Precautions for using zirconia implant abutments

By Moustafa A. Aboushelib, DDS, MSc, PhD, and Bien van Paridon, DDS, PhD

The introduction of zirconia to the dental field opened the design and application limits of all-ceramic restorations.

Thanks to its high strength and fracture toughness, long-span posterior restorations are now possible with high accuracy and success rate. Additionally, its white color allows better reproduction of the required color especially in the anterior zone.

These properties make it an interesting material for the construction of implant abutments and superstructures. The fabrication of zirconia implant abutments utilizes state-of-the-art CAD/CAM technology, which uses patients’ models for the production of an individual customized abutment.

Moreover, the CAD phase allows accurate positioning and angulation of the zirconia abutment ensuring obtaining the best esthetics.

The fabrication of zirconia implant abutments is complicated by the problem of providing adequate fixation to the implant body. For titanium abutments, the fixation screw exerts direct pressure on the abutment, which in turn is provided with external or internal hex to provide connection with the implant body.

On the other hand, zirconia is a brittle material and friction between the fixation screw and the internal surface of the ceramic abutment could produce high internal stresses that could lead to unexpected fracture. This problem is solved by insertion of a friction fit internal metallic nut (Procera zirconia abutment for Straumann implants), which is equipped with an external hex for establishment of proper contact with the implant body (Fig. 1).

Additionally, the fixation screw interlocks with the metallic nut during tightening procedure (Fig. 2).

AAIP to host 28th annual meeting

The American Academy of Implant Prosthodontics will hold its 28th annual meeting on Nov. 6 at the Marriott at McDowell Mountains, Scottsdale, Ariz., in association with the Dental Implant Clinical Research Group and Midwestern University College of Dental Medicine.

The theme of the meeting will be “Implant Update — 2010,” and feature outstanding dental clinicians and a well-known financial analyst.

Featured speakers at the meeting are Drs. Robert J. Braun, Clement Guarlotti, Leonard I. Linkow, Harold F. Morris, Peter A. Neff and Azfar Siddiqui, and G. Kent Mangelson.

Linkow, considered by many of his colleagues as the “Father of Oral Implantology,” will speak on “Five Decades of Dental Implants.” In 1992, New York University College of Dentistry in Philadelphia, will speak on “Systemic Implications of Oral Disease and its Relation to Oral Implantology.”

Siddiqui, associate professor of dentistry at Midwestern University College of Dental Medicine, will speak on “Lateral Bone Condensing and Expansion for Dental Implant Placement.”

Guarlotti, past president of the American Academy of Implant Prosthodontics, will discuss “New Implants for Old Fixed Prostheses.”

Mangelson, CFP, an expert in the area of lawsuit protection and prevention, will speak on “Advanced Lawsuit Protection and Tax Reduction Strategies for Dentists.” Man-
the unique modulated ultrasonic vibration of Piezosurgery is micronometric (extreme precision) and selective (no trauma to soft tissues); additionally, combined with irrigation, the vibration produces a “cavitation effect” that helps to keep the surgical site sterile and bloodless.

Over the years, as the result of Mectron’s continuous technological innovation, more than 50 insert tips have been designed and engineered to provide surgeons with the best cutting tools for each anatomical situation. Indeed, Piezosurgery allows one to perform bone surgeries with high precision, greater respect for soft tissues, greater visibility and enhanced healing.

What are the advantages of Piezosurgery in implant and bone surgery? The surgical advantages of Piezosurgery are many and truly remarkable: 1) First, Piezosurgery delivers high precision. The ultrasonic wave employed by the device is a “microwibrilation,” which compared to the macrovibrations of traditional bone-cutting instruments makes this technology incredibly more precise and safe. Indeed, the cutting action is harmless to soft tissues.

Thanks to the specific resonance range, the device is extremely effective on mineralized tissues but totally harmless to soft tissue, allowing for a safety level never experienced before.

This feature is obviously of crucial importance when operating in proximity of delicate soft-tissue structures, such as blood vessels, nerves, mucosa, etc. Third, thanks to its dual-wave technology, Piezosurgery delivers maximum intraoperative visibility.

When the “hammering effect” produced by the wave modulation on the insert tip hits the irrigation solution, the latter is converted in a fine spray. The sprayed molecules of the irrigation fluid hit the cutting site, cool it down and produce a temporary hemostatic effect, allowing for maximum visibility during surgery. Once terminated, the surgery bleeding resumes, hence starting all biological processes heading to a proper healing. Lastly, one of the greatest advantages of Piezosurgery is the fact it is gentler to the tissues and, in fact, reduces healing time. Histological and biomolecular studies have shown that compared to traditional techniques, the use of Piezosurgery is not only characterized by minimal postoperative bone loss but actually promotes faster healing.

In my opinion, this incredible feature makes Piezosurgery the preferable instrumentation for most bone surgical applications.

How did your father, Dr. Tomasso Vercellotti, get involved with Piezosurgery? Prompted by the limitation in precision and safety of traditional bone-cutting instruments, my father pioneered the use of piezoelectric ultrasonic frequencies for bone surgery. Upon realizing that the effectiveness of conventional ultrasonic instruments in cutting bone was extremely limited, he set off, in conjunction with Mectron Medical Technology, to develop a new technology that would allow overcoming such limitations. Their joined efforts resulted in the creation of Piezosurgery, a technology that has truly revolutionized the way we approach bone surgery.

My father’s clinical and scientific efforts were truly indispensable to make Piezosurgery into a surgical revolution. First, he wanted to ensure that this new technology would truly benefit surgeons and patients alike, improving surgical predictability and reducing morbidity and complications.

To this goal, my father engaged in several research collaborations with clinicians and institutions around the world. In addition to studies on cutting efficacy of the technology and improved healing response in animal models, further clinical research activity has arisen immediately since the initial distribution of the Piezosurgery technology.

To date, Piezosurgery is the only piezoelectric surgical technology that has been demonstrated to be effective and successful by the clinical community through peer-reviewed publications. The number of publications on Piezosurgery increases every day, testimony of the clinicians’ understanding and adoption of the truly revolutionary nature of this technology.

The results of this research, published in more than 70 scientific articles, prove the advantages of Piezosurgery and make a compelling, evidence-based argument for its adoption in a variety of bone surgical applications. Why did he get so passionate about this procedure? My father realized immediately the technology he had developed had remarkable characteristics and understood he had an opportunity to simplify and improve a variety of surgical procedures. Along with several international colleagues, for several years he has been developing new surgical protocols and procedures. As a result, an entirely new page 1B page 1C
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design is associated with the problem of generation of internal stresses, which could lead to unexpected fracture of the zirconia implant abutment. This article will evaluate the fracture causes of several broken zirconia implant abutments. Fractographic analysis of the broken segments will allow recognition of the location and site of the critical fracture.

Case presentations: Case 1
A broken zirconia implant abutment was sent by the treating dentist for fracture analysis. Patient’s records indicated that the patient complained of loosening of the implant-supported zirconia-veneered crown (#21). The treating dentist also complained that the internal metallic nut lost friction contact with the zirconia abutment and that he had to re-assemble the components before screw fixation. The abutment was fractured after two incidents of screw loosening. The same problem led to fracture of the second abutment, after which the dentist decided to insert a titanium abutment. Scanning electron microscopic examination indicated that the abutment was fractured due to pressure from the metallic screw nut.

The solution
Once the metallic nut has lost friction contact with the zirconia abutment and that he had to re-assemble the components before screw fixation, the abutment was fractured after two incidents of screw loosening. The same problem led to fracture of the second abutment, after which the dentist decided to insert a titanium abutment. Scanning electron microscopic examination indicated that the abutment was fractured due to pressure from the metallic screw nut.

Case 2
This next case featured a broken zirconia implant abutment. SEM analysis revealed that it was an angled abutment, which corrected the tilt of an implant replacing a maxillary lateral incisor. The entire buccal wall was fractured beneath the temporarily cemented zirconia-veneered crown.

The solution
Zirconia is a brittle ceramic material that must be used in adequate thickness to gain full potential of its high strength. A minimal wall thickness (0.5-0.7 mm) is required in the entire structure of the zirconia implant abutment. This thickness must be increased in areas of high stresses to avoid unexpected fracture. Tilt correction resulted in over-reduction of the buccal wall (0.3 mm thickness), which resulted in fracture of the weakened segment.

To reduce possibility of fracture, it is recommended to use a metallic abutment for correction of angle of insertion.

Case 3
The final case featured a broken veneer porcelain from a Procera zirconia superstructure. This new design combines both the implant abutment and the framework of the restoration in one single structure, thus reducing the number of components the dentist uses during the prosthetic phase.

The solution
Using single component superstructures has several advantages as they simplify the handling procedure, do not require anti-rotation feature and reduce the number of structural interfaces of the entire restoration. On the other hand, they require careful design to provide adequate support for the veneer ceramic.
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Discussion
Analysis of the broken zirconia implant abutment gave insight about the cause of fracture.
For Procera abutments with the metallic nut, the friction fit system lost adequate retention after a short service time in the mouth leading to loosening of the inserted restorations. According to complaints of the treating dentists, it is not recommended to reassemble the metallic nut and tighten the fixation screw as this will not result in reliable retention of the restoration. In such case, it is recommended to insert a new abutment from the manufacturer using patient’s records. Moreover, over-tightening the fixation screw beyond the recommended torque could lead to generation of wedging forces inside the zirconia abutment.
The screw head could exert pressure on the metallic nut leading to spreading of its vertical walls.
Using a confirmatory X-ray before tightening the fixation screw and keeping to the recommended torque could prevent such problem. For cases with marked angle correction, it is recommended to use a metallic abutment in order to avoid over-reduction of the axial walls.
On the other hand, using single component zirconia implant superstructure, which is composed of zirconia abutment and the framework as one component, could facilitate easier handling and simplify the insertion procedure due to reduction of the components used.
Moreover, careful design consideration of the requirements of both the abutment and the zirconia framework is mandatory to ensure good function of each element. Lack of adequate support beneath the veneer ceramic or over-reduction of the axial walls of the zirconia abutment could lead to unexpected fracture.

References available upon request from s.rendon@dental-tribune.com.

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new surgical discipline based on the advantage of Piezosurgery’s unique features was developed. This new discipline, known as Piezoelectric Bone Surgery (PBS), has notably simplified a variety of clinical applications and has allowed surgeons across the world to perform procedures that would have been almost impossible with any other instruments.

Thanks to the intense clinical research, many surgical techniques have been radically simplified and predictability has increased, with dramatic reduction of patient morbidity. As an example, the use of Piezosurgery is changing evidence-based medicine in the surgical studies of the maxillary sinus, where membrane perforation rates have been decreased from 30 percent to 7 percent.

What is the best and least indicated use of the Piezosurgery?
Piezosurgery is extremely versatile and can be used in a great variety of surgical applications. Indeed, through the sapient use of osteotomy, osteoplasty and drilling techniques, the device allows one to perform bone surgery even in the most difficult anatomical situations. Examples of procedures that can be performed with Piezosurgery include extractions, sinus lifts, ridge expansion, bone block harvesting, bone chips harvesting, accelerated surgical orthodontics, nerve lateralization, retrograde endodontics, crown lengthening and implant site preparation in delicate anatomical situations. In general, Piezosurgery is ideal for all surgeries that require fast, precise and safe bone cutting. Our device is not indicated for procedures that involve cutting soft tissues, poorly mineralized bone structures and dental enamel.

Are there other units in the dental industry, and what is the difference between the technologies?
Following the invention of Piezosurgery by Tomaso Vercellotti and Mectron Medical Technology, several companies, recognizing the great potential of our technology, seized the opportunity to enter the market with imitations of our device. Despite other companies’ claim that all devices are equal, that is simply not the case. In my opinion, while this may be a commercially sound strategy, it is a true disservice to the clinical community. Unfortunately, equating all devices creates confusion and leads clinicians exposed to inferior devices to conclude that the technology per se is not valid.

However, it is important for clinicians to be aware that Piezosurgery is not a generic term and does not refer to any technology or application. Piezosurgery refers to the only patented, evidence-based piezoelectric technology for bone surgery. When clinicians try and use our technology, they realize that imitations do not compare to it at all. As a testimony to this fact, all major opinion leaders in the United States employ and endorse only the real Piezosurgery technology.

There are experiences and insights in the technology that only the original developer can have, and that cannot be simply retro-engineered. The imitation units utilize different ultrasonic frequencies, different power levels and inferior insert tip designs. In this latter regard, for instance, no other device has saws that are as thin and fast as ours. Indeed, Mectron Medical Technology developed a proprietary manufacturing process that takes months to complete, and the resulting insert tips are unrivalled in terms of precision and performance. Because no other company could replicate this process, the performance of imitation devices in cutting bone thicker than a few millimeters is unsatisfactory for most clinicians who perform heavy-duty bone surgery.

A major difference between our technology and its imitations is that only Piezosurgery is clearly and unequivocally proven and supported by scientific research. To my knowledge,
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there are only a handful of publications relative to other technologies, and none proves substantial equivalence to Piezosurgery in regard to biomechanical, histological and clinical results. In a world where medicine is constantly striving to improve, only evidence-based technology should be trusted and incorporated in daily practice. Unfortunately, sometimes commercial interests and strategies confound the public, hence hindering the progress of the discipline. As a scientist, I understand that a discipline’s progress is achieved through trial and error, independent verification and hypothesis testing. Therefore, I always encourage clinicians to research Piezosurgery thoroughly and independently, seeking the advice of reputable experts and always keeping in mind what is best for their patients.

Lastly, at Piezosurgery Incorporated, we are experts dedicated full-time to the Piezosurgery technology only, and truly believe that our products can improve the quality of life for both surgeons and patients. To fulfill this goal, we value clinical education and customer service. For instance, when a clinician incorporates Piezosurgery in his or her practice, our product specialists provide in-office training for the staff and the surgeon and assist to the development of the Piezosurgery 3 device, now available in the North American market. This new device has a specific function optimized for implant placement, new and simpler settings, and is up to 30 percent faster than the previous model. Additionally, thanks to the development of more sophisticated software, the Piezosurgery 3 device has improved self-diagnostic and safety features, which allow the surgeon to operate with confidence.

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