CAD/CAM
international magazine of digital dentistry
2012

- **case report**
  CBCT-assisted implant therapy

- **opinion**
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- **interview**
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Dear Reader,

Passion makes the world go round. Some of us are passionate about music, others about painting, yet others about movies or photography. Passion can drive the fulfilment of our dreams, but requires that we look ahead. It is difficult to imagine that we could pursue our passions today with magnetic tape, film photography, analogue techniques or an ancient computer.

In recent years, the pace of life has changed significantly; we use fast Internet, speed couriers and require instant responses. The same is true of dentistry. Patients demand quick and inexpensive therapeutic solutions, yet expect the highest standard of work. In order to meet these demands, dentists have to rely on the latest technologies.

Initially, the use of CAD/CAM in dentistry was a novelty, requiring an inordinate amount of time to produce a viable product. Over the last 30 years, the development of new equipment, materials and software has advanced digital dentistry to the next level, facilitating the use of CAD/CAM technologies in both dental offices and laboratories. Nowadays, digital dentistry is a part of daily practice for a growing number of dentists and dental technicians. By incorporating CAD/CAM automation and digital imaging into their strategic business models, dental offices and laboratories are able to save on time and labour, while improving the quality and precision of their work.

The way ahead is digital dentistry; it saves time, enhances treatment and ensures precision like never experienced before. Successful use of the technology, however, depends on you, whether you wish to be a pioneer in the field or prefer to use the proven technologies.

This edition of CAD/CAM is concerned particularly with implantology and orthodontics. You will find information on new concepts in computer-guided implantology, using CBCT and CAD/CAM techniques, as well as the latest industry news and information on upcoming and past meetings.

I hope that you will find the magazine informative and find inspiration to follow your path!

Yours faithfully,

Magda Wojtkiewicz
Managing Editor
editorial
03 Dear Reader
| Magda Wojtkiewicz, Managing Editor

special
06 New concepts in computer-guided implantology (Part II)
| Dr Gian Luigi Telara

case report
12 CBCT-assisted implant therapy: A case study
| Dr Nilesh Parmar
16 Implantology—the perfect art of camouflage thanks to CAD/CAM
| Robert Michalik

feature
30 Space management in adults using CAD/CAM aligners—Three case reports
| Dr Khaled M. Abouseada

industry news
36 New Planmeca ProMax 3D ProFace system enables safer and faster facial surgeries
| Planmeca
38 3Shape technologies—Closing-in on complete digital dentistry
| 3Shape
40 Straumann opens its CAD/CAM system with CARES Visual 7.0
| Straumann
42 CEREC Club Select: additional benefits for users
| Sirona

digital platforms
43 Course calendar

opinion
26 CBCT in orthodontics
| Prof Giampietro Farronato et al.

news
34 Doctors implant first customised 3-D printed mandible
| Claudia Duschek

about the publisher
49 submission guidelines
50 imprint

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Abstract

In recent years, there has been a growing interest in guided implantology. A digital work-up is certainly of great benefit for clinicians to better understand their patients’ bone morphology and density and consequently to plan implant positions correctly, and to have their hands guided during implant placement by means of a surgical guide. There are many systems on the market today and many researchers have studied post-operative CT scans and planning scans by means of superimposition, in seeking to understand the secret to achieving perfect correspondence and the best system, but this perfect accuracy has not yet been found and there appears to be a mismatch between planning and the actual implant position.

I have developed a device (Dental Implant Positioning System, International PCT IT 2009 000192, WO 2010/125593 A1; patent pending) that respects the implant’s spiral movement in accordance with mathematical criteria. The same criteria are also important in theorising limits and achieving accuracy using computer-guided implantology.

Introduction: Passive systems and the limits of the human visual, auditory and spatial resolution

Is it possible, using one technique, among the many on the market, to create repeatable results in terms of a final prosthesis? How many of the presently marketed systems in guided implantology really are passive? Do passive infra-red systems really facilitate repeatability?

Human visual resolution limits do not allow for accuracy: eye, ear and fine hand movements have not yet crossed this threshold. Human spatial resolution can be evaluated with reference to the modulation transfer function (MTF). This is also...
a good means of evaluating the optical properties of CT scans. Spatial frequency has been widely studied and it is now generally accepted that line pairs (black and white) can be perceived up to a tenth of a millimetre (human visual acuity). The same is true for hearing (in hertz) and hand movements (we cannot control a movement beyond 0.1 mm).

A passive device therefore appears necessary to ensure that the same implant position can be reproduced repeatedly and independently of the operator within the threshold defined above. This fulfils my definition of “passivity”.

_The limitations of infra-red control systems_

This last point also means that infra-red control systems are excluded by definition, since their accuracy is operator dependent. Apart from spatial resolution limits, this kind of technology is affected by time-delay problems, partially due to the machine itself and partly due to the temporal resolution limits of the operator (eye, ear, hand). Therefore, infra-red control should not be considered passive. These systems are equipped with a virtual smooth sleeve and are operator dependent. Furthermore, they can be monitor or mouse guided, when the handpiece is transformed into a computer mouse. Ironically, we tend to consider the surgical tutoring toy a passive tutoring system only because it is provided with sensors along its holes (Figs. 16a & b), but not because of its functionality.

It is my opinion therefore that an entirely passive device, in which all necessary information is included, is superior to semi-active devices. Furthermore, passive devices should be easy to handle and intuitive to use, and their design should not allow any freedom for the operator (the operator has already decided upon the location of the implant through planning and the surgical guide).

_Accuracy verification_

Many studies on accuracy verification have been conducted. In these, scientists have sought to determine and measure accuracy by means of comparing the planning data and data acquired post-operatively. Their aim is to evaluate which of the marketed systems delivers the most accurate results.
other optical system, have optical limits and owing to CT's MTF and intrinsic limits, CT scans can be considered low-resolution 3-D images. They also achieve spatial resolution levels far from those needed in our field to ascertain placement precision. Consequently, statistical inferences based on superimposition cannot be said to deliver valid proof.

**High-contrast spatial resolution**

I scanned an implant using the latest NewTom CBCT (CB3D VG-I MARK 3), and viewed the scan using SimPlant Crystal (Materialise Dental) to verify the resolution and the precision of the measurement. The best I was able to achieve was 0.1 mm. This means that a real measurement of 1.43 mm could be achieved on CT within 1.33 and 1.53 mm, and 0.3 mm is the possible measurement error (Fig. 17a). The same difficulties also arise with MSCT scans (Fig. 17b).

Spatial frequency is evaluated by means of MTF, the ratio between the output and the input signal, with one describing an ideal system with no loss of information at the output. MTF defines limiting resolution, which describes the ability of a system to perceive two objects as distinct. At high frequencies, that is a high number of line pairs per mm (lppm), MTF will approach zero (Figs. 18a & b). When taking MTF into account, we must evaluate a CT scan according to its optical performance. When the frequency is increased, a series of square waves, corresponding to a 1:1 ratio with combined white and black lines, changes into a series of bell-shaped waves. This process is termed the point spread function. As a result, the contrast decreases, which makes it increasingly difficult to visualise the edge of the lines. MTF is the Fourier transformation of the point spread function. When the frequency is low and the quality ratio is one, the wave corresponds perfectly to the square waves. When the frequency increases, the ratio decreases and the wave becomes increasingly bell shaped. At an MTF of 2%, the image will be of a uniformly grey colour (Figs. 18c & d). The CT scan limiting resolution is therefore 2 lppm at best (Fig. 18e).

**Low-contrast spatial resolution**

Moreover, we can extend our discussion to the contrast level at which an image is observed and analyse low-contrast spatial resolution. When the contrast decreases at high frequencies, we have to cope with a low-contrast level image that is noise dependent. Furthermore, the optical spatial resolution properties depend on the part of the screen at which we are looking. The resolution is at its best at the isocentre, worsening both in the radial direction and along the circumference, the azimuthal direction (Fig. 19). While this phenomenon holds true for the cone beam in particular, a cone-beam effect is also achieved with MSCT: the more slices we have, that is, the greater the fan beam width of each subsequent MSCT scan, the greater the cone-beam effect (Figs. 20a & b). When the isocentre is considered the central part of the radiation fan, this effect can be seen in the outermost slices of the radiation fan beam especially (Fig. 20c). Axial reconstruction algorithms report this cone-beam effect in relation to a spiral path in the axial images (Fig. 20d).

Compensating cone-beam reconstruction algorithms or spiral interpolation algorithms help to solve this problem, for instance the multi-row Fourier reconstruction. Similarly, an extension of the advanced single-slice rebinning method (ASSR), which combines the idea of ASSR with a z-filtering approach, has been proposed as a solution to this problem, but its validity has not been adequately
Errors in sleeve placement

CT is also responsible for errors in sleeve placement inside the surgical guide. These errors are caused by an inescapable approximation in the CT resolution limits. CT cannot exceed its MTF limit, and this should be considered during planning and data transfer.

There can be repercussions on the sleeve placement inside the surgical guide, both for smooth or threaded sleeves. Sleeve position and axis are parameters associated with this procedure, as well as the sleeve axis, should be considered. However, from a practical perspective, they have no relevant influence on this procedure, but the limits given by these parameters are sufficient for the production of a surgical guide. Furthermore, they respect the structures adjacent to the implant site, for example plates and vascular adjacent structures, IANs, sinuses, nasal cavities, pterygopalatine fossae, mental foramina and adjacent roots.

Owing to the technical production limits of CT, the sleeve position in the surgical guide tends to be inaccurate, regardless of the technique applied (STL or stone surgery).

Evaluation of data-transfer techniques

As for data transfer in the course of producing a surgical guide, the chosen technique should result in the sleeve being placed in the centre of the palate bone. In order to decide between CAD/CAM and stone surgery for this process, a cadaver study may help in comparing and evaluating the various techniques on the market.

In order to prove repeatability, each cadaver must be scanned several times. Each scan should consider the protocol of a different company or manufacturer. The corresponding surgical guides should be tested on the same cadaver in order to evaluate the precision of each technique in placing the sleeves in the centre of the bone, according to position and axis.

Surgical kits should fit into the mouth and I assume that the axis should respect the palate’s anatomy. Furthermore, drilling and implant placement should be avoided in order to prevent inaccuracies other than those derived from using smooth sleeves. Likewise, a repeated scan for superimposition is not of any use. Mathematically speaking, a system can be considered reliable if its repeatability can be confirmed. In the cadaver study, the cadaver should therefore be tested to fit several repeated surgical guides. A similar technique proposed by Al-Harbi, in which the accuracy of the sleeve axis is assessed via CMM (coordinate measuring machine) and laser techniques, also appears promising.

The study by Bou Serhal et al. is based on a cadaver study, but once again, the cadaver was scanned according to a superimposition protocol. But why expect to obtain more information from a second CT scan if we know that CT can be imprecise? There are many articles on the reliability of CT and its correspondence to the anatomical truth, such as the studies by Lou et al., Brown et al. and Damstra et al.

However, these publications appear to restrict their interest to the scanned fiducial landmark measurements and record an error between 0.1 and 0.5 mm for 2-D CT. It is therefore my opinion that these studies fail to distinguish sources of error such as the MTF limit and smooth sleeves by concentrating on the superimposition of two low-quality 3-D images.
special guidan implantology

The study by Stumpel\textsuperscript{15} provides important information on the accuracy of STL surgical guides. Their reliability is ascertained via a teeth-borne surgical guide. After a stone model has been scanned and matched to the planning, the surgical guide is used like a jig and the correspondence between the STL model and the mouth is measured.

An HU threshold appropriate for the bone algorithm is necessary in order to avoid producing an STL model of inadequate size. The merging of planning and stone model scanning can further help improve its accuracy. The dimensional tolerance of an STL model is about 0.3\% when SLS or LS and stereolithography (either SL or SLA) are applied. These techniques yield tolerances of +/- 0.3\% and a minimum of +/- 0.005.

Since less resolution is needed to produce a surgical guide than to ascertain implant position, the software can only be used for planning and STL surgical guide production. It cannot, however, be used for verifying the implant position. In order to embed either smooth or thread-timed sleeves that can guide drills and implants while respecting the pt. anatomy, 0.1 mm is sufficient.

Moving on

Superimposition cannot differentiate between inaccurate sleeve placement and inaccuracies of the sleeve position and axis of the surgical guide or inaccuracy resulting from using a smooth sleeve. Instead, these are confused, which leads to the conclusion that a comparison of planning and post-operative scans will not lead to any convincing results, even if the superimposition was perfectly executed and different kinds of software were used in unique clinical situations. At worst, the ALARA principle cannot be followed and patients are subjected to an inordinate amount of radiation.

Once we accept that errors are likely when superimposition is done, we can consider other techniques. These techniques should be designed to avoid errors derived from using a smooth sleeve. An ideal system, for example, would allow for a prosthesis, and the surgical guide would allow for identical implant and analogue positions both in the model and in the mouth.

Thus, from now on, we can be extremely accurate when working with a thread-timed device in the implant phase. After the surgical guide has been made, we must demonstrate the accuracy of the implant placement. The surgical guide with its repeatable results allows us to work on an infinite number of master casts. Our nth master cast is the mouth, and its correctness can be evaluated by means of a jig.

In 2007, Nobel engineered a threaded device for zygomatic implants, which was considered for use in other Nobel implants (patent number: WO 2007/129955 A1). Their threaded guiding sleeve functions with a threaded implant mounter. They claim that these devices lack any vertical fastening features and do not use any notches to index the hex. Consequently, they warn that there may be no hex correspondence. Therefore, additional rotation may be needed. Additional rotation amounts to missing depth (it is mathematics: if you go on screwing, you deepen the screw itself); therefore, with a threaded sleeve, missing the depth because a system has not been adequately fastened means missing the hex as well. Additional rotation is only approximately adjusting a device that has lost the phase and these two parameters. These two parameters will be missed. In order to obtain the correct final hex position (and consequently also the depth), I invented a helical gear.

Conclusion

Accuracy in implant placement appears to depend on the context of the respective case; for example, it appears less relevant when immediate loading is not the preferred option or if an impression can be taken immediately after implant placement. However, accuracy in implant placement can help prevent cortical vascular perfusion disorders (cortical plate perfusions) or arterial vessel damage. This appears to be especially important in areas in which hard- and soft-tissue stability is required for long-term results, for example for biomechanical concepts that require submillimetric precision. Furthermore, tissue stability should be considered in all areas of the mouth for aesthetic and trophic reasons.

On the one hand, CT scans to date offer low-resolution 3-D images of the bone. The software available, on the other hand, delivers both good planning and safe sleeve positions and axes independently of the technique used to obtain a surgical stent.
However, we cannot rely on the planning, since it cannot discriminate errors. As two superimposed low-resolution 3-D images cannot result in a high quality image of the implant, relying on the planning would increase imprecision in accuracy measurements. I therefore recommend platform positioning according to mathematical criteria in order to achieve a correct, prosthetically driven position.

When sleeve placement is considered, jig correspondence between the abutments on the master cast analogues and the same abutments’ clinical position on the implants can help avoid inaccuracies in terms of either the sleeve position or the axes of the surgical guide. Furthermore, it can help evaluate inaccuracies resulting from using a smooth sleeve.

To date, no publications have reported on such a technique, presumably because this kind of verification can impose too much stress on any method owing to the time required to ensure precision this way. Indeed, repeatability seems incidental to the thread-timed sleeve. Thread timing can be an impasse on the way towards a precisely placed implant, since analogues and implants cannot be forced into the same positions both repeatedly and operator independently. In other words, it is unlikely that all relevant parameters, such as the position in the ridge and the axis, the depth and the rotational feature orientation, can be taken into account.

No publications have reported on such a technique, either, simply because no method has been concerned with verifying accuracy so precisely. Repeatability is incidental to a thread-timed sleeve. Thread timing can be an impasse on the way towards a precisely placed implant, since analogues and implants cannot be forced into the same positions both repeatedly and operator independently. In other words, it is unlikely that all relevant parameters, such as the position in the ridge and the axis, the depth and the rotational feature orientation, can be taken into account.

In general, aggressive marketing tactics are an important ethical factor when computer-guided implant placement is considered. The Millennium Research Group has estimated a 20% growth in the number of guided implant placements by 2013. Similarly, dentists are likely to increasingly perceive the need for planning software and drilling templates. In the future, however, CAD/CAM techniques will not only be applied in planning, but also be used for surgery in order to enhance prosthesis and tissue stability. A passive device that is easy to handle and based on thread timing can pave the way to computer-guided progress.

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

Part I of this series—New concepts in computer-guided implantology was published in CAD/CAM Vol.3, Issue 1/12. A PDF is available from the publisher.
Implant treatment in the anterior mandible has favourable long-term success rates when compared with other areas of the mouth (Gökçen-Rohlig et al. 2009). Placement of dental implants in the interforaminal area is considered a safe and predictable procedure. However, perforation of the lingual cortical plate can result in a profound and potentially life-threatening sublingual bleed (Bucal 2008). The blood supply to this area is provided by the submental, sublingual and mylohyoid arteries, which if perforated may set off a massive internal haemorrhage in the floor of the mouth.

Although rare, this can ultimately cause protrusion of the tongue, resulting in airway obstruction and necessitating surgical intervention. It has been suggested by Tepper et al. (2001) that CT imaging of this area is warranted for visualising 3-D bone anatomy prior to surgery, thereby reducing the possibility of surgical instrumentation of this sensitive area.

In this case report, I shall show how CBCT coupled with chairside diagnostic imaging can help in planning, simplifying and executing implant placement in the anterior mandible.

Patient history

A 44-year-old female patient who was undergoing long-term periodontal treatment presented with mobile and painful lower incisors. She exhibited very good oral hygiene but with a periapical area and mobility associated with tooth #14 and Grade II mobility of her lower incisors. The patient described difficulty and embarrassment when eating owing to the movement of her lower teeth and wanted a fixed solution.

Clinical examination

The patient had a lightly restored dentition with a thin gingival biotype. As previously mentioned, her
oral hygiene was good and she was a non-smoker (gave up 11 years previously). She exhibited bilateral canine guidance with no evidence of any para-func-
tion. Her BPE scores were 312/231.

_Treatment options_

Owing to the patient's history of periodontal dis-
ease and associated mobility, she was aware that some form of replacement was necessary. The patient did not want a removable restoration and preferred a fixed solution. In this area of the mouth, either fixed bridgework or an implant-retained prosthesis was possible.

After discussing the options and highlighting the increased risk of peri-implantitis in patients with previous periodontal disease (Esposito 2006), the patient opted for a fixed implant-retained solution. The treatment was to be planned in such a way that if she lost her posterior molars in the future, a full-
arch fixed prosthesis could be made after subsequent implant placement.

_Treatment plan_

Treatment was to be carried out as follows:

1. continuation of periodontal treatment and oral hygiene advice;
2. CBCT GALILEOS (Sirona) scan to assess bone height, bone profile and associated anatomy;
3. extraction of all four lower incisors and tooth #14;
4. placement of two SLA active implants (Straumann);
5. restoration with a screw-retained four-unit PFM bridge.

_CBCT_

It was decided to take a full-volume CBCT scan to further assess the upper teeth and tooth #14 for future implant replacement. The CBCT scan showed excessive bone loss around the anterior incisors with a small area of periapical radiolucency around tooth #31. A cross-sectional view showed thick, well-developed cortical plates with very little lingual concavity. Owing to the good bone height and mini-
mal pathology, immediate implant placement was planned.

Owing to the patient's bone loss, the lower incisors had drifted, giving a less than desirable tooth posi-
tion. One of the patient's main complaints was the gaps that had appeared between the lower incisors and the uneven appearance of the incisal edges.

To aid implant placement in the correct angu-
lation, a CEREC Bluecam image was taken and ma-
nipulated so that the lower tooth positions were in harmony with the rest of the dentition.

This proposal was then overlaid onto the CBCT scan and was used to facilitate implant planning. The aim was to provide the patient with a screw-
retained bridge with access holes through the lin-
gual aspects of the lower incisors, whilst main-
taining a sound margin of safety from the lingual cortical plate.
case report _implant therapy

The patient healed without incident and owing to the favourable lingual undercuts of the lower teeth was able to wear the denture comfortably during the healing process. Owing to financial reasons, the planned implant placement for the tooth #14 site was deferred until a later date.

After eight weeks of healing, fixture-level open-tray impressions were taken in Impregum (3M ESPE), and a four-unit screw-retain bridge was fabricated. The tooth set for the denture was duplicated on the final bridge, as the patient was happy with the tooth size and shape. Owing to the previous bone loss, pink porcelain was added to the bridge to improve the emergence profile and reduce the crown lengths of the lower incisors.

The bridge was seated and torqued to 35 Ncm and composite placed in the access holes. A baseline long-cone periapical radiograph was taken to serve as a baseline for bone-level measurements. The occlusion was checked, with the patient exhibiting canine guidance in excursive movements. The patient was shown how to clean under the bridge using super floss and TePe brushes and placed on a long-term maintenance programme.

_Prognosis_

The bridge has a good long-term prognosis, as this patient is highly motivated, and exhibits excellent oral hygiene. She is aware of the increased risk of complications, and the possibility of losing more teeth in the long run, but after having worn a denture for three months, she is determined to avoid becoming a long-term denture wearer. The patient will see me at six-monthly intervals and sees a hygienist every three months for maintenance.

**Figs. 14**_After eight weeks of healing._

**Figs. 15**_Insertion of final bridge._

**Figs. 16 & 17**_Appearance at one month review._

**Figs. 14, 15, 16 & 17**

Dr Nilesh R. Parmar was voted Best Young Dentist in the East of England in 2009 and runner-up in 2010. He is one of the few dentists to hold a University of London degree from all three London dental schools and is currently studying for his third MSc in Orthodontics at the University of Warwick. He is an Astra Tech Clinical Coach and has his own practice in Southend-on-Sea, Essex. He also works as a visiting implant dentist at Sparkly Smile in Blackheath and the New York Dental Office.

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COMMITTED TO SIMPLY DOING MORE FOR DENTAL PROFESSIONALS
Implantology—the perfect art of camouflage thanks to CAD/CAM

Author: Robert Michalik, Poland

When I graduated from the Faculty for Dental Technicians in Warsaw Medical School in 1987, I had no idea that my profession would change so much over the course of the next quarter of a century. At that time, I enthusiastically welcomed every new innovation, many of which I pioneered the use of in Poland.

Looking back today after more than 20 years, I can confidently say that dental technology has undergone a profound technical revolution. After all, nowadays, it is difficult to imagine a modern dental technician’s laboratory where CAD/CAM technology remains unknown.

My first experience with CAD/CAM was in 2004 when I decided to buy a device from DeguDent. I intentionally use the word ‘device’ here, since it was not what we would today consider a CAD/CAM system based on scanning and virtual modelling. However, I was overwhelmed by the potential this machine offered me at the time. For a brief while, dental technicians and dentists were divided into proponents of and opponents against CAD/CAM. The latter were mainly against the system because of ignorance and a fear of new technology. I myself used the machine for two years until at last I succumbed to the temptation and bought another technical novelty.

I first saw this machine, produced by Wieland, at the International Dental Show in Cologne. The thing that was so innovative about it and such a great advance on previous models was the 3Shape scanner that was able to scan the model and transfer data to the CAD software, thereby making it possible to produce a virtual model of the construction.
The system was such a breakthrough and the possibilities it offered so enormous that in 2006 I began using the 4820 model. The volume of orders that my laboratory handled increased dramatically, since in contrast to the DeguDent machine, which could initially cut four-unit and later seven-unit bridges, Wieland’s CAD/CAM system allowed me to cut 14-unit constructions from various types of material (plastic, steel, titanium).

Based on my own observations and my many years of experience, I can boldly say that the greatest progress in terms of technology has been achieved by scanners. The newer machines have only increased the amount of bone that can be cut and accelerated cutting speed. It is the scanners that have ensured revolutionary advances in the development of CAD/CAM.

A major role in the development of scanners has been played by 3Shape, which is currently the undisputed leader in the field. A modern user of CAD/CAM has all he needs to ensure a perfect prosthetic appliance, i.e. everything from a temporary crown right up to complex implant-supported restorations. Moreover, all the work can be done today in virtual articulation, which overcomes the technological problems that traditional methods faced.

Patients today require fast and inexpensive therapeutic solutions, while ensuring the highest standard of work. CAD/CAM systems help reduce production costs significantly. Hence, the high purchase price of investing in a CAD/CAM system pays off. The limitless opportunities it offers for co-operation between laboratories also attest to the superiority of CAD/CAM technology. Just as the development of airlines made rapid relocation to any corner of the globe possible, so CAD/CAM promotes work between laboratories from all over the world. And herein probably lies its greatest success: international co-operation that connects people brings its own benefits and satisfaction. There have been many occasions in my professional practice when I have performed work to order without ever being face to face with clients. This is proof of the importance of Internet communication in the dental industry.

Obviously, the CAD/CAM system is only half the story, for the hands of the dental technician are still irreplaceable when it comes to veneering porcelain.
substructure. No system can apply porcelain in such a way that the restoration looks like a natural tooth. Hence, the ideal is to combine the possibilities of-fered by CAD/CAM with the artistic abilities of the dental technician. A properly prepared construc-
tion, good marginal seal and the choice of material are all very important factors, but the final finish of the crown still depends on the aesthetics attained through the skill of human hands. The work of the dental technician requires knowledge of many dif-
ferent materials and how they are fashioned, as well as extensive manual skills in working easily with both colour and shape.

A long-standing acquaintance of mine, the out-
standing master of dental technology Klaus Mü ter-thies, stresses repeatedly that form takes prece-
dence over colour. The patient focuses first on the way the prosthetic restoration harmonises with his natural teeth. If the form is disturbed, colour defects appear together with details that do not have too important an influence on the overall appearance of the crown.

Although the majority of patients do not know how to assess a prosthetic restoration accurately, I have noticed a growing awareness among them of the quality of the work. This is increasing in pro-
portion to general advances in people’s lifestyles. The majority of us want to remain young and look beautiful forever. Hence, more and more people view dentition in terms of the need not only to re-
store missing teeth but also to correct those they still have. A good example of this is the boom in orthodontics, and the demand for teeth whitening and improving their smile using veneers.

Another very important factor in prosthetic art is that it requires the collective effort of an entire team—everyone from an attending dentist, an orthodontist, and a surgeon/implantologist, right up to a dental technician. I have had the great fortune to work with partners who have chosen to work in the same area of technological development and aesthetic prosthetic work. One of the doctors work-
ing closely with my laboratory on a daily basis often remarks, “as the dentist so the technician and vice versa.” Probably, these words reveal how close the ties have always been between the dental techni-
cian and the dentist. The restoration case study I will present here reflects my belief that prosthetic work is a combination of modern technology with its skilful use and a high level of artistry in the hands of the technician.

Case report

A 27-year-old female patient presented to our dental office to achieve a more aesthetic smile. At the age of 17, she had suffered an accident (she was hit by a swing), as a result of which her tooth #21 had shifted significantly in an upwards direction owing to significant bone atrophy and root resorp-
tion (Fig. 1). The young age of the patient and her still progressing bone growth did not augur success.

Only when she was 27 did she pursue improving her appearance. The situation required that she have her tooth extracted, undergo an implant procedure and have a prosthetic crown placed. The first prob-
lem that emerged during the preliminary analysis prior to the implant procedure was that the amount of bone and the thickness of the bone plate would
have forced us to add grafting material. The patient did not consent to such a solution and expected a predictable cosmetic effect with the stress on very good final aesthetics.

In the first stage, we made a Maryland bridge (Fig. 2). Such a solution provided protection for the patient during the osseointegration period. Several months after the surgical procedure, the implant (in this case Ankylos, DENTSPLY Friadent) was exposed. It turned out that the implant was positioned in an excessively palatal direction. The challenge was to restore a symmetrical line to the patient’s cervical margins, as well as a natural biological gingival margin. The backward position of the implant required the use of an angled abutment of 30°. Unfortunately, the system we used effectively restricted such an approach, since at the time that the above procedure was performed it was still impossible to achieve customisation in a dental laboratory (this is definitely possible today).

A decision to make an all-zirconia abutment with an angle of inclination above 15° is quite risky. Hence, the solution we adopted was to modify the crown while not changing the shape of the abutment. Such an approach requires the attending dentist to play a major role in the process so that the preparation and transfer of the emergence profile of the abutment and prosthetic crown correspond perfectly to the natural tooth. Using composite material, the doctor shapes the temporary restoration to retain the place for the final crown for a period of several weeks so that it later can serve as a model for the definitive crown. It is important to remember that as the gingiva is being shaped the patient must at all times be provided with a temporary restoration, guaranteeing support for the soft tissue.

Therefore, the doctor transferred the emergence profile with the help of a doubling of the crown with the abutment. After the crown had been removed, pattern resin was applied in its place. Simultaneously, a standard zirconia abutment was modified in the dental laboratory into the desired shape using a water-cooled high-speed bur and then scanned. An image of the scan was modified by superimposing a second scan over the projected emergence profile of the crown. Both parts were joined together in the CAD programme and the structure thereby created was cut from the Provi Disc composite material (Robocam), which is often used for temporary restorations. At this stage, the best approach is to try in the cut-out substructure and if necessary im-
prove its size and shape. Only if the fit is perfect will a substructure be cut out from zirconium dioxide.

The choice of material is something that should be considered very carefully. Observing the rule of "what, where and when?", the choice will depend on the position of the abutment, its colour characteristics and the quantity of light diffusion needed. The last factor has a great impact on the natural appearance of the prosthetic restoration. For this very reason, I try above all to use all-ceramic materials, especially in the anterior section.

The material used in the present case study was zirconium dioxide (Robocam), which is processed in a machine supplied by the same company called Robomill 5. The machine mills all available soft materials and the water cover makes it possible to cut IPS e.max ceramics (Ivoclar Vivadent).

Following a consultation with an attending dentist, it was agreed that owing to the large superstructure of the mucosal section on the vestibular side the restoration would have to be screw retained. Such a solution ensures that the patient's oral hygiene can be examined frequently in that area. The abutment and crown were joined together in the laboratory in order to avoid any possible complications owing to excess cement left after the restoration had been placed in the patient's mouth. The part serving as the emergence profile of the crown from the gingiva was not covered with veneering porcelain. It was only polished to a shine without covering it with glazing. The surface of the zirconia prepared in such a way has a greater chance of adhering tightly to the patient's gingiva.

The present case study confirms that modern prosthetics could not exist without modern solutions such as CAD/CAM.

Summary

What other innovations will surprise us in the not-too-distant future? Will traditional layering and firing of ceramics be replaced by other methods? This remains an open question, but perhaps the profession of the dental technician will soon be limited to working only and exclusively with computers.

Acknowledgements

I would like to thank my wife, Dorota Michalik, for her artistic veneering of the prosthetic restoration presented, as well as Dr Kristian Owczarczak, for his great contribution as a dentist, and with whom I carried out the clinical case study.

All the prosthetic restorations were made using the CAD/CAM Robocam, and the materials used were Robocam zirconium dioxide, IPS e.max (Ivoclar Vivadent) and Vision veneering ceramics.

About the Author

Robert Michalik

Graduated from the Faculty for Dental Technicians in Warsaw Medical School in 1987. After two years of work in the Medical University’s dental laboratory, he opened his own dental laboratory, Inter-Dent, which he is still running. In 2003, he was the first in Poland to start working with dental CAD/CAM systems. In 2007, he began development of the first Polish CAD/CAM system in collaboration with Delcam and 3Shape. Also in 2007, he submitted an application to patent a method of creating telescopic crowns with intermediate crowns. He is the author of several articles for the trade press.

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The European Association for Osseointegration (EAO) has drawn up new guidelines on the use of diagnostic imaging in implant dentistry. The guidelines have been published online ahead of print and can be accessed as an early view article at www.onlinelibrary.wiley.com. They will be published in print in an upcoming issue of Clinical Oral Implants Research.

The EAO published its first set of guidelines on diagnostic imaging in 2002. Since then, new radiographic technologies and techniques have become available, including cone-beam computed tomography (CBCT). The new guidelines were drawn up in response to the 2008–2011 SEDENTEXCT project (www.sedentexct.eu), which recommended that the EAO review its 2002 guidelines in light of the availability of CBCT.

Owing to its relatively low cost, as well as the growing number of potential clinical applications, there is an increasing demand for CBCT imaging in clinical dental practice. Although it can provide valuable clinical information, practitioners are required to minimise and balance any patient exposure to ionising (X-ray) radiation with any net benefits to the patient in treatment outcome.

An international panel of expert clinicians and radiologists were invited to participate in the workshop. They were tasked with reviewing and updating the original EAO guidelines and with reaching a consensus on a range of relevant issues.

The new guidelines provide a comprehensive, authoritative and practical framework for clinicians. They will help clinicians fulfi l their obligations in ensuring that the use of diagnostic imaging examinations in implant dentistry is justified and obtained at the lowest radiation dose to the patient.

They also highlight the special responsibilities, training and knowledge that are considered prerequisite for both CBCT and conventional radiographic techniques.

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“Digital technology is becoming essential”

An interview with Dr Dobrina Mollova, Managing Director of CAPP

In October, Singapore’s recently opened Marina Bay Beach Resort will become a showcase for everything related to digital dentistry when the first CAD/CAM & Computerized Dentistry International Conference opens its doors to dental professionals from all over the Asia Pacific region. Organised by the Centre for Advanced Professional Practices (CAPP) in Dubai, the congress is based on the successful concept of the CAD/CAM & digital dentistry events held in the Middle East. CAD/CAM spoke with Dr Dobrina Mollova, Managing Director of CAPP, about the state of preparations and the prospects of the field in Asia.

What are the main challenges of bringing the concept to Singapore?

The growth of CAD/CAM dentistry alongside new technology, materials and equipment has seen a rapid integration into both dental offices and laboratories. Without a doubt, digital technology is becoming essential for every dental practice and laboratory. The question is: are we prepared to keep up to date with this growing industry and are we able to implement this pool of information in our practices without the proper expertise? This will be the main challenge for us.

Are you planning to extend the concept to other countries in Asia?

Our target is the entire Asia Pacific region, which is much larger than the market in the Middle East. Similar to Dubai, Singapore has become a commercial hub for the entire region and, for this reason, we are inviting professionals from all over Asia Pacific to come and learn about the promising technologies in the dental industry. According to our sponsors, there could be potential for holding a similar conference in China but we have not yet decided to go there, as we want to wait for the outcome of the conference in Singapore.

How large is the dental CAD/CAM market in Singapore in terms of size and penetration?

To date, we do not have meaningful statistics for Singapore. According to MarketResearch.com, however, the Japanese market for dental prosthetics and CAD/CAM devices was the largest in the Asia Pacific region in 2010, followed by the Republic of Korea. In the same year, the total Chinese and Indian markets for dental CAD/CAM grew by 7.5 per cent. The global market for CAD/CAM is experiencing double-digit growth at the moment.

Looking at Dubai, are you able to say something about the impact your conference had on the field of dentistry and how digital technology is perceived?

This is an interesting question, as I have just been through the recordings of our first confer-
ences. There is clearly a huge difference in view of presentations, the knowledge we have gained and the technology that is available. Back in 2006, we started with only 160 participants, who were mainly dentists. Meanwhile, this number has quadrupled and includes dentists, dental technicians and dental assistants—basically, the entire dental team. An increasing number of participants are specialists, who have gradually become interested in the aspects of computerised dentistry, but at first there were only prosthodontists.

_**Will the Singapore conference reflect this diversity?**_

The congress will not be limited to dental CAD/CAM technology. Unlike our conference in Dubai, this time we want to put more emphasis on 3-D imaging systems, a technology that has shown the potential to transform diagnostics in dentistry completely. Besides treatment planning and diagnostics, the list of topics will range from the selection of materials for different indications to the use of digital technology in more traditional clinical areas like orthodontics.

_**Will you also offer seminars or hands-on workshops during the Singapore conference?**_

The main goal of this conference will be to bring a group of high-end dental professionals together to enable them to discuss and learn about these new technologies in detail. Therefore, we do not plan to offer any hands-on training at the moment unless there is a request by the industry. This does not rule out such training in the future. At the fifth CAD/CAM & Computerized Dentistry International Conference in Dubai in 2011, for example, we had seven workshops, which were well received.

_**How many attendees do you hope for?**_

We are aiming at 400 attendees for the first conference, which in my experience is a realistic target, given the size of the market and our presence in Asia Pacific through our partners. We are already cooperating with several dental associations, while seeking new professional partners from the dental community who are eager to work with us. Owing to the enthusiasm of the SDA, we believe that we can make this event successful.

Those who are interested will be able to find more information online at www.capp-asia.com or www.facebook.com/cappasiapacific.

_**Dr Mollova, thank you very much for this interview.**_
The aim of orthodontic diagnosis is to identify dento-alveolar, skeletal and functional alterations in the maxillo-facial complex. Diagnosis and treatment planning are based on a combination of study models, intra-oral and extra-oral images, and radiographs, traditionally consisting of panoramic and cephalometric radiographs.

Cephalometric analysis (CA) plays an important role in diagnosis and treatment planning. Traditional CA is based on three different X-ray projections: latero-lateral teleradiography, postero-anterior teleradiography and axial projection. However, conventional radiographs are limited because they provide a 2-D representation of 3-D structures. The traditional system, analysing the three dimensions separately, is insufficient because dento-facial alterations often take place in 3-D space.

Thus, the limits of traditional CA are:
- errors in radiographic projection, resulting in enhancements and distortions;
- operator errors in the measurement systems;
- errors in the identification of the cephalometric landmarks owing to superimposition of anatomic structures; and
- inability to evaluate the three dimensions of the craniofacial complex.1

The recent introduction of CBCT in combination with computer software allows the application of this new methodology to different fields of dentistry, including its successful use in orthodontics (Fig. 1).2 Owing to CBCT, the 3-D morphology of the cranial skeletal structures can be represented properly. With CBCT, the patient is exposed to similar levels of radiation as during conventional CA and up to 20 times less than during multi-slice-CT exams (Table I).3

At the Orthodontic Department at the University of Milan, CA is performed with a new 3-D methodology that allows for an easy, effective and repeatable way to decrease operator-driven errors.4 It is based on the identification of 18 points (10 median and 8 lateral), all of which are identified on a hard-tissue CT section and verified on the two remaining CT sections. Further verification is then performed on the volume rendering generated by SimPlant OMS (Materialise).

The 18 points determine 36 measurements on the sagittal, vertical and transversal dimensions (Fig. 2). At the University of Milan, 44 skeletal Class I normodivergent patients were selected from an archive of 500 CBCT scans.

The cephalometric diagnosis of a skeletal Class I normodivergent relationship is based on the School of Milan. The same patients were then analysed with 3-D cephalometry. The results allowed the identification of a normal range of values for each measurement (Table II).

The 3-D technique goes beyond the limitations of 2-D analysis in many ways:

Table I_Effective radiation dose (background radiation 8 µSv/day).

<table>
<thead>
<tr>
<th>Method</th>
<th>Scan parameters in kV</th>
<th>Dose in µSv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cephalometric analysis</td>
<td>69 / 15 mA / 14.1 s</td>
<td>50</td>
</tr>
<tr>
<td>Latero-lateral teleradiography</td>
<td>80</td>
<td>30</td>
</tr>
<tr>
<td>Postero-anterior teleradiography</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>Multi-slice CT</td>
<td>120 / 400 mA / 0.5 s</td>
<td>2370</td>
</tr>
<tr>
<td>CBCT</td>
<td>120 / 5 mA / 20 s</td>
<td>110</td>
</tr>
<tr>
<td>CBCT</td>
<td>120 / 5 mA / 10 s</td>
<td>60</td>
</tr>
</tbody>
</table>
effective representation of true 3-D morphology of the cranial structures without distortion, avoiding projection and identification errors; reduced operator bias because the measurements are performed automatically; simplicity and repeatability in the identification of landmarks, using true anatomic structures without superimposition or the problems of geometric construction; ability to obtain CA using the three dimensions; and dento-skeletal alterations can be analysed in 3-D in order to determine appropriate treatment.

Combined orthodontic and surgical planning

The introduction of 3-D imaging techniques has revolutionised the planning phase of combined orthodontic and surgical treatment. The use of the computer, together with dedicated software, allows for a fast, precise and standardised procedure. 3-D virtual planning entails the following:

- CBCT scan;
- high-definition impression;
- reference aligner;
- digital scan cast; and
- CBCT digital cast interface.

Using virtual planning, it is possible to obtain the virtual visual surgical treatment objective and the virtual orthodontic model. High-definition impressions are obtained using polyvinyl siloxane, which guarantees well-defined details while allowing for the double-pour method. Double-poured casts are necessary to obtain an adequate scan and require the use of both a full cast and individual dental elements selected from a second cast. Single dental element scans allow for proper analysis of contact points. An optical cast scan is performed using structured-light scanners, which produce a 3-D image captured by a camera. In this manner, a group of points is determined by the software, which then determines the coordinates of the acquired points and finally creates the 3-D image (Fig. 3).^5

Moreover, the digital dental cast is then combined with the CBCT scan, which allows for a very detailed analysis of both the bone (through the CBCT scan) and the dental structure (through the cast scan). CBCT does not provide enough data regarding all the dental details necessary to produce the orthodontic model (Fig. 4).^6

In order to superimpose the two records properly, a specific three-contact point bite registration wax, known as the reference aligner, has been introduced. The reference aligner needs to be applied to the teeth when the high-definition impressions are taken. It is made of Moyco (an extra-hard wax) and consists of a supporting arch and three spheres. These are made of calcium-based glass, which has cast-pouring radiopaque properties. The wax is applied during CBCT and is placed between the cast arches during the optical scan (Fig. 5).

<table>
<thead>
<tr>
<th>Table II</th>
<th>Normal values range.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoSx – Me = 77,46 mm ± 2</td>
<td>GoDx – Me = 77,35 mm ± 2,03</td>
</tr>
<tr>
<td>CdSx – GoSx = 51,49 mm ± 3,69</td>
<td>CdDx – GoDx = 52,18 mm ± 3,48</td>
</tr>
<tr>
<td>S – GoSx = 80,05 mm ± 2,4</td>
<td>S – GoDx = 80,15 mm ± 2,37</td>
</tr>
<tr>
<td>ANS PNS ^ GoSx Me = 41,12° ± 0,81</td>
<td>ANS PNS ^ GoDx Me = 41,12° ± 0,9</td>
</tr>
<tr>
<td>S N ^ GoSx Me = 46,21° ± 1,11</td>
<td>S N ^ GoDx Me = 45,94° ± 1,24</td>
</tr>
<tr>
<td>CdSx GoSx Me = 118,88° ± 2,58</td>
<td>CdDx GoSx Me = 118,83 ± 2,51</td>
</tr>
<tr>
<td>CdSx GoSx N = 54,31° ± 1,22</td>
<td>CdDx GoDx N = 54,3° ± 1,2</td>
</tr>
<tr>
<td>N GoSx Me = 65,64° ± 0,98</td>
<td>N GoDx Me = 65,58° ± 1,09</td>
</tr>
<tr>
<td>PNS – A = 44,82 mm ± 1,1</td>
<td>S – N = 65,3 mm ± 1,35</td>
</tr>
<tr>
<td>N – Me = 106,33 mm ± 2,8</td>
<td>N – ANS = 47,92 mm ± 1,33</td>
</tr>
<tr>
<td>ANS – Me = 59,49 mm ± 1,62</td>
<td>S N A = 80,66° ± 0,89</td>
</tr>
<tr>
<td>S N B = 78,24° ± 0,93</td>
<td>A N B = 2,62° ± 0,31</td>
</tr>
<tr>
<td>Ba S N = 130,03° ± 1,76</td>
<td></td>
</tr>
</tbody>
</table>
It is remarkable that the wax thickness does not significantly influence the accuracy of the radiographic scan and consequently the results of the CA. The software is able to recognise the presence and size of the spheres in the CBCT scan and matches them to those corresponding areas on the cast. This is currently the only method that allows for an overlap with an error margin of less than 0.1 mm. Once the data has been collected, it is possible to perform different kinds of analyses before the surgical treatment. The software presents powerful segmentation tools that allow the splitting of the maxillo-facial complex from the mandible, providing two separate images.

This feature is relevant in orthodontic and surgical planning for calculating bone movement. The clinician can select the tissues to be moved following a procedure similar to the manual one. For example, it is possible to select the osteotomic lines in order to simulate a forwards or backwards mandible shift, finding the exact shift needed (in mm) to properly correct the malocclusion (Fig. 6). Once the bone correction has been finalised, it is possible to create a 3-D orthodontic model and display the resulting dental correction to be obtained by the end of the treatment.

Finally, shifting back the bone structure (and the dental arch with the final model) to the original maloccluded position, it is possible to obtain the target cast to be reached before the surgical treatment. On the cast, it is then possible to build successive images using CAD/CAM techniques to track progress towards orthodontic pre-surgical treatment.

Virtual surgery has a twofold objective: firstly, to verify that the planned shifts are in fact feasible; and secondly, to position the cast according to the ratios needed to build the surgical splint, which will be used during the surgical procedure. The digital cast superimposition reduces the treatment planning phase, as it is not necessary to reveal the facial arch or to use the articulator. In fact, all the data can be sourced from the combination of the CBCT and cast scans. Recent studies focus on the enhancement of the system through the development of an intra-oral scanner, which will allow direct 3-D impressions, skipping the conventional impressions, which—although precise—can be influenced by manual errors.

Although complex, using software offers many advantages because it enhances both orthodontic and surgical techniques, while ensuring a very high quality result. In fact, a CAD/CAM technique allows for a standardised procedure and easy quality checking, in comparison to traditional operator-performed techniques, which are open to inaccuracies.

Creating customised multi-bracket appliances

In virtual orthodontic and surgical planning, it is possible to create a digital orthodontic model once
the bone bases have been shifted towards their proper position. The latest dental shift software is able to perform single-element segmentation automatically. The operator can obtain a full 3-D visualisation of the dento-alveolar relationship and can consequently modify tip and torque, rotate and shift dental elements in the 3-D space in order to simulate the orthodontic treatment.

In order to display the results of the pre-surgical orthodontic treatment immediately, the software shows two overlapping images, differently coloured to distinguish the initial situation from the ideal one (Figs. 7 & 8). As a result, a digital model is created, containing all the details to reach a functional occlusion.

The first step in the process of creating a customised bracket is possible thanks to CAD/CAM technology.¹⁰,¹¹ The CAD/CAM technique entails two phases: the design phase (CAD) and the manufacture phase (CAM),¹² performed through computers that send instructions to milling machines in order to create the end-product.¹³ These machines work either through removal (such as a CNC cutter) or through addition—stereolithography (SLA), 3-D printer or plastic materials/composites, laser sintering (SLS) or laser fusion (SLF) of metal materials.

The elements that allow the bracket customisation depend on its base. The base is designed through the CAD software and placed on the centre of the dental surface. The software will then allow us to customise the bracket (Figs. 9 & 10). In designing the bracket, it is possible to distinguish between a partial and a complete customisation. The first entails the customisation of the size and shape of the bracket portion facing the dental surface, but features a standard angle in the non-customisable portion of the twin bracket. Complete customisation entails the additional modification of the angle between the bracket base and the twin portion. This is the ideal, considering that the spatial parameter of the dental elements might vary according to the different malocclusions.

Once the design phase has been finalised, the brackets are ready for manufacture by a milling machine. These machines, which mill very small items, need to be run in a standardised environment with maintained conditions to guarantee high precision while minimising the possibility of errors. Consequently, the higher the precision required, the larger the milling machine will be. It is also necessary to place the machine in a dedicated environment with a special floor cover with amortising panels that stabilise the cutter and partially absorb the vibration produced.

Moreover, a very small cutter of approximately 0.001 mm needs to be used. For example, considering that the smallest cutters can remove up to 3% of a millimetre each time, three to four passes will be required to create the mesh facing the tooth (Fig. 11).

The technological progress represented by CAD/CAM as described is based on the digital design feature and the computer-automated manufacturing process.¹⁴ The main advantages are better control of the production process and a significant reduction in operator-driven errors, while enabling the use of sophisticated materials, such as Grade 5 titanium, which was not possible with traditional techniques.¹⁵

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

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Using CAD/CAM technology to produce a series of clear plastic overlays is an aesthetically agreeable solution for space management. Initially, the use of aligners was restricted to treating minor orthodontic cases only,1 but the improvement in aligner manufacturing in the last five years has allowed us to use aligners in a variety of malocclusion situations today.2

Recently, successful outcomes have been reported with aligner treatment for more complex malocclusion.3 In the following article, I present three such cases from my private practice.

Case I: Space adjustment after extraction for implant placement

Diagnosis

This case was referred to me by a colleague. The main requirement of my colleague and his patient was space adjustment.

Clinical examination revealed a space of 3 mm between the lower right lateral incisor and the lower right canine; a suspended bridge consisting of an abutment over the lower right second molar; a pontic for the lower first right molar, which was very small in size; and an occlusal rest on the second lower right premolar (Fig. 1).

Treatment objectives

Our objective was to close the spaces in the lower arch except the space of the missing lower right first molar, which would be increased. In planning the treatment, CAD/CAM technology was utilised (Fig. 2).

Treatment plan

The treatment plan was to remove the old bridge and move the lower right canine, first pre-
molar and second premolar mesially to close the anterior space. This would open up enough space to replace the missing lower right molar with an implant.

Treatment progress

The patient used 19 aligners for two weeks each. The entire treatment time was nine months and two weeks. The movements achieved are shown in Table I.

Results

Upon final treatment, the anterior spaces had been completely closed and space had been created to replace the missing lower right first molar with an implant (Fig. 3).

Case II: Space management for a congenitally missing tooth

Diagnosis

A 32-year-old male patient reported to my clinic with spaces between his upper teeth and forwardly placed incisors.

The patient was diagnosed with a Class I malocclusion with a missing upper right lateral incisor, spacing in the upper arch, proclined upper and lower incisors, a midline shift owing to deviation of the upper midline 1 mm to the right side, and higher upper labial frenum attachment (Fig. 4).

Treatment objectives

The treatment objectives were:

1. maintenance of the Class I molar and canine relationship;
2. creation of adequate space for the missing upper right lateral incisor;
3. closure of any other spaces in the upper arch;
4. midline correction; and
5. retroclination of the upper and lower incisors.

Table II: Teeth movement records for case 2.
case report CAD/CAM aligners

Treatment plan

We decided to use aligners for both upper and lower arches to manage the upper arch spaces and to retrocline both upper and lower incisors. The treatment plan was accomplished using CAD/CAM technology (Fig. 5).

Treatment progress

The treatment progress was recorded every month as shown in Figure 6. During the first month, the upper right central incisor was moved mesially. In the second, third and fourth months, more mesial movement of the upper right central incisor occurred, as well as retraction of both upper and lower incisors. In the fifth month, correction of the midline shift was achieved and a frenectomy was performed. Finishing and final detailing was achieved in the last month. After finishing the treatment, upper and lower clear retainers were prepared and a pontic of composite was added at the space of the missing lateral incisor. Overall treatment time with aligners lasted for six months and two weeks for the upper arch and four months and two weeks for the lower arch. The movements achieved with each aligner are shown in Table II.

Results

Facial and intra-oral photographs (Figs. 7a–h) show midline correction, closed upper spaces (except the space of the missing upper right lateral) and decreased upper and lower proclination.

Case III: Generalised spacing and protrusion

Diagnosis

A 44-year-old female patient presented with complaints about protrusion and spaces between her upper teeth. She had no complaints with regard to her lower arch. All upper incisors were covered with crowns.

She was diagnosed with a Class I malocclusion with proclined and spaced upper incisors, lower arch crowding and 1 mm overjet (Figs. 8a–e).

Treatment objectives

The treatment objectives were to close the upper spaces and retract the upper incisors. Therefore, the lower teeth had to be moved back to allow upper teeth movement.
Treatment plan

All upper incisors were covered with crowns. The patient was satisfied with these crowns with regard to their shade, size and shape. In such cases, three treatment options are available:

1. new crowns for the upper anterior teeth;
2. conventional braces, which would lead to two problems: risk of frequent bracket bonding failure and scratching of the labial crown surfaces; and
3. aligners.

By using aligners, neither did the crowns need to be changed nor did we face problems generally associated with brackets. Using CAD/CAM technology, Figure 9 shows the initial situation and the expected outcome.

Treatment progress

As shown in Table III, the first phase of treatment focused on levelling and aligning the teeth in both upper and lower arches. Thereafter, intrusive and extrusive forces were applied to level the lower incisors followed by the retraction of the teeth by lingual tipping. The entire treatment time lasted less than five months using only nine aligners.

Results

As shown in Figures 10a–e, all the spaces were closed in the upper arch, the lower arch crowding was relieved, and both upper and lower incisors were retracted.

Discussion

Although space management in adults can be done using prosthetic appliances alone, cooperation with an orthodontist in such situations can lead to better aesthetic results, especially when teeth are moved using aligners, an almost invisible treatment option. Patient cooperation is the critical factor in achieving a successful aligner treatment. Aligners should be worn for at least 20 hours per day, seven days a week.

The overall hygiene maintenance and the level of clinical finish achieved are of satisfactory quality. The acceptance of this treatment modality is far higher compared with conventional orthodontics.

Conclusion

Space management in the dental arch in adult patients, which can be caused by different factors such as extracted teeth, congenitally missing teeth or generalised spacing, should be approached with a team including an orthodontist. Aligners have the advantage of being an invisible appliance, offering better oral hygiene and patient acceptance as compared with fixed orthodontics.

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

Table III

| Teeth movement records for case 3. |

<table>
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CAD/CAM contact
Belgian researchers have developed and produced the first patient-specific, 3-D printed titan implant. For the first time in the history of implantology, a customised implant has replaced a complete mandible. It restored form, function and aesthetic aspects of a natural mandible in a significantly shorter period compared with classical treatments.

The Functional Morphology research group at the University of Hasselt’s BIOMED research institute recently presented the first customised 3-D printed mandible, which was implanted in a patient in June 2011. The procedure was conducted on an 83-year-old woman who suffered from serious osteomyelitis, which had affected almost the entire mandible. Given the severe and rapidly progressive infection in this senior patient’s lower jaw-bone, treatment options were rather limited. The classical treatment, namely removing the damaged bone, would have resulted in a small mandible without any support and function. Researchers faced the challenge of restoring vital functions, such as breathing, speech, chewing and sensation. The decision to reconstruct the entire mandible with a customised 3-D printed implant was made to spare the senior patient a long surgery and shorten the subsequent stay in hospital. It was the first time that a complete mandible was replaced.

“The introduction of printed implants can be compared to man’s first venture on the moon: a cautious but firm step,” said Prof Jules Poukens of BIOMED.

The artificial jaw weighs approximately 107 grams, which is almost as heavy as a natural mandible. The implant is designed to allow the direct insertion of dental bars or bridge implants at a later stage and therefore provides the perfect foundation for dental restoration. Owing to perfect fit, the surgery was completed in four hours, which is only a quarter of the time needed with the classical method. This spared the patient additional adjustment surgeries and speeded up recovery. According to Poukens, the patient regained normal function with adequate speech, swallowing and unrestricted movement within one day after surgery.

Planned and designed by doctors and engineers from various institutions in Belgium and the Netherlands, the implant was produced by LayerWise, a company experienced in metal Additive Manufacturing (AM) technology, which is a specific form of 3-D printing used to create implants layer by layer. A high-precision laser selectively heats metal powder particles to quickly melt and attach them to the previous layer. The titan model was coated with bioceramic afterwards. AM is used to print functional implant shapes that would otherwise require multiple metal working steps or that cannot be produced any other way.

Metal AM is generally gaining importance in medical implantology. The technique is increasingly being adopted in dentistry and in other medical fields. Many companies already use printers able to build 3-D models for the production of prototypes of new products because they allow the most complex geometrics to be produced.

Researchers agree that 3-D implants are an excellent addition to current treatment options. “As illustrated by the lower jaw reconstruction, patient-specific implants can potentially be applied on a much wider scale than transplantation of human bone structures and soft tissue,” said Dr Peter Mercels, Managing Director of LayerWise.

The revolutionary jaw implant was granted the 2012 AM Award by the Additive Manufacturing Network in Belgium.
INTERNATIONAL CONGRESS IN IMPLANTOLOGY AND ESTHETIC DENTISTRY

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Planmeca introduces Planmeca ProMax 3D ProFace, a unique CBVT imaging unit with an integrated 3-D facial scanning system. This true 3-D application is designed to fulfill the most diverse diagnostic needs of today’s maxillo-facial and dental professionals. The Planmeca ProMax 3D ProFace unit acquires a 3-D facial image of the patient without exposing the patient to radiation, allowing the medical or dental professional to plan surgery and document the follow-up images.

Planmeca ProMax 3D ProFace is the first to introduce an integrated 3-D unit that produces a realistic 3-D facial image, in addition to traditional digital maxillo-facial radiography. One single scan generates both a 3-D and a CBVT image. Alternatively, the 3-D image can be acquired separately through a completely radiation-free process: the lasers scan the facial geometry and the digital cameras capture the colour texture of the face.

The 3-D image visualises soft tissue in relation to dentine and facial bones, providing an effective follow-up tool for maxillo-facial operations. As Planmeca ProMax 3D ProFace acquires both a 3-D and a CBVT image in a single scan, the patient position, facial expression and muscle position remain unchanged, resulting in perfectly compatible images. For careful preoperative planning, the medical professional can study the facial anatomy thoroughly using Planmeca Romexis software, which facilitates a detailed surgery and enhances the aesthetic results.

"This new product clearly demonstrates our ground-breaking R&D and best practices in imaging. Planmeca provides the most advanced tools—3-D imaging units and software—for visualising patient anatomy, making treatment planning and follow-up for orthodontic, maxillo-facial and aesthetic surgeries more precise, faster and safer," explained Helianna Puhlin-Nurminen, Vice-President of the Digital Imaging and Software Applications division at Planmeca.

The product is based on the recognized Planmeca ProMax platform, which makes future upgrades extremely simple. The Planmeca ProMax 3D ProFace feature is available for Planmeca 3-D products: Planmeca ProMax 3D, Planmeca ProMax 3D Mid and soon also for Planmeca ProMax 3D Max.

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3Shape technologies — Closing-in on complete digital dentistry

To improve and expand their services, both dentists and labs need to address dentistry as a whole. 3Shape provides digital methods for improving efficiency throughout all phases of dental treatment, starting from the intra-oral impression scanned at the dentist’s clinic and continuing all the way through to manufacturing.

Dental System 2012 offers many features specifically designed to enable labs to develop their business as service centres for dentists. As a central part of this strategy, 3Shape Dental System 2012 facilitates workflows relevant to all areas of dentistry.

3Shape’s TRIOS is a complete digital impression solution for dental clinics that enables dentists to capture the intra-oral situation directly, achieving huge benefits in relation to traditional analogue impression taking. 3Shape TRIOS includes intra-oral scanning, intelligent software, and communication with the lab. Unique features include spray-free scanning, complete motion and positioning freedom while scanning, instant impression validation, and smart scan-edit tools.

Digital workflows enabled by 3Shape’s solutions:

The dentist or the clinic’s secretary creates the digital order using a form that is customised according to the specific lab’s requirements. The dentist easily scans the patient’s teeth, validates the digital impression, and immediately sends the case to the lab while the patient is still in the chair.

Labs using Dental System can receive TRIOS digital impression scans or third-party intra-oral scans (Sirona CEREC, Cadent iTero) from the dentist’s clinic directly in their TRIOS Inbox and can then start the design process immediately.

With 3Shape’s new Model Builder, labs can use TRIOS scans directly to design lab models, including implant models, either in-house or locally. The digital models are fully prepared for optimised manufacturing on 3-D printers or milling machines.

Dental System’s Digital Temporaries feature enables labs to digitally design and produce temporaries — directly from the pre-preparation scan and without pouring a gypsum model.

Labs can prepare aesthetic Virtual Diagnostic Wax-ups to send to the clinic for dentist–patient preview before the patient’s teeth are even prepared.

3Shape Communicate enables easy lab–dentist collaboration during all steps of the case. Approved designs can be reused when designing the final crown, saving time and ensuring aesthetics.

3Shape’s CAMbridge software automatically prepares digital designs for manufacture, and Dental System supports almost all materials and manufacturing equipment.

Digital technologies are rapidly becoming the standard in dental clinics, labs and manufacturing centres, and now the most advanced systems support collaboration and workflows between them.

Contact

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1060 Copenhagen K
Denmark

www.3shape.com
THE STARS IN COMPUTERIZED DENTISTRY

Theatre Presentation
One-visit chairside dentistry: How to make CAD/CAM Restorations Esthetic and Durable in Clinical Practice

Dr. Michael Dieter, Germany

Dr. Andreas Kurbad, Germany
• Computer Navigated Implantology
• Esthetic Engineering

Dr. Simon Smyth, UK
• Everyday CAD/CAM Usage: Preparation, Practicality & Possibilities, What Benefits You and Your Practice
• Further Possibilities of CAD/CAM: One Visit Smile Makeovers and Permanent Bridges Chairside

Dr. med. dent. Peter Gehrke, Germany
• Two-Piece CAD/CAM Zirconia Implant Abutments
• Optimizing Implant Function & Esthetics at the Perio-Prosthetic Interface: The Role of the Superstructure

Having presented its new dental design software, CARES Visual 7.0, at the recent Chicago Dental Society Midwinter Meeting, Straumann has now begun the rollout of this new system to CAD/CAM customers in Europe and North America. Like all Straumann software, CARES Visual 7.0 is designed to enhance user friendliness and versatility, but what distinguishes it is that it offers customers the possibility of producing prosthetic elements through third-party milling, thereby opening the Straumann CAD/CAM system.

Using CARES Visual 7.0, customers can design prosthetic crowns, bridges, onlays, inlays, etc. by computer and then route the design data to a milling lab either at or outside Straumann. At Straumann, the workflow is validated and seamless, and one of the broadest ranges of materials and applications is offered. Importantly, prosthetic restorations delivered through this process are covered by the Straumann guarantee.

The decision to have the prosthetic restorations milled externally might be driven by special functional or material preferences that are not available through Straumann. Today, many dental labs have to invest in multiple CAD/CAM systems in order to serve a mixed customer base with differing requirements. This places considerable economic and administrative burdens on the labs, which could be reduced through a single open system.

Dr Sandro Matter, Executive Vice-President of Straumann’s Prosthetics Business Unit, commented: “Customers want state-of-the-art functional software that offers flexibility and full assurance of predictability and reliability. CARES Visual 7.0 meets these criteria and ensures Straumann quality. It means that labs can now invest in a CAD/CAM system without the fear of being locked in to a single manufacturer.”

CARES Visual 7.0 is available as an upgrade to customers with CARES Scan CS2 scanners and comes installed in all new Straumann CARES systems delivered as of 1 March 2012.

Creating the open dental software platform of the future

Digital technologies are becoming widespread in dentistry and cover a broad spectrum of applications—from general practice management, treatment planning, imaging, guided surgery, digital impression taking, right through to computer-aided prosthetic design and manufacture. As digitalisation grows, so too does the number of incompatible systems, making dental labs reluctant to invest in technology that might become obsolete or compromise flexibility. Software standardisation—the precondition for open systems—will go some way towards resolving this.

A year ago, Straumann and 3M ESPE—a pioneering leader in digital dentistry—joined forces with Dental Wings to create an open global standard software platform for use across a range of dental applications. The initiative is expected to offer enhanced flexibility, simplicity, and convenience for users, while saving time, costs and investment.

CARES Visual 7.0 has been developed on the open DWOS (Dental Wings Open Software) software platform, which—thanks to its scope, quality and functionality—is positioned to become the future standard software solution in dentistry.

About Straumann CARES

Straumann CARES Digital Solutions provide dental professionals with a complete, reliable and precise solution. From scanning the intra-oral situation to sophisticated, prosthetic-driven backward planning, the digitalisation of dental workflows is bringing about new and exciting possibilities for patients, surgeons and lab technicians. The Straumann CARES platform offers seamless connectivity to thousands of scanners in dental practices worldwide and provides Straumann customers with access to future leading-edge developments in digital dentistry.

Contact

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Peter Merian-Weg 12
4002 Basel
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www.straumann.com
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Signature
CEREC Club Select: additional benefits for users

In the interests of longevity and reliability, dentists should regularly maintain and update their dental capital equipment. For some years now, CEREC Club has offered users the latest CEREC software upgrades and updates free of charge. As Sirona continues to develop its portfolio of dental CAD/CAM systems, the company has now decided to relaunch its Club membership package.

The new CEREC Club Select comprises an extensive range of services that have been precisely tailored to the requirements of CEREC AC users.

Firstly, users receive regular software upgrades and updates ensuring that their equipment remains fully up to date. Secondly, special maintenance kits and an extended spare parts warranty protect the dentist’s investment long-term. Additionally, CEREC Club Select members are entitled to take part in online tutorials on www.dentalusers.com free of charge over a six month period.

CEREC Club Select membership commences on installation of the CEREC AC (contracts can be signed within a period of 30 days thereafter) and runs for 36 months.

The contract covers one CEREC AC and up to two milling units installed either at the same time or subsequently. After the initial membership contract has expired, the user can opt for CEREC Club Select Plus membership for a further 36 months.

CEREC Club Select Plus comprises services that are geared to this specific stage in the product lifecycle—i.e. software upgrades and updates as well as new hardware components, in particular a free of charge update PC for the CEREC AC. This ensures that the dentist can exploit the full potential of the software.

CEREC Club Select has been available in numerous countries since 1 April 2012. Authorized dealers can order membership packages via the Sirona webshop.

The benefits of CEREC Club Select membership at a glance:
- CEREC and/or inLab software upgrades and updates depending on milling unit type;
- In addition to the manufacturer’s warranty, free spare parts for one CEREC AC and up to two Sirona milling units for a period of two years;
- Three maintenance kits;
- Online tutorials for a period of six months.

The benefits of CEREC Club Select Plus membership at a glance:
- Free of charge upgrade PC for the CEREC AC acquisition unit;
- CEREC and/or inLab software upgrades and updates depending on milling unit type.

CEREC Club Select is not available in the United States and in Canada.
Announce your courses in CAD/CAM!

**WHAT?**

**LIVE EDUCATION SYMPOSIUM AT FDI ANNUAL WORLD DENTAL CONGRESS**

29 August–1 September 2012

HK Convention and Exhibition Centre, Hong Kong, China

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. This year marks a special edition as it is the 100th FDI World Dental Congress.

**WHERE?**

**WHERE?**

**WHAT?**

Dental Tribune America, LLC
c/o Christiane Ferret
116 West 23rd Street, Ste. 500, New York, NY 10011, USA

+1 424 744 0608

c.ferret@dtstudyclub.com

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.
The CAMLOG Foundation is a foundation established under Swiss law. It engages in targeted supporting 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 serve the patient. Since its establishment in 2006, the CAMLOG Foundation has funded numerous scientific projects, has promoted continuous training and education and has generated a broad international platform for the exchange of knowledge between scientists, practitioners and industry.

As part of its scientific mission, the CAMLOG Foundation has assumed patronage of the International CAMLOG Congresses, which take place every two years.

The international CAMLOG Congresses are platforms for gaining and exchanging new knowledge and ideas and they are well known for the quality of their lectures and their balance between scientific evidence and practical knowledge.
Under the motto “Feel the pulse of science in the heart of Switzerland”, CAMLOG had invited all to Lucerne, Switzerland, for the 4th International Congress—and they ALL came. More than 1,300 participants meant a new record attendance in the internal congress ranking of the CAMLOG Group, that with this impressive success again underscored its claim to place among international leaders in implant dentistry.

The starting shot for congress activities was given on Thursday, May 3, a day before the actual congress, with four German/English workshops that had been sold out well in advance. These theoretical and practical events on all aspects of soft-tissue management were held at 2,100 meters above sea level on Mount Pilatus, a unique location only accessible by cogwheel railway or aerial cableway with a fascinating view of an ensemble of more than 70 alpine peaks.

Then on May 4 and 5 at the Culture and Congress Center in Lucerne on Lake Lucerne directly, an internationally renowned panel of speakers presented the state-of-the-art of implant dentistry.

The range of topics included:
- innovations in implant-abutment connections;
- long-term clinical experience with platform switching;
- the demographic shift and increasingly aging patients;
- current trends in digital dentistry;
- meet the experts with “complicated” cases/patients, including lively panel discussion.

As the concluding participant survey showed, the connection between the scientific content of the first morning of the congress and the practical topics of Friday afternoon and Saturday was viewed as particularly successful and instructive.

And not to miss out on the “social networking”, CAMLOG had invited to two raving parties. Both on Friday and Saturday evening, happy congress participants and partygoers made certain that “Let’s rock the Alps” was literally experienced by all attending on the “Rigi”, Lucerne’s “own” mountain.

Against the background of this resounding success, the CAMLOG Foundation disclosed immediately at the end of the Lucerne congress that the 5th International CAMLOG Congress, for which planning has already started, will be held in Spain in 2014.
Preparations for the 35th International Dental Show (IDS), which will be hosted in Cologne in March 2013, are already gathering pace. For the 2013 show, the organisers of the world’s largest fair for dental medicine and technology are expecting a repeat of last year’s interest from the dental world, when nearly 2,000 suppliers and 118,000 trade visitors made IDS 2011 the most successful ever.

The Society for the Promotion of the Dental Industry (Gesellschaft zur Förderung der Dental-Industrie—GFDI), IDS organiser and the commercial enterprise of the Association of German Dental Manufacturers (Verband der Deutschen Dental-Industrie—VDDI), and global company Koelnmesse, who is staging the event, have mailed the registration forms to potential exhibitors, kicking off preparations for next year.

Koelnmesse has already received numerous enquiries for stand space. Following the record results of IDS 2011, with 1,954 suppliers from 58 countries and around 118,000 trade visitors from 149 countries, the organisers are expecting similar interest next year. "According to a representative survey, around 90 per cent of the exhibitors of IDS 2011 are planning their participation at IDS 2013," said Dr. Martin Rickert, VDDI CEO. "This shows that the IDS is a not-to-be-missed event for all those who wish to successfully operate in the dental industry."

As with previous shows, the first day of the fair will be Dealers’ Day, which concentrates on the
specialist dental trade and importers, thus offering the opportunity of uninterrupted sales negotiations at the exhibitors’ stands.

As in 2011, the IDS will occupy exhibition space of 145,000 m². The organisers expect the dental trade show to attract more than 1,900 national and international exhibitors. Even at this stage, many exhibition enquiries have been received from potential first-time exhibitors from abroad. Additionally, 12 foreign group presentations are expected so far.

According to the organisers, the undisputed status of the IDS as the world’s leading fair for the dental industry was also impressively underlined by the results of an independent exhibitor and visitor survey of IDS 2011. The event brought together decision-makers from the dental profession, dental technicians trade, specialist dental trade and dental industry from all over the world, which ensured great satisfaction among the IDS exhibitors. In addition, 97 per cent of the German suppliers reached their key customers in the domestic market and 83 per cent reached their key accounts from abroad.

Of the foreign exhibitors, as many as 98 per cent networked with their international customers and 95 per cent with their German customers, according to the survey. Furthermore, 95 per cent of the German and 98 per cent of the international exhibitors made new contacts with interested German parties.

Also, 81 per cent of the German and 99 per cent of the foreign suppliers acquired new international contacts.

According to the survey, the majority of visitors were satisfied with last year’s IDS. Moreover, 78 per cent of the German and 81 per cent of the foreign trade visitors rated the product range as good to very good.

All images courtesy of Koelnmesse GmbH.
International Events

2012

IACA Conference
26–28 July 2012
Hollywood, FL, USA
www.theiaca.com

FDI Annual World Dental Congress
29 August–1 September 2012
Hong Kong, China
www.fdiworlddental.org

XXI Congress of the European Association for Cranio-Maxillo-Facial Surgery
11–15 September 2012
Dubrovnik, Croatia
www.eurofaces.com

AAID Annual Meeting
3–6 October 2012
Washington, DC, USA
www.aaid-implant.org

CAD/CAM & Computerized Dentistry International Conference
6 & 7 October 2012
Singapore
www.cappmea.com

EAO
10–13 October 2012
Copenhagen, Denmark
www.eao.org/eao-congress

SA Society of Maxillofacial Oral Surgery
11–14 October 2012
Cape Town, South Africa
www.sasmfos.org

Nobel Biocare Symposium 2012
19 & 20 October 2012
Toronto, Canada
www.nobelbiocare.com

Nobel Biocare Symposium 2012
19 & 20 October 2012
Rimini, Italy
www.nobelbiocare.com

AAMP (joint meeting with ISMR)
27–30 October 2012
Baltimore, MD, USA
www.res-inc.com/AAMP-ISM-R-Meeting/

National Osteology Symposium Brazil
8–10 November 2012
São Paulo, Brazil
www.osteology.org

Greater New York Dental Meeting
23–28 November 2012
New York, NY, USA
submission guidelines:

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

- the complete article;
- all the image (tables, charts, photographs, etc.) captions;
- the complete list of sources consulted; and
- the author or contact information (biographical sketch, mailing address, e-mail address, etc.).

In addition, images must not be embedded into the MS Word document. All images must be submitted separately, and details about such submission follow below under image requirements.

Text length

Article lengths can vary greatly—from 1,500 to 5,500 words—depending on the subject matter. Our approach is that if you need more or 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.

Text formatting

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

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

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

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

Image requirements

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

Please place image references in your article wherever they are appropriate, whether in the middle or at the end of a sentence. If you do not directly refer to the image, place the reference at the end of the sentence to which it relates enclosed within brackets and before the period.

In addition, please note:

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

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

Also, please remember that images must not be embedded into the body of the article submitted. Images must be submitted separately to the textual submission.

You may submit images via e-mail, via our FTP server or post a CD containing your images directly to us (please contact us for the mailing address, as this will depend upon the country from which you will be mailing).

Please also send us a head shot of yourself that is in accordance with the requirements stated above so that it can be printed with your article.

Abstracts

An abstract of your article is not required.

Author or contact information

The author’s contact information and a head shot of the author are included at the end of every article. Please note the exact information you would like to appear in this section and format it according to the requirements stated above. A short biographical sketch may precede the contact information if you provide us with the necessary information (60 words or less).

Questions?
Magda Wojtkiewicz (Managing Editor)
m.wojtkiewicz@dental-tribune.com
Great new features

**Dental System™ 2012 - the future proof solution**

**Model Builder**
Create lab models directly from TRIOS® and 3rd party intraoral scans. Support for implant models.

**TRIOS® integration**
Receive TRIOS® digital impressions instantly from dentists and start designing right away.

**3Shape Communicate™**
Upload 3D design visualizations with a single click. Share and discuss your cases with dentists.

**2nd Generation Removable Partial Design**
Intuitively mimics the familiar workflow while significantly reducing production time.

**Digital Temporaries**
Create cost-effective temporaries without pouring a model using Virtual Preparation and Virtual Gingiva.

**D800 3D scanner**
Two 5.0 MP cameras. Scans a single-die in 25 seconds, captures texture and scans impressions.

**Backing our users with technology, care and expertise**

**New Dynamic Virtual Articulation**
Like using your physical articulator. Support for Occlusion Compass. KaVo PROTAR®evo, Whip Mix Denar® Mark 330, SAM® 2P, Artex® compatible and more to come.

**Next Generation Telescopes**
Full freedom for designing telescopic crowns. Support for attachment crowns and open telescopes. Add multiple bands, parametric attachments, and customized attachments.

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