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The advent of Cone Beam Computed Tomography (CBCT) has paved the way for clinicians to adopt the technology for a variety of different treatment modalities, including dental implants, oral surgery, orthodontics, endodontics, TMJs, airway analysis, sleep apnoea, guided surgery applications, and more. Many of these procedures and related concepts have been highlighted within the pages of cone beam magazine.

The use of CBCT diagnostic imaging has proved to be a vital, important, and perhaps invaluable tool to visualise patient anatomy in order to evaluate dental implant receptor sites and avoid adjacent vital anatomy. However, there are many potential sites which are found to be deficient in available bone width, height, and volume. These sites may be critical to the desired restorative outcome, and therefore may require additional pre-prosthetic surgery to ensure long term implant and soft-tissue stability. It is well-documented that hard- and soft-tissue grafting can play an important role in managing potential implant receptor sites. Pre-operative CBCT evaluation is becoming more and more important for the proper evaluation of deficient sites.

The use of CBCT and interactive treatment planning software applications are continuing to evolve as an aid to helping clinicians improve their appreciation of sites deficient in available bone, and to plan the most appropriate treatment alternative for each patient’s needs. The planning process has been enhanced through the use of pre-surgical diagnostic models, intra-oral scanning, simulated virtual bone grafting, fixation or tenting screw placement, and the use of 3-D printing to create biomedical models, and more.

It is our goal for the readers of cone beam magazine to be exposed to the many evolving uses of CBCT imaging modalities and how CBCT serves as a foundation for many procedures that go well “beyond” dental implants. Perhaps the incredible potential will be realized as multiple technologies are merged together to define the most efficient and cost effective digital workflow.

Please enjoy our latest publication, and expand your horizons!

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The DTI publishing group is composed of the world’s leading dental trade publishers that reach more than 650,000 dentists in more than 90 countries.
Cone Beam Computed Tomography (CBCT) is playing an increasingly important role in diagnosis and treatment planning of dental implants, and can serve as an excellent preoperative tool prior to sinus grafting procedures. When implants are placed in the maxillary arch, consideration must be given to the pathology and anatomy of the maxillary sinuses. Studies show that the prevalence of mucosal disease secondary to endodontic or periodontal disease ranged from 5 to 38%. The prevalence of sinus pathology found on CBCT on asymptomatic patients has been estimated to range from 25 to 56%. The literature is in agreement that a mucosal thickening of 1–2 mm or less is normal.

Mucositis, the most common sinus pathology, is the term for mucosal thickening and is associated most commonly with apical infection and allergies. Mucous drains from the sinus through the ostium, which is located superiorly in the sinus, and should be away from the surgical area to be grafted; the disadvantage is that there is no gravitational drainage due to the ostium’s superior placement. The next most common pathology is a mucous retention cyst. It normally appears as dome shaped and is usually the result of a blocked mucous gland duct. Sinus polyps occur when there is inflammation and oedema in the lamina propria of the sinus membrane. Polyps are solid unlike retentions cysts, which are fluid filled. Both appear similar radiographically, although polyps are more likely to be pedunculated whereas a cyst is more likely to have a broad base. Some less common sinus pathologies are a mucocele, which is when the ostium is blocked and mucous accumulates in the sinus. Mucoceles are expansile in nature and can cause sinus wall displacement. When displacement occurs, it makes it easier to differentiate between a large mucous retention cyst and a mucocele. Benign and malignant tumours can grow large and are capable of destroying any sinus boundary.

Opacities in the sinus can be antroliths, osteomas and exostoses. Antroliths are opacities from mineralisation around organic material and are not attached to the bony wall, whereas osteomas and exostoses are attached to the bony wall. Lastly, some pathology may arise from outside the sinus and invade into the sinus. Examples of these would be odontogenic cysts and radicular cysts.

With CBCT imaging modalities, most sinus pathologies have a similar opacity, making it hard to distinguish between pathologies; greater emphasis should then be placed on evaluating the shape and distribution of lesions. It is therefore critical to have a scan of the entire sinus up to the orbital floor, because it is the superior aspect of the lesion that helps to make a final differentiation (e.g. dome shaped, straight or meniscus). A complete scan of the sinuses also helps to determine whether the ostium is blocked. A blocked ostium will have greater likelihood of morbidity following implant surgery since bacteria and debris will not be able to adequately drain. It should be noted that referral is warranted for any patients manifesting sinus pathology regardless of whether or not they are having bone grafting or implants placed.
Before Cone Beam Computer Tomography (CBCT) became available, Multi Detector Computer Tomography (MDCT) was the principle method of 3-D imaging in the diagnosis and treatment planning for dental implants. With MDCT, bone densities were evaluated using Hounsfield Units (HU), which is a measure of radiodensity measured from beam attenuation of axial slices. With CBCT, because of the angulation of the slices as the beam rotates around the head, regions of the same density in the skull can have a different grayscale value (GV) in the reconstructed CBCT dataset.

Other factors affecting grayscale values with CBCT include limited field of view, higher amounts of scattered radiation, limitations with reconstruction algorithms, exposure parameter differences, and endo/exomass, which is defined as the amount of mass inside and outside the FOV. These variables can lead to a variability of GVs, particularly in axial slices as well as between slices. Therefore, essential differences between MDCT vs CBCT complicates the use of quantitative grey values for CBCT.

Given these issues, the article states that quantitative use of GVs in CBCT should be generally avoided at this time. Greater emphasis is being placed on a newer paradigm, which would focus more on a structural evaluation of the bone (i.e. trabecular pattern) rather than bone density. The paradigm shift is in part related to implant surfaces that have a higher degree of engineering to facilitate osseointegration, whereas older machined surfaces relied more heavily on bone density alone. New ways of analysing bone structure are being developed that focus more on 3-D trabecular bone architecture, bone surface and volume and spacing between trabeculae and marrow spaces.

Only in the past 15 years has Cone Beam Computed Tomography (CBCT) been used for the imaging and analysis of the TMJ. Prior to this, Multi Detector Computed Tomography (MDCT) was one of the main modalities for evaluation of the TMJ. Studies have shown, however, that CBCT is comparable in its accuracy to MDCT when comparing distances of joint spaces and cortical surface details. One of the main indications of CBCT with respect to TMJ diagnostics is to elucidate bony changes in patients with Osteoarthritis (OA). CBCT has been determined to be accurate in determining bony surface changes as well as erosive changes seen in Rheumatoid Arthritis (RA) at the condylar head. The articular surfaces can be accurately imaged to evaluate for osteophytes (angular bony projections) and a normal rounded appearance of the condylar surface with or without the presence of erosion. Other indications for CBCT for TMJ are intra-articular fractures and fibro-osseous ankylosis. One study showed that clinical decision making changed when based on CBCT after previously being based on physical and panoramic evaluation. CBCT is a cost-effective alternative to CT for the evaluation of TMJ although more sensitive to artefacts. Diagnostic evaluation of TMJ using CBCT is limited to osseous joint components and cortical bone integrity.
Digital possibilities in fabrication of implant prostheses

Author: Dr Joannis Katsoulis, Switzerland

Introduction

In contemporary dental medicine, computers and implants are closely linked. By dealing with this topic, the question arises whether one can speak about a(n) (r)evolution in planning and manufacturing of tooth- and implant-supported reconstructions in the field of implant prosthetics.

Dental prosthetics are concerned with the restoration of lost teeth and tooth-bearing tissues in the oral cavity. Loss of teeth and edentulism are quite frequent in old age and often the main reasons to visit a dentist. Hence, dental implants have become important means of therapy, whereby computer-assisted procedures play an increasing role in the daily routine of the dental practice. Thus, it is no contradiction to use modern computer technology and new materials equally for young and old people.

The continuous advancement of specialised fields in radiological imaging, manufacturing methods in the engineering industry and dental implantology have extended the possibilities of decision making, planning and surgical as well as prosthetic realisation of a therapeutic plan. Actually, this proceeding of dental medicine only has been made possible by bringing together these formerly independent disciplines, which basically depend on the increased performance of digital data processors.
Revolution or evolution?

Despite these developments, many colleagues do not consider a computer a helping advice in their daily routine. Any digitalisation of a certain practice area needs a modification and adaption of the whole team’s workflow, depending on the scope of digitalisation. This requires a large effort of all employees involved, the willingness to learn from earlier mistakes and to keep pace with the progressing digital technologies. One thing is certain: Innovations in dental medicine do occur more often and faster nowadays. Therefore, revolution or evolution does not depend on the given digital possibilities but rather on the individual experience and know-how.

In dental medicine, computer technology is no more a real technological revolution. Virtual implant-planning based on volume tomography has facilitated the decision making and information for a patient for quite some time now (Fig. 1). Computer-assisted implant placing occurs with high precision in partially or fully edentulous patients. Here, the so-called backward planning ensures a high level of predictability of the surgical and prosthetic result. The surgical realisation of the 3-D planning with stereolithographic splints is an important advancement in complex cases and can contribute to less invasive and rapid proceedings in selected cases. By this, one can precisely determine whether a completely “flapless” procedure is possible for single or all planned implants in the jaw and which augmentative technique is indicated. Especially for older patients with relatively more risks when implanting, a well-planned, minimally-invasive proceeding with a shortened operation time is of advantage.

Additionally, the digitalised anatomical and prosthetic conditions can be analysed virtually and with the help of clearly-formulated criteria contribute to the decision making in case of either fixed or removable implant-borne reconstructions. It has turned out that the proportion of bone in the upper jaw is clinically often overestimated. According to the characteristics of an atrophy of the alveolar ridge, the prosthetic-oriented planning will control the implant positioning and type of reconstruction of the operation virtually in advance.
special _digital technologies

CAD/CAM technologies in implant prosthetics

Closely connected to computer-assisted implant planning is the CAD/CAM technology (Computer-Aided Designing/Computer-Assisted Manufacturing), which has significantly changed the dental medicine in the course of the past twenty years. The more parallel dental implants can be planned and clinically placed, the easier and more stable the design (Fig. 2) of CAD/CAM frameworks/FDPs (Fixed Dental Prostheses) and bars made of titanium or zirconia can be kept. These materials are also characterised by improved technical and biological features. Consequently, technical and biological complications are to be expected less often.

Depending on the connection type of implant systems, also full-ceramic reconstructions can be screwed together directly on the implant’s level (Fig. 3).

The fitting accuracy of implant-borne CAD/CAM-titanium and -zirconia reconstructions are significantly higher than the conventionally produced bridges with cast alloys. By now, most of the major manufacturers offer their own CAD/CAM systems and have centralised production facilities for manufacture of frameworks and bridges at their disposal. Thus, a fitting accuracy below 50 µm (Figs. 4 & 5) seems routinely possible for full-arch reconstructions with the required care and know-how of the production process.

The CAD/CAM production is specific for metals like titanium and ceramics, as for example zirconia. For milling with CNC-machines, especially suited milling cutters are used. After the milling of zirconia in the overdimensioned green-/white-body, the final crystallisation (sintering and HIP) of the work piece is made. Despite of automated and mechanical processes, the CAM step requires the experience of specialised engineers who are able to oversee the processes and step in if problems occur.

The current development efforts and advancements take place in the area of software possibilities and the connection of individual digital subareas. Thereby, a universal data format (STL) enables the forwarding of data by intra- or extra-oral scanners via CAD- and CAM software. However, it probably might take some time until the various providers will open their systems completely and thus enable users to freely choose between the digital work steps.

Editorial note: A list of references is available from the publisher.
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**Today we are standing** on the verge of a digital revolution in dentistry. The digitalisation will offer a new infrastructure in the treatment of our patients.

This article will focus on the digital treatment planning that is possible in an ordinary general dental practice today. There will be some remarks about the needed hard- and software in order to get an overview of the possibilities and pitfalls before acquisition. We will look at the possibilities with tooth-borne surgical guides, since the topic regarding treatment of edentulous patients with surgical guides has been covered extensively in the past.

Before treating any patient, we need a treatment plan. In a simple composite case, a plan in the mind of the dentist might be enough. But when we move to more complex cases, the need for a thorough blueprint becomes essential.

The following sequence is based on the assumption that the patient has healthy joints, relaxed muscles with a balanced occlusion in centric relation (CR). If this is not the case we recommend you take care of these issues before any final prosthetic treatment.

1. Photos – extraoral and intraoral. DSD (Digital Smile Design)
2. Video (optional for emotional patient communication)
3. Models (digital or stone)
4. Facebow registration
5. CR bite registration
6. Protrusive bite registration or a digital movement analysis
7. Cone beam scan in implant cases
8. Wax-up.
It is most important to get the patient expectations in alignment with the dentist before starting detailed treatment planning. We need to know what the patient wants in order to deliver it to the patient. To be able to communicate effectively with the patient, we need to know ourselves and we need to know our clinical abilities and limitations before applying our work. In my opinion, the patient experience is essential in case presentation.

Clinical photos both extraorally and intraorally are the first step in the treatment planning process. We recommend that you start with the protocol from AACD (American Academy of Cosmetic Dentistry) or DSD (Digital Smile Design by Christian Coachman). These are well documented protocols and contain all the basic photos needed.

The photos will be used following the DSD protocol to visualise the end result to the patient and in communications with specialists and the dental lab (if needed). The DSD protocol enables a multidisciplinary treatment planning process without seeing the patient in the practice. Every step is done through a free cloud-based service. It is inexpensive, flexible and easy to do.

The data from the DSD is transferred to a model of the patient (Figs. 1a–d). This can be done on a stone model or a digital model. With the models aligned, it is possible to make an additive wax-up with the exact proportions of the DSD. With a stone model, we make a silicone stent that is carefully trimmed. We fill it with a bis-acrylic material and position it in the mouth of the patient. With a digital wax-up we need to make a composite shell that is either milled or printed on a 3-D printer. The shell can be glued into position with bis-acrylics or flowable composite.

With the try-in smile we take a series of photos. The photos will be used to verify with the patient that we are on the right track. If needed, the try-in smile can be adjusted until the wanted result is achieved. If we make any corrections, a new impression is taken for our final treatment plan.

Once the patient has accepted the treatment plan, we proceed with a functional wax-up. The functional wax-up will guide the treatment of the patient. It will enable us to visualise the final restorations. At this point we can decide exactly what will be: the ideal implant position; the ideal abutment; the ideal restorative material; the ideal shape of the restoration; the need for grafting (hard and soft tissue).

The easiest way to achieve the most precise functional setup is by using the Arcus Digma (KaVo; Fig. 2). It is the only system that enables you to make a very...
detailed motion analysis (10 microns) that replicates the jaw movements exactly by utilising computer technology.

Arcus digma has a bite-fork that makes it easy to position the upper jaw in the articulator. A fully adjustable articulator or a digital articulator is preferred. It is critical to get a perfect bite registration in CR. The functional wax-up can be generated semi-automatically in the CAD/CAM software by using the data gathered from the models and functional movements. Alternatively, we do it the old fashioned way by adding wax to the stone model. (Note that the precision of the wax-up will reflect the care taken to acquire the diagnostic information.)

With the wax-up approved by the dentist, the placement of the implant can be performed in the cone beam imaging software. We use the OnDemand software by Cybermed Inc. The software has a fair price. It can handle all DICOM based cone beam images. The In2Guide plugin (in OnDemand) enables you to do the implant planning with whatever guide system you prefer (i.e. Straumann, Nobel Biocare, Zimmer, etc.). Usually we use the universal drill kit developed for the In2Guide system. It gives the user the ability to place any implant on the marked with this single drill kit. The only brand specific tools needed is the implant driver and a prosthetic kit. Another advantage of the In2Guide software is that you don’t have to segment the cone beam image or export it into third party software. The planning is done in the same software as where you do your diagnosis. In my opinion, this makes it easier to implement in the practice.

One note about guide sleeves. The In2Guide software enables you to choose whatever guide sleeves you want to use. There is a huge difference between the distance from the coronal implant surface and the guide sleeve among the different guide systems.
Care should be taken not to place the guide sleeves in contact with any hard or soft tissue. It is a great feature to be able to choose the system that fits your preferences.

In order to make a tooth-retained guide, we make a cone beam image of the patient. (Note the required size of the field of view [FOV]. You need enough teeth and bone to make a guide.) A model of the soft tissue and high precision surface of the teeth is merged with the cone beam image in order to make a good fitting surgical guide. The model can be scanned by a lab-scanner or by the cone beam scanner. An option to make an intraoral scan is available, but currently only for treatment planning.

The intraoral model will be displayed as a green outline in the In2Guide software (Figs. 4a & b). Since we know the ideal distance from a bone level implant to the surface of the soft tissue is 3 mm, we place the chosen implant type (from the In2Guide library with almost all commercially available implants) and plan the positioning in the third dimension. Now we are able to measure the distance from the implant to the surface of the soft tissue. Hereby we can achieve an ideal emergence profile. We can measure the distance from the implant to the top of the guide sleeve to verify correct depth of the implant during surgery.

At the same time, we get to know if there is sufficient bone support for the implant or if we have to graft. The ability to plan any grafting procedure in advance of the operation gives a better predictability, patient compliance and effective scheduling of the surgery.

Looking at the intraoral photos and the planned 3-D implant position we make the decision to do open or closed surgery. If possible we will do a tissue punch because it is faster and less traumatic to the tissue and
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Our patients love the flapless insertion of implants. There is virtually no post-operative bleeding, swelling, sutures or pain compared to raising a flap. I admit that we often have to do some type of grafting but when I am able to do a flapless procedure, I will do it. (It is a fast procedure and a great internal marketing opportunity.)

At this point we make a decision whether we want a customised Atlantis titanium abutment, a customised titanium/zirconia abutment or a screw-retained crown. We always use customised abutments for cemented solutions to make sure the risk of cement residuals is minimal. The customised abutments are designed with a preparation margin of 0.5 mm, subgingivally facially and approximally. On the oral surface, the margin is placed 1 mm above the gingiva. This is impossible with stock abutments. Implant Direct has some implants that are delivered with a stock abutment. This abutment can be modified and scanned with an intraoral scanner and with CAD/CAM technology we can mill a customised zirconia abutment part that will be glued to the stock abutment. The gingiva will establish a strong hemidesmosome attachment to the zirconia and thereby create a better seal to the surrounding environment. Furthermore, it will allow us to produce every prosthetic part in-house and save time.

Screw-retained crowns are primarily used in the posterior and only in selected cases when we think we need easy retrievability. I admit there are many different philosophies about this subject. And I admit it is harder to remove excess cement in the posterior.

We use a semi-permanent composite cement or tempbond to cement all our restorations. We want all restorations to be retrievable in case of future complications.

At this point we know how the final result will look like. The abutment design and the position of the implant. We know whether or not we need grafting and
if it is going to be an open or closed procedure. We know the exact type and size of implant and what surgical kit we will be using. Now we just have to order the surgical guide. In our practice we let In2Guide design and produce our guides, since it is a laboratory at KaVo that does all the work under strict quality control. We are confident in the precision and quality of the product. It takes about 7–10 days from placing the order online until we receive the guide. We do not charge our patients extra for the surgical guides since the time we save during surgery more than covers the costs of the guide. And after the placement of the implant we always have an ideal position of the implant in regards to the final prosthetic outcome. Placing a crown in harmony with the functional occlusion has improved the aesthetic results and reduced our prosthetic failure rate, including the amount of peri-implantitis. It is my belief that a lot of so-called peri-implantitis we see today is related to occlusal problems rather than biofilm. But that is a totally different issue.

Before doing any surgery, we need to think about a provisional restoration. The function of the provisional is primarily to prevent tooth migrations and to shape the soft tissue. This can be a fixed or a removable solution; direct or indirect. Among the removable solutions, we have the partial denture, the Essix retainer, bite splints with teeth mounted as provisionals, etc. (Figs. 5a-c). Among the fixed solutions there is the Maryland bridge and the immediate loaded implant crown. The immediate crown is usually made directly but can be made in advance utilizing the In2Guide software and the CAD/CAM team at KaVo. It requires a scanned model of the opposing arch and a bite registration (the two models held together). Once again we can use a lab-scanner or the conebeam scanner to acquire these data. This way we receive a surgical guide and a screw-retained provisional implant crown to be placed immediately after surgery. It is tricky but doable and removes the problem with bis-acryls in the wound.

The whole treatment planning protocol can seem a little overwhelming. But in reality it is fast and saves a lot of chair time. The implant planning in In2Guide for a single implant takes approximately five minutes once you get accustomed to the software.

In our practice, we have been working with surgical guides since 2010. They were introduced because we saw too many implants placed in a less than ideal prosthetic position. It was a problem faced with more than six different experienced surgeons. There seemed to be a paradigm among a lot of surgeons saying ‘We place the implants where the bone is’. In such cases, we do not want to do the final prosthetic work because it will always be a compromise.

Every step in implant surgery has to be planned and executed exquisitely with the final prosthetic solution in mind. It is the only way to a predictable and good result for the patient.

Isn’t that what it is all about?

__about the author__

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_First Danish In2Guide user._
Angulated Screw Access concept shifts the functional and aesthetic boundaries of computer-aided implant dentistry

Authors: Uli Hauschild, Italy & Dr Sébastien Rousset, France

One of the latest developments from DENTSPLY Implants is the angulated screw access (ASA) concept for ATLANTIS ISUS Bridge and Hybrid. This feature opens up new functional and aesthetic options when fabricating screw-retained dental prostheses. It allows for the creation of a screw channel at an angle of up to 30° to the implant axis, thereby enabling a more functional and aesthetic screw-retained prosthesis.

The case presented here shows the individual steps involved, from implant positioning to the fabrication and delivery of a screw-retained bridge. Although the temporary prosthesis was screwed in conventionally, the final prosthetic restoration, delivered three months later, achieved much better aesthetics—exclusively due to the displacement of the screw-access channels.
Depending on the bone availability at the implant site, it is not always possible to place every implant in optimal positions for the prosthesis. Unfavourable implant axes make the fabrication of the prosthesis more difficult, which may significantly influence the functional and aesthetic outcome. The introduction of computer-guided implant placement has fundamentally changed this. This technology enables resources to be optimised through precise planning beforehand and simulation of treatment progress. The ATLANTIS ISUS angulated screw access fits this concept well. While the implant position remains the same, space can be optimised just by moving the screw channels, giving wide-reaching consequences for the final result.

Use of the ATLANTIS ISUS angulated screw access can allow a screw-retained prosthesis to be selected in numerous cases where otherwise the aesthetical and functional outcome would not be ideal.

When fabricating a titanium framework using CAD/CAM technology for a screw-retained prosthesis, the new ATLANTIS ISUS angulated screw access allows the screw access to be angled up to 30° to the implant axis. ATLANTIS ISUS uses a specific hexagonal screwdriver and screws that are identical to the originals except for the screw head interface. This way you can transmit the screw force to the screw axis even when it is applied at an angle. Figure 1a illustrates how an implant screw in an angled channel can remain accessible when use of a straight screw channel (Fig. 1b) would not be feasible.

**Case report**

The 41-year-old patient had been edentulous in the maxilla since the age of 26 and wanted a fixed restoration with immediate restoration. There was no contraindication for an implant-supported prosthetic restoration. Figures 2 and 3 show the initial clinical and radiographic situation.

The treatment plan followed the computer-guided implant treatment criteria for fixed screw-retained bridges. After bite registration (Fig. 4), an aesthetic try-in was made in the laboratory, and this was tried in the patient’s mouth. The dual scan prosthesis (Fig. 5) was made on this basis. Data from the subsequent CT scan was transferred to the SIMPLANT software (DENTSPLY Implants), which simulated the definitive prosthetic tooth positions (Fig. 6).
Figures 7 and 8 show the analysis of the radiographs, which were viewable in slices, thus allowing for very accurate analysis of the bone situation at the planned implant site. Although the patient had good bone volume overall (Fig. 9), the width of the alveolar ridge below the sinus was not always sufficient (Figs. 7 and 8). The aim was to place 8 implants as parallel as possible. The bridge that would later be screw-retained would occupy the original position of the natural teeth.

The dual scan prosthesis was superimposed (matched) with the data obtained from the CT scan in the SIMPLANT software to determine the most optimal implant position. The natural gingival margin was also taken into account (Fig. 10). Guided by the desired prosthetic result, the dentist also selected the implant positions with the aim of optimising the aesthetic result (Fig. 11).

The position of the ANKYLOS implants (DENTSPLY Implants) were planned using the SIMPLANT software.
and calculated so that the implant axes would be as straight as possible. Balance Base abutments (DENTSPLY Implants) were selected, and the SIMPLANT Guide (Fig. 12) was ordered.

The Immediate Smile digital enabled further processing of the planning (Fig. 13) and fabrication of a temporary bridge (Figs. 14–16). While the SIMPLANT Guide was being fabricated, the laboratory used the Immediate Smile digital to mill a 3-D model that simulates the positions of the gingiva and abutments (Fig. 15). The temporary prosthesis (Fig. 16) was fabricated on this model. To allow for immediate loading and ensure splinting of the implants, this temporary prosthesis consisted of a metal framework and was veneered with composite.

At the start of the procedure, the SIMPLANT Guide was positioned on the gingiva and secured with four fixation screws (Fig. 17). The eight ANKYLOS implants (all 3.5 mm in diameter and either 8 or 11 mm long) were placed according to the manufacturer’s recom-
After removing the guide, primary stability was checked and improved if necessary. The placement heads (Fig. 19) were removed, and the Balance Base abutments were selected according to the gingival thickness at each site (Fig. 20). Comparison of the previously produced simulation with the panoramic view following implant placement illustrates the precision of the procedure (Figs. 21 & 22).

The temporary prosthesis was made in a conventional manner and screwed in place (Fig. 23). The space did not allow for fabrication of a smaller tem-

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Fig. 27. Model with gingival mask.
Fig. 28. 3-D view of the master cast with gingival mask in ISUS viewer.

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Figs. 29a & b. Transfer of the aesthetic try-in to the digital view.
Fig. 30. Screw accesses displaced in occlusal/palatal direction.
porary bridge. The patient found the teeth to be too large and the dental arch to be positioned too far out (Fig. 24). After three months, the temporary bridge was removed and osseointegration was checked. Transfer posts for the open tray technique were screwed into the implants, and the impression was taken (Figs. 25 & 26). A master cast with gingival mask was then made and scanned (Figs. 27 & 28). To correct the dental arch...
and tooth shape, the definitive tooth set-up was checked in an aesthetic try-in to create an optimal basis for designing the final framework (Fig. 29).

To improve the aesthetics, the ATLANTIS ISUS angulated screw access was used when designing the definitive restoration. As described above, this feature allows access to the implant screw even when the screw access is angulated. In the present case, this meant optimisation of the space in the tooth set-up angle. Figure 30 shows the straight screw channel, which was previously in the incisal margin of the front tooth. The arch could be made smaller in the posterior region as the screw channels there could be displaced into the centre of the masticatory surfaces. As a result, the definitive restoration achieved better results in terms of aesthetics and function than that of the temporary restoration, although the implant positions remained the same. Figures 31 to 34 illustrate the computer-aided design with 3-D software at DENTSPLY Implants’ production facility.

The definitive titanium framework was modelled in the software and then milled (Figs. 35–39). The framework was then veneered with composite and completed (Fig. 40).
**Conclusion**

The ATLANTIS ISUS angulated screw access increases the aesthetic and functional options by enabling displacement of screw channels for screw-retained implant-supported bridges (Figs. 41 and 42). DENTSPLY Implants now offers access to the screws for prosthetic restoration that can be requested up to 30° of the implant axis. Figure 43 shows epicrestal placement of the eight ANKYLOS implants. By using ATLANTIS ISUS angulated screw access the possibilities for when a screw-retained implant bridge can be used increases. It fits the computer-guided implantology principle perfectly and is thereby further optimizing resources (Fig. 44).

*Editorial note: A complete list of references is available from the publisher.*
CBCT as a diagnostic and treatment planning tool and assessment of low dose programs for endodontic follow-up cases

Author_ Dr Sirpa Pöyry, Finland

**Introduction**

Endodontics is a field of dentistry that requires precision and accuracy at their highest levels. The same preconditions apply to the image quality needed for endodontic diagnosis. Cone Beam Computed Tomography (CBCT) has turned out to be an excellent point-of-care imaging solution for an endodontic practice as the quality and quantity of diagnostic information is far superior to any other imaging modality.

Even though the radiation dose of CBCT imaging is naturally higher in comparison to 2-D imaging, the dose level is still very reasonable and quickly offset by the yielded diagnostic data.

Radiation hygiene is, nevertheless, constantly a hot topic both at academic and practical discussions within dentistry. The rapid technological progress of CBCT technology has discovered new means of decreasing the patient dose while improving, or at least maintaining, the diagnostic information intact. Low-dose programmes might not instantly appear to be compatible with the resolution requirements of endodontic images, but new innovations open up the avenue for decreased dose also for endodontic patients.

This case study describes how CBCT provides key information of relevance in endodontic diagnoses and treatment planning, and how lower resolution and thus lower radiation dose may be totally applicable also for follow-up imaging of certain type of endodontic cases. It is just a question of justification and optimisation of the patient dose versus needed image quality—about choosing the right resolution for the job.

**Case report**

A 46-year-old male patient came to the clinic for a check-up. A native panoramic image (CRANEX D, dose area product DAP 70 mGy/cm²) revealed a symptomless apical periodontitis in a root canal treated d17. Root canal treatment had been performed 4 years earlier (Fig. 1).

As there was no healing to be detected, it was necessary to make a further treatment plan. The patient had been previously surgically operated on for cancer, and at the time of the diagnosis there was no information of follow-up care for the disease.

In order to acquire more information, to confirm the diagnosis and to find out the root morphology of the d17, a CBCT scan (CRANEX 3D, FOV 6x4 with high resolution, exposure values 90 kV, 8,0 mA, 6,10 s, DAP 380,7 mGy/cm²) was taken as a further radiological examination (Fig. 2).

Retreatment would have been one option of treatment, but because of the cyst-like finding in the apical area pushing the maxillary sinus bottom up, root resection was chosen. CBCT images proved the root morphology to be favorable for it, and as a result, an apicoectomy was performed one month later. Both the buccal and palatal roots were filled with Biodentin retrograde fillings.
The follow-up control took place 21 months post-operatively. At the clinical examination, the tooth appeared to be symptomless and the intraoral status was stated to be normal. For radiological examination, a low dose CBCT scan was taken (CRANEX 3Dx, FOV 5x5, 90 kV, 4 mA, 1.17 s, DAP 40.5 mGy/cm²) and it showed good healing in the apical area (Fig. 3).

Conclusion and discussion

In this case, CBCT imaging technique was of great assistance to the dental team while making the treatment plan and following up with the patient. The radiological findings confirmed the suspected pathoses and gave a firm basis for accurate diagnosis and treatment planning.

CBCT has turned out to be an ideal diagnostic tool in endodontics, which is a sensitive playfield of tiny details, where each move has to be carefully considered and justified. CBCT literally provides endodontists with another dimension, and therefore greatly contributes to the efficiency of the clinical work. The benefits of CBCT may be summarised as follows:

- Gives diagnostic confidence.
- Acts as a navigator during the treatment process.
- Makes clinical work safer.

Concerning low-dose imaging programmes, low resolution has generally not been an option for endodontic imaging due to the accuracy and precision of required image quality. The current advanced reconstruction algorithms, however, enable good enough image quality even with a low radiation dose, which makes the low dose programmes a reasonable alternative to be considered when endodontic follow-up cases are concerned.

In this case, the low-dose CBCT image was shown to be good enough for following up the healing process. The effective radiation dose was 4µSv, whereas the dose with the same FOV (5x5) and standard resolution would have been five times higher, 20 µSv, equaling thus the radiation dose of a native panoramic image. However, dose sensitivity did not come at the expense of the image quality, but the needed diagnostic data for the follow-up evaluation was well provided by the low dose option.
NobelClinician is the key to successful treatment outcomes

Precise implant planning + effective visual communication = satisfied patients

Author_ Dr Peter Wöhrle, USA

_Treatment planning has always been an integral step in dental implant treatment. The old adage, “Failing to plan is planning to fail” is especially true in implant dentistry where there are so many factors to consider. While the extent of planning is left to the discretion of the clinician, modern technology has made it easier and safer than ever to give patients the highest-quality care. Examining a patient’s clinical situation and planning the locations where implants will need to be placed is only one aspect of the preliminary work we do in implant dentistry. The individual patient’s needs, wishes and expectations are important considerations as well, and add to the complexity of a case.

Gaining an understanding of the full picture of any given case is essential for helping the patient better understand the extent of the treatment, as well as ensuring a successful treatment outcome.
Planning in three dimensions

Various methods exist for better visualising the unseen factors hidden behind tissue and in the bone. Panorex model-based planning is one option. Tracing relevant anatomical pictures with a pen on a transparent paper is another. One could also select the appropriate length of the intended implant system through transparent "radiographic guides" (transparent slides containing the outlines of the implant system).

However, my preferred method is using 3-D X-ray datasets in combination with dedicated planning software.

For select cases, I began using the planning and guided surgery options that became available with the original launch of the NobelGuide treatment concept in 2005.

Already satisfied with the treatment predictability I had grown to expect with NobelGuide, the 2011 launch of the diagnostics and treatment planning NobelClinician Software took me a step further.

Now I can follow a complete and effective workflow that can turn my treatment plan into reality as it anticipates and defines the future prosthetic restoration.

As a Mac (Apple Inc.) user, I was very pleased to find that this stand-alone software was available for OS X as well as a Windows version.

In addition to the enhanced diagnostics and planning features, the new treatment team collaboration options have proved very helpful for ensuring successful patient outcomes.

Through NobelConnect, I am now able to safely upload and access my stored plans online using any of my Mac computers (Apple Inc.)—whether I’m using my big office desktop or a laptop while travelling.

Now my primary source

The latest update to NobelClinician provides even more precise implant planning options, and is a very effective visual communication tool when I want to discuss treatment choices with patients. The new volume rendering feature gives me the capability to generate very realistic 3-D models of the patient’s anatomy, without the need of a sometimes time-consuming CT conversion step.

Instead, the volume rendering feature gives me a fast overview of the patient’s anatomy, including pre-existing metal objects—such as previously placed implants or screws and osteosynthesis plates from trauma interventions. Volume rendering helps me to use NobelClinician as my primary source for X-ray based patient diagnostics.

Fig. 2. Planning: Visualize the patient’s anatomy and prosthetic needs in order to ensure optimal implant selection and positioning. Easily accessible, intuitive tools make this process a rewarding and secure exercise.

Fig. 3. Clinically relevant reports: Plan with NobelClinician Software, and you can generate structured reports immediately for documentation and to use during surgery. With integrated NobelConnect functionality, you can share your treatment plans with your partners.

Fig. 4. Communication: Present and communicate the treatment plan to your patients with NobelClinician Communicator, the new iPad application available in the App Store.
There's an application for that

I am also very impressed with the quality of the automatic report. It includes relevant information for my entire treatment team.

Additionally, the new version allows me to import and review clinical pictures and other digital images, periapical X-rays, for instance, or panorex data, if relevant to the case.

One exciting new feature that is a part of the latest update is not actually so much a software upgrade as an application. Available via the Apple App Store, the new Nobel Clinician Communicator iPad (Apple Inc.) application gives me a convenient option to comfortably present the treatment plan to my patient in virtually any setting.

It makes it easy for me to flip through important clinical pictures, X-rays or other images to help my patient better understand the treatment plan. Additionally, I can securely store the presentation on the Nobel Connect online space, ensuring no information will be lost.

Keeping prosthetic options at your fingertips is a key aspect of the Nobel Guide treatment concept. It is fascinating that I can now plan my implants very predictably and prepare the provisional restoration—even before surgery—for finalisation in the patient's mouth once guided surgery has been completed.

The stents are impressively accurate because I use the calibration object to calibrate the workflow, beginning with my own CBCT. This results in surgical templates that fit very accurately.

I am very excited about the new developments in this area, especially focusing on partially dentate patients.

Nobel Clinician provides me and my staff not only with the big picture, but with the full picture. For us this means better planning, more effective communication and collaboration tools that we can trust. We can even order the products needed for the specific surgery directly online! In fact, all Nobel Biocare components are available through the software, regardless if guided surgery is being implemented or not.

I depend on Nobel Clinician to treat my patients better than ever before.

Dr Peter Wöhrle received his DMD degree cum laude and master of medical sciences in oral biology from the Harvard School of Dental Medicine. Additionally, he has completed advanced education programs in both prosthodontics and implant dentistry at Harvard, as well as a four-year certified dental technician program in Switzerland. While at Harvard, he worked with his mentor, Dr Paul Schnitman, on the groundbreaking concept of immediate loading with Brånemark System implants. Dr Wöhrle is a member of the Academy of Osseointegration, the European Academy of Osseointegration, the American Academy of Esthetic Dentistry, and the American College of Prosthodontists. He is renowned as the only dentist with formal training in the interrelated fields of implant surgery, prosthodontics, and laboratory technology.

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Owning a dental practice or group has always presented challenges, but the marketplace has never been more crowded than it is now. With an ever-increasing level of choice for patients, it is more important than ever for dental businesses to stand out from the crowd. While we of course all know the value of providing a first-rate customer service, and that will always remain the most important factor, how many of us recognise the importance of creating and building a brand?

Generally, in dentistry, branding has not been regarded in the same way it is in the corporate world, where multi-national businesses expand on the strength of their brands. But now, with the growth of dental corporates and multi-practice groups, branding is becoming an increasingly important factor. That is not to say that branding is only the domain of the big players. Creating a brand which is unique and people can identify, talk about, recommend to others and remember is just as important for a single practice, and in some situations even more so, where there are other local competitors for existing and potential clients to choose from.

“...it is more important than ever for dental businesses to stand out from the crowd.”

Effective branding is also important when looking to expand, franchise or sell one’s business. When dentists are adding another site to their existing portfolio, doing so under a brand will enable people to know who is moving into their area, and can help give confidence that this is an established dental business taking over their local site. One example being a business in North East England I act for, the Burgess & Hyder Dental Group, who now operate eleven clinics across the region under their brand.
They are welcomed into each area as their brand is widely known, as is the quality associated with it.

Equally in franchising, the importance of a strong brand is crucial to enable a business to thrive in other areas relies on an existing strength of reputation. Through being part of that recognisable brand, patients will know that each site under that umbrella will offer the same levels of service and quality. Another of my clients, Damira Dental, has recently rebranded from Aspire Dental Care, and is pursuing a franchising model under its new and fresh identity. The business, which has 14 sites across the South of England, has amassed a strong reputation during its eight years in operation, and the strength of its service coupled with its branding will allow that to be replicated across the UK.

The creation of a brand identity, which can help support the expansion of a business, can also be of great importance when it comes to selling. It is much easier to market a business which is well known and has invested time and effort in standing out from the crowd. To a potential buyer, they are important factors in instilling the confidence to take on a site in a new territory.

In this day and age of dentistry being an increasingly competitive business, distinguishing oneself from the many other players has never been more important, and is something that must be given due consideration.

**About the Author**

Amanda Maskery is one of the UK’s leading dental lawyers. She is Chair of the Association of Specialist Providers to Dentists (ASPD) in the UK and a Partner at Sintons law firm in Newcastle. She can be contacted at amanda.maskery@sintons.co.uk.
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According to the announcement made by 3D Medical Limited (3DM) in the middle of May 2015, the Company is pleased to confirm that, in an Australian first, and working with a leading oral and maxillofacial surgeon, it has successfully developed a 3-D printable and customised titanium jaw joint for use in corrective jaw surgery.

A 32-year-old male patient underwent a groundbreaking five hour operation at the Epworth Freemasons Hospital in East Melbourne to correct a rare jaw deformity. The jaw deformity had left the patient with a skewed lower face and limited jaw opening, resulting from a missing left temporomandibular jaw joint and consequent lack of growth in the left side of the face. The patient's severe deformity was an ideal case for 3-D printing application, enabling the corrective implant to be perfectly fitted to the complex geometry of the mandible. Working closely with leading oral and maxillofacial surgeon, Dr George Dimitroulis, and leveraging global expertise from Australia and abroad, 3DM developed a customised titanium jaw joint that was successfully implanted into the patient (Fig. 1).

The commercialisation process not only included the design and development of the implant but also extended to 3DM gaining necessary approvals with hospitals, clinicians, healthcare suppliers and the health insurer who paid for the cost of the procedure. Dr Nigel Finch, Chairman of 3DM said: 'The successful outcome of this procedure not only achieves a fantastic result for the patient but it also serves to validate the end-to-end business model of 3DM in designing and developing custom implants: Following the surgery, Dr George Dimitroulis commented: 'We are at the cross-roads of an exciting era of customised medical devices that will become an integral part of healthcare in the 21st century.' Dr Finch also said: '3DM expects to see an increase in cases of this type as leading clinicians and hospitals seek to leverage the data-rich medical images used in patient diagnoses by harnessing computer-aided design and precise 3-D printing to more efficiently solve complex clinical problems.'

Fig. 1 X-ray of the patient’s jaw.

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_3D Medical Limited_ is an Australian company based in Melbourne. At 3D Medical, our aim is to aid medical professionals in the facilitation of improved clinical care, improving medical procedures, diagnostics and ultimately improving patient outcomes. 3D Medical is a medical specific 3-D printing and holographic projection and data integrations provider. Our services 3D Medical Printing; EchoPixel (holographic projection technology); GestSure (in surgery image control); Mach 7 (enterprise imaging solution provides healthcare organisations with the ability to archive, consolidate, access, and share medical imaging data across departments, locations and regions); and MediDATA provide medical practices the opportunity to leverage their analytical capabilities to gain an improved understanding of the characteristics of the patients which drive their business. These new and innovative products leverage data already captured by conventional imaging modalities and apply it in more meaningful ways to deliver improved economic and patient outcomes.
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ICOI and German affiliates will celebrate World Congress in Berlin, Germany

Author_ Craig Johnson, ICOI, Executive Director

The International Congress of Oral Implantologists (ICOI), its component society, the Deutsche Gesellschaft für Orale Implantologie (DGOI), and German affiliate, Bundesverband der Implantologisch Tätigen Zahnärzte in Europa e.V (BDIZ EDI), will join hands as they present ICOI’s World Congress XXXII in the capital of Germany, Berlin.

This year’s World Congress will be held from 15 to 17 October. The venue for the meeting will be the Maritime Hotel Berlin. The theme for this congress will be “Evidence-Based Innovations in Oral Implantology.”

True to the title of World Congress, the faculty will bring together clinicians and academicians from around the world as they present the latest in dental implantology on topics such as soft-tissue applications around implants, growth factors in surgical healing, treatment of periimplantitis, digital communication skills for minimally invasive surgery and much more.

On Thursday morning, (October 15), the congress will begin with a four-hour “Young Implantologists” program. Delegates to this congress will want to take advantage of what is new on the horizon as presented by “up and coming” implantologists Roberta Gasparro (Italy), Teruaki Homma (Japan), Elisa Choukroun (France), Filipa Braga (Portugal), Paolo Nuzzolo (Italy), Daniel Grubeau (Germany), Giuseppe Pantaleo (Italy), Nicolaos Mallios (Greece), Tom Giblin (Australia), Gil Asafana (Israel) and Thilo Damaskos (Germany).

The afternoon will be filled by several no-charge pre-congress courses given by our sponsors. Follow-
The proceedings of the 2015 World Congress of ICOI will feature an opening reception on Thursday evening. This event will provide attendees with a welcoming environment to network and socialize with colleagues from around the world.

Then Friday and Saturday, (October 16 and 17), will feature ICOI’s main podium speakers: Drs. Ata Anil (Turkey), Joseph Choukroun (France), Mariusz Duda (Poland), Galip Gurel (Turkey), Fouad Khoury (Germany), Richard Leesungbok (South Korea), Pascal Marquardt (Germany), Jaafar Mouhyi (Morocco), Ady Palti (Germany), Yvan Poitras (Canada), Eric Rompen (Belgium), Ilia Roussou (Greece), Gerard Scortecci (France), Ralf Smeets (Germany), Paolo Trisi (Italy) and Konstantinos Valavanis (Greece).

A social highlight for the congress will be the Gala Dinner to be held on Friday evening at the beautiful Restaurant Maritim. The gala will immediately follow the presentation of ICOI’s awards ceremony and promises to be a night to remember. The food and drink will be complemented by a rousing band brought in from Baden-Baden who will entertain the guests as they dance into the night.

Berlin is not only the capital of Germany, but also its cultural center, famous now for its museums, its philharmonic orchestra, multiple opera companies, modern architecture and captivating nightlife. Visitors to the new Berlin can also see reminders of the city’s 20th century history, including the Holocaust memorial, the Berlin Wall memorial and the Brandenburg Gate, a symbol of Berlin’s unification. Plan to visit Germany with ICOI at this perfect time of year: autumn in Berlin.

For more information and to register for this World Congress, please visit the ICOI website: www.icoi.org.
International Events

2015

**EAO**
24–26 September 2015
Stockholm, Sweden
www.eao-congress.com

**SCAD 2015 Annual Conference**
24–26 September 2015
Chicago, USA
www.scadent.org

**ICOI World Congress**
15–17 October 2015
Berlin, Germany
www.icoi.org

**AAID Annual Educational Conference**
21–24 October 2015
Las Vegas, USA
www.aaid.com

**DENTECH CHINA**
21–24 October 2015
Shanghai, China
www.dentech.com.cn

**12th International CAD/CAM Expo & Symposium**
20–22 November 2015
Los Angeles, USA
www.dloac.org/symposium

**ADF**
24–28 November 2015
Paris, France
www.adf.asso.fr

**Greater New York Dental Meeting**
27 November–2 December 2015
New York, USA
www.gnydm.com

**CAD/CAM International Conference 2015**
4–5 December 2015
Suntec, Singapore
www.capp-asia.com

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**151st MIDWINTER MEETING**
25–27 February 2016
Chicago, USA
www.cds.org

**IMAGINA Dental**
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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.

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Questions?

Magda Wojtkiewicz (Managing Editor)
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