ce article
Aesthetic replacement of maxillary premolar

case report
Adaptation of traditional working methods to the creation of Cr-Co ceramic restoration with CAD/CAM technology

cone beam supplement
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synergy (ˈsɪnərɪ) — the interaction or cooperation of two or more organisations, substances, or other agents to produce a combined effect greater than the sum of their separate effects.

The explosion of ‘digital dentistry’ has expanded the clinician’s ability to treat patients with an array of different protocols, devices, materials, and software applications. It is an exciting time to practise dentistry no matter where in the world you happen to be. However, just because we are now embracing the term ‘digital’ does not mean that we truly understand the power that this technology represents. In my opinion that power rests not on the technology itself, but the synergy between various components of both the analog and digital world.

When a patient presents needing dental implants, we may rush to take a panoramic radiograph or even a 3-D cone beam CT scan. While a panoramic radiograph is an adequate screening modality, it has inherent limitations making definitive diagnosis for implant receptor sites potentially inaccurate. While a CBCT scan can provide excellent information regarding the individual patient’s anatomy, alone, it may not be entirely adequate to treatment plan with the highest degree of accuracy.

In the ideal world the diagnostic process should begin with an understanding of the desired restorative outcome. Therefore it may be advisable to fabricate a diagnostic wax-up, or a complete denture set-up to determine the functional and aesthetic needs prior to the CBCT scan. A scannographic template can be fabricated to help relate the restorative plan to the existing underlying bone. Additionally, an optical scan or intraoral scan can be completed to create a digitised version of the tooth set-up, along with the opposing occlusion. These digital files can then be combined with the CBCT data creating a total diagnostic foundation to create one or more treatment options for the patient requiring dental implants and/or grafting procedures.

These steps are especially critical when an immediate implant-supported transitional restoration is planned. Immediate loading protocols whether for a single tooth or full arch restoration require excellent pre-surgical prosthetic planning and the fabrication of an accurate transitional restoration. While the temporary restoration can be constructed by either analogue or digital means, it is clear that direct CAD/CAM modalities are the preferred path. CAD/CAM applications are also becoming the preferred method to fabricate the definitive restorative outcome, often based on the morphology of the temporary.

Therefore, the new digital workflow requires synergy between various components, including pre-surgical prosthetic planning, diagnostic wax-ups, complete denture set-ups, intraoral and/or optical scanners, interactive treatment planning, and CAD/CAM software applications. As the digital universe continues to expand, it will be more and more important to manage these resources with an open platform to maximise potential synergies. Within the publications of Dental Tribune International, it is our goal to provide guidance for clinicians wishing to learn more about these exciting new protocols.

Respectfully

Dr Scott D. Ganz
Dear Reader

Dr Scott D. Ganz

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“I believe that the digital future holds promising prospects”

An interview with Dr João Fonseca from Portugal

Dr João Fonseca was one of the distinguished speakers at the Ivoclar Vivadent International Expert Symposium which this year was held in Madrid, Spain. DTI had the opportunity to speak with him about the benefits and drawbacks of digitisation in dentistry.

DTI: With the ongoing digitisation process, dental professionals now have possibilities that were unthinkable 30 years ago. What are the main impacts—and certainly benefits—of this development on the field of dental aesthetics?

Dr João Fonseca: Computer chips and architecture have evolved enormously over the last few decades. Nevertheless, some predicted leaps in technology have yet to happen, as Moore’s Law predictions are right on track. Google announced recently that it is launching a new processing unit that will enhance our processing capabilities by a factor of three Moore’s generations (seven years). Smarter machines with better algorithms that take advantage of billions of transistors and complex chip architecture will be used in the future to better aid the dental team in all phases of the treatment plan. And that will, of course, mean the generation of better proposed treatment based on morphology databases and algorithms, with higher possibilities of success regarding aesthetic integration. In addition, the possibility of immediately printing and snapping on aesthetic mock-ups might be a powerful diagnostic tool in the near future.

Although digital technology can facilitate and increase the efficiency of dental treatment, some human qualities are probably difficult to replace. Yes. Although some enthusiasts in the field of artificial intelligence predicted a technological singularity [Editorial note: According to the technological singularity hypothesis, accelerating progress in technologies will result in a runaway effect in which artificial intelligence will surpass human cognitive ability] during this century, to date, machines are not able to learn or to feel the way we humans do. When you gaze at the stars or watch the sunset on a perfect summer’s day, it is this kind of sensation that cannot yet be described in a mathematical formula or decomposed in a way that could be emulated by a computer. There are other aspects in dental prosthetics and aesthetics for which we could debate whether machines would be able to replace us, but I think human emotion will continue to draw a line for many years to come.

Apart from the new possibilities that digital dentistry offers, what does the increasing automation mean for both the patient and the clinician? Increasing automation means that fewer and faster human-intervening steps will likely relieve the bur-
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- The Planmeca PlanMill® 40 unit is ideal for high-precision milling

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den of complicated execution in oral rehabilitation. Clinicians will have more sophisticated tools in every phase of treatment planning and execution. This will allow them to give greater attention to patients’ expectations and details that are sometimes compromised, as clinicians focus on the execution barriers often imposed by the workflow. Patients will benefit because automation has the potential to reduce treatment time, improve the treatment experience, potentially reduce overall cost and increase success rates.

What would be a good combination of the best of both conventional methods and CAD/CAM regarding dental restorations?

In my opinion, with the currently available technology, functional and aesthetic diagnostics in dental medicine should be a human-based, human-executed task. To give an example, although I find digital tools of interest in aiding patient–clinician–technician communication, morphology assessment, discussion and approval should be a process involving real intra-oral prototypes (regardless of the way these are obtained during the diagnostic workflow). Regarding definitive restorations, I think that the future is unpredictable, as bioengineering is advancing at a fast rate. So, it is unlikely that ceramic materials will be cutting-edge in 30 years’ time. For now, we can make monolithic restorations with 3-D staining and glazing, combined with mechanical polishing. This integrates amazingly in many clinical scenarios and is likely to become a trend as materials improve every year. It may be that, in the next ten years, laboratories can print dentine mamelons and inner characterisation effects, which would make handcrafted veneers and crowns a thing of the past.

A recent study in Japan has investigated the possibilities of a robotic device for automatic tooth preparation. Do you think that this is a realistic scenario for the near future?

As Tom Davenport stated early this year, “…smart leaders will realise that augmentation—combining smart humans with smart machines—is a better strategy than automation.” Evolution will happen in both directions, as smarter machines will require smarter minds. I believe that the digital future holds promising prospects. Never before have we witnessed so many young talented dentists eager to share their experience and contribution to dental aesthetics. Materials will improve even further in the near future, with better functional performance and chameleon effects. 3-D printing will enable multilayering to be an automated process, reducing human resources spent on minor tasks and allowing professionals to focus on planning and decision-making during fabrication of dental prostheses. Dental aesthetics will become more attractive for the patient, and more clinicians will be able to deliver restorations with a high-quality standard to their patients.
Materials and systems for all ceramic CAD/CAM restorations

A review of the literature

Authors: Drs Christian Brenes, Ibrahim Duqum & Gustavo Mendonza, USA

Introduction

Dental crowns have been used for decades to restore compromised, heavily restored teeth, and for aesthetic improvements. New CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) materials and systems have been developed and evolved in the last decade for fabrication of all-ceramic restorations.

Dental CAD/CAM technology is gaining popularity because of its benefits in terms of time consuming, materials savings, standardisation of the fabrication process, and predictability of the restorations. The number of steps required for the fabrication of a restoration is less compared to traditional methods (Fig 1). Another benefit of CAD/CAM dentistry includes the use of new materials and data acquisition, which represents a non-destructive method of saving impressions, restorations and information that is saved in a computer and constitutes an extraordinary communication tool for evaluation.

The incorporation of dental technology has not only brought a new range of manufacturing methods and material options, but also some concerns about the processes involving restorations’ fit, quality, accuracy, short and long-term prognosis.

The purpose of this document is to provide a review of the literature regarding the different materials and systems available up until 2015 in the USA.

CAD/CAM materials

Glass ceramics

The first in-office ceramic material was Vitablock Mark I (Vident); it was a feldspathic-based ceramic compressed into a block that was milled into a dental restoration. After the invention of the Mark I block, the next generation of materials for CAD/CAM milling fabrication of all-ceramic restorations were Vita Mark II (Vident) and Celay, which replaced the original Mark I in 1987 for fine feldspathic porcelains primarily composed of silica oxide and aluminum oxide. Mark II blocks are fabricated from feldspathic porcelain particles embedded in a glass matrix and used for single unit restorations available in polychromatic blanks nowadays. On the other hand, Celay ceramic inlays have been considered clinically acceptable by traditional criteria for marginal fit evaluation.

Dicor-MGC was a glass ceramic material composed of 70 percent tetrasilicic fluormica crystals precipitated in a glass matrix; but this material is no longer available on the market. Studies from Isenberg et al. suggested that inlays of this type of ceramics were judged as clinically successful in a range from 3–5 years of clinical service. In 1997, Paradigma MZ100 blocks (3M ESPE) were introduced as a highly filled ultrafine silica ceramic particles embedded in a resin matrix; the main advantage of this material is that it can be used as a milled dense composite that was free of polymerisation shrinkage but can not be sintered or glazed.

In early 1998, IPS ProCAD (Ivoclar Vivadent) was introduced as a leucite reinforced ceramic, which was similar to IPS Empress but with a finer particle size; this material was designed to be used with the CEREC system (Sirona Dental) and was available in different shades. More recently, the introduction of IPS Empress CAD (Ivoclar Vivadent) and Paradigm C that according to the manufacturer (3M ESPE) is a 30 to 45 percent leucite reinforced glass ceramic with a fine particle size.
To overcome aesthetic problems of most CAD/CAM blocks having a monochromatic restoration, a different version was developed as a multicoloured ceramic block, which was called VITA TriLuxe (Vident) and also IPS Empress CAD Multiblock; the base of the block is a dark opaque layer, while the outer layer is more translucent; the CAD software allows the clinician to position or align the restoration into the block for the desired outcome of the restoration.11,12

In 2014, the Enamic (VITA) material was released as a ceramic network infiltrated with a reinforcing polymer network that has the benefits of a ceramic and resin in one material, but no clinical data are available.14

Alumina-based ceramics

Alumina blocks (Vitablocs In-Ceram Alumina, VITA) are available for milling with the CEREC system (Sirona Dental) and now compatible with other milling machines as well. Due to the opacity of alumina-based ceramic materials, the In-Ceram Spinell (VITA) blocks were developed as an alternative for anterior aesthetic restorations; it is a mixture of alumina and magnesia. Its flexural strength is less than In-Ceram Alumina, but veneering with feldspathic porcelain for a more aesthetic result could follow it after the milling process.14,15

Nobel Biocare developed Procera material; for its fabrication high purity aluminum oxide is compacted onto an enlarged die that is fabricated from the scanned data.16 The enlarged fabricated core shrinks to the dimensions of the working die when sintered at 1,550 °C; this material offers a very high strength core for all-ceramic restorations; the crown is finished with the application of feldspathic porcelain.17 More recently, In-Coris AL (Sirona Dental) has been introduced as a high-strength aluminum oxide block with similar mechanical properties as Procera.18

Lithium disilicate

Lithium disilicate is composed of quartz, lithium diox- ide, phosphor oxide, alumina, potassium oxide and other components. According to Saint-Jean (2014) the crystallisation of lithium disilicate is hetero- genous and can be achieved through a two or three stage process depending if the glass ceramic is intended to be used as a mill block (e-max CAD) or as a press ingot (e-max press). Lithium disilicate blocks (Fig. 3) are partially sintered and relatively soft; they are easier to mill and form to the desired restoration compared to fully sintered blocks; after this process the material is usually heated to 850 °C for 20 to 30 minutes to precipitate the final phase. This crystallization
Zirconia is a polymorphic material that can have three different forms depending on the temperature: monoclinic at room temperature, tetragonal above 1,170 °C, and cubic beyond 2,370 °C. According to Picton (1999) 'the phase transitions are reversible and free crystals are associated with volume expansion.' Different authors state that when zirconia is heated to a temperature between 1,470 °C and 2,010 °C and cooled, a volume shrinkage of 25 to 35 percent can occur that could affect marginal fit or passiveness of the restorations.22

This feature limited the use of pure zirconia until 1970 when Rieth and Gupta developed the yttria-tetragonal zirconia polycrystal (Y-TZP) containing 2 to 3 percent mol-yttria in order to minimise this effect.10

One of the most interesting properties of zirconia is transformation toughening; Kelly (2008) describes it as: 'A phenomenon that happens when a fracture takes place by the extension of an already existing defect in the material structure, with the tetragonal grain size and stabilizer, the stress concentration at the tip of the crack constitutes an energy source able to trigger the transformation of tetragonal lattice into the monoclinic phase.' This process dissipates part of the elastic energy that promotes progression of cracks in the restoration; there is a localised expansion of around 3.5 percent that increases the energy that opposes the crack propagation.4

Zirconia restorations can be fabricated from fully sintered zirconium oxide or partially sintered zirconium oxide blanks (green-state). Proponent of milling fully sintered zirconia claim that fitness of restorations is better because it avoid volumetric changes during the fabrication process. On the other hand, the partially sintered zirconia (Fig. 4) is easier and faster to mill and proponents of milling partially sintered blanks claim that micro cracks can be induced to the restoration during the milling process and it also requires more time and intensive milling processes; this micro defects or surface flaws can affect the final strength of the final restoration and could potentially chip the marginal areas; however further research is needed about this topic.10

One of the first systems that used zirconia was In-Ceram Zirconia (Vident), which is a modification of the In-Ceram Alumina but with the addition of partially stabilised zirconia oxide to the composition. Recently many companies have integrated zirconia into their CAD/CAM workflow due to its mechanical properties, which are attractive for restorative dentistry; some of these properties are: high mechanical strength, fracture toughness, radiopacity for marginal integrity evaluation, and relatively high aesthetics.13–14

Different manufacturers are using zirconia as one of their main materials such as: Ceramill Zolid (Amann

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**Table I: Recommended dimensions for E-max CAD by Ivoclar Vivadent.**

<table>
<thead>
<tr>
<th>Material thickness</th>
<th>Anterior</th>
<th>Premolar</th>
<th>Molar</th>
<th>Veneers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staining technique</td>
<td>1.2</td>
<td>1.5</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Cut-back technique</td>
<td>1.2</td>
<td>1.5</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Layering technique</td>
<td>0.8</td>
<td>0.8</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Values are expressed in millimetres.

strength of 360 to 400 MPa (two to three times stronger than glass ceramics); the blocks are blue in the partially crystallised state but it achieves the final shade after it is submitted to the fusing process in a porcelain oven for 20 to 25 minutes to complete the crystallisation; the final result is a glass-ceramic with a fine grain size of approximately 1.5 μm and 70 percent crystal volume incorporated in a glass matrix.20

In 2014, Vident released Suprinity; the first ceramic reinforced with zirconia (10 percent weight); this material is a zirconia reinforced lithium silicate ceramic (ZLS) available in a precrystallised or fully crystallised (Suprinity FC) state indicated for all kind of single all-ceramic restorations.

**Zirconia**

Zirconia has been used in dentistry as a biomaterial for crown and bridge fabrications since 2004; it has been useful in the most posterior areas of the mouth where high occlusal forces are applied and there is limited interocclusal space.21
Girbach), Prettau (Zirkonzahn), Cercon (DENTSPLY), BruxZir (Glidewell Laboratories), IPS ZiCAD (Ivo... and systems

CAD/CAM systems

A number of different manufacturers are providing CAD/CAM systems that generally consist of a scanner, design computer and a milling machine or 3-D printer. Laboratories are able to receive digital impression files from dentists or use a scanner to create digital models that are used for restorations designing or CAD. Dental scanners vary in speed and accuracy. Milling machines vary in size, speed, axes, and also in which restorative materials can be milled; in this category milling machines could be classified as wet or dry depending if the materials require irrigation.

The development of dental CAD/CAM systems occurred around 1980 with the introduction of the Sopha system developed by Dr Duret. A few years after that event, Dr Mormann and the electrical engineer Marco Brandestini developed the CEREC-1 system in 1983, the first full digital dental system created to allow dentists to design and fabricate in-office restorations. Since then, the continuous evolution of systems dedicated to this field has continued and has exponentially increased in the last decade.14

CEREC systems has evolved into CEREC Bluecam scanner; accuracies as close as 17 microns for a single tooth have been reported by authors using this system. Recently CEREC Omnicam was introduced offering true colour digital impressions without the need of a contrast medium. In a recent study by Neves et al. (2013) on the marginal fit of CAD/CAM restorations fabricated with CEREC Bluecam, they compared lithium disilicate single unit restorations to heat-pressed restorations and 83.8 percent of the specimens had a vertical gap measurement with less or at least 75 microns.15

The CEREC InLab CAD software (Sirona Dental) was designed for dental laboratories for a wide range of dental capabilities that can be combined with third party systems. With this software, the dental technician is able to scan their own models using Sirona inEos X5 (Sirona Dental) scanner and design the restoration; once this process is completed, the file can be sent to a remote milling machine or a milling centre for fabrication in a wide range of materials.

The Procera system, introduced in 1994, was the first system to provide fabrication of a restoration using a network connection. According to research data the average ranges of marginal fit of this restorations vary in size, speed, axes, and also in which restorative materials can be milled; in this category milling machines could be classified as wet or dry depending if the materials require irrigation.

Another system that was developed years ago was the Celay system, which fabricated feldspathic restorations through a copy-milling process. The system duplicated an acrylic resin pattern replica of a restoration. Zirkonzahn developed a similar system called the Zirkograph in 2003, which was able to copy-mill zirconia prosthesis and restorations out of a replica of the restoration. Some years after, the Cercon system (DENTSPLY Ceramco) was able to design and mill zirconia restorations out of a wax pattern.1

Almost at the same time that these companies developed the first copy mill prototypes, Lava (3M ESPE) introduced in 2002 the fabrication of yttria-tetragonal zirconia polycrystal (Y-TZP) cores and frameworks for all ceramic restorations. With the Lava system, the die is scanned by an optical process, the CAD software...
In the last decade, companies have decided to differentiate their products by having a full CAD/CAM platform or by focusing on specific areas of expertise like CAD software and intraoral scanners; these companies claim to be open platform because their systems allow to export universal files such as STL or OBJ (Fig. 5) to be used with the majority of nesting softwares and milling machines that are able to import them.

Defenders of closed platforms claim that the integration of different CAD/CAM systems does not allow for a good integration between parts and probably leads to the incorporation of fabrication errors; at this point no research about systems integration is available. Table II shows some of the systems used for dental CAD with their file output; Table III shows some of the most used CAM systems with their material recommendations and capabilities.

Some of the main concerns from clinicians about all-ceramic CAD/CAM restorations accuracy of fit are: scanning resolution, software designing limitations, and milling hardware limitations of accuracy. Clinicians’ and technicians’ experience with the CAM/CAM system integration is also a key factor for fabricating good restoration; the computer software per se will not allow an inexperienced operator to create an excellent dental restoration from scratch.18

Discussion

Several advantages can be drawn from including CAD/CAM dental technology, 3-D scanning and the use of mill materials for all-ceramic restorations. Even though clinical studies have shown that marginal fit of CAD/CAM restorations is compared to conventional restorations the fabrication of dental restorations is still a complex task that requires experience, knowledge and skills.

The incorporation of new systems and materials bring a lot of concerns regarding system implementation, capabilities and mechanical properties of the different materials. One of the biggest problems that still remain in CAD/CAM dental systems is the accuracy of each step in the CAD/CAM chain, from digital impression to the milling step. Using computer aided manufacturing is dependent on the calibration of hardware with software in the workflow. Furthermore, the virtual configuration of the die spacer between the designs and enlarge the restoration or framework that is milled from a pre-sintered blank. Studies on marginal adaptation suggest that Lava restorations have a marginal fit that can be as low as 21 microns.27 Some other systems that were able to mill zirconia were DCS Zirkoni(DCS Dental) and Denzir.16

Table II: Most popular dental CAD systems available for 2015.

<table>
<thead>
<tr>
<th>CAD System</th>
<th>Manufacturer</th>
<th>File output</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Shape</td>
<td>3Shape</td>
<td>Propietary/STL</td>
</tr>
<tr>
<td>ARTI / Modelliere</td>
<td>Zirkonzahn</td>
<td>STL</td>
</tr>
<tr>
<td>CeraMill</td>
<td>Amann Girrbach</td>
<td>STL</td>
</tr>
<tr>
<td>Cercon Eye/Art</td>
<td>Dentsply</td>
<td>Propietary</td>
</tr>
<tr>
<td>CEREC</td>
<td>Sirona Dentsply</td>
<td>Propietary</td>
</tr>
<tr>
<td>Delcam</td>
<td>Delcam</td>
<td>STL</td>
</tr>
<tr>
<td>Dental Wings</td>
<td>Dental Wings</td>
<td>STL</td>
</tr>
<tr>
<td>PlanCAD</td>
<td>Planmeca</td>
<td>STL</td>
</tr>
<tr>
<td>Exocad</td>
<td>Exocad</td>
<td>STL</td>
</tr>
<tr>
<td>InLab</td>
<td>Sirona Dentsply</td>
<td>Propietary</td>
</tr>
<tr>
<td>Procera</td>
<td>Nobel Biocare</td>
<td>Propietary/STL</td>
</tr>
</tbody>
</table>

Table III: Most popular dental CAM systems available for 2015.

<table>
<thead>
<tr>
<th>CAM System</th>
<th>Manufacturer</th>
<th>Type</th>
<th>Milling materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>BruxZir Mill</td>
<td>Glidewell</td>
<td>Dry</td>
<td>Zirconia, wax, PMMA</td>
</tr>
<tr>
<td>CeraMill Motion</td>
<td>Amann Girrbach</td>
<td>Wet/dry</td>
<td>Zirconia, Glass ceramic, ceramic resins, Lithium Disilicate, Chrome Cobalt, PMMA, wax, titanium</td>
</tr>
<tr>
<td>Datron D5</td>
<td>Datron</td>
<td>Wet/dry</td>
<td>Zirconia, Glass ceramic, ceramic resins, Lithium Disilicate, Chrome Cobalt, PMMA, wax, titanium</td>
</tr>
<tr>
<td>Denzir</td>
<td>Ivoclar</td>
<td>Dry</td>
<td>Zirconia</td>
</tr>
<tr>
<td>PlanMill</td>
<td>Planmeca</td>
<td>Wet</td>
<td>Lithium disilicate, ceramic resin</td>
</tr>
<tr>
<td>InLab MC XL</td>
<td>Sirona</td>
<td>Wet/dry</td>
<td>Zirconia, Glass ceramic, ceramic resins, Lithium Disilicate, Chrome Cobalt, PMMA, wax, titanium</td>
</tr>
<tr>
<td>LAVA</td>
<td>3M ESPE</td>
<td>Dry</td>
<td>Zirconia, wax, glass ceramic</td>
</tr>
<tr>
<td>M1/M5</td>
<td>Zirkonzahn</td>
<td>Wet/dry</td>
<td>Zirconia, Glass ceramic, ceramic resins, Lithium Disilicate, Chrome Cobalt, PMMA, wax, titanium</td>
</tr>
<tr>
<td>Procera</td>
<td>Nobel Biocare</td>
<td>Wet</td>
<td>Aluminum oxide</td>
</tr>
<tr>
<td>Zenotec</td>
<td>Ivoclar</td>
<td>Dry</td>
<td>Zirconia, wax, PMMA</td>
</tr>
</tbody>
</table>
tooth and the restorations is essential for the accuracy of the marginal adaptation and has to be calibrated for each one of the systems. Weitltsstein et al. demonstrated that the difference of fit between CAD/CAM restorations is directly related to the gap parameters from the computer design and also related to the intrinsic properties of the CAD/CAM system.¹⁶

Conclusion

This review of current and past literature regarding the evolution, characteristics, and marginal fit of milled CAD/CAM all-ceramic restorations materials and systems show that it is possible to fabricate restorations with the same marginal fit expected from conventional methods and within the range of clinically accepted restorations. When comparing both methods the advantage of using CAD/CAM technology is not to obtain the most precise level of fit, but rather to obtain a high level of reliability in a large number of restorations; especially when high production levels are expected. However, there are a limited number of clinical studies and the diversity of the results between systems and protocols does not allow us to give a definitive conclusion._

References


about

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Dr Gustavo Mendonza. DDS. MS. PhD. Clinical Associate Professor. Department of Biologic and Materials Sciences, Division of Prosthodontics, University of Michigan School of Dentistry.
Thermoplastic materials have been used in aviation and space engineering for a long time. Owing to their high mechanical strength and low modulus of elasticity, they have begun to increasingly replace metal in many manufacturing industries too, particularly those where metal has been the dominant choice until now. Implants for intervertebral discs, as well as hip and knee joints, are made of PEEK, a thermoplastic polymer. Four million implants have been fitted during the last 15 years with outstanding success.

In recent years, thermoplastic materials have also been used in dental technology. This article discusses a number of common plastic materials that have become alternatives for use in the manufacture of non-metal telescopic dentures.

About 15 years ago, the first attempts were made, not without initial problems, to produce non-metal telescopic dentures. These dentures were made by injection moulding using a polyamide (PA) in the dental laboratory. A wax mould of the framework, bar and secondary crowns is made as an integral part, embedded in plaster in a flask and the wax boiled out. The plastic material, which is available in the laboratory as granular material, is heated in the injection moulding device and injected into the mould. After a period of cooling, which should not be shorter than specified, the prosthesis is removed from the mould and finished. Special milling cutters are needed because the material tends to become viscid when cut.

Very importantly, absolutely no metal must be entrained. If the denture were to cut by a tool previously used for cutting metal, minute metal particles would be incorporated into the thermoplastic material by the milling cutter. Friction would easily be controlled by expansion plaster.
The good sliding properties and the high friction of the secondary crown particularly surprised us. When inserted, the secondary crown slides along the primary crown and is retained partly by clamping and partly by suction. Our patients found the good sliding properties and the light weight comfortable. The modulus of elasticity of PA is very low, which lends flexibility to the material. This gives the patient a sensation of a readily adapting denture, rather than a foreign body, in his or her mouth (Figs. 1–3).

The low modulus of elasticity, however, turned out to be the greatest drawback of the material. The moduli of elasticity of all plastic materials used for bonding are very high and two moduli as wide apart as these cannot be bonded reliably for a long time by any means available to dental laboratory technicians. As a consequence, many dentures develop cracks and spalls in the bonds after several months. In addition, the large pores on the surface of the denture led to discoloration, particularly in patients with an altered acid–base balance.

FPM

A short while after PA, the industry launched a successor material with FPM. This thermoplastic fluoropolymer offers some flexibility, but less than that of PA, however. The modulus of elasticity is marginally higher than that of PA, but distinctly lower than that of metal. Consequently, similar problems as those encountered with telescopic dentures of PA occurred.

PMMA

We have obtained good results with PMMA (Polymethylmethacrylate). This plastic material is very hard and inflexible. Finishable in different colours, it is used for complete dentures and occlusal splints, as well as for long-term temporary dentures, crowns and bridges. The material is not susceptible to plaque, and discoloration is very inconspicuous.

The moduli of elasticity of bonding materials and PMMA are similar; thus, cracks and spalls of bonds did not occur. Patients who had previously worn a telescopic prosthesis of PA or fluoropolymer, however, complained that the denture of the new material was uncomfortable to wear. PMMA’s lack of flexibility gave patients the sensation of having a foreign body in their mouth (Figs. 4–6).

Unfortunately, denture breaks were reported after some time, particularly in free-end situations. Also, dentures not lined regularly and exposed to high force tended to break. We believe one reason for that is the fairly high modulus of elasticity, which makes the material somewhat brittle. The greatest problem,
however, is that thermoplastic materials cannot be repaired. There is no way of repairing cracks or fractures. The only solution is to make a new denture.

**PEEK**

PEEK (Polyetheretherketone) was first used for telescopic dentures about six years ago. In general medicine, it has been used for hip, knee and intervertebral disc implants for almost 15 years. According to German company Evonik Industries, as many as four million implants have been fitted and not a single case of proven allergy to that material has been reported. The modulus of elasticity of PEEK is similar to that of bone, with positive consequences for integration. This is one of the reasons that PEEK merits the attention of dental laboratory technicians. Finally, there is a material with a hardness similar to that of bone, not as soft as PA or FPM plastics and not as hard as PMMA. These very rigid materials often cause dental technicians problems, for example with all-ceramic solutions for the upper jaw, where craniomandibular problems frequently arise.

PEEK is a very light-weight material with a long history of use in space flight. Non-conductive, it has been used in semiconductor technology for a long time. This property also offers benefits for use in the oral cavity.

The pharmaceutical industry uses PEEK in production. Parts in contact with the product are made of PEEK owing to its low discoloration and high resistance to wear and corrosion. Both properties are also very useful for dental technology.

PEEK is indicated for removable, as well as conditionally removable, prostheses. Therefore, bridges, crowns, telescopic dentures and attachments, as well as screwretained superstructures, can be fabricated.
The material has very good sliding properties and patients report that it is extremely comfortable to wear.

There are two different methods of manufacture. One is injection moulding and the other is CAD/CAM milling. The minimum thickness of telescopes is 0.6 mm. The minimum thickness of frameworks and bars is distinctly higher, but varies depending on the design and the size of the telescopic prosthesis, as well as the number of available telescopes. Generally, a PEEK telescopic prosthesis will be a little thicker than a metal telescopic prosthesis. It is an absolute necessity that the primary crown be made of zirconia, as abraded metal particles would otherwise collect under the secondary crown.

The veneer bond strength was tested in a study at the University of Regensburg, Germany, in 2012. In order to pass the test, a value of 5 MPa had to be achieved. Of all the veneering systems tested, PEEK scored 10 MPa and above and passed all of the bond strength tests. In other tests, such as discoloration and shear strength, it also achieved very positive results, confirming the suitability of PEEK for use in the oral cavity. When subjected to load at fracture tests, a PEEK bridge achieved 2,354 N and was far superior to a ceramic bridge, with 1,702 N. Hence, PEEK can withstand higher loads in the oral cavity than can ceramic material, and so wide-span telescopic dentures can be made of PEEK.

Friction is one of the most critical characteristics of telescopic prostheses. The friction of PEEK is very good and can be controlled excellently with expansion plaster. However, most important is that friction is permanent. We made our first telescopic prostheses of PEEK about five years ago and we have not observed any loss of friction in that time (Figs. 7–13).

Conclusion

Our laboratory has the experience of having made over 300 non-metal telescopic prostheses over the course of 11 years. After initial problems and several tests, PEEK has finally proven a suitable material for telescopic dentures in the long term. Non-metal telescopic prostheses are in no way inferior to metal telescopic dentures, provided they are made professionally. On the contrary, the light weight, the high wear comfort and the absence of metal, in particular, are compelling arguments for dental technicians and patients alike.

Even in our laboratory, we have come across PEEK prostheses with cracks, but these have invariably been due to manufacturing mistakes. Prostheses made correctly exhibit no cracks. Cracks and spalls of the veneering of PEEK dentures can be found about as often as in telescopic prostheses of metal—that is, rather seldom.

PEEK is extremely resistant to plaque and inert to acids and chemicals; therefore, the denture can be cleaned with a chemical dental cleaner.

It is necessary when handling telescopic dentures of PEEK to apply ceramic guidelines because the material could otherwise be weakened owing to crack propagation. In addition, the prosthetic design must follow certain criteria. For example, a prosthesis without a transverse bar must always include a backing plate in the secondary part to provide sufficient stability. Dental technicians required to make non-metal telescopic prostheses should therefore receive sufficient training and instruction so that the required high-quality level can be maintained. Those who work with PEEK only rarely and who therefore lack experience are advised to have telescopic prostheses of PEEK designed and cut in a specialised laboratory.

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Aesthetic replacement of maxillary premolar
with immediate implant placement and metal ceramic crown over CAD/CAM abutment

Author: Dr Larry R. Holt, USA

Introduction

This article describes treatment to solve a common dental complication (loss of tooth due to vertical root fracture). Contemporary implant therapy and subsequent CAD/CAM laboratory procedures provide an elegant solution to this patient’s dental emergency. Treatment was accomplished during a period of approximately six months.

Case presentation

The patient was a healthy, 52-year-old female with an unremarkable medical history. Her dental history and general dental health were excellent. Unfortunately, she suffered a vertical fracture of tooth #5, which necessitated its extraction (Fig. 1).

The treatment plan was for extraction and immediate implant placement with concurrent bone grafting as required. A temporary partial denture was planned to provide aesthetic replacement and to support and shape tissue during the healing process. The final restoration was to be a cemented PFM crown supported by an Atlantis (DENTSPLY Implants) gold hue abutment.

Material selection was based on the patient’s cross bite occlusion that transitioned from normal to cross bite across this particular tooth’s occlusal table. Crown and abutment could potentially be subject to occlusal stress due to this transitional relationship. A restoration that provides maximum strength was desirable for long-term stability of the restoration. The patient had a thin biotype and the gold hue abutment provides both strength and a more natural tissue colour.1 The gold colour provides ‘warmth’ of colour in the critical transmucosal region. Titanium abutments provide strength but can telegraph a greying effect on thin tissues.

CE credit

This article qualifies for CE credit. To take the CE quiz, log on to www.dtsstudyhub.com. Click on ‘CE articles’ and search for this edition of CAD/CAM. If you are not registered with the site, you will be asked to do so before taking the quiz.
Treatment began with a preoperative appointment to take the necessary records (impressions of both arches, facebow transfer, shade taking, bite registration and clinical photography). The prescription that was sent to the lab ordered a partial denture fabricated from duracetyl resin and to develop a tooth born surgical guide. The lab was instructed to simulate the extraction site by removing the tooth from the study cast provided. This model was duplicated for fabrication of the two appliances.

Laboratory product was provided to surgeon. Atraumatic extraction was accomplished and the temporary partial denture was immediately implanted (Legacy Three, Implant Direct), placed with facial bone grafting (Figs. 2 & 3).

There was a healing screw placed and the site was closed with appropriate membrane and suturing techniques. The unilateral partial denture was not delivered at time of surgery. The patient was seen in the restorative office and the temporary partial denture (Duratek, Drake Precision Laboratories) was modified to provide tissue support and begin development of an ovate tissue site. The partial denture was placed uneventfully. These appliances are extremely retentive and not subject to dislodgement or pressure over the implant site during function. The patient was seen one week later for a postoperative check and adjustment of the temporary appliance (Fig. 4). The patient was instructed to return to surgical clinic in approximately four months for a final evaluation prior to restorative procedures.

Four months after surgery, the patient was seen by the surgeon to uncover the implant, remove the healing screw and place a temporary abutment. The temporary partial was adjusted to accommodate the added height of the healing abutment (Fig. 5). The patient was instructed to return to the restorative office for definitive restoration of the implant in approximately three weeks.
The patient returned to the restorative office for evaluation and to develop necessary records for the laboratory fabrication of the definitive restoration. The implant site was evaluated and deemed adequately healed to proceed with restorative procedures (Fig. 6). The healing abutment was removed and a closed tray impression coping was fitted onto the implant (Fig. 7). A radiograph was taken to confirm complete seating of the impression coping. A full-arch impression was taken with heavy body PVS impression material (Panasil Tray Soft, Heavy Body Regular Set, Kettenbach) (Fig. 8). The healing abutment was replaced once impression was taken. A bite registration (Futar D Fast Set Kettenbach), new opposing impression (Silginate plus Panasil Light Body Fast Set, Kettenbach) and shade map were taken. All clinical products were sent to the laboratory along with shade photography and a complete written prescription.

A PFM high noble crown and Atlantis gold hue custom abutment were prescribed. The abutment was ordered as tissue contouring with 1 mm deep margin placement circumferentially (Atlantis, DENTSPLY Implants). The use of a custom abutment allows modification of the transmucosal tissue profile and to ideally position margins. Tissues were previously shaped with the ovate pontic of the temporary partial. The final crown was planned to be chairside custom stained. The lab was cautioned that occlusion on this restoration was in the path of the patient’s cross bite transition from normal to cross bite.

The appointment was uneventful. The healing abutment was removed and the Atlantis abutment was placed (Fig. 11). Due to positive tissue pressure from the tissue contouring, the abutment was slowly placed with incremental turns of the retention screw. Tissue blanching was carefully observed. The abutment was fully seated and within five minutes, tissue blanching had disappeared. The Atlantis abutment was torqued to the manufacturer’s specifications (30 Ncm). A radiograph was taken to confirm the final seating of the abutment.

The PFM crown was tried on and interproximal contacts adjusted to allow complete seating of the crown. Occlusion was marked with appropriate articulation ribbon and adjustments were accomplished, with particular attention to functional path and centric contacts. The final occlusion respected the cross bite while providing a light occlusal contact that became normal in intensity upon biting. All functional contact was adjusted to be in minimal contact during excursions. Adjacent teeth provided partial group function.

Once all clinical adjustments were done, a laboratory technician was consulted for the final shade matching. The initial shade was very close to ideal. The tech-
nician accomplished minor modifications (minimal characterisation staining and reduction in final surface gloss). Proximal contacts and the occlusal table were polished after final glazing. The crown was lined with silicone tape and then the bite registration material was injected into the crown to fabricate a cementation jig (Fig. 12). This step is very important to avoid excess cement extrusion during final seating of the restoration.

All pre-cementation procedures were completed, including approval by patient of both aesthetics and bite comfort. The abutment screw access hole was sealed with silicone tape, respecting the external contours of the abutment to allow complete seating of the restoration. This is a critical step to maintain patency for future access to retention screw.

The crown was steam cleaned and thoroughly dried. Intraorally, the abutment was thoroughly cleaned and dried in preparation for cementation procedures. The attending dental assistant maintained cheek retraction and a dry field.

The walls of the crown were lined with implant cement (Dental Implant Cement, radiopaque, Premier). The crown was then seated on the previously fabricated cementation jig to extrude excess cement. Cement adaptation to the internal walls of the crown was confirmed and the crown was seated over the custom abutment. Excess cement was removed by a combination of hand instrumentation and dental floss after initial cement setting.

The crown was left under biting pressure with cotton roll over the occlusal table for five more minutes to allow for the cement to fully set. Meticulous inspection of sulcus was accomplished to remove any vestige of implant cement. A postoperative radiograph was taken to evaluate complete seating of crown and to confirm removal of any excess radiopaque cement. The occlusion was confirmed and patient was dismissed. One-week recall was accomplished to confirm occlusion and to re-evaluate soft-tissue response to the restoration.

**Conclusion**

This case study reveals the potential for implant-supported tooth replacement. The aesthetic result was excellent and final gingival contours were consistent with adjacent dentition. The tissue colour was natural and did not reveal any hint of the underlying implant or abutment. Restoration margins were concealed within the gingival sulcus. This treatment provided an elegant solution for this all-too-common dental emergency. The patient was extremely pleased with the result (Figs. 13–15).

**Editorial note:** The author would like to express gratitude to Drake Precision Dental Laboratories (Charlotte, NC) for all services provided for this treatment. In addition, Dr Todd Engle, DDS, (Charlotte, NC) provided extraordinary care during extraction and immediate placement of implant.

**References**

Fixed and removable implant restorations:
A solution for every arch

Author: Dr Paresh B. Patel USA

Introduction
When a patient presents with an edentulous arch or terminal dentition, implant treatment can be provided that improves not only form and function, but also quality of life. For patients desiring better chewing capability, stability, aesthetics and comfort than a traditional denture can offer, both removable and fixed implant restorations are superior alternatives. While the appropriate implant solution can vary depending on the patient’s oral health, anatomy, quality and quantity of bone, and financial resources, full-arch prosthetics have progressed to the point where virtually every patient can be restored.

Although fixed, implant-supported restorations offer the highest levels of stability, function and patient satisfaction, removable overdentures are a dramatic improvement over conventional complete dentures as well. Both treatment options effectively mitigate the bone resorption that occurs following the loss of teeth, helping to preserve the oral and facial structures and, by extension, the self-confidence of the fully edentulous patient. Determining which solution is appropriate requires a careful evaluation of the individual patient’s circumstances and desires. Even when an implant overdenture is delivered, the prosthesis can eventually be converted to a fixed restoration.

As evidenced by the case that follows, in which one arch is restored with an implant overdenture and the other with a BruxZir Full-Arch Implant Prosthesis (BruZir), practitioners today have a great deal of clinical flexibility. Whatever prosthetic approach is adopted, immediate, life-changing relief can be provided to patients suffering from terminal dentition or an uncomfortable, poorly functioning traditional denture. Further, the dramatic overhaul of this patient’s oral health demonstrates the life-changing capabilities of implant therapy, which helped him overcome severe functional and aesthetic challenges that were impacting practically every facet of his life prior to treatment.

Case presentation
A 47-year-old male presented with terminal dentition in both arches resulting from periodontal disease and severe caries (Figs. 1a–c). The patient had already lost many of his teeth, and the dentition that remained had been rendered unstable by his periodontal condition (Fig. 2). He had saved up enough money for a fixed implant restoration for his upper arch, for which he desired the most functional, life-like prosthesis possible. While he couldn’t afford...
such a restoration for both arches, he wanted a re-
tentive appliance for his mandible, with the option
of later upgrading to a fixed prosthesis.

The patient accepted a treatment plan in which his
maxilla would be restored with a BruxZir Full-Arch
Implant Prosthesis and his mandible with an Inclu-
sive Locator Implant Overdenture. Fabricating his
maxillary restoration from monolithic zirconia
would ensure maximum long-term durability. This
was important provided the relatively young age
of the patient, who would not have to worry about
his upper prosthesis succumbing to fractures, chips
or stains.

His lower appliance would be held in place by
connecting to the implants via Locator attach-
ments (Zest Anchors), which are an economical
means of improving prosthetic retention and sta-
bility. The overdenture caps that connect to the
Locator attachments would be incorporated in the
prosthesis chairside, though it should be noted that
many clinicians elect to have the laboratory handle
this step.

The surgical phase of treatment called for the
extraction of the patient’s remaining teeth followed
by the immediate placement of eight dental im-
plants. CBCT scans were taken to help determine
the optimal placement of the implants within the
available bone and away from the patient’s vital oral
anatomy. Evaluation of the CBCT scan determined
that there was sufficient height, width and quality
of bone to place the implants in the appropriate
locations and angulations via freehand surgery.
Four 3.7 mm Inclusive Tapered Implants (Glidewell
Direct) would be placed in each arch to support
the fixed maxillary restoration and the removable
mandibular prosthesis.

At the surgical appointment, the patient’s remain-
ing teeth were removed, and a flap was raised to
visualise the socket sites and areas of implantation.
Bone levelling was performed on the patient’s max-
illary arch to elevate the patient’s smile transition
line above the upper lip.

The maxillary osteotomies were positioned to facili-
tate an All-on-4 configuration, with the posterior
implants tilted to maximise the anterior-posterior
(A-P) spread, avoid the sinuses, and accommodate
the patient’s bone limitations (Fig. 3). Osteotomies
were created for the placement of four mandibular
implants, as opposed to the minimum of two re-
quired for a Locator overdenture. This would en-
hance retention of the overdenture while affording
the possibility of upgrading to a fixed restoration at
a later time.

Following the creation of the osteotomies, the
implants were placed (Figs. 4a–c). Inclusive
Multi-Unit Abutments (Glidewell Direct) were
attached to the maxillary implants, correcting
for the divergent angulation of the implants.
This would both position the restorative platform
in a manner that would situate the screw access

Fig. 2: Preoperative panoramic
radiograph exhibits periodontal
disease, cervical caries, terminal state
of the patient’s dentition, and the
compromised state of the surrounding
periodontium, which had
rendered the teeth mobile.

Fig. 3: Maxillary implants with parallel
pins in place exhibit the axial
placement of the anterior implants
and the tilted angulation
of the posterior implants.

Figs 4a–c: The Inclusive Tapered
Implants were threaded into place,
achieving excellent initial stability.
holes of the eventual prosthesis toward the lingual aspect and allow for a molar-to-molar restoration (Fig. 5).

Note that when patients present for treatment with terminal dentition, they are commonly anxious about losing their teeth and the effect this will have on their speech and chewing capabilities. For this reason, it is important to make every effort to ensure that the patient leaves with functional appliances in place. Thus, traditional dentures were fabricated from preliminary impressions in advance of the surgical appointment for modification and delivery following placement of the implants (Fig. 6).

Having achieved sufficient primary stability, the Inclusive Tapered Implants placed in the patient’s maxilla could be immediately loaded. Thus, the upper denture was trimmed and modified chairside to connect to the multi-unit abutments through temporary cylinders (Figs. 7a & b). This would satisfy the patient’s desire to leave the surgical appointment with a fixed, fully functional maxillary prosthesis in place. Note that the two distal-most molars were removed to minimise the cantilevers and the forces transmitted to the implants during osseointegration. Healing abutments were placed in the mandibular implants to begin developing the transmucosal passages. The lower immediate denture was then modified and relined to seat over the implants during healing.

This approach provided the patient with same-day temporary restorations, and he walked out of the office with properly functioning teeth for the first time in many years. The effect this had on the patient’s comfort, function and appearance was immediate and profound (Figs. 8a & b). The final radiograph taken after seating the temporary appliances confirmed excellent positioning of the implants (Fig. 9).

Figs. 5: Multi-unit abutment with carrier in place illustrates correction of the implant’s angulation to establish a uniform prosthetic platform around the arch.

Fig. 6: Traditional dentures were fabricated in advance of the surgical appointment so they could be immediately converted to serve as temporary appliances during the healing phase.

Figs. 7a & b: Same-day conversion of the maxillary denture to an immediate fixed prosthesis was achieved by adding multi-unit temporary cylinders using cold-cure acrylic and trimming the appliance into a horseshoe shape.

Figs. 8a & b: Note the dramatic change in the appearance of the patient, who left with chairside-converted dentures in place on the same day as surgery, including a screw-retained, fixed provisional for his upper arch.
The patient returned after three and a half months of healing so the stability of the implants and health of the soft tissue could be evaluated. Removal of the temporary appliances revealed excellent tissue health around the healing abutments of the mandible and multi-unit abutments of the maxilla (Figs. 10 a & b). Vinyl polysiloxane (VPS) impressions were taken to begin the restorative process (Figs. 11a–c). Because multi-unit abutments and healing abutments were placed on the day of surgery, the restorative process began above the tissue level, without any need for secondary surgery or anaesthesia.

The restorative protocol for both prostheses included wax rims and setups, which the lab produced on the working casts fabricated from the impressions (Figs. 12a & b). The maxillary wax rim incorporated temporary cylinders through which screws could connect to the dental implants. The lower wax rim was designed to seat over Locator attachments.

At the next appointment, the wax rims were seated, the jaw relationship was recorded using conventional denture technique, and a bite registration was taken (Figs. 13a & b). A VPS "wash" impression of the mandibular arch was also taken with the wax rims and Locator impression caps in place (Fig. 14). This would aid the lab in designing an overdenture that fully rests on the tissue instead of the implants.

The case was returned to the lab, and wax setups were produced (Figs. 15a–c). During the try-in appointment, the wax setups were evaluated to confirm the vertical dimension of occlusion, interocclusal relationship, phonetics, aesthetics, midline, teeth arrangement, tooth colour and shape, incisal edges, and function (Figs. 16a–c).

After final approval of the wax setups, the restorative protocols for the two prostheses diverged, as the lab moved directly to the final implant overdenture from the approved wax setup, while the process for the BruxZir Full-Arch Implant Prosthesis...
inclued an implant verification jig, custom final impression, and provisional implant prosthesis. These extra measures were taken to make absolutely certain that the definitive prosthetic design was accurate before milling the final restoration from monolithic zirconia.

The implant verification jig was attached to the implants so a precise final impression could be taken (Figs. 17a–c). The custom tray provided by the lab was filled with VPS material and seated over the implant verification jig. As the VPS material set, the relative positions of the implants represented by the verification jig remained fixed, ensuring an extremely accurate final impression.

The approved wax setups and final maxillary impression were returned to the lab so the final mandibular implant overdenture and maxillary provisional implant prosthesis could be produced. The final lower appliance was fabricated on the master cast and included recess wells in which metal housings with overdenture caps would be cured chairside (Figs. 18a & b). These denture caps provide retention and stabilise the prosthesis by seating over the Locator attachments and keeping the appliance in place during function.

A new master cast of the maxilla was produced based on the custom open-tray final impression. The new master cast and final-approved wax setup were scanned. A virtual model was generated upon which the fixed monolithic prosthesis was designed using CAD software (Figs. 19a & b). Because this digital model was based on the final impression containing the verification jig, screw access holes were created in precise alignment with the positions of the maxillary implants.

The CAD design was used to mill a provisional implant prosthesis from polymethyl methacrylate (PMMA) (Figs. 20a & b). This appliance was tried in and worn for a trial period, thus ensuring an accurate prosthetic design. The provisional implant prosthesis is an essential element of the restorative process, as significant adjustments cannot be made to the final restoration once it has been milled from BruxZir Solid Zirconia.

At the following appointment, the Inclusive Locator Implant Overdenture was seated and checked for proper fit, function and support from the soft tissue.
Then the provisional implant prosthesis was screwed into place, and its teeth positioning, function and aesthetics were verified (Figs. 21a & 21b). With both appliances in place, the interocclusal relationship was checked (Figs. 22a & b). Minor occlusal adjustments were made directly to the maxillary provisional implant prosthesis, as PMMA is easily modified.

Slight alterations were also made to the lower implant overdenture. Then, blockout shims and the retentive overdenture caps were seated over the Locator attachments (Figs. 23a & b). Quick Up self-cure material (VOCO America) was added to the recess wells of the overdenture before seating the appliance over the metal housings.

After letting the material set for approximately three minutes, the overdenture was removed, picking up the denture caps in the prosthesis. The minor voids surrounding the denture caps were then filled with Quick Up light-cured pink composite (Fig. 24).

Figs. 16a–c: The upper and lower wax setups were tried in to evaluate fit, aesthetics, occlusion and function per standard denture technique. Figs. 17a–c: The individual sections of the implant verification jig were seated and luted together before being picked up in the open-tray final impression, which was made using a custom tray and Capture VPS material (Gildewell Direct).
The appropriate retentive inserts, which are available in a variety of strengths depending on the functional capabilities of the patient and the number of implants, were swapped into the metal housings (Fig. 25). The implant overdenture was reseated, providing excellent retention, stability and function for the patient.

With the final mandibular restoration in place, the patient wore the provisional full-arch implant prosthesis for a trial period of two weeks (Fig. 26). This opportunity to wear the appliance during actual day-to-day function instilled a high degree of confidence in the prosthetic design for the patient and doctor alike. Following patient approval, the provisional implant prosthesis was returned to the lab so it could serve as the blueprint for the final restoration and the minor adjustments made to the appliance could be included in the definitive prosthetic design.

The final BruxZir Full-Arch Implant Prosthesis was digitally fabricated with precision (Fig. 27). As an example of the final result, see Fig. 28.
exact reproduction of the test-driven provisional, the definitive prosthesis fit perfectly and offered the aesthetics and function the patient had come to expect (Figs. 28a & b). The final restoration effectively addressed the unique circumstances of the case, providing the most durable, stable prosthesis possible for his upper, and a lower restoration that greatly improves prosthetic retention and can be upgraded to a fixed prosthesis should the patient's situation change.

Conclusion

Practitioners now have the clinical flexibility to offer patients a wide range of treatment options, from entry-level, economical restorations like the Inclusive Locator Implant Overdenture, to the fixed, highly durable BruxZir Full-Arch Implant Prosthesis. There is a viable means of treating nearly all patients, whatever their oral health, needs and finances. Given the life-changing benefits of implant therapy and the straightforward restorative protocols of today, this service should be offered to all patients confronting the challenges presented by complete edentulism.

References


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Adaptation of traditional working methods to the creation of Cr-Co ceramic restoration with CAD/CAM technology

Author: Richard Demange, France

This article describes the adaptation of tried and tested fixed prosthesis work protocols to new CAD/CAM techniques. Based on a complete upper and lower bridge case, we also address technical and economic interests by offering a sealed implant prosthesis with a Cr-Co coating achieved by laser microfusion or trans-screwed by machining.

Implant placement and adaptation of the existing prosthesis

The placement of maxillary and mandibular implants was delayed by several months in accordance with the patient’s wishes. As the mandibular prosthesis poses the greatest problem in terms of stability and fixture, it was implanted first.

Case presentation

A 60-year-old female patient was completely edentulous and no longer wanted to use removable prosthesis. The dentist proposed placing six implants on her lower jaw. For aesthetic reasons (avoidance of occlusal screwing channels), the future ceramic bridge will be sealed on titanium implant pillars. For the upper jaw, he recommended inserting ten implants with multi-unit pillars to facilitate the placement of a trans-screwed ceramic bridge.
In the same session, the apparatus was modified and rebased on healing screws so that the patient did not find himself without an appliance (denture). The same will apply to the maxillary prosthesis.

**Validation key for the maxillary impression**

In order to ensure the reliability of the maxillary impression a validation key must be made in plaster. This comprises a normal sized plate made of plaster with low shrinkage characteristics and which is not too hard (e.g. ’Snow White’). This is then trans-screwed by each implant in the mouth. If it does not break, it means that the model used for making it is reliable.

**Articulator mounting**

A practical and reliable method for mounting on the articulator is the use of temporary appliances (dentures). In fact, once the impressions have been taken and the working models have been prepared, the appliances are positioned on implant replicas of the models. By placing both appliances in intercuspal relation, it is easy to obtain the patient’s occlusion. There are many benefits: it saves time as it is no longer necessary to make occlusion wax rims, and potential sources of errors are eliminated during the registration of the waxes. In order not to deprive the patient of both his/her dentures, this stage should ideally be performed in the dental surgery. If the teeth of the dentures are too worn, it is preferable to take an inter-cuspal silicone bite to facilitate interlinking the two devices at the time of placement on the articulator.

**Preparation**

It is essential for the dentist to take impressions of temporary appliances. The models that are created from these impressions are also mounted on the articulator so that the working model and the study model are interchangeable on the articulator. If the appliances are suitable from a functional and aesthetic perspective, they can be faithfully reproduced. In this case, as the patient’s current prostheses could be improved aesthetically, we decided to create two aesthetic assemblies on a resin base (Fig. 1). The upper assembly was trans-screwed at the level of the two posterior implants and in an anterior position to give the model stability. For the same reasons, the bottom is wedged on six implant pillars.

As soon as the aesthetic assemblies are validated at a functional level (occlusal relation of both arcades, DVO, phonetic, etc) and at an aesthetic level (length and projection in the sagittal direction of the anterior tooth region of the upper jaw, laugh line, any animation, etc), they become the basis for the laboratory technician’s work. In other words, these ceramic frameworks must be designed on these...
attributes. Similarly, the future cosmetic material must adhere precisely to the guiding assemblies. Until now the prosthodontist has sculpted the framework in wax and casted it in alloy before adjusting and surfacing it. During the wax modelling process, he would also use models mounted on the articulator, with silicone keys representing the volume of the appliance to ensure that the framework had a good homothetic reduction. Nowadays, with CAM/CAD, it is essential to scan the aesthetic assembly or the model of the appliance to allow for this homothety.

Scanning

Scanning entails acquiring digital data on the case. In other words, it is the stage that will make it possible to transpose the physical case (models on the articulator) into a virtual case (computer screen). For the sealed mandibular framework, scanning performed at the laboratory, using Dental Wings, a leading provider of digital dentistry technologies.

A recent accessory enables the different models (maxillary and mandibular with and without guiding assemblies) to be scanned easily and reliably and to depict them on the screen with the same occlusal relationship as that determined by the articulator. It is the kit calibration for the Dental Wings scanner and a certain number of articulator brands. For the machined maxillary framework which requires even more accuracy, it is performed at Simeda (Anthogyr CAD/CAM solution).

Modelling

Once the scanning stages are completed, the modelling or design stages can be started: marking the boundaries, choosing the sealing spaces and the design. The frameworks are created on the basis of the master assembly volumes (green transparent (Fig. 2) and blue transparent (Fig. 3)). The laboratory technician uses the software to select the homothetic shrinkage parameters for the assemblies.

Manufacturing

The Dental Wings scanner is a so-called ‘open’ system, which means that the user can freely choose the company that is going to manufacture the framework. For Cr-Co frameworks by laser micro-fusion, we use the approved production centre Bego, Advanced Dental Factory in Montpellier. They are in fact equipped with a machine from EOS, the
leading expert in laser microfusion. They use the entire BEGO patented process and BEGO know-how to manufacture these frameworks with Wirobond + alloy. We are very satisfied with this partnership, which remains the best performing microfusion solution. Advanced Dental Factory, as well as the BEGO France production centre, which opened in 2013 in Lyon, are the only entities that offer this satisfactory combination.

The principle involves depositing a fine layer of alloy powder and passing a laser beam over the desired location to make the metal particles melt, thereby binding them together. This is repeated many times until the required volume is obtained (Figs. 6 and 7). The fineness of the powder and the accuracy of the laser, make it possible to achieve excellent fits (Fig. 8).

It should, however, be remembered that such results are not obtainable from all microfusion machines and they must also be operated properly. They are very temperamental manufacturing tools—calibration and maintenance are very important for obtaining a perfect copy of the file.

For Cr-Co machined and trans-screwed frameworks, the files are sent to the company at Simeda, the Anthogyr CAD/CAM solution, based in Mersch, Luxembourg. Even if they are partners of Anthogyr, they are able to machine for several other implant brands. The accuracy and density of their parts are perfect (Figs. 9 & 10). In order to check, simply use the Sheffield passivity test.

**The Sheffield passivity test**

It is a simple and efficient way of checking the passivity and adjustment of our implanted frameworks. This test involves attaching the prosthesis to the first analogue with a single fastening screw. It is then necessary to ensure that the framework does not have gaps on any of the analogues. The process is then repeated for the second analogue and so on until the last one. If the framework is adjusted at each stage, it is because it is perfectly passive. In order to check whether the framework will facilitate adherence to the lengths and projections of the master assemblies, it is necessary for example to take an indentation key on the free rims of the maxillary assembly and to position the work model with the corresponding positioned framework (Figs. 11 & 12). This makes it possible to visualise the quantity of space left for embellishment, as well as the support given to the latter by the framework.

The cost of a microfusion framework is six times less than the cost of machining a trans-screwed framework. This is justified in various ways. Firstly, in terms of manufacturing: with machining there is considerable loss of raw material. The drills used wear out quickly and are expensive. With microfusion, there is very little loss of Cr-Co. Secondly, a part that must be perfectly adapted to an implant is more complex than a simple mounting. Lastly, the cost of the standard or customised implant pillars, which support the framework of the microfusion framework, must not be forgotten. The sealed technique is more aesthetic as there are no access wells with visible screws.

**Fig. 16:** Finished restoration on the model.
**Figs. 17 & 18:** Finished restoration—details.
**Fig. 19:** Finished restoration—view of the screwing channel on the intrados side.
**Fig. 20:** Finished restoration—details of the mandibular bridge.
**Fig. 21:** Finished restoration—lingual view.
case report full mouth restoration

(Fig. 13). It is also more comfortable. In fact, at the design stage of the implant pillars, the technician can suitably adjust their shapes in line with the future prosthesis. This then facilitates the production of ceramic crowns with the ideal shape. With trans-screwed prostheses (Figs. 14 & 15), there is less room for manoeuvre, which leads us to make more voluminous teeth in some cases. Pieces are more likely to break off ceramic crowns if the screwing channels are slightly off centre from the middle of the occlusal table. In fact, the solidity of a ceramic crown is dependent on its width and the support it derives from the framework. This is sometimes lacking in fine areas which extend the screwing channels. This is why it is recommended, if aesthetics permit, to make these areas fully metallic rather than to cover them with a fine ceramic layer. Trans-screwed prostheses, on the other hand, have the advantage of being easy to dismantle. They can therefore be easily cleaned to prevent peri-implantitis.

Finishing and polishing of ceramics

If the maxillary implant validation key has been created in advance, the occlusion is reliable and the aesthetic mountings have been validated, it is certainly possible to limit the number of dental appointments and mount the cosmetic material directly following the manufacture of the frameworks. The projections and lengths of the teeth are compared with the aesthetic assemblies once again. However, the ceramic material is not polished in order to allow the technician to make the final aesthetic adjustments (Figs. 16–25).

Conclusion

The laboratory has been equipped with CAD for more than 6 years now, which gives us a good grasp of the technology. This transition was smooth but not without problems. In fact, at the time the software did not function so well and a number of things were not as easy to perform as they are today. What is fascinating is the continuing developments. After the laboratories, the dental practices now need to discover digital tools. Work techniques will consequently continue to develop. It is important not to lose sight of what is fundamental to both our professions and to obtain, thanks to CAD/CAM, even better results, which are more practical, more rapid and, above all, more predictable.

Acknowledgement

I would like to thank Dr Schleicher for his close co-operation and the clinic, as well as Simeda, Anthogyr, BEGO, Euromax and Advanced Dental Factory for their participation.

contact

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  Disc for CAD/CAM based on CoCr.
  CTE 13.9-14.0 x 10^-6 K^-1

- CC DISK Zr Smile
  Disc for CAD/CAM made of pre-sintered ZrO2.
  With exceptional light transmission and translucency.

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  Disc for CAD/CAM made of pre-sintered ZrO2.
  For natural restorations with no colouring liquids needed.

- CC DISK Ti2

- CC DISK Ti5

- CC DISK Zr/HT

- CC DISK PMMA

- CC DISK WAX
Two approaches, one goal

Author: Dr Eduardo Mahn, Chile

In the restoration of anterior teeth, clinicians have to select the most appropriate material for the case at hand on the basis of specific criteria. Recently developed restorative materials have opened up a myriad of exciting possibilities. In situations in which teeth show signs of erosion, abrasion, abfraction or a combination of these phenomena, practitioners will tend towards using ceramics or composite resins, depending on how much intact tooth structure remains.

Traditionally, composites are used for Class III, IV and V defects; however, ceramic veneers are preferred in cases in which a large amount of tooth structure is missing or a major change is planned (e.g. a smile makeover). When two central incisors need aesthetic enhancement, the choice of approach is not as clear. Irrespective of the material used, a minimally invasive approach involving very little preparation of the tooth structure can be taken nowadays owing to the high strength of modern materials (e.g. lithium disilicate glass-ceramic). Nevertheless, it is important to remember that minimal preparation is an option only if the teeth are properly aligned. As long as the desired changes to the tooth shape and shade are small, the preparation can be limited to the enamel. In many cases, however, orthodontic treatment is needed before the tooth position and/or shape can be optimised by means of restorative procedures. This minimally invasive approach requires the dental practitioner to convince the patient of the necessity of undergoing preliminary orthodontic treatment.

It is our aim to remove as little of the tooth structure as possible in every case that we treat. With modern materials such as lithium disilicate and leucite-reinforced ceramics, we can press or mill veneers that are as thin as 0.6 mm and even 0.3 mm with confidence. Only a few years ago, treatment with indirect restorations still required at least two appointments. Ceramic materials such as IPS Empress CAD (Ivoclar Vivadent) allow clinicians to produce polychromatic monolithic veneers and crowns in less than one hour and without having to glaze them. Nonetheless, many dentists still believe that dental technicians with their well-honed manual skills produce better aesthetic results than a machine does, and they do not see the need to embrace digital technology. As a result, some clinicians are reluctant to invest in this technology because of the high acquisition costs of the milling machines. Through the clinical case study presented here, we want to fo-
cus on aspects like the importance of having a suitable treatment plan, the possibilities currently available for the fabrication of veneers, the potential of the press and CAD/CAM techniques, as well as the latest improvements made in the field of cementation.

Clinical case

A 31-year-old female patient presented to our office because she was dissatisfied with her anterior teeth. She complained about the malalignment of the maxillary and mandibular central incisors (Fig. 1). A detailed clinical examination established that the composite restorations in these teeth were defective. As a result of erosion, a considerable amount of tooth structure had been lost. In addition, malalignment of teeth #21 and #41 was quite obvious.

The treatment plan we presented to the patient included initial orthodontic treatment followed by minimal preparation of the two central incisors for two ceramic veneers. The patient was referred to an orthodontist for treatment. Unfortunately, it took more than a year before she presented to the practice again and we were quite surprised to find that the two central incisors had been restored with poorly finished direct composite veneers (Fig. 2). In addition to preventing any contamination of the working field, the clinician must accomplish the arduous task of creating an appropriate emergence profile, proper contours and contact areas, and producing a suitable micro- and macro-texture, and all this within a single appointment. Many simply underestimate the challenging nature of this type of restoration, and this was a case in point.

Owing to the poor preparation, the composite veneers had to be removed and replaced with new ones. In this particular case, the advantages of using the indirect technique were obvious. The patient agreed to have two ceramic veneers made for her. For this purpose, impressions were taken and a master cast was produced. This working model provides the dental technician with the opportunity to evaluate the situation in detail. He or she has the time to think about possible ways of correcting the malalignment.

Dentists do not have this luxury of time when they are treating a patient in the dental chair, as they have to finish the restorations as quickly as possible in order to prevent contamination of the treatment area and keep chair time to a minimum for the comfort of the patient. In the present case, another hurdle had to be overcome: any composite material that might have remained on the tooth structure had to be clearly identified using trans-illumination with white light-emitting diode light (Fig. 3) and carefully removed without damaging the healthy tooth structure. Next, the teeth were prepared, retraction cords were placed and an impression (Virtual, Ivoclar Vivadent) was taken (Fig. 4). The patient was provided with a temporary restoration, which was made with
case report anterior teeth restoration

We followed two different routes in fabricating the veneers. We instructed our laboratory technician to make two ceramic veneers using the press technique with IPS e.max Press (Shade HT A1, stained; Ivoclar Vivadent), and we milled two ceramic veneers with our in-office CAD/CAM machine using an IPS Empress CAD Multi block (Shade A1; Ivoclar Vivadent) at the same time. The veneers made in the dental office were just polished and not glazed. Figures 6 & 7 allowed us to compare the results from a facial perspective.

This experiment illustrated the aesthetic potential of modern ceramics. Both types of restorations blended in beautifully with their surroundings. The appearance of the veneers produced using CAD/CAM technology came very close to that of the manually manufactured version. Nevertheless, in the end, we opted for the laboratory-fabricated veneers with the consent of the patient, since we were able to achieve a slightly better match to the neighbouring teeth by staining the restorations.

Figures 8 & 9 show the try-in pastes (Variolink Esthetic LC, Ivoclar Vivadent) on the prepared teeth. The most suitable composite cement shade was determined on the basis of two differently coloured pastes. With Light+ and Warm+, two extreme options were compared. The difference was clearly visible when the pastes were applied. Even though the darker shade (Warm+) was very close to that of the natural tooth structure and would have worked well with the veneers, we selected the lighter shade. This is very common, as in most cases we tend to prefer the lighter version because it provides a better contrast to the tooth structure and therefore renders the removal of excess cement easier and faster.

Before the veneers were seated, retraction cords were placed and the enamel was etched (not the dentine; Fig. 10). Adhese Universal (Ivoclar Vivadent) was used as the bonding agent to place the veneers (Fig. 11). The excess luting composite was then carefully removed (Fig. 12) and a glycerine gel (Liquid Strip, Ivoclar Vivadent) was applied. This gel prevents the formation of an oxygen inhibition layer at the margins. The luting composite was cured with two curing lights (Bluephase Style, Ivoclar Vivadent) simultaneously and cooled with plenty of water (Fig. 13). Figure 14 shows the harmonious result produced by the lithium disilicate veneers.

Conclusion

State-of-the-art restorative materials have immense potential. Depending on the particular requirements of the patient and the indication, they allow a suitable treatment option to be determined quickly and easily. The case presented here shows that highly aesthetic ceramic veneers can be fabricated with minimal effort using in-office equipment (IPS Empress CAD Multi). Nevertheless, pressed ceramic veneers were chosen for this patient, since they offered the possibility of applying stains, through which a very close match to the neighbouring teeth could be attained. As a principle, however, highly aesthetic results can be achieved with both approaches if the appropriate treatment protocol is followed.

contact

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Current and related literature abstracts

Author: Dr Barry A. Kaplan, USA

Relationship between preoperative Cone Beam Computed Tomography and intraoperative findings in sinus augmentation (Int J Oral Maxillofac Implants. 2015 Nov-Dec;30(6):1244-8.) (Figs. 1a & b).

Maxillary posterior areas present problems for placing implants due to diminished bone height, low bone density and anatomic restrictions of the maxillary sinuses that lie above the alveolar ridges. When the residual ridge is 5 mm or less, a sinus augmentation procedure is commonly used to augment the amount of available bone for implant placement. The maxillary sinus must be completely evaluated for anatomic and/or pathologic findings prior to any surgical intervention. Failure to do so could lead to post-operative surgical morbidity, such as infection. Cone Beam Computed Tomography (CBCT) is becoming the gold standard for pre-operative Sinus examination due to its low distortion and comparatively low radiation compared to conventional CT. Although the radiation dosage is slightly higher than a panoramic X-ray, you have the added advantage of viewing the sinuses in 3 dimension. The most common complication during sinus surgery is membrane perforation resulting during the opening of the bony window or during elevation of the membrane. This study compared pre-operative CBCT to intraoperative findings to see if there was greater risk of perforation during elevation in the presence of bony septum, thin Schneiderian membranes and reduced residual ridge height.

Preoperative Scans from an ICAT Next Gen CBCT (Imaging Sciences International, Hatfield, PA) were taken and evaluated for several criteria. Bony septum were evaluated using axial slices, Membrane thickness was measured using the coronal slices and the residual ridges evaluated using sagittal slices. Also, intraoperatively, it was noted whether perforation occurred and how long the surgery took. The results were that membrane perforation occurred in 24.5 % of the cases. In cases with the presence of septum, membrane perforation occurred 57.1 % of the time. Other studies have suggested that the presence of septum is the reason for membrane thinness. While the mean membrane thickness in the study was 3.96 ± 2.01 mm, there was no significant correlation between membrane thickness and occurrence of perforation. Also, the residual ridge bone height had no significant correlation with the occurrence of membrane perforation. In summary, CBCT is an important tool in the preoperative patient evaluation so that sinus septum can be identified to reduce the risk of membrane perforation.

Accuracy and reliability of Cone Beam Computed Tomographic measurements of the bone labial and palatal to the maxillary anterior teeth (Int J Oral Maxillofac Implants. 2015 Nov-Dec;30(6):1249-55.) (Figs. 2a & b).

Maintaining the integrity of the maxillary buccal plate during immediate implant extraction is critical to the aesthetic outcome. Direct clinical measurement of the facial plate in other studies showed the facial plate to range from 0.8 to 1.4 mm. Conversely, mea-
surements of the facial plate using CBCT have shown a labial thickness ranging from 0.6 to 1.73 mm. This study evaluated buccal and palatal bone thicknesses in the anterior maxilla by CBCT and compared these with direct clinical measurements.

After extraction, the labial plate was measured at 1 mm, 4 mm and 8 mm from the osseous crest and the palatal wall was measured from 1 mm and 4 mm from the osseous crest using a caliper. Additionally, measurements were taken from a pre-surgical CBCT (NewTom VG, Voxel size 0.3 mm). Mean thickness of the labial bone was 0.50 ± 0.32 mm and 0.76 ± 0.37 mm for direct and CBCT measurements respectively. The majority of the buccal sites had a thickness of <1 mm. For the palatal thickness, 1.16 ± 0.53 mm and 1.41 ± 0.51 mm for direct and CBCT respectively. CBCT measurements overestimated measurements in 77% of the cases. As the thickness of the labial and palatal bone increased in thickness (greater than 1 mm) the discrepancy between the two methods of measurements decreased. Overall the differences between CBCT and direct measurement were not clinically significant. Although, most studies have found that CBCT underestimates bone thickness this study found the opposite. One explanation for the overestimation might be the result of partial bone volume averaging and blurring of thin bone layers. In conclusion, CBCT measurements correlate well with clinical findings except when labial thicknesses are less than 1 mm.

Evaluation of periapical lesions and their association with maxillary sinus abnormalities on Cone Beam Computed Tomographic images (J Endod. 2016 Jan;42(1):42-6.) (Figs. 3a & b)

Pain in the maxillary posterior areas can sometimes be difficult to diagnose due to the proximity of the teeth to the maxillary sinus and they share a common nerve supply. Roots of maxillary teeth can come in very close proximity and even protrude into the sinus. When periapical infections of the maxillary roots occur, infection can spread into the maxillary sinus causing inflammation. Sinus membrane thickening can be a sequelae in the presence of inflammation. When this occurs, it may be difficult to elucidate the source of the infection with a two-dimensional X-ray. CBCT offers better diagnostic capabilities because of its 3-D reconstructed images that can be viewed in several planes. This retrospective, cross-sectional study compared the presence, size and distance of periapical radiolucencies (RL), with the presence of sinus abnormalities using CBCT.

Images from I-CAT Cone Beam (Imaging Science International, Hatfield, PA) were evaluated using a resolution of 0.25 mm voxels. Maxillary sinuses were assigned a number from 1–6 based on the type of pathology seen (eg. mucosal thickening, presence of polyps, opacifications). Periapical RLs were graded based on size. The results showed that 64.3% of the teeth with periapical RLs had maxillary sinus abnormalities. The larger the periapical RL, the greater its association with maxillary sinus abnormalities (>8 mm had the highest correlation). Additionally, greater association with maxillary sinus abnormalities when the periapical lesion was <2 mm from the sinus floor. Mucosal thickening was the most common finding when associated with a periapical lesion. In general, however, sinusitis of odontogenic origin accounts for 10–20% of all maxillary sinusitis cases. This is because the sinus floor acts as a barrier to dental infection. In conclusion, the study showed sinus abnormalities were highly correlated with periapical RLs that were in very close proximity to the sinus. CBCT is a useful tool for visualising the maxillary roots and their proximity to the sinuses.

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Fig. 3a: Mucosal thickening and periostitis.
Fig. 3b: Antrolith.
**Introduction**

The causes of early implant failures during the osseointegration process include poor quality and quantity of bone and soft tissue,1–8 the patient’s medical condition,2, 6, 8–10 unfavorable patient habits (bruxism, heavy long-term smoking, poor oral hygiene, others),3, 4, 6, 8, 11 inadequate surgical analysis and technique,3, 7–11 inadequate prosthetic analysis and technique,3, 7, 8, 11–13 suboptimal implant design and surface characteristics6, 9, 13 implant position or location3, 14 and unknown factors.

This article attempts to further investigate implant location as one of many factors in early stages of diagnosis that improves success rate in implant dentistry treatment. Predisposing factors to implant complications in different jaw regions are discussed.

CBCT Zones D1 to D5 is formulated to better analyse implant dentistry procedure preparation during the diagnostic phase based on the location that has a logical sequence during examination of the alveolar ridge of both maxilla and mandible to have pre-existing information regarding the demands and the clinical requirements in different zones of the jaws. This article identifies the Hounsfield units (HU) of different alveolar jaw regions, according to which dental implants can be inserted with better understanding of what to expect.

Five CBCT zones are identified in this article in a logical sequence: the discreet zone D1 being the anterior mandible, the danger zone D2 being the posterior mandible, the death zone D3 being the anterior maxilla, the demand zone D4 being the posterior maxilla and the delicate zone D5 being the posterior maxilla that requires sinus lift procedure.

Zones D1–D5 are related to the bone quality classification of Lekholm & Zarb.15 D1 known as an interforamina area in which a careful diagnosis should be made due to the following procedure, bone density is very high and the osteotomy drills could heat the bone, irrigation temperature could facilitate healing response, dullness of the drills during osteotomy should be counted for, tap drills are required, arterial supply in the symphasis area should be considered and this area is utilised as a donor site for the chin (symphyseal) block bone graft. D1 includes six
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anterior teeth: four incisors and two canines. A thin alveolar process in this area necessitates implant diameter selection of a narrow-to-standard diameter (3–4 mm). Based on many case reports, a penetration of the thin lingual mandibular cortex during an implant insertion in this area on occasion can lead to serious bleeding with formation of expanding sublingual haematomas. Haemorrhage from a branch of the sublingual artery (a branch of the lingual artery), the submental artery (from the facial artery), or the mylohyoid artery (from the inferior alveolar artery, a branch of the maxillary artery) or their anastomoses can in some cases cause a life-threatening airway compromise. Tepper et al. demonstrated the presence of at least one (sometimes multiple) lingual perforating vascular bone canal[s] and suggested a routine CT examination prior to an implant procedure in this area. A similar report of serious haemorrhage from an implant insertion in the first mandibular premolar position also suggests a common arterial supply of all eight mandibular front teeth and one more reason for including first premolars in this zone. A successful placement of two to six implants in this zone in many edentulous arch cases offer a stable foundation for a variety of implant-retained and implant-supported removable and fixed mandibular prostheses. A symphysial (chin) monocortical block bone graft harvested in this area is often used for the horizontal augmentation of bone in other regions, especially for the anterior maxilla.

D2 is a bilateral area of the alveolar ridge of the posterior mandible from the first premolar to the retro-molar pad. The mental foramen in the front and the inferior alveolar canal below limits this functional implant zone. An implant’s success in this area relates to the quality (density) of bone and quantity of preserved alveolar ridge, among other factors. The ramus block bone graft is often harvested in the proximity of this zone. Embryologically, this bilateral mandibular alveolar zone develops above the inferior alveolar canal. The alveolar height between the inferior alveolar canal and the alveolar crest is routinely analysed in oral implantology when posterior mandibular implants are considered. A heavy masticatory demand during function, especially for people with parafunctional habits, necessitates an insertion of two to three implants into this region for replacement of missing first, second premolar, first molar, and occasionally the second molar.

D3 is a zone of the alveolar ridge of the anterior maxilla (aesthetic area), including six front teeth: four incisors and two canines. Part of the anterior maxilla is a protruding alveolar process with thin labial and thick palatal cortical plates covering and protecting the upper front teeth. A prominent position of the anterior maxilla and upper front teeth in the face is responsible for bone and soft-tissue injuries. Fracture of crowns and roots, subluxation, displacement and avulsion of teeth are frequent in this zone. The main blood supply to the anterior maxilla is derived from the branches of the maxillary artery: the anterior superior alveolar artery (from the infra-orbital artery), the great palatine artery, and the nasopalatine artery. A middle superior alveolar artery is occasionally described as a branch of the infra-orbital artery that supplies the region of the canine tooth. The anterior and middle superior alveolar arteries anastomose with the posterior superior alveolar artery to form an arterial network feeding both endosteal and periodontal plexuses.

Another traumatic event in the life of the alveolar ridge is a tooth loss. A tooth extraction, or periodontal disease also leads to bone resorption. The progression of healing after a tooth extraction goes through certain resorptive stages of fibrin clot organisation (first four weeks), immature (woven) bone formation (four to eight weeks), mature (lamellar) bone development (eight to twelve weeks), and bone stabilisation stage (twelve to 16 weeks or about four months). Post extraction bone resorption is always three-dimensional, with the greatest loss of bone in the buccal–palatal or horizontal direction (the width) and occurring mainly on the buccal side of the alveolar ridge. Schropp et al. reported that two thirds of the horizontal bone loss occurs within three months and one-third takes place within the remaining nine months of the first year post extraction. A mean reduction of the width of the ridge has been reported to be 5 to 7 mm within a six-month period or 50 percent during the twelve months following tooth extraction. The loss of bone height is smaller, reported to be about 1 mm within the first six months post extraction. If a bone grafting and implant treatment approach is not considered soon after trauma, the atrophy of the alveolar process of the anterior maxilla continues with time. Resorption of the buccal plate compromises the anatomy of the edentulous alveolar ridge and makes it difficult to place an implant in the prosthetically favourable position. Even when a dental implant is placed, its strength is diminished without the presence of a buccal cortical plate. Using a two-dimensional finite element model for stress analysis, Clelland and associates demonstrated low stresses and high strains surrounded the implant for the all-cancellous (lack of cortical plate) bone model. When a layer of thick cortical bone was added to the model, it had a significant impact and improved stresses and strains on the implant.

D4 is related to first and second premolars in the maxillary region and rarely first and second molars.
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Although this area is not considered the maxillary anterior teeth, it is still a prime concern for the patients during conversation and smiling. In addition to two anterior premolar teeth, two posterior molars are not considered as a separate class in this group if sinus lift is not required due to their common bone quality. These implants once restored are the longest support in front of maxillary sinuses. Park, Hyo-Sang et al. reported that the cortical bone density of the maxilla ranged approximately between 810 and 940 HFU at the alveolar bone except for the maxillary tuberosity (443 HFU at the buccal and 615 HFU at the palatal alveolar bone), and between 835 and 1,113 HFU at the basal cortical bone except for tuberosity (542 HFU).33 The cortical bone density of the mandible ranged between 800 and 1,580 HFU at the alveolar bone and 1,320 and 1,560 HFU at the basal bone. The highest bone density in the maxilla was observed in the canine and premolar areas, and maxillary tuberosity showed the lowest bone density. Density of the cortical bone was greater in the mandible than in the maxilla and showed a progressive increase from the incisor to the retromolar area.

D5, known as the sinus zone, is a bilateral zone of the alveolar ridge of posterior maxilla located at the base of the maxillary sinus from the second premolar to pterygoid plates. There are certain common features of replacement of missing tooth or teeth (rarely two premolars and commonly one or two molars) with dental implants in this zone. It often relates to the degree of sinus pneumatisation and vertical bone deficiency that may require supplemental surgical procedures in the subantral area in order to place endosseous implants.

This bilateral maxillary posterior zone that extends from the second premolar to the pterygoid plates is located at the base of maxillary sinuses (antra of Highmore). Embryologically, the hard palate and the alveolar process of the maxilla form the barrier between the maxillary sinus and the oral cavity. The bone height between the floor of the maxillary sinus and the alveolar crest is routinely analysed in oral implantology when posterior maxillary implants are contemplated. An increase of sinus volume or sinus pneumatisation after a loss of posterior tooth/teeth often necessitates vertical bone augmentation with a sinus lift procedure. The bone of this region is also known to have compromised bone quality (types 3 and 4) that can increase an implant failure rate. The main blood supply to the posterior maxilla derives from the posterior superior alveolar artery, the greater and lesser palatine arteries (all from the maxillary artery), the ascending pharyngeal branch of the external carotid artery, and the ascending palatine branch of the facial artery. An injury to the posterior superior alveolar artery during the lateral approach for subantral augmentation can cause haemorrhage that may require coagulation.

Materials and method

From a data base of 1,134 patients who had received 4,800 dental implants from 2001 till August 17, 2015, randomly a prosthodontist with no knowledge of these criteria was requested to select 100 files from the data base and present them for this study. The 100 files had received panoramic and cone beam computed tomography (CBCT, Table 1) during their diagnostic visit. The average HFU of the randomly selected 100 cases was calculated.

Results

Hounsfield unit: The data in table #1, out of 100 samples, demonstrated that the average HFU was the minimum in D5 (213 HFU), and followed by D4 (528 HFU), D3 (561 HFU), D2 (599 HFU) and D1 (654 HFU) in ascending order respectively (Fig. 1 and Table 2).

Discussion

There are few literature reports that attempt to study implant location, among a multitude of other factors, to determine its influence on the success or failure of dental implant treatment. Becker et al. evaluated 282 implants placed in the maxillary and mandibular molar positions in a prospective study.34 The six-year cumulative success rate (CSR) for maxillary posterior implants was 82.9 percent, for mandibular posterior, 91.5 percent. He concluded that CSR in the posterior regions is lower than usually reported for anterior regions of the maxilla and mandible due to differences in bone quality and quantity. Eckert et al. assessed 1,170 endosseous implants placed in partially edentulous jaws in a
A retrospective study: anterior maxilla, posterior maxilla, anterior mandible, and posterior mandible. In his report, the location of implants did not appear to have any effect on implant survival, implant fracture rates, screw loosening, or screw fracture. Parein et al. analysed 392 consecutively placed Branemark implants that were inserted in 152 partially edentulous posterior mandibles and restored with 56 crown and 168 bridge restorations in a long-term retrospective study. The CSR of all implants in the posterior mandible was 89.0 percent at six years.

Fewer complications were found in implant prostheses located exclusively in the premolar region versus molar and mixed molar-premolar implant restorations. Drago investigated the location-related osseointegration of 673 implants placed in 169 patients that were observed from seven months to eight years following occlusal loading. Implant osseointegration was 89.1 percent in the anterior maxilla, 71.4 percent in the posterior maxilla, 96.7 percent in the anterior mandible, and 98.7 percent in the posterior mandible. Moy et al. analysed implant failure rates and associated risk factors, observed implant failure of 8.16 percent in the maxilla and 4.93 percent in the mandible. Increased age (over 60) was strongly associated with the risk of implant failure. Bass et al., evaluating 303 patients with 1,097 implants over a three-year period, assessed the success rate of implants in the maxilla at 93.4 percent and 97.2 percent in the mandible. Poor bone quality played the major role in implant failure with bone quantity demonstrating less importance.

All presented reports appear to agree that the CSR of dental implants is generally high and that implant location plays an important role in implant success. CSR of implants in the mandible seems to be slightly higher than in the maxilla—a difference of about 4 percent. The success rate of implants in the anterior regions seems to be higher than in the posterior regions of the jaws, mostly due to the quality of bone: about 12 percent difference between anterior maxilla and posterior maxilla, and about 4 percent difference between anterior mandible and posterior mandible. On the basis of reviewed literature reports, an implant treatment in the anterior mandible appears to be the most successful. The posterior maxilla appears to be the least successful region of the jaws for implant rehabilitation.

**Conclusion**

There is a trend of escalating levels of HFU in different parts of the oral cavity. The highest being the anterior mandible, followed by the posterior maxilla, posterior mandible, anterior maxilla and posterior maxilla with sinus lift procedure respectively. Estimated HFU can assist the surgical phase, as the number of the ancillary procedures can be pre-estimated according to different areas in the mouth during the diagnostic phase.

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

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**Average HFU of different areas in the mouth**

<table>
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<th>No. of Cases</th>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2**

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**Fig. 1**

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Localized ridge augmentation utilising titanium mesh with CPS morsels and simultaneous implant placement—A case report

Authors: Drs. Lanka Mahesh, Gregori M. Kurtzman, Dildeep Bali, Vishal Gupta & Taran Preet Singh, USA & India

Implant placement in the atrophic anterior maxilla can often be a difficult task due to deficient bone height, width, and volume. Many procedures have been introduced to aid in the reconstruction of the maxillary alveolar ridge to gain adequate bone to enable implant placement. Surgical modalities for alveolar ridge augmentation, along with guided bone regeneration, has been proven to be successful in re-establishing an appropriate alveolar ridge width. Guided bone regeneration is generally accomplished with the use of particulate bone of various types, and this bone is often protected by membranes. It has been found that the quantity of bone regenerated under the membranes has been demonstrated to be directly related to the amount of the space under the membranes. This space can diminish if the membrane collapses or is compressed, resulting in a less than satisfactory treatment outcome. To avoid the potential problem of membrane collapse, a technique of ridge augmentation is described, which involves the use of a rigid titanium mesh barrier to protect the regenerating tissues and to help protect the underlying bone segments. In this case report, excellent results were demonstrated for a maxillary anterior defect, augmented using guided bone regeneration with simultaneous placement of an implant to replace the maxillary right central incisor tooth particulate bone graft material protected by titanium mesh. The use of CBCT was essential for the pre-operative diagnostics and useful for demonstrating the volume gain in the post-graft assessment of the site.

Introduction

Resorption of the edentulous or partially edentulous alveolar ridge or bone loss due to periodontitis or trauma frequently compromises dental implant placement in a prosthetically ideal position. These deformities can lead to complications in attempts for the restoration of related areas. Therefore, augmentation of an insufficient bone volume is often indicated prior to, or in conjunction with, implant placement to attain predictable long-term functioning and an aesthetic treatment outcome. In recent years, there has been an increase in the number of studies focusing on the augmentation of these atrophic ridges either before or at the time of implant surgery. Predictable bone regeneration of large alveolar defects with complex morphology can pose a significant clinical challenge. Preservation or creation of a soft tissue scaffold needed to create the illusion of a natural tooth, or root prominence for an implant supported restoration is often challenging and difficult to achieve. A subtle mistake in the positioning of the implant or the mishandling of soft or hard tissue can lead to aesthetic failure and patient dissatisfaction.

Autogenous bone grafts are considered by many to be the gold standard in bone regeneration procedures. However, donor site morbidity, unpredictable resorption, limited quantities available, and the
need to include additional surgical sites are the drawbacks to autografts, which have intensified the search for suitable alternatives. Bone-substitute materials have increased in popularity as adjuncts to or replacements for autografts in bone augmentation procedures to overcome the limitations related to the use of autografts. Bone-substitute materials can be categorised into three groups: (1) allogenic: from another individual within the same species; (2) xenogenic: from another species; or (3) alloplastic: synthetically produced.

The technique of guided bone regeneration (GBR) was evolved to augment atrophic or damaged ridges. GBR employs a physical barrier to selectively allow new bone growth into the space created between the barrier and the existing bone. The emergence of synthetic bone substitutes for grafting should enable today’s practitioners to perform an almost endless variety of procedures that involve the repair or regeneration of alveolar bone around dental implants or natural teeth. Such materials must satisfy various regulatory requirements and meet clinicians expectations for safety and effectiveness. It has been shown that an expanded polytetrafluoroethylene membrane can be used to improve the healing of both pathologic and experimentally created defects; however, this material is not rigid. The rationale of using a titanium mesh is to contain and stabilise the graft with an unyielding material, allowing maximum bone regeneration and minimising overall loss of bone volume. Various forms of titanium mesh have been successfully used to rigidly maintain the alveolar contour with different types of grafts. Graft materials such as alloplastic bone in combination with membranes enhance the treatment success of bone defects.

Case report

A 19-year-old male reported with a missing maxillary right central incisor. The patient gave history of trauma due to accident, which resulted in the loss of the maxillary right central incisor. On clinical examination, deficiency in the anterior residual alveolar ridge with loss of buccal cortical plate was noted. The patient was in good health and was a non-smoker with no medical contraindications for surgery, had excellent oral hygiene and a strong desire to restore the area with a fixed prosthesis. On examination there were no clinical signs of periodontitis and dental caries. Radiographically, the clinical findings were verified and revealed vertical and horizontal bone loss that was limited to the maxillary right central incisor (Fig. 2) Using the native software, non-distorted measurements were made on the cross-sectional slices to determine the dimensions of the defect within the residual socket site, and lack of facial cortical-plate as confirmed in the axial view.

Treatment planning

Different treatment options were reviewed with the patient to replace the missing central incisor tooth.
After discussing the pros and cons of each option, it was determined that the most acceptable treatment plan would be an implant-supported restoration. In order to facilitate implant placement, it would also require augmentation of the compromised alveolar ridge using an alloplast bone graft secured with a rigid titanium membrane. The ultimate goal was for a single implant-supported prosthetic replacement.

Treatment procedure

A local anaesthetic agent was administered in the area of the maxillary right upper central incisor. An incision was made on the buccal and palatal aspect of the involved edentulous ridge and a full thickness flap was reflected from the maxillary right lateral to the maxillary left central incisor tooth to reveal the anticipated horizontal and vertical bone defect diagnosed with CBCT imaging (Fig. 3).

Once the soft tissue was removed from the defect area, an osteotomy was prepared under copious irrigation to receive a single implant 3.8 mm in diameter by 11.5 mm in length inserted at 35 Ncm (Kelt Implant) (Fig. 4). Approximately 1 cc of calcium phosphosilicate (CPS) Morsels (NovaBone) (Fig. 5) was mixed with sterile saline and allowed to hydrate before being placed and packed into the defect and positioned to fill all void areas.

A sterile titanium mesh (Fig. 6) was trimmed to size and placed under the facial flap following the GBR protocol to secure the bone graft in its place and was fixated with the cover screw of the implant. Extensive periosteal releasing incisions were made in the facial flap to permit complete tension-free coverage of the membrane. Primary wound closure was obtained by horizontal mattress and interrupted cytoplast 4/0 sutures (Osteogenics). Post-operative oral hygiene instructions were discussed with the patient.

The patient was seen post-surgically after two weeks for suture removal; no untoward post-operative symptoms were noted. The patient was put on a 2 week, 1 month, 3 month and 6-month recall, ensuring the proper management of implant site. An interim fixed resin-bonded retainer (Maryland Bridge) was utilised during the healing phase. After 5 months, prior to second stage surgery, a post-graft CBCT (Figs. 7a–d) was performed and a horizontal bone gain of 5.3 mm was noted. A comparison of pre- and post-operative CBCT images revealed the extent of bone volume achieved (Figs. 8a & b).

The patient was recalled for second stage surgery, where the titanium membrane was removed and the healing collar placed (Figs. 9a & b).

After 3 weeks of additional healing, fixture level impressions were accomplished for the laboratory phase. (Impregum 3M ESPE). The final single tooth
Implant-supported prosthesis can be seen in Figs. 10a & b. The post-insertion radiographic image at 14 months revealed excellent bone adaptation surrounding the implant, with sufficient interproximal height of bone (Fig. 11).

Discussion

A differential diagnosis to the cause of the problem associated with the patient’s maxillary right central incisor was ambiguous. The patient did present with a history of trauma but the typical findings of wounds, injuries to the oral mucosa, fracture of the tooth, pulp exposure, vitality tests, displacement and mobility were not evident, though the patient did report displacement. Another potential diagnosis could be localised aggressive periodontitis, which exhibits itself typically with small amounts of plaque, mobility and migration of the molars and incisors, an increase in the size of the clinical crown and rapid progression.

Alternate treatment modalities included a removable partial denture, fixed partial dentures and resin bonded bridges (Maryland bridges). Removable partial dentures, while a viable option, can contribute to the loss of alveolar bone on both abutment and non-abutment teeth. The dissatisfaction rate of removable partial dentures is relatively high. The use of fixed partial dentures would have required the unnecessary destruction of adjacent teeth with pristine tooth structure to prepare anchor abutments. Another option would be a resin-bonded bridge, which would reduce the amount of adjacent tooth destruction but with a high incidence of pontic failure and de-bonding. Using the classification system proposed by Funato et al. 2007, the site in this case was Class IV, which is characterised by vertical and buccal bone loss. It was thus necessary to perform bone and tissue augmentation so that optimal gingival profiling and a more aesthetic result could be achieved.

Reconstruction of defects in the anterior part of the maxilla to enable implant placement is a challenging treatment. The alveolar ridge augmentation, along with GBR, has been introduced in recent years to re-establish an appropriate alveolar ridge width. Bone regeneration in membrane-protected defects heal in a sequence of steps that stimulated bone formation after tooth extraction. After blood clot formation, bone regeneration is initiated by the formation of woven bone initially along new blood vasculature at the periphery of the defect. The woven bone is subsequently replaced by lamellar bone, which results in mature bone anatomy. Ultimately, bone remodelling occurs with new, secondary osteons being formed.

Bone graft materials have been used to facilitate bone formation within a given space by occupying that space and allowing the subsequent bone growth. The biologic mechanisms that support the use of bone graft materials are osteoconduction, osteoinduction and osteogenesis. Barrier membranes are biologically inert materials that serve to protect the blood clot and prevent soft tissues cells (epithelium and connective tissue) from migrating into the bone defect, allowing osteogenic cells to be established. Vertical increase of a narrow alveolar crest has been shown to be possible with membranes. Membranes have been manufactured from biocompatible materials that are both non-resorbable and resorbable. The advantage of a titanium barrier membrane (non-resorbable) is its ability to maintain separation of tissues over an extended period.

Figs. 7a–d: Computed tomography scan after 5 months.
extended time. Unless the barrier is exposed, it can remain in place for several months to years but it require a subsequent surgical procedure to remove them.

Bone augmentation and simultaneous implant surgery procedures allow clinicians to reconstruct alveolar bone deficiencies, preserve alveolar dimensions, and place missing teeth with dental implants in a prosthetically driven position with natural appearance and function. The 2-year clinical results obtained in this case demonstrate CPS alloplast with GBR along with simultaneous implant placement to be a predictable and successful procedure to augment bone at sites exhibiting insufficient bone volume for implant placement under standard conditions and proved to be a successful strategy for anterior aesthetic rehabilitation.

Conclusion

Placing dental implants in the maxillary anterior region requires precise planning, surgery, and prosthetic treatment. This article illustrated the steps needed to create ideal aesthetics in the maxillary anterior region. Rigorous treatment planning allows the implant surgeon, working with the restorative dentist, to select location, angulation, and spacing of dental implants to achieve ideal aesthetics. Treatment planning also dictates the necessity for hard- and soft-tissue grafting, which is often crucial for an ideal aesthetic result. Further, the prosthetic restoration of a dental implant must be ideal to achieve the desired aesthetic result. This article has discussed the importance of a comprehensive and interdisciplinary approach to treatment planning, surgery, and restoration of dental implants in the maxillary anterior region of the mouth.

References

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The field of digital dentistry is rapidly evolving, with new dental technologies emerging as part of a more efficient and comprehensive workflow. By pairing Planmeca CAD/CAM solutions with X-ray units in the Planmeca ProMax 3D family, dental professionals can bring together a wide range of detailed information for treatment planning and diagnostic purposes. This seamless combination of CAD/CAM and 3-D CBCT technology has opened new doors in creating a new standard of care for patients—offering high-quality features for different specialities, all available through one software interface.

Planmeca Romexis is the only dental software platform in the world to combine all imaging and the complete CAD/CAM workflow. This powerful solution is at the heart of the Planmeca ecosystem, as it provides dental professionals with the ability to acquire more detailed data sets than ever before. Planmeca Romexis includes advanced tools for all specialities, such as implant planning and other restorative treatments. The software presents dental clinics with a superior way to increase their patient flow and improve the level of care offered.

Seeing more than ever before

Bringing together CBCT data and CAD/CAM work provides a comprehensive level of clarity. Planmeca ProMax 3D imaging units reveal intricate information on soft and hard tissue structures, including the mandibular nerve canal, while the Planmeca PlanScan intraoral scanner captures precise data above the gum line. This combination of these data ensures a complete understanding of any case and makes 3-D prosthetic designing quick, accurate and easy. Clinics are able to operate more flexibly, as restorations can either be milled at a clinic with the Planmeca PlanMill 40 milling unit, or easily sent to a dental lab in an open STL data format.

The rise of same-day dentistry

A more active role in the manufacturing of restorations opens up avenues for dental clinics to significantly increase their patient volume and grow their business. A streamlined digital workflow ensures the full utilisation of resources, leading to a more efficient treatment environment. Same-day dentistry is as beneficial for patients as it is for clinics; instead of two visits, patients can be treated in one hour—with no temporary crowns or physical dental models required.

Open architecture for maximised efficiency

Standardised data is the driving force behind many of the latest developments in digital dentistry, as it guarantees the interoperability of images and dental data across different hardware platforms—reducing costs, increasing predictability and enhancing patient safety. Bringing Planmeca’s CBCT and CAD/CAM systems together through the Planmeca Romexis software platform makes effective chairside dentistry a reality, and presents dentists with a streamlined opportunity to substantially grow their practice.

Dentsply Sirona announces acquisition of MIS Implants

Global dental manufacturer Dentsply Sirona has announced a definitive agreement to acquire all of the outstanding shares of privately held MIS Implants Technologies, a dental implant manufacturer headquartered in northern Israel, for US$375 million (€341.5 million). According to the companies, the agreement creates many new opportunities for growth and services for both parties, and will benefit customers and patients around the globe.

“MIS is uniquely positioned to address the value segment of the implant market in both its home region and around the globe. It is strategically important to be able to address the implant market with distinct organizations, portfolios and brands targeting both the premium and value segments. MIS has a broad portfolio of implants and related products under a well-established brand, making it a great complement to our company,” commented Jeffrey T. Slovin, CEO of Dentsply Sirona.

A global leader in the field of dental implants, Dentsply Sirona offers individual and rigorously tested products for every stage of implant therapy. The company develops and produces innovations in implant surface technologies, implant–abutment connections, immediate placement protocols and guided surgery. At the beginning of 2016, Sirona and Dentsply completed their merger, thereby creating the world’s largest manufacturer of professional dental products and technologies, Dentsply Sirona. With the addition of MIS, the Dental Solutions Company aims to extend the range of therapy concepts to additional market segments.

MIS (Make It Simple) was founded in 1995 in Shlomi in Israel. The company has a strong presence in the value segment, selling its products in more than 65 countries worldwide. MIS aims to simplify implant dentistry through innovation and clinical education. The MIS brand offers a wide range of dental implants and prosthetic solutions, together with grafting materials and guided surgery services.
“The journey of innovating the clinical workflow has just begun”

An interview with Hans Geiselhöringer, President of Nobel Biocare

From 23 to 26 June, Nobel Biocare held its global symposium in the world metropolis of New York in the US. The company staged a truly exceptional event with a high-class educational programme at the Waldorf Astoria in Manhattan. As the official media partner of the event, Dental Tribune International had the opportunity to meet with Hans Geiselhöringer, President of Nobel Biocare and Dental Imaging, at the symposium for a short interview.

Dental Tribune International: Has the global symposium met your expectations?

Hans Geiselhöringer: We are extremely happy with the symposium because it has exceeded our expectations in every sense, regarding the record number of participants, the motivation of our team and customers to engage in discussions, as well as the quality of the speakers and their presentations.

We have always had high standards at our meetings, but I must say that I was really thrilled by the way innovation was presented not only by our company but also by the clinicians and experts themselves.

In addition, I found the NEXT GEN forum in particular incredible, as it gave us confirmation that we are on the right track to doing more for the younger generation of implantologists. I was positively surprised to see how enthusiastic and open our young clinicians are to working hard with us to move this project forward.

Overall, we have seen at this symposium that the future is bright, and I strongly disagree with some critical voices that suggest that there will no longer be real innovations in implantology. In my opinion, the journey of innovating the clinical workflow has just begun.

With regard to training of the next generation of dentists, what role can or should Nobel Biocare play in implant education?

Education is key. We believe that it is very important that clinicians start the thought process for the clinical workflow early. We have some programmes in place already and will promote these programmes to help and support universities in the education of young dentists in implantology. For example, we support academic institutions and dental students through the provision of NobelClinician Software licences for implant planning and patient communication.

Only recently, voters in the UK decided that the country should leave the European Union. How could the Brexit affect the dental industry and are there any immediate concerns for Nobel Biocare?

This is a question that is really difficult to answer, as the short- and long-term consequences of the
Brexit remain unclear. I believe that even experts cannot predict the impact of the Brexit on the industry. From a personal point of view, I believe it is never a good thing to have many separate markets. However, whether the Brexit will affect us as Nobel Biocare directly, I do not yet know.

How has the acquisition by the dental platform of the Danaher Corporation, which occurred at the end of 2014, affected Nobel Biocare’s business?

We have seen only positive effects. The transition into the dental platform has given us new opportunities to develop resources for innovation, marketing and sales that we would not have had without this partnership. Collaboration with other brands within the platform has granted access to expertise that is allowing us to lead innovation in dentistry. We are learning from our colleagues and have gained tools that are helping us to refine our processes and accelerate results.

The new home of Nobel Biocare is a very good one.

The next big occasion in the dental event schedule is the International Dental Show in March next year. Are there even more innovations to come from Nobel Biocare?

I cannot disclose anything yet. However, I can tell you already that there will be significant innovations presented. The potential that we are going to bring to the market will be of the same magnitude as that experienced at the symposium over the past few days. Nobel Biocare will accelerate its delivery of significant and meaningful innovations, each developed with the well-being of the patient in mind.
International Events

2016

FDI Annual World Dental Congress
7–10 September 2016
Poznan, Poland
www.fdi2016poznan.org

SCAD 2016 Annual Conference
15–17 September 2016
Chicago, USA
www.scadent.org

27th Annual NYU/ICOI Implant Symposium
5 November 2016
New York, USA
www.icoi.org

8th Dental Facial Cosmetic International Conference
4–5 November 2016
Dubai, UAE
www.capp-asia.com

ADF
22–26 November 2016
Paris, France
www.adf.asso.fr

Great New York Dental Meeting
25–30 November 2016
New York, USA
www.gnydm.com

2017

Academy of Osseointegration
Annual Meeting
15–18 March 2017
Orlando, USA
www.meetings.osseo.org

IDS 2017
21–25 March 2017
Cologne, Germany
www.ids-cologne.de

IMAGINA Dental
6th Digital Technologies & Aesthetic Dentistry Congress
13–15 April 2017
Monaco
www.imaginadental.org
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- 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.).

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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.
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Questions?

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