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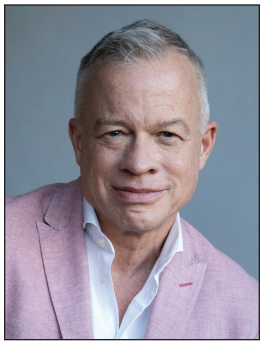

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Prosthodontics Newsletter™

Focusing on Dental Implants

Titanium Base Abutments for Fixed Implant Restorations

The relatively recent development of titanium base abutments for implant-supported fixed prosthodontics, particularly single implant restorations, was intended to solve key laboratory and clinical problems. Although these abutments have been generally successful in this regard, rigorous investigation into mechanical, biologic and esthetic parameters and limitations of use is necessary. This issue of Prosthodontics Newsletter *reviews recent evidence on factors that contribute to the effective use of titanium base abutments.*

Screw- vs Cement-retained Single Crowns

All-ceramic implant-supported single crowns, either screw-retained on a 2-piece ceramic abutment or cemented on a prefabricated or individually designed titanium abutment, are common choices for restorations, with lithium disilicate ceramics meeting esthetic and mechanical demands and excellent survival rates at 1 and 2 years. Spitznagel et al from Heinrich-Heine-University, Germany, investigated the role of retention mode and fatigue application on the failure load of monolithic lithium disilicate implant-supported crowns.

Researchers created 3 groups of titanium implants restored with lithium disilicate crowns:

- a screw-retained milled monolithic crown bonded to a prefabricated titanium base
- a screw-retained pressed monolithic crown bonded to a prefabricated titanium base
- a separate pressed crown cemented on a custom-designed lithium disilicate abutment and bonded to a prefabricated titanium base

Half the specimens in each group underwent cyclic mechanical loading and thermocycling in a chewing simulator. All the specimens, designed to simulate the replacement of mandibular molars, were then mounted in a universal testing machine and subjected to single load to fracture.

After a chewing simulation equivalent of 5 years in service, no specimens showed any cracks, fractures or mobility. The crowns cemented to custom ceramic abutments failed at significantly lower load values than did the screw-retained crowns; however, the force required for failure in all groups

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Screw- vs Cement-retained Single Crowns

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exceeded normal physiological bite forces.

Comment

The results of in vitro tests such as these have usually been confirmed in clinical trials. Until and unless long-term, prospective clinical trials prove otherwise, cement-retained and screw-retained ceramic implant-supported single crowns can be assumed to have equal survival rates in real-world usage.

Spitznagel FA, Bonfante EA, Vollmer F, Gierthmuehlen PC. Failure load of monolithic lithium disilicate implant-supported single crowns bonded to Ti-base abutments versus to customized ceramic abutments after fatigue. J Prosthodont *2021;doi:10.1111/jopr.13369.*

Titanium Base Abutments and Peri-implantitis

Controlling peri-implantitis—inflammation in the peri-implant mucosa that leads to loss of supporting bone—is a major issue in successful implant therapy. Increased biological complications in cement-retained restorations are typically caused by excess residual cement; subsequent inflammation may lead to marginal bone loss and implant failure.

Cement-retained restorations seem to perform better mechanically than screw-retained restorations, which have shown an increased risk of ceramic failure, along with the possibility of screw failure. Titanium base abutments merge the benefits of both these restorations, combining effective, extra oral control of the cement line and predictable retrievability of the crown–implant connection, while significantly improving esthetics.

Table 1. Mean peri-implant clinical and radiographic inflammatory measures at 12-month follow-up.

Parameter	Control group	Titanium base group
Marginal bone loss (mm)	1.15 ± 0.82	1.23 ± 0.79
Probing depth (mm)	2.64 ± 0.54	2.34 ± 1.09
Bleeding on probing (% of sites)	29%	35%

None of the differences between groups were significant.

In a randomized clinical trial, Pamato et al from the University of Southern Santa Catarina, Brazil, compared the impact of titanium base and cement-retained abutments on peri-implant soft tissue and crestal bone. Patients partially edentulous in either the mandible or the maxilla with no diagnosis of chronic periodontitis were divided into 2 groups:

- **cement-retained group** (control)**:** restorations were cemented onto cement-retained abutments
- **titanium base group:** restorations were cemented onto titanium base abutments

After residual excess cement was removed, bleeding on probing and probing depth, along with marginal bone level, were measured at implant loading, then at 6- and 12-months follow-up. At 12 months, bleeding on probing, probing depth and mesial and distal bone loss were comparable in both groups (Table 1). More than 40% of sites with a probing depth of ≥3 mm had bleeding on probing; the likelihood increased significantly with each additional 1 mm of probing depth. Interproximal surfaces had a higher risk of bleeding on probing than did approximal surfaces.

Comment

Titanium base abutments performed as well as cement-retained abutments and did not interfere with peri-implant soft tissue health or marginal bone loss 1 year after loading. Current evidence suggests that titanium base abutments are a good alternative to cement-retained abutments.

Pamato S, Honório HM, da Costa JA, et al. The influence of titanium base abutments on peri-implant soft tissue inflammatory parameters and marginal bone loss: a randomized clinical trial. Clin Implant Dent Relat Res *2020;22:542-548.*

Stability of Ceramic Restorations

When compared with traditional screw-retained metal restorations, newer ceramic restorations have esthetic advantages, but the difficulty of removing excess cement can lead to complications. All-ceramic restorations bonded to a titanium base outside the mouth before being screwed to the implant allow for more efficient removal of excess cement. Pitta et al from the University of Geneva, Switzerland, tested mono-

lithic ceramic abutment–crowns in a variety of materials to evaluate their mechanical stability, including survival and complication rates, and bending moments.

The study looked at 4 different types of maxillary central incisor abutment–crowns, using a porcelain-fused-to-metal (PFM) crown as control:

- **TAbut+LDS:** milled monolithic lithium disilicate crown bonded to a customized titanium abutment
- **TiBase+LDS:** milled monolithic lithium disilicate abutment–crown bonded to a titanium base
- **TiBase+ZR:** milled monolithic yttria-stabilized zirconia (ZR) crown bonded to a titanium base
- **TiBase+PICN:** milled monolithic polymer-infiltrated ceramic-network (PICN) crown bonded to a titanium base
- **GAbut-PFM** (control)**:** porcelain-fused-to-metal crown with a gold abutment

All specimens were placed on internal conical connection implants with a 4.3 mm diameter using a 1-piece screw-retained restoration, except for group TAbut+LDS, which was bonded on a customized implant abutment. All specimens underwent thermocycling and a chewing simulation, then were assessed for catastrophic events and complications. After any specimens that suffered loss of retention or screw loosening were repaired; all were loaded until failure using a universal testing machine.

All 12 specimens in the TAbut+LDS and in the TiBase+LDS groups survived, while one-third of the TiBase+ZR specimens and 41.7% of the TiBase+PICN specimens suffered catastrophic events. The TiBase+ZR and TiBase+PICN groups also displayed high complication rates (Table 2). Both the fracture load and bending moments were significantly worse for the TiBase+PICN restorations than for the other groups.

Comment

Results suggested that hybrid abutment–crowns milled from blocks of lithium disilicate with titanium bases can be a time- and cost-efficient alternative to porcelain fused to metal on a gold abutment. Neither TiBase+ZR or TiBase+PICN restorations appeared to be viable alternatives.

Pitta J, Hjerppe J, Burkhardt F, et al. Mechanical stability and technical outcomes of monolithic CAD/CAM fabricated abutment-crowns supported by titanium bases: an in vitro study. Clin Oral Implants Res *2021;32:222-232.*

Evaluating Titanium Base Abutments

Newer, prefabricated titanium base abutments combine the mechanical properties of a titanium connection and the esthetics of a ceramic abutment. Implant-supported ceramic crowns fabricated using computer-aided design/computer-assisted manufacturing (CAD/CAM) have an excellent survival rate, comparable to that obtained with traditional porcelain-fused-to-metal (PFM) crowns at a fraction of the cost, yet there is little evidence evaluating the combination of titanium base abutments and CAD/CAM fabricated ceramic crowns.

To compare the fracture resistance of screw- and cement-retained ceramic and polymethylmethacrylate (PMMA) crowns with titanium base abutments and PFM implant-supported crowns, DuVall et al from the Uniformed Services University of Health Sciences, Maryland, fabricated 12 implant restorations (tooth #30) for each of 6 groups with titanium base abutments:

- screw-retained, monolithic, lithium disilicate

Table 2. Catastrophic and noncatastrophic events after thermomechanical aging.

	Catastrophic events			Noncatastrophic events			
	Abutment	Crown	Survival rate	Cracks	Debonding	Screw loosening	Complication rate
GAbut-PFM	1/12 (8.3%)	0	91.7%	0	N/A	2/11 (18.2%)	18.2%
TAbut+LDS	0	0	100%	0	0	0	0%
TiBase+LDS	0	0	100%	0	7/12 (58.3%)	0	58.3%
TiBase+ZR	3/12 (25%)	1/12 (8.3%)	66.7%	0	7/8 (87.5%)	0	87.5%
TiBase+PICN	0	5/12 (41.7%)	58.3%	2/7 (28.6%)	6/7 (85.7%)	0	85.7%

N/A, not applicable.

- cement-retained, lithium disilicate crown with leucite-reinforced abutment
- cement-retained, leucite-reinforced crown with lithium disilicate abutment
- cement-retained, lithium disilicate crown with zirconia abutment
- cement-retained, leucite-reinforced crown with zirconia abutment
- screw-retained, monolithic PMMA and 2 groups with UCLA abutments:
  - screw-retained, PFM
  - cement-retained, metal abutment, PFM crown

Each restoration was connected to a 5 mm × 11.5 mm implant. Specimen were thermocycled, then subjected to 250,000 cycles in a dynamic load cycler; after inspection for surface fractures, they were statically loaded in a universal testing machine until failure.

No surface fractures occurred before static loading to failure. The screw-retained PFM crown on the UCLA abutment and the screw-retained monolithic PMMA crown on the titanium base abutment required significantly greater loads to fracture than did the other groups, while the cement-retained PFM crown and the cement-retained leucite-reinforced crown with zirconia abutment performed more poorly than other groups.

Comment

Overall, the performance of the titanium base abutment equaled that of the UCLA abutment.

DuVall NB, DeReis SP, Vandewalle KS. Fracture strength of various titanium-based, CAD-CAM and PFM implant crowns. J Esthet Restor Dent *2021;33:522-530.*

Cement and Color Outcomes

Successful esthetic outcomes of implant therapy require natural-looking soft tissue at the implant site. A metal implant abutment may create a grayish tinge, with titanium abutments more likely to cause a change in the color. Also affecting the color outcome of CAD/CAM glass-ceramic lithium disilicate crowns is the cement used to bond the crown to the abutment. Liu et al from Peking University School and Hospital of Stomatology, China, analyzed how the choice of cement affected the esthetic outcome of the restoration.

The researchers mimicked 45 left lateral incisors with identical monolithic lithium disilicate crowns supported by titanium bases; the crowns were then divided into 15 groups. Three groups of crowns were cemented to unmodified titanium abutments using provisional adhesives; 6 groups were cemented to unmodified titanium abutments with 6 brands of cement; and 6 groups were cemented to sandblasted titanium abutments with the same 6 cements. All samples were screw-retained to a replica bone-level implant embedded in artificial gingiva with a 2-mm thickness at the site of the titanium abutment. A spectrophotometer measured the color at 3 standardized sites on each sample using a color scale established by the International Commission on Illumination; values of color difference above ΔE 1.815 are visible.

No provisional adhesives had a significant effect on the soft tissue color. Median color values for the surfaces of crowns attached to unmodified titanium abutments ranged from ΔE 1.4 to 2.9 (a significant difference); median values measured at the soft tissue ranged from ΔE 1.7 to 1.9, not a significant difference. Median values for the crowns attached to sandblasted titanium abutments ranged from ΔE 0.8 to 4.0, while the range at the peri-implant soft tissue was ΔE 1.4 to 2.2; Multilink HO 0 self-curing resin-based cement performed best, regardless of the abutment.

Comment

In both the crown and the peri-implant tissues, cement choice influenced the restoration's esthetic outcome. The fact that no temporary cement had an effect on color suggested that cement choice is not predictive of final outcome. Opaque cements performed best with the darker color of the metal substructures.

Liu X, Fehmer V, Sailer I, et al. Influence of different cements on the color outcomes of titanium-based lithium disilicate all-ceramic crowns and peri-implant soft tissue. Int J Prosthodont *2020;33:63-73.*

In the Next Issue

Implant crown cementation and residual subgingival cement

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.