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Volumetric CBCT in neuromuscular dentistry
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To scan or not to scan, is that the question?

In 1996, I was honoured to have been invited to present at the first joint meeting of the European Association for Osseointegration and the Academy of Osseointegration held in Amsterdam in the Netherlands. At this meeting, I presented on the use of CT for the diagnosis and treatment planning of dental implants. A novel concept at the time was to create a radiopaque scanning or scannographic template to identify the tooth position in relation to the underlying bone. This template was fabricated prior to the scan and was worn by the patient during the scan acquisition. In the mid-1990s, we did not have virtual teeth and could not create a virtual occlusion, or import an optical scan of a stone cast, and therefore the information received was invaluable and provided the necessary information to plan for restoratively driven implant reconstruction. The industry was just then integrating the necessary software tools to choose implant sizes (diameters and widths) as positioned within the available bone of the receptor site, and then to simulate the abutment projections that would link the proposed implant to the radiopaque tooth incorporated in the scannographic template. Therefore, 18 years ago, it was suggested that to achieve the most from the scan, advanced planning and extra steps were needed to fabricate a scan template prior to the actual scan. At that time, we had to send our patients to a radiology centre or a hospital for the CT scan, at a high cost per scan. This created several barriers to the use of the technology.

With the introduction of CBCT devices during the past decade, most barriers to acquiring the scan have been diminished. In the normal course of diagnosis and treatment planning, we now have a much lower radiation dose to work with. With many devices, we have the ability to collimate the image (field of view) to further reduce exposure to the patient, and we can even obtain a full diagnostic image with a scan time of less than five seconds with the newest devices!

However, with these advances, several questions come to mind. Are we getting the most from the scans that are acquired each day? Are clinicians spending the extra time with pre-surgical planning steps to fabricate scanning templates and diagnostic wax-ups, or using fiducial markers when appropriate? Have these protocols been incorporated into everyday practice now that CBCT devices are so predominant, and who is providing these extra services? Are we using the software tools to their full potential to diagnose and treatment plan with the highest degree of accuracy? Our new digital workflow may need to start sooner than we think, indicating a paradigm shift that may include intra-oral optical scanning, desktop scanners, associated software applications, and collaboration with dental laboratory technicians who are quickly adapting to this technology.

It is my personal hope that clinicians will read about the latest state-of-the-art uses of the technology for a variety of different treatment modalities within the pages of our new cone beam International Magazine. It is through further education that the questions above will be answered, as we all learn from our combined experiences to obtain the most diagnostic information from each CBCT scan. Our patients are counting on it!

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Editor-in-Chief
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Current perspectives on oral surgery

How to improve consistency and implementation of contemporary treatment recommendations and options in general dental practice

Author: Dr Ziad Noujem, Lebanon

The term “surgery” is derived from the Greek words “chir” (hand) and “ergos” (work). According to this etymology, surgery should include any clinical work implemented with our hands. In daily clinical practice, however, the use of this word is often limited to practical therapeutic acts, such as those involving cutting soft tissue (incisions), flap raising, osteotomies and reconstruction, as well as repairing and dressing living tissue.

The term “oral” pertains to the mouth (or oral cavity), and oral surgery would consequently encompass maxillary sinus membrane lifts, onlay and inlay bone grafts, the placement of dental osseointegrated implants, exodontia (including surgical extraction of impacted teeth and tooth-like structures), as well as the incision and drainage of cellulitis, just to name a few. Despite these different fields of use, the limits of oral surgery are not yet well defined and may reach maxillofacial surgery, a term that implies a greater scope of surgical interest, such as temporomandibular joint surgery, orthognathic surgery, the treatment of head and neck trauma, as well as cancer surgery.

General dental practitioners are only required to undertake surgical treatment of teeth, tooth-like structures, and soft tissue surrounding teeth. In this regard, the UK General Dental Council defines “surgical dentistry” as “those surgical procedures within the mouth which would normally be accomplished for a cooperative patient under local anaesthesia, with or without sedation, in a tolerably short operating time.”

In the past 30 years, oral surgery has progressed significantly in the diagnosis and treatment of dental and jaw pathology. Dentistry, particularly surgical dentistry, is rapidly changing and evolving, and dentists worldwide are attempting to adapt to the revolutionary changes and new opportunities resulting from globalisation of dental and medical surgical specialties. New insights and discoveries related to oral surgery are indeed astonishing and many of them have already been applied in everyday practice, and addressed in textbooks and at international conventions.

The near future will probably witness Er:YAG laser bone ablation replacing surgical drill osteotomy in oral surgical practice. Indeed, scanning electron microscope observations have determined that Er:YAG laser treatment produces well-defined edges. Melting and carbonisation associated with carbon dioxide lasers could not be observed on sites irradiated with Er:YAG lasers. In addition, FTIR spectroscopy revealed that the chemical composition of bony surfaces after ablation with an Er:YAG laser was almost the same as that after conventional drilling with a bur, proving that the use of Er:YAG laser ablation can be an alternative to traditional bur ablation in oral and periodontal osseous surgeries, particularly in mandibular ramus onlay block harvesting, apicectomy, cysts and benign jaw tumour surgery, or the irradiation of bisphosphonate-associated jaw osteonecrosis.

Dental pulp stem cells (DPSCs) can nowadays be cryopreserved and stored for years, while still retaining their multipotency and bone-producing capacity. These highly specialised cells show very low morbidity and are easy to collect from extracted wisdom teeth or buds, for example. They also interact with bone biomaterials and substitutes, which makes them an ideal cell population for jaw reconstruction. In addition, stromal bone-producing DPSCs, a multipotent stem cell subpopulation of DPSCs, are capable of differentiating into osteoblasts, and they are claimed to possess immune
privilege and exert anti-inflammatory abilities like many other mesenchymal stem cells.

Introduced in the late 1990s, CBCT is becoming the main imaging armamentarium of oral surgeries, as it provides more and comprehensive anatomical information and data that help to improve pre-operative and peroperative clinical implementation of the extraction of impacted teeth, cystectomies, removal of benign jaw tumours, and placement of dental implants.

While oral surgery continues to develop further with new technologies and visions, the assessment and diagnosis of patients will still form the cornerstone of any surgical specialty. Decision-making, a complex cognitive process that involves consideration of surgical patients’ complaints and preferences, the availability of evidence-based data, as well as practitioners’ case-specific clinical judgement, consequently remains an ongoing challenge for oral surgeons and dental general practitioners alike.

Inter-clinician variability and disparity in decision-making are very well known in dentistry and medicine. In oral surgery, treatment recommendations, options and decisions can vary widely among practising dentists. In many cases, they are based more on personal values and expertise than on objective, rigorous or evidence-based analysis of treatment alternatives, risks, prognosis and benefits. There are treatment guidelines for the management of impacted teeth but none for aggressive and relapsing jaw cysts and odontogenic tumours, for which documented long-term treatment success has not yet been achieved. Owing to this lack, the treatment planning process in oral surgery remains a dilemma and warrants further interest and research.

As a matter of fact, regional differences in training, education, and dental school treatment philosophy, the "schools effect", may significantly influence decision-making processes. It seems likely that specialists are much more confident in their ability to manage surgical cases successfully. A better understanding of interclinician variability in collaborative decision-making will definitely help the oral health community in improving consistency and implementation of oral surgical treatment recommendations and options.

One of the most promising approaches is probably the non-surgical medical treatment of tumours and lesions of the jaws, as reported by Marx and Stern in 2003. They found a 65 per cent rate of complete resolution of central giant cell granulomas (CGCGs) in the jaws through intra-lesional corticosteroid injections. Dexamethasone and triamcinolone are currently the most popular intra-lesional steroids, and weekly injections with these are common practice not only for CGCGs, but also for solitary jawbone lesions of Langerhans cell histiocytosis, a proliferative disease of the macrophage/dendritic cell lineage.

CGCGs, considered troublesome pathologies, are also currently medically managed by calcitonin, a polypeptide hormone produced in humans primarily by parafollicular cells of the thyroid gland, C cells. Calcitonin is known to counteract parathyroid hormone, inhibit osteoclast activity and increase calcium influx in bones. In this regard, salmon calcitonin, which is used in postmenopausal osteoporosis, hypercalcaemia, Paget’s disease and bone metastases, is considered to be more active than human calcitonin and to be an important tool in the medical treatment of jaw tumours and lesions. The main question is whether intranasal salmon calcitonin is as effective as subcutaneous human calcitonin in the medical treatment of CGCGs of the jaws.

Finally yet importantly, many clinicians and clinical investigators believe in the radical treatment of ameloblastomas, odontogenic tumours well known for their aggressiveness and high recurrence after conservative treatment. For these reasons, en bloc resection is often implemented, which includes a resection of at least 1–2 cm of normal sound jawbone beyond the tumour’s margins. Such a radical surgical procedure is unacceptable in children with growing jaws though because segmental resection often leads to jaw deformity and dysfunction, which in turn may hamper physical growth and the mental wellbeing of the child/adolescent.

At the very least, conservative treatment of an ameloblastoma, if indicated, will gain time until growth of the jaw is finally complete. Considering that the majority of ameloblastomas in children are unicystic and have a very low rate of recurrence, they can be managed by enucleation, a conservative form of surgical treatment.

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

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CBCT-predicted marginal mandibular resection in patient with oral squamous cell carcinoma

Authors: Dr Drago B. Jelovac & Prof. Vitomir S. Konstantinović, Serbia

One of the most important aspects of preoperative staging in head and neck surgery is the preoperative determination of local bone invasion by the malignancy because prediction of the extent of the surgical procedure is very important for the surgical outcome. It is especially important if a tumour extends into bone structures, that is, the mandible, because it often requires a mandibulectomy. In addition, for such cases, the supero-inferior extent of bone invasion is important for the surgeon to plan for either marginal or segmental mandibulectomy.

According to current literature, the standard protocol for staging oral cavity malignancies includes multi-slice computed tomography (MSCT) and MRI of the head and neck, CT, conventional 2-plane X-ray of the chest and abdominal ultrasound. The results gathered from MSCT, MRI and CT are usually reviewed to determine whether local bone invasion has occurred. In 1998, cone beam computed tomography (CBCT) technology was clinically introduced, allowing 3-D diagnosis of the hard tissue of the face and jaws, third molars and salivary calculi, as well as other indications.

There is also evidence that CBCT is a potential tool in the assessment of facial skull bone invasion caused by oral cavity malignancies. Based on the newest data in the literature concerning the comparison of sensitivity and specificity, it can be concluded that
CBCT is superior to CT and MRI in the assessment of bone invasion by tumours in the maxillofacial region. Further advantages of CBCT imaging include lower radiation doses than MSCT and its ability concerning the anatomic assessment of the stomatognathic system.

Case report

This case report concerns a 55-year-old male patient suffering from oral squamous cell carcinoma (Fig. 1). The CT scan did not show any clear bone invasion in this case (Fig. 2). In order to obtain information that was more precise and to determine appropriate surgical planning related to the extent of bone invasion, a CBCT scan of the mandible was performed (SCANORA 3Dx, SOREDEX, Tuusula, Finland). In the axial view (Fig. 3), it may be seen that the tumour had invaded the lingual mandibular cortex in the symphyseal region, extending up to the buccal cortex.

OnDemand3D image editing software (Cybermed) offers a tool for the quantification of measurements by using the ROI and Profile function. ROI analysis of the bilateral segments of the mandible showed a lower average grey scale value in the suspected osteolytic zone (Figs. 4 & 5).

After a detailed examination of the suspected mandibular bone invasion, a precise surgical plan could be compiled. Resection lines were determined according to the profile and ROI tool results (Fig. 6). In this case, a marginal mandibular resection was the treatment of choice, performed "en bloc" with a specimen taken by radical neck dissection (Figs. 7 & 8).

Conclusion

According to the adequate CBCT-based preoperative surgical planning, the tumour could be resected in toto, showing free margins in the non-resected area of the mandible.

Owing to its variability in imaging and resolution, CBCT could be of great importance in oncological surgery and diagnosis.

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

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Optimized implant planning: DICOM-STL matching

Author_Drs Frank Schaefer, Dagmar Schaefer & Mike Zäuner, Germany

_Introduction_

On the basis of three-dimensional X-ray images, in the 1990s the first software programmes allowed a navigated insertion of dental implants. But the digitisation of dental processes started even earlier, namely in the mid-1980’s. Imaging techniques allowed the production of components based on virtual construction. Today, this principle is well established both in the dental-clinical field and especially in the dental laboratory. Meanwhile, 3-D data sets of objects are created not only by normal camera shots, but there are also special 3-D scanners in use. In particular, today’s desktop scanners are so precise in their resolution accuracy that they are able to exactly reflect the real model or oral situation. Simultaneously with the capturing process, different methods have been developed to transfer the acquired 3-D data sets back to reality. While initially this was a milling and prototyping process, currently the sintering and printing processes are favoured. For a long time, navigated implantology and 3-D scanning has been developed in parallel, where at best surgical templates were fabricated by prototyping on basis of X-ray data sets.

Goal: optimal implant position

In recent years, the matching of 3-D X-ray data sets (DICOM) and 3-D model data sets (STL) has begun. The goal was and still is to find the optimal surgical and prosthetic implant positions for navigated insertion to provide an optimal solution for the patient. In addition, the production of temporary dentures and in individual cases an immediate treatment is so much better and much more reliable and predictable. At the same time, an objective quality control of both the planning and the result is practicable through matching of DICOM and STL data sets. By means of some case studies, we show which diagnostic and technical possibilities have been feasible since the establishment of the diagnostics and navigation system CTV in 2005 in the following article.

_Implant planning with CTV_

X-rays are subject to the laws of physics. Therefore, all the resulting images are generally afflicted with an error regarding distortion, defraction and interference. Because these errors have their origin in the radiological density changes of the object, some areas cannot be represented or are misrepresented. Particularly critical are movement-induced distortions in CBCT images. They cannot be completely avoided or even predicted. A further increase in accuracy solely from radiological data does not seem to be possible currently. The solution is to collect additional data by using independent methods to achieve a “rectification” and detail enhancement through combination with the radiological data. For example, the line of the gingiva and other surface structures in the 3-D X-ray image cannot be traced precisely. The solution here is the correct matching

![](image1)

Fig. 1. Planned implant with full-guided drill sleeve; gingiva line set by the clinician according to X-ray image (pink); by matching obtained with the situation model – real – gingiva line (yellow).

Fig. 2a. Virtual matching in 3-D X-ray: planned implants with a situation model (red). Image cut: orthogonal ridge section with gingiva line (yellow) from the situation model.

Fig. 2b. Virtual matching in 3-D X-ray, implants planned with aesthetics wax up (green); image: orthogonal ridge section with tooth line (yellow) of aesthetic wax-up.

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of DICOM data sets with the digital capture of the associated surface structures, e.g. anatomical model. With the situation model the real surface profile is obtained. If an aesthetic modelling (wax-up) is scanned and matched additionally, the planned position of the implants both in axial direction as well as in mesial/distal orientation can be determined optimally (Figs. 1, 2a & b).

3-D data matching

The comparison of the real positions of the inserted implants in the jaw with the virtual planning is done by matching the 3-D X-ray planning capturing with the post-op 3-D picture. Here it is irrelevant whether the planning and the post-op 3-D capturing come from the same device type (DVT/CT) or not. This method also allows for a standardised follow-up (Fig. 3).

DICOM and STL data matching

For the manufacturing of surgical templates, for models to produce temporary restorations in navigated implantations and planning of definite dentures (backward-planning) matching data sets from

Fig. 3. Post-surgical matching; inserted implant (left), transition with virtual implant (middle), with virtual implant with abutment (right); from gingiva line situation model (yellow).

Fig. 4a. STL mesh of situation model with inserted drilling sleeves; drilling sleeves separately (top left).

Fig. 4b. STL mesh of situation model with laboratory implant analogs; laboratory implant analogs separately (top left).

Fig. 5. Model replica of SLT-data set with: a) surgical drilling sleeves on fabricated guides, b) designed laboratory implant analogs, c) implemented real abutments.

Fig. 6. Calculated OPG from CBCT data and planned implant positions; arrows: planning under still existing dentures.

Fig. 7. Situation 4th quadrant of Figure 6 including planned implant positions and abutments (parallelised). Mesh of the situation model (red) and wax-up (green).
DICOM and STL data are used. Virtual models can be designed with exactly positioned sleeves for full-guided systems and or with laboratory analogues of the planned implants. This range can be extended, provided that the STL data sets of components to be designed are available, such as implant abutments. The thus created virtual model is transferred by milling, printing, sintering, etc. back to reality and can then be used e.g. in the laboratory for the production of temporary dentures or surgical guides. The more accurate the replications process the better the models (Figs. 4a & b, 5a–c).

Safe implant-planning

It is also possible to safe implant-planning make with still incorporated metal structures, even if the X-ray image at these locations with radiation artifact areas is insufficiently evaluable. In the described case, the usage of a non-optimal DVT had been assumed, due to extensive metal restorations. Alternatively, the structures would have to be removed. Because of many opportunities in the CTV system, a virtual planning for minimally invasive, navigated implantation is almost unrestricted. (Figs. 6–8c)

Complex planning

For complex planning, even when there is not an optimal bone situation and accompanying surgical services (e.g. sinus lift) are needed, the matching processes of the CTV system support the surgeon. By virtual articulation of the scanned models and matching with the X-ray data, a position and axial direction of the planned implants and their subsequent supra structure in relation to the remaining dentures or natural teeth are determined and other accompanying, necessary surgical procedures can be pre-planned (Figs. 9a–g).

Comprehensive matching process

Last but not least, quality controls, such as of the finished surgical drilling template, are carried out with these comprehensive matching processes. In order to achieve this, the template is scanned and matched as best as possible with the planning images for covering. Ideally, there are no deviations. If differences occur, the implantologist must decide whether he can use this template or a new preparation will be necessary. In this way, failures in implantation and subsequent prosthetic treatment are avoided (Figs. 10a–e, 11a–c).
**Conclusion**

The procedures for overlay of DICOM and STL data contained in the CTV system allow a comprehensive planning of implant positions regarding surgical, prosthetic and aesthetic aspects. Due to the diversity of options, shortcomings of X-ray or model data sets can be fairly settled. This method eliminates the need of a special transfer device for the implementation of the design positions from the virtual to the real world. Thus, the described approach is independent from the existing dental infrastructure as the data exchange with freely selectable machining centres can be done via internet. The goal is to enable a consistent minimally invasive surgical-implantological procedure, to reduce failure rates and to meet the often high demand for prosthetics and aesthetics from the patient’s perspective.

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Computer-controlled implantology: Digital workflow facilitates resource-optimised treatment

**Authors** Uli Hauschild, Italy, Dr Albert van Hove, Monaco, Dr Sébastien Rousset, France & Dr Dominik Muylaert, Belgium

![](image1)

**The success of dental implant reconstruction** depends upon decisions made throughout the treatment process. The patient's initial situation must be correctly assessed, with full consideration given to all the existing oral structures, including the teeth, bones and soft tissue. The time required for various treatment alternatives must be carefully weighed; time is a resource crucial to the comfort and well-being of the patient and an important cost factor for the whole implant team.

Advancements in computer-based technology, including 3-D imaging and advanced software applications, have made it possible to streamline and optimise the implant treatment workflow in ways that previously were unimaginable. The following comprehensive case illustrates the results that can be achieved when adopting a completely digital approach to treatment planning, implant placement and immediate seating of an aesthetic full maxillary restoration. This approach combines processes that until now have been independent, enabling successful low-pain (morbidity) delivery of an exceptional result.

**Case presentation**

A 65-year-old male patient presented with advanced periodontal disease. All his remaining maxillary teeth were loose (Figs. 1–5). The patient...
explained that he wanted a quick solution, with the caveat that he did not wish to be toothless at any time or to leave the practice with an obvious temporary restoration.

A CBCT scan was obtained, along with a precise impression and bite registration. No major treatment was planned for the mandible. Owing to the fact that all the maxillary teeth required extraction, a treatment plan incorporating immediate seating of a full arch restoration was developed, for which the patient provided informed consent. The laboratory fabricated a maxillary master cast along with a duplicate (Fig. 6), and the teeth were carefully removed preoperatively from the duplicate cast. The objective was to create an impression of aesthetic natural dentition that would not significantly change the patient’s appearance.

A set-up was fabricated, starting in one quadrant and using the other as a guide (Figs. 7 & 8). The second side was then completed. The new teeth were placed in ideal positions, and only minor aesthetic alterations were made. On a conventional denture set-up, the interdental spaces are filled with gingiva-coloured acrylic. In this case, however, the
teeth were widened to create more space for the implant abutments. The completed set-up (Fig. 9) was crucial in demonstrating the potential final results and determining the position of the implants. The parameters specified here must not be changed to accommodate both the surgical and restorative phases of treatment. The set-up is therefore also known as the "point of no return". These steps represented the analogue or conventional method of creating the diagnostic wax-up.

The completed set-up was sprayed to facilitate digitalisation of the cast utilising an open laboratory scanner (SinergiaSCAN, Nobil-Metal; Figs. 10–13). The model of the patient’s initial oral condition and the edentulous cast on which the set-up was created were both scanned for incorporation into the implant planning software. The CBCT scan DICOM data was first imported into the SIMPLANT interactive treatment planning application (DENTSPLY Implants). The digital workflow continued with the import of the virtual STL files of the digitised stone models (Figs. 14a–c). The STL 3-D volumes were then combined with the patient’s CBCT images in the SIMPLANT software, using the Optical Scan module (Fig. 16). The separate datasets are accurately superimposed or combined to allow for improved diagnostics, as they can be easily manipulated by the software. The surface detail of the digitised stone casts and wax-up is far superior to the surface detail of the CBCT scan image.

Using the interactive implant treatment planning module, eight implants were simulated in the patient’s bone, each with a virtually elongated axis that helped demonstrate parallel positioning in relation to the proposed restoration as represented by the diagnostic wax-up. In order to achieve the desired surgical and restorative results, various technical aspects must be considered. The length and width of the implants in the bony receptor sites must be sufficient for implant stabilisation and each implant’s screw access channel should ideally end in the middle of the planned tooth for a screw-retained prosthetic design (Figs. 16–22). Figures 23 to 26 show the patient’s jaw before and after tooth extraction, along with the prosthetic design and the axis projection of the simulated implants.

Owing to the number of extractions in this case, the surgeon opted for a bone-supported surgical guide. Using specific software segmen-
The ability to combine digital datasets allows for unparalleled diagnostic interaction, providing state-of-the-art preoperative assessment of the virtually placed implants, abutments, gingiva and bone. Once the surgeon was satisfied with the virtual plan for the implants, the software was directed to fabricate the simulated bone-supported surgical guide (Fig. 27). The data was then sent via the Internet for stereolithographic (rapid-prototyping) fabrication of the resin surgical guide (Fig. 30). The implant-specific SIMPLANT SAFE surgical guide incorporated drilling sleeves to match the manufacturer’s drilling sequence (Fig. 30). In addition, a 3-D printed model of the situation after implant placement was fabricated for use as a control model during manufacture of the temporary restoration. This optional step provided additional confidence in the accuracy of the temporary restoration. However, it is possible to make a temporary restoration using digital data exclusively (Figs. 33–36).

**Fabrication of the temporary restoration**

The digital workflow as described helps to facilitate the fabrication of a temporary restoration that must fit immediately and accurately after implant placement. The bone-supported SIMPLANT SAFE Guide in the software (Fig. 27). The virtual template for the manufacture of the 3-D model (Fig. 28). The virtual template for the manufacture of the SIMPLANT SAFE Guide (Fig. 29). The SIMPLANT SAFE Guide, the bone-supported drilling aid, after stereolithographic fabrication and incorporation of drilling sleeves (Fig. 30). The laser-printed 3-D model (3D Systems) (Fig. 31). On the model, it is possible to see the exact position of the abutments after implantation (Fig. 32). Exocad DentalCAD software: mandible, virtual design in the maxillae, articulated with the abutments in position (Fig. 33). Construction in exocad DentalCAD (Fig. 34). The STL data is sent to the milling machine (Fig. 35). The virtual construction of the tooth position in exocad DentalCAD in comparison with the scanned set-up (Fig. 36).
case report _ dental implantology

placement, as readjustment during the operation can be quite difficult, if not impossible. In order to provide a measure of safety, two temporary restorations were fabricated for this particular procedure. The first was produced digitally. The implant planning data was exported as STL files from the SIMPLANT software and imported into the CAD software (exocad DentalCAD; Figs. 33–36). The restoration was then designed in exocad DentalCAD based upon the location of each implant and abutment, and the diagnostic wax-up.

Once the design process had been completed, the CAM process was completed on a CNC milling machine, which milled the restoration from a solid block of PMMA (Figs. 37 & 39). As with most milled restorations, the restoration was not entirely finished when removed from the milling machine but required only a few additional manual steps for completion (Fig. 40). The holes intended to receive the abutment cylinders were designed for cement space of approximately 1 mm so that the temporary restoration could be inserted directly after the operation.

Fig. 37. The milled PMMA temporary restoration.
Fig. 38. The palatal view of the PMMA temporary restoration.
Fig. 39. The abutment cylinders included cement space of approximately 1 mm so that the temporary restoration could be inserted directly after the operation.
Fig. 40. The dental technical working steps are reduced to minimal manual finishing.
Fig. 41. The aesthetically enhanced temporary restoration.

Fig. 42. A comparison of both variations: both the same size but the right-hand piece of work had far greater stability.
Fig. 43. A comparison of both variations: aesthetically no difference was noticeable.
Fig. 44. The clinical situation before the operation under general anaesthetic.
Fig. 45. The sterile surgical guide for implantation.
Fig. 46. The situation after extraction of the teeth.
Fig. 47. The open gingival flap.
Fig. 48. Positioning the SIMPLANT SAFE guide on the edentulous bone.
Fig. 49. Drilling according to the instructions from SIMPLANT.
Fig. 50. Placement of the implants (ANKYLOS C/X) alternately...
aesthetic appearance (Fig. 41). The second temporary restoration was fabricated by hand in the laboratory utilising the 3-D printed model and was based on a metal substructure (Fig. 42). Each restoration was designed to be worn by the patient throughout the anticipated three to six months of osseointegration. When both restorations were compared, they were the same size, but the hand-made restoration appeared to be distinctly stronger (Fig. 43). When it was placed on the 3-D model, the aesthetic appearance was also satisfactory.

The surgical procedure

Surgery was carried out under general anaesthesia in the Princess Grace Hospital Centre in Monaco. The teeth were extracted and the extraction sockets were meticulously cleaned (Figs. 46 & 47). A gingival flap was reflected sufficiently to allow for the bone-supported surgical guide to be positioned on the alveolar ridge (Fig. 48). It fitted perfectly. The surgeon then followed the implant-specific drilling protocol to prepare ostotomies for the eight implants (ANKYLOS C/X, DENTSPLY Implants; Fig. 49). The implants were placed alternately with the specially designed carriers that allowed for placement through the guide. The implants were strategically positioned and secured to prevent the guide from tipping and then blocking the implants with the positioning aid (Figs. 50 & 51). Once the surgical guide had been removed, Balance Base Abutments (ANKYLOS, DENTSPLY Implants) were connected (Figs. 52 & 53).
The surgeons judged that the two terminal implants could not sustain immediate loading, as the bone in those areas was too soft (Fig. 54). Bone graft material (Bio-Oss, Geistlich) was filled in around those two implants and covered with a Gore-TEX Regenerative Membrane (Gore Medical; Fig. 55). Cover screws were then placed and the areas were sutured so that the Balance Base Abutments were barely visible under the gingiva (Figs. 56 & 57). According to the original CBCT-derived plan, the remaining six implants had bone in sufficient volume and density to enable immediate loading, and the connection to the two terminal implants would help improve healing. The ANKYLOS retention copings were positioned and tightened (Fig. 58). The surgeons opted to insert the CAM-fabricated PMMA temporary restoration so that the patient would not have to go home without any maxillary teeth (Figs. 59 & 60). It was decided to insert the metal-strengthened long-term temporary restoration the following day. This additional step was necessary because the two terminal implants were not immediately loadable and because it was determined that the PMMA restoration would not be able to provide sufficient stability for six implants long term. This was the first time that the surgeons had inserted a previously manufactured temporary restoration for immediate loading. The fit of the PMMA restoration was excellent and the aesthetic appearance was pleasing, even after the extensive surgery.

Fig. 56. Sealing both terminal implants with a surgical cover screw.
Fig. 57. The stitched gingiva.
Fig. 58. Positioning of the ANKYLOS retention coping.
Fig. 59. The milled PMMA temporary restoration is inserted.
Fig. 60. The aesthetics after this complex operation was pleasing.

Fig. 61. The temporary restoration was fixed with composite.
Fig. 62. Photopolymerisation.
Fig. 63. One day after the operation, the PMMA temporary restoration was exchanged for the temporary bridge with the metal substructure.
The gingiva adapted well to the contour of the restoration and sufficient occlusion was achieved. The temporary restoration was fixed with light-curing composite and the exact position was reconfirmed (Figs. 61 & 62). As planned, the following day, the PMMA restoration was exchanged for the temporary bridge with the metal substructure. Function, aesthetics, and adhesive fixation were all checked, and the patient and the surgical team were all pleased with the results (Figs. 63–65).

**Conclusion**

The application of computer technology and advanced 3-D imaging in implant dentistry using multiple interactive software applications makes it possible to create advanced designs that are multilayered, simultaneous and precise, enabling true resource optimisation. In the clinical case example, the design and production of a complex treatment plan were carried out using a state-of-the-art digital workflow. The data export procedure allowed for simulation of optimal abutment positioning. The CBCT image data was used to position the implants accurately within the desired envelope of the diagnostic wax-up, allowing for the restorative data to be exported for CAD and fabrication of the temporary restoration before the treatment on the patient had even begun. The analogue or manual working steps in the laboratory were replaced by the digital workflow as made possible through advanced computer-aided processes.

Resource optimisation using digital workflow has great advantages for both patients and dental implant treatment teams. When it is possible to deliver an immediate-load restoration supported by sufficient dental implants, our patients can continue their lives with less psychological burden, and implant teams benefit from predictable operating procedures and efficiency. The craftsmanship of a competent dental technical specialist and the skill of a good dental surgeon when combined with 3-D preoperative planning can reduce operator and patient stress to a minimum, reduce patient morbidity and reduce surgical time, even when the operation must be relatively invasive, as represented by the clinical case illustrated._

**Fig. 64** The situation before the insertion of the final piece of work six months after surgery.  
**Fig. 65** A radiograph twelve months after surgery.  
**Fig. 66** The situation after twelve months.
Shortening guided surgical implant times based on a combination of CBCT and digital surface scanners

Authors: Drs Alejandro Lanis & Orlando Álvarez del Canto, Chile

The introduction of digital surface scanners to the dental field and the simplicity of data transfer are closing the gap in the creation of a completely “virtual patient” with the optimisation of the digital treatment workflow. Something that a few years ago sounded like science fiction in dentistry, is possible today owing to the technological advances that have been incorporated into our field. The prosthetic, surgical, radiological and laboratory worlds are being fused in sophisticated digital platforms, enabled by the capacity to import the data obtained from digital surface scanners and the DICOM files into surgical and prosthetic planning software. The complete digitalisation of patients’ information and the possibility to combine it offer several advantages to clinicians and are changing the way in which patients perceive invasive dental treatments. Because of their advantages in providing personalised treatment, intra-oral scanners for digital impressions and surgical simulation software will be used as a fundamental technology for diagnosis, planning, treatment and prevention.

Case report

A 55-year-old healthy female patient presented to our practice desiring mandibular molar...
rehabilitation. She complained about the absence of a mandibular left first molar (tooth 36) owing to an extraction performed several years ago because of failed endodontic treatment. After a complete diagnostic evaluation, including clinical and photographic analysis, a CBCT scan of the left mandible was performed using ProMax 3D’s (Planmeca; Figs. 1 & 3a). At the same appointment,

Fig. 3a. A CBCT scan of the mandibular left quadrant.
Fig. 3b. Surface scanning of the edentulous zone.
Fig. 3c. Digital reconstruction of the mandibular left quadrant after the surface scanning process.
Fig. 3d. The digitally reconstructed arches in maximum intercuspation.

Fig. 4a. A lateral view of the initial digital crown design.
Fig. 4b. A lateral view of the maxillae and the mandible in maximum intercuspation with the virtual crown design.
Fig. 4c. An occlusal view of the final crown design.
Fig. 4d. A lateral view of the final crown design.
a digital surface scan of the left maxilla, left mandible and of both arches in maximum intercuspation to establish interocclusal contact was done with a TRIOS digital scanner (3Shape; Figs. 2 & 3b–d). Once all the diagnostic information had been gathered, a treatment appointment was made for the next day.

The digital scan files and the DICOM files obtained from the CBCT were imported into the Implant Studio software (3Shape), in which an innovative technique of spacial recognition allows the creation of a 3-D superimposition of the real intraoral situation and the radiographic images. A restorative design tool included in Implant Studio was utilised to create a functional and aesthetic virtual crown with the ideal prosthetic position on the reconstructed surface image (Figs. 4a–d). After the final crown evaluation, the 3-D digital implant position was defined to obtain the most convenient prosthetic and surgical result, respecting vital structures, such as the inferior alveolar nerve and vascularity. Thus, the designed virtual crown was used as a radiographic template (Fig. 5).

The planning can be performed using an intraoral surface scan and can be checked with the cone beam 3-D reconstruction at the same time, assuring the optimum implant position and avoiding any bone fenestration or dehiscence (Figs. 6a & b).

The implant selected was a Tapered Internal implant (BioHorizons; D 4.6 mm × L 10.5 mm, platform D 4.5 mm). Once the implant position had been approved, a teeth-supported virtual surgical guide was designed (Figs. 7a–d). The final guide design...
was sent as an STL file (Figs. 8a–c) to the 3-D print manufacturer, where the surgical guide was fabricated in two hours (Objet Eden260V, Stratasys; Fig. 9). Once the guide had been fabricated, a final try-in was performed on the study model to assess any fit inaccuracies or surgical access problems before sterilising the guide and the BioHorizons guided surgery kit (Fig. 10a).
The next day, the patient returned to our practice for the surgical procedure. After a mouth rinse with 0.12% chlorhexidine gluconate (Oralgene, Laboratorios Maver) for 2 minutes and the disinfection and preparation of the surgical field, local anaesthetic was delivered to the edentulous area (tooth 36 region) by buccal, crestal and lingual infiltrations (2% lidocaine hydrochloride and 1:100,000 epinephrine). After a few minutes, the surgical guide was placed in position and the 4.6 mm-diameter guided tissue punch was utilised through the master cylinder placed in the surgical guide at 1,200 rpm. The guide was then removed and the sectioned soft tissue was removed with a tissue elevator and kept in saline solution (Figs. 10b–d).

The 2.0 mm guided key in position in the master cylinder in the surgical guide.

The 2.0 mm pilot guided drill was used to begin the osteotomy.

The 4.1 mm tapered guided drill was used to widen the osteotomy.

The surgical site showing the osteotomy without the surgical guide.

The guided implant driver and drill stop key with the Tapered Internal implant.

Guided implant placement.

The implant placed in final position.

A healing abutment was placed.

A small connective tissue graft was placed in a buccal wedge to create denser and thicker keratinised tissue around the implant.

A post-op periapical radiograph of the implant.
The surgical guide was repositioned and a 2.0 mm diameter guided key was placed into the master cylinder. A pilot guided drill of 21 mm in length and 2.0 mm in diameter was utilised to start the osteotomy at 1,200 rpm through the guided key cylinder. The surgical guide system compensates 10 mm in actual drill depth so the final osteotomy in this situation was performed at 11 mm depth (Figs. 11a & b). The procedure was sequentially repeated with the 2.5 mm guided key and tapered guided drill of 21 mm in length and 2.5 mm in diameter, the 3.2 mm guided key and tapered guided drill of 21 mm in length and 3.2 mm in diameter, the 3.7 mm guided key and tapered guided drill of 21 mm in length and 3.7 mm in diameter, and finally the 4.1 mm guided key and tapered guided drill of 21 mm in length and 4.1 mm in diameter (Fig. 11c).

The surgical guide was then removed to check the osteotomy site (Fig. 11d). The guide was then repositioned and the implant was mounted in the 4.6 mm guided implant driver (Fig. 11e). The implant was placed through the master cylinder at 15 rpm and 50 Ncm torque (Fig. 11f). Once the implant was at the final depth position (Fig. 12a), the guided implant driver was removed and a healing abutment (BioHorizons; D 4.5 mm × L 3 mm) was screwed into the implant (Fig. 12b). A small connective tissue graft taken from the soft tissue removed by the tissue punch was then placed in a buccal wedge to gain soft-tissue volume and thickness in the remaining keratinised tissue (Fig. 12c). No sutures were indicated. A post-operative radiograph was taken to evaluate the final implant position.

**Conclusion**

The combination of digital surface scans and CBCT images for virtual planning for implant surgery can be used for safe and effective non-invasive computer-guided implant placement. Implant Studio is a user-friendly realisation of this innovative technology and can significantly reduce the preoperative preparation procedures and treatment times while maintaining surgical accuracy. In this specific clinical situation, the computer-guided surgical preparation and surgery took no longer than two days, improving the waiting times associated with conventional CBCT guided surgical systems.

We invite anyone interested in this innovative technology to visit our clinic and specialist CAD/CAM training centre in Santiago in Chile, where participants will be involved in practical clinical cases, be given live surgery demonstrations, and attend lectures about guided surgery procedures and CAD/CAM surgical and restorative technologies.

Readers can find a video of the procedure at the following link: https://www.youtube.com/watch?v=2gNwAtWEQ7Y&feature=youtu.be

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

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Volumetric cone beam computed tomography in neuromuscular dentistry

Author_ Richard W. Greenan, USA

**History**

CT was invented in 1972 by British engineer Sir Godfrey N. Hounsfield of EMI Laboratories, England, with the first “CAT-Scans” patent granted to Robert S. Ledley on November 25, 1975. Most conventional medical MDCT’s incorporate a fan shaped beam (Fig. 1) whereas dental CBCT systems today utilize a cone shape beam (Fig. 2). With _Three-dimensional imaging_ for dentistry is here and has already proven to be the practical alternative to traditional 2-D dental radiology, as expected. A single volumetric cone beam computed tomography (CBCT) scan can now replace the conventional cephalogram, panoramic, PA skull and tomograms of the TMJs, implant sites and paranasal sinuses in one 10–20 second scan. The advent of volumetric CBCT has overtaken conventional medical CT in both its reduction of radiation, significant increase in restorative detail and at a lower cost to both the clinician and patient. This new technology is already redefining cephalometric analysis.
conventional CT, X-ray is produced as the gantry rotates the X-ray tube and detector around the patient (Fig. 2) producing an image or “slice” with each 360 degree rotation and then stacks the multiple scans and slices.

In a cone beam computed tomography geometry, the entire subject is exposed just once from a single point source using an amorphous silicon (aSi:H) flat-panel sensor, CsI, CMOS or CCD as its detector. A single rotation CBCT scan results in a volumetric scan of the entire subject with complete data acquisition in just two to three minutes.

In March 2001, the NewTom QR-DVT 9000 became the first CBCT system to receive FDA approval in the United States (Fig. 3). Followed in 2003 by the Imaging Sciences International i-CAT incorporating...
similar CBCT technology but in a sit-down and relatively affordable system (Fig. 4).

In 2008, NewTom introduced the upright VG system (Fig. 5) utilizing its exclusive Smart Beam Technology with significant reduction in radiation dosage.1

With a single 10–20 second CBCT scan and a large FOV (field of view), we now have the full 3-D volume of the head and neck from Nasion down to C4 including a panoramic, TMJ’s, pharyngeal airway, paranasal and maxillary sinuses, etc., with a single scan. Three-dimensional rendering and the MIP (maximum intensity projection) in Figure 6 will undoubtedly demand new cephalometric landmarks and analyses (Fig. 7) in addition to enhancing patient understanding and acceptance.

Three-dimensional data will continue to enhance our existing knowledge with:

1) A measureable assessment of bone quality and density (Hounsfield units).
2) The ability to measure arch widths before and after treatment (Fig. 8).
3) Actual impacted dentition orientation in three dimensions (Fig. 9).
4) Upper airway evaluation (Fig. 10).
5) Pharyngeal volumetric airway evalution before and after treatment (Fig. 11).
6) TMJ morphology and condylar position (Fig. 12).

Yet, with this technology comes the personal responsibility to further one’s education on 3-D anatomy—an absolute necessity for a proper, comprehensive neuromuscular diagnosis. We must also learn how to accurately create the necessary images from this single scan.

For example with 3-D pans, we must increase the reconstructed cut-plane width to incorporate the coronoid processes to assess potential hyperplasia and impingement and to incorporate maxillary bone as well as basal bone for potential ossifications of the stylohyoid ligament (Eagles syndrome). Failure to do so will result in a myriad of false negatives and potential misdiagnoses.

Proper mapping of the anatomy is no more critical than for the temporal mandibular joints, best illustrated in the below axial views. The three axial images (Submental view) in Figures 13–15 are actually on the same patient, but demonstrate three different and distinct condylar morphologies. Which one would you map for your TMJ study? The answer is Figure 13.

Figure 13 demonstrates bilateral kidney shaped condyles, while both Figures 14 and 15 are indicative of potential osteogenic degeneration.

Too often, Figure 14 is mapped with the straight TMJ tool (Fig. 16), creating the false positive of bi-
lateral avascular necrosis, as seen here in the bilateral coronal views (Fig. 16), an artefact with invasive consequences!

The operator should have continued to Figure 13, and using the oblique or panoramic tool, drawn the necessary Bezier curve incorporating both lateral and medial poles (Fig. 17).

_Soft-tissue legalities_

There has been a great deal of discussion and unwarranted fear being disseminated by a few self serving oral and maxillofacial radiologists in addition to the manufacturers of smaller FOV systems. Implying that we are now responsible for diagnosing brain tissue!

Three-dimensions do not change the fact that brain tissue maladies and diagnoses are not taught in dental school and that CBCT systems by their very nature are not to be used in lieu of a medical CT or MRI for soft-tissue diagnoses.

With the cephalograms I read, an image encompassing more cranial anatomy than the typical large FOV CBCT scan, I see one or two fibrosarcoma in sella and the thyroid every month because I look for them. But I see few articles in our dental journals that address these very issues, and I suspect that our medical radiology journals also devote little ink to periodontal disease.

A review of the current literature suggests:

“In comparing cone-beam technology with conventional CT, it should be kept in mind that cone beam systems dedicated to maxillofacial diagnostics by their physical nature do not provide enough low-contrast resolution to discriminate soft tissue structures.”

“Where it is likely that evaluation of soft tissues will be required as part of the patient’s radiological assessment, the appropriate imaging should be conventional medical CT or MR, rather than CBCT..”

Statement 8 comes close to this in recommending that CBCT not be used where soft tissue assessment is a significant aspect of the need for imaging.”

_Conclusions_

CBCT has been responsible for a significant reduction in radiation as compared to medical CT (68 µSv vs. 1200–3300 µSv). One CBCT scan is equivalent to approximately five plain film panoramic radiographs, significantly less than a full-mouth series. CBCT images can be saved and viewed as native DICOM, PDF and JPEG compressed files and imported into most third-party patient management software programs.

As a result of this evolution, there are now numerous free DICOM 3-D multiview readers available for both PC and Mac platforms, yet this author prefers the Anatomage Invivo 3-D software for its ease of use and options. CBCT has also been responsible for making CT technology affordable while opening up paths for future research and innovation, particularly in neuromuscular orthopaedics.

_Editonal note: a complete list of references is available from the publisher._

_Dr Greenan is an internationally known X-ray authority and president of Imaging Systems Inc., the Academy for Advanced Radiographic Studies, author of A Practical Atlas of TMJ and Cephalometric Radiology and has published in numerous journals and textbooks on dental implants, orthodontics and TMJ radiology._

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Pioneering Planmeca Ultra Low Dose protocol—An even lower patient dose than in panoramic imaging

Planmeca ProMax 3D units offer the unique Planmeca Ultra Low Dose imaging protocol, which enables CBCT imaging with an even lower patient radiation dose than standard 2-D panoramic imaging. This pioneering imaging protocol is based on intelligent 3-D algorithms developed by Planmeca and yields a vast amount of detailed anatomical information at a very low patient dose.

Ultra-low-dose images are ideal for many clinical cases, such as:

1. Post-operative and follow-up studies in maxillo-facial surgery
2. Orthodontics:
   - Localisation of unerupted or impacted teeth
   - Detection of facial asymmetries
   - Defining orthodontic landmarks for cephalometric analysis
3. Otorhinolaryngology studies:
   - Sinus imaging
   - Airway measurements
4. Implant planning

Figs. 1a–d. An effective patient dose of only 14.7 µSv.
New imaging practices

The Planmeca Ultra Low Dose protocol has changed imaging practices at Tampere University Hospital in Finland. “We have been using the new Planmeca Ultra Low Dose protocol since last summer, and have found it to be very useful in many imaging indications. These include post-operative follow-up, orthodontic cases requiring localisation of impacted teeth and their effects on adjacent teeth, the detection of facial asymmetries, sinus imaging in otorhinolaryngology cases where sinusitis needs to be excluded, pharyngeal airway measurements in sleep apnoea patients, as well as many implant cases”, said Dr Jorma Järnstedt, specialist in oral and maxillofacial radiology.

“The new imaging protocol has already changed traditional imaging practices: in many cases, 2-D imaging can no longer be justified, since an ultra-low-dose 3-D image simply yields so much additional information at a similar radiation dose. Our patients are often concerned about radiation exposure, but once they hear that the dose is even lower than in traditional panoramic 2-D imaging, they are always relieved. In addition, referring physicians often specifically ask us to use the Planmeca Ultra Low Dose protocol. We take around 2,000 CBCT images per year, and the number is constantly growing. We have been using the new protocol for the imaging of both large and small areas. It has proven to be a very beneficial method that improves the quality of patient care and yields a vast amount of detailed anatomical information at a low radiation dose.”

Dr Jorma Järnstedt, DDS, is a specialist in oral and maxillofacial radiology at the Department of Radiology of the Medical Imaging Centre at Tampere University Hospital.
Earlier this year the KaVo Kerr Group used one of Chicago’s most innovative venues to launch a portfolio of 20 new products—all linked across the organization’s newly formed global platform of brands. The “Mosaic of Dentistry” event took place at the Chicago Illuminating Company, housed in a former power plant/warehouse that dates to the early 1900s. It was a suiting venue for the evening’s theme: the critical role that innovative products play in dentistry—and patient care.

The evening’s host, Dr Lou Shuman, president of The Pride Institute, said: “Sure, we fix cavities and straighten teeth. Sure, we give people better-looking smiles. … But we’re really in the business of providing great care and improving the quality of life of the people we serve. And everyone here is part of this fabric — this mosaic of dentistry.”

With that, the event took on the aura of an upscale fashion show, with top executives and brand managers coming out one at a time as if on a runway—with music and lights completing the mood. And just like a fashion show, each of the 20 products they represented was briefly described.

Next, attendees were presented with another surprise, when the venue seemed to transform again, this time turning into a private exhibit hall, with each of the products represented. Attendees were invited to participate in hands-on demonstrations and meet directly with the leadership teams behind each of the products.

The variety of products and brands on display clearly demonstrated the breadth of KaVo Kerr Group’s portfolio of dental brands and operating companies. Those brands include KaVo, Kerr, Kerr Total Care, Pentron, Axis | SybronEndo, Orascptic, Pelton & Crane, Marus, DCI Equipment, Gendex, DEXIS, Instrumentarium, SOREDEX, i-CAT, NOMAD, Implant Direct and Ormco.

Among the 20 products introduced: MASTERtorque M8900L handpieces from KaVo; the Demi Ultra Curing Light and an enhanced SonicFill from Kerr; the CariVu caries detection device from DEXIS; the i-CAT FLX MV CBCT from i-CAT; the ElementsFree cord-free obturation unit from Axis | SybronEndo; the Op300 Maxio digital panoramic imaging system from Instrumentarium; the Pro II handheld intraoral X-ray unit from NOMAD; Nano HD loupes from Orascptic; the 3000 dental chair with “Narrow Back Advantage” from Pelton & Crane; and the NuStar SII dental chair from Marus._

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At the beginning of 2014, 3DISC Imaging, a manufacturer of digital imaging solutions for the medical, dental, chiropractic, and veterinary markets, launched its next-generation Quantor+ Imaging Software. According to the company, the QuantorMed+ and QuantorVet+ Imaging Software provide improved productivity and workflow to professionals using a FireCR+ Medical or Veterinary Reader.

Quantor+ Imaging Software provides optimised image acquisition, processing, and management capabilities, according to 3DISC. In addition, it has a chronological and intuitive workflow, which eases the process of acquiring high-quality images.

The software features an improved control panel, which groups buttons according to functionality. A visible navigation bar is available at all times to guide users through the workflow, and enables the easy addition and modification of study filters.

The improved functionality includes a convenient note field for each image, which allows staff to save comments directly in the image file.

Moreover, users can crop, etch, enhance, increase brightness and contrast, and perform other adjustments. An updated colour scheme with a dark background offers maximum contrast when viewing images.

According to Thomas Weldingh, CEO of 3DISC Europe, “With the next-generation software and unique touch-screen interface, image acquisition, processing, and management have never been easier. Facilities can use the DICOM-compliant interface to download patient and exam information from a work list, which can be matched automatically. For facilities without a HIS, RIS or PACS, a local database enables direct management of patients and studies—DICOM and non-DICOM images can be viewed on the same workstation on which they were acquired.”

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CAD-Ray Imaging Centres offer advanced 3-D technology

CAD-Ray provides dentists access to cone beam imaging for enhanced diagnosis, 3-D treatment planning and guided implant surgery.

CAD-Ray Imaging Centres across the US use state-of-the-art 3-D cone beam imaging technology to help dentists make informed diagnoses and provide better treatment outcomes. Patients can now be referred to a CAD-Ray Imaging Centre to receive high quality three-dimensional radiographic scans of their entire craniofacial anatomy while providing dentists with all the tools necessary to translate the 3-D scans into successful implant placements.

The imaging centres, founded by Dr Armen Mirzayan, serve as full-service facilities. When a patient is referred to a CAD-Ray centre, benefits go far beyond the initial 3-D scan. Unlike most other imaging centres, the practitioners at CAD-Ray can also capture a digital model of the edentulous arch, allowing for proper design of an implant placement. Once the referring doctor approves the design, the CAD-Ray practitioner orders a stent on behalf of the doctor to ensure that a fully guided fixture placement can be performed with the least amount of risk. The expert design team is well versed in all implant lines that now offer fully guided kits.

CAD-Ray Imaging Centres provide greater accuracy, precision, and detail across dental procedures performed today. Integrally involved in empowering doctors to successfully incorporate CAD-Ray imaging into their practice, Dr Mirzayan strongly believes that any doctor that routinely performs an extraction can readily incorporate guided implants into their treatment protocol. "CAD-Ray’s mission is to allow every dentist the opportunity to place implants predictably, efficiently, in the proper location, with the least amount of risk," explains Dr Mirzayan.

Additional clinical benefits of CAD-Ray Imaging Centres’ 3-D technology include:

- Access to state-of-the-art cone beam imaging;
- Increased predictability, producing a higher standard of treatment in all disciplines of dentistry;
- Higher case acceptance, as patients can visualize and readily understand why treatment is necessary;
- Minimal exposure to radiation for patients as 3-D cone beam systems use much less radiation than hospital or medical grade CT scanners.

Currently, the CAD-Ray Centres are located in Los Angeles and Chicago but plans to expand the CAD-Ray Imaging Centres include 10 new offices across seven states. For more information on CAD-Ray Imaging Centres and its technology, visit: www.CAD-Ray.com.

Dr Armen Mirzayan, a California native, is the founder of CAD-Ray Imaging Centers. He received a Master’s Degree in the field of Medical and Dental Sciences from Boston University and his Doctoral Degree in Dental Surgery from Northwestern University in Chicago. Dr. Mirzayan currently holds a private practice in Los Angeles, while continuing to commit his time to further educating patients on the latest advancements in oral health care.
Planmeca makes strategic investment in E4D Technologies

Planmeca, the world’s largest privately owned dental imaging company and equipment manufacturer, announced in December 2013 that it had made a non-controlling strategic investment in E4D Technologies, developer of CAD/CAM restorative systems and software solutions. This strategic investment reinforces Planmeca’s ongoing commitment to helping dental care providers improve patient care by offering a comprehensive portfolio of integrated digital dental solutions for dentists and dental laboratories.

“Planmeca’s investment in E4D Technologies offers us an opportunity to grow our company globally,” said Dr Gary Severance, Chief Marketing Officer of E4D Technologies. “In addition, Planmeca has been a market leader in extra-oral digital imaging for many years, and we look forward to furthering the seamless integration of our CAD/CAM platform with the additional digital solutions offered by Planmeca. Our customers will benefit from the combination of these unique and innovative products and services.”

Under the new agreement, Planmeca joins the partnership of Henry Schein and Ivoclar Vivadent, who have been strategic equity partners in E4D Technologies since 2007, along with several members of E4D Technologies’ senior management team.

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The Academy of Osseointegration is recognized as the premier association for professionals interested in implant dentistry. It has always been at the forefront of scientific advances in dental implant and tissue replacement therapy. In an interview, Annual Meeting chairmen Lyndon Cooper, DDS, PhD, and Donald Clem III, DDS, discuss this year’s meeting, which was held recently, and plans for the 2015 event.

Sierra Rendon: How many people attended AO Annual Meeting 2014?
Dr Lyndon Cooper: More than 2,000 clinicians joined us for the 29th annual meeting of the Academy of Osseointegration (6–8 March 2014, Seattle, USA), which recorded the fourth largest attendance in its history. We had 624 international attendees representing 45 countries and more than 1,100 exhibitors who showcased products and services to support implant dentistry.

Why did AO choose the theme “Real Problems, Real Solutions”?
We have seen that implants are widely applicable and generally successful, and we recognize that clinician education is critical to success among our patients. This year, we sought to inform clinicians that a segment of our population will experience implant complications and failure, but emerging strategies can help them recover success. We encouraged the clinical team to examine implants carefully, address issues promptly and recognize when—and learn how to—intervene to preserve dental implant and patient health.

What were some highlights of the clinical sessions?
Leading experts led the program with insights on who experiences complications, why they occur and what evidence says about how well we address these complications. Consistent with the plan, a broad range of data was presented. The early focus on periimplantitis opened the minds of the audience, while the closing futuristic presentations certainly left everyone feeling inspired. Our clinical presentations anchored the meeting by demonstrating what good science offers great clinicians who adopt an evidence-based approach to caring for people.

Was research a big focus of the meeting?
Yes, presentations ranged from digital planning, new aesthetic techniques and prevention strategies to molecular strategies and stem cell biology. Abstract presentations explored original scientific and clinical research, clinical innovations and case presentations that could help shape the future of implant dentistry. We had a record number of more than 250 Scientific Posters as well.

The new board of directors was also announced in Seattle. How does the AO enjoy such a seamless transition in leadership?
Approaching its 30th year, the AO is fortunate to have organization leadership and leadership development that are very carefully managed. We are all very excited to announce that Dr. Joseph Gian-Grasso, a periodontist from Philadelphia, was elected to serve as the 2014–2015 president of AO. He will follow in the footsteps of a very successful president, Stephen Wheeler, DDS. Dr. Gian-Grasso—along with the rest of us—will remain committed to establishing a nexus where specialists and generalists from around the world can come together to learn and stay up-to-date on the rapidly advancing clinical research and innovations in the dental implant and tissue engineering industries.

_Have you already started planning for AO 2015?_ Yes, because it’s AO’s 30th anniversary, we’re all very excited about it. Mark the calendar now to join us in San Francisco from 12 to 14 March 2015, where we plan to on the power of collaboration to advance the art and science of dental implant therapy.

_Can you give us a few glimpses at what’s in store for next year?_ The opening symposium will feature teams of doctors presenting on how they manage patients together for optimal results. The keynote speaker will be Dr Daniel Alam, who was a member of the multi-disciplinary team of doctors and surgeons at Cleveland Clinic who performed the first near-total face transplant in the United States. He will speak to the critical importance of different disciplines coming together to support a patient’s medical, surgical and emotional needs to make them whole again.

AO also will take a look at what the academy has learned throughout its 30-year history and summarize current recommendations to address the most challenging conditions in implant dentistry. AO has enlisted some of the foremost authorities in both surgical and restorative dentistry to share their knowledge and views to support this initiative.

Keeping with AO tradition, we also want to ensure the closing symposium doesn’t disappoint. It will be an interactive session where attendees can vote on keypads to give their opinion on various treatment options for presented cases. A panel of experts will also discuss and debate the options.

_What are you most excited about for the meeting?_ At the annual meeting, we are excited to build on AO’s past and chart the way for its future. This will be done via top-notch surgical and restorative tracks, as well as a “Morning with the Masters,” for which AO has put together an outstanding group of experts to give attendees pearls that can be used in the office on Monday morning. Ultimately, patient safety and benefit must be based on sound evidence—that’s what the academy is all about and our annual meetings are as well. To learn more about AO membership, please visit our website (www.osseo.org/NEWmembership.html).

_Thank you very much for the interview._
Rimini show confirms that the future of dentistry is digital

The use of digital technology seems to be changing dentistry forever and nowhere has this been more obvious than in Italy in May, where numerous manufacturers from Italy and abroad showcased their latest devices and materials to thousands of dental professionals at this year’s Amici di Brugg dental show.

Besides Henry Schein’s ConnectDental pavilion, a booth dedicated entirely to the company’s combined portfolio for an all-out digital workflow and other services such as Sirona’s Digital Dental Academy, a new application designed for Google Glass draw special attention from visitors. Specifically designed to work on the head-mounted device, Dental Glass is intended to improve workflow in dental practices by projecting information directly in the clinician’s field of view, similar to a pilot’s head-up display. This way, clinicians can remotely access patient records, among other data, display radiographic images, or manage appointments through voice recognition software or a touchpad located at the earpiece, according to the Italian developer Gerhò, a subsidiary of the Breitschmid group. The manufacturer said that the app will also allow the capture of photos and video in high-definition format through its built-in camera.
Google Glass is currently only available in the US. When the device will be released to European markets is still unclear owing to some technical limitations and the lack of distributors, according to reports. The technology, however, is currently being experimented on for its future use in general and dental medicine. Last year, for example, Dental Tribune reported on the first maxillofacial surgery broadcast with the device, which took place at Hospital de Molina in Murcia in Spain.

Completely digital solutions however are already available in dental offices. BIOLASE, for example, offers such solutions and has expended great effort on its Total Technology Solution in recent years. In addition to its complete range of dental lasers, the US dental technology company now offers sophisticated imaging equipment and CAD/CAM solutions, such as the GALAXY BioMill System, which allows digital fabrication of restorations chairside.

“The adoption cycle of new technologies is growing increasingly shorter and more advanced technologies like the Waterlase will rapidly find their way into dental practices. Dentists that do not upgrade their equipment will likely begin to lose patients, become uncompetitive and lag behind,” BIOLASE CEO Federico Pignatelli explained to Dental Tribune International (DTI) at the show.

DTI CEO and publisher Torsten R. Oemus confirmed this forward-looking corporate strategy by emphasising the strong points of the digital revolution: “Turning dental offices into high-tech playgrounds is indeed becoming a global trend, which reaps rewards for patients and dentists alike. Technology is what differentiates a modern dental office from a conventional one, increases patient flow, and advances diagnostic and treatment outcomes, which ultimately leads to increased revenues.”

He invited dentists who are unsure about how digital technologies could benefit their practice to attend the Digital Dentistry Show, the first edition of which will be held in autumn 2014 at the International Expodental show in Milan in Italy. Focusing entirely on digital products and applications for dentistry, the unique expo format will not only showcase the latest products and solutions by leading providers in the field, but also offer education in the form of lectures and webinars from 16 to 18 October.

Information about what to expect from the event and how to register is available on the events website: www.digitaldentistryshow.com.
International Events

2014

18th World Congress on Dental Traumatology
19–21 June 2014
Istanbul, Turkey
www.iadt-dentaltrauma.org

IACA 2014 Annual Meeting
24–26 July 2014
Bahamas
www.theiaca.com

AAED 39th Annual Meeting
5–8 August 2014
Santa Barbara, USA
www.estheticacademy.org

ICOI Summer Implant Prosthetic Symposium
21–23 August 2014
Chicago, USA
www.icoichicago2014.org

FDI Annual World Dental Congress
11–14 September 2014
New Delhi, India
www.fdi2014.org.in

2014

EAO 2014
25–27 September 2014
Rome, Italy
www.eao.org

EPA Annual Conference
25–27 September 2014
Istanbul, Turkey
www.epa2014.org

ICOI World Congress
3–5 October 2014
Tokyo, Japan
www.icoi.org

ESCD Annual Meeting
9–11 October 2014
Rome, Italy
www.escdonline.eu

155th ADA Annual Session
9–12 October 2014
San Antonio, USA
www.ada.org

Digital Dentistry Show
16–18 October 2014
At the International Expodental Milano, Italy
www.digitaldentistryshow.com

AAID Annual Meeting
5–8 November 2014
Orlando, USA
www.aaid.com

3rd Digital Dentistry Symposium
14–16 November 2014
Istanbul, Turkey
https://blog.sirona.com

ADF Meeting
25–29 November 2014
Paris, France
www.adf.asso.fr

Great New York Dental Meeting
28 November–3 December 2014
New York, USA
www.gnydm.com
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- the complete list of sources consulted; and
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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.

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

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

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

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

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

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

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Questions?

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