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PROSTHODONTICS™

NEWSLETTER

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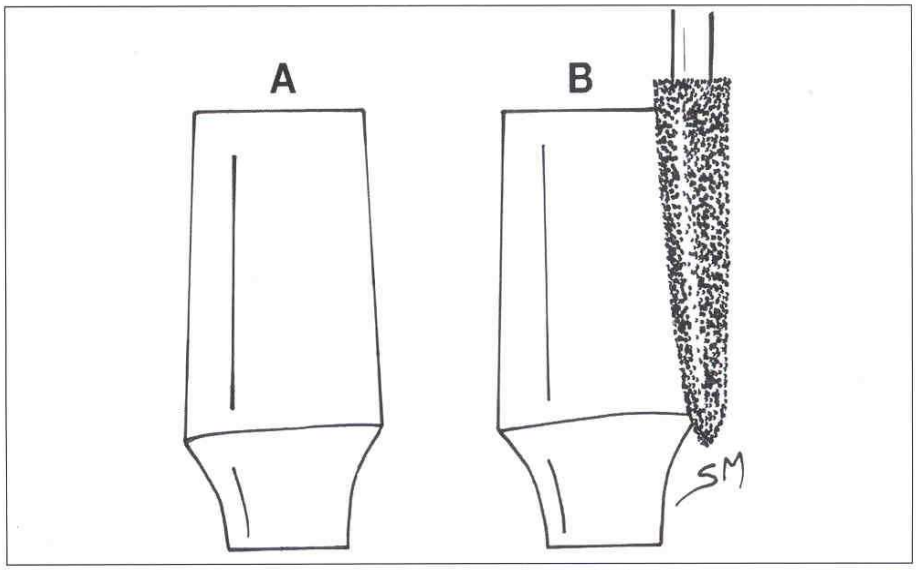

An in vitro study of titanium implant abutments compared the fracture resistance of the abutments (A) as supplied by the manufacturer and (B) after preparation to receive a complete crown. (See *Fracture Resistance of Zirconia Implant Abutments*, inside.)

In Vitro Studies in Prosthodontics

New materials and techniques are introduced regularly to the dental profession, and information on the expected clinical behavior and clinical outcomes of these materials and techniques is highly desirable. With novel materials and approaches to treatment, nonclinical—i.e., in vitro—studies can provide highly useful preliminary information. These in vitro studies can be conducted quickly and relatively inexpensively, and results can be compared with those reported previously for established materials and techniques. This issue of *Prosthodontics Newsletter* reviews a group of recently published in vitro studies investigating new materials and techniques.

Fracture Resistance of Zirconia Implant Abutments

One factor that can influence the esthetic result of an implant-supported crown is the abutment type and material. The commonly used titanium abutment can produce an unesthetic blue hue in the surrounding soft tissues.

While polycrystalline ceramic abutments, such as alumina and zirconia abutments, do not produce this undesirable hue, their fracture resistance has been a concern. Reported fracture resistance of titanium abutments is 324 ± 85 N. The fracture resistance of alumina has been reported as 239 ± 83 N, and zirconia has been reported to fracture at 294 ± 53 N.

To prepare an abutment to receive a crown, dentists commonly modify these abutments. The grinding process during abutment preparation could produce microcracks in the zirconia surface that could substantially reduce the abutment's fracture resistance.

To evaluate abutment preparation with diamond stones on the fracture resistance of zirconia abutments (4.5/5.0 diameter, 5.5 mm; Astra Tech, Inc.), Adatia et al from the University of North Carolina School of Dentistry compared abutments of 3 different types using a total of 30 specimens ($n = 10$).

Group 1 (control) abutments were supplied by the manufacturer. Group 2 abutments were prepared with a 0.5-mm chamfer, 1 mm above the abutment's height of contour, combined with 2.0 mm of occlusal reduction. Group 3 abutments received a 1.0-mm chamfer, 1 mm above the abutment's height of contour, and 2.0 mm of occlusal reduction.

Abutments were prepared with coarse diamond stones (Two-striper; Premier), in a high-speed handpiece with continuous air/water coolant spray. After preparation, the abutments were attached to their analogs, which were embedded in stainless steel test mounts, with titanium abutment screws tightened to 25 Ncm (see cover illustration). The specimens were loaded at a 60° off-axis angle in a universal testing machine (Instron, Model 4411), at a crosshead speed of 0.1 mm/minute until failure.

Failure loads displayed large variations within the groups, with no statistically significant differences among the groups. The resultant fracture loads were recorded as follows:

- 429 ± 140 N for the control group,
- 576 ± 120 N for the 0.5-mm chamfer group and
- 547 ± 139 N for the 1.0-mm chamfer group.

All specimens showed a general pattern of failure, beginning with deformation of the abutment, followed by deformation of the abutment screw and then abutment fracture. Abutment preparation did not alter this failure pattern.

Comment

For all specimens, the screw became loose during the testing procedure. Screw loosening is preferable to damage to the implant itself. None of the stainless steel implant analogs were damaged, suggesting that the abutment screw was the first element of the assembly to be affected by the progressive loading of the abutment. The results with the use of actual implants, which are made of titanium (a softer metal), might be different.

The mechanical behavior of this type of internally fitting abutment is different from an abutment fitted to an external hex. Also, in this study, the long axis of the implant was coincidental with the long axis of the prepared abutment, with the screw axis opening centered at the occlusal portion of the abutment. In a clinical setting, implants are often placed at an angle different from the required angulation of the artificial tooth and abutment, with the screw access opening emerging onto one of the axial surfaces of the abutment after preparation. A noncentered screw access channel would alter the mechanics and could result in a fracture strength different from the results of this study.

Adatia ND, Bayne SC, Cooper LF, Thompson JY. Fracture resistance of Yttria-stabilized zirconia dental implant abutments. J Prosthodont *2009;18: 17-22.*

Fracture Resistance and Marginal Seal of Pulpless Teeth Restored With Ceramic Crowns

Pulpless teeth with limited coronal tooth structure are commonly restored with a post-and-core and crown. An alternative approach, referred to as an endo-crown, is a complete crown restoration that extends into the access cavity to the level of the pulpal floor without the use of a traditional post-and-core.

An in vitro study by Forberger and Göhring from the University of Zurich, Switzerland, evaluated the

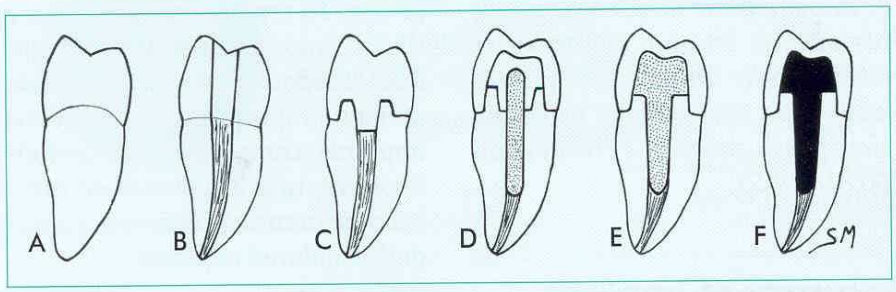

Figure 1. Groups were A, UNTREATED (no endodontic therapy, no post); B, COMP (no post, access cavity sealed with composite resin); C, ENDOCROWN (no post, "endo-crown" technique); D, FRC-POST (glass fiber-reinforced composite resin post with composite resin core); E, ZRO-POST (zirconia ceramic post-and-core); and F, GOLD POST (conventional cast gold alloy post-and-core).

marginal continuity and fracture behavior of pulpless teeth restored with high-strength ceramic crowns and various foundation restorative techniques, including the endo-crown method. Forty-eight human premolars were divided into 6 groups ($n = 8$; Figure 1).

The intaglio surfaces of experimental lithia disilicate ceramic crowns (Ivoclar Vivadent) made with a heat-pressed technique were airborne-particle abraded and etched with 5% hydrofluoric acid (IPS Ceramic Etching Gel; Ivoclar Vivadent), then silanated (Monobond-S; Ivoclar Vivadent). Crowns were then adhesively cemented to the teeth with the Ivoclar Vivadent bonding system.

All specimens were cyclically loaded and thermocycled in a computer-controlled masticator (CoCoM2; PPK), with 1.2 million 49-N loads at 1.7 H_2, combined with 3000 temperature cycles of 5°C–50°C–5°C. Marginal adaptation of all crowns was measured before and after thermo-mechanical cyclic testing.

Specimens were then loaded in a universal testing machine (Schenck Trebel; TeMeCo) at an angle of 60° to the long axis of the teeth until failure, with a crosshead speed of 0.5 mm/minute. Mean failure loads were calculated, and the mode of failure was analyzed for each group.

After this testing, marginal continuity decreased significantly only for the no post, "endo-crown" technique (ENDOCROWN) group and the glass fiber-reinforced composite resin post with composite resin core (FRC-POST) group. Mean failure loads ranged from 1092.4 ± 307.8 N for the FRC-POST group to 1253.7 ± 226.5 N for the ZRO-POST group, but results were not significantly different among the groups. Deep-root fractures occurred in 37–63% of the specimens, with the exception of the untreated control group, which experienced no problematic fractures.

Comment

Decreases in marginal integrity were significant for the ENDOCROWN and FRC-POST groups. Changes in marginal adaptation were not significant for crowns supported by rigid post systems. The presence of posts did not influence the pattern of failure, suggesting a positive influence when a rigid post system supports a ceramic crown.

Forberger N, Göhring TN. Influence of the type of post and core on in vitro marginal continuity, fracture resistance, and fracture mode of lithia disilicate-based all-ceramic crowns. J Prosthet Dent *2008;100:264-273.*

Fracture Resistance of Endodontically Treated Teeth

To restore a tooth that has received endodontic therapy, dentists commonly use a post-and-core. If the margin of the final crown extends 1.5–2 mm apical to the margin of the core, circumferentially for 360°, a ferrule effect will be established, whereby the crown provides encirclement of the tooth to resist fracture of the remaining tooth structure. An in vitro study by Arunpraditkul et al from Srinakharinwirot University, Thailand, evaluated the effect of an incomplete ferrule on the fracture resistance of pulpless teeth.

Thirty-two extracted second mandibular premolars were decoronated 3 mm above the cemento-enamel junction (CEJ). The cervical portion of each tooth was prepared for a complete crown, with a 0.5-mm chamfer terminating 1 mm above the CEJ.

The teeth were randomly divided into 4 groups. Group 1 (control) possessed a 360° circumferential ferrule. Groups 2, 3 and 4 were prepared with an interrupted ferrule with only 3 intact walls, missing the buccal, lingual or mesial wall, respectively. Cast posts-and-cores and complete crowns were made from nickel–chromium alloy (Remanium CS; Dentaurum) and cemented with zinc phosphate cement (Hybond, Shofu). A com-

pressive load was applied 45° to the long axis, 2 mm below the buccal cusp, with a universal testing machine (Instron 5566) at a crosshead speed of 5 mm/minute until failure. The mode of failure was also evaluated.

The control group (group 1) recorded the highest fracture resistance (1190.3 ± 110.5 kg), which was significantly greater than those of all the other groups. Fracture resistance values for the 3 experimental groups were as follows:

- group 2, 578.5 ± 197.4 kg;
- group 3, 786.6 ± 132.8 kg; and
- group 4, 785.4 ± 289.9 kg.

No significant differences were noted among the 3 experimental groups. The mode of failure in group 1 was typically a horizontal root fracture; that of the other groups was either vertical or oblique fracture.

Comment

The presence of a 360° ferrule enhanced the fracture resistance of the teeth, confirming the commonly held belief that such a ferrule design is desirable. The mode of failure was horizontal root fracture for the control group, primarily at the mid-root level. Teeth with incomplete ferrules experienced primarily vertical or oblique root fractures. However, these observations appear unimportant because all teeth would be nonrestorable after fracture.

Arunpraditkul S, Saengsanon S, Pakviwat W. Fracture resistance of endodontically treated teeth: three walls versus four walls of remaining coronal tooth structure. J Prosthodont *2009;18:49-53.*

Accuracy of Implant Impressions

There are various approaches to making impressions required to fabricate an implant-supported prosthesis, including a splinted pick-up technique with multiple implants, a nonsplinted pick-up technique and a transfer technique. The method of making the impression can potentially influence the accuracy of the final results.

Searching the literature from January 1980 to May 2008, Lee et al from Louisiana State University selected 41 articles, all in vitro studies, comparing the accuracy of implant impressions related to impression technique and clinical factors. Seven articles advocated a splinted technique, 3 advocated a nonsplinted technique and 7 reported no significant differences between the 2 methods. Five articles reported more accurate results with the pick-up technique, 2 reported better results with the transfer technique and 7 indicated no significant difference between the 2 techniques.

Of the impression materials, polyether and vinyl polysiloxane were the 2 most commonly studied. Of the 11 studies in the systematic review, 10 reported no difference in the accuracy between these 2 materials; 2 reported less accuracy when making impressions of angulated implants compared with parallel implants; and 2 reported no difference in accuracy between parallel and angulated implants.

Comment

Comparing the number of implants in the impression appears to be an important variable. For example, when ≤3 implants were included in the impression, most studies found no difference between the pick-up and transfer techniques. However, when ≥4 implants were included in the impression, a higher accuracy with the pick-up technique was reported.

Of the 4 studies related to angulation of the implants, the 2 studies reporting more accuracy with parallel implants also used a cast with 4 or 5 implants. The 2 studies reporting no angulation effect on accuracy used casts with 2 or 3 implants.

Results of these 41 studies suggest that a number of variables can influence the accuracy of an implant impression, but the number of implants to be impressed will influence the effects of these variables. Impressions of ≥4 implants appear to be more sensitive to these variables.

Lee H, So JS, Hochstedler JL, Ercoli C. The accuracy of implant impressions: a systematic review. J Prosthet Dent *2008;100:285-291.*

NEXT:

- Conventional vs implant-stabilized mandibular dentures
- Design of an implant abutment with cement-retained crown
- Bar design for implant-supported mandibular overdenture

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