figs. 7a & b: Placement of the second-quadrant zygomatic implant with the help of the navigation instrument. **Fig. 8:** Intra-op aspect of implant placement. **Fig. 9:** 3D intra-op images provided by the navigation system.

To maintain accuracy, the StealthStation S8 system uses dynamic referencing to constantly track the position of the anatomy during registration and navigation. Two devices are required for dynamic referencing: a patient frame of reference and a locator. The patient's frame of reference is rigidly positioned in relation to anatomy. The locator, which is a camera for optical tracking or a transmitter and an instrument interface for electromagnetic tracking, finds the patient's frame of reference and reports the position of the frame to the navigation software.

As the frame of reference remains in a rigid and fixed position in relation to the anatomy, any movement of the anatomy or of the locator results in corresponding movement of the frame of reference in the locator's field of view. This allows the locator to detect any movement of the anatomy by identifying the position of the frame of reference, which moves simultaneously with the anatomy. The system can then display the instrument or implant location relative to the patient's frame of reference while maintaining accurate navigation. Without dynamic referencing, any movement of the locator after registration would be invalid, as the position of the frame of reference would be changed in the navigation field. Dynamic referencing allows the flexibility to reposition the locator at any time. The system consists of a platform, clinical software, surgical instruments and a reference system (including patient and instrument trackers; Fig. 1). 3D images of the patient can be displayed by software from various perspectives (axial, sagittal, coronal and oblique planes).[43,44]

Clinical case

A 56-year-old male patient attended the oral-maxillofacial surgery consultation at Clitrofa medical centre in Trofa in Portugal to perform an implant-supported rehabilitation of the upper jaw. The clinical evaluation revealed a partially



Figs. 10a–c: Final CT scan with cross-sectional **(a)**, coronal **(b)** and sagittal **(c)** views.

edentulous jaw with the presence of teeth #11, 12, 13, 21 and 24, which supported a removable prosthesis (Fig. 2).

To complete the preoperative evaluation, a high-definition CT scan was performed, which revealed an extremely resorbed maxilla in the posterior. Placement of two zygomatic implants in the posterior and four conventional implants in the anterior sector of the maxilla was indicated (Fig. 3). The CT scan was uploaded to StealthStation S8, and matching between the patient's actual anatomy and imaging was performed. The flat emitter was placed below the patient's head to eliminate obstructions for pinless and surgical workflows (Fig. 4).

After elevation of a full-thickness flap with bilateral identification of the infraorbital nerves, an osteotomy was performed to create a bone window to access the interior of the maxillary sinus. The navigation instrument most suitable for this type of surgery was chosen for its flexibility, thickness and length (Fig. 5). The images displayed on the monitor are in real time intra-operatively, allowing the alteration and verification of the osteotomy in the space planes. Confirmation of existing bone availability, maintenance of the integrity of the relevant anatomical structures and placement of the zygomatic implant in the ideal position for each clinical case are ensured. Zygomatic implants are placed according to this checklist (Figs. 6a–7b). The 3D positioning of the zygomatic implants allowed excellent primary stability as well as adequate positioning for prosthetic restoration (Fig. 8).

The images provided intra-operatively and in real time are of great definition and highly informative. The system also allows the introduction of a colour code to establish safety limits with respect to the length and diameter of the zygomatic implants. Navigation can also be used for other conventional implants (Fig. 9). After completion of the surgery, a new high-definition CT scan was performed to check the final positions of the two zygomatic implants placed in the posterior of the maxilla and the four conventional implants placed in the anterior sector of the maxilla (Fig. 10).

Conclusion

The StealthStation navigation system is an intra-operative advantage in the placement of the zygomatic implant and can form part of surgical protocols in its current form. However, there are some aspects that should be improved, namely the incorporation of a virtual library with the dimensions of the available zygomatic implants and the adaptation of the navigation system to the contra-angle handpiece used in this type of surgery.

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

about

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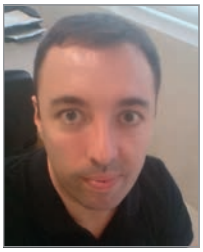

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Since dental students had to suspend their clinical training during the pandemic, some dental schools around the world have announced that they will not be taking in new students in 2021.

COVID-19 and dental education: Will dental schools admit new students in 2021?

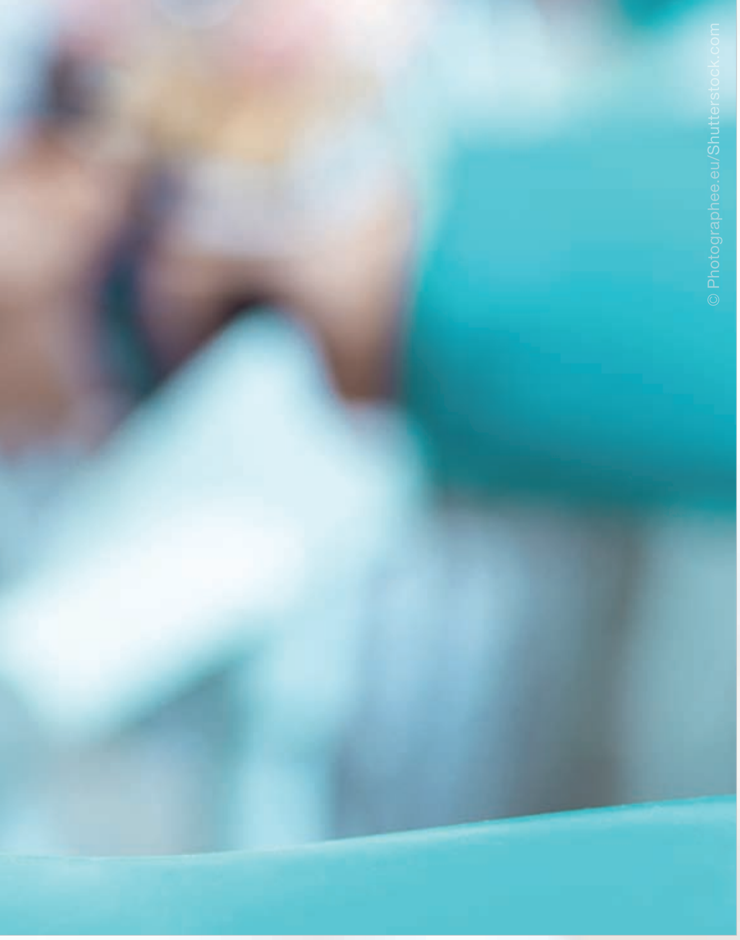
By Iveta Ramonaite, Dental Tribune International

Since the COVID-19 pandemic has severely restricted access to clinical practice, students around the world have been adversely affected by the far-reaching consequences the pandemic has had on dental education. To make the most of the current situation, numerous schools have instituted video and virtual platforms in order to familiarise students with standard clinical procedures. However, the knowledge gained through online learning is limited, and some students are now being asked to repeat the 2020–2021 academic year in order to complete the necessary clinical training. To this end, some dental schools have announced that they will not be admitting new students in 2021.

Owing to the high risk of the virus spreading through aerosol transmission in clinical practice, dentistry has been severely affected by the pandemic. This has manifested itself in a lack of the in-person training for dental students which is crucial for the successful completion of their education. Students have also been burdened by various fears and worries caused by factors such as the necessity to adapt to the updated infection control protocols and the need to rise to academic challenges.

The gravity of this situation is clearly evident in Scotland. Since final year dental students have been unable to graduate owing to a lack of practical clinical experience, Universities Scotland, the representative body of Scotland's 19 higher education institutions, has announced that dental schools will not be accepting new students in September 2021. Mairi Gougeon, Scotland's public health minister, was quoted as saying that the decision was difficult but necessary.

"The quality and calibre of dental treatment in Scotland is outstanding and it needs to be protected by taking the



appropriate measures in education to ensure future dental professionals have reached the General Dental Council's standard of clinical competence and can enter the workforce with confidence," she noted.

To help avoid crippling debt for students, the Scottish government will be offering financial support to those who have been asked to repeat their final year. According to Gougeon, affected students will be eligible for a bursary equal to the amount of their student loan.

Dental schools in Europe are yet to make the decision

Discussing the situation in Europe, a spokesperson at the European Dental Students' Association (EDSA) told DTI: "We know that a lot of students are particularly worried about their lack of experience and the impact it will have on their future education and job prospects. Every student has the right to build a successful career and to receive dental training that prepares him or her to deliver safe and effective oral health care to the population he or she serves. If a student has received insufficient clinical experience to provide this, then a limited extension to the length of his or her course may be appropriate, depending on the local context."

According to some sources, several universities in Malta and Greece have already chosen to extend their terms. Other countries are considering taking the same action but have not yet made the final decision.

Talking about possible extensions to the length of courses, the association noted that any extensions granted to students should be proportional to the amount of clinical time missed. However, EDSA noted that dental schools should consider carefully all the options available to safely increase the provision of clinical teaching and to avoid extensions where possible, since these may lead to financial burden. The spokesperson added: "Students must be protected from the financial impact of extending their studies. They should not pay additional fees, and schools and governments should seek to provide financial support for living costs, especially for those who may struggle in the case of an extension."

Dental schools in the US still accepting students

Although the COVID-19 pandemic has severely disrupted dental education in Scotland, the situation is not the same in some other parts of the world. For example, for dental schools in the US, it is business as usual. Dr Karen P. West, president and CEO of the American Dental Education Association, told DTI: "Dental education continues to move forward in the US, and all existing dental schools in the country are continuing to accept new students this year. In fact, applications to schools are thriving."

Students in the country have been quick to adapt to the changes in teaching and learning and have embraced the shift to virtual classrooms, with all its possibilities. "Although the COVID-19 pandemic disrupted learning last year, schools adapted and developed innovative educational environments in which to teach and learn. In accordance with the Centers for Disease Control and Prevention guidelines for patient care in the COVID-19 environment, students are providing clinical care, and competency assessments are continuing," she noted.

"Although the COVID-19 pandemic disrupted learning last year, schools adapted and developed innovative educational environments in which to teach and learn."

"Students are not being asked to repeat the 2020–2021 academic year based on COVID-19 alone. To their credit, faculty and students quickly adjusted to the changed environment, embracing virtual learning options that have allowed dental education to grow and flourish in new and ground-breaking ways," West concluded.

Study finds differences in accuracy of intra-oral scanners

By Franziska Beier, Dental Tribune International

A comparison of ten intra-oral scanners from different manufacturers found differences in their accuracy.

Even though intra-oral scanners have been around for more than three decades and their use in dental practice is increasing, few investigations have evaluated the 3D accuracy of digital implant scans. As discrepancies between implant components must be minimal, researchers from Seoul National University School of Dentistry have evaluated the trueness of ten intra-oral scanners in determining the positions of simulated implant scan bodies.

The researchers tested the null hypotheses that there would be no significant difference in 3D accuracy among the intra-oral scanners and that the scan body position would have no effect on the trueness.

They evaluated the performance of the CEREC Omnicam and CEREC Primescan (Dentsply Sirona), CS 3600 (Carestream Dental), DWIO (Dental Wings), i500 (Schütz Dental), iTero Element (Align Technology), PlanScan (Planmeca), TRIOS 2 and TRIOS 3 (3Shape), and True Definition (3M) in acquiring the accurate positions of six cylinders simulating implant scan bodies in a partially edentulous model. Digital scans from each intra-oral scanner were compared with the reference data set obtained by means of a coordinate measuring machine. Deviation from the actual positions of the six cylinders along the x, y and z axes and the overall 3D deviation of the digital scan were calculated.

Contrary to the first null hypothesis, the researchers found that the type of intra-oral scanner and the position of the simulated cylindrical scan bodies influenced the degree and direction of the deviations in accuracy. The lowest deviation was found at the cylinder next to the reference origin, while the highest deviation was observed at the contralateral side for all tested scanners. CEREC Primescan and TRIOS 3 had the highest trueness, followed by the i500, TRIOS 2 and the iTero Element—although the difference was not statistically significant. The DWIO and PlanScan showed the lowest accuracy in partially edentulous mandibular digital implant scans.

The second null hypothesis—that scan body position would have no effect on trueness—was also rejected, as digital scans deviated with distance from the reference origin. The further the scan was from the origin, the greater the deviation was. This result is in accordance with previous studies confirming the reduced trueness of digital implant scans owing to accumulation of errors during image stitching.

The research group noted that a limitation of the study was that the digital impressions were collected in an *in vitro* model, which may differ from *in vivo* scenarios in which the outcome could be influenced by factors such as patient movement and presence of soft tissue and moisture.

The study authors concluded: "It would be recommended to use an (intra-oral scanner) that is capable of producing accurate complete-arch scans, especially for fabrication of long-span prostheses or appliances."

The study, titled "Trueness of ten intraoral scanners in determining the positions of simulated implant scan bodies", was published on 28 January 2021 in Scientific Reports*.*

Amann Girrbach presents attractive gateways to the future at virtual congress

By Amann Girrbach

Digitisation holds lucrative opportunities for the future of the dental industry. During its innovative AG.Live CON virtual congress that will take place from 20 to 24 April, Amann Girrbach will be showcasing how these opportunities can be easily exploited. Renowned dental technicians and clinicians will meet with the leading minds in research to explore avenues to advanced digitisation.

For many years, Amann Girrbach has been supporting dental technicians in the digitisation of their workflows with its innovative efforts. Stemming from its pioneering role, the Austrian company also supports laboratories and clinicians in taking the next step towards digital transformation. The trend is evident: the demand for direct and straightforward restorations is increasing, challenging the established structures and conventional boundaries between the laboratory and the dental practice. However, digitisation and the associated new forms of collaboration will ultimately result in a win-win situation for dental technicians and clinicians, the well-being of the patient always the focus.

To provide optimal networking for both parties, Amann Girrbach has developed the AG.Live platform, which is now being presented during a virtual congress and exhibition. AG.Live provides infrastructure for patient case management with a level of consistency and efficiency which has never been achieved before. For example, the platform will allow dentists to offer quality direct restorations while permanently having the expertise of a dental technician at their disposal. Even in the case of simple restorations, a joint decision can be made quickly as to whether direct implementation is possible or whether the specialist in the laboratory is required.

Further information about registration for the virtual congress and exhibition can be found at https://academy.amanngirrbach.com/en.

3Shape and Ivoclar Vivadent intensify collaborative efforts

By 3Shape

3D scanner developer 3Shape and smart product systems manufacturer Ivoclar Vivadent are scaling up their collaborative efforts. Their common goal is to develop the best possible oral health solutions for the health and wellbeing of patients.

Both companies strive to offer highly efficient and fully integrated digital workflows. The scanning and CAD software solutions from 3Shape are coordinated with the PrograMill and PrograPrint CAM machines from Ivoclar Vivadent. This efficient combination, together with superior dental materials, ensures results that promote good oral health.

The two companies are collaborating in the following areas:

- patient consultation with IvoSmile, augmented reality software that provides the patient with a preview of the treatment result in real-time 3D;
- a fully integrated chairside solution featuring PrograScan One intra-oral scanners and PrograMill One, a compact five-axis milling machine designed for IPS e.max; and
- integration of the Ivotion Denture System and the patented workflows from Ivoclar Vivadent in 3Shape's Dental System 2020.

Diego Gabathuler, CEO of Ivoclar Vivadent, is excited about his company's collaboration with 3Shape: "Ivoclar Vivadent and 3Shape together offer competitive end-to-end solutions not only for dental offices, but also for laboratories and orthodontic practices."

3Shape CEO Jakob Just-Bomholt added: "The success story of 3Shape and Ivoclar Vivadent continues. We believe that these offerings will enhance the overall patient experience, and give dentists and technicians all the benefits of 3Shape's and Ivoclar's powerful products. We look forward to seeing the creative minds of both companies coming up with more solutions and workflows that will further enhance dental treatment procedures."

Smart implant workflow solutions

Making your work flow in implant dentistry

In any dental clinic, workflow is very important for business success and patient satisfaction. To achieve these key goals, dental practices need to have smart implant workflow solutions in place. In addition, you want to experience flow when treating patients; it will help you overcome challenges, feel confident and find solutions to complex cases.

Making your work flow in implant dentistry revolves around identifying the smoothest and most convenient workflow for each customer and making sure to deliver whatever is needed to ensure that. Within a vast world-class assortment of products and solutions for implant treatment, there are complete solutions that create the best possible workflow and make work flow better.

Workflow with Astra Tech Implant EV and Azento

You might say that a workflow is like a machine. Take out its key component, and it just does not run like it should. Astra Tech Implant EV is just such a component. The way it is designed, how you can place it, the handling experience, its long-term functionality, how it will promote aesthetics decades from now—all this matters. Some of these aspects are directly noticeable, whereas some will only become evident in the future. Still, they all influence your workflow. When you know that the implant works and acts as expected, you can relax, trust it and focus on your main task: improving the everyday life of your patients. When you do this, you rid them of dental worries, which helps them feel better and more confident in doing the things that trigger their flow in life. A user of Astra Tech Implant EV knows all this—how the components of the machinery fit perfectly in order to form a smooth and efficient process.

The right solution and digital tools can improve your workflow, help reduce bottlenecks and inspire better team flow at your end. One example of this is Azento, the all-in-one-box solution for single-tooth replacements. It reduces the costly instrument and materials inventory. You get a fully guided surgical solution. It is designed to take away time-consuming procedures in order to streamline the workflow so that the team can focus on the core tasks. The result? You stand a better chance of having flow at work, which will ultimately boost your business success.

Therefore, the aim is to create the best possible workflow solutions for implant dentistry professionals by identifying customer-unique solutions that secure high-quality treatments while saving time and effort.

www.dentsplysirona.com/makingyourworkflow

How to send us your work

Please note that all the textual components of your submission must be combined into one MS Word document. Please do not submit multiple files for each of these items:

- 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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