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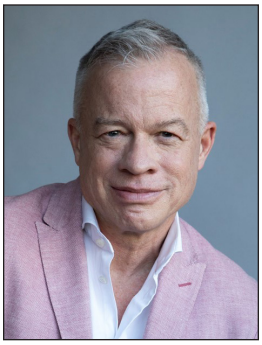

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Prosthodontics Newsletter™

Focusing on Dental Implants

Anterior Implant Restorations and Esthetic Abutment Considerations

Optimized esthetic outcomes, critical to anterior restorations, rely on improved materials, implant components and techniques for anterior restorations, along with the expertise of the clinician. This issue of Prosthodontics Newsletter reviews recent evidence related to anterior implant esthetics and titanium bases that clarify the state of the clinical science in this important area.

Impact of Abrasion and Cement Type on Zirconia Abutments

While computer-milled zirconia prostheses may provide the most esthetic restorations used with titanium abutments, they lack the necessary retentive force and require the use of self-adhesive resin cement. Some have suggested that abrading titanium bases with airborne particles may increase resin cement adhesion, but study results have been ambiguous. Linkevicius et al from Vilnius University, Lithuania, analyzed the strength of different luting agents and the influence of airborne-particle abrasion on cemented zirconium oxide copings to titanium bases.

After dividing 30 5-mm prosthetic titanium bases into 3 groups of 10 each, the researchers bonded each group of titanium bases to zirconium oxide copings with 1 of 3 resin cements:

- G-CEM LinkAce (GC Corp)
- RelyX U200 (3M ESPE Dental Products)
- Ceka Site (Ceka PRECI-LINE)

The assemblies were dynamically loaded using a mastication simulator and then thermocycled. Subsequently, the bases and copings were debonded and the cement removed from the zirconia copings. The cement on titanium bases was removed by airborne-particle abrasion using 50-µm aluminum oxide at 0.2-MPa pressure from 10 mm.

(continued on next page)

Inside this Issue

Impact of Abrasion and Cement Type on Zirconia Abutment

(continued from front page)

Significant differences were found among the various cements in retentive strength; the G-CEM LinkAce cement required the greatest force to dislodge the zirconium oxide copings, followed by RelyX U200 and Ceka Site. The chemical composition of the 3 resin cements may explain their varying retentive strength. The bond created by all 3 resin cements was significantly weakened by airborne-particle abrasion of the titanium bases, with the force required to dislodge the copings reduced by approximately 50% for G-CEM LinkAce and RelyX U200; the force required dropped by >70% for Ceka Site (Table 1).

Comment

This study surprisingly concluded that airborne-particle abrasion of titanium bases actually weakens rather than strengthens the bond between the base and the zirconia coping. The brand of resin cement made a significant difference in retention strength.

Linkevicius T, Caplikas A, Dumbryte I, et al. Retention of zirconia copings over smooth and airborne-particle–abraded titanium bases with different resin cements. J Prosthet Dent 2019;121:949-954.

Wear Levels at The Implant–Abutment Interface

The esthetic outcome of titanium single-tooth implants restored with titanium abutments is less than ideal when soft tissue thickness is ≤2 mm. The first cure introduced for this problem was all-ceramic abutments made from aluminum oxide ceramic cores. Unfortunately, these abutments had a low fracture resistance. Zirconia abutments proved to be a better solution.

Stimmelmayr et al from the University of Munich, Germany, conducted an in vitro study comparing wear at the implant–abutment interface in titanium implants with zirconia and titanium 1-piece abutments. They divided 6 titanium implants into 2 groups: 3 implants connected to zirconia abutments and 3 implants connected to titanium implants, each secured with a titanium screw. All the implants were subjected to dynamic loading of >1 million cycles. Scanning electron micrographs (SEM) and 3-dimensional computed tomography (3D-CT) micrographs were used to analyze the implant-abutment interfaces. Results were compared with scans taken before dynamic loading.

On the SEM images, implants connected to zirconia abutments showed minimal wear or abrasion. In contrast, implants connected to titanium abutments showed many scratches and undercuts vertical to the cam-groove, along with coiled furrows on the implant shoulder and a cam-groove resulting from rotational movement of the abutment. Wear on the implant shoulder was significantly greater on implants connected to zirconia abutments (Table 2). No implants showed any implant fracture, abutment fracture, zirconia titanium core connection loosening, abutment screw loosening or abutment screw fracture.

Comment

That none of the implants or abutments failed during testing raises the question of whether the additional wear associated with zirconia abutments is clinically significant. The clinician needs to weigh the potential for damage of the internal implant connection, which could potentially cause prosthetic failure that could require implant removal, with the increased esthetics in the anterior region associated with zirconia abutments.

Stimmelmayr M, Edelhoff D, Güth J-F, et al. Wear at the titanium–titanium and the titanium–zirconia implant–abutment interface: a comparative in vitro study. Dent Mater 2012;28:1215-1220.

Table 1. Mean dislodging forces (N) before and after airborne-particle abrasion of titanium bases.

Luting agent	Nonabraded titanium bases	Airborne-particle–abraded titanium bases
G-CEM LinkAce	1338 ± 69	662 ± 65
RelyX U200	665 ± 36	352 ± 21
Ceka Site	467 ± 22	122 ± 17

All numbers are mean ± standard deviation.

Table 2. Wear at the implant shoulder after maximal loading force.

Implant	Titanium abutments	Implant	Zirconia abutments
#1	0.5 µm	#4	8.5 µm
#2	1.0 µm	#5	10.5 µm
#3	0.5 µm	#6	11.5 µm
Mean ± SD	0.7 ± 0.3 µm		10.2 ± 1.5 µm

SD, standard deviation.

1-Piece and 2-Piece CAD/CAM Designed Abutment Strength

The esthetic superiority of ceramic abutments compared with metallic abutments has been well established. The development of custom zirconia abutments made through the computer-aided design/computer-assisted manufacture (CAD/CAM), rather than the lost-wax method, heralded the possibility of making stronger ceramic abutments. Previous research suggested that 2-piece zirconia abutments would demonstrate greater stability than would 1-piece zirconia abutments.

Gehrke, a private practitioner from Germany, et al investigated the relative strength of stock abutments, 1-piece custom zirconia implants manufactured by CAD/CAM technology and 2-piece custom zirconia implants with secondary titanium insert manufactured by CAD/CAM technology. The study involved 3.8-mm diameter specimens divided into 3 groups: unprepared prefabricated zirconia stock abutments (CERCON Dentsply Implants); 1-piece CAD/CAM zirconia abutments (Compartis DeguDent); and 2-piece CAD/CAM zirconia abutments (XiVE Ti-Base, Dentsply Implants) with zirconia copings (Compartis DeguDent). The 2-piece abutments were abraded with airborne particles before being bonded. All abutments were mounted on XiVE S implants (Dentsply Implants) that mimicked a replacement for the maxillary right central incisor and were then placed in a chewing simulator that combined thermocycling and fatigue testing. After fatigue testing, the specimens underwent fracture resistance testing until failure occurred.

All stock abutments and 1-piece custom abutments fractured into ≥2 fragments during the load-bearing capacity test. Although none of the 2-piece custom abutments fractured, they demonstrated failure through the bending of the retaining screw. The 2-piece custom abutments showed appreciably higher fracture resistance than did the other 2 groups, while the force required to deform the 2-piece abutments was consistently greater than in the other 2 groups. However, the 1-piece abutments performed more consistently and predictably under stress.

Comment

The authors noted that titanium abutments withstand greater levels of stress than do all types of zirconia abutments, an issue that should be considered in posterior areas with their greater forces and lesser esthetic needs. For anterior restorations, 2-piece zirconia abutments with titanium inserts designed using CAD/CAM technology outperformed both 1-piece and stock zirconia abutments.

Gehrke P, Johannson D, Fischer C, et al. In vitro fatigue and fracture resistance of one- and two-piece CAD/CAM zirconia implant abutments. Int J Oral Maxillofac Implants 2015;30:546-554.

Implant Abutments in the Anterior Region

Many published reports on implant abutments have combined anterior and posterior abutments in their results without considering the varying requirements for placement in different areas of the dentition, resulting in a lack of clear evidence regarding implant abutments in the esthetic zone. Thus, Bidra and Rungruanganunt from the University of Connecticut Health Center undertook a systematic review of the published literature to evaluate evidence limited to implant abutments in the anterior region.

The authors analyzed results from 27 published reports, including 4 randomized clinical trials, covering 951 implants. Almost all the

studies involved single crown restorations in the maxilla. Types studied included titanium abutments, cast metal alloy abutments, alumina abutments, complete zirconia abutments and zirconia abutments with a titanium base. Restorations included metal–ceramic cemented crowns, all-ceramic cemented crowns, porcelain veneered directly to abutments and acrylic resin veneered directly to abutments.

Comment

The heterogeneity of the studies and the fact that most of the reported results were short term made it difficult for the authors to draw conclusions. Fractures occurred most frequently among alumina abutments followed by zirconia abutments, but none were reported for titanium or cast metal alloy abutments in the anterior region. Buccal fistulas and mucosal recession, the most frequently reported biological complication, were found in both screw-retained and cemented restorations.

Bidra AS, Rungruanganunt P. Clinical outcomes of implant abutments in the anterior region: a systematic review. J Esthet Restor Dent 2013;25:159-176.

Fracture Strength of Various Zirconia Abutment Designs

Ceramic implant abutments for the anterior and premolar regions have been in use for >25 years. They provide superior esthetic results, avoiding the gray mucosal discoloration found in patients with thin labial mucosa and the gray color from exposure after mucosal recession typical of titanium abutments. But the brittleness of ceramic abutments creates its own set of problems.

Sailer et al from the University of Zurich, Switzerland, undertook an in vitro study to compare the fracture strength of zirconia abutments with external connections and internal connections. They evaluated 4 different abutments:

- Group A: 2-piece (ceramic with a secondary metallic component) abutment with an internal connection (Straumann CARES abutment on Straumann RN implant)
- Group B: 1-piece abutment with an external connection (Procera abutment on Brånemark implant)
- Group C: 2-piece (ceramic with a secondary metallic component) abutment with an internal connection (Procera abutment on NobelReplace implant)
- Group D: 1-piece abutment with an internal connection (Zirabut SynOcta Regular-Neck 1.5 abutment on Straumann RN implant)

In each group, 10 abutments were left unrestored; another 10 received glass–ceramic crowns to better mimic clinical loading situations. All 80 specimens were subjected to a static load until fracture or deformation occurred.

Among the unrestored abutments, the 2-piece abutments with internal connections (groups A and C) had bending moments higher than the 1-piece abutments, regardless of the type of connection (groups B and D). The restored abutments did not demonstrate a bending moment significantly different from the unrestored abutments; however, restored abutments in group C exhibited a significantly higher bending moment than the other restored groups.

Comment

These results suggested that internally connected 2-piece abutments that add a secondary metallic component to ceramic abutments would outperform 1-piece all-ceramic abutments. If a 1-piece ceramic abutment is employed, those with external connections demonstrated a higher strength than did those with internal connections.

Sailer I, Sailer T, Stawarcyzk B, et al. In vitro study of the influence of the type of connection on the fracture load of zirconia abutments with internal and external implant–abutment connections. Int J Oral Maxillofac Implants 2009;24:850-858.

In the Next Issue

Current status of immediate loading in implant dentistry

Our next report features a discussion of this issue and the studies that analyze them, as well as other articles exploring topics of vital interest to you as a practitioner.

Do you or your staff have any questions or comments about Prosthodontics Newsletter? Please write or call our office. We would be happy to hear from you.