Prosthodontics
NEWSLETTER

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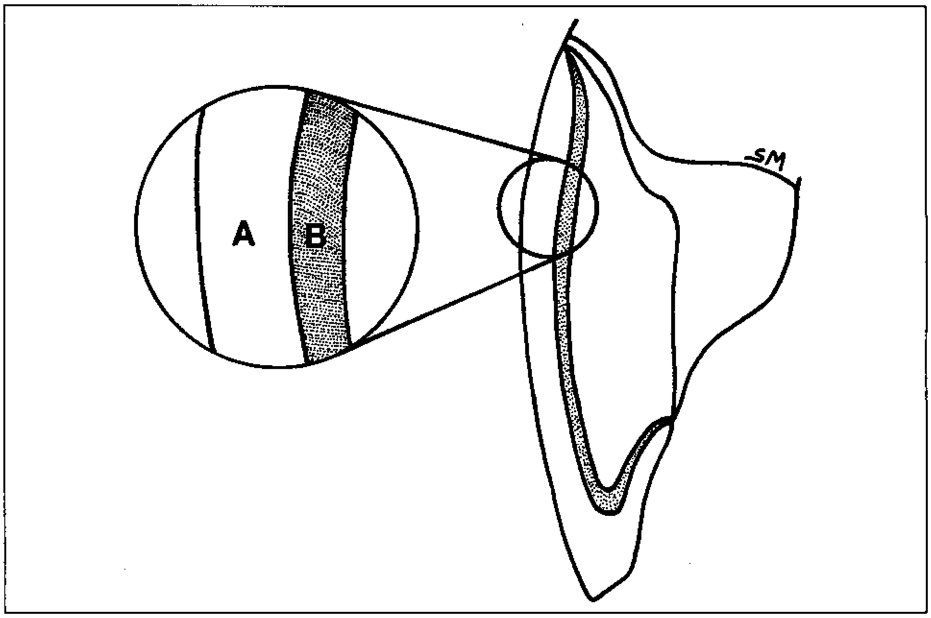

A study of the potential for porcelain laminate veneers to crack indicated that the ratio of the facial thickness of ceramic (A) to the thickness of the composite luting material (B) was a predictor of crack propensity (see *Propensity of Porcelain Laminate Veneers to Develop Cracks* inside).

All-ceramic Dental Restorations

Because of its strength and durability, the metal–ceramic crown is the most common esthetic dental restoration. All-ceramic restorations are more prone to fracture and are often reserved for placement in low stress areas of the dental arch in situations where esthetic demands are exceptionally high. Nevertheless, recent advances in dental ceramic technology have substantially improved the physical properties of a number of all-ceramic systems.

This issue of *Prosthodontics Newsletter* is devoted to recent research reports related to dental ceramic restorative materials.

Strength of Glass-infiltrated Ceramics

A recent *in vitro* study evaluated the fracture strength of magnesia-core porcelain after glass infiltration. Eighty ceramic cores for an all-ceramic crown were fabricated from magnesia-based porcelain. The cores were fired to eight different temperatures and half the specimens from each group were subjected to a glass-infiltration process.

The finished copings were bonded to filled-resin dies and tested for fracture strength with a universal testing machine. In all groups, an increase in the fracture strength was recorded for the glass-infiltrated specimens. A combination of glass infiltration and a maximal sintering temperature of 871°C or 899°C produced the strongest cores.

Comment

All-ceramic crowns continue to attract the attention of patients and dentists alike because of their superior esthetic properties, which allow a more natural appearance. Nevertheless, the ultimate strength of these all-ceramic restorations also remains a concern. Finding materials with improved resistance to fracture is a goal of researchers.

The glass infiltration method was originally described for use with aluminous porcelain cores and has been marketed as the In-Ceram technique (Vident). These glass-infiltrated aluminous cores have been reported to provide improved strength to all-ceramic crowns.

Results of this study suggest that the glass-infiltration technique can also produce exceptionally strong magnesia cores. One advantage of a magnesia core over an aluminous porcelain core is the ability to bond magnesia to tooth structure.

Bonding procedures have been shown to almost double the resistance to fracture of some all-ceramic crowns. However, it has been established that In-Ceram crowns cannot be effectively bonded to teeth.

Evans DB, O'Brien WJ. Fracture strength of glass-infiltrated magnesia core porcelain. Int J Prosthodont *1999;12:38-44.*

Evaluating Resin Cements for Porcelain-Dentin Bonding

Resin cements commonly used to bond ceramic restorations to dentin were evaluated in an *in vitro* study of their shear strengths. Two dual-cured materials (Porcelite dual-cure, Sybron Kerr, Romulus, MI, and Dual, Vivadent, Amherst, NY) and one chemically-activated resin (C&B luting composite, Bisco Inc., Itasca, IL) were the materials investigated by the authors of this study.

Conical ceramic specimens were bonded to the dentin of extracted teeth with the use of a resin adhesive (Optibond, Sybron Kerr). Shear strengths were tested at 10 minutes, 30 minutes, 90 minutes and 7 days (see Figures 1 and 2).

Bond strengths of both dual-cured resins were superior to the strengths achieved with the chemically cured material for all time periods. Nevertheless, the results indicated significantly higher strengths at 7 days as compared to early strength values for all materials.

After 7 days, the bond strengths were found to be 4-to-6 times higher

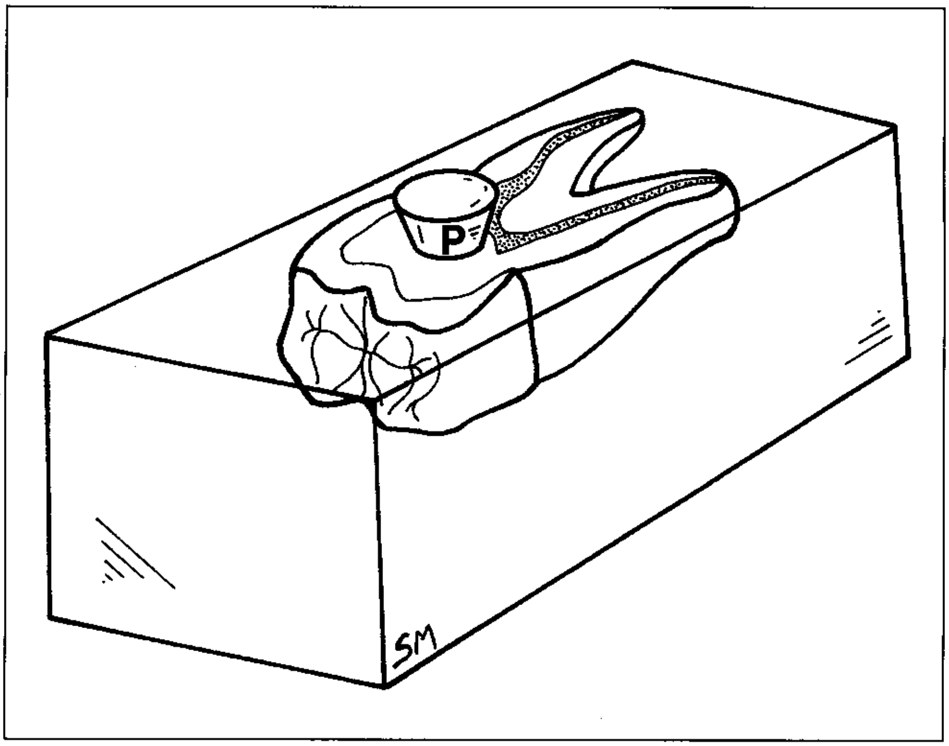

Figure 1. *To test porcelain-to-dentin shear-bond strength, teeth were embedded in acrylic resin and sectioned. Then conical porcelain samples (P) were bonded to dentin.*

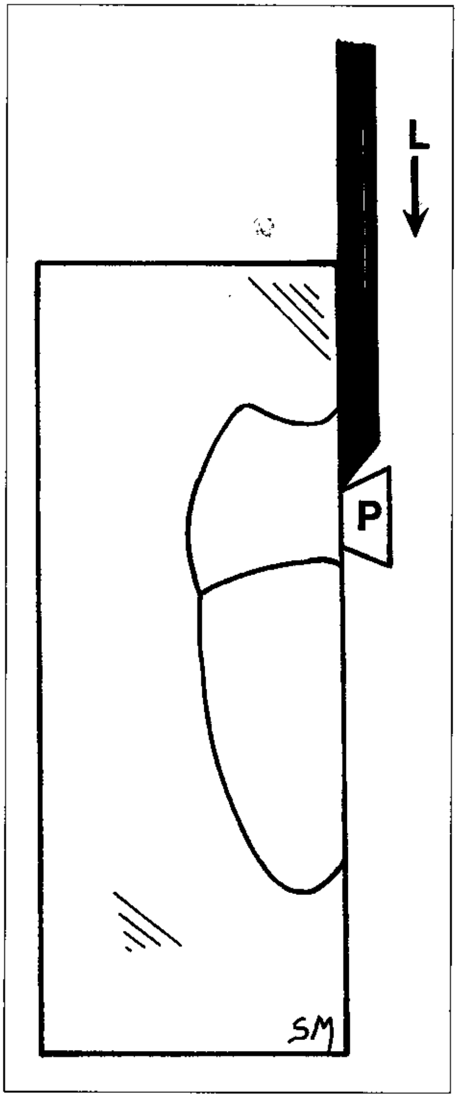

Figure 2. *Porcelain cones (P) were loaded (L) until shear failure.*

than those recorded 90 minutes after bonding.

Furthermore, there was a wide range of values recorded for all of the materials. This observation suggested that these bonding procedures were highly technique sensitive with relatively unpredictable results.

Comment

Adhesive resin cements are now commonly recommended instead of conventional cements for luting most all-ceramic restorative systems. The results of this study suggest that the resin bond is weak for at least the first 1½ hours.

Any recontouring of the restoration after the luting process can be detrimental to the immature resin bond.

Dentists should be aware of this feature of the curing process of resin cements and avoid stressing resin-bonded all-ceramic restorations soon after luting.

Braga RR, Ballester RY, Carrilho MRO. Pilot study on the early shear strength of porcelain-dentin bonding using dual-cure cements. J Prosthet Dent *1999;81:285-89.*

Propensity of Porcelain Laminate Veneers to Develop Cracks

A recent investigation of the simulated clinical behavior of porcelain laminate veneers evaluated the potential for developing cracks in veneers luted to extracted teeth. One standardized porcelain veneer was fabricated by 27 dentists for 27 extracted teeth.

Veneers were silanated and luted with a composite resin bonding technique. Specimens were stored for 21 days, then thermocycled from 5°C to 50°C for 1000 cycles. The veneers were carefully investigated for cracks before and after the thermocycling process.

After the specimens were sectioned, both the thickness of the veneering porcelain and the resin lute were measured by scanning electron microscopy.

Results indicated cracks in 11 of the 27 veneers and that the cracks only occurred after thermocycling. The ratio of the facial thickness of ceramic and the composite resin lute (CER/CPR) was calculated and found to influence the incidence of cracking.

It was determined that restorations with a facial CER/CPR ratio greater than 3 were less likely to crack. Most cracks were found in specimens with a ratio less than 3.

Comment

The porcelain laminate veneer was introduced more than 10 years ago and has become popular as a method of conservatively restoring anterior teeth. The combination of 3 unlike materials (ceramic, composite resin and natural enamel) will result in mismatched thermal coefficients of expansion and contraction under normal clinical conditions.

Results of this study suggest a high potential for cracking and ultimate failure of a porcelain laminate veneer under certain conditions. A relatively thick layer of composite resin with a thin overlying layer of ceramic appears to place undue stress on the ceramic veneer as a result of differing thermal coefficients of the materials.

The authors found an increased potential for crack formation in thin ceramic veneers only when the resin film was relatively thick. Therefore, it appears that thin veneers are not a problem when other conditions are optimal.

This study indicates that tooth preparation for a porcelain laminate veneer should be well controlled to ensure uniform reduction of the facial surface of the tooth. Taking this into account, the technician should avoid inordinate relief of the die to prevent excessive thickness to the composite resin film.

Mange P, Kwon K-R, Belser UC, et al. Crack propensity of porcelain laminate veneers: a simulated operatory evaluation. J Prosthet Dent *1999;81:327-34.*

Next:

- Counter-torque device for implants
- Factors influencing implant success
- Fit of implant-supported prostheses

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

Comparing Bond Strength of Etched Ceramics

A recent study evaluated the effects of surface treatments on the bond strength of two dental ceramic materials. GC ceramic (GC Dental Industrial) and PVS ceramic (SS White) were tested for the effects of no surface treatment, etching with hydrofluoric acid alone and etching plus silane treatment. The surface roughness of the two ceramic materials after etching was also evaluated with scanning electron microscopy.

Results of the bonding study indicated that etching the ceramic materials with hydrofluoric acid combined with the silane treatment produced the best tensile bond strengths. The topography-profile study indicated a greater increase in surface roughness from the etching procedure with the PVS ceramic.

Comment

Many porcelain restorations are bonded to tooth structure and bonding has been reported to significantly increase the survival of these restorations. For optimal results, this particular study indicates that the practitioner should etch the restorations with hydrofluoric acid and apply a silane coupling agent after adjusting the restoration in the mouth and immediately prior to the bonding procedure.

Jardel V, Degrange M, Picard B, et al. Correlation of topography to bond strength of etched ceramic. Int J Prosthodont *1999; 12:59-64.*

Effects of Cyclic Loading on Dental Ceramics

Two materials that are commonly used for all-ceramic crowns were evaluated for their resistance to fatigue failure. Glass-infiltrated aluminous porcelain disks (In-Ceram, Vident) and leucite-reinforced porcelain disks (IPS-Empress, Ivoclar Williams) were tested. The disks were prepared as a monolayer of core material only and as a core layer laminated with a veneering porcelain.

For each experimental condition, half the disks were polished smooth and half were prepared with a standardized minute crack. Specimens were tested for their biaxial flexural strengths. Additionally, specimens were dynamically loaded for 10^5 cycles at 60% of their mean breaking loads.

For the aluminous porcelain system, precracking significantly reduced resistance to fatigue failure, whereas pre-cracks had no significant effect on the results for the leucite system.

Comment

In vitro testing of materials is valuable but results may not predict clinical behavior. Failure in the mouth is usually the result of fatigue (i.e., after a great many load cycles, but with each load below the fracture threshold). Therefore, static tests of flexural strength alone may be misleading.

Results of this study suggest that In-Ceram crowns are susceptible to fatigue failure when microcracks are present. IPS-Empress crowns, on the other hand, appear less sensitive to fatigue failure.

Ohyama T, Yoshinari M, Oda Y. Effects of cyclic loading on the strength of all-ceramic materials. Int J Prosthodont *1999;12:28-37.*

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.