Ceramic dental implants: What benefits do they offer?

By Brendan Day, DTI

Although the search for metal-free implant materials began in the late 1960s, recent improvements in ceramic materials have made their development process considerably easier. As an alternative to titanium-based implants, ceramic implants offer greater aesthetic appeal and possess antiallergenic and tissue-friendly properties. This article highlights some of the companies that currently offer ceramic implants and explores why they are still much less commonly used than their titanium counterparts.

For the better part of four decades, titanium and titanium-alloy dental implants have been successfully used as tooth replacements. However, recent research findings have raised fears regarding these implants’ tendency to corrode and decay. During the corrosion process, titanium implants release particles or ions into their surrounding tissue, which could lead to implant failure and bone disintegration. A 2014 paper published in the *Open Journal of Stomatology*, titled “Corrosion aspect of dental implants—An overview and literature review”, detailed this process by explaining that the compatibility of titanium implants is largely the result of a thin layer of oxide that forms on their surface. This layer can erode due to movements between bone tissue and the implant during loading conditions, which could lead to corrosion, leaking and an overall weakening of the implant. Given their non-metallic nature, ceramic implants are not susceptible to this form of decay.

However, the lack of concrete evidence concerning the mechanical properties and osseointegration of ceramic implants has impeded their uptake, although this is partially due to their relative newness. The FDA only approved ceramic implants in 2007. Additionally, there have also been relatively few clinical studies conducted on their long-term use. However, in the *Clinical Implant Dentistry and Related Research* journal, a 2015 study of zirconia implant abutments that supported entirely ceramic crowns found that after 11 years of use, these abutments had a cumulative success rate of 96.3 per cent. In addition, a 2010 study in the journal for *Clinical Oral Implants Research* found that the osseointegration of zirconia implants is similar to that of titanium implants. Despite these positive findings, the sheer lack of depth in research has deterred the majority of dental professionals from using ceramic implants.

The one-piece design of ceramic implants is another element that has both positive attributes and drawbacks. A one-piece implant eliminates the connective point between the abutment and the fixture, ideally reducing bacterial growth and improving overall oral health. However, a high level of attention to detail with regards to the implant’s placement is required, as it does not possess the same capability as titanium implants to correct errors in placement with an angled abutment. This inability to correct errors in placement created the demand for two-piece ceramic implants that allow for more flexible placement options and better healing.

The American Academy of Implant Dentistry estimates that, while three million Americans currently have at least one dental implant, this number is rising by half a million each year. Given the growing global demand for dental implants, it is more important than ever to provide patients with options that best suit their individual needs. Although they are an expensive option, ceramic implants are increasingly meeting the standards for stability, compatibility and osseointegration that titanium-based implants have set. Combining this with their aesthetic appeal and anti-allergenic nature, ceramic implants should continue to grow in popularity.

“Ceramic implants today, in my experience and for many fellow ceramic implantologists, have the same success rate as titanium implants. They are now as versatile as metal implants thanks to the evolution in design, surface enhancement protocols and biomaterial improvements”, says Dr Sammy Noumbissi, President of the International Academy of Ceramic Implantology (IACI), an association entirely dedicated to ceramic alternatives of metal-based...
Impacts. Various treatment modalities are applicable with ceramic implants: immediate placement, immediate provisionalization, full arch and full mouth rehabilitation can be performed with excellent and predictable outcomes. However, believe that adopting ceramic implants should be accompanied by training or shadowing from an experienced clinician, even if one has experience with titanium implants.

Only a few implant manufacturers focus on ceramics

Interestingly, most of the major implant manufacturers do not have a ceramic implant on the market, let alone in development. The most notable exception is Straumann. Headquartered in Basel, Switzerland, Straumann is an international leader in implant and restorative dentistry, with its products and services available in more than 100 countries. Straumann currently offers Pure, a completely zirconia-based implant that is ivory-coloured, similar to a natural tooth. The company recently announced that it has entered into a partnership with maxon motor, which will allow it to develop dental implant components through ceramic injection moulding rather than conventional cutting techniques. The move demonstrates the company's recognition of the growing market for aesthetically pleasing, metal-free implants. Given that one of the main barriers to zirconia implants is their comparably high price, Straumann aims to make it a more widely available and affordable option.

In addition, TAV Dental is one of the few companies that offer both one-piece and two-piece ceramic implants. Their primary focus is to create state-of-the-art zirconia dental products through an innovative approach to technology, fostered by their parent company, TAV Medical. TAV Dental offers a variety of one-piece and two-piece zirconia implants that are entirely white, a distinct aesthetic improvement from the metallic colour of a titanium implant that is often visible. Furthermore, the inert nature of TAV Dental's zirconia implants make them less likely to fracture and highly resistant to foreign compounds, as well as the application of heat, further benefiting patients.

Another company manufacturing ceramic implants, Ceraboot, introduced its zirconia implant system to the European market in 2005 and the US market in 2011. Located in Barcelona, Spain, the company utilised improvements in ceramic materials to design a one-piece ceramic implant. Whereas titanium-based implants have two separate parts—the fixture and the abutment—Ceraboot's product incorporates both elements into one implant. This ensures that there is no prosthetic connection where bacteria can grow, theoretically leading to better periodontal health.

One of the primary players in ceramic implantology is Dental implant with their metal-free Zeramex system. Established in 2005, the company spent four years researching and developing a two-part implant made of zirconia, presenting it to the world in 2009. Zeramex offers a revolutionary approach to ceramic implantology through their metal-free, screw-in implant, allowing for a flexible restoration with a high level of biocompatibility. Combining this with a higher resistance to corrosion results in a product that rivals titanium implants in performance.

Zyssystems is a Switzerland-based company that, through their Zirkolith range of products, offers extensive ceramic implant options. Similar to TAV Dental, they offer both one-piece and two-piece implants and their osseointegration rate is similar to leading titanium implants. Another company, VITA, has entered the ceramic implant market with its own one-piece cylindrical ceramic implant in operation since 1994. With a focus on innovation, VITA claims their ceramic implant offers faster, safer healing than titanium-based implants. With a compatibility rate of 98 per cent for more recent models, zirconia-based ceramic implants are increasingly matching the standards set by titanium implants and could thereby become a more viable option.

As Noumbsi concludes, “The future of ceramic implants is really bright for many reasons. Patients increasingly ask for safer, less invasive solutions, as well as metal-free alternatives for teeth repair or replacement. Dental attitudes and understanding of zirconia and bioceramics are slowly but steadily evolving, with a definite shift toward biological and inert materials. There has also been a shift in the health care industry towards wellness and wellbeing, and providing therapies that have little to no side effects.”

Since some of the larger players in the implant industry are incorporating, or have already adopted ceramic implants in their product lines, either by development or by corporate acquisitions, implantologists could eventually look at ceramic implants as a viable alternative to titanium.
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Shifting consumer preferences and positive uptake of CAD/CAM technology

Current developments in the European dental implant market

By Artur Kim & Dr Kamran Zamanian, Canada

Europe has some of the most highly penetrated markets for dental implants in the world, including Italy, Germany and Spain, but it also contains regions with considerably under-developed markets, such as France and the UK. A shift in consumer preferences will be a key characteristic of the European market in the future, in both the dental implant fixture market and final abutment market. Although the shifts will contrast one another, they will both have a significant impact on the market in terms of overall pricing, the competitive landscape and technological innovation.

Historically, premium dental implant companies have dominated in Europe, but have recently faced increased competition from the value and discount brands. A growing prevalence of local manufacturers and an increasingly cost-sensitive consumer demographic will contribute to overall price depreciation and the declining presence of premium implants in the future.

Region-specific growth of the premium segment is highly reliant on the prevalence of domestic, lower cost dental implant brands. In countries such as Italy, Germany and Spain, there is a plethora of local value and discount dental implant companies that have emerged to cater to the growing value and discount brands. A similar trend has also been observed in countries such as Italy, Germany and Spain.

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Premium implant companies have acknowledged the impact of value and discount brands on the market, not only through discount pricing, but also through acquisitions and strategic investments. In April 2015, Straumann increased its ownership of Neodent, a leading value implant manufacturer from Latin America, to 100 per cent in order to strengthen its product portfolio and maintain a competitive position in both the premium and value segments. Straumann has also invested in a number of value and discount brands that cater to the European market, including Biudenta, Medentika, MegaGen and Anthogyr. These investments are supplemented by Instradent, Straumann’s business platform established in 2014, which currently provides distribution for Neodent and Medentika through an online store and worldwide network.

In June 2016, Dentsply Sirona continued its expansion by announcing a definitive agreement to acquire MIS Implant Technologies, an implant manufacturer that has a leading position in the titanium abutment segment. The agreement covers the acquisition of MIS’s intellectual property, customer and market data, product development, and global marketing and sales and service network.

Similar to the historical dominance of the premium segment in the implant market, the market for final abutments has traditionally been controlled by the stock abutment or prefabricated abutment segment. Although the majority of stock abutments lack many benefits associated with patient-individualised solutions found within the custom-cast abutment and CAD/CAM abutment segments, they still provide a relatively simple and cost-effective solution in most implant procedures. The segment is expected to continue experiencing price erosion owing to increasing pricing pressure from local, low-cost and generic manufacturers.

Another recent development within the stock abutment segment also contributing to price depreciation is the introduction of Ti-base abutments. Ti-base abutments, also known as titanium bars or titanium interfaces, are a recent innovation within the stock abutment market that are a cost-effective alternative to traditional CAD/CAM abutments, since they are intended for in-house or independent milling machine use. Examples include Straumann’s Variobase and Nobel Biocare’s Universal Base, which give dentists the option of placing a cement-retained or screw-retained restoration. Ti-bases also allow dentists to choose between a hybrid abutment and a hybrid abutment crown (a combination of an abutment and a monolithic crown). The presence of Ti-base abutments has grown rapidly across most regions in Europe and is expected to become the predominant stock abutment type in the near future. The cost-effective nature and flexibility of options offered with Ti-base abutments will help maintain the position of the total stock abutment segment in the overall market. Stock abutments currently represent over 50 per cent of the total final abutment volume in the majority of markets across Europe, but this share is expected to steadily decrease.

Recent improvements in production capability and technological innovation have made CAD/CAM abutments significantly more affordable than in the past. CAD/CAM abutments are now relatively comparable in price to custom-cast abutments and are more easily accessible, especially in regions where milling laboratories with CAD/CAM production are in greater abundance. Furthermore, CAD/CAM zirconia abutments are primarily required in cases in which aesthetic outcomes are of high priority, such as the anterior region of the mouth. CAD/CAM abutments are expected to continue to experience double-digit growth, and the expanding market share of the segment will limit ASP of the overall abutment market, since it carries a significantly lower premium relative to stock abutments and custom-cast abutments.

Consolidation and emerging players in the competitive landscape

In addition to investments in value and discount companies, the market for dental implants has been distinguished by consolidation among the top competitors. Most recently, Dentsply Sirona was established after the merger of DENTSPLY International and Sirona Dental Systems in February 2016, combining the strengths of each company in dental consumables and innovative technology, respectively. The premium implant company acquired ASTRA TECH in 2011 and announced the acquisition of MIS in June 2016. In June 2015, Zimmer Biomet was formed through the merger of Zimmer and Biomet, combining the dental divisions of each company. Zimmer Dental and BIONOMET joined the list of the largest implant companies.

Although the premium implant companies still collectively maintain over 60 per cent of the European market, they are expected to face challenges from emerging players in the value and discount segments. Competitors that have been able to secure a notable market share from the premium companies include BioHorizons, CAMLOG, Global D, medentis medical, Sweden & Martin and regional manufacturers.

Other notable developments in the European market for dental implants include the increased uptake of ceramic materials, growing presence of implant companies in the biomaterials space and rising demand for modern surgical protocols, such as immediate loading and full arch restorations. Overall, growth within each segment will be highly dependent on the aforementioned factors and region-specific characteristics.
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One week diary with our X-Mind Trium 3D CBCT in practice

By Dr Diyari Abdah, UK

There is mounting evidence in the literature in regards to the diagnostic superiority of 3-D imaging versus 2-D. As a result, many clinicians today are using 3-D imaging either by referring their patients to a CBCT-scanning centre or having mobile units visiting them, and the only benefit of this method is that there is no initial capital outlay to buy the machine. In contrast, the benefits of having your own in-house CBCT machine are many, including the total convenience of an on-demand service at any time (pre-op or during and after if needed), learning one software and fully utilising it rather than having to learn different software for different machines (manufacturers), thus not utilising it to its fully intended use.

Additionally, patient appreciation that they do not have to travel to another location and that fact that you care enough to have a machine installed in your clinic for their convenience and yours.

Our X-Mind Trium CBCT unit from AisX (AIS) is rather young in our practice, and we have yet to fully utilise it. Every day we find new uses and ways to benefit our patients by using 3-D imaging where applicable.

Following the latest evidence from experts in the utilisation of 3-D imaging can help a lot in deciding where and when to use it, consequently minimising dosage and improving diagnostics and planning.

We owe our patients the lowest possible dose with the corresponding acceptable diagnostic value, and sometime a 2-D image is just not enough to give satisfactory diagnostic value. A lot of guesswork is often involved with 2-D imaging that could affect our decision-making and treatment planning.

Judging every case individually is important in order for the benefits of using a CBCT scan to outweigh the potential risks involved with the use of any type of X-ray unit. A modern CBCT machine should allow for different FOV settings to be utilised, in order to minimise the dose to the patient.

Despite the choice of four different FOV settings on the X-Mind Trium, and other settings that reduce the radiation significantly, individual assessment of every case is still very important to get the most of the 3-D image without exposing the patient to extra radiation.

In many cases, a small FOV that is enough for one to several teeth could be equal to a few periapical radiographs but with a much higher diagnostic value.

In order to show how a CBCT scanning machine can affect the day-to-day dentistry in a small family practice, it would be beneficial to share a week’s diary, bearing in mind each practice’s needs are different, but one thing should be common above all, and that is to assess every case individually and never take 3-D scans routinely, even despite their clear benefits.

When a 3-D image is necessary, patients appreciate the information and education they get by discussing the case with them while pointing to vital structures and solutions in 3-D versus an old-fashioned 2-D image that did not make sense to the untrained eye in most cases.

So here are a small selection from a week’s diary utilising the X-Mind Trium 3D CBCT in the clinic. More CBCT scans were probably obtained on any one day depending on the cases on that day, however, due to space limitations in this article, only one to two cases per day were selected.

**Day 1**

The patient had all his lower teeth extracted many months ago, due to mobility and infections and preferred to have a fixed solution through implant therapy. Patient currently is wearing a well-fitted temporary denture with radiopaque markers (gutta-percha in 6–8 holes around the implant. The aim is to assess every case individually and never take 3-D scans routinely, even despite their clear benefits.

A 3-D scan was obtained using the X-Mind Trium 3D CBCT scanner to be utilised as an invaluable resource in the treatment planning of the case. Through the scan, the type and position of the implants in relation to the density of the surrounding bone were checked.

The AIS 3-D Software that comes with the device, includes a library of most current implants on the market, allowing to place the right implant in the right angulation plus abutments and crowns in order to maximise the predictability of positioning the implants, thus improving its success.

For clinicians who use more than one implant system, to change the implant model that was inserted from the library, we simply click in the middle of the implant and the implant library is opened again and it is possible to choose another implant model, the software will keep the same insertion point and direction of the previous one. In addition, the software will easily evaluate the bone density around the implant. The aim is to show, both through colour maps and numerically (Figs. 3 & 4) the values before commencement of surgery (green if the values are acceptable and high and red if the values are low—Fig. 5), allowing the clinician to make the right decision. This can also be a very good educational tool to show patients how their bone density potentially is around the implants.

In our experience, patients appreciate this feature once shown what they mean.
Day 2

An implant is planned to replace a missing lower molar, and the position of the mandibular canal is not clear on a 2-D image anyway, and even on the 3-D image the position is still a little confusing. Here we decided to use the AIS software’s FlyMode option, which is like a virtual endo-scanner, to see if it helps us to determine the correct position in the buccal-palatal aspect together with some guessing work.

3-D imaging can be an invaluable tool for this matter. The patient refused orthodoxodontic extrusion of the upper left canine and wanted both the deciduous and permanent canines extracted in order to be replaced by an implant support crown. In planning the case, a CBCT scan was obtained to serve many purposes as to assess the positions including any anatomy and bone surrounding these teeth. Since this image was taken, both teeth were extracted, and the socket was grafted fully to prepare the site for a later placement (Figs. 7 & 8).

Day 3

Obtaining the correct position and trajectory of a retained upper canine has been traditionally dealt with by taking different 2-D images (periapicals) at different angles and possibly an occlusal to determine the correct position in the buccal-palatal aspect together with some guessing work.

3-D imaging can be an invaluable tool for this matter. The patient refused orthodontic extrusion of the upper left canine and wanted both the deciduous and permanent canines extracted in order to be replaced by an implant support crown. In planning the case, a CBCT scan was obtained to serve many purposes as to assess the positions including any anatomy and bone surrounding these teeth. Since this image was taken, both teeth were extracted, and the socket was grafted fully to prepare the site for a later placement (Figs. 7 & 8).

Day 4

Case 1

A lower molar case was in the planning stage, and the position of the mandibular canal was located.

At this stage, different implant sizes were tested to check for best fit and maximum integration prospects in the future.

The AIS software indicated that the first implant was too long and there was a risk of nerve damage (Fig. 9). Thus another implant size was chosen to allow sufficient clearance above the nerve and the density of the bone was chosen at the same time, indicating good “green” values that the patient also could understand (Fig. 10).

These tools as mentioned above can be quite an eye opener for patients and their engagement can affect the outcome positively.

Case 2

A broken and lose bridge was planned to be removed. The lower left second molar which served as the most posterior bridge abutment tooth was beyond saving (visual inspection and probing).

3-D imaging helped when planning the case. It helped tracking the position of the mandibular canal in relation to the proposed implants (Figs. 11 & 12).

In addition, the density of the bone was also checked (Fig. 10), indicating that a wider implant is possibly a better choice to improve integration rather than the current one used from the implant library. This will also allow us for deciding to perhaps perform an under preparation of the osteotomy site in order for the implant to engage in the bone better, this obviously depends on the type of implant used and other factors that the expert clinician will be familiar with.

Day 5

This case was performed by another clinician who was hoping for the best. The patient refused orthodontic extrusion of the upper left canine and wanted both the deciduous and permanent canines extracted in order to be replaced by an implant support crown. In planning the case, a CBCT scan was obtained to serve many purposes as to assess the positions including any anatomy and bone surrounding these teeth. Since this image was taken, both teeth were extracted, and the socket was grafted fully to prepare the site for a later placement (Figs. 7 & 8).

A CBCT scan was obtained (Fig. 14) as part of case planning, and clearly the scan shows that, this may prove difficult or at least very challenging. In addition, on the 3-D image we noted that the tip of the implant on the left side might be colliding with the root of the adjacent tooth, with long-term uncertainty as a result (Fig. 15). In this scanning slice (Fig. 16) we also noted the challenge ahead for grafting this implant successfully, which indicated that a lot of consideration has to be given and careful planning has to be employed in order to make the case successful.

However and despite the outcome so far with these two implants, the patient appreciated the high value of the 3-D technology and being able to see the problem clearly and from different perspectives, eliminating any guess-work that might affect the final outcome, and guiding the treatment in the right direction.

Conclusion

These cases and many more every week pass through any dental clinic, with patients hoping for best available treatment under best circumstances (clinical, timescale, financial etc).

We know that 3-D imaging is here to stay and in order to make treatments safer and more predictable for our patients, we have to engage in these technologies and involve the patients more in showing them their clinical conditions and perhaps the limitations (anatomical, structural etc) together with other factors that may affect treatment planning and outcome, hopefully for the better. We hope to be able to use our CBCT scan for more indications, especially in endodontics as few times we have seen amazingly positive results in using a CBCT scan in some difficult endodontic cases since we acquired this 3-D technology. It is the way forward and we wish we had the X-Frame Trium 3D Scanner earlier.

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