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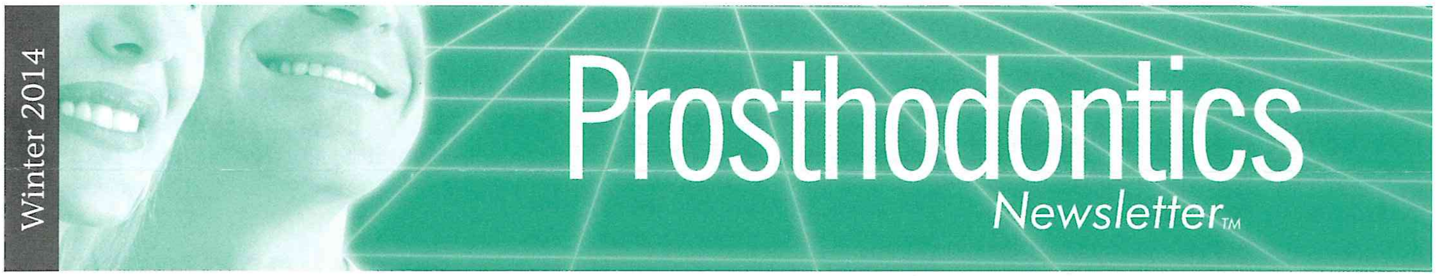

Dental Material Science for Practitioners

Appropriate manipulation of a variety of materials by the restorative dental team is critical to successful and durable dental restorations of all kinds. Unfortunately, keeping up with the world of restoration material science is both intellectually challenging and extremely time-consuming. Every day, the dental team faces many important questions that dramatically impact the delivery of restorative dentistry. To gain insight, regular investigation of the professional literature is essential.

Long-term Performance of Bilayer Ceramic Restorations

While bilayer ceramic–ceramic prostheses are becoming the choice to replace coronal structures and missing teeth, few randomized, controlled studies have evaluated their performance. Esquivel-Upshaw et al from the University of Florida College of Dentistry analyzed the clinical performance of 3 types of full crowns: a metal–ceramic crown made from a palladium–gold–silver–tin–indium alloy; a nonveneered (glazed) ceramic–ceramic crown made from lithium disilicate glass–ceramic; and a core ceramic/veneer ceramic crown made from lithium disilicate glass–ceramic with a glass–ceramic veneer.

Twelve of each crown type were randomly placed in 32 patients according to 11 criteria: tissue health; secondary caries; occlusion; proximal contact; marginal integrity; absence of sensitivity to percussion, heat, cold and air; color match; surface texture; absence of opposing tooth wear; anatomic contour; and presence or absence of cracks/chips or fracture. They were rated on a scale of 1 (unacceptable and needing immediate replacement) to 4 (excellent). Patients were followed at 1, 2 and 3 years after placement.

At both the 1- and 2-year recall, no statistically significant differences were found for any of the 11 criteria among the 3 types of crowns, with all crowns rated either good or excellent. However, at year 3, the metal–ceramic crowns performed significantly better ($p < .001$) in surface texture and crown wear. Roughness on both types of the ceramic–ceramic crowns was noted primarily on the contact areas along the buccal (for the mandibular teeth) or lingual

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(for the maxillary teeth) surface and the occlusal surfaces.

Comment

The authors suggested that the surface roughness seen in year 3 could have resulted from loss or degradation of the glaze. Further studies are needed to determine why the glass–ceramic veneer on the metal–ceramic crowns showed superior performance.

Esquivel-Upshaw J, Rose W, Oliveira E, et al. Randomized, controlled clinical trial of bilayer ceramic and metal-ceramic crown performance. J Prosthodont *2013; 22:166-173.*

Stability of Definitive Casts

Gypsum, used extensively in dentistry, is required for the traditional manufacture of definitive restorations. The American National Standards Institute/American Dental Association classifies dental gypsum into 5 types; definitive casts are made from Types IV and V (high-strength) dental stones. Ideally, these definitive casts would remain stable for an extended period of time to achieve accuracy in the creation of definitive restorations. Unfortunately, such stability may not be the norm.

Michalakis et al from Tufts University School of Dental Medicine, Massachusetts, subjected 5 different high-strength stones to 2 different storage conditions and noted linear dimensional changes at 1, 24, 48, 72 and 96 hours, as well as at 1, 2 and 3 weeks. The materials, all routinely used for fabricating definitive casts, came from 5 different manufacturers: Fujirock EP (GC America Inc., Alsip, IL), Vel-Mix (Kerr Corp., Orange, CA), Suprastone (Kerr Corp.), Hard Rock (Whip Mix Corp., Louisville, KY) and Jade Stone (Whip Mix Corp.). Three were classified as Type IV and 2 as Type V.

The stone powder was mixed with water following manufacturers' instructions and poured into a die, with 20 specimens made of each stone. These stones were then evenly divided into 2 groups:

- **Control group:** stored at 21° ± 1°C at 50% ± 10% relative humidity
- **Experimental group:** stored at 40° ± 1°C at <20% relative humidity

The stones were measured at 8 time intervals. All experimental group Type IV dental stones contracted after 24 hours and continued to slowly contract through 2 weeks; similar results were found for Type V dental stones.

On the other hand, control group stones expanded through the first 96 hours by 0.19% ± 0.17% for Type IV stones and 0.36% ± 0.02% for Type V stones. The control group's Type IV stones showed contraction at 1 and 2 weeks, as did 1 of the Type V stones. All stones in both groups showed no change between 2 and 3 weeks.

Comment

The risk of contraction appears to be greater when stones are subjected to higher temperatures and lower humidity. Dentists who practice in regions with a hot, dry climate should complete framework waxing and casting procedurés as soon as possible to avoid shrinkage of the stone.

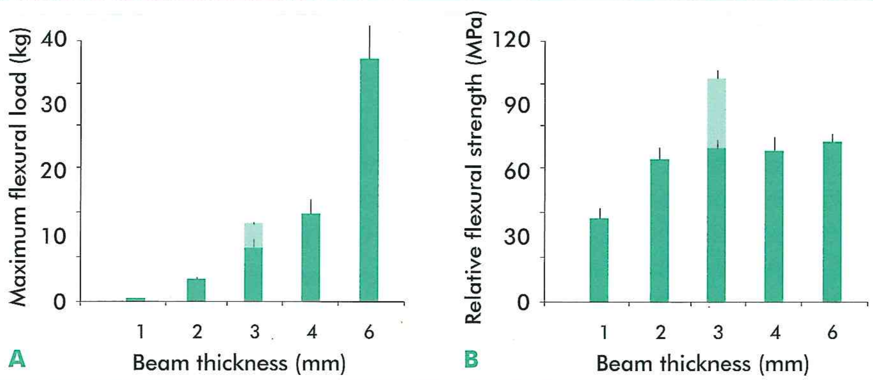
Michalakis KX, Asar NV, Kapsampeli V, et al. Delayed linear dimensional changes of five high strength gypsum products used for the fabrication of definitive casts. J Prosthet Dent *2012;108:189-195.*

Avoiding Denture Base Fractures

Fracture of fixed and removable resinous prostheses usually occurs near overdenture abutment teeth or implants, where localized stress is likely to focus. New polymeric materials, sometimes reinforced by metal or fiber, offer the hope of additional strength and uniformity within the denture base, but many studies of the effects of base thickness on fracture resistance do not account for other variables that contribute to failure. Choi et al from the New York University College of Dentistry studied how flexural strength is affected by the thickness of a resinous beam containing a prosthetic tooth.

The researchers created 1-, 2-, 3-, 4- and 6-mm-thick ($n = 7$) resin beams, each with a prosthetic tooth centrally placed; 7 3-mm beams without teeth served as controls. All specimens were artificially aged by thermocycling and mechanical testing, then subjected to extensive fracture testing. The 1- and 2-mm-thick beams survived the testing without fracture; thicker beams all

Figure 1. (A) Maximum flexural loads of acrylic resin beams. Greater thickness markedly increased the load-bearing capacity of resinous beams containing denture teeth. The presence of a denture tooth substantially decreased the load-bearing capacity of resinous beams. (B) Relative flexural strength of acrylic resin beams. The 2-, 3-, 4- and 6-mm beam groups with denture teeth did not differ in relative flexural strength; the 1-mm-thick beams behaved in a mechanistically different manner. The presence of a denture tooth substantially decreased the relative flexural strength of resinous beams. In both graphs, dark green bars represent beams with denture teeth; the light green bar superimposed on the 3-mm-thick group represents the 3-mm-thick beams without denture teeth.



underwent brittle fracture. That the fractures rarely occurred directly against the tooth suggested that the bond between the tooth and the base withstood the artificial aging.

Ranging from 0.6 kg (1-mm thick) to 38 kg (6-mm thick), each thickness group's supported load differed significantly from those of the other groups; the 4-mm-thick beams supported 4× the load supported by the 2-mm-thick beams. The control beams supported 1.4× more load than did comparable beams with teeth, suggesting that the presence of denture teeth significantly reduced the beams' load-bearing capacity (Figure 1).

Comment

This study suggested that a thicker denture base will lead to a longer-lasting prosthesis. The requirement for a minimum denture base thickness of 2 mm seems to be supported by these findings.

Choi M, Acharya V, Berg RW, et al. Resinous denture base fracture resistance: effects of thickness and teeth. Int J Prosthodont *2012;25:53-59.*

Fracture Strength Of All-ceramic Crowns

Compared with metal–ceramic restorations, all-ceramic restorations demonstrate many advantages. Not only are they more esthetically pleasing, mimicking the translucency of natural teeth, but all-ceramic restorations are biocompatible, impervious to corrosion and hypoallergenic. However, despite their popularity in the esthetic zone, metal–ceramic restorations have been preferred for posterior teeth because of the high occlusal loads experienced there.

Skouridou et al from the University of Sheffield, United Kingdom, tested the fracture strength of all-ceramic resin bonded crowns on teeth prepared both traditionally and using techniques of minimally invasive dentistry. Maxillary first molar teeth were prepared for all-ceramic crowns using 3 different designs:

- **Group 1:** Traditional preparation for crowns (2-mm occlusal reduction, 1.5-mm round shoulder; $n = 10$)
- **Group 2:** Minimal preparation for crowns (1.2-mm occlusal reduction, 0.8-mm chamfer; $n = 10$)
- **Group 3:** Ultra-minimal preparation for occlusal veneers (0.8-mm occlusal reduction, 0.5-mm chamfer; $n = 10$)

All restorations were manufactured from a machinable leucite-reinforced glass ceramic material, glazed and bonded according to the manufacturers' instructions. They then underwent thermocycling and mechanical loading (TCML), with human molars as antagonists, to simulate 5 years of service in the posterior dentition. Crowns that survived the TCML without developing cracks were loaded until failure using a fracture-testing machine.

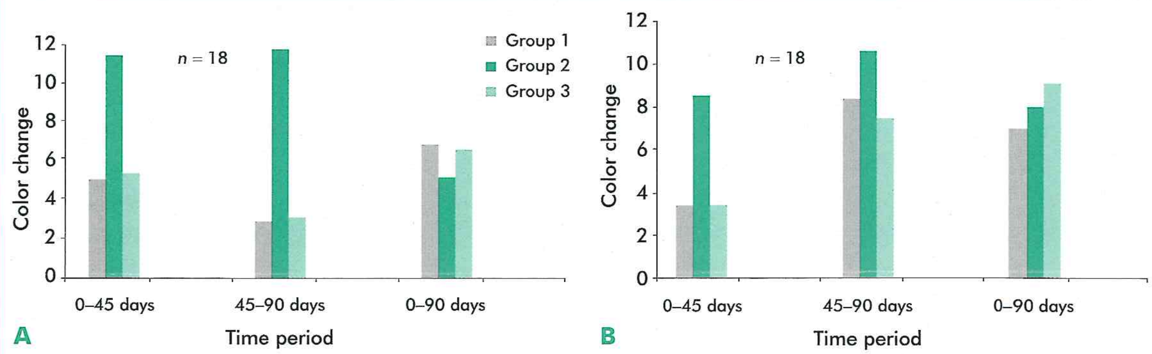
In group 1, 3 of the 10 crowns developed surface cracks during TCML, as did 4 of the 10 crowns in group 2 and all 10 crowns in group 3. The mean fracture resistance was 1070 ± 181 N for group 1 crowns and 1110 ± 222 N for group 2 crowns, an insignificant difference.

Comment

The goal of using minimally invasive methods to preserve as much tooth structure as possible is a worthy one. However, more study is needed to determine which materials and techniques can best help reach that goal.

Skouridou N, Pollington S, Rosentritt M, Tsitrou E. Fracture strength of minimally prepared all-ceramic CEREC crowns after simulating 5 years of service. Dent Mater *2013;29:e70-e77.*

Figure 2. Color change of group 1 (Vita VMK 95), group 2 (Ceramco-3) and group 3 (Duceram Kiss) after exposure to coffee (A) and tea (B) for 45 days and 90 days.



Color Changes in Dental Porcelains

One difficulty with feldspathic porcelain restorations is that they may become discolored over time from the chemical instability of the porcelain or exposure to various foods and drinks. Jain et al from Hitkarini Dental College, India, evaluated the color change of 3 different dental porcelains after exposure to common beverages (Figure 2).

The study included 30 porcelain samples from each of 3 brands: Vita VMK 95 (Vident, Brea, CA), Ceramco-3 (Dentsply, York, PA) and Duceram Kiss (DeguDent, Hanau, Germany). The specimens were immersed in 300 mL of 5 different beverages: coffee, Coca-Cola, orange juice, tea and water.

Using brightness, red/green and yellow/blue coordinates, each specimen was measured for color before immersion, then after 45 and 90 days in the beverage. Each was also measured for surface topography, another factor in color shifting, at baseline and after 90 days.

At 90 days, the Vita VMK 95 specimens showed a general trend toward greater brightness and shifts toward the red and yellow axes; the Ceramco-3 specimens showed a decrease in brightness and fairly stable measurements in the other 2 dimensions; the Duceram Kiss specimens showed a decrease in brightness (although with a much larger variation in results than shown in the other porcelains). None of the color shifts for any combination of porcelain and beverage reached statistical significance. Orange juice caused the maximum surface roughness among all the beverages.

Comment

In general, coffee caused more discoloration than did the other beverages. Surface roughness differed significantly among the brands of porcelain, which may reflect different chemical compositions.

Jain C, Bhargava A, Gupta S, et al. Spectrophotometric evaluation of the color changes of different feldspathic porcelains after exposure to commonly consumed beverages. Eur J Dent *2013;7:172-180.*

In the Next Issue

Factors associated with worn dentitions

Our next report features a discussion of this issue and the studies that analyze it, 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.