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opinion
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Dear Reader,

With 2012 drawing to a close, I would like to take a brief look back at the past and share some thoughts with you.

While it sometimes appears that time flies by at a rapid pace, advancements in dentistry have truly been rapid. Presumably, the extraordinary progress may not be felt as strongly by dentists in the former Eastern Bloc countries, such as the Czech Republic, as it is by dentists in Western Europe or the USA. However, nearly 20 years ago, most of our dental units worked with pulleys and cables, while the offices were equipped with chairs that did not allow treatment of a patient in a horizontal position.

From a global perspective, dentistry has undergone a series of significant changes. Not long ago, there was only one company involved in CAD/CAM technology—intra-oral scanning and milling of dental restorations in particular. Currently, there are nearly 10 intra-oral scanners and at least 20 extra-oral laboratory scanners from which to choose. Today's dentists can obtain intra-oral images from CBCT devices and we can manufacture implant guides in-office while the patients wait—all of which was the realm of science fiction until recently. I am grateful to be experiencing this exciting development.

Therefore, I am not sure that today we can still refer to 3-D technologies in dentistry as "revolutionary". In some areas of dentistry, these technologies have already become a diagnostic tool, or have even established themselves as a standard operating procedure. That is one of the reasons we decided to build, and in May 2012 opened, the Czech Society of CAD/CAM Dentistry (CSCD) Training Center. The centre is focused primarily on the practical education of dentists and dental technicians in the use of CAD/CAM technologies and CBCT. Inspired by the old Chinese proverb "It's better to see once than to hear a hundred times", we equipped the centre and the operating room with high-definition cameras and audio-visual data channels. This allows the participants to view the live procedures in the classroom (in the case of large audiences, the entire process can be shown in a nearby 3-D cinema).

In the centre's training laboratories, every course participant is equipped with his or her own ready-to-use intra-oral scanner and a phantom head connected to the dental units—because as dental professionals we all realise that without training and hands-on practice in proper preparation all advantages of CAD/CAM technologies are meaningless.

I wish you not only a perfect fit for your scans and millings, but also a fulfilling personal and professional life in the upcoming year. I also sincerely hope to see you at some of the practical courses in the Czech Republic soon!

With kind regards and best wishes,

Dr Josef Kunkela
President of the Czech Society of CAD/CAM Dentistry
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For nearly 100 years, dentists have relied on 2-D radiographic imaging for diagnosis and treatment planning. With the 1999 introduction of cone-beam computed tomography (CBCT), all dentists now have tools available for more accurate diagnosis and treatment.1

The ability to look at a tooth in any direction and orientation, as well as in 3-D, eliminates much of the guesswork commonly experienced with 2-D radiographs.

We have been limited in most cases to only a buccal-lingual view provided by periapicals, bitewings and panoramic radiographs with the occasional axial view of an occlusal film. Medical CT scans and images began in the early 1970s and were sometimes used by dentists, offering our first multiplaner views.2

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The adoption of 3-D cone-beam imaging is appropriate and has important advantages for all modalities of dentistry. From every specialist to the general dentist, the increased amount of radiographic information as well as increased accuracy will aid in the most sound diagnosis possible.

CBCT description

CBCT is a single or partial rotation of an X-ray source around the head, capturing X-rays on various flat panel arrays and sensors. The information is converted to a series of axial slices by computed tomography and stored as virtual anatomy in the computer.

With the use of sophisticated software, the dentist is able to view information in several different views, including: axial slices (head-to-toe orientation), coronal slices (front-to-back orientation), and sagittal slices (side-to-side orientation) all known as multiplaner reconstructions (MPR). The thickness of each slice can be varied to include more or less information.

Because the voxels (volumetric pixels 3-D) are isotropic, other MPR images can be generated by slices drawn at any angle, curve or thickness through the scan to view areas critical to the final diagnosis.3,4

The final view offered by CBCT is a 3-D view that can be rotated and viewed in any direction.
Once again through software manipulation, 3-D images can be viewed as conventional radiographs, maximum intensity projections (MIP), soft-tissue projections and a variety of other views.

This nearly endless ability to manipulate the data aids in the diagnosis and identification of disease, nerve canals, sinus morphology, dental caries, bone density, fractures, endodontic pathology, implant placement criteria, periodontal defects, bone pathology, fractured teeth, iatrogenic trauma, TMJ morphology and disease, third molar position and many more healthy or diseased conditions.

**Early CBCT adoption with implants**

The first and primary use of CBCT for early adopters was implant placement. As the scope and the value of the information became better known, dentists of all branches began to see the value of MPRs and 3-D renderings including periodontics, endodontics, oral surgery, treatment of TMJ, orthodontics, implantology and general dentistry.1,7,8

Clinical periapical and panoramic radiographs for the placement of implants can be misleading with elongation, foreshortening, superimposition and geometrically incorrect data.7,8 A look at the implant in the periapical shows no obvious disease to an existing integrated implant. Clinically, a buccal fistula was present with exudate and slight pain. The CBCT scan (Fig. 1) reveals a more accurate view showing a buccal defect on a sagittal MPR. A surgical flap revealed a dehiscence of the coating of the implant. Removal of the foreign body resulted in an asymptomatic and healthy patient.

The evaluation of the available bone for the initial implant placement can be crucial for the long-term success of the case. If there is inadequate bone available, grafting may be a necessity. CBCT studies render the most accurate information available at a low radiation dose. The periapical shows an obvious lack of bone height, but does not show the buccal-lingual dimensions or an accurate view of the sinus morphology (Fig. 2).

The MPR view of the CBCT shows all necessary measurements to perform the sinus lift and grafting with the immediate placement of the implant fixture (Fig. 3). Three-dimensional views show the floor of the sinus and any soft-tissue pathology (Fig. 4). Having accurate measurements in all dimensions is an advantage of CBCT scanning.

**CBCT and endodontics**

Endodontics is a field that is rapidly adopting the use of CBCT and for good reason. The inherent geometric deficiencies of 2-D radiographs make the CBCT scan a valuable adjunct to investigate the root morphology in both 3-D and MPR. The typical periapical will show superimposed canals in the anterior, bicuspids and molars as well as unwanted bone densities both buccal and lingual to the affected tooth making the image quality poor.

![Fig. 4](https://example.com/f4.png) The 3-D CBCT showing anatomy of the maxillary sinuses.  
![Fig. 5](https://example.com/f5.png) Axial MPR showing mesial buccal roots in first, second and third molars.

![Fig. 6](https://example.com/f6.png) Periapical showing minimal pathology with no radiolucency.  
![Fig. 7](https://example.com/f7.png) Coronal MPR showing a short fill on the mesial lingual and radiolucency.  
![Fig. 8](https://example.com/f8.png) Sagittal MPR showing unfilled canal and radiolucency.
The ability to view MPR slices in cross-section, long axis and oblique directions gives the ability to follow all canals in any direction and show their relationship and measurements from other known structures. This virtual tour of the root morphology is a great benefit to the final treatment outcome (Fig. 5).3,4

Post root-canal infection can be difficult to diagnose with the standard periapical. The endodontic fills may appear to be normal even though other clinical findings and symptoms are abnormal. The patient presents several months post root-canal treatment with pain on palpation and pressure and avoids this side of the mouth.

A periapical radiograph shows minimal pathology (Fig. 6). The roots appear to be filled and a small puff of sealer extends through the apex of the mesial roots. The distal root structure and fill appear normal. There is little indication of periapical radiolucency only a widening of the periodontal ligaments of the mesial roots.

A CBCT scan reveals a completely different picture. The coronal MPR reveals a short fill near the apex of the mesial lingual root and a large radiolucency (Figs. 7 & 8) not visible on the periapical radiograph (Fig. 6).

Missed canals are difficult to see in a buccal-lingual projection of the periapical radiograph as one canal is superimposed on the other (Fig. 9). Often, as viewed in this radiograph, we see periapical pathology with an apparent normally filled canal. CBCT scans allow dentists to look for pathology in MPR planes to identify the actual problem before invasive procedures are performed on the patient. The axial view shows a lingual canal exists and is untreated. The coronal view confirms the diagnosis and treatment can be completed (Fig. 10).

Today’s endodontists, as well as general dentists, are benefiting from the diagnostic capabilities of the high-resolution CBCT scanners available over conventional 2-D periapical.5,6

Oral surgery

Oral surgery, with its inherent invasive nature, can be better served using CBCT with MPR as well as 3-D images. The ability to perform virtual surgery is a benefit to both the doctor and the patient. Doctors have the advantage of seeing morphology and landmarks in real-time space and time with accurate measurements, and patients will gain a better understanding of the problems and the solutions their doctors are offering them.

Third-molar extractions can be risky based on 2-D and panoramic radiographs. These radiographs can often superimpose nerves and sinuses over root structures. Dentists using 2-D radiographs must often rely on experience to assess the risks of iatrogenic trauma. The use of CBCT with MPRs and 3-D images reduces any guessing as well as the chance for any permanent damage to the patient. With the adoption of CBCT, the judgment is based on solid evidence and the risk will decrease.

A panorex of the superimosed third molars gave no solid evidence the canal lies between the roots. It is only with the use of CBCT and the MPRs that the nerve can accurately be seen traversing between the mesial buccal and mesial lingual root (Fig. 11).4,5

Other surgical advantages include the identification and the position of supernumerary or impacted teeth. The images show accurate positions and show definitive morphology that will aid in removal of the proper teeth (Fig. 12). Knowing the exact position of many of these teeth is a benefit to both the doctor and patient. It will lead to the most precise surgical path and the least invasive procedure.

Periodontics

The explanation of periodontal problems are often misunderstood by the patient. As doctors we talk about
pockets, point to X-rays and propose treatment only to have patients refuse treatment because they do not understand what we are clinically describing. Using the 3-D portion of the CBCT scan can improve the understanding and acceptance of treatment plans. The images are a picture of the problem that is owned by that patient and much easier to understand by the layperson. Illustrating periodontal defects and pockets allows the patient to better participate in the process (Fig. 13).

The MPRs and the 3-D projections aid in surgical planning for periodontists, allowing for accurate measurements and bone analysis prior to osseous surgery that doctors cannot get using the periapicals or panoramics. Studies have shown that CBCT images are more accurate than panoramic radiographs. For the periodontist placing implants, the ability to measure bone density and avoid important anatomy is important.4,5

_Orthodontics_

Orthodontists are beginning to adopt large field-of-view CBCT. Recent studies show that linear measurements of bony structures are more accurate using CBCT and have less distortion than currently used methods of measurement: lateral cephalometric, posteroanterior (PA) and submentovertex (SMVT).5 Accurate measurements of tooth volume and tooth position can aid in accelerated treatment times and more precise treatment. Along with tooth position, density of bone and size of arches, the orthodontist also has an accurate evaluation of the temporomandibular joint and position of the condyles. Impacted teeth are easily identified and position either buccal or lingual can be confirmed prior to movement or removal. Both MPRs and 3-D projections give the clinician a complete picture of the problems and the treatment course.

With a single CBCT scan, orthodontists can produce all of the information they need: panoramic, cephalometric, PA, SMVT, tooth size and volume, crowding evaluation in any plane, TMJ evaluation and airway analysis, all with both soft-tissue and skeletal information.5,7

_Conclusion_

We treat our patients in 3-D, and now, with conebeam computed tomography, we are changing the way we diagnose from 2-D to 3-D. The addition of this technology will increase your diagnostic skills with better and more complete information at your disposal. As with any type of invasive diagnostic tool, clinicians should weigh the risk to benefit in using CBCT scans.

Judicious use of CBCT and knowledge of patient’s lifetime doses should always be a consideration as well as the availability of other diagnostic tests appropriate for the problems of the patient. When adopting new technology, training is paramount. Along with training comes the responsibility of the doctor to read and diagnose information from CBCT scans.

Do not avoid CBCT from lack of knowledge; instead, take this opportunity to become a better diagnostician and radiologist. As you review radiology and pathology, your use of CBCT will aid in making the most accurate diagnosis and the most complete treatment plans._

_ about the author _

Dr Dan McEowen is a 1982 graduate of Loma Linda School of Dentistry and has been in private practice for 26 years. He is a founding member of the World Clinical Laser Institute, achieving a mastership level of proficiency. McEowen has lectured and trained internationally in techniques using lasers in general and specialty dental fields. He is a member of the ICOI and is active in implantology. McEowen has been involved in cone-beam technology for more than five years and owns 3D Imaging Center in Maryland.

(Editorial Note: A complete list of references is available from the publisher.)
Intra-oral and panoramic images are not 3-D and clinicians can obtain only vague measurements from them owing to magnification changes due to positioning. In addition, they are not efficient for viewing certain pathologies. In response to these limitations, CBCT 3-D imaging technologies were developed. CBCT 3-D captures a volume of data and, through a reconstruction process, it delivers images that do not contain magnification, distortion and/or overlapping anatomy.

In recent years, CBCT 3-D has begun to make significant inroads into every discipline in our dental profession, expanding the horizons of clinical dental practice by adding a third dimension to cranio-facial treatment planning. CBCT uses advanced 3-D technology to provide the most complete anatomical information on a patient’s mouth, face and jaws areas, leading to enhanced treatment planning and predictable treatment outcomes.

Essentially, this represents a paradigm shift, where measurements and anatomical relationships are precise and provide practitioners with a clear understanding of their patients’ anatomical relationships. According to dental practitioners using this technology, it helps them perform treatment more efficiently.

Regarding oral implantology, it is estimated that growth in implant-based dental reconstruc-
tion products will outstrip all other areas of dentistry, according to Kalorama Information. The traditional method of replacing a tooth with a dental bridge has been shown to be problematic, and more permanent solutions are urgently needed.

With a rapidly ageing population in the developed world and the resulting enormous need for dental restoration, a large number of companies have seen the opportunity to adopt these sophisticated dental techniques. And indeed, as some have predicted, the growth in dental implant-based procedures has increased considerably in recent years.

As a result, there has been a rapid increase in the number of practitioners involved in implant placement, including specialists and generalists, with different levels of expertise. At the same time, a number of unusual complications associated with these procedures have arisen.

A literature and web search revealed several published reports of such complications, which include implant fractures (Fig. 1), impingement on adjacent teeth (Fig. 2), perforation of the lingual undercut (Fig. 3), sinus perforations (Fig. 4) and implants displaced into the maxillary sinus (Fig. 5).

The clinical management associated with some of these complications is difficult at times and considered very invasive. Therefore, while the quantitative relationship between successful outcomes in dental implant treatment and CBCT-based dental imaging is unknown and awaits discovery through large prospective clinical trials, I strongly believe that using CBCT- and 3-D-based dental imaging is becoming a reliable procedure from a precautionary standpoint based on a series of recent preliminary clinical studies and case reports.

I also strongly believe that by taking 3-D CBCT images prior to placing dental implants, many of the above-mentioned complications can be circumvented.

Editorial note: Dr Almog’s presentation, Introduction to CBCT, especially as it pertains to prevention of failures in oral implantology, at the Dental Tribune Study Club Symposia at Greater New York Dental Meeting 2010 is available online at www.DTSStudyClub.com.

Reference

_about the author

Dr Dov Almog is a prosthodontist with more than 30 years of diversified professional experience in clinical, academic and research environments. His publications include articles on CBCT, dental implants, carotid artery calcifications and practice management. In 2003, in acknowledgment of his research on incidental findings of carotid artery calcifications on panoramic radiographs, he received the Arthur H. Wuehrmann Award from the American Academy of Oral and Maxillofacial Radiology. Dr Almog currently serves as chief of the dental service for the VA New Jersey Health Care System of the US Department of Veterans Affairs.

Fig. 4 Left sinus perforation.
Fig. 5 Implants displaced into the maxillary sinus.
Use of CBCT in implant dentistry should follow justification and optimisation

The European Association for Osseointegration (EAO) recently updated its guidelines for the use of diagnostic imaging in implant dentistry, which now include cone-beam computed tomography (CBCT) and are supposed to address the As Low As is Reasonably Achievable principle as well as to optimise both conventional radiography and new procedures. A commentary by Prof. Keith Horner, University of Manchester, UK.

_CBCT is the most significant development in dental imaging during the last 25 years. It brings cross-sectional imaging into the dental practice and has obvious uses in implant dentistry. Concerns have been raised, however, over the radiation doses, which are usually higher than those of conventional dental radiography.

When the word “radiation” is used, alarm bells ring for everyone. One of the most common questions asked by dentists is how the dose of one X-ray examination (e.g. a panoramic radiograph) relates to another (e.g. CBCT). This is almost impossible to answer because there is a wide range of possible doses from any type of X-ray examination, reflecting differences in equipment, the image receptor, the field of view and so on. Recent reviews indicate that doses from CBCT are typically an order of magnitude greater than those from conventional dental radiography. The health risks from such exposures are also proportionately higher; although we can perhaps console ourselves by remembering that risk falls with patient age, and that many implant patients are in the older age groups.

The foundations of radiation protection of patients are justification and optimisation. Justification embodies the principle that all exposure to X-rays should give a positive net benefit to the patient. It is implicit within this that the X-ray imaging strategy should be “prescribed” for each patient and therefore that no imaging should be performed until a history and clinical examination have been performed. Referral criteria are an essential aid to the justification process, being clinical guidelines based on, at best, a solid body of evidence or, where the evidence is lacking, consensus. Optimisation is the principle that all exposure should be as low as reasonably achievable. As radiation exposure factors are reduced, image quality will fall, but lowering exposure to a point at which image quality is still adequate is an important strategy, as well as cutting down the size of the field of view.

So, where do we go from here? CBCT is a great technological advance, but that does not mean we must use it if a conventional radiograph, or good clinical examination, would be sufficient. We have to recognise that regulatory authorities dealing with radiation in Europe are aware of CBCT in dental practices and are keeping a watchful eye on how we use this technology. The best way for us to demonstrate that we are appropriate users of CBCT is to follow the principles of justification and optimisation—and to show that we follow them. This means only using CBCT when it is going to answer a question that cannot be answered by other methods involving less, or no radiation.

When we use CBCT, we should never just “press the button” using a standard exposure for everyone, but we should adjust the exposure factors to a level that gives adequate image quality and use the smallest appropriate field of view. These simple steps will reassure our patients that we have their best interests at heart; that is what we really want—isn’t it?

Prof. Horner addressing the audience of a EAO pre-congress course on CBCT in implant practice.
(DTI/Photo Daniel Zimmermann, DTI)

**About the author**

Prof. Keith Horner, University of Manchester, UK.

**Keith Horner** is Professor of Oral and Maxillofacial Imaging at the University of Manchester’s School of Dentistry. He was also a contributor to the latest revision of the EAO’s guidelines for the use of diagnostic imaging in implant dentistry.
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Traditional imaging will not disappear with CBCT

An interview with Prof. Stefan Haßfeld, Germany

“The ability to examine the craniofacial anatomy with help of three-dimensional images obtained through Cone Beam Computerized Tomography (CBCT) has been praised as the new gold standard in oral surgery. CAD/CAM recently had the opportunity to speak with Prof. Stefan Haßfeld from the University of Dortmund’s Department of Oral and Cranio-Maxillofacial Surgery in Germany about the technology and its future potential at the FDI Annual World Dental Congress in Hong Kong.

_CAD/CAM_: Prof. Haßfeld, in your opinion, has CBCT become a standard in dentistry?

Prof. Stefan Haßfeld: CBCT has been available in dentistry for over a decade and since then has been established as a standard for many indications. Despite this development, I doubt that the technology will make traditional imaging obsolete any time soon. Instead, it will be used as an aid in more complex treatments.

_One of the areas in which CBCT is used is implant treatment planning. What are the other main areas of application?

Nowadays, the technology is widely used in complex oral and maxillofacial surgery procedures. For example, we regularly examine large cysts and deeply impacted third molars with CBCT.

“In many cases, we expect a significant reduction in operative risks and an improvement in surgical planning.”

Its use can also be of benefit for the diagnosis of maxillary sinus diseases, as well as in traumatology or the correction of anomalies and dysgnathias.

_What potential does the technology offer regarding the improvement of treatment outcomes?

In contrast to traditional imaging, CBCT allows the human autonomy and pathology to be assessed in detail in 3-D space. This can be extremely helpful for treatment planning and the assessment of regions that present a surgical risk, like adjacent nerves, teeth or blood vessels. In many cases, we expect a significant reduction in operative risks and an improvement in surgical planning.

_According to the industry, the radiation dose for patients is significantly lower with CBCT. Do you agree with this statement?

I would have to disagree, since compared with traditional imaging, CBCT usually has a higher radiation dose. However, it also yields completely different information. By taking a high number of single images from different angles, CBCT can provide lower radiation doses only in a few exceptional cases.

_Is this the only drawback compared with traditional imaging techniques?

As CBCT has another field of indications, comparison with traditional imaging techniques is not appropriate. However, there are indeed some shortcomings, like higher radiation doses and costs, as well as a lower resolution compared with dental film.

_What role will CBCT play in dental practices in the future?

CBCT will take root in dental practices, particularly in those with emphasis on surgery, when it comes to certain complex treatment issues. For all the mentioned reasons, traditional imaging methods will not disappear.

A panoramic X-ray image, for example, provides an excellent overview of the entire jaw arch for clinically oriented examinations, with only little effort and at a small radiation dose. Dental film still offers the highest resolution for viewing details. Rather, the establishment of CBCT for dental imaging offers us additional options for daily practice.

_Thank you very much for this interview._
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Early childhood anterior tooth trauma

Implant-prosthetic restoration with a XiVE implant following piezoelectric bone splitting and bone grafting

Author_ Dr Fred Bergmann, Germany

Introduction

Being able to replace missing teeth by means of implants has opened up new opportunities in patient care and revolutionised the field of prosthetic rehabilitation. Progress in implant design and in surgical technique has increased the predictability of the treatment results and the survival rates of implants and implant-supported prostheses. In the maxilla, however, owing to the anatomical conditions, implant therapy currently has its limits.

Due to its cancellous bone structure, the maxilla does not offer optimal conditions for the primary and long-term stability of implants. The maxillary sinus is a further factor that makes the planning and insertion of implants in the posterior region of the maxilla difficult and requires extensive pre-implantation measures to prepare the implant site.

From an aesthetic perspective, implant treatment in the maxillary anterior region is a challenge for dentists. The smallest error in the positioning of the implant or improper handling of the peri-implant hard and soft tissue can lead to an irreversible cosmetic failure. Single-tooth implants in particular require all of the dentist's skills. In patients with a thin biotype, the visibility of the abutment through the thin gingiva presents a common problem.

Post-operative recession, resulting in parts of the implant becoming visible, is also common. Such recession generally occurs when a too large implant diameter has been selected or the implant has been positioned too close to the vestibular surface.
Insufficient hard and soft tissue may eventually lead to the implant restoration not integrating aesthetically with the existing dentition. Often, a reconstruction of the interdental papilla is not possible, and the contour of the marginal gingiva cannot be shaped harmoniously. A high smile line does not allow any compromises at all in soft-tissue aesthetics, since the colour and contour of the peri-implant mucosa must correspond to the soft tissue in the region of the neighbouring natural teeth. Careful planning, considering all relevant clinical and patient-related parameters, is therefore very important for achieving a predictable and aesthetically satisfactory treatment result in the implant restoration of a single tooth.

In a single-tooth replacement in the maxilla following traumatic anterior tooth loss, the practitioner faces the problem of a reduced amount of hard and soft tissue. Frequently, portions of the bony alveolar ridge near the tooth have been lost owing to trauma or natural resorption processes.

Careful selection of the grafting technique and implants with an osteoconductive surface makes treatment success predictable in terms of implant stability and aesthetics. Along with free connective-tissue grafts and guided bone regeneration using autogenous or xenogeneic bone materials, piezoelectric bone splitting or bone spreading techniques can be used for reconstruction.

Piezosurgery has been established as a successful technique in a variety of dental disciplines over the last ten years. Thanks to the adjustable ultrasound working frequency, different tissue types can be treated selectively without the risk of injury. With its narrow 60 to 200 µm width, the frictionless and vibration-free sectioning falls significantly below the incision width produced by using conventional instruments.

Today, bone splitting is considered to be a safe and simple method for the expansion of bone tissue. In a systematic review, success rates of 95 to 100 per cent were reported using this technique in combination with a single- or two-stage approach.

The final consideration in planning is the selection of the appropriate implant type: healing and osseous integration are markedly dependent on the chemical composition, loading, roughness and the morphology of the surface of the implant. Thanks to its good bone–implant interface characteristics and the associated increased primary stability, the XiVE implant system (DENTSPLY Implants) can also be placed securely and predictably into bone where the site is weak and into areas of low bone density. Long-term results demonstrate a high survival rate for XiVE implants, which can be traced back to the macro- and micro-design of the implant system.

Case report

Anamnesis

A 23-year-old, healthy patient presented at the practice requesting the replacement of tooth #21. The tooth had already been endodontically restored following an anterior tooth trauma in the patient’s childhood. Despite multiple revisions, the apical periodontitis had not healed. The tooth had been extracted and, as a result, there was severe bone resorption. The gap was initially restored with an interim prosthesis. Orthodontic treatment followed some years after the extraction, during which the gap in region #21 also had to be widened for the implant restoration.

Clinically and radiologically, a caries- and filling-free dentition was evident, with orthodontic brackets and archwires in the maxilla and mandible. There was evidence of severe buccal resorption of the alveolar process in region #21 (Fig. 1).

3-D radiological analysis

A 3-D analysis of the bony structures and the position of the nerve and the vascular bundles was performed for the treatment planning. Three-dimensional assessment plays a central role in the...
The surgical procedure was determined on the basis of the digital volume tomogram (DVT). The central issue was the optimal method of reconstructing the resorbed bone.

Since the horizontal bone volume was adequate, spreading the alveolar ridge by means of bone splitting in combination with implant placement and guided bone regeneration was the treatment of choice. The anatomy of the patient's alveolar ridge and his bone quality confirmed the decision to use the XiVE implant, as its unique surface promotes the stable attachment of osteogenic cells and its apically increasing thread depth contributes to a high degree of primary stability.

In the DVT transverse view, a XiVE implant with a diameter of 3.8 mm and a length of 13 mm was virtually placed using the software in the optimal implant position. It was established that the buccal lamella would have fallen short of the layer thickness of 1 to 1.5 mm necessary for the long-term retention of the implant (Fig. 2). Since this is indispensable for uneventful healing and an aesthetic result, the bone splitting was to be performed to a depth of 7 to 10 mm. The 3-D image demonstrated that the bone volume was adequate for this procedure. In addition to the bone splitting, a final lateral onlay graft had to be performed.

The axial view of the 3-D image is well suited to estimating the position of the nasopalatine nerve (Fig. 3). The position of the nerve is a limiting factor for the implant position in the palatal direction. The risk of a fracture of the buccal lamella or of damage to the nerve, however, is small when the correct procedure is used.

Surgical procedure

The mucoperiosteal flap was prepared and raised for the purposes of a full thickness flap. The periosteum was carefully detached from the bone (Fig. 4). Following the completion of the implant placement, the sutures should be located approximately over the split bone with the inserted implant. The alveolar crest at the planned implant site was initially marked using a round drill and then enlarged with a pilot drill.

In the next step, two small vestibular incisions and a horizontal incision to a depth of 10 mm and at an angle of 90 degrees were done using the Piezotome (Acteon; Fig. 5). The two relatively deep (5 to 7 mm) vertical incisions prevent a fracture of the buccal lamella, improve its mobility and protect the marginal periodontium of the adjacent teeth. The alveolar bone was then gradually expanded horizontally using the appropriate instruments (Fig. 6). In the process, the bone was also condensed horizontally at the same time by compression to improve the primary stability of the implant. Using a twist drill, the bone for the implant site was prepared gradually (Fig. 7).

The bone chips were removed simultaneously via the grooves in the twist drill to where they could be collected extra-orally. The implant site was prepared at low speed in order to avoid overheating the tissue. The vestibular lamella was stabilised by the apically pedicled flap on the periosteum and fixed. After the final drilling, the actual preparation of the implant site was complete. The bone-specific crestal preparation of the cavity was then carried out using the crestal twist drill to adapt the preparation to the clinical situation (Fig. 8).

In the next step, a XiVE S plus implant with a diameter of 3.8 mm and a length of 13 mm was...
mechanically inserted at a slow rotational speed (Fig. 9). In the process, the XiVE implant thread grips the bone palatally, while the labial lamella is not traumatised. The implant was sealed against saliva and bacteria using a colour-coded cover screw in preparation for the submerged healing phase.

The gaps in the implant site were then filled using the autogenous bone chips collected during the drilling process. In order to compensate for the resorption of the autogenous bone, a stable-volume alloplastic bone-grafting material was placed over the bone chips as a second layer. The raspatory was placed in front of the nasopalatine nerve to protect it, as there is only a thin bone lamella between the nerve and the mucosa. A resorbable collagen membrane was then placed over the augmented area and fixed to the bone with two titanium nails (FRIOS membrane tacks, DENTSPLY Implants). In this way, the mucoperiosteal flap prevented shifting of the membrane.

A double-layered wound closure was performed in order to prevent dehiscence. First, a resorbable suture (4.0) was used to attach the periosteum to the periosteum (Fig. 11). Then the mucosa was passively fixed with two over-and-over sutures. The radiological control shows that the XiVE implant in region #21 was positioned nearer to tooth #22 than to tooth #11 (Fig. 12). This distal position is typically due to the location of the nasopalatine nerve and is unavoidable.

Uncovering and soft-tissue management

Three months post-implant placement, the vestibular gingiva showed no signs of inflammation (Fig. 13). Measures to improve the soft-tissue volume in the aesthetic zone were planned. The XiVE implant was uncovered (Fig. 14) and the cover screw was replaced by a Friadent gingiva former for this purpose (Fig. 15).

Fabrication of the temporary restoration using CAD/CAM technology in the dental laboratory

After a brief healing phase of ten days, the patient was recalled for the actual temporary restoration. A suitable impression coping with a transfer technique with a TransferCap was inserted into the implant for impression taking using a polyether material (Fig. 16).

The cast model of the maxilla subsequently fabricated in plaster was then scanned in. An individual abutment was virtually created with the aid of the ScanBase, which displays the scanable counterpart to the TitaniumBase (DENTSPLY Implants; Fig. 17). The resulting construction data was transmitted to the milling machine, where the abutment was milled from a lithium disilicate block (Fig. 18). The finished abutment was cemented to the TitaniumBase. After completion, the precise position for the intra-oral insertion was reproduced on the master cast using a transfer key made from Pattern Resin.

Fig. 13. Three months post-implant placement, the gingiva showed no signs of inflammation.

Fig. 14. The XiVE implant was uncovered.

Fig. 15. To improve the soft-tissue volume in the aesthetic zone, the cover screw was replaced by a Friadent gingiva former.

Fig. 16. Friadent transfer post with a suitable TransferCap in situ prior to impression taking.

Fig. 17. Virtually created individual abutment.

Fig. 18. The abutment was milled from a lithium disilicate block on the basis of the construction data.
case report  implant prosthetic restoration

In the next step, the fully anatomical provisional crown was designed using the software and milled from a lithium disilicate block (Fig. 20). After completion, it was polished to a high gloss (Fig. 21).

**Placement of the temporary crown**

Subsequently, the mucosa healed around the gingiva former and exhibited a homogeneous, inflammation-free structure (Fig. 22). Prior to the screwing of the TitaniumBase abutment into the XIVE implant, the screw channel was cleaned with chlorhexidine then dried and the peri-implant mucosa was cleansed.

The precise intra-oral position of the abutment was checked using the resin transfer key. Following this, the optimal position for the temporary crown was also determined by means of the key and the crown was temporarily attached using cement (Fig. 23).

**Conclusion**

The method of implant placement and a grafting procedure with bone splitting in a single session described here presents a realistic alternative to conventional grafting of hard and soft tissue in the aesthetic region. The prerequisite is an adequate horizontal and vertical bone volume, in order to make the deep incisions necessary to mobilise the buccal lamella. The removal of bone blocks from additional surgical sites can be dispensed with for the patient.

The XIVE implant, which also guarantees primary stability in weak bone, with its unique, osseointegration-promoting surface and its compressive apical section, made the implant placement in this complicated case predictable, safe and successful.

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

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**Fig. 19** The precise position of the TitaniumBase, which was cemented to the customised abutment, was reproduced by means of a transfer key.

**Fig. 20** The temporary crown was virtually designed using the software and milled from a lithium disilicate block.

**Fig. 21** The finished, highly polished crown.

**Fig. 22** The healed peri-implant soft tissue.

**Fig. 23** The crown, inserted with the aid of the transfer key and temporarily attached using cement.

**Fig. 24** When the mouth was open, the length of the incisal edge conformed to the functional, aesthetic and phonetic requirements.

**Fig. 25** The final radiological control shows a well-osseointegrated implant, along with the radiopaque TitaniumBase and superstructure.

**Fig. 22** The healed peri-implant soft tissue.

**Fig. 23** The crown, inserted with the aid of the transfer key and temporarily attached using cement.

**Fig. 24** When the mouth was open, the length of the incisal edge conformed to the functional, aesthetic and phonetic requirements.

**Fig. 25** The final radiological control shows a well-osseointegrated implant, along with the radiopaque TitaniumBase and superstructure.
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CAD/CAM patient-specific abutments and a new implant design

Authors Prof. Frank Liebaug & Dr Ning Wu, Germany

Introduction

The objective of any dental reconstruction is the natural, functional reconstruction of the stomatognathic system and the functionally unimpaired or functionally treated masticatory organ. This objective can only be achieved if individual patient parameters and distinctive anatomical features are incorporated into surgical planning and the subsequent prosthetic restoration.

Implant-prosthetic care methods must be established as independent therapy alternatives for specialists and patients, and the possibility of achieving this objective is high. With attention focused on the prosthetic functional aspects of implantology, the prosthetic therapy objective is currently becoming the focal point of all efforts.

From the point of view of the practising dentist, the main emphasis in treatment planning for implant-supported dentures is placed on the prosthetic specialist. If said specialist is also trained in implants and surgery, he will place the implant himself as a support measure for his prosthetic therapy, which results in great simplification with regard to planning and the treatment process. As a rule, however, a dentist who deals with prosthetics will complete his implant prosthesis in close collaboration with an oral surgeon or oral-maxillofacial surgeon.

While surgeons are concerned with the best possible implant procedure or implant design, prosthetic specialists bring us back to the starting point of implantology: the patient’s wishes. Patients do not want implants; rather they want beautiful new teeth with which they feel confident in day-to-day life.

Team-work is gaining increasing importance in this regard, since, depending on the functional prosthetic objective, prosthetic specialists, dental technicians and implant surgeons might have to work together on the optimal implementation of the planned results using navigation and CAD/CAM systems. In the future, this method of integrating implantology will be found in just about every practice. As the hardware for 3-D planning is currently very expensive, dentists should seek suitable partners to support them in the integration of current therapy options.

Furthermore, from a biological and an economic perspective, production should rely on the most biologically compatible material with sufficient mechanical stability, for example titanium and cobalt-chromium alloys. Zirconium oxide is also an option. However, in terms of casting engineering, the processing of these alternative materials does not offer sufficient precision of fit. Cast implant structures manufactured from non-precious metals have been found to exhibit gaps with an average width of 200 to 230 µm between the superstructure and the implant abutment. In contrast, cast structures manufactured from precious metal alloys have been found to have gaps with an average width of 40 to 50 µm. The use of alternative materials thus requires the use of alternative production technologies, if only to obtain the required precision.

Ideally, a superstructure is milled from an industrially prefabricated solid material in order to eliminate inhomogeneities safely. Following this line of thought, milling-based manufacture of superstructures using the CNC (computer numerical control) procedure began more than ten years ago. Attempts with this kind of CAD/CAM technology demonstrated that the achievable precision of current constructions—between 20 and 30 µm—is better than the precision of fit achieved with cast precious metal structures.

With modern scanning and software technology, this production principle has been extended to the area of virtual construction. Thus, the CNC milling procedure, which has been used for years, is supplemented with the possibility of a purely virtual con-
struction. This technology is now offered by various manufacturers.

Objective

Our objective as specialists must not only be the replacement of a lost tooth as soon as possible after extraction, but also be the satisfaction of our patients’ constantly increasing aesthetic demands—with regard to the anterior tooth area in particular—through suitable bone and soft-tissue management.

Thus, even when the implant is being inserted, preference must be given to keeping the crestal bone structure as unchanged as possible because in this way the interdental papilla and the peri-implant gingiva can be maintained in the long term.4

Case presentation

The realisation of the patient’s wish was facilitated in the following case in close collaboration with Zahn technik Zentrum Eisenach after the tooth replacement was firmly in place, despite alveolar bone loss and difficult gingival conditions (Figs. 1 & 2). The surgical procedure for this case is described in Liebau and Wu (2011).5

The anatomically formed and bevelled OsseoSpeed TX Profile implants (DENTSPLY Implants) were used in regions #12, 11, 21 and 22. These implants are specially designed to preserve the marginal bone in an alveolar ridge with angular atrophy both vestibularly and orally, that is, 360 degrees around the implant.6 Restoration with patient-specific ATLANTIS abutments (DENTSPLY Implants) was planned in order to complete prosthetic restoration optimally after successful implantation and osseointegration. As described in Noelken (2011),7 the marginal bone can be preserved cheaply by the use of these implants, which are new to the dental market. Optimal soft-tissue support can be achieved with individualised manufactured abutments.

Challenge in terms of maxillary anterior tooth loss

While replacing a missing tooth with an implant can now be considered routine, rehabilitation in the maxillary anterior region still represents a particular challenge for the treatment team. In addition to successful osseointegration of the implant, particular attention must be given to functional and aesthetic parameters to achieve a restoration that perfectly harmonises with natural teeth.8

Prior to surgery: Addressing the patient’s wishes and providing information

The patient’s wishes must always be considered before treatment begins. The patient should be offered clarification prior to treatment, particularly in difficult initial situations with evident hard-tissue loss and unfavourable gingival conditions. For forensic reasons, photographic documentation of the initial situation is an indispensable aid in addition to diagnostic casts. It should also be used as the basis for discussion with the patient.

If bone on the labial side has already been lost and the optimal bone contours have not been restored with a bone transplant, achieving the desired aesthetic result is nevertheless often not difficult.

In terms of this 67-year-old patient, the implants were exposed by incision to the middle of the alveolar ridge from regions #12, 11, 21 and 22 after a four-month healing phase (Fig. 3).
It should be noted that, owing to the bevelled design of the implants used, an almost seamless insertion into the natural osseous alveolar process is achieved, and thus the plastic cover and the primary wound closure are simplified for the surgeon. This is also the basis for a quick and smooth healing process.

Three-dimensional bone structures can be preserved using the above-mentioned OsseoSpeed TX Profile implant. Healthy bone is a prerequisite for optimal prosthetic restoration with regard to aesthetics. The otherwise often necessary hard- and soft-tissue transplants can now mostly be avoided.

The extent to which a temporary restoration can be screwed together after prosthetic pretreatment and after the implant region has been moulded, or whether a removable device can be used temporarily, depends significantly on the patient’s financial resources. In addition to the use of gingiva formers native to the system, temporary restorations aid the moulding, preparation and stabilisation of the peri-implant soft tissue during and after the healing phase. As the interim prosthesis guaranteed functionality and aesthetics that satisfied the patient, additional moulding of the soft tissue was achieved through special gingiva formers or healing abutments.

The results obtained in terms of preservation of the marginal bone using the ASTRA TECH Implant System (DENTSPLY Implants) are documented in Palmer et al. (2000) and Wennström et al. (2005). Preservation of the marginal bone level and healthy soft tissue are indispensable for the long-term success of implant treatment both clinically and aesthetically. The bone provides the soft tissue with stability, while the soft tissue protects the bone from micro-organisms.

A special feature of the implant system used is the patented Conical Seal Design, which prevents micro-movements and micro-gaps at the interface between the implant and abutment, reliably protecting the implant and bone from bacteria. The clinical relevance of the pump effect caused by micro-movement and possible crestal bone resorption were experimentally tested by Zipprich et al. (2007). Furthermore, arising stress is distributed farther into the bone and peak loads are simultaneously reduced. In this regard, the preference for preserving the marginal bone level must be clarified as well. The implant-abutment connection is thus reliably sealed against bacteria and the bone is thereby protected from external influences. Maintenance of the superstructure is also made easier for the patient.

The integration of the abutment is simplified by the conical implant-abutment connection. However, with regard to the bevelled OsseoSpeed TX Profile implants, particular attention must be given to the precise transfer of the clinical situation to the model being manufactured using moulding aids and transfer posts during precision moulding, which requires specific experience and a good instinct.

The individualised ATLANTIS abutments are a good solution for cemented crowns or bridges, as they guarantee optimal functionality, are the basis for sophisticated prostheses and are easy to use.
ATLANTIS abutments fabricated from titanium, titanium nitride-coated titanium (ATLANTIS GoldHue) or zirconium oxide are available for all established implant systems. All abutments are supplied by the manufacturer with the corresponding abutment screws. The ATLANTIS VAD (virtual abutment design) software allows the production of abutments that are based on the final tooth form and thus guarantees not only a natural, aesthetic result but also optimal functionality. A model was produced from the impression following healing, implant exposure (Fig. 3) and insertion of temporary gingiva formers (Fig. 4).

The master cast should have a stable removable gingival mask made of silicone (Fig. 7). Casts should be placed onto articulators before the dentist or dental laboratory sends them in to Astra Tech so they can subsequently be sent with the ATLANTIS CaseSafe shipping box. The models can be converted into a virtual image using a 3-D scanner after the model has been produced in a high-tech dental laboratory or after the model has been sent, should no scanner be available immediately (Figs. 8–10).

After the specialist has confirmed the virtual abutment design, which is sent via e-mail, the ATLANTIS abutment is manufactured, verified and sent to the attending dentist (Figs. 7 & 11). Individualised prostheses can be manufactured in the dental laboratory after the precision of fit and the position of the patient-specific abutment have been verified (Fig. 12).

It must always be ensured that the abutment screw delivered with the abutment is used for the final insertion of the abutment in the mouth. The ATLANTIS abutments are designed to correspond to the form of the dentine core of natural teeth. Of course, the ATLANTIS VAD software allows for consideration of the specialist’s preferences, which should take the patient situation into account, with regard to the production of the individualised abutment. The size of the abutment is determined by the average profile created by the form and size of the healing or temporary abutment.

The mucosa may be temporarily anaemic when the abutment is inserted into the patient’s mouth (Figs. 13–15). ATLANTIS abutments are manufactured with standard gingival moulding if the specialist does not select or provide any particular options when the order is placed.

Considering the extremely unpromising initial situation (Figs. 1 & 2), a result that was satisfying in terms of functionality and aesthetics for both the patient and the dental/prosthetic specialist was achieved after the individualised crown restoration had been placed (Figs. 16 & 17).

The patient’s wish for stable and natural-looking teeth was fully satisfied, which was ultimately the main criterion and motivation for our efforts as the treating team. Additional improvement of the soft-tissue situation is expected if the patient adheres to the appropriate cleaning technique.

Conclusion

Implantology is a central component of modern therapy procedures in dentistry. Continuous development of materials, implant design and the relevant technologies seeks to obtain high reliability with a good long-term prognosis for a wide range of indications. Careful diagnosis and detailed planning are indispensable if patients’ increasing demands are to be satisfied. In particular, care in aesthetically demanding clinical situations requires interdisciplinary treatment in many cases. The possibilities presented by this case report for the production of patient-specific abutments on anatomically formed and bevelled OsseoSpeed TX Profile implants constitute a gain and are the basis for long-term success, even in the event of reduced bone and difficult soft-tissue conditions.

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The importance of occlusion

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The correct physiological restoration of occlusion poses a major challenge for every dentist and technician. Even the smallest high spot, measuring just a few microns, can cause dysfunction in a patient's masticatory system. In restorative dentistry, occlusal proportions are constantly changing. It is therefore essential, for the benefit of the patient, to understand and monitor the function of teeth in static and dynamic occlusion. Functional occlusion is important for the overall health of the patient. The interdisciplinary verification of symptoms and treatment is an integral part of daily practice. Therefore, checking the occlusion during treatment is strongly encouraged.

Occlusion and the potential effects of occlusal interference on patients

Every restoration, extraction, prosthetic device and orthodontic treatment changes the static and dynamic occlusion. The smallest occlusal interference of just a few microns is disruptive to the proprioceptors of the stomatological system. This can cause bruxism (clenching or grinding), which can result in functional disorder of the cranio-mandibular system. Overstraining teeth, periodontium, muscles and joints are the effects.

It is important not only to detect, but also to avoid further functional disorder in the cranio-mandibular system. The smallest interference to habitual occlusion can cause serious disturbances for the patient. An acute functional disorder such as clenching or grinding can become chronic in the long term.

Patients with new fillings, crowns and bridges, or who have undergone orthodontic treatment, who complain of typical symptoms (cranio-mandibular dysfunction syndrome) should undergo...
examination of their occlusion specifically. Premature contacts are often uncomfortable, as the proprioceptors are sensitive to pressure. The patient will try to compensate for the occlusal interference by adopting a new habitual position, with consequences for the attached tissue structures.

Position for occlusal restoration

Essential to any kind of occlusal restoration is the position of the mandible. Most patients are treated in their habitual position of the mandible, which is the correct position for most patients. For patients with more complex restorations or patients suffering from temporomandibular joint disorders, a new physiological positioning of the mandible is essential. In most cases, centric occlusion is the new therapeutic position.

Centric relation is the position of the mandible relative to the maxilla, with the intra-articular disc in place, when the heads of the mandibular condyles are against the most superior part of the distal-facing incline of the glenoid fossa (i.e. the mandibular condyles are in their most superior and anterior position).

For balanced occlusion in a static position, the patient should have enough ABC contacts on each quadrant in the intercuspal position. In this position, the teeth of the opposing jaws achieve complete intercuspation and are in maximum contact with each other.

Figs. 5 & 6. The best physiological position: the condyles are in centric position with enough occlusal contacts.
Figs. 7 & 8. The condyles are still in centric position. An interfering initial contact is evident on tooth #36.

Figs. 9 & 10. Compensatory reaction caused by the interfering contact on tooth #36. The mandible has shifted to a new position, which is out of centric occlusion, to compensate for the occlusal interference.
The physiological influence of interfering initial contacts

For most of the patients, their habitual position of the mandible in maximum occlusion is the preferred position for occlusal restoration. However, even a tiny interfering prematurity contact of only 20 µ can trigger a compensatory reaction, placing the mandible into a new physiological position. This is a natural reaction of our biological system to avoid higher forces focused only on one area.

For example, if you are eating something and you chew on a little grain of sand, you automatically shift your mandible to a different position to protect your teeth. A permanent "grain of sand" (occlusal interference) can trigger an overload of the biological system, in which case the patient will have reached his or her maximum capacity for compensation. Pain symptoms can then become chronic.

Occlusal restoration

In order to reconstruct physiological occlusion, correct visual identification of contact points is essential. Occlusion checking materials (articulating papers) with the effect of progressive colour transfer are helpful in identifying occlusal forces in intercuspal habitual position. Areas with higher force loads can be identified as darker-shaded markings with higher contrast. These markings likely indicate the initial contacts. Areas with less intense colour markings indicate contacts with lower occlusal forces or areas with no contact. Upon close examination, these markings look like a donut. The centre of the contact point has a lighter shade. The more intense-coloured edge of the contact point is not part of the contact. Just the lighter-coloured centre is the real contact area. For occlusal equilibration, only these areas should be adjusted. For a balanced occlusion, the patient should have enough ABC contacts on each quadrant.

Occlusal corrections can be additive or subtractive. If modification of the occlusal relationship in patients who have been grinding their teeth over a long period is needed, this may be challenging, as they would already have lost a significant part of their hard tooth tissue. A splint is indicated for treating such patients (additive occlusion).

Conclusion

The reconstruction of physiological occlusion is essential for the complex functioning of the entire stomatognathic system. There are various concepts of occlusion. For recording and analysing the complex movement of the mandible, a wide range of electronic devices are available.

Beside all these tools, a basic understanding of the biomechanical design of an occlusal surface is essential. Today, we have a wide selection of different occlusion indicators to visualise these biomechanical structures. Soft colour-impregnated occlusion checking papers, in combination with thin occlusion checking films, are optimised for visual checking of the occlusal relationship between the maxilla and mandible.
Computer-aided crown design—Fabrication of CAD/CAM crowns chairside

Author Dr Andreas Bindl, Switzerland

CAD/CAM technology allows dental professionals to manufacture solid all-ceramic crowns chairside. A digital image of the preparation is captured with an intra-oral camera and the crown is designed accordingly. A variety of ceramics are available for the construction of the crown, for example an aesthetic, easy-to-mill ceramic such as IPS Empress CAD (Ivoclar Vivadent). As this leucite glass-ceramic is weaker than zirconium oxide, these crowns must be seated with the adhesive technique (for example with Syntac/Variolink II or Multilink Automix, all Ivoclar Vivadent). This makes them strong enough to withstand masticatory forces in the long term.

IPS e.max CAD (Ivoclar Vivadent), which has been on the market for some time, is a lithium disilicate glass-ceramic that demonstrates a flexural strength of 360 MPa. This ceramic is machined to the desired shape while it is still in its metasilicate or blue state (approximately 130 MPa). Subsequently, the ceramic is crystallised for 20 minutes. During this process, the material attains its final state and obtains its excellent mechanical and aesthetic properties. IPS e.max CAD is available in a low translucency (LT) version, which is suitable for the fabrication of crowns and implant-retained crowns. The high translucency form is intended for the construction of inlays and partial crowns. The stains and glaze are applied before the crystallisation process.

As a result, subsequent polishing is unnecessary. Owing to the high strength of the restoration, adhesive cementation with a separate dentine conditioner is not indicated as long as the thickness of the ceramic is not less than 1.5 mm. Self-adhesive...
Cementation materials can be used. The new self-adhesive composite cement SpeedCEM (Ivoclar Vivadent) is particularly suitable for this purpose.

In this case report, the chairside creation of a crown is described on the basis of a clinical case using IPS e.max CAD LT and the new SpeedCEM luting cement.

**Clinical case report**

Tooth #25 of a 32-year-old female patient was restored with a crown owing to extensive destruction of the dental hard tissue (Fig. 1). First, the tooth was prepared with a shoulder of approximately 1 mm in width (epigingivally). Subsequently, the preparation was dusted with IPS Contrast Spray (Ivoclar Vivadent) and a digital impression was taken with the CEREC Bluecam camera (Sirona). The Version 3.8 of the CEREC software generates a visual image of the antagonists, which replaces the centric bite record. In order to match the maxillary and mandibular teeth, an image of the centric situation was captured from the buccal aspect (Fig. 2). The maxillary and mandibular teeth were matched semi-automatically (Fig. 3).

The 3.8 version is capable of designing biogeneric occlusal surfaces for full crowns. The software provides a design proposal for the tooth morphology, which is based on the occlusal surface of the distal neighbouring tooth and the antagonist (Fig. 4). The image of the bucco-oral cross-section of the crown allows the user to check the minimum occlusal thickness of 1.5 mm (Fig. 5). The occlusal view of the crown in the blue state during try-in, before crystallisation firing (Fig. 6). The buccal view of the crown in the blue state during try-in, before crystallisation firing (Fig. 7). The occlusal view of the crystallised and glazed crown on tooth #25 (Fig. 8). The buccal view of the crystallised and glazed crown on tooth #25 (Fig. 9).
The thickness of the ceramic (0.2 vol.%) during crystallisation is taken into account by the software and adjusted accordingly.

After the crown had been milled, the proximal and occlusal contacts were adjusted on the patient (Figs. 6 & 7). In this case, the white and creme materials from the corresponding stain assortment (IPS e.max CAD Crystall./Stains, Ivoclar Vivadent) were sparingly applied to the cusp tips and the sunset material to the tooth neck and in the fissures.

Immediately afterwards, a glaze in spray form (IPS e.max CAD Crystall./Glaze Spray) was applied to the outer surfaces of the crown. The spray was applied several times. Once the restoration had been fully coated with a white-opaque glaze layer, the crown was fired in a combined crystallisation and firing process in the Programat CS furnace (Figs. 8 & 9).

Before the restoration was cemented in place, the inner surface of the crown was etched with 4.9 per cent hydrofluoric acid (IPS Ceramic Etching Gel, Ivoclar Vivadent) for 20 seconds. Subsequently, it was silanised for 60 seconds (Monobond Plus, Ivoclar Vivadent). The crown lumen was filled with the self-adhesive SpeedCEM. Next, the crown was securely seated on the prepared tooth by applying even pressure (Fig. 10).

The cement residue was polymerised for one second per surface (mesio-oral, disto-oral, mesio-buccal, distobuccal) with a curing light (bluephase in the low power mode, Ivoclar Vivadent) at a distance of about 5 mm. In this cured state, the cement was removed with great care using a scaler and a probe. The cement was fully cured with the bluephase in the high power mode. Subsequently, the cement margin was polished. The final inspection revealed the restoration to be in harmony with the overall situation (Figs. 11 & 12).
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osseo.org

ADA CERP® Continuing Education Recognition Program
Planmeca ProMax 3D Mid—An optimal volume size for every 3-D imaging application

Planmeca has introduced a new product to the recognised Planmeca ProMax 3D range. Planmeca ProMax 3D Mid provides an extended selection of 3-D volume sizes, combined with traditional 2-D panoramic and cephalometric imaging.

Planmeca ProMax 3D Mid offers the user an optimal volume size for every application requiring 3-D imaging. For example, for endodontics requiring high resolution, implantology requiring images with a smaller field of view, and for orthodontics requiring large image sizes. The volume sizes range from 34 x 42 mm to 160 x 160 mm. This wide selection of volume sizes allows optimisation of the imaging area according to the specific diagnostic task—always complying with best practice and the ALARA (as low as reasonably achievable) principle to minimise radiation.

Additionally, Planmeca ProMax 3D Mid offers a new kind of panoramic imaging. The standard panoramic imaging program is optimised to expose only the teeth area to radiation, reducing patient dose. Optionally, the temporomandibular (TMJ) joints can be imaged with a program in which the TMJ imaging angles can be adjusted, as with regular TMJ programs.

“Planmeca ProMax 3D Mid clearly demonstrates our best achievement in imaging. It provides the most advanced visualisation of patient anatomies for a variety of diagnostics needs—never compromising the important principle of minimising the radiation dose when feasible,” explained Auvo Asikainen, Vice President of the X-ray Division at Planmeca.

Planmeca ProMax 3D Mid is based on Planmeca ProMax technology. Planmeca’s existing 3-D imaging products in this range are Planmeca ProMax 3D’s, ideal for applications where a smaller field of view is sufficient, Planmeca ProMax 3D for general 3-D applications with a field size covering the mandible and maxilla, and Planmeca ProMax 3D Max for a variety of field sizes from a single tooth to the entire maxillofacial area.

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CEREC Omnicam: Powder-free 3-D scanning in full colour

This autumn Sirona presented its new CEREC camera in Europe. The CEREC Omnicam generates full-colour scans of intra-oral surfaces without the need for a powder coating on the teeth (Fig. 1). Operating the camera is simple and intuitive. Moreover, the imaging functionality and camera dimensions are ergonomically designed. Sirona, a technology and market leader in the dental industry, launched its new CEREC Omnicam camera in August at a special event in Las Vegas, USA. This exciting new product was recently unveiled to dental professionals in Europe at an informative product presentation attended by distributors and the media at the company's new headquarters in Salzburg. At the launch, the generation of precise whole-arch scans in the shortest possible time using the camera was demonstrated.

Three features of the CEREC Omnicam stand out in particular: it supports video streaming; it digitises the structures of the jaw in their natural colour; and it does not require powder coating of the tooth surfaces. Instead, the user moves the camera head over the intra-oral surfaces with a smooth, flowing movement. The CEREC Omnicam is extremely resistant to camera shake.

A virtual 3-D model is displayed in natural colour on the monitor of the CEREC AC. Thanks to this life-like visualisation, it is easy to distinguish between different materials (enamel, dentine, metal or composite) and identify the palatinal and gingival contours. As a result, it is easy to navigate around the oral cavity and determine the preparation margins—even in subgingival areas. The extensive depth of field of the CEREC Omnicam delivers high-precision images, even in cases in which the camera has been placed directly on the tooth.

The ergonomic, lightweight camera feels comfortable in the hand. Thanks to the slimline design and the compact camera head, it is easy to scan inaccessible areas such as the distal surfaces of the posterior molars (Fig. 2).

In addition, the CEREC Omnicam boasts a patient-counselling mode. The dentist can record short video clips and present these to the patient via the CEREC AC monitor. This promotes effective communication and enables the patient to make important decisions based on reliable information.

In future, CEREC AC will be available in combination with either the tried-and-tested CEREC Bluecam or the new CEREC Omnicam. Both cameras are easy to use and generate high-precision scans. The Bluecam and Omnicam differ in terms of technology and field of application. Whereas the CEREC Omnicam is particularly well suited to multiple restorations, the strengths of the CEREC Bluecam lie in its proven precision and extensive field of view, which makes it ideal for single-tooth restorations. The Bluecam generates a series of 3-D images, which are subsequently combined in order to create a panoramic image of the teeth. The benefits of the CEREC Omnicam at a glance:

**Unrivalled handling:**
- slim, lightweight casing and compact camera head;
- natural flowing movement of the camera over the tooth surfaces;
- anti-vibration function;
- extensive depth of field.

**Powder free:**
- fewer processing steps;
- short learning curve;
- the digital impression-taking process can be delegated to an assistant.

**Colour visualisation:**
- improved patient counselling;
- the natural colours of the virtual 3-D model enable the dentist to identify the various tooth surfaces clearly and determine the preparation margins.

Owing to the ongoing marketing authorisation procedures, the CEREC Omnicam is not yet available in China, Japan, South Korea, certain countries in the CIS and South America.

Thanks to the slimline design and the compact camera head, scanning the posterior teeth is trouble-free.
3Shape introduces CAD Points—A unique pay-per-design service that opens up new opportunities for dental labs

3Shape CAD Points provides a new way for medium-sized or smaller labs to offer a wider range of services with a minimal upfront investment. CAD Points gives labs pay-per-design access to 3Shape’s add-on modules for designing customised abutments, implant bars and bridges, removable partial dentures and other advanced indications.

Dental labs can purchase CAD Points through 3Shape’s Webshop or reselling partners and moments later can use their CAD Points to pay for creating a new design, according to predetermined CAD Point pricing. CAD Point functionality is integrated into 3Shape’s Dental System, and users of the system can gain access to add-on modules for advanced indications using CAD Points. Through their status overview, users can easily keep track of their CAD Points, and they receive notifications when their CAD Points are about to run out.

3Shape CAD Points gives easy access to designs for advanced indications

With CAD Points, 3Shape, a technology leader in 3-D scanning and CAD/CAM software for dental applications, is offering a unique business opportunity to dental labs. 3Shape CAD Points is a flexible getting-started package for labs that want to offer services for a complete range of dental indications, or test potential new business models, without committing to a major upfront investment.

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Straumann and Align announce in October that they had decided to discontinue their distribution agreements for the iTero intra-oral scanner in Europe and North America with effect from 31 December 2012.

The agreement for exclusive distribution in Europe was signed in 2009 between Straumann and Cadent, the developer of iTero, which was acquired by Align Technology in April 2011. The agreement awarding Straumann non-exclusive distribution rights in North America was signed shortly before the acquisition.

Beat Spalinger, Straumann’s president and CEO, explained the rationale behind Straumann’s decision: “We are convinced that intra-oral scanning will have a major role in daily dental practice thanks to its superior accuracy, convenience and patient comfort in comparison with conventional impression taking.

Furthermore, we are convinced that iTero is one of the best intra-oral scanners available. However, we have decided to step back from distributing this hardware for three reasons.

First, our experience over the past three years has shown that a single hardware brand limits our addressable market. Moving ahead, our CARES CAD/CAM system will be accessible to various intra-oral scanning systems, including the iTero scanner.

Second, our core business is in tooth replacement and restoration. We now have the digital workflow in place to enable us to produce high-precision prosthetics for dental implants, starting from an intra-oral scan.

As a result, we no longer need to sell intra-oral scanners directly and will focus our resources on driving our CARES business. And lastly, we have come to the conclusion that the business case for distributing scanners is not economically viable for us in the present economic environment.”

Align and Straumann are fully committed to providing continued support and services to existing iTero customers. The two companies are currently working together on plans for a smooth transition and will communicate details to customers once they are finalised. In the meantime, Straumann will continue to offer first-level equipment support in Europe for at least the next 12 months, after which Align will assume full responsibility for regional customer service.

Straumann is strongly committed to digital dentistry and the development of digital workflows as part of its CARES platform and product offering. The discontinuation of the distribution agreements with Align will not affect the launch of new CARES services and products.

However, it will have an impact on Straumann’s intra-oral scanning staff and further details in this respect will be communicated with the company’s third-quarter results on 30 October. Sales of intra-oral scanners constitute approximately one per cent of the Straumann Group’s net revenue._
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The CAMLOG Foundation is calling for submissions for its third CAMLOG Foundation Research Award. The award is presented biennially at the International CAMLOG Congress and is open to all talented scientists/researchers and dedicated professionals at universities, hospitals and practices under 40 years of age. The submissions must have been published in an accredited scientific journal and can be submitted in either English or German. The articles must deal with one of the following topics in implant dentistry or a related discipline:

- diagnostics and planning;
- hard- and soft-tissue management;
- sustainability of implant-supported prostheses;
- physiological and pathophysiological aspects; and
- advances in digital procedures.

The contributions will be evaluated by the CAMLOG Foundation Board. The winner of the 2012/2013 CAMLOG Foundation Research Award will be given the opportunity to present his/her work to a wider audience during the 2014 International CAMLOG Congress. Furthermore, the authors of the three best contributions will receive attractive cash prizes of €10,000, €6,000 and €4,000, respectively.

The entry conditions and the mandatory registration form can be downloaded from the internet at www.camlogfoundation.org/awards. The registration deadline is 30 November 2013.

The CAMLOG Foundation is a foundation established under Swiss law. It engages in the targeted support of gifted young scientists, promotion of basic and applied research, and continuing training and education to promote progress in implant dentistry and related fields to better serve the patient.

As part of its scientific mission, the CAMLOG Foundation holds its international congress every two years.
Announce your courses in CAD/CAM!

WHAT?

LIVE EDUCATION SYMPOSIUM AT FDI ANNUAL WORLD DENTAL CONGRESS

28–31 August 2013

Istanbul Congress Center, Istanbul, Turkey

The Dental Tribune Study Club would like to invite you to participate at our Live Education Symposium at FDI Annual World Dental Congress. We will offer an ambitious schedule of continuing education (CE) lectures in various dental disciplines. Each day will feature a selection of lectures led by experts in the field, providing an invaluable opportunity to learn from opinion leaders, while earning ADA CERP C.E. Credits. We have developed a program that is both diverse and engaging, with every lecture offering you the practical guidance you seek to take back to the practice and put to immediate use.

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CONTACT INFO

For more information and to reserve a spot for your course(s) in the upcoming issues, please contact Vera Baptist, Product Manager CAD/CAM, at +49 152 29929405 or v.baptist@dental-tribune.com.
Digital dentistry conference draws over 500 to Singapore

Author: Dental Tribune Asia Pacific

Top left_CDO Patrick Tseng (left) getting hands-on with the latest equipment. (Photos courtesy of CAPP Asia, Singapore)
Top right_CAPP's Business Development manager Tzvetan Deyanov and Managing Director Dr Dobrina Mollova in talks with DTI publisher and CEO Torsten R. Oemus (from left to right). (DTI/This Photo Daniel Zimmermann)

Attendance figures for the first CAD/CAM & Computerized Dentistry International Conference in the Asia-Pacific region have exceeded original expectations, the Center for Advanced Professional Practices (CAPP) has announced. According to its figures, more than 520 dental professionals took part in the event, which was sponsored by major market players and saw 14 lecturers from around the globe presenting in fields like computer-guided surgery and 3-D dental imaging.

Plans for a follow-up conference in the city-state are already being discussed and will be announced in the coming weeks, CAPP officials recently told Dental Tribune Asia Pacific. The event will be held in autumn next year after the organisation’s eighth Dubai congress scheduled for May 2013.

CAPP has been organising congresses for dental CAD/CAM and computerised dentistry in the emirate since 2006. As a spin-off of its suc-
cessful annual series there, a conference was organised for Asian dentists for the first time this year. Besides a three-day scientific programme, it offered a theatre presentation on chairside CAD/CAM-fabricated restorations, as well as a parallel session that aimed to provide dental technicians in the region with an overview of the latest digital technology and guidelines for its use in dental labs. In addition, renowned orthodontist Dr Khaled Abouseada held a workshop on using ClearPath, a US-developed invisible aligner orthodontic therapy manufactured and distributed by ClearPath Orthodontics in Saudi Arabia, with dental CAD/CAM.

Prof. Seung-Pyo Lee and Shin-Eun Nam from South Korea won the poster presentation competition with their new method of measuring interdental space using 3-D virtual models. They competed against fellow researchers from South Korea and Malaysia, who presented latest findings on digital restoration using implant prostheses, among other things.

“We should all be open to learning about the newest technologies,” Dr Kuan Chee Keong, President of the Singapore Dental Association (SDA), remarked. “CAD/CAM technology is inevitable and it is a very good idea to hold such a conference here.”

Keong added that his association will continue to support CAPP’s efforts in Singapore in the years to come. The SDA has worked with the company over the last 12 months to raise awareness of the event among local dentists, who represented more than 40 per cent of the conference attendees.

The event also received support by Dental Tribune’s flagship publication DT Asia Pacific, as well as its CAD/CAM international magazine of digital dentistry.

CAPP recently partnered with the international dental publisher, agreeing to manage its operations in the Middle East and Africa.
EAO celebrates successful anniversary event in Copenhagen

20th congress of the European Association for Osseointegration presented latest concepts and developments in implant dentistry

Author: Dental Tribune International

Celebrating the achievements of implant dentistry in the last 20 years, thousands of clinical specialists from Europe and around the globe recently gathered at the Bella Center exhibition and congress venue in the Danish capital for the annual scientific congress of the European Association for Osseointegration (EAO). Following a successful event in Athens last year, the congress event more than 2,300 scientists and clinicians involved in implant and restorative dentistry over the course of four days.

Besides an extensive scientific programme covering topics like imaging and factors of implant loss, the event saw a record number of companies exhibiting established clinical solutions.
and a number of new products, including dental implants and sophisticated surgical equipment.

Market leader Nobel Biocare, for example, had its new OsseoCare Pro drill motor, which can be operated entirely through Apple’s iPad tablet computer, on display. Italian manufacturer mecon presented its multipiezo pro device, which can be used for ultrasonic implant cleaning, in Copenhagen.

New implant devices were exhibited by MIS Implants, MegaGen and BioHorizons.

Held for the 20th time, the EAO’s latest annual meeting looked back on various issues related to implant dentistry from the last two decades. Acknowledging the progress being achieved in the field, a Saturday morning session titled "Future perspectives of implant dentistry" discussed future prospects of bioactive implant surfaces and the use of computer-guided implant planning, among other topics. For the first time, a session organised by members of the EAO’s Junior Committee also presented new revolutionary ideas that could shape implant dentistry in the years to come.

Having originated from a clinical meeting by implant specialists in the late 1980s, the EAO is today an established authority and one of the most important scientific and clinical forums for implant dentistry in Europe. It is comprised of renowned clinicians and researchers from around the world.

With more than one third of visitors coming from regions outside the continent, its annual scientific congress has recently gained more relevance internationally.
Since the 1980s, digital technology has increasingly been used in dentistry. Initially, CAD methods were used in manufacturing glass-ceramic inlays and crowns. Later, stereolithography was used to make guides for navigated implantation. Today, advances in the development of CAD/CAM have reached just about every aspect of dentistry and caused significant changes in some cases. The state of the art in CAD/CAM will be on display at the International Dental Show (IDS) in Cologne from 12 to 16 March 2013.

While not everything is digital and conventional techniques are certainly still necessary, progress continues to advance at a rapid pace. It is a good idea to become well informed about these latest developments, as this is the only way to determine which innovations are important for one's own work.

At IDS, dentists will discover how the possibilities of CAD/CAM technologies can optimise daily work in their practices, regardless of whether the practice already uses integrated digital processes or plans to do so in the future. In some cases, dental technicians have been benefiting from advancements in CAD/CAM for years. As far as they are concerned, the innovations that will be presented at IDS represent an opportunity to expand the range of services they offer at their own laboratories.
Regardless of whether the issue is CAD manufacturing processes, new materials or advanced milling machines, high-tech is becoming increasingly important in laboratory work. Planning and preparation processes are becoming more detailed and goal oriented. The virtual process chain actually starts at the dentist’s chair. First, digital impressions of the patient’s teeth are made using an oral scanner. The data is then transferred, a virtual design is made using CAD planning software, and finally a precise visualisation of the functional and aesthetic results is displayed. And all this takes place before treatment even begins!

These techniques not only affect collaboration between the practice and the laboratory, but also offer immediate benefits to the patient. Intra-oral scanners, for example, are very popular because they eliminate the need to take impressions using a moulding compound—a process that is rather uncomfortable for some patients. For patients who are especially anxious, this could be decisive in enabling them to overcome their fear of a visit to the dentist. The intra-oral scanner market is diverse. Thanks to different functional principles and different ways of handling the instrument, the no-contact impression technique appears to have enormous potential. In addition to generating patient loyalty, it also makes collaboration between dentists and dental technicians particularly efficient.

The latest planning tools also contribute to successful dentist-technician cooperation. With these tools, a virtual preview of the planned dental prosthesis can be created. In other words, an important decision-making aid is now in the hands of the patient. It is certainly easier to convince patients of the benefits of a particular treatment when they have the desired results before their eyes. The appropriate software can thus provide valuable assistance during consultations, which is an advantage for both the dentist and the technician.

“Developments in the CAD/CAM segment are making great strides,” according to Dr Markus Heibach, Executive Director of the Association of German Dental Manufacturers (VDDI). “Whether it’s materials, software, CAM modules or the networking of the individual components and processes, all of the relevant innovations will be presented at IDS in Cologne.

In addition, visitors will have the opportunity to go directly to trade fair stands, where they’ll get first-hand information and be able to discuss important issues with manufacturers and experts.”

IDS is held in Cologne every two years and is organised by the Society for the Promotion of the Dental Industry (Gesellschaft zur Förderung der Dental-Industrie) and the commercial enterprise of the VDDI, and staged by Koelnmesse.
International Events

2013

2\textsuperscript{nd} BIOMET 3\textsuperscript{i} European Symposium
11 \textsuperscript{th} 12 January 2013
Madrid, Spain
www.biomet3ieuropeansymposium.com

International Dental Show
12–16 March 2013
Cologne, Germany
www.ids-cologne.de

ITI Congress North America
4–6 April 2013
Chicago, USA
www.iti.org

8\textsuperscript{th} CAD/CAM \& Digital Dentistry International Conference
2 \textsuperscript{nd} 3 May 2013
Dubai, UAE
www.cappmea.com

International Symposium Osteology
2–4 May 2013
Monaco
www.osteology.org

ITI Congress South East Asia
16 \textsuperscript{th} 17 May 2013
Bangkok, Thailand
www.iti.org

MIS' 2\textsuperscript{nd} Global Conference
6–9 June 2013
Cannes, France
www.mis-implants.com

Nobel Biocare Global Symposium
20–23 June 2013
New York, USA
www.nobelbiocare.com

FDI Annual World Dental Congress
28–31 August 2013
Istanbul, Turkey
www.fdiworldental.org

2\textsuperscript{nd} Asia–Pacific Edition
9\textsuperscript{th} CAD/CAM \& Digital Dentistry International Conference
5 \textsuperscript{th} 6 October 2013
Singapore
www.cappmea.com

EAO 2013
16–19 October 2013
Dublin, Ireland
www.eao.org

AAID Annual Meeting
23–26 October 2013
Phoenix, AZ, USA
www.aaid-implant.org
submission guidelines:

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

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

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

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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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In addition, please note:

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

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

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Questions?

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