

Precautions for using zirconia implant abutments

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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 allowed better reproduction of the required color especially in the anterior zone. These properties made zirconia an interesting material for the construction of implant abutments and superstructures.¹

The fabrication of zirconia implant abutments utilizes state of the art CAD/CAM technology which uses patient's models for the production of an individual customized abutment.² 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 which could lead to unexpected fracture.³

This problem is solved by insertion of a friction fit internal metallic nut (Procera zirconia abutment for Strauman 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). This design is associated with the problem of generation of internal stresses which could lead to unexpected fracture of the zirconia implant abutment. This article evaluated the fracture causes of several broken zirconia implant abutments. Fractographic analysis of the broken segments allowed 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. Patients

Fig. 1 SEM image, 27x. Internal metallic nut which depends on friction fit inside the zirconia implant abutment.

Fig. 2 SEM image, 10x. The metallic fixation screw used to press on the metallic nut for providing adequate retention with the implant body.

Fig. 2a A broken maxillary premolar was extracted and implant was immediately inserted.

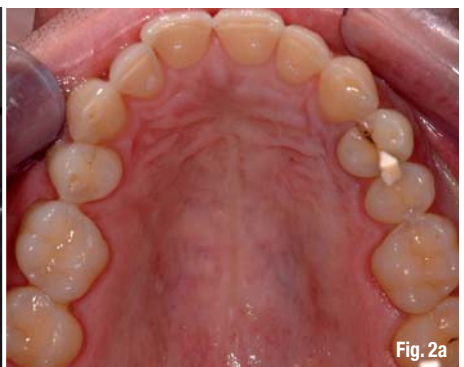
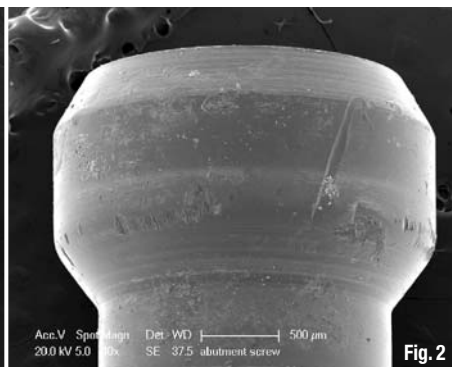
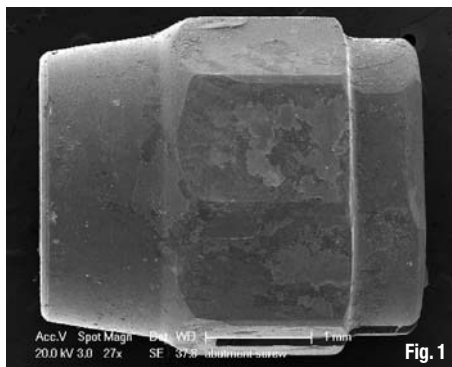




Fig. 2b_ Procera zirconia abutment. **Fig. 2c_** Procera zirconia veneered crown inserted over the zirconia abutment.

records indicated that the patient complained of loosening of the implant supported zirconia veneered crown (tooth 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 incidence 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 fit with the zirconia abutment it can not be correctly reinserted inside the abutment and areas of friction contact between the improperly assembled components could lead to generation of high internal stresses causing fracture of the zirconia implant abutment as was reported for the two examined abutments. A new abutment should be used in such case.

Case 2

A broken zirconia implant abutment was examined. 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 (0.5-0.7mm) 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 recommend to use a metallic abutment for correction of angle of insertion.

Case 3

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.

This single component zirconia structure does not utilize an internal metallic nut for achieving contact with the implant body. On the contrary, this single component super structure utilizes directly the fixation screw to obtain direct fixation to the implant body.

The solution

Using single component superstructures has several advantages as it simplify the handling procedure, does not require anti-rotation feature, and reduces the num-

sticky granules

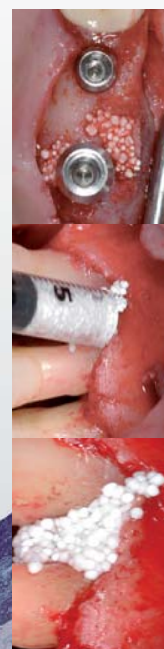
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Fig. 2d



Fig. 2e



Fig. 3

Fig. 2d_ The first and the second Procera zirconia abutments were fractured after short period of service intra-orally.

Fig. 2e_ A new zirconia veneered crown was inserted over a titanium abutment. Observe the grayish color at the cervical margin.

Fig. 3_ Digital image demonstrating a fractured zirconia abutment due to over reduction of the buccal wall.

Fig. 4a_ Digital image of a broken veneer porcelain from a four unit implant supported fixed partial denture.

Fig. 4b_ Digital image demonstrating the contact surface with the implant body. Antirotation is not required for this fixed partial denture as the whole framework and the implant abutment are joined into a single superstructure.

ber of structural interfaces of the entire restoration. On the other hand, it requires careful design to provide adequate support for the veneer ceramic.

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 complains of the treating dentists, it is not recommended to re-assemble 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 restriction 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 its 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 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.

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Fig. 4a



Fig. 4b

3D Panorama

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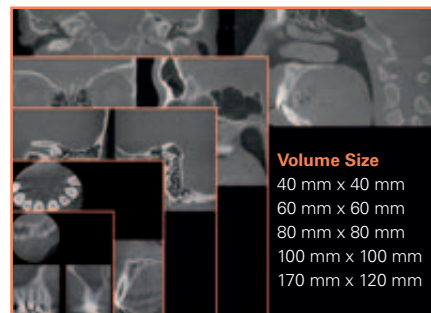
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