A Professional Courtesy of:

Izchak Barzilay
D.D.S., Cert. Prostho., M.S., F.R.C.D.(C)

Effrat Habsha
B.Sc., D.D.S., Dip. Prostho., M.Sc., F.R.C.D.(C)

Howard F. Klaiman
D.D.S., Cert. Prostho., F.R.C.D.(C)

Vinay M. Bhide
B.ArtsSc.(Hons), D.D.S., M.Sc. (Perio), F.R.C.D.(C)

David Chvartszaid
D.D.S., M.Sc. (Prostho, Perio), F.R.C.D.(C)

2300 Yonge Street, Suite 905 • Box 2334 • Toronto, Ontario M4P 1E4
(416) 322-6862 • Fax: (416) 322-5282
www.buildyoursmile.com

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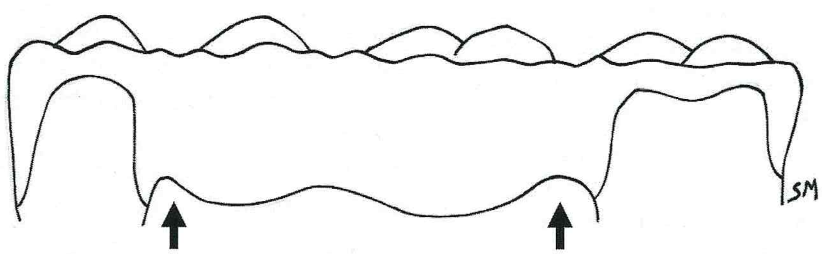

Most clinical investigations of zirconia-based, posterior fixed partial dentures (FPDs) have examined 3-unit FPDs. A recent study of 4-unit FPDs found that the cross-sectional height of the connector between the pontic and the retainer (arrows) was an important predictor of success. See *POSTERIOR, 4-UNIT, ZIRCONIA-BASED FIXED PARTIAL DENTURES.*

Technological Advances in Prosthodontics

Improvements in technology for the practice of prosthodontics are being launched by dental manufacturers at an unprecedented rate. The very rapid pace of the introduction of these advances in materials and techniques has made it difficult for researchers to keep up with the technology. While technological advances show much promise, research is still necessary to ensure the highest quality of patient care. This issue of *Prosthodontics Newsletter* focuses on research reports related to new technology.

Posterior, 4-unit, Zirconia-based Fixed Partial Dentures

Metal-ceramic fixed partial dentures (FPDs) have been used successfully for decades to replace missing teeth, and a number of studies in the literature have examined the longevity of these prostheses. All-ceramic FPDs have become more popular recently; however, reports on their survival rates are limited.

Zirconia has been reported to possess very favorable mechanical properties when used as a substructure for all-ceramic FPDs. Nevertheless, problems

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Posterior, 4-unit, Zirconia-based Fixed Partial Dentures

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reported with these zirconia-based FPDs include

- chipping of veneering ceramics
- low-temperature degradation of the supporting zirconia substructures

The clinical performance of zirconia-based FPDs was reported recently by Salido et al from the Complutense University of Madrid, Spain. The study investigated the 4-year clinical performance of 17 4-unit, posterior FPDs placed in 10 patients.

The zirconia substructures were fabricated from the Lava System (3M ESPE, St. Paul, MN). The abutment–pontic connectors were made with a minimal cross-sectional area of 9 mm^2, and the pontic–pontic connectors were a minimum of 16 mm^2 in cross-sectional area. Retainer thicknesses were a minimum of 0.5 mm (see cover illustration).

FPDs were evaluated after 1 week, 6 months, and then after 1, 2, 3 and 4 years. Three FPDs were lost because of a fracture of the distal connector between the posterior pontic and the posterior retainer, (mean service time, 25.3 months). After 23 months of clinical service, 1 FPD failed as a result of a vertical fracture of an endodontically treated abutment.

In the 3 FPDs whose connectors fractured, chipping of the veneering ceramics was observed 1 week before the framework fractured. Minor chipping was observed in 2 additional FPDs. After 4 years of follow-up, the cumulative survival rate for the FPDs was 76.5%. Restorations that survived the 4-year period were rated clinically acceptable according to the California Dental Association criteria.

Comment

The majority of zirconia-based FPDs investigated in previous studies were 3-unit prostheses with 2 abutments and 1 pontic. This study included only 4-unit FPDs with 2 abutments and 2 pontics. The heights of the fractured connectors in this study ranged from 3.5 mm to 3.6 mm.

A previous publication recommended a minimal connector height of 4 mm for long-span, zirconia-based FPDs. The connectors of the failed prostheses did not meet this recommendation, and the authors concluded that posterior, 4-unit, zirconia-based FPDs should be restricted to situations where 4 mm of height is available for the occluso-gingival thickness of the connectors.

Salido MP, Martínez-Rus F, del Río F, et al. Prospective clinical study of zirconia-based posterior four-unit fixed dental prostheses: four-year follow-up. Int J Prosthodont *2012;25:403-409.*

Fracture Load of Zirconia Crowns

Long used in dental restorations, metal-ceramic crowns can present esthetic problems, such as shadowing of the teeth and soft tissues. Ceramic crowns were developed to improve esthetics, but they are vulnerable to fracture. The zirconia ceramic crown, with its higher fracture resistance, ease of manufacturing and better esthetics, has been proposed as an alternative to conventional dental porcelain crowns.

Zirconia ceramic crowns use a high-strength zirconia substructure and a more esthetic veneering feldspathic porcelain to develop the final crown contours. Because zirconia is opaque, the esthetics at the cervical portion of the veneered crown can be adversely affected when a standard coping design with a 0.2-mm cervical collar is used. To improve esthetics, the zirconia collar can be cut back to allow only veneering ceramics at the finish line of the crown preparation, or the coping thickness can be altered.

Kim et al from Yonsei University, South Korea, compared the fracture load of zirconia-substructure crowns relative to coping thickness and facial collar design. From a nickel-chrome alloy (VeraBond 2; Aalba Dent Inc., Fairfield, CA),

Figure 1. Four zirconia coping designs were investigated: A, standard coping (0.5-mm coping thickness with 0.2-mm facial collar height); B, collarless coping (0.5-mm coping thickness without facial collar); C, modified thicker coping (0.7-mm coping thickness with 0.2-mm facial collar height); D, thicker coping (0.7-mm coping thickness with 0.7-mm collar height).

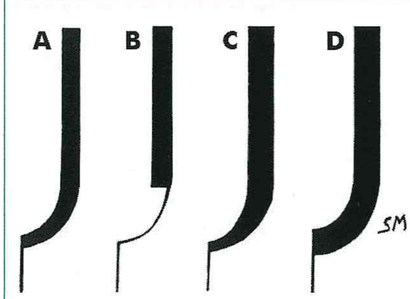

Table 1. Design parameters and fracture load (N)

	Standard coping group	Collarless coping group	Modified thicker coping group	Thicker coping group
Coping thickness (mm)	0.5	0.5	0.7	0.7
Margin thickness (mm)	0.2	collarless	0.2	0.7
Mean fracture load (N)	2126.9[a]	2329.1[a,b]	2112.7[a]	3179.3[b]
Standard deviation	576.9	948.3	623.9	1137.7

Same superscript letters are not statistically significant ($p > .05$; Tukey Honestly Significant Difference test).

Table 2. Design parameters and fracture load (N) after cyclic loading

	Standard coping group	Collarless coping group
Coping thickness (mm)	0.5	0.5
Margin thickness (mm)	0.2	collarless
Mean fracture load (N)	1366.1	1232.2
Standard deviation	519.1	403.8

48 metal dies were fabricated. Each die was scanned (Cercon Eye; Dentsply Prosthetics, York, PA), and a zirconia coping was designed (Cercon Art System; Dentsply Prosthetics) with a 30-µm cement space. Partially sintered zirconia blocks (Cercon Base; Dentsply Prosthetics) were milled (Cercon Brain; Dentsply Prosthetics) to form copings and then fully sintered.

The authors studied 4 different coping designs (Figure 1). Copings were veneered (IPS e.Max Ceram; Ivoclar Vivadent, Schaan, Liechtenstein), and the finished crowns were cemented to their metal dies with a resin cement (Variolink II; Ivoclar Vivadent). After 24 hours of storage, the fracture load (N) for the crowns was measured in a universal testing machine (Instron 3366; Instron Corp., Norwood, MA). Loads were applied 2 mm from the incisal edge of each crown, 30° from the long axis of the crown.

Cyclic loading tests were conducted on additional specimens with the standard coping design ($n = 5$) and with the collarless coping design ($n = 5$). The load cycle frequency was 5 Hz, with a minimal load of 0 N and a maximal load of 200 N with 600,000 loading cycles. Fracture loading tests were performed after cyclic loading. Test results are summarized in Tables 1 and 2.

Comment

Although the thicker coping group recorded the highest mean fracture load, it would be the least esthetic alternative in the esthetic zone. The collarless coping design and the standard coping design did not differ significantly with regard to mean fracture loads, suggesting that the collarless design is a viable esthetic alternative to the standard design.

Kim JH, Park JH, Park YB, Moon HS. Fracture load of zirconia crowns according to the thickness and marginal design of coping. J Prosthet Dent *2012;108:96-101.*

Low-temperature Degradation of Zirconia

Zirconia is a polycrystalline material that has been used as a substructure for all-ceramic fixed restorations. Zirconia can also be used to fabricate monolithic restorations. Zirconia exists in 3 phases: monoclinic, tetragonal and cubic.

Pure zirconia is monoclinic at room temperature. Above 1170°C, the material converts to the tetragonal phase. When zirconia, to which small quantities of a metallic oxide such as yttria (Y_2O_3) have been added, is heated above 1170°C and then cooled down to room temperature, the material will remain stabilized in the tetragonal phase, which is stronger than the monoclinic phase.

If a crack begins to form in stabilized tetragonal zirconia, the crystals can convert back to monoclinic zirconia at the crack. Because the monoclinic phase is 3% to 4% larger in volume, this transformation can induce compression in the crack and help to restrict crack propagation. This type of transformation, called transformation toughening, is desirable.

An undesirable tetragonal-to-monoclinic transformation can occur from hydrothermal stress, a phenomenon called low-temperature degradation (LTD). Exposure to moisture, inevitable in the oral environment, can lead to LTD, with potential weakening of the zirconia.

Alghazzawi et al from Taibah University, Saudi Arabia, evaluated the structural stability of yttria-stabilized zirconia (Y-TZP). Researchers prepared 64 zirconia specimens to simulate monolithic restorations; 32 served as controls, and 32 were subjected to accelerated aging by being boiled in artificial saliva for 7 days to simulate LTD in vivo.

LTD treatment increased surface roughness (12.23 ± 6.16 nanometers [nm] to 21.56 ± 13.39 nm) and the monoclinic fraction (2.4 ± 0.6% to 21.0 ± 2.0%); however, there was no significant reduction in the concentration of yttria or zirconia. Flexural strength of the Y-TZP was also unaltered by the simulated LTD treatment.

Comment

The increase in roughness does not appear to be clinically relevant, and the flexural strength of the material was unaltered with the LTD treatment. These results suggest that LTD is of limited importance relative to the long-term in vivo function of Y-TZP restorations.

Alghazzawi TF, Lemons J, Liu P-R, et al. Influence of low-temperature environmental exposure on the mechanical properties and structural stability of dental zirconia. J Prosthodont *2012;21:363-369.*

Frameworks for Hybrid Complete Dentures

Edentulous patients have reported difficulties with conventional complete dental prostheses, and elderly edentulous patients often avoid foods that they cannot chew, significantly impacting their diet. Implant-supported fixed complete dentures (sometimes referred to as hybrid prostheses) can resolve many problems encountered by edentulous patients, but these restorations are not trouble free.

Drago and Howell from Eon Clinics, Wisconsin, and Southwest Dental Group, Arizona, respectively, reviewed the historical perspectives and current recommendations for implant-supported fixed complete dentures. The restorations were designed primarily to replace missing teeth in the mandible and were contoured with hygiene as an overriding factor because the prosthesis was not removable. Application of a similar design in the maxillary arch was less successful because of problems with lip support and phonetics.

Initially, these frameworks were fabricated empirically with the lost-wax technique by casting a noble alloy against prefabricated components. Distal cantilevers were incorporated into the frameworks; however, scientific concepts, such as biomechanics, were absent from the original design protocols. With time, principles such as the anterior/posterior spread were incorporated into the design when determining the optimal length of a distal cantilever segment.

Advances in technology such as the use of computer-assisted design/computer-assisted milling techniques for framework fabrication have the potential to produce a more cost-effective framework with improved accuracy of fit.

After reviewing the material, the authors made the following recommendations:

- Fabricate frameworks with an accurate and passive fit between the framework and the implants and/or abutments.
- Design frameworks to resist tensile and compressive forces.
- Design frameworks consistent with predetermined positions of the artificial teeth.

Comment

Technological improvements have the potential to produce frameworks with better fit at a reduced cost and improved quality of treatment for edentulous patients.

Drago C, Howell K. Concepts for designing and fabricating metal implant frameworks for hybrid implant prostheses. J Prosthodont *2012;21:413-424.*

In the Next Issue

- Fracture rate of all-ceramic crowns
- All-ceramic vs metal-ceramic fixed partial dentures
- Masticatory performance with removable partial dentures

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.

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.