special
The battle between digital and analogue

case report
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What is next?

As 2018 comes to a close, we should take a moment to appreciate all of the incredible advances in technology and new products that have been introduced during the year. Regardless of which area of dentistry is considered the industry continues to innovate, clinicians continue to push the envelope, and hopefully these advances will translate to improved care for our patients. 2019 will bring us many additional surprises at the upcoming International Dental Show (IDS) in Cologne, Germany, always the focus for new product introductions and the world’s premier venue to showcase products related to all phases of dentistry. What is there to look forward to? Plenty.

It has become crystal clear that dentistry has been slowly moving from the analogue to the digital universe. Intraoral radiographs are no longer processed film with chemicals in a darkroom as digital sensors and computer software have provided an interactive medium for quicker access to images with enhanced diagnostic tools. Images that exist on the computer screen can be enlarged, adjusted for clarity, archived easily, printed or e-mailed with a few keystrokes. Each year the sensor technology continues to evolve to become the industry standard, yet digital radiography has not reached 100% saturation with dental offices around the world. What’s next?

Digital radiography has further expanded to include cone beam computed tomography which has become an essential diagnostic tool for dental implants, oral surgery, orthodontics, endodontics, and airway analysis. Computers continue to gain faster and faster hardware processors with more powerful graphics cards pushing shrinking pixels on higher-resolution monitors, therefore, providing clinicians with increased ability to visualise individual patient anatomical presentations.

Additionally, interactive software applications are constantly undergoing upgrades with advanced tools for both clinicians and dental laboratory technicians. However, as we all know the ultimate goal for our patients is to maintain good oral health, function, and aesthetic restorations. To that end, one of the major catalysts for the growth of digital dentistry has been the intraoral scanner. The ability to move from the analogue impression to a digital impression for a tooth preparation or to capture the position of an implant has transformed the restorative protocols and workflows for the present and the future. Virtual teeth can be designed on a tablet computer or a smart phone. Perhaps it is the merging of these technologies that has truly provided new levels of accuracy for the diagnostic, surgical, and restorative phases of dentistry.

A second major catalyst that has caught our industry by storm is the availability of low cost, accurate, 3-D printers that can take our ideas, our virtual designs, our virtual treatment plans, and bring them to a physical model that we can hold in our hands. Our world is changing rapidly... dentistry is forever evolving—and the ultimate beneficiary are the patients we serve. Let’s all look forward to “what’s next” in the coming year!

Happy Holidays to all!

Dr Scott D. Ganz
Editor-in-Chief
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The innovative design of the MIS MGUIDE and its surgical kits simplifies digital dentistry. The use of CAD/CAM allows for a prosthetically driven, safe and accurate procedure. To learn more about the MIS MGUIDE, go to www.mis-implants.com

MAKE IT SIMPLE. WE KNOW HOW!

The innovative design of the MIS MGUIDE and its surgical kits simplifies digital dentistry. The use of CAD/CAM allows for a prosthetically driven, safe and accurate procedure. To learn more about the MIS MGUIDE, go to www.mis-implants.com
The use of digital technologies in dentistry is on the rise, a fact that clinicians Dr Galip Gurel, Dr Stefan Koubi and dental technician Hilal Kuday are well aware of. They are convinced that the use of modern technologies is a growing trend in all areas and to believe that this will not come to the dental clinic would be a big mistake. Ulyana Vincheva, Managing Director of Dental Tribune Bulgaria and publisher of Dental Tribune Bulgarian Edition, had the opportunity to talk with them about their lecture during the 2018 Competence in Esthetics meeting held in Belgrade in Serbia on 10 November and organised by Ivoclar Vivadent. They told her of their fascination for digital dentistry and their vision of the near future, in which they believe virtual reality and artificial intelligence will feature.

You are three of the world’s top experts in dentistry and you work together as a team, but you are also good friends, right?

Koubi: Of course! Nicely done teamwork is only possible among people who like each other.

During your lecture you spoke about “the most personalised smile design”. What is the point? Do you believe in the individualised approach for every case, and how does it fit in with a fully digitalised workflow?

Gurel: As I explained in our lecture, we have been working like this for years. It provides a personal touch. It depends on your intuition how you approach and evaluate the patient and his or her smile. Even with this protocol, you should have some trials. Maybe sometimes the result will be superb; sometimes the patient won’t like it. Our workflow was already a personalised smile design, but we didn’t know it until we started our research. When we started sharing cases with each other, at first, we selected only the best cases, trying to evaluate which part of the smile design goes with which part of the patient. Does it depend on physical appearance, which we can’t change, or on personality, how the patient wants to be perceived? We fragmented all these smiles and tried to analyse, for example, on what the tooth axis depends, on what the tooth shape depends. After that, we cross-matched these cases and came out with some results, which we put into a software programme. This software is based on hundreds of algorithms, and most recently, we developed software that is driven by artificial intelligence and suggests smile designs that are appropriate for the patient because they go well with his or her facial appearance and his or her personality. That is how we started using this programme. The first stop was the VisagiSmile, which gives us the 2-D design. This programme was amazing for someone who is into aesthetics. If I show the programme to Hilal or to Stefan, they will understand it and transfer it to the patient either as a mock-up or a wax-up, but for majority of the dentists it wasn’t an easy task. The main problem was that many dentists couldn’t translate it to the patient’s mouth. We realised that many of our colleagues don’t use mock-ups.
They take an impression, send it to the lab and the lab technician prepares a wax-up. Back then, the lab technicians didn’t have much supporting material. They had only a few photographs and a stone model, and they tried to build up the entire case based on that. Nothing was personalised. Everything changed the moment we realised that our IT team could transform 2-D into 3-D. That is how Rebel was born. Thanks to Rebel, we can transform all of this knowledge into a 3-D digital wax-up, which can be sent to the dentist for 3-D printing, then for impressions and back to the patient’s mouth. This is the chronology of how personalised smile design became a reality.

As I mentioned in our lecture, when you go into Rebel, there are some mandatory fields you need to fill in, like the facial photographs, the intraoral scanning, the questionnaire, and your or your patient’s preferences. For example, if you would like to have a mild surface texture or a strong or smooth one, you need to enter this information into the software. Ninety per cent of the information needed can be entered only by clicking, nothing further. Some of the data needs to be entered as a text, but this is very limited, so definitely I can state that Rebel is extremely user-friendly. From a technical perspective, if you send a case without writing anything, only with the information that has been registered by clicking and selecting one of the given options, you will still have a 100% digital wax-up. Maybe only 5% needs to be entered manually by the clinician in order to complete the smile design. As far as I know, to date, this is the only software that instantly gives you a 100% digital 3-D wax-up.

A few years ago, you emphasised the importance of proper communication with lab technicians. Does Rebel help in this matter?

Gurel: I think Rebel is an amazing tool for ceramists—and I am not talking only for ceramists like Hilal, who is a superstar and a great professional. For the majority of lab technicians, Rebel represents an amazing tool and opportunity to immediately create a 3-D wax-up that not only is aesthetic in their opinion, but also perfectly suits the patient’s facial appearance and personality. At the beginning when starting beta testing of this project and giving lectures to dentists and lab technicians, the lab technicians were the first to embrace the idea because it makes their lives much easier. Instead of spending hours carving and sculpting the wax-up without having all the information and parameters needed, with Rebel they can have an accurate wax-up ready in a split second. Of course, they can make some small changes if they like. In my lecture, you saw how amazingly one can translate all details, like surface texture and tooth shape, into 3-D printing or CAD/CAM milling in order to be tested in the patient’s mouth even before one starts prepping the teeth.

Dr Koubi, what are the benefits of digital technology for dentists?

Gurel: Thanks to digital solutions, even more dentists who were previously afraid to work in the aesthetic area will go into aesthetic dentistry. Imagine that every patient who needs an aesthetic smile rehabilitation is like an empty canvas, and it is up to us to create a masterpiece. Digital technology will support us in our artwork, enable us to be even more precise.
Koubi: I would like to briefly address the previous two questions. Generally speaking, you have two realities. One is the patient’s expectations. Patients would always prefer a customised smile, not a standardised one. And the second one is the technician’s abilities. Most lab technicians have a specific signature, their own style, and they pretty much repeat it with every case. I am talking about the majority of technicians, not the top professionals. The beauty of the software is that you have a digital library and you can include as many tooth shapes and forms as you like. And after that, you can play with the software and make some modifications. The problem is that most dentists are not able to experiment with the software because we don’t have the knowledge and ability to do it. That’s the main problem with smile design: the dentists are not able to experiment with the software and the lab technicians have one and the same signature. Rebel provides a solution, giving you the advantage of outsourcing the headache of smile design. We have to be realistic: most dentists are not able to use the software or have already mentioned, digital technology serves you as a tool. But you and your lab technician need to be well trained and then explain to the patient that if he or she doesn’t transfer the mock-up into the mouth even with this crowd- ing and then explain to the patient that if he or she doesn’t want the dentist to prep this tooth then he or she needs to undergo an orthodontic treatment. The possibility of having this visual information and communicating with the patient enables you to achieve superb outcomes.

Gurel: Well, there are always limitations. First of all, it won’t work in extremely crowded dentition. We shouldn’t expect miracles. Rebel can cope with cases with a reasonable initial situation, for example minor crowding or minor spacing. It is not mandatory for the restorative technique to be additive for every case. That’s another great advantage of Rebel, meaning that if a part of a tooth is protruding out of the aesthetic arch, the software doesn’t take that into account. It will place the original shape over the ideal arch position, leaving that part outside. The advantage of this is that in a traditional system in order to put the wax-up into the patient’s mouth we have to first cut the protruding edge of the tooth and then make the mock-up, which means we have already started prepping the teeth and if the patient is not satisfied, it will be a problem. With Rebel, you can transfer the mock-up into the mouth even with this crowding and then explain to the patient that if he or she doesn’t want the dentist to prep this tooth then he or she needs to undergo an orthodontic treatment. The possibility of having this visual information and communicating with the patient enables you to achieve superb outcomes.

Mr Kuday, would you like to add something to this topic?

Kuday: As a dental technician, I would like to say that digital workflow is a tool you can always rely on. If you integrate digital technology into your everyday practice, it definitely raises the quality of your work. We dental technicians study anatomy, biology and morphology and are a part of the team, so if dentists don’t respect our work as lab technicians and don’t send us all information needed to create beautiful, nicely fitting prosthetic restorations, then our hands are tied. Fortunately, I am lucky to work with dental experts like Drs Gurel and Koubi, who appreciate my work in the lab. All of the precious information that they register from the patient’s mouth, the questionnaire in Rebel, give us an idea of how to follow nature. At the end of the day, we are a team; we sit down and work together in order to create a beautiful job as partners.

Koubi: With Rebel, we are not talking about replacing the lab technician; we are talking about supporting and assisting him or her. It is very important to keep that in mind. Rebel is a very useful tool to improve the quality of the technician’s work in order to create even more beautiful restorations.

Gurel: One other thing: thanks to Rebel, even more dentists who were previously afraid to work in the aesthetic zone will go into aesthetic dentistry. Imagine that every patient who needs an aesthetic treatment is like an empty canvas. You need to create an artwork there and not every dentist is capable of doing that. Rebel gives you the opportunity to create a masterpiece without worrying about how to use Rebel. All other programmes, as Stefan and Hilal have already said, require detailed computer knowledge in order to create proper smile designs or a great deal of time to work with digital libraries, to position the teeth and to establish a really aesthetic smile. For the dentist to be able to achieve a perfect smile with a single mock-up is a completely different story. That’s the beauty and ease of using Rebel. The effect of integrating Rebel into the dental world will not be erasing and replacing all dental technicians. Instead, it will create a huge community of dentists doing aesthetic cases, which will increase the number of veneers, crowns and bridges to be made. As an end result, more dental technicians will be needed to cope with the rising needs.

You have touched on some advantages of digital technology, but what are its limitations?

Gurel: Well, there are always limitations. First of all, it won’t work in extremely crowded dentition. We shouldn’t expect miracles. Rebel can cope with cases with a reasonable initial situation, for example minor crowding or minor spacing. It is not mandatory for the restorative technique to be additive for every case. That’s another great advantage of Rebel, meaning that if a part of a tooth is protruding out of the aesthetic arch, the software doesn’t take that into account. It will place the original shape over the ideal arch position, leaving that part outside. The advantage of this is that in a traditional system in order to put the wax-up into the patient’s mouth we have to first cut the protruding edge of the tooth and then make the mock-up, which means we have already started prepping the teeth and if the patient is not satisfied, it will be a problem. With Rebel, you can transfer the mock-up into the mouth even with this crowding and then explain to the patient that if he or she doesn’t want the dentist to prep this tooth then he or she needs to undergo an orthodontic treatment. The possibility of having this visual information and communicating with the patient enables you to achieve superb outcomes.

Koubi: We need to have a very clear vision regarding the digital technologies because it is a reality already. In order to be good with digital technologies, you need to be a skilful driver and manager of the whole process because, as we have already mentioned, digital technology serves you as a tool. But you and your lab technician need to be well educated. That’s the basis of your teamwork. Sometimes, people are confused because they believe digital technologies will provide them with all of the clinical solutions, but that’s not true. It only supports us in our work; it speeds it up and improves its quality. We use artificial intelligence to simplify our life, but not to replace the human with his or her mind and knowledge.
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Kuday: I would like to talk through it from a human perspective. If we retain the human factor in the technology, then everything will be alright. Nowadays, we are talking about self-driving cars replacing drivers. Sooner or later, it is going to happen. But if we would like to do something as a team, we need to integrate the human factor to control the whole process. From an ethical point of view, human touch is mandatory during the digital workflow. The operator needs to be either the dental technician or the dentist, not the engineer. The human, not the technology, has to be the creator and leader. The new digital technologies are developing very, very rapidly. For example, if you buy an iPad today, tomorrow it will be out of date. This is dictated by today’s economic situation.

Do we need major reforms in dentistry? If so, what might those be with regard to digital technology?

Koubi: We need many reforms in dentistry. I will speak also on behalf of my friends and colleagues. In France, two types of dentistry have been established for years: mass dentistry and elite, boutique dentistry. Digital dentistry is very useful for mass dentistry because it makes aesthetic treatment faster and more affordable, but we have to keep in mind that we work in the medical field, not in economics, for example, and we are treating patients. We have to take responsibility for all our actions. Digital technologies will improve the average quality of our work, but will never be better than an exceptionally good dentist. It is the same in other medical fields: surgical robots perform better than an average surgeon, but robots will never be more skilled than an experienced and well-trained surgeon. Most dentists cut too much tooth structure. If you examined 1,000 impressions, you would see that most teeth are over-prepped. Thus, the risk of complications rises. Thanks to robots, we can standardise quality. Is it the best quality? No, it is not, but that’s not the purpose. So it needs to be clear that digital dentistry is certainly our future, but I don’t believe everything will become digital. We need to implement also the human touch in order to exploit all advantages that digital technologies provide, but at the same time to avoid their weaknesses.

What does the future hold for dentistry in your opinion? How do you see the dental world in 20 years?

Koubi: Our future is digital for sure! We will have less useless stuff; the impression trays and impression materials will be forgotten. Everything in the dental office will be clean, white and clear as it is now in our clinic. My wish and hope for the future is that dental students will receive better training and be better prepared for the digital workflow. The digital process needs to be better integrated into university curricula. Universities all over the world have to make a significant shift and to implement digital education in every institution.
dental specialty so that students graduate already prepared to work with digital technologies because nowadays they have to learn how to do it after graduation by attending additional courses and lectures. Education, not only university education but also continuing education, will become more and more relevant and it will be key to success.

Gurel: My short-term project is to see our robot DIGICUTO working. Five years ago, nobody believed that the iPhone would be so small and able to multitask so quickly. Now, it is a reality: your phone, your computer, your camera, everything is becoming even smarter. Our idea has already been born. When we will realise it depends on two things: technical issues, which in my opinion will be solved soon, and patient acceptance—people usually ask me not how it will be done technically, but how patients will allow a robot to prep their teeth instead of a dentist. In the near future, cars will be driven without drivers by artificial intelligence. Our concept is the same; it is even safer. I think the near future will look like that. I hope, as Stefan said, that digital technology will enable us to offer even more affordable treatment plans. I hope that new 3-D printable materials like ceramics will speed up treatment and once again make it cheaper so that more people worldwide will have access to high-quality dental care instead of what they are getting now. Everybody deserves to be treated in a precise and predictable manner.

Kuday: Regarding future development, I think “affordable” is definitely the key word. Everybody deserves to have unique restorations, not only wealthy people. I would like to emphasise that, if the quality of 3-D printed restorations is high enough, then I will accept it.

What do you think the role of leading brands will be in the future?

Gurel: We are all professionals with many years of experience, working with big companies. In my opinion, the companies should not sell materials only, but should sell complete storylines, and by that, I mean things connected with each other, so that if somebody starts working with some system he or she should not even think about leaving it. Just like Apple. Once you buy an iPhone, then you buy an iPad, then a MacBook Pro, so you always stay in the family. Why? Because they are very nicely connected with one another. Many people nowadays are afraid of the word “digital”. They are concerned that they don’t have advanced computer skills, and don’t know how to use the software or how to shape the teeth digitally. Working in a digital workflow doesn’t require all of this. A digital protocol should be very user-friendly and intuitive so that once you start using it, you will feel the urge to dive even deeper into it and to also try a scanner, for example. And if it is easy to work with, then you won’t even think about buying a device from another company.

Koubi: The aim of artificial intelligence is to simplify our life, not to replace the human with his or her mind and knowledge. Digital technologies will improve the average quality of our work, but will never be better than an exceptionally good dentist. It is the same in other medical fields: surgical robots perform better than an average surgeon, but robots will never be more skilled than an experienced and well-trained surgeon.
If you follow the Ivoclar storyline and you are satisfied with all of its products, then you won’t buy another brand’s porcelain blocks, for example, because you are sure that quality of the end result is guaranteed only if you stay in the family. And if the brand you are satisfied with also offers you a robot to prep the teeth, it will complete the whole storyline and you won’t look for different solutions. Getting a milling machine from one company, porcelain from another and a scanner from a third will create a higher risk of mistakes and complications, so adopting one brand is more convenient for everybody.

**Koubi:** Dentists want to buy solutions, not ingredients. If you go to an Italian restaurant, you order a whole plate, not the pasta itself, and you are sure that it will be cooked al dente. It is similar to some of the brands on the market: they stress the qualities of some ingredients, some materials, but customers are looking for integrated solutions. This is important for producers to keep in mind and for them to develop and improve their sale strategy according to it.

**Kuday:** Affordable dental treatment is definitely the key word. Everybody deserves to have unique restorations, not only wealthy people. And digital technology will make it come true.

**Gurel:** When a company delivers a product to patients or to dentists, it should be connected in a clear workflow. If the patient sees the smile design and approves it, the dentist shouldn’t have any fear or uncertainty regarding how to achieve it. In my opinion, dentists won’t even try it because they might be afraid of how to proceed, how to create such a smile design. That is the reason why I am saying we should have a well-established workflow and every new product launched on the market needs to be connected with the rest. When a patient wants a particular smile design, the dentist needs to be certain which 3-D design programme to use. I believe defining a very clear treatment process lies in the near future of companies.

**Thank you very much for this interesting conversation! It has been a pleasure having all three of you!**

**Acknowledgement**
This conversation was held with the kind support of Ivoclar Vivadent, who provided its lecture room for the speakers to comfortably sit and chat after their lecture at the Competence in Esthetics congress in Belgrade. The conversation was transcribed by Dr Pavlina Koleva.
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Introduction

The Straumann Pro Arch concept involves different treatment solutions for the fully edentulous patient. The objective is to provide a predictable, reproducible and simple treatment that restores patients’ oral health and consequently improves their quality of life dramatically. The possibility of immediate, same-day rehabilitation by means of temporary fixed prostheses offers maximum treatment quality and satisfaction for both the dental team and patient. The objective of the treatment with an immediately loaded fixed prosthesis on implants is to improve the patient’s quality of life by providing function, aesthetics and health until osseointegration is established.

Owing to the fully digital workflow, which starts with the use of an intraoral scanner, the work team is able to offer a treatment of extreme precision in a simple way. This marks the beginning of a completely digital treatment right up to the final prosthesis. This could be considered as a new form of implantology in which the different elements of treatment are optimised to obtain a spectacular result.

With this objective in mind, at i2 Implantología, we have developed a number of solutions and protocols covering the different clinical situations in fully edentulous patients and based on classical implantology principles to obtain predictable and reproducible results, with the use of the intraoral scanner as the principal element. Our protocols include the use of certain elements (adequate implant system, Osstell, etc.) and action protocols for scanning, surgical and prosthetic procedures and laboratory operations, including the production and maintenance of the provisional prosthesis.

In this case report, we present the i2 Standard protocol. This can be applied to patients requiring the removal of terminal dentition. In summary, this involves selected extractions, implant placement, intraoral digital impressions, and the design and production of the temporary fixed prosthesis in PMMA, with placement in the patient on the same day.

It is important to note that our fully digital protocol to reach the final prosthesis is based, if needed, on the production of subsequent different temporary prostheses until osseointegration is established. We will modify the initial design (and produce further temporaries) always according to a fully digital approach, in order to obtain the final mock temporary prosthesis that fulfils the functional and aesthetic parameters in the patient. The information provided by this final mock temporary will be copied on to the final prosthetic design. A trained dental team, clinic and laboratory are mandatory.
Initial situation

A 68-year-old patient with no medically relevant history and hopeless dentition was referred by his periodontist. A panoramic radiograph and dental CT scan were taken to evaluate the bone availability, disposition and density (Figs. 1 & 2). After the different treatment options were discussed, and in view of the patient’s overall dental, social and financial situation, an implant treatment with a same-day fixed temporary restoration was the first choice for both the dental team and the patient.

Treatment planning

The goal was to load the implants immediately with a fixed screwed temporary prosthesis. To achieve this, the strategic extraction of some dental elements was planned, with the temporary preservation of those key elements that, in the intraoral scanning, determined the patient’s aesthetics, vertical dimension of occlusion and prosthetic arch. We decided to perform minimally invasive surgery, where possible, with a flapless technique to avoid any mobile tissue that could affect intraoral scanning. The placement of six Straumann Bone Level Tapered, Roxolid, SLActive implants with screw-retained abutments (SRAs) was planned for the restoration.

Surgical procedure

Before starting the surgery, an initial study model scan was obtained with the intraoral scanner and sent to the laboratory as the patient’s original file (File 1). This file contained all of the information concerning the patient’s preoperative situation, including teeth, aesthetics, vertical dimension of occlusion and occlusion (Fig. 3).

The surgery was performed under local anaesthesia and with patient monitoring by an anaesthesiologist using conscious intravenous sedation with midazolam and pulse oximetry monitoring. Removing failing teeth was the first task, keeping in place those teeth with less mobility and in strategic positions to maintain antagonist contacts, and trying to keep the same preoperative bite (Fig. 4).

Extraction sockets were fully debrided with a bur to remove all of the granulomatous tissue. Gingival trimming was also performed on those gingival parts with deep pockets. Cleaning with hydrogen peroxide and saline was the final step, obtaining fresh places for the implants.

Keeping in mind the bone anatomy, availability and expected density, the final implant locations were selected
and the implant beds were prepared at 800 rpm with continuous saline irrigation. The implant beds have to be prepared such that parallelism is maintained between all the implants. When placing tilted and/or non-parallel implants, the preparation angle should be either 17° or 30° to match the available SRA custom angulation. Accordingly, the dentist is constantly striving for the least divergent implant preparation, drilling at 0, 17 or 30°. The Pro Arch guide is very useful for this purpose.

Furthermore, undersized drilling with continuous bone density assessment according to the operator’s own experience is mandatory to achieve the highest insertion torque, taking account of the biological bone situation and the mechanical properties of Roxolid. In this case, six implants (Straumann BLT, Regular Neck, Roxolid, SLActive, four of Ø 4.1 mm and two of Ø 4.8 mm) were placed with the handpiece at 45 Ncm, with a final manual setting and monitoring of the insertion torque (Figs. 5 & 6). Careful orientation of the Loxim orientation marks is mandatory to maintain the desired parallelism of the SRA prosthetic screws.

After final implant seating, BLT Type 54 SmartPegs from Osstell were placed on each implant, and the ISQ level was measured and recorded at implant connection level. Values between 75 and 85 out of 100 were obtained, confirming the immediate loading possibility on all the implants (Figs. 7 & 8).

SRAs were connected to all of the implants: two 17° Type A angulated SRAs were placed on the anterior implants to correct the angulation for immediate prosthetic rehabilitation. Straight SRAs were placed on the remaining implants (Fig. 9). New ISQ levels were measured at abutment level using the convenient BLT Type 25 SmartPegs. It is important to record the ISQ level at implant and abutment level in the surgery so that the values can be extrapolated in future Osstell readings at SRA level.

To obtain the final intraoral surface scan, original Straumann SRA scan bodies were connected to the SRAs under visual control (Fig. 10). A new intraoral scan was taken to record the patient’s current oral situation, showing the scan bodies and the preserved strategic teeth. This file (File 2) was also sent to the laboratory (Figs. 11 & 12). When the laboratory confirmed receipt of both files, the preserved teeth were extracted and healing caps placed on the abutments, completing the surgery.

Prosthetic procedures

On receipt of the scan body file (File 2), the laboratory imported it into 3Shape’s Dental System and created a virtual model, matching the virtual SRA scan bodies from Straumann’s original library with the intraoral SRA scan bodies (Figs. 13 & 14). A working file was created for designing the temporary prosthetic emergence profile for the SRA.
To perform the design of the temporary full-arch prosthesis and maintain (or modify) the vertical dimension of occlusion and occlusion, the patient’s pre-preparation study model scan file (File 1) was imported as a pre-preparation scan (blue) and merged with the implant file scan (File 2), using the preserved teeth present on both scans. The software allowed us to mark the same points on the preserved teeth on both files, the study model scan and the implant scan (both contained the preserved teeth). Thus, the laboratory was able to work on a single file containing both Files 1 and 2, merged by means of the preserved teeth. Designing the temporary prosthesis is an easy task using the image of the patient’s own teeth as a mock to be copied (Fig. 15). Any design modification can easily be done (Figs. 16 & 17).

Finally, the designed temporary was sent to the milling unit and produced on a convenient PMMA disc (Telio CAD, Ivoclar Vivadent), resulting in a perfect full-arch bridge about 2 hours later. In this case, using SRAs, a monolithic Telio CAD bridge was produced without any Variobases (Straumann) for the SRAs. Final temporary production steps included characterisation and polishing (Fig. 18).

Returning to the patient, the healing caps were removed (Fig. 19), and the prosthesis was placed, allowing for a passive fit on the abutments, with an initial handpiece tightening of each SRA screw to 5 Ncm. After the seating was checked, the torque of each SRA screw was increased, also with the handpiece, to 35 Ncm (Fig. 20). The occlusion was checked and contacts were inspected (Fig. 21). The screw holes were sealed with PTFE and a temporary filling material. A panoramic X-ray was taken, and SRA screw positions were evaluated to confirm the perfect temporary bridge fit (Fig. 22). The patient was discharged on 500 mg of amoxicillin every 8 hours and 25mg of dexketoprofen every 12 hours for one week. Oral hygiene and diet instructions were given, and a one-week follow-up appointment was scheduled.

Treatment outcomes

Bearing in mind that this is a one-day treatment, the overall treatment time per jaw is about 3 to 4 hours from the beginning to the end of the procedure. With this minimally invasive protocol, postoperative pain, swelling and discomfort are minimal. Patients are able to recover their health and social life immediately, without the psychological and social impairment associated with longer classical procedures.

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Fixed or removable? 
That is the question.

Dr Alessio Casucci & Alessandro Ielasi, Italy

Edentulism is considered to be a disability and a major oral health problem worldwide. Replacing missing teeth with a well-designed and -fabricated complete denture can satisfy the patient who has both a suitable clinical condition and adaptability. However, complete dentures do not restore function in all patients, especially in the case of the rejection of a removable solution for psychological reasons.

The increased awareness, survival, and success of implants and implant restorations have expanded the options for restoring the edentulous mouth from conventional dentures to implant-assisted prostheses. Furthermore, numerous studies have demonstrated that restorative approaches involving implants improve edentulous patients’ masticatory function, quality of life and self-esteem.

Implant restorations have to be planned properly, evaluating different parameters to achieve long-term success. Bone resorption, aesthetics and phonetic parameters can be determinants in establishing a proper treatment plan. Several patient-related parameters such as hand ability, maintenance and other functional aspects, have to be considered before starting patient treatment. Scientific literature too has to be considered by the clinician in order to evaluate clinical protocols, especially for the mandible where the possible standard of care must be established. A consensus regarding this standard of care for the fully edentulous maxilla based on a critical appraisal and comparison of the cost-effectiveness of different prosthetic solutions has not yet been achieved.

For the maxilla, the literature abounds with descriptions of technical solutions, ranging from a fixed solution retained by four axial or tilted implants and upwards to a removable solution supported by two to ten splinted or free-standing implants. It has been reported that patient expectations are higher regarding treatment with fixed restorations.

For some patients, a removable maxillary restoration would be the best solution providing facial scaffolding and especially for patients with a wide smile and/or high smile line covering the prosthesis-tissue junction. In addition, it is beneficial to adverse ridge relations or discrepancies and gives more latitude if the palatal contour for phonation has to be adjusted. Furthermore, it can be challenging to properly clean a fixed restoration in patients with severe maxillary resorption. It has been reported that fixed restorations result in phonetic disturbances in 42% and aesthetic problems in 37% of the treated patients.

The case described in this paper reports on the treatment of an edentulous patient in whom implants were
placed and prosthetic solutions were defined before the surgical procedures. The patient was rehabilitated with a fixed restoration in the mandible as established. For the maxilla, the finalisation moved from a fixed to a removable solution because of aesthetic and phonetic aspects.

Clinical case

A 63-year-old male patient edentulous in both arches was evaluated for definitive implant supported restorations.

Case history

The patient had lost his remaining teeth a few years before our visit. He had been restored with complete dentures fabricated on the basis of his repaired previous partial dentures. The patient did not report a significant medical history and occlusal or temporo-mandibular disease. At the preliminary appointment the patient communicated mainly a functional discomfort due to the instability of the mandibular denture during mastication.

He reported several problems using the mandibular denture, complaining of its instability in almost every situation (during speech, eating, etc.). The maxillary denture had low retention and the palatal extension was poorly tolerated. The previous dentist had planned to rehabilitate the patient with fixed implant restoration in both arches, but after the implant placement, the patient had had several health problems due to an ischaemic stroke and this had delayed the prosthetic finalisation. At the same time, he had been forced to move to our city because he was living with his daughter and she had changed her job.

Clinical evaluation

At the first visit the patient informed us that the implants had been placed the year before. He reported some sore spots due to the maladaptation of the bearing base to the tissue. The complete dentures were found to be unstable during static evaluation (Figs. 1a & b).

Radiographic evaluation

The dental panoramic tomogram revealed six implants in the maxilla and five implants in the mandible, and slight bone resorption was detected around the fixtures (Fig. 2).

Prosthetic evaluation

The patient’s lips revealed a lack of support when wearing the complete dentures, the free-way space was more than 5 mm and it was mainly the mandibular space that were displayed during speaking. The maxillary teeth were not displayed even during smiling (Fig. 3). The lower third of the face was too short when the patient closed the mouth when wearing the complete dentures, revealing more than 10 mm between the vertical rest position and the vertical dimension of occlusion. The occlusal plane also needed to be parallelised to the bi-pupillary and Camper’s planes. The centric occlusion position was not repeatable.

Prosthetic goals

In order to improve the aesthetic, phonetic and functional aspects with definitive restorations, we decided to:
- improve the upper lip support,
- increase vertical dimension of occlusion,
- improve exposure of the maxillary teeth,
- reduce exposure of the mandibular teeth,
- improve occlusal plane parallelism to the bi-pupillary and Camper’s planes,
- establish a stable and repeatable occlusal position,
- verify parameters during adaptation time.

Treatment plan

In order to manage all of the prosthetic goals that may have effected important changes in patient function and adaptation, it was decided to divide the treatment plan into different steps:
1. Restoration of all of the prosthetic parameters with new temporary complete dentures.
2. Verification of all of the parameters during patient adaptation time.
3. Fabrication of two copies of the dentures that could be used to register implant impressions and the inter-arch position in order to retain all of the data required for finalisation.
4. Construction and delivery of the definitive rehabilitation.

Clinical and laboratory procedures

Preliminary impressions

In the first appointment, two alginate impressions were taken (normal-setting alginate Neocolloid, Zhermack)
using Schreinemakers trays. In order to stabilise and support the impression material, a moulding wax was adapted to their surface (Cera Azzurina Morbidissima, Zeta). The adhesive for the alginate was applied to the surface of the prepared trays (Fix Adhesive, Dentsply Sirona).

The first impressions were taken according to a two-phase technique and a high-consistency alginate was used. After removing the impression, it was prepared by removing the undercuts in order to support relining with a low-viscosity alginate. The adhesion between the alginites was promoted by drying the first material.

**Preliminary models and tray construction**

Preliminary models were poured using Class III plaster (Elite Model, Zhermack) according to the manufacturer’s instructions (Figs. 4a & b).

Once the models had been squared and finished, the extension of the individual impression trays was drawn. Undercuts were eliminated with Tenasyle wax (Imadent) and models isolated using Separating Fluid (Ivoclar Vivadent). The trays were prepared with a self-curing resin (SR Ivolen, Ivoclar Vivadent). The trays were finished to a thickness of 2 mm, except for the borders in the sublingual areas and the retro-zygomatic areas, where they were about 3–4 mm thick.

On the basis of the trays, the wax rims were melted simulating the dental arches’ volume in order to aid the clinician in taking a closed-mouth impression. For the lower base, Tenasyle wax was used and Moyco Beauty Pink X-Hard Wax (Moyco Industries) for the upper base. For the upper wax rim, the average of distance between the vestibular sulcus and the incisal edge was set to...
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22 mm at the level of the central incisors and 18 mm at the molar region. The incisal edge of the upper wax rim was positioned about 8–10 mm forward of the centre of the incisive papilla, with an inclination of about 20° on the sagittal plane.

Regarding the lower jaw, the rim was prepared maintaining a distance between the labial sulcus and the incisal edge of 18 mm in the anterior and posterior regions. It was positioned corresponding to the mandibular alveolar ridge and tilted about 8–10° on the sagittal plane. The rims were realised simulating an arch in accordance with the anatomical trend of the residual ridges. Moreover, they were taken to a thickness of about 2–4 mm in the incisal region and about 8–10 mm in the molar region. Finally, the lower wax rim was extended posteriorly to the point where the ramus of the mandible begins to curve up. The posterior limit of the upper wax rim was set to the mesial limit of the maxillary tuberosity (Figs. 5a & b).

Closed-mouth definitive impressions

The stability and the adaptation of the impression trays were checked. After that, the border length and thickness were verified using a silicone-based paste (FIT CHECKER II, GC).

In the next phase, evaluating the support of the patient’s lips, the rims were adapted. The upper rim was orientated parallel to the Camper’s plane and the midline was recorded on it. Thus, phonetic tests were performed (“f”, “v” and “s”) in order to establish the position of the anterior teeth, and to allocate the space between the upper and lower planes. The vertical di-

Figs. 7 & 8: Bordering and definitive impressions. Fig. 9: Definitive impressions and centric relation registration. Figs. 10a & b: Positioning models in the articulator.
mension of occlusion was also determined. Finally, the centric relation was recorded (Fig. 6).

At this point, the trays were trimmed with different thermoplastic sticks (ISO FUNCTIONAL, GC and Impression Compound, Red, Kerr Italia) in order to determine a selective pressure in the inner peripheral seal. The patient was also trained to activate the muscles of lips, cheeks and tongue to define three-dimensionally the extension of the prosthetic margin. During the trimming phase, owing to the ability to bring the rims into contact, the patient could complete swallowing movements. Furthermore, the repeatability of the centric occlusion position was verified several times using this approach.

Before taking the impression, the external areas of the border were released to avoid hyperextension related to the overlap of the impression material. These procedures did not affect the areas of inner seal. The upper tray was drilled to facilitate the outflow of the impression material. The final impressions were recorded with zinc oxide paste for the upper arch (Luralite, Kerr Italia) and polysulphide material for the lower arch (Permlastic Light Bodied and Regular, Kerr Italia; Figs. 7 & 8).

Finally, the vertical dimension of occlusion and centric relation were confirmed. Thus, a face-bow transfer was also indicated (UTS 3D, Ivoclar Vivadent) set according to the Camper’s plane. In order to complete information about the size and shape of the anterior teeth, the Form-Selector (Ivoclar Vivadent; Fig. 9) was used.

Functional impressions were poured with Class IV plaster (Vel-Mix Classic Die Stone, Pink, Kerr Dental Laboratory Products) maintaining the peripheral border. The plaster was mixed under vacuum with distilled water and following manufacturer’s instructions. Before removing the impressions, models were mounted in the articulator (Stratos 300, Ivoclar Vivadent) using the face-bow (Figs. 10a & b).

Before removing the trays from the master models, the length and position of the rims were recorded using a silicone key. The models were then isolated using Separating Fluid and the undercuts rectified using a resilient resin (Flexacryl Soft, Lang Dental Manufacturing), being careful to avoid flow to the fornx. Once the resin was polymerised, the base was prepared using Ivolen. The anterior teeth were set using the information recorded from the rims (Figs. 11a–c).

Figs. 11a–c: Anterior tooth set-up. Figs. 12a & b: Aesthetic evaluation and posterior seal probing. Figs. 13a & b: Occlusal contacts before polymerisation. Fig. 14: Potsdam ditching and flasking preparation.
Tooth set-up
This appointment was focused on the evaluation of the aesthetics, phonetics, vertical dimension of occlusion and repeatability of centric relation. The patient observed and accepted the set-up with a member of his family. It was decided to create two embrasures on the anterior teeth in order to reduce incisal edge convexity. The posterior seal area was evaluated by probing the compression of the tissue using a ball condenser (Figs. 12a & b).

Temporary complete denture construction
The posterior teeth were mounted using a static laser (CANDULOR). Posterior tooth contacts were obtained according to lingualised occlusion concepts and the Gerber occlusal scheme (Figs. 13a & b).¹¹

Curing and finishing the complete dentures
The posterior seal area was ditched on the model using the clinical information of the different levels of compression of the tissue. The prostheses were waxed for deposit. The polymerisation was performed using the IvoBase system (Ivoclar Vivadent), a fully automatic injection system. The shrinkage of the specific PMMA resin is fully compensated for during polymerisation, thus obtaining the most accurate denture base adaptation (Fig. 14).

After polymerisation, the prostheses were replaced into the articulator and the occlusal grinding was performed in order to maintain all of the occlusal contacts that were established before polymerisation (Figs. 15a–c).

Temporary denture delivery and follow-up
Upon delivery, the prostheses were placed into the oral cavity and left to adapt for 10 to 15 minutes with the patient clenching two cotton rolls placed bilaterally between the arches. After that, the adaptation of the bases was checked with FIT CHECKER II. The patient was instructed to perform functional movements and to speak. The length and thickness of the borders were verified with the silicone-based paste and corrected when it was required.

Figs. 15a–c: Post-polymerisation occlusal grinding.

Figs. 16a & b: Information registration and realisation of denture copies. Figs. 17a–d: Definitive impression registration.
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Finally, the occlusion was checked, revealing bilateral symmetrical contacts. The patient was instructed on managing and cleaning the complete dentures in the initial days. Follow-up visits were planned at 24 hours and one and two weeks after delivery. The patient reported a rapid adaptation to the new dentures, only a few points of pressure caused ulcerating lesions. Phonetics and stability were improved after the treatment. Control appointments were conducted in the weeks after delivery and excellent levels of adaptation were reported, regarding both aesthetic and phonetic aspects.

Fabrication of denture copies

The successful adaptation to the temporary dentures confirm that all the parameters (vertical dimension of occlusion, centric relation, aesthetics and phonetics) could be maintained in the definitive restoration. It was decided to fabricate copies of the temporary dentures and to use them as a closed-mouth tray. The temporary bearing bases were rebased with a polysulphide impression material (Permastic Light). The intermaxillary position was registered using a bite registration silicone (Occlufast, Zhermack). The copies were obtained using self-curing transparent resin (ProBase, Ivoclar Vivadent; Figs. 16a & b).

Closed-mouth implant impression registration

After the implant surgery, a multi-unit abutment was placed. At the impression appointment, pick-up copings were attached to the implant abutments. Denture copies were prepared in order to be positioned with perfect adaptation to the oral mucosa.

Finally, definitive impressions were taken with polyether material (Permadyne and Impregum, 3M ESPE). The intermaxillary position was as registered after removing all of the implant pick-up copings that could determine occlusal interferences. A face-bow was also taken before removing the maxillary impression (Figs. 17a–d). Master models were prepared using a removable soft resin to reproduce peri-implant tissue. The impressions were poured in Class IV plaster, and the obtained models were placed in the articulator using the face-bow measurements.

Before removing the impressions from the master model, a silicone key was prepared in order to record the position of the anterior teeth (Fig. 18). Two occlusal bases were prepared with wax rims in order to verify the intermaxillary position. Additionally, implant pick-up copings were splinted using stone (Elite Arti, Zhermack; Fig. 19).

Implant and inter-arch position check

The intermaxillary position was confirmed, but the upper stone key was fractured during screwing procedure. Thus, it was splinted with stone, and after repositioning the implants, replaced on the model. The implants’ position was definitely confirmed (Figs. 20a–d).

Tooth set-up

The tooth set-up was performed according to the information of the denture copies, using the silicone key. The complete set-up was evaluated with the patient and all occlusal, aesthetic and phonetic aspects confirmed. The tooth set-up approved during the patient try-in was sent to the laboratory for framework design.

Fixed or removable?

Depending on the discrepancy between the position of the clinical crown and the alveolar ridge contour in the bucco-oral dimension, compensation with the denture base of a removable reconstruction may be necessary. However, for a fixed complete denture, the clinical crown should ideally be at the soft tissue level of the alveolar ridge. For this solution, minimal bone resorption and a limited inter-arch space with an optimal tooth–lip relationship are required (Fig. 21).

These parameters, mainly determined by tooth position and the amount of residual alveolar bone, have to
be considered before planning a maxillary implant-supported restoration. In this case, the patient was informed before implant surgery that his dentition was to be restored with fixed restorations in both arches. However, our prosthetic evaluation determined that it was not feasible because of the horizontal distance between the teeth and implants.

The patient was informed about the advantages and disadvantages of fixed or removable prostheses. Moreover, a tooth set-up was prepared without a buccal flange in order to analyse potential problems regarding facial support, phonetics, aesthetics and hygienic access. With the patient’s consent, it was decided to realise a removable solution for the maxilla and a fixed restoration for the mandible.

Clinical case finalisation

The implant overdenture was prepared maintaining the insertion path perpendicular to the occlusal plane. Two bars were fabricated in order to reduce the volume required for primary and secondary frameworks. In both bars were placed two different ball retentive systems (Rhein’83). The mesial one was mini, and the distal one of normal size. This kind of solution could guarantee enough retention for the restoration and durability of the attachment system. Moreover, owing to the number and position of the implants, complete palatal support was reduced, including the maxillary tuberosities as determinant support areas (Figs. 22a & b).

Delivery and follow-up

Definitive restorations were realised maintaining all of the prosthetic parameters of the temporary restoration. Patient adaptation was excellent concerning the aesthetic, phonetic and hygienic parameters, despite at the beginning of treatment having been oriented to a max-

Figs. 20a–d: Occlusal check and implant pick-up coping splinting.

Fig. 21: Space evaluation. Figs. 22a & b: Implant overdenture framework fabrication and try-in.
illary fixed rehabilitation (Figs. 23a & b). The prosthesis-bar-supported solution could guarantee enough retention and stability to the patient in both functional and psychological aspects. At the three-year follow-up, the tissue was healthy owing to the patient’s hygiene compliance (Figs. 24 & 25).

Discussion and conclusion

While this clinical case reported good patient adaptation to the definitive restorations, modifying the initial treatment plan can be a challenge, especially when patients chose to be treated with implants because they are maladapted to removable solutions. As reported in this case, with a sufficient number of implants of adequate length, the superstructure can be purely implant-supported in construction. However, when bone is severely resorbed,15 the distance between the implants and the incisal edge position cannot be solved with a fixed restoration because of the lack of lip support or poor phonetics.

Current criteria for planning and deciding on treatment have been reported in literature and are considered a fundamental guide for establishing the treatment plan.16,17 This case treatment would emphasise the importance of not promising the patient a fixed maxillary restoration until the final wax trial has been accepted.18–20

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Implantology has become a fundamental, if not routine, component of oral rehabilitation and the most reliable procedure in the discipline’s attempt to realise restitutio ad integrum. In modern dentistry, implant-supported restorations are considered to be the usual and best care options. However, particularly in patients with malignancies of the oral cavity, there are fundamental changes to the anatomy of the oral cavity due to the extensive surgical procedures and adjuvant radiotherapy. In the post-irradiated jaw, a purely mucosa-supported prosthesis is not indicated owing to xerostomia and the necrosis risk of irradiated bone. The only practical way to prevent load on the mucosa is the insertion of dental implants and the subsequent incorporation of an implant-supported fixed denture.1, 2

Traditionally, determining implant position, size, number, direction and placement depended on the preoperative diagnostic imaging, which was limited to 2-D radiographs and guiding templates. Three-dimensional imaging and navigational aids offer the treating implantologist enhanced certainty and additional options, especially in high-risk cases, such as patients with extreme alveolar ridge atrophy or patients with malignancies of the oral cavity. With 3-D imaging, implant prosthetic dentistry has taken a major step forward. The dentist can plan the surgical procedure virtually in combination with 3-D planning programmes.5–7 This has been made possible mainly by the steady improvement of specific implant planning programmes, such as CTV (computer tomography visualisation) software.

With navigated implantology, it is possible to pass through the alveolar crest, locate structures and assess the existing bone at all levels. On the basis of the available data obtained on computer, the length, inclination, diameter and ideal position of the implants can be determined.1–4 Prerequisite for navigated implantology is the use of appropriate imaging techniques, particularly the 3-D radiographic method of cone beam computed tomography (CBCT; Table 1).6–8 This modern 3-D diagnostic enables detailed surgical planning of implantation, taking into account prosthetic considerations. Navigated implantology offers several advantages:7–9

- precisely guides the osteotomy drills, through a secure, reproducible positioning of the template, directing the surgeon on the exact location and angulation to place the implant based on the virtual treatment plan;

<table>
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<th>Effective dose in µSv</th>
<th>Multiple doses of a dental panoramic tomogram</th>
<th>Dose as % of annual natural radiation</th>
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<td>NewTom</td>
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<tr>
<td>CT scan</td>
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<td>323</td>
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</table>

Table 1: Comparison of radiation exposure of various methods and systems.
allows flapless, minimally invasive surgery, avoiding unnecessary bone exposure, which entails less bleeding, less swelling, and a reduced healing time and postoperative pain;
- low-distortion and detailed radiographic analysis and an improved learning curve for the dentist, surgeon and dental technician team;
- provides greater safety for patients and dentists through 3-D planning, especially with complicated jaw conditions or low bone volume and the risk of postoperative complications is significantly reduced;
- virtual planning provides the conditions for considerably increased accuracy of implant placement and avoidance of vital structures, followed by the prosthetic restoration of masticatory function;
- the operation period is significantly shorter.

However, computer-assisted implant surgery is not free of risks. Navigated implantology also has certain drawbacks and limitations, which have to be considered as well:10–12
- problems with the template positioning in edentulous jaws and inaccurate fixation of the surgical guide, resulting in displacement during the surgery;
- fracture of the surgical guide;
- dependence between the guide system and software and usually the learning curve for the dentist, surgeon and dental technician team is complex;
- reduced mouth opening can lead to changed positioning of surgical instruments;
- the total cost of the tools needed, including the software programme and surgical templates, is higher in comparison with that of traditional methods;
- intra-operative modification of implant position is not allowed.

In computer-aided implantology, the treatment procedure is very precise, but for a successful outcome and a predictable end result, backward planning is essential, since it allows the implants’ alignment in the arch, helps in treatment predictability, and promotes the maintenance of aesthetic and biomechanical principles.11–13

The backward planning for a computer-aided implantation includes the following steps:
1. Impression and model fabrication.
2. Planning of prosthetic restoration.
3. Preparation of a scan template with three reference balls (aluminium, 2 mm in diameter; Fig. 1).
4. CT/CBCT scan of the patient with the inserted scan template.
5. Reading the radiographic data into the CTV system and virtual planning of the implantation.
6. Transfer of the planning data to the drilling template.
7. Guided implant placement.

Case presentation

In this section, we present two clinical cases of prosthetic rehabilitation of a patient with extreme alveolar ridge atrophy and a tumour patient with iliac crest bone grafting and computer-aided implantation using the CAMLOG Guide System. The preoperative planning, the operation phases and the patient’s postoperative wound healing are described. The study was conducted in the oral and maxillofacial surgery department of St. Lukas Hospital in Solingen, Germany. The patients concerned presented for implant rehabilitation in our department after surgical resection and irradiation and before augmentation of the extreme alveolar ridge atrophy of the lower jaw with iliac crest bone. The insertion of implants was performed after obtaining CBCT scans and virtual planning of the implantation using CTV software.

Case 1

A 67-year-old female patient was referred to our department for implant rehabilitation. She was generally healthy, totally edentulous in the upper jaw and partially edentulous in the lower jaw. The initial clinical examination and the CBCT scan showed a very extensive vertical and horizontal bone defect in regions #34–37.
and 44–47 as consequence of progressive resorption. After the final diagnosis and planning, we discussed the possible restorative options and alternative solutions. The patient was not satisfied with her removable denture in the lower jaw and wished for a fixed denture.

In order to make treatment possible with bridge constructions on osseointegrated titanium fixtures, bone grafting was necessary in the edentulous regions of the lower jaw. The patient was explicitly informed of the possible risks and dangers from the functional and aesthetic perspective during and after the treatment period and the treatment steps were explained. Five months after the reconstruction of the alveolar jaw with iliac crest bone (Fig. 2), we were able to continue our therapy planning, which included preoperative prosthetic planning and navigated implantation.

After taking impressions, a wax set-up was produced. The aesthetic set-up in wax served for the shape specification for the preparation of the provisional restoration, the final restoration and the implant planning. The virtual planning followed. The radiographic template for CBCT imaging was prepared on a duplicate of the master model with light-curing tray material. Three radiographic balls made of aluminium were inserted into the radiographic template (Fig. 1). The use of the three balls increased the precision of the planning, because in this procedure, the ball midpoints and not edges were adjusted. A CBCT scan was performed with the patient wearing the radiographic guide. The basis for the implant planning was the data set obtained from the CBCT scan.

The minimally invasive, transgingival implantation was planned using the 3-D data set with the CTV software. Anatomical conditions had to allow the placement of at least four implants in the ideal position for prosthetic rehabilitation (Fig. 3). Once an implant had been planned, it was easy to see the vestibular and lingual cortical bone.
After bone volume analysis, implants were planned on the lingual aspect, and the implant platform virtually positioned at the level of the coronal part of the vestibular alveolar crest (Fig. 4). The main feature in the production of the surgical guide was the secure positioning and stable fixation of the drilling sleeves in the template. For the production of the drilling template, the drilling sleeves were placed on the plastic models produced by an additive process (Fig. 5).

The surgical procedure was performed under local anaesthesia with Ultracain® D-S forte 1:100,000. Cefuroxim (500 mg) antibiotics were given one hour before surgery and twice a day for six days thereafter. The patient rinsed with chlorhexidine gluconate (0.2%) for one minute before the intervention (Fig. 6).

The surgical template was placed intraorally in the correct position and in relation to the opposing arch. Considerable care was taken when placing the surgical template (Fig. 7). After correct placement and stabilisation of the surgical template, flapless implant surgery was performed in accordance with the drilling protocol for the type of implant used (Fig. 8). At the regions #34 and 44, two CAMLOG fully guided implants of 4.3 mm in diameter and 13.0 mm in length were inserted, and in regions #36 and 46 implants of 4.3 mm in diameter and 11.0 mm in length.

Moreover, two small full-thickness flaps were raised in order to remove the osteosynthesis screws used to stabilise the autogenous bone graft in the previous augmentation surgery (Fig. 9). The insertion of the implants was carried out with the standard placement head and the DRM ratchet to the maximum primary stability, with a preset insertion torque of 35–45 Ncm. The gingiva formers were inserted to a torque of 20 Ncm (Fig. 10) and the flaps were sutured after the implant insertion with non-resorbable sutures (Prolene 5/0). The sutures were removed after seven days. A postoperative
dental panoramic tomogram showed the inserted implants in the lower jaw and the areas of augmentation on both sides were also clearly recognisable (Fig. 11).

After the operation, the patient was instructed to cool and protect the operating area; a chlorhexidine gluconate mouthwash (0.2%) was prescribed for one minute twice a day for two weeks after surgery and painkillers, if necessary. The patient was instructed on oral hygiene. Scheduled visits after surgery were after one week, two weeks and one month. At these visits, the healing process was found to be very good and painless. The definitive prosthetic restoration was planned for four months after the implantation.

Case 2

A 75-year-old male patient was referred to our department for dental examination and for implant rehabilitation. In 2011, he had been diagnosed with squamous cell carcinoma on the right side of the tonsil. After the tumour resection and neck dissection and an adjuvant radiation therapy of up to 65 Gy, the patient was in the ambulatory tumour follow-up phase of care. This was the case because the tumour resection was inconspicuous and without signs of recurrence. Through the previous tumour surgery, the anatomy of the oral cavity had changed fundamentally: owing to xerostomia and radiation-induced caries in 2013, all of the remaining teeth in both jaws had had to be extracted.

The first clinical examination in our department found a totally edentulous upper and lower jaw with a loss of taste and xerostomia. The dental panoramic radiograph showed about 10 per cent vertical and 15 per cent horizontal bone loss in both dimensions in the upper and lower jaw. After the final diagnosis and planning, we discussed the possible restorative options and alternative solutions. Because of the post-irradiated jaw, a purely mucosa-supported prosthesis was not indicated, and owing to the xerostomia, the maintenance of a purely mucosa-supported prosthesis was not guaranteed. Therefore, the only medically reasonable and practical solution was the insertion of dental implants, six implants in the maxilla and six in the mandible, with subsequent incorporation of an implant-supported fixed denture.

Fig. 11: Dental panoramic tomogram of the patient after the surgery for control of the implants’ positions. Figs. 12a & b: Virtual dental panoramic tomogram showing the digitally determined 3-D implant positions in the maxilla (a) and in the lower jaw (b). Fig. 13: Fully navigated drilling templates after CBCT planning (drilling sleeves, fully guided 4.3 mm, violet).
After taking the impressions in our department, the master models were made in the dental laboratory in a model tray socket and a wax set-up was produced and customised according to the aesthetic and functional evaluations. The patient was prepared for the computer-guided implant procedure. He underwent a CBCT with the radiographic template and the acquired DICOM images were processed with the aid of the CTV software. The planning with this software produced a report in which the coordinates of each of the three ball midpoints were determined, allowing the laboratory technician to orient and reproduce the surgical template (Figs. 12a & b). The drill guides were produced via a thermoforming technique on a duplicate model of the master model. Subsequently, the drilling sleeves were incorporated with the sleeve holders in the drilling template using the additive-produced plastic model. The transparent base of the template enabled intraoperative assessment of the template placement on the tegument through an even ischaemia due to the contact pressure during implantation (Fig. 13).

The surgical procedure was performed under local anaesthesia with Ultracain® D-S forte 1:100,000. Cefuroxim (500 mg) antibiotics were given one hour before surgery and twice a day for six days thereafter. The patient rinsed with chlorhexidine gluconate (0.2%) for one minute before the intervention. After infiltration anaesthesia in the upper and lower jaw, and bilateral nerve block anaesthesia in the lower jaw and upper palate, the surgical template was carefully inserted and stabilised correctly in the lower jaw.

In the mandible, the mucosa was punched out with a rotating punch at regions #36, 34, 32, 42, 44, and 46 (Fig. 14). After disassembling the template, the gingiva points marked with the punch were cut down and the punches removed in order to obtain a punched and prepared lower jaw (Fig. 15). Thereafter, the drilling template was used again. According to the manufacturer’s instructions, cannon drills (6 mm pilot drill; 9, 11 and 13 mm form drills) were used to prepare the implant osteotomies at regions #36, 34, 32, 42, 44 and 46 (Fig. 16).

The insertion of the implants was carried out with the standard placement head and the DRM ratchet to the maximum primary stability, at about 30–35 Ncm (Fig. 17).

Fig. 14: Insertion of the template in the mandible. Fig. 15: Punched and prepared mandible. Fig. 16: Implant placement. Fig. 17: Manual insertion of the CAMLOG implant with the locked torque wrench. Fig. 18: All guided CAMLOG implants in the lower jaw. Fig. 19: Implantation result with all of the implants in situ.
Subsequently, the implant navigation posts and the surgical template were removed in order to insert the gingiva formers in the maxilla, which were inserted to a torque of 25 Ncm (Figs. 18 & 19). The procedure in the maxilla was analogous to the operative implant bed preparation and insertion of the implants in the lower jaw, where six fully guided CAMLOG implants of 4.3 mm in diameter and 11.0 mm in length were inserted in regions #15, 14, 12, 22, 24 and 25. A postoperative dental panoramic tomogram showed the inserted implants in the maxilla and mandible (Fig. 20).

After the operation, the patient was instructed to cool and protect the operating area; a chlorhexidine gluconate mouthwash (0.2 %) was prescribed for one minute twice a day for two weeks after surgery and painkillers, if necessary. The patient was included in our implant maintenance programme and instructed on oral hygiene. Scheduled visits after surgery were after one week, two weeks and one month. At these visits, the healing process was found to be very good and painless. The definitive prosthetic restoration was planned for five months after the implantation.

Discussion and conclusion

The advancements in the field of implantology, such as 3-D imaging, implant planning software, CAD/CAM technology, and computer-guided and navigated implant surgery, have led to the digitalisation of implant dentistry and have taken implant prosthetic dentistry a major step forward. With significant achievements accomplished in the field of digital implant dentistry, implant placement has become highly predictable, even in patients where implant surgery was previously contra-indicated.6, 7, 14

Modern 3-D diagnostics enable detailed surgical planning of implantation, including prosthetic considerations. This achievement is mainly due to the continued improvement of implant planning programmes such as CTV software. CTV is used to display digital image data for diagnosis and precise prosthetic implant-oriented planning, with subsequent template-based implant placement.6, 13, 14

In conclusion modern implant navigation is based on sound systematic, prosthetic and surgical knowledge. It can optimise implant treatments and safely achieve the desired result, but it can never compensate for a lack of knowledge and surgical skill of the operator.7, 12, 14

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Azento brings the clinician financial and time-saving benefits

By DTI

The recent Dentsply Sirona World 2018 conference in Orlando saw the launch of Azento, a single tooth replacement. Dental Tribune International spoke with Jo Massoeils, Director of Digital Implant Solutions at Dentsply Sirona, and Dr Daniel Butterman, a general and cosmetic dentist practising in Colorado in the US, about how Azento can benefit clinicians and what the future holds for implant dentistry.

Mr Massoeils, Dr Butterman, what distinguishes the Azento system from competitors, and what are its advantages?

Butterman: For me, it’s the simplicity at all stages, from ordering to inventory, that sets the Azento system apart. Being able to design a final restoration straight from the treatment plan is so different from anything that we’ve ever seen, and this streamlined workflow has many time-saving benefits in terms of patient chair time, number of visits and so on. In many dental offices, the team will take either a film or digital X-ray of a patient’s mouth. Then, they’ll show the patient this tiny X-ray and point out certain areas of concern, perhaps begin to draw on it or use templates to show how the implant will be placed. The patients will say that they understand, but mostly because they are being polite—there’s really no comprehension. But when I show a patient their custom digital treatment plan, created with Azento, it’s far easier to highlight the issues that the implant placement will aim to correct. It allows the patient to
co-diagnose with me, to see what the course of treatment can and should be.

**Massoels:** The streamlined workflow offered by Azento brings with it tangible financial and time-saving benefits by reducing administrative responsibilities, number of visits and patient chair time. It is designed to help dentists select the best-fitting implant, determine optimal implant positioning, healing environment and restoration for each case.

This spring, Dentsply Sirona celebrated the grand opening of its new, state-of-the-art training facility, the Dentsply Sirona Academy, in Charlotte in North Carolina. Will there be any training available at this centre for dental professionals interested in using Azento in their workplace?

**Massoels:** Absolutely. There will be hands-on training courses as part of Azento’s rollout in the US and we have been working very hard on developing a digital training option as well. We’ve found that many clinicians don’t necessarily want to have to go to a physical training course, but would rather be able to view it on their mobile phones or computers. As a result, we have a lot of training material for Azento that is now online and available for users of this solution.

Are there any cases that can’t be treated with Azento? What are its limitations?

**Massoels:** Currently, Azento is available for single tooth replacements in situations where there are two neighbouring teeth already. There are also certain clinical situations that are outside of Azento’s scope, and experts looking at the scans will identify these during the planning stage. Having these extra sets of eyes looking at each case and helping to categorise them is a clear benefit for clinicians.

**Buttermann:** It’s a great safety net to have for dentists—a second opinion that comes with the purchase of an Azento box.

Technology is shifting really quickly these days. How do you see it evolving in the next few years within implantology and 3-D printing?

**Buttermann:** Well, I have a 3-D printer in my practice and I do use some workflows for 3-D printing, but I will be honest—there are a lot of places where inexperienced users of this technology can make mistakes. I think there will be a place for it in the near future for the clinician, but it’s still more reliable for new users to have implants fabricated.

**Massoels:** I think 3-D printing is a very exciting development. Another interesting field that is close to my heart is treatment planning. Though our current solutions for this are good, there are areas that we can improve with the assistance of artificial intelligence technology. We have data from hundreds of thousands of successful implant cases from all around the world that we will be able to use in the future to help generate treatment plans within seconds.

Thank you very much for the interview.
Bringing a turnkey restoration solution to dentists

At the 2017 Greater New York Dental Meeting, 3DISC launched its Heron IOS intraoral scanner to the world. Three months later, in February 2018, the US-based imaging company presented an improved device to attendees of the Chicago Dental Society Midwinter Meeting (Fig. 1). In an interview, Thomas Weldingh, 3DISC Deputy Group CEO, took the time to present the key benefits of the Heron IOS for dental professionals.

Mr Weldingh, what can you tell us about the new scanner?
We seek to cater to the segment of solo and midsize practices with an easy-to-use and affordable solution. With the Heron IOS, we have aimed to solve three major challenges that we know of from the existing scanners on the market: dimensions, ergonomics and affordability. We have succeeded in bringing a scanner to the market that is extremely easy to use, featuring a small, lightweight hand- and mouthpiece with a rotatable tip for providing the best possible ergonomic grip (Fig. 2).

The Heron intraoral scanner is one of the lightest weight colour scanners in the market, weighing only 145 grammes, which is considerably below the average weight of other colour scanners. The ability to use scanners comfortably is important for dentists and, with its light weight, combined with the rotatable tip, the Heron provides one of the best ergonomic solutions in the industry.

“With the Heron IOS, we have aimed to solve three major challenges: dimensions, ergonomics and affordability.”

What are the key benefits of the 3DISC intraoral digital impression solution?
Our digital scanning product is a uniquely simple hardware and software solution. The dentist simply connects the Heron to his or her laptop or PC in the clinic, using the accompanying practical base for desktop use. The scanner comes with our QuantorClinic software, built on
“The Heron intraoral scanner is one of the lightest weight colour scanners in the market.”

exocad’s software platform, which is one of the most widely used CAD/CAM software platforms in the dental industry. The Heron IOS was developed and produced at our facilities in Virginia, USA.

What is planned in terms of clinical testing of the product?
The Heron IOS has been tested by dentists in the USA and Europe since spring 2018. We want to ensure that the product works as intended in the clinical environment while looking for improvements we can add to the workflow of the clinic and integration with dental laboratories.

Why did you decide to enter the intraoral scanner market?
The market is dominated by a few larger manufacturers. We believe there is room for an alternative intraoral system in the marketplace, a system that brings immediate value into the dental practice, making impression taking simple, hassle-free and cost-effective. Device and maintenance costs are among the challenges restraining the adoption of current intraoral scanners, as well as demand for an open and license-free software architecture. We believe in the need and opportunity to bring a product to market that meets these challenges.

Why does 3DISC aim to cater for solo to midsize practices, and what are the benefits such practices can expect from your products?
Solo and midsize practices are the segment that is currently hesitant to incorporate digital dentistry. Among the reasons are complexity in the existing solutions and high prices and maintenance costs. We see a gap and a need for a product in this segment with first and foremost a noncomplex and simple price model, and a technology that is easy to adopt and get started with, without compromising on the performance and quality of the final fit. Dental practices can expect both high-quality intraoral imaging and an affordable price point $25,990 without any annual licensing fees for the Heron intraoral scanner. For the solo or midsize practice wanting to enter into digital dentistry, we believe that 3DISC is bringing the best solution to dentists with our Heron IOS.

When and where is the launch and when will the product be available?
Product shipping will start in the third quarter of 2018 in the Americas, Europe, the Middle East, Africa, Korea, Southeast Asia, Australia and New Zealand.

Mr Weldingh, thank you very much.

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“The Heron intraoral scanner is one of the lightest weight colour scanners in the market.”

Fig. 2: The lightweight hand- and mouthpiece with a rotatable tip provides the best possible ergonomic grip.
Successful digital implant workflow

Planmeca’s software-driven solution for implant dentistry provides a kind of freedom and flexibility that is hard to match. Users can efficiently manage their entire implant workflow with the Planmeca Romexis® software: from CBCT imaging to intraoral scanning and from implant planning to guide design. As it is a truly open software, it allows users to utilise data from Planmeca or other equipment. There are no hidden or extra fees for importing and exporting files. Taking an implant plan to actual surgery is now easier than ever, as the software’s new Planmeca Romexis® Implant Guide module lets users design their own surgical implant guides. This elevates implant planning to another level, as virtual plans can accurately be brought to reality. Creating implant guides with the software requires few simple steps. Users can also flexibly select their preferred workflow, as completed guide designs can either be 3-D printed in-office or exported as STL files to a partner lab for 3-D printing.

SEVEN implant system

This past June, at the EuroPerio9 congress in Amsterdam, Netherlands, MIS launched the enhanced SEVEN implant system. Several key features have been added, that make the internal hex implant even better. Its biological stability and predictable aesthetics combined with the extensive R&D process which has led to these new improvements, have given the SEVEN a potential advantage in soft-tissue preservation and growth, as well as an array of restorative benefits. The combination of its unique features may provide the dentist with higher predictability, better aesthetic results and bone preservation.

The implant incorporates the platform-switching design concept. Implants with a platform-switched configuration have been shown to exhibit less bone loss when compared to non-platform-switched implants, which may lead to soft-tissue preservation and growth. The SEVEN’s root-shaped geometry and unique thread design enable excellent primary stability, allowing for a simpler and faster implant placement. With a new, comprehensive concept for enhanced aesthetics and better bone preservation in mind, and in order to support the advanced new implant features, an additional line of concave abutments has also been added. The concave emergence profile was designed for a larger gingival volume, and along with its gold shading, offers a better aesthetic result.

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The digital world is creating numerous opportunities for dental practices. To the practitioner, these may seem countless and it may not be easy to keep pace with relevant developments. The 2019 International Dental Show (IDS), which is to be held from 12 to 16 March in Cologne in Germany, will present the state-of-the-art technology and help clinicians determine the most suitable solutions for their practices and focus of work following the motto “It depends on which innovation brings me and my practice forwards here and now.”

Whereas in the above-mentioned case, the priority was above all speed, digital technologies assist with both complex and difficult treatments. For example, in the field of implantology: a patient requires a fixed prosthesis for his edentulous mandible. Based on radiographs and model scan data, the dentist–dental technician team
plans the treatment together in the scope of backward planning from the final prosthesis to the positions of the individual implants. The digital availability of the data facilitates this process and if necessary also enables a further professional to be involved—even at short notice.

There are various ways of implementing the planned treatment, including many options that involve digital support. For example, for a safe surgical treatment, drilling templates can be ordered from the dental laboratory or from an industry partner that provides the service. External support is also available for the virtual design and production, so that the individual work steps can be more flexibly divided up among the team (surgeon, prosthodontist, dental technician) today than ever before. In this way, the practice aims to achieve quality assurance or, indeed, an improvement in the quality, while at the same time possibly saving time and money. Experts predict a pace of progress that will mean that by IDS 2019 or IDS 2021 at the latest more digital implant treatments will take place than analogue treatment using standard products.

“The current trends for the digital technologies for the practice, as well as extensive workflows for surgeons, prosthodontists and dental technicians, will be presented in a unique form at IDS,” said Mark Stephen Pace, Chairman of the Board of the Association of the German Dental Industry. “The opportunities of digital dentistry have now arrived in all disciplines—from implantology and prosthetics, through to endodontics and orthodontics. As such, it is certainly worthwhile for representatives from all specialised areas to experience the current innovations at IDS in a diversity that can be found in no other place.”

Pictures courtesy of Koelnmesse GmbH.
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