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 anti-allergenic 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 (IAOCI), an association entirely dedicated to ceramic alternatives of metal-based...
implants. "Various treatment modalities are applicable with ceramic implants: immediate placement, immediate temporization, full arch and full mouth rehabilitation can be performed with excellent and predictable outcomes. I, 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 comparatively 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 benefitting patients.

Another company manufacturing ceramic implants, Ceradent, 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—Ceradent’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 Dentalpoint with their metal-free Zeramex system. Established in 2005, the company spent four years researching and developing our 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.

Zystroms 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 Zahnbahenk, has entered the ceramic implant market with its own one-piece cylindro-conical ceramic implant in operation since 1994, and with a focus on innovation, VITA claims their ceramic implant offers faster, safer healing than titanium-based implants. With a compatibility rate of 97 per cent for more recent models, zirconia-based ceramic implants are increasingly matching the standards set by titanium implants and may one day become a more viable option.

As Nourmabii 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 understandings of zirconia and bioceramics are slowly but steadily evolving, with a definite shift toward biological and inert materials. There has 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.

**Treatment plan should be adapted for smokers**

By DTI

**XJIAN, China:** A Chinese study comparing implant stability and peri-implant tissue response in heavy smokers and non-smokers has found that smoking did not affect the overall success of implant surgery, as all implants achieved osseointegration without complications at least by the end of the 12th week after placement. However, smoking did cause the bone around the implants to heal more slowly; thus, implants began to osseointegrate considerably later than in the non-smoking group.

Research has demonstrated that smoking can negatively affect implant and bone integration. In order to improve treatment outcomes and avoid implant failure, surgeons need to have a precise understanding of how the habit will affect the healing process.

In the current study, 45 ITI (Straumann) implants were placed in the partially edentulous posterior mandibles of 32 male patients, of whom 16 were heavy smokers and 16 did not smoke at all. Implant stability and peri-implant tissue response were assessed at three, four, six, eight and 12 weeks post-surgery.

Although implants in both groups achieved osseointegration by the end of the 12th week, the healing process differed significantly between non-smokers and heavy smokers. In non-smokers, stability improved and implants began to better integrate into the bone after the second week. In the smoking group, however, implants only began to osseointegrate and become more stable after the third week.

Despite successful short-term outcomes in both groups, smokers experienced more problems, including greater bone loss around the implants and deeper soft-tissue pockets. However, smoking had no significant effect on plaque build-up or subcritical bleeding in the study group.

In light of the findings, the researchers suggested that surgeons might need to change their standard implant loading schedule for patients who smoke heavily. In addition, smokers should be aware that their habitual smoking promotes the loss of marginal bone and the further development of dental pockets and could thereby lead to complications even after osseointegration, they concluded.
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is a research an-
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Dr Kamran
2017 Europe Dental Implant
Report Suite. Her current work includes
the 2017 Europe Dental Bone Graft Sub-
stitute Suite and the 2017 Europe Ortho-
pods Soft Tissue Repair Suite.

Shifting consumer preferences and positive uptake of CAD/CAM technology

By Artur Kim & Dr Kamran Zamanian, Canada

Europe has some of the most
highly penetrated markets for
dental implants in the world, in-
cluding Italy, Germany and Spain,
but it also contains regions with
considerably under-developed
markets, such as France and the
UK. 5 A shift in consumer prefer-
ences will be a key characteristic of
the European market in the fu-
ture, 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 domi-
nated in Europe, but have recently
faced increased competition from
the value and discount brands. A
growing prevalence of local man-
ufacturers and an increasingly
cost-sensitive consumer demo-
graphic will contribute to overall
price depreciation and the declin-
ing presence of premium implants
in the future. 1

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
demanded early to the growing
cost sensitivity expressed by den-
tsists. Within these regions, the
premium segment of the market
has lost significant market share and is
exhibiting far lower growth rela-
tive to the past. It is expected that
this trend will continue to spread
throughout Europe, as consumer
preferences shift towards lower
cost products. Several competitors
in the German and Italian implant
markets have been particularly
successful at capitalising on the
shift in consumer preferences and
now represent the top leading im-
plant brands in those regions, both
in terms of volume and revenue. 1

Premium implant companies have
acknowledged the impact of
value and discount brands on the
market, not only through discount
pricing, but also through acquisi-
tions 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 competi-
tive position in both the premium
and value segments. 2 Straumann
has also invested in a number of
value and discount brands that
cater to the European market, in-
cluding Biomet, Medentika, MegaGen and Anthogyr. These in-
vestments are supplemented by
Instradent, Straumann’s busi-
ness platform established in
2014, which currently provides
distribution for Neodent and Me-
dentika through an online store
and worldwide network. 3 In June
2016, Dentsply Sirona continued
its expansion by announcing a de-
finitive agreement to acquire MIS
Implants Technologies, an Israeli-
based company that has a leading
position in the premium implant
segment. 3 Large conglomerates
have also taken note of the changing
structure of the market, with
Henry Schein making strategic
investments in BioHorizons and
CAMLOG, while Danaher Corpora-
tion has invested in Nobel Biocare
and Implant Direct.

Rapidly growing CAD/
CAM segment in the
final abutment market

Similar to the historical domi-
nance of the premium segment in
the implant market, the market
for final abutments has traditionally
been controlled by the stock abut-
ment or pre-fabricated abutment
segment. Although the majority of
stock abutments lack many bene-
fits associated with patient-indi-
vidualised solutions found within
the custom-cast abutment and
CAD/CAM abutment segments, they
still provide a relatively sim-
ple and cost-effective solution
in most implant procedures. The
segment is expected to continue ex-
periencing price erosion owing to
increasing pricing pressure from
local, low-cost and generic manu-
facturers. 5 Another recent develop-
ment within the stock abutment
segment also contributing to price
depreciation is the introduction of
Ti-base abutments.

Ti-base abutments, also known
as titanium bases or titanium
interfaces, are a recent innovation
within the stock abutment market
that are a cost-effective alterna-
tive to traditional CAD/CAM abut-
ments, 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-re-
tained 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
it is expected that the pre-
dominant stock abutment type in
the near future. The cost-effective
nature and flexibility of options of-
fered with Ti-base abutments will
help maintain the position of the
stock abutment segment in the
overall market. Stock abut-
ments currently represent over 50
per cent of the total final abutment
volume in the majority of markets
across Europe, but this share is ex-
pected to steadily decrease. 1

Recent improvements in pro-
duction capability and technologi-
cal innovation have made CAD/CAM
abutments significantly more af-
fordable than in the past. CAD/CAM
abutments are now relatively com-
parable in price to custom cast abut-
ments and are more easily accessi-
ble, especially in regions where mul-
iling laboratories with CAD/CAM pro-
duction are in greater abundance.
Furthermore, CAD/CAM zirconia
abutments are primarily required in
cases in which aesthetic outcomes
are of higher priority, such as in the
anterior region of the mouth’s 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 cost premium relative to stock abutments and custom-cast abutments. 1

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 consolida-
tion 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 consuma-
tibles and innovative technology,
respectively. 6 The premium implant
company acquired ASTRA TECH in
2011 and announced the acquisi-
tion of MIS in June 2016. 6 In June
2015, Zimmer Biomet was formed
through the merger of Zimmer
and Biomet, combining the dental
divisions of each company. Zimmer
Dental and BIOMET is:

Although the premium im-
plant companies still collectively
maintain over 60 per cent of the
European market, they are ex-
pected to face competition 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 & Mar-
tena and regional manufacturers. 1

Other notable developments in
the European market for dental
implants include the increased up-
take of ceramic materials, growing
presence of implant companies in
the biomaterials space and rising
demand for modern surgical pro-
tocols, such as immediate loading
and full arch restorations. Overall,
growth within each segment will
be highly dependent on the
afore-mentioned factors and re-
gion-specific characteristics. 1
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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 full 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 ACTION 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 3D 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 fields of view (FoV) 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 scan 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 lower denture. Initially the idea was to take a scan of the existing denture with radiopaque markers (gutta-percha in 6-8 holes made in the denture) to plan for the placement stage. However, a decision was made to duplicate the existing denture using a Lang duplication flask in order to fabricate a clear acrylic radiographic guide (Figs. 1 & 2).

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.

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 commencing 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 like this feature once shown what they mean.

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**By Dr Diyari Abdah, UK**

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Day 2

An implant is planned to replace a missing lower molar, and the position of the mandibular canal is not very 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 a virtual endoscope that follows the mandibular canal trajectory from within, and aids to clarify the path and double check if our nerve tracking was correct (Fig. 6).

This is one of the unique features of the software that can help clarify and controlling nerve-tracking.

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 view to determine the correct position in the buccopalatal 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 assessing 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 possible 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 with planning the case. It helps 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. 13), indicating that a wider implant possibly is 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 a later placement (Figs. 7 & 8).

According to the colleague, primary stability was good at the time of placement and the implants were “buried” in the bone with some bucal fenestrations, hence the grafting so everything indicated success.

After the patient complaining about some threads showing through the soft tissue, the colleague suggested further grafting to secure the implants.

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 guesswork that might affect the final outcome, and guiding the treatment in the right direction.

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-Mind Trium 3D Scanner earlier.

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