The ZiReal Post: A New Ceramic Implant Abutment

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ABSTRACT

Restorations in the anterior esthetic zone present significant challenges in both the surgical and prosthetic phases of implant dentistry. Titanium has been established as the material of choice for endosseous implants, resulting in a high degree of predictability. Many types of implants require transmucosal abutments to retain implant restorations. Ceramics may be the ideal material to replace natural teeth, but most transmucosal abutments are made of titanium. However, ceramics may also be used as abutments in implant restorations. This combination of ceramics for abutment and crown provides better translucency for the implant restoration than is available with metal abutments and porcelain-fused-to-metal crowns. Ceramic abutments and implant restorations also minimize the gray color associated with metal components that is transmitted through the peri-implant tissues. Customized emergence profiles also may be obtained with ceramic abutments; this generally improves the predictability and consistency of the esthetics obtainable in implant restorations. Zirconia as a ceramic material offers not only outstanding material properties but also a well-documented biocompatibility.

CLINICAL SIGNIFICANCE

This article discusses the clinical and laboratory features of a new ceramic abutment, ZiReal™ Post (Implant Innovations, Inc., Palm Beach Gardens, Florida).

(*J Esthet Restor Dent* 15:10–24, 2003)

Two goals of modern dentistry are restoration of optimal function and esthetics.[1,2] Commercially pure titanium has proven to be the material of choice for long-term osseointegration of dental implants.[3,4] Ceramic materials are ideal for replacing tooth structure when both esthetics and function are paramount because of its optical qualities and long-term intraoral stability.

Ceramic restorations were introduced in 1886 by Charles Land. They became more widely used in dentistry in the 1960s when they were first bonded to metals,[5] increasing the longevity associated with dental ceramics, but it was not until the addition of aluminum oxide to reinforce dental porcelain that interest in all-ceramic restorations increased.[6] Today there are numerous all-ceramic restorative systems available that have proven their reliability in clinical studies around the world.[5–11] A milestone in esthetic implantology was the first all-ceramic implant abutment called CerAdapt® (Nobel Biocare, Gothenburg, Sweden), which was introduced in 1991.[12,13] This alumina abutment consisted of a densely sintered, highly purified 99.5% aluminum oxide (Al_2O_3) ceramic core. It was designed to fit directly onto the

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restorative platform of an externally hexed implant. Wohlwend and colleagues introduced the first zirconia abutment (Zirabut®, Wohlwena Innovative, Zurich, Switzerland) in 1997.[14] Sadoun and Perelmuter have described a glass-infiltrated alumina-zirconia abutment that is custom made in the dental laboratory.[15] Implant Innovations, Inc. (Palm Beach Gardens, Florida) has designed and introduced a new zirconia abutment (ZiReal™ Post). The abutment itself is made from a high-quality zirconia ceramic. However, a unique feature of this abutment is that it consists of a titanium component that has been fused to the zirconia abutment at the apical end. This design permits metal-to-metal contact at the abutment-implant interface and should result in the same high predictability associated with metal abutment–implant connections.

Ceramic abutments can also be produced by computer-aided design/computer-aided manufacturing (CAD/CAM) systems. The Procera® system (Nobel Biocare) mechanically scans the shape of the custom-made resin abutment. This information is delivered via modem to a Procera work station. The shape of the abutment is reproduced in ceramic or metal. The Procera abutment is returned to the technician for completion of the restoration.[16] The DCS System® (DCS Dental AG, Allschmil, Switzerland) mechanically scans the abutment shape and then mills the abutments from a prefabricated material block.[17]

Nonexternally hexed implant systems also offer all-ceramic abutments. Straumann (Waldenburg, Switzerland) recently presented an In-Ceram™ zirconia abutment made in cooperation with Vita Zahnfabrik (Bad Sackingen, Germany). This aluminum oxide abutment is partially preinfiltrated at the implant-abutment interface. The abutment is customized and finished in the laboratory and can be screwed onto the implant to support a crown. Friadent (Mannheim, Germany) has designed the Cera Base® abutment for the Frialit® 2 system. The prefabricated alumina portion can be bonded with composite resin on a titanium sleeve in the laboratory. The abutment can then be fastened to the implant with an abutment screw. Degussa Dental (Hanau, Germany) has designed the Cercon-Balance-Post™ for its Ankylos Implant System®. This system is unique in that it provides for a conical connection between the zirconia abutment and the implant with an abutment screw.

THE ZIREAL POST

The zirconia used in the ZiReal Post is zirconium oxide (ZrO_2) that is partially stabilized with 3% yttrium oxide (Yt_2O_3). This particular zirconia ceramic is characterized by fine-grained microstructures known as tetragonal zirconia polycrystals (TZPs). The minimal requirements for TZP ceramics as implants for medical applications are described by the standard ISO 13356.[18] Zirconia has a transformation toughening mechanism in its microstructure that is not found in other ceramics. These exclusive characteristics provide numerous advantages for this material in many applications.[19] Zirconia is significantly stronger than other ceramics (Table 1), which should result in fewer post-treatment complications. Zirconia has already been proven clinically as an abutment material in the Zirabut; a 4-year clinical study at the University of Zurich reported no fractures.[20,21]

All-ceramic abutments cannot be machined to the same degree of precision as can metal abutments or inserts. An imprecise fit between abutments and implants generally leads to abutment screw loosening and/or other clinical problems. The ZiReal Post is made from zirconia; however, the apical portion of the ZiReal Post that seats onto the restorative platform of the implant is made of titanium (Figure 1). The titanium insert minimizes the shortcomings of full-ceramic abutments relative to the implant–ceramic abutment connection. The titanium insert is connected to the zirconia by a newly developed sintering process. The two parts are firmly combined by a sealing glass. The abutment screw seat is on the zirconia part, compressing the ceramic-metal interface (Figure 2). Once the ZiReal Post has been inserted onto the hex of the implant, the abutment screw can be tightened to 35 Ncm. The metal-to-metal connection between abutments and implants

TABLE 1. MATERIAL PROPERTIES OF VARIOUS DENTAL CERAMICS

Material	Flexural Strength (MPa)	Fracture Toughness (MPa m)
Zirconia	900*	9.00*
Alumina industrial	547	3.55
Alumina slip cast	419	2.48†
Dicor MGC§‡	220	2.02
IPS Empress¶‡	182	1.77
Sintered ceramic (Omega#‡)	85	0.99

*Adapted from Rieger.[53]
†Adapted from Luthy.[54]
‡Adapted from Geis-Gersdorfer.[55]
§Dentsply International, York, PA.
¶Ivoclar, Schaan, Liechtenstein.
#Vita, Bad Säckingen, Germany.

with a defined torque have been well documented[22]; wear and corrosion have not proven problematic for clinicians.[23,24] If the ceramic is directly involved with the implant–abutment connection, as in all-ceramic abutments, the metal of the implant often abrades and wears.[25] This metal-ceramic connection decreases the accuracy of the implant-abutment connection and increases the potential for post-insertion complications. Use of the all-ceramic abutment–metal implant restorative platform should be avoided because there is a high risk of metal wear of the implant hex by the much harder all-ceramic abutment. In this instance, abrasion of the metal implant restorative platform and hex may occur, even with an appropriately tightened abutment screw. This phenomenon is called *fretting wear*. This condition generally gets worse when the abutment screw becomes loose.

The ZiReal Post has been fabricated for use in both direct intraoral and indirect laboratory procedures. In either case, the restorative abutment margins can be prepared with coarse diamond burs to follow scalloped gingival contours. The shape and angulation of the ZiReal Post can also be altered with diamonds. Fischer and colleagues studied the effect of grinding on zirconia abutments with and without water coolant.[26] X-ray-diffraction analysis demonstrated that the polymorphism of the material was only minimally influenced by the laboratory preparation of the abutments. Abutment preparation with or without water coolant had no influence on the strength of the material. The heat and the mechanical influences generated during this procedure are not thought to have any consequences for the zirconia. If the ZiReal Post is prepared in the laboratory by the dental laboratory technician, the restorative dentist makes an impression direct to the restorative platform of the implant.

Figure 1. ZiReal Posts for the 4.1-mm implant restorative platforms with two different diameters (5 mm and 6 mm). Zirconia is fused to titanium inserts at the apical end of the abutments providing for a metal-to-metal interface between the zirconia abutments and the titanium implants.

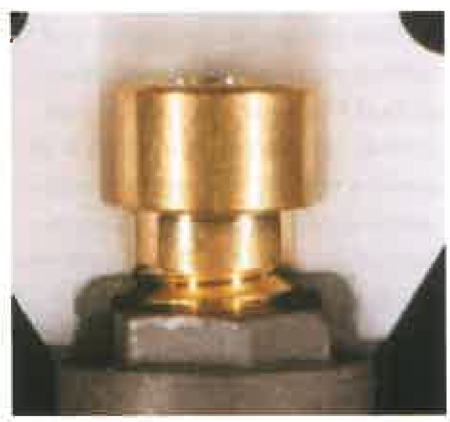

Figure 2. The ZiReal Post does not show any ceramometal contacts at the implant-abutment interface. The zirconia and the titanium insert are firmly combined by the sealing glass.

A master cast is poured with an implant laboratory analog in place. The ZiReal Post is selected based on the emergence profile of the tooth being replaced.

The ZiReal Post has been designed for use as an abutment that is screwed directly onto an externally hexed implant. The final restoration must be a cement-retained crown.

The ZiReal Post is available for two implant restorative platforms, 4.1 mm and 5 mm. There are two different emergence profiles available for each platform. The diameters are 5 mm and 6 mm for the 4.1-mm platform and 6 mm and 7.5 mm for the 5-mm platform. All collar heights are 4 mm, and the extended height above the collar is 7 mm. Additional sizes will be available in the future. They probably will include preangled abutments and milling posts for laboratory use. ZiReal Posts are available in one ceramic shade; present research in ceramic science may provide additional shades. The light transmission of the ZiReal Post is comparable to that of a natural tooth (Figure 3). Therefore, it is helpful in clinical situations where high esthetic demands are present.

CASE REPORTS

The following clinical examples represent treatments in which teeth were extracted and immediately replaced with implants. The implants were restored with provisional restorations immediately after the implants were placed. However, the implants were not immediately loaded with occlusal function.

Case 1

In case 1 the left lateral maxillary incisor was extracted secondary to continued problems after endodontic therapy. The tooth was atraumatically extracted with the alveolus left intact. An osteotomy for the implant was prepared within the confines of the socket, and a 5 mm–diameter implant was placed (Figure 4). A ZiReal Post was positioned on the implant. The ZiReal Post was prepared intraorally with coarse diamond burs and water coolant (Figure 5). The facial margins of the abutment were prepared so they ended just inside the periimplant sulcus. A suitable provisional crown (Ion®, 3M Dental Products Division, St. Paul, Minnesota, USA) was chosen and directly relined on the ZiReal Post; the margins were able to be optimized extraorally after abutment removal (Figure 6). The abutment screw was tightened to 35 Ncm with a torque driver and the provisional restoration cemented to the ZiReal Post with temporary cement (Temp Bond®, Kerr Sybron Dental Specialties, Orange, CA). There were no centric or eccentric contacts on the provisional restoration. The patient was told not to chew with the provisional restoration. This procedure represents a significant improvement over past treatment protocols in which patients had to wear removable partial dentures or interim adhesive fixed partial dentures during the period of osseointegration. Healing occurred over the following 6 months and the peri-implant tissues stabilized (Figure 7). The provisional crown was then removed, and the ZiReal Post was reprepared intraorally. The contours of the peri-implant tissues were significantly different from the contours that existed at the time of the tooth extraction and implant placement. The preparation's margins were reprepared and again placed slightly submucosally to hide the facial margin of the

Figure 3. The amount of light transmitted through a ZiReal Post is comparable to the amount of light that is transmitted through a natural tooth.

Figure 4. Case 1. The maxillary left lateral incisor was extracted and an OSSEOTITE™ (3i Implant Innovations Inc, West Palm Beach, FL) implant was immediately placed into the extraction site.

Figure 5. Case 1. The appropriate ZiReal Post was selected and placed onto the external hex of the implant. The ZiReal Post was prepared intraorally with coarse diamond burs and water coolant.

Figure 6. Case 1. A suitable provisional crown (3M ESPE) was selected and directly relined on the ZiReal Post as in conventional crown-and-bridge procedures. The ZiReal Post can be removed to optimize the margins extraorally.

definitive restoration (Figure 8). The abutment screw was retorqued to 35 Ncm with a torque driver. The screw access opening was restored with gutta-percha and a light-cured composite resin. Retraction cords were placed into the peri-implant sulcus (Figure 9), and an impression was made following conventional crown-and-bridge procedures (Figure 10). At the time of final cementation, the ZiReal Post was care-

Figure 7. Case 1. The provisional crown in place on the ZiReal Post 6 months after the implant was placed into the extraction site of the maxillary left lateral incisor. The peri-implant tissues have stabilized and healed consistent with the emergence profile of the provisional crown.

Figure 8. Case 1. The ZiReal Post is reprepared with a diamond bur in keeping with the contours of the peri-implant soft tissues.

Figure 9. Case 1. A retraction cord placed in the peri-implant sulcus prior to taking a conventional impression.

Figure 10. Case 1. The conventional impression was sent into the laboratory. The master cast was fabricated in conventional fashion.

fully cleaned with a rubber cup and pumice (Figure 11). An all-ceramic crown (IPS Empress®, Ivoclar, Schaan, Principality of Lichtenstein) was cemented to the ZiReal Post with composite cement (Panavia F®, J. Morita, Tustin, California, USA). The peri-implant mucosal tissues–tooth complex of the lateral incisor blends nicely with the adjacent natural teeth (Figure 12). Owing to the high density of zirconia, more than 6 g/cm^3, it has a much better radiopacity than does alumina. Figure 13 shows a radiograph of the implant and the ZiReal Post 7 months after insertion. The perfect seating of the ZiReal Post onto the implant platform can be controlled and verified visually.

Case 2

In case 2 the patient fractured the maxillary right first premolar. The tooth was extracted without fracturing the alveolar housing. The osteotomy was prepared, and an implant was placed (Figure 14). The appropriate ZiReal Post was selected and placed onto the external hex of the implant and the abutment screw was torqued to 35 Ncm with a torque driver (Figure 15). The ZiReal Post was prepared intraorally with coarse diamond burs and water coolant. A provisional restoration was fabricated from a silicone matrix that was made prior to the tooth's extraction. Occlusal contacts were not present on the provisional restoration in centric or eccentric mandibular movements. The patient was instructed not to use this restoration for chewing. Healing of both the soft and hard tissues occurred over the next 6 months. The gingival tissues healed consis-

Figure 13. Case 1. Radiograph demonstrates the precise fit between the titanium insert of the ZiReal Post and the implant restorative platform with the external hex.

Figure 11. Case 1. The ZiReal Post and the healed soft tissues at time of the final cementation. The screw access opening was restored with gutta-percha and a light-cured composite resin.

Figure 12. Case 1. The all-ceramic crown (IPS Empress) was cemented to the ZiReal Post with composite resin cement. Note the similar optical properties between the ceramic crown–ZiReal Post combination and the natural teeth.

Figure 14. Case 2. The maxillary right first premolar was extracted secondary to a nonrestorable vertical fracture. A 5-mm OSSEOTITE implant was immediately placed into the extraction site.

tent with the emergence profiles of the provisional restoration (Figure 16). The gingival tissues demonstrated minimal inflammation with contours similar to those of the gingival tissues of the adjacent natural teeth. Precision fit of the provisional restoration is important to achieve this type of tissue response. The ZiReal Post was reprepared consistent with the gingival margins, and the abutment screw was retorqued to 35 Ncm with a torque driver (Figure 17). A retraction cord was placed into the peri-implant sulcus, and a final impression was made using conventional crown-and-bridge techniques and materials. The master cast was developed in conventional fashion, and an all-ceramic crown was made on the master die (IPS Empress 2). The ZiReal Post was cleaned properly prior to final cementation. To optimize the adhesive cementation technique, a retraction cord was placed in the peri-implant sulcus (Figure 18). The all-ceramic crown was cemented to the ZiReal Post with composite cement (Figure 19). Figure 20 shows the restored implant 2 months after final cementation. Note the healthy and natural-looking peri-implant tissues, a key element of the natural appearance of this restoration. The crown

Figure 15. Case 2. A ZiReal Post was placed and the abutment screw tightened to 35 Ncm with a restorative torque indicator (3i Implant Innovations, Inc).

Figure 16. Case 2. The provisional crown has been in place on the ZiReal Post for 6 months. The peri-implant soft tissues have healed consistent with the emergence profile of the provisional crown.

Figure 17. Case 2. The margins of the ZiReal Post were reprepared in keeping with the margins of the peri-implant tissues.

Figure 18. Case 2. The ZiReal Post was cleaned properly prior to final cementation. To optimize the adhesive cementation technique, a retraction cord was placed in the peri-implant sulcus.

Figure 19. Case 2. An all-ceramic crown (IPS Empress 2) was cemented to the ZiReal Post with composite cement. This image was made prior to cement cleanup.

Figure 20. Case 2. The restored implant 2 months after final cementation. Note the healthy and natural-looking peri-implant tissues.

is cement retained; no occlusal opening disturbs the esthetic result (Figure 21).

DISCUSSION

Zirconia has been used in Europe since the 1980s as bearings in total hip replacements. One review article states that more than 300,000 TZP ball heads had been implanted with only two failures.[19] Use of zirconia may surpass that of alumina in the future because it has demonstrated less of a tendency to mechanical failure in clinical practice.[27–29] Dentistry may follow medicine's lead and increase its use of zirconia, which has been reported in dental areas besides implant prosthodontics. Endodontically treated teeth have been restored with intraradicular posts made from zirconia.[30] The first clinical results have shown considerable promise.[31] Zirconia has also been studied in conventional fixed prosthodontics. The fracture resistance of ziconia three-unit fixed partial dentures has been studied in a laboratory setting. Fracture resistance of zirconia was significantly greater than the fracture resistance of other ceramic materials tested.[32] Full-ceramic fixed partial dentures made of veneered zirconia showed no fractures in a clinical study in which posterior teeth were being replaced.[33]

The CerAdapt alumina abutment was introduced in 1991.[12,13] Although this product has been commercially available for more

Figure 21. Case 2. The crown is cement retained. In the occlusal view, screw access does not disturb the esthetic outcome of this replaced first premolar.

than a decade, there are still no published clinical data for single-tooth implant restorations. Some authors have reported minor problems in both clinical and laboratory situations.[2] It has been this author's experience that alumina abutments have demonstrated a high tendency for fracture during preparation in the laboratory.

In both clinical cases outlined in this article, full-ceramic crowns have been bonded onto the ZiReal Posts. Resin bonding to zirconia ceramic cannot be established by the standard methods that are used for conventional silica-based dental ceramics. In the literature there is a controversy about the procedures and products to achieve the optimal bond strength to zirconia; however, the combination of sandblasting with Al_2O_3 and the use of composite resin leads to a clinically acceptable bond strength.[34–36]

At the present time ceramic abutments and all-ceramic crowns are the ideal combination to obtain optimal esthetics. Natural teeth are generally translucent. Incident light is reflected off them, absorbed into them, and sometimes transmitted through them. All light entering a tooth is scattered or refracted. Opaque materials such as metals are impenetrable to light and make transmission impossible.[37] A metal-free crown can use all of the light-conducting potential of the ZiReal Post and is therefore the restoration of first choice for optimum esthetics. A porcelain-fused-to-metal crown also can be used in combination with the ZiReal Post. This provides better esthetics than does a porcelain-fused-to-metal crown in combination with a metal abutment that will shine through the periimplant tissue.

Scherrer and de Rijk, in a laboratory study, studied the fracture resistance of all-ceramic crowns as a function of the elastic modulus of the supporting dies.[38] The fracture load increased markedly with the increase in elastic modulus. An in vivo study by Lee and Wilson suggested that the elastic modulus of the core material may have an influence on the fracture resistance of aluminous porcelain jacket crowns. It may be appropriate to recommend the use of materials of high elastic modulus for core placement on teeth to be restored with all-ceramic crowns.[39] Malament and Socransky reconfirmed these data clinically. They analyzed the failure rate of 1485 Dicor®, (Dentsply International, York, PA) crowns in a 16-year study and reported that the risk of failure was three times higher when the Dicor crowns were cemented onto dentin rather than onto a gold buildup.[40] See Table 2 for elastic moduli of several common dental materials.

When CerAdapt was introduced in 1991, implantology was confronted for the first time with a ceramo-metal contact at the implant-abutment interface. The alumina ceramic was to be in direct contact with the titanium implant restorative platform. When metal and ceramic are contact, the metal usually abrades.[24] *Tribology* is the science and technology of interacting surfaces in relative motion; it defines *wear* as the loss of material from a surface by means of some mechanical action and *fretting* as a small oscillatory motion between two solid surfaces in contact. *Fretting wear* is defined as the wear arising as a result of fretting. Fretting wear

TABLE 2. YOUNG'S MODULUS (STIFFNESS) OF VARIOUS DENTAL MATERIALS.

Material	Young Modulus (GPa)
Glass ionomer	4–8
Hybrid composite	10–25
Human dentin	13–25
Human enamel	70–120
Gold alloy	94–140
Zirconia	210
Alumina	380

occurs when repeated loading and unloading causes cyclic stresses that induce surface or subsurface breakup, resulting in the loss of material. Vibration and micromovements are a common cause of fretting wear. The hardness of a material is strongly correlated with its wear behavior. Table 3 details typical hardness values (Knoop) for some dental materials. Diamond is the hardest material; therefore, it is the favorite material to use as an abrasive for grinding instruments.

Screw-retained abutments have some rotational movements that are measurable at the implant-abutment interface. Laboratory tests have demonstrated that abutments move about the external hex of implants. This movement may be measured in terms of degrees of rotation.[22] Even with high clamping forces at the abutment-implant junction, micromovements may occur between the implant and the abutment. These micromovements can alter the ceramic and the titanium surfaces. The torque used to tighten the abutment retaining screw controls this force. The clamping force initially helps to prevent rotation between the abutment and the implant. The elastic strain in the abutment-implant screw system and regional plastic deformation of the screw threads gradually reduce the preload clamping force.[41–43] The clamping force between the abutment and implant restorative platform is also involved in minimizing rotation of the abutment. When the preload force is diminished and micromovements exist between the implant and the abutment, component wear and screw loosening lead to postinsertion clinical problems. Abutment screw loosening has been reported to be the most frequent complication of single-tooth restorations.[44]

Clinically, if an abutment screw loosens between an all-ceramic abutment and a titanium implant restorative platform, significant damage may occur to the external hex of the implant. Figures 22 to 24 are a series of three scanning electron micrographs from a pilot study evaluating the effects of a mobile abutment on an external hexed implant owing to abutment screw loosening. A simulation of 500 chewing cycles was performed on an implant-supported restoration, on which the abutment screw was minimally loosened. This represents clinical reality when a patient is not aware of micromovement between the abutment and the implant restorative platform. Two different abutment designs were studied. Figure 22 demonstrates the implant restorative platform of a new implant that has never been attached to an abutment. The implant in Figure 23 was loaded with a ceramic abutment (CerAdapt). The implant in Figure 24 was loaded with a ZiReal Post; also demonstrated is the effect of loading an externally hexed implant with a full-titanium abutment. The damage to the external hex is most significant on the implant that was loaded with the all-ceramic abutment (see Figure 23). The corners of the hex have been rounded and the top of the hex has been changed to a ring shape. Titanium debris that was abraded from the external hex by the all-ceramic abutment is visible. Metal abrasion also can be seen on the apical surface of the ceramic abutment; the black materials are titanium filings from the implant head (Figure 25). The antirotational property associated with the use of

TABLE 3. HARDNESS VALUES OF VARIOUS DENTAL MATERIALS.

Material	Knoop Hardness (kg/mm^2)
Gold-palladium alloy	200
Titanium	250
Human enamel	340
Quartz	820
Zirconia	1,200
Alumina	2,100
Diamond	8,000

this implant is significantly compromised. This type of restoration would most likely have long-term postinsertion complications. ZiReal Posts do not have a tendency to undergo this type of deformation because the zirconia of the abutment is not in contact with the titanium of the implant restorative platform. The minimal damage identified in Figure 24 reveals merely slightly rounded edges of the outermost portion of the external hex.

As many studies indicate, osseointegrated implants have an excellent long-term performance that spans several decades[3,4]; the mechanical perfection of the implant head should also have high priority. Only if the hex is in impeccable condition can the absolutely mandatory antirotational effect for single-tooth implant restorations be guaranteed. The ZiReal Post offers the well-documented titanium-titanium junction at the implant-abutment connection.

In Willmann's review fretting in modular dental implant systems is not reported.[24] However, this study was published before the introduction of the first ceramic-metal junction in implant dentistry. There are no reports of fretting between conventional titanium-titanium junctions. In orthodontics a clinical study compared the effect of ceramic and stainless steel brackets on the notching of archwires during clinical treatment. Ceramic brackets showed significantly more destruction in the wire than did stainless steel brackets. It has been stated that the micromovements of the wire or the tooth during mastication caused fretting wear.[45] In orthopedic hip surgery, an evolution from fixed-head femoral prostheses to modular designs has allowed a combination of the wear resistance of a cobalt alloy femoral

Figure 22. Scanning electron micrograph of the external hex of an unused new implant (×35 original magnification).

Figure 23. Scanning electron micrograph of the external hex of an implant that was loaded with an all-ceramic abutment (CerAdapt). Note that the corners of the hex have been rounded and the top of the hex has also been altered to a ring shape. Titanium debris that was abraded from the external hex by the all-ceramic abutment is visible (×35 original magnification).

Figure 24. Scanning electron micrograph of the external hex of an implant that was loaded with a ZiReal Post. The slightly rounded edges of the outermost portion of the external hex should not result in post-insertion complications (×35 original magnification).

Figure 25. Photograph of the apical end of the CerAdapt abutment from the implant in Figure 23. Note the black material on the internal hex of the CerAdapt abutment. These debris are titanium filings that have been abraded from the external hex of the titanium implant.

head with the flexibility of a titanium alloy combination. The head and neck components of these modular designs are mated at a conical tapered junction with no cement between them. These two components show different wear behavior. Clinical studies show more surface destruction in these cases than when the head and neck components were made from the same alloy.[46–48]

The 4-year study of the full zirconia abutment Zirabut demonstrated encouraging clinical and technical results. In two articles Glauser and colleagues reported no zirconia-abutment fractures.[20,21] All of the zirconia abutments were prepared in the laboratory. However, these articles do detail two unexpected screw loosenings. The loose screws occurred even though all of the gold screws had been torqued with a torque controller to 32 Ncm. This may be an indication of a less-than-optimal fit between the ceramic abutment and external hex of the implant restorative platform. It is very demanding or even impossible from an engineering point of view to produce an internal hex in zirconia or any other ceramic as precise as that in titanium. Another explanation for these screw loosenings could be fretting wear, which has been described above.

In both of the clinical cases that were described above, 4.1-mm abutments were used on 5-mm implant restorative platforms. It has been the author's experience that this mismatch between the abutment and implant restorative platforms does not cause clinical problems. This combination may even have some clinical advantages. A small sample of clinical cases has shown different bone resorption patterns around the implant restorative platforms of these combinations when compared with the traditional matching of abutment and implant restorative platforms with similar-sized components. It seems that the microgap at the abutment-implant interface determines the amount of bone loss around the implant. Similar to bone loss around natural teeth, bacteria cause the bone to resorb, at least at a distance of 1.5 mm from the implant-abutment interface.[49,50] If the abutment used is smaller in diameter than the diameter of the implant restorative platform, the microgap and the bacteria are farther away from the bone. This may reduce the amount of bone resorption seen around these implants.

All-ceramic abutments in either alumina or zirconia offer the possibility to add ceramic by a sintering process in a furnace, an option desired by many dental technicians. The diverse reasons for this include being able to change the shape, color, or bonding potential of the surface. Sintering the entire crown onto a ceramic abutment cannot be recommended because sintered ceramic is not as strong as is the abutment ceramic (see Table 1). Sintered ceramic in functional contact needs to be supported; this has been established in porcelain-fused-to-metal technology. Otherwise, ceramic fracture is likely to occur.[51] Dental porcelain on the abutment surface also might have a negative influence on the epithelial attachment at the abutment level. Soft tissue recessions and bone resorption have been described in these situations.[52] At this time sintering procedures cannot be recommended for the ZiReal Post, even though heating the ZiReal Post up to 700°C should not affect the sealing glass between the titanium insert and the zirconia.

SUMMARY

The ZiReal Post is a ceramic abutment made of zirconia with a small titanium insert at the apical portion of the abutment. Zirconia ceramics have several advantages over other ceramics owing to fundamental differences in their respective microstructures and physical properties. The ZiReal Post is an abutment that can provide optimal esthetic results. The optical characteristics of zirconia permit light to be transmitted through the abutment and all-ceramic crown restoration. The peri-implant tissues also will transmit light in a way that differs from how light is transmitted through the peri-implant tissues adjacent to a metal implant abutment. Zirconia has performed well in clinical trials. It is believed that the ZiReal Post

performs better than do all-ceramic abutments, in part owing to the titanium insert at the apical end of the abutment. This insert provides for a stable metal to metal implant–abutment interface. Additionally, it is thought that all-ceramic abutments in direct contact with the implant will result in both wear and fretting wear of the implant head and hex. This wear may result in more postinsertion complications than have been reported with a metal-to-metal implant–abutment interface.

ACKNOWLEDGMENTS AND DISCLOSURE

The author would like to thank his team for their outstanding cooperation, especially Esther Grob and Mario Sisera for their excellent laboratory work.

The author has financial interest in 3i Implants.

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COMMENTARY

THE ZIREAL POST: A NEW CERAMIC IMPLANT ABUTMENT

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The present article by Dr. Brodbeck introduces the clinical use of the ZiReal Post, a zirconium implant abutment that is glass-sealed to a titanium insert. The obvious intent of this design is to provide an implant abutment that presents a metal surface at the implant abutment interface of flat top hexed implants. This implant abutment differs, therefore, from abutments made entirely of a ceramic material as exemplified by the Ceradapt abutment, the Procera ceramic abutment, the InCeram Zirconia abutment, and the Cercon Balance-Post.

This article uses two well-documented clinical cases to illustrate the use of this ceramic abutment. The author suggests that there are two major advantages to the metal-included design. First, the presence of metal-to-metal contact may reduce potential problems of fretting wear. Second, it is suggested that higher preload may be established at the metal-to-metal interface and improve the long-term performance of the restoration. The potential damage to the implant hex by fretting does indicate an important point of clinical concern. However, it is not clear from available data whether the problem of abutment screw loosening varies among titanium-to-gold, titanium-to-titanium, or titanium-to-ceramic interfaces. The degree of fretting wear damage to dental implant-abutment interfaces also is not well known.

Although the author's presentation of existing evidence offers some support for the claims, rigorous testing of these ideas embellished by this design remains to be performed. Significantly, dynamic testing of the implant-abutment interface at the various implant-ceramic abutments has not been performed in any comparative manner. As well, remarks concerning the biologic width raise additional questions about the long-term relationship of soft tissue with this or other ceramic abutments. Preclinical animal studies suggest that aluminous ceramic material is well integrated with the peri-implant mucosa. But soft tissue responses to this zirconium abutment (and others) represented as provided by the manufacturer or modified, or prepared, or clinically polished have not been well documented.

Clinical experience has indicated select situations in which the use of a ceramic abutment may benefit the esthetic quality of the definitive implant-supported restoration. This report is a valuable addition to the literature that illustrates the use of an additional ceramic abutment choice with the suggested advantage of improving the implant-abutment interfacial behavior attributable to the included metal core structure.

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