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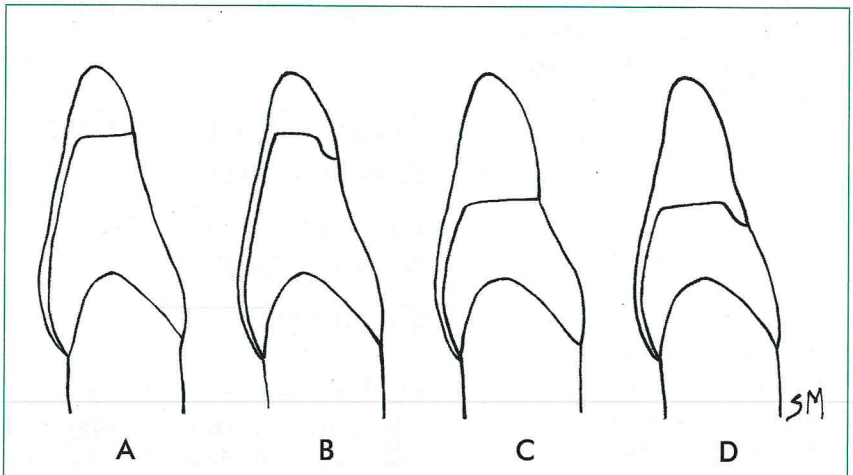

An in vitro study of the fracture resistance of porcelain laminate veneers with different tooth preparation designs was recently reported. There were 4 groups: (A) shoulder finish line/unworn tooth, (B) shoulder with chamfer finish line/unworn tooth, (C) shoulder finish line/simulated worn tooth and (D) shoulder finish line with palatal chamfer/simulated worn tooth. See *PREPARATION DESIGN AND LOAD-TO-FAILURE OF CERAMIC LAMINATE VENEERS.*

Advances in Fixed Prosthodontics

Few areas of dentistry have advanced as rapidly as that of fixed prosthodontics. As new materials and techniques have been introduced, the fit and durability of fixed restorations that also possess superior esthetic qualities have improved. Patient satisfaction with these advances has reached an all-time high. This issue of *Prosthodontics Newsletter* presents a series of studies related to advances in fixed prosthodontic materials and techniques.

Preparation Design and Load-to-failure of Ceramic Laminate Veneers

The success of a porcelain laminate veneer is influenced by the amount of enamel available to bond with the restoration. Table 1 summarizes 4 types of tooth preparation that have been advocated for porcelain laminate veneers. Another factor that can influence success is the amount of remaining tooth structure in severely worn or fractured teeth.

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Inside this Issue

Preparation Design and Load-to-failure of Ceramic Laminate Veneers

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An in vitro study by Schmidt et al from the University of Washington measured the load-to-failure of porcelain laminate veneers. Variables included tooth preparation design (incisal shoulder and incisal shoulder with palatal chamfer) and the amount of remaining tooth structure (unworn tooth and simulated worn tooth; $n = 8$) for each of the 4 groups (cover illustration).

The prepared teeth were restored with pressed ceramic veneers (IPS Empress; Ivoclar Vivadent, Schaan, Liechtenstein). After the prepared teeth had been etched for 15 seconds with 37% phosphoric acid (Scotchbond Etchant Gel; 3M ESPE, St. Paul, Minn.), a bonding agent (One-step; Bisco Inc., Schaumburg, Ill.) was applied to the prepared teeth. The veneers were etched with 9.5% hydrofluoric acid (Porcelain Etching Gel; Ultradent, South Jordan, Utah) for 180 seconds, then silanated with ceramic primer (Scotchbond Primer; 3M ESPE). The etched and primed veneers were luted with light-polymerizing composite resin cement (Rely-X Veneer; 3M ESPE). Each specimen was placed in a metal holder in a universal testing machine (Model 5585H; Instron Corp., Norwood, Mass.) with a 1-kN load cell at a cross-head speed of 0.05 mm/minute loaded 1 mm from the incisal edge at an angle 90° to the palatal surface of the tooth. A load was applied until catastrophic failure occurred. Load-to-failure was recorded, along with the mode of failure (cohesive failure, adhesive and cohesive failure, adhesive failure, and root fracture).

The highest mean load-to-failure was recorded for the unworn tooth with the palatal chamfer (166.67 ± 28.89 N), followed by the unworn tooth with the shoulder finish line (131.84 ± 18.88 N), the worn tooth with the palatal chamfer (119.56 ± 23.88 N) and the worn tooth with the shoulder finish line (90.56 ± 9.32 N). The mode-of-failure data indicated that 87.5% of unworn teeth and 81.25% of simulated worn teeth had either cohesive or mixed cohesive and adhesive failures with fractured veneers.

Comment

In this study, the addition of the palatal chamfer to the incisal shoulder of the tooth preparation improved the load-to-failure rate compared with the tooth prepared with a shoulder finish line alone. Nevertheless, the study has a number of limitations. Results apply only to the materials and techniques used, and the 90° force on the veneers does not occur in a clinical setting. Specimens did not undergo thermal cycling through changing temperatures or dynamic loading (artificial aging) prior to testing. Perhaps results would have been different had the specimens been artificially aged.

Schmidt KK, Chiayabutr Y, Phillips KM, Kois JC. Influence of preparation design and existing condition of tooth structure on load to failure of ceramic laminate veneers. J Prosthet Dent *2011;105:374-382.*

Table 1. Types of tooth preparation design for porcelain laminate veneers

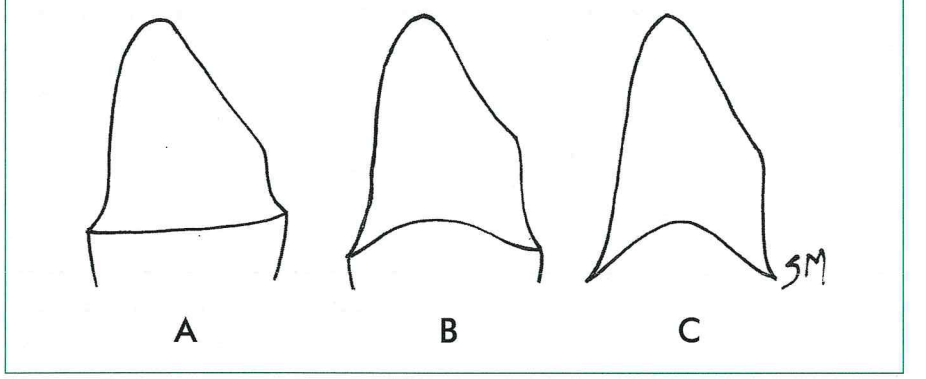
• Window preparation (limited to the facial tooth surface)
• Feathered incisal edge preparation (extended to the incisal margin, but without a definite finish line)
• Incisal shoulder finish line
• Overlapped incisal edge preparation (with a palatal chamfer)

Tooth Preparation Design and Marginal Fit of Zirconia Crown Copings

The effect of the circumferential finish-line configuration of a tooth preparation and the marginal fit of a zirconia crown coping has not been previously studied. Azar et al from the University Medical Centre of the Johannes Gutenberg University, Germany, conducted an in vitro study to evaluate the effect of 3 tooth preparation designs on marginal adaptation.

- Design A had a constant finish-line depth.
- Design B had a 1.5-mm incisal-gingival variation of the finish-line depth.
- Design C had a 3-mm incisal-gingival variation (Figure 1).

Figure 1. Schematic representation of the 3 tooth-preparation designs studied.



After the dies were fabricated, 12 zirconia copings were made for each die.

The dies were scanned with an optical scanner (CEREC inLab; Sirona Dental Systems, Bensheim, Germany). The cement space was set at 0 µm. The copings were milled and postsintered in a high-temperature furnace. Marginal gaps were measured on the facial, lingual, mesial and distal areas of the crown margins.

Results indicated that copings with a constant finish-line depth had no statistically significant differences in mean marginal gaps between facio-lingual and mesio-distal regions. In contrast, the dies with variations in finish-line depth recorded significantly different marginal gap discrepancies. Mean marginal gaps ranged from 43 µm to 67 µm.

Comment

This study reported that a tooth preparation with a variable depth to the finish-line configuration resulted in decreased marginal accuracy of the crown copings. Nevertheless, although differences were statistically significant, they were relatively small and within the range of clinical acceptability. Because of the anatomy of anterior teeth and the nature of the periodontal attachment, it is common to have a tooth preparation design with nonuniform gingival depth.

This study has some limitations. Because it could not completely simulate in vivo conditions, it could not be used to draw conclusions for clinical situations.

Azar MS, Lehmann KM, Dietrich H, et al. Effect of preparation depth differences on the marginal fit of zirconia crown copings: an in vitro study. Int J Prosthodont *2011;24:264-266.*

Translucency of Shaded Zirconia Core Material

High-strength zirconia used as substructure material for all-ceramic crowns now comes in varying shades. A study by Spyropoulou et al from the University of Michigan aimed to evaluate the effect of this shading on the translucency of zirconia.

The manufacturer fabricated disk-shaped zirconia specimens ($n = 90$) (NobelProcera; Nobel Biocare AB, Oslo, Norway) using computer-aided design/computer-aided manufacturing (CAD/CAM). The disks were 12 mm in diameter and 0.6 ± 0.01 mm in thickness. There were 3 groups ($n = 30$) according to shade:

- light
- medium
- intense

Translucency was measured with a spectrophotometer (CM-2600d; Konica Minolta, Ramsey, N.J.). Because thickness is a covariable relative to translucency, all specimens were measured prior to the spectrophotometer reading to ensure standardized thicknesses. Light reflectance was measured over a black background (Yb) and a white background (Yw). Contrast ratio (CR) was then calculated with the formula CR = Yb/Yw where CR is a measure of a material's masking ability. A value of 1.00 indicates complete masking and complete lack of translucency. The light-shaded disks had a mean CR of 0.880, medium-shaded disks had a mean CR of 0.877 and the intense-shaded disks had a mean CR of 0.885. These values suggest that there is some partial translucency to the zirconia.

Comment

Translucency can be desirable or undesirable. If the objective is to mask a discolored tooth or a cast-metal post and core beneath an all-

ceramic crown, low translucency (or a high CR value) is preferred. If the objective is to match adjacent, highly translucent teeth, a low CR value would be desirable. The differences in CR among the 3 shades would not be noticeable clinically, and the relatively high CR suggests that this zirconia substructure material would be best when used to match moderately opaque teeth.

Spyropoulou P-E, Giroux EC, Razzoog ME, Duff RE. Translucency of shaded zirconia core material. J Prosthet Dent *2011; 105:304-307.*

Long-term Survival Of Densely Sintered Alumina Crowns

Densely sintered alumina is a substructure material used for both anterior and posterior all-ceramic crowns, but studies on the survival of alumina crowns have been relatively short term. A recent prospective study by Galindo et al from the University of Basel, Switzerland, evaluated a group of 155 alumina crowns in 50 patients.

The crowns, placed at the university dental school between December 1997 and May 2005, used the Procera All-Ceram System (Nobel Biocare, Göteborg, Sweden) and were fabricated with computer-assisted design/computer-assisted manufacturing (CAD/CAM) technology. The flexural strength of alumina ranges from 487 to 699 MPa; the fracture toughness ranges from 4.48 to 6 $MPa/m^{½}$.

The core thickness of the alumina was 0.6 mm. For anterior teeth, a collarless design was used. For posterior teeth, a conventional substructure design with a collar was used. Crowns were placed with either dual polymerizing resin cement (Panavia F2.0; Kuraray Medical Inc., Okayama, Japan) or glass-ionomer cement (Ketac-Cem Aplicap; 3M ESPE, Seefeld, Germany).

Follow-up for the 112 crowns in the 29 patients ranged from 3 to 10.7 years (mean, 7.8 years). When considering technical failures only, the estimated 10-year survival probability was 95%. The estimated overall survival probability after 10 years was 84%. There were no significant differences in treatment failures between anterior teeth and posterior teeth.

Biologic failures included

- 1 endodontic failure
- 3 root fractures
- 1 periodontal failure
- 3 incidences of dental caries

Technical failures involved 2 crown fractures and 1 veneering porcelain fracture.

Comment

The study's results were comparable to other studies of all-ceramic systems using the same CAD/CAM system. The difference in this study, however, is the long follow-up time. Most of the previous studies had a follow-up time of 5–6 years. Metal-ceramic restorations are considered the gold standard for strength and durability, and the results of the present study compare favorably with longevity studies devoted to metal-ceramic restorations. Of the 3 crowns that fractured, 1 was the result of insufficient interocclusal clearance. One occurred after endodontic access through the crown, and 1 was associated with a bruxist patient.

Zirconia is a newer high-strength substructure material, but long-term data on the survival of these restorations is not available. One study reported a 92.7% survival rate for zirconia crowns, but the study covered only 3 years and was retrospective. The present study was prospective.

Galindo ML, Sendi P, Marinello CP. Estimating long-term survival of densely sintered alumina crowns: a cohort study over 10 years. J Prosthet Dent *2011; 106:23-28.*

In the Next Issue

- Prosthodontic maintenance of mandibular 2-implant overdentures
- Reinforcement of implant-supported overdentures
- Effect of horizontal misfit of implant-supported bars

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.