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EDITORIAL

Computers and Dental Computing

Our world, both professional and personal, is changing rapidly. One of the dominating influences mandating change is within the world of computers. Many dentists now have computers in their offices, and yet a large percentage do not. Are they missing out on something, or is this just an office gadget to intimidate the dentist and his/her staff?

Personal computers are relatively new; only in the past decade have they become available. During that time computers have changed remarkably. Computers available today are much less expensive, and have the speed and the capability of manipulating data and text in a manner once only possible with large mainframe computers. The computers of today are in a price range almost everyone can afford, and yet many do not consider them to be practical.

Many people hesitate to get into computing because the technology is changing rapidly, and they don't want to start until the final development of the "ultimate model" is delivered. Of course such logic just moves those individuals farther and farther out of the cycle.

Just how practical are computers, anyway? There are computer programs available for today's office which would make the practice much easier and more cost-effective to operate. These programs would allow insurance claims to be printed out and billed at each patient visit, or they could be sent via the computer on a telephone line to the insurance office for instantaneous delivery. Patient billing could be handled by the computer with statements automatically run for all outstanding accounts, including the printing of the envelopes. Offices could handle correspondence in a more timely manner with a word processor. Documents written on the computer are easily corrected and most word processors have built-in spelling-checkers.

Expanding computer technology will have a much greater impact upon our profession and our lives within the next three to five years than have past computer applications. Within that time we will see: computers into which you can enter data directly by voice communication; dental records stored entirely on the computer, taking less time to create the record than at present; filmless radiographs stored on the computer for future use, as well as the ability to enhance radiographs; storage of video records of the patient's oral cavity, to include, if you like, the treatment you provided; and the computer's ability to evaluate your treatment performance based on the record of treatment and its success or failure. Dentists would be assisted by the ability to use the computer to access known sources of information, such as the *Physicians' Desk Reference*, currently available on a computer disk. Also available is a computer program concerning drug interactions; you can access this to get an instant response to your questions. Things to come include "Computer Bulletin Board," which dentists will access through their computers to ask for information of anyone who cares to answer the question, including university faculty. Soon you will be able to use your computer to dial a university bulletin board and ask about the new "Brand X" the salesperson was promoting in your office. If you want to know what the current research shows on selected topics, it will be at your fingertips--for a fee, of course.

Dentists need to get on the "computer bandwagon" now. To delay will be costly, for in the relatively near future you will be left far behind. Get a computer at home also and equip it with a telephone modem. You will be surprised how much you can get out of it. Come join us; it's exciting!

David J Bales
Editor

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ORIGINAL ARTICLES

Microleakage of Castings Cemented with Glass-Ionomer Cements

HEBER GRAVER • HENRY TROWBRIDGE
KLARA ALPERSTEIN

Summary

When metal copings were luted to prepared, extracted teeth with KetacCem, ChemBond, TempBond, and zinc-oxide-eugenol (ZOE), only thermocycled ZOE exhibited severe leakage. It appears unlikely that postcementation microleakage is the cause of tooth sensitivity associated with the use of glass-ionomer cements.

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INTRODUCTION

Recently, glass-ionomer cements have been used to lute cast-metal restorations to vital teeth; however, there have been reports of sensitivity following the use of glass-ionomer cements (Council on Dental Materials, Instruments and Equipment, 1984; Charbeneau, Klausner & Brandau, 1988). While sensitivity has been attributed to the initial acidity of glass-ionomer cements (Smith & Ruse, 1986), excessive hydraulic pressure created by cementation (Pameijer & Stanley, 1984), and improper manipulative techniques (Berry & Berry, 1987), the cause of the problem is still a matter of conjecture.

Experimental evidence supports the view that tooth sensitivity and pulpal inflammation are closely related (Lundy & Stanley, 1969; Johnson, Dachi & Haley, 1970). In restorative dentistry a major cause of pulpal inflammation is bacterial colonization of cavity walls (Brännström & Nybörg, 1971; Vojinović, Nybörg & Brännström, 1973; Brännström, 1984). The results of other studies suggest that bacteria will grow beneath restorations only in the presence of microleakage (Bergenholtz & others, 1982; Cox & others, 1987). Consequently, if glass-ionomer luting cements fail to provide an adequate marginal seal, it is possible that pulpal inflammation resulting from microleakage may play a role in postcementation sensitivity.

In general, dental restorative materials exhibit varying degrees of microleakage because they do not adapt perfectly or adhere chemically to tooth structure. As a consequence, saliva with its bacterial components can penetrate the gap between the dental restoration and the cavity wall. Microleakage remains a major cause of clinical failures in restorative dentistry by causing tooth discoloration, accelerated deterioration of some restorative materials, recurrent caries, pulp pathology, and postoperative tooth sensitivity (Walton, 1987).

The present investigation had two objectives: 1) to assess the extent and nature of tooth sensitivity following the use of glass-ionomer luting cements, and 2) to determine whether microleakage might contribute to this problem.

MATERIALS AND METHODS

Questionnaire

In an attempt to determine the extent to which patients experience postoperative sensitivity following the use of glass-ionomer luting cements, a questionnaire was designed and mailed to 40 practicing dentists (Fig 1). These dentists were selected because they had contacted a dental manufacturer's representative to report that cementation of castings with glass-ionomer luting cements had resulted in tooth sensitivity.

Leakage Study In Vitro

In order to determine whether marginal leakage might contribute to postcementation sensitivity, tests were conducted on extracted, caries-free premolar and molar teeth. Immediately following extraction the teeth were cleaned and stored in a 0.9% saline solution until ready for use. The teeth were prepared for full crowns as follows: A tapered round-end diamond stone was used in a high-speed handpiece with an air-water spray to accomplish the occlusal, approximal, and lateral reductions and to produce a chamfer effect at the gingival cavosurface margin. Subsequently, a technique-metal coping was fabricated for each specimen.

The specimens were divided into four experimental groups. A different luting cement was used in each group. The products tested were as follows: ZOE Cement (SS White Co, Holmdel, NJ 07733) (Powder: Lot No 19963; Liquid: Lot No 96); ChemBond (LD Caulk Co, Milford, DE 19963) (Powder: Lot No 081579; Liquid: Lot No 080879); KetacCem (ESPE-Premier, Norristown, PA 19401) (Powder: Lot No 0044; Liquid: Lot No 006) or TempBond (Kerr/Sybron Corp, Romulus, MI 48174) (2 Pastes: Lot No 51248).

Positive controls consisted of specimens in which no luting agent was used to cement the

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1. How often have you used glass-ionomer cements for cementing castings?

2. How often have patients complained of postcementation sensitivity (approximate percent of total cases)?

3. Which products have you used?

4. In general, how soon after cementation did the teeth become sensitive (i e, hours, days, weeks, months)?

5. About how long did the sensitivity last?

6. Nature of the pain (circle appropriate answers):

   mild / moderate / severe / spontaneous (unprovoked) / continuous / evoked by thermal stimuli / evoked by biting pressure

7. How was the sensitivity usually managed?

   ___The sensitivity eventually disappeared without intervention

   ___The casting was removed

   ___Root canal treatment

   ___Other (please explain)

8. Have you had sensitivity problems with other types of cements? If so, which ones?

9. Additional comments (Use back of form if more space is needed).

FIG 1. *Questionnaire*

coping to the crown preparation. In most specimens the exposed dentin of the crown preparation was air-dried prior to cementation of the metal coping. In some of the specimens, however, the dentin was moistened with tap water using a damp cotton pledget. All cements were mixed according to manufacturers' directions.

In each specimen cement was applied to the periphery of the interior of the coping as well as to the entire cavity preparation. Copings were then placed on the crown preparation so as not to trap air and held for the recommended length of time with a firm, steady pressure. Excess hardened cement was removed with a sharp scaler. The dentin of specimens in the Chem-Bond group was coated with varnish according to the manufacturer's directions. No varnish was used in the other groups. All of the specimens were then stored in a 0.9% saline solution.

One day following cementation approximately one-half of the teeth in each of the experimental groups were thermocycled 50 times through water baths of 3 °C and 60 °C for one minute in each bath.

After sealing the apical foramen with green stick compound, all of the specimens were immersed in methylene blue dye solution (2%) for one hour. The specimens were then removed and thoroughly washed in water, dried, and embedded in wax. A circular diamond saw was used to section each tooth faciolingually through the center of the restoration in order to expose the occlusal, axial, and gingival interfaces between the coping, cement, and tooth structure.

The sectioned specimens were examined and photographed under a dissecting microscope. The extent of dye penetration beneath the castings and into the dentin was scored according to a system modified after Andrews and Hembree (1975) (Table 1).

Table 1. Scale of Marginal Leakage around Restorations

Degree of microleakage	Level of methylene blue dye penetration at interface of metal coping and tooth
0	None
1	Slight, at cavosurface angle
2	Moderate, along the gingival wall but not penetrating to the axial wall
3	Extensive, including the axial wall
4	Gross, including the axial wall and penetration into dentinal tubules under the axial wall to the pulp chamber

RESULTS

Questionnaire

Thirty-four of the 40 dentists (85%) who were mailed questionnaires regarding postcementation sensitivity completed and returned the questionnaire. Sixty-three percent of the respondents had used glass-ionomer cements to lute castings more than 100 times. All of the respondents had experienced the problem of postcementation sensitivity, some on many occasions. Usually the sensitivity had developed within a few days following cementation. The intensity of the pain experienced by patients varied from moderate to severe. In most cases the dentist relieved the sensitivity by removing the casting and recementing it with zinc oxide-eugenol (ZOE). Sensitivity seldom regressed spontaneously. Occasionally sensitive teeth required root canal treatment. Zinc phosphate cement was the only other luting cement that was associated with postcementation sensitivity.

Leakage Study In Vitro

The results of assessment of marginal leakage around metal copings are summarized in Table 2. The most severe leakage was observed in positive control specimens where no cement was used. Moderate to severe leakage was observed in some of the ZOE specimens. Figure 2 depicts moderate leakage in a ZOE specimen in which the dentin was air-dried prior to cementation of the casting. The dye penetrated along the gingival walls but not along the axial walls (second-degree microleakage).

Gross marginal leakage was observed in ZOE specimens in which the dentin was air-dried prior to cementation and the specimens were subsequently thermocycled (Fig 3). The dye had penetrated fully along the axial walls as well as in

Table 2. Measurements of Marginal Leakage around Restorations

Luting Material and Procedure	Degree of Marginal Leakage 0	1	2	3	4	Total Number of Restorations
No cement (positive control)	0	0	0	0	2	2
ChemBond, moist field, thermocycled	10	0	0	0	0	10
KetacCem, moist field thermocycled	10	0	0	0	0	10
TempBond, moist field, thermocycled	10	0	0	0	0	10
KetacCem, air-dried	9	1	0	0	0	10
KetacCem, air-dried, thermocycled	9	1	0	0	0	10
ChemBond, air-dried	10	0	0	1	0	11
ChemBond, air-dried, thermocycled	6	4	0	0	0	10
ZOE	4	3	3	0	0	10
ZOE, thermocycled	1	0	0	3	6	10

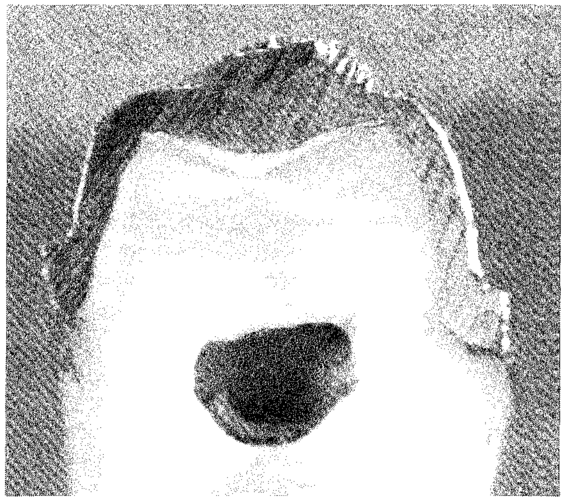

FIG 2. *A section through a metallic restoration luted with ZOE cement. Methylene blue dye has penetrated along the gingival wall. (Example of second-degree marginal leakage)*

the dentinal tubules under the restoration and extended to the pulp chamber (fourth-degree microleakage).

No dye penetration occurred in 28 of 30 specimens in the KetacCem group. Figure 4 depicts a specimen from this group in which the dentin was air-dried prior to cementation. There was no evidence of marginal leakage (zero-degree

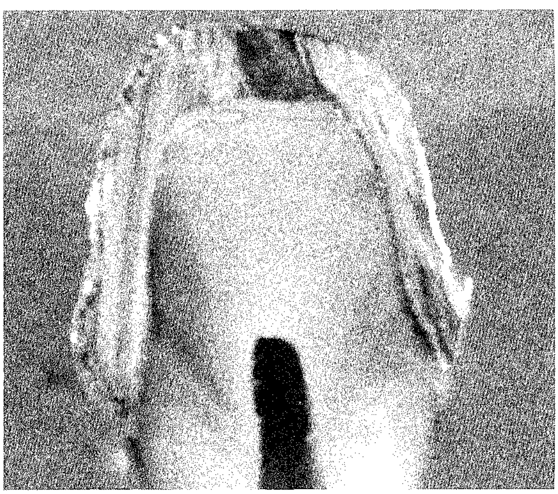

FIG 3. *A section through a thermocycled metallic restoration luted with ZOE cement. Methylene blue dye has penetrated along the axial walls and to the pulp chamber. (Example of fourth-degree marginal leakage)*

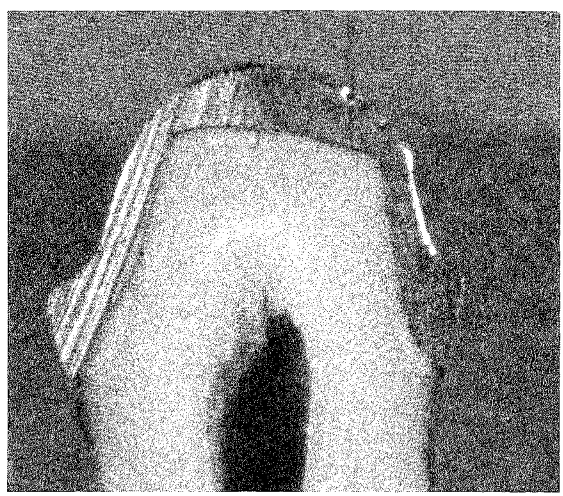

FIG 4. *A section through a metallic restoration in which the dentin was air-dried prior to cementation with KetacCem; no marginal leakage*

microleakage). First-degree microleakage was observed in two specimens from this group. In both specimens the dentin was air-dried prior to cementation. One of the specimens had been subjected to thermocycling. Moistening the dentin prior to cementation had no effect on the extent of dye penetration.

ChemBond was used to lute copings to 31 prepared teeth. Severe marginal leakage was observed in only one specimen belonging to the subset in which the dentin was air-dried prior to cementation of the casting. This specimen had not been thermocycled. Slight leakage occurred in four of 10 specimens which were air-dried and later thermocycled. No specimens showed dye penetration when the dentin was moistened prior to cementation.

When ZOE was used to lute copings to 20 prepared teeth, 15 restorations showed some degree of leakage. Five restorations showed no leakage while nine restorations exhibited extensive to gross microleakage.

TempBond was used to lute 10 restorations to prepared teeth. In these specimens the dentin was moistened prior to cementation and the specimens were subsequently thermocycled. None of the specimens exhibited any degree of microleakage.

DISCUSSION

The survey carried out in this study provides further evidence that the use of glass-ionomer luting cements may be associated with post-restorative sensitivity; however, there was great variability among the respondents with regard to the incidence of sensitivity. The incidence in some practices was very high while in others it was quite low. This variability is difficult to explain, but it suggests that the problem may be operator-related.

One of the oldest and most frequently used methods for the study of microleakage around restorations is the use of organic dyes such as methylene blue. The significance of such studies has been questioned, as marginal leakage of dyes in laboratory studies is not proof that fillings will fail clinically. In fact, the vast majority of restorations are successful even though the margins of most restorations can be penetrated by dyes. As dye molecules are much smaller than bacteria, marginal penetration of dye is probably not a crucial measure of microleakage; however, severe dye penetration may indicate that the gap at the margin of restorations is large enough to permit the entrance of bacteria.

If the coefficient of thermal expansion of a restorative material differs significantly from that of tooth structure, the dimensions of the space around the filling material will change as the tooth is subjected to temperature variations. This will result in expansion or contraction of fluid in the space as well as fluid exchange between the tooth and restoration (Nelsen, Wolcott & Paffenbarger, 1952). For this reason, it has become common practice to subject specimens to thermocycling in microleakage experiments in vitro. It is felt that thermocycling simulates clinical conditions that may stress the marginal seal (Bauer & Henson, 1984). The number of cycles that should be employed is a matter of debate. Recently it has been reported that short-term cycling appears to be as effective as protracted cycling regimens (Crim & García-Godoy, 1987). The clinical relevance of thermocycling has been challenged (Brännström, 1984; Trowbridge, 1987).

The results of this study showed that no significant leakage occurred with two cements, KetacCem and TempBond. Moistening the dentin prior to cementation did not result in dye penetration with either of these cements.

KetacCem is a fast-setting, newer type of glass-ionomer cement. It consists of a calcium-aluminum-fluorosilicate and polyacrylic acid mixture in powder form. The liquid consists of an aqueous solution containing an accelerator (Stark, 1984). KetacCem adheres chemically to tooth structure, stainless steel, semiprecious metals, tin-coated gold, and platinum. It is more resistant to an aqueous environment and therefore adheres readily to wet tooth structure, thus leaving a minimal film thickness. The excellent film thickness attained with this cement provides a completely seated crown margin. Because it sets rapidly and is more resistant to hydration, a protective waterproof varnish need not be placed over KetacCem while it is setting. Once it has set, KetacCem exhibits an extremely low solubility in oral fluids (Mount & Makinson, 1982; Smith, 1983). Presumably these desirable properties provide an explanation as to why in the present study the specimens in the KetacCem group exhibited little or no marginal leakage.

In the ChemBond group, slightly more marginal leakage occurred when the dentin was air-dried prior to cementation of the casting. ChemBond is an older, slower-setting type of glass-ionomer cement based on the hardening reaction occurring between aluminosilicate glass powder and an aqueous solution of polyacrylic acid (Wilson & Kent, 1972). It is particularly susceptible to attack by water during the setting reaction. According to Mount & Makinson (1982), glass-ionomer cements with a prolonged setting time should remain undisturbed for approximately 60 minutes to be sure that the material is sufficiently resistant to hydration upon exposure to the oral fluids. During this time the restoration must be coated with a waterproof varnish or the physical properties will be adversely affected.

It has been shown that varnishes are effective in reducing the diffusion of fluids around the margins of restorations (Going & Massler, 1961). A study in vitro comparing varnish-protected margins of ChemBond to unprotected margins demonstrated dramatically less microleakage in the varnish-protected group (Myers & others, 1983). In a clinical study ChemBond, which was isolated from moisture during setting, demonstrated lower solubility than zinc-phosphate cement (Mitchem & Gronas, 1981).

The slightly greater degree of leakage occurring around copings cemented with ChemBond could have resulted from one of several factors: 1) hydration of the cement before it was fully set, 2) an incomplete layer of varnish over the cement after the cement had set, or 3) weaker bonding between the older type of glass-ionomer cement and the metal casting.

Severe leakage occurred only when no cement was used or when ZOE cement was used and the specimens were subjected to a thermocycling regimen. ZOE has been shown to have superior sealing properties when used as a cement for restorations, and for this reason it has been employed in surface-sealing experiments to exclude bacteria from cavities (Brännström, 1982; Cox & others, 1987). Set ZOE cement consists of zinc-oxide particles embedded in a matrix of zinc eugenolate. The coordinate bond of the eugenolate is weak and is readily hydrolized to yield free eugenol and zinc oxide (Hume, 1986). When ZOE comes into contact with free water, immediate release of eugenol occurs. Wilson and Batchelor (1970) claim that aqueous leaching of eugenol from ZOE cement is continuous as the cement matrix hydrolizes. Eventually the cement loses its mechanical strength and disintegrates.

TempBond is a modified type of ZOE cement. Additives introduced into the original formulation have improved the physical and mechanical properties of the cement, especially a reduction in the solubility value (Baum & McCoy, 1984). The present study supports the findings of previous investigations (Gilson & Myers, 1970) that modified ZOE cements are capable of improving the seal around the margins of metal castings and thus counteract the harmful effects of microleakage.

In the present study, thermocycling seemed to promote marginal leakage when castings were cemented with ZOE. The reasons for this are speculative. It is possible that the margins of restorations underwent dimensional changes which increased the extent to which ZOE cement came into contact with free water. Release of eugenol may have occurred as a result of progressive hydrolysis of the surface layer of the cement, thus allowing the dye to diffuse inward through the cement. Another possibility is that in exposing the specimens to the 60 °C water bath, the high temperature may have had a deleterious effect on the cement.

On the basis of this study it appears unlikely that postcementation microleakage is the cause of tooth sensitivity. Although the cause of sensitivity has yet to be elucidated, it is reasonable to assume that during the multistep procedure of restoring a tooth with a metal casting there are opportunities for the dentin to become infected and the pulp to become inflamed. This could occur while temporizing the tooth with a provisional restoration.

Brännström (personal communication) believes that the condition of the dentin at the time of final cementation of the casting is of critical importance in the development of postrestorative sensitivity. If leakage occurs beneath a provisional restoration, bacterial plaque may become established on the surface of the dentin. Subsequent diffusion of bacterial products to the pulp could then evoke an inflammatory reaction and pulpal hyperalgesia. Brännström (1986) has hypothesized that outward drainage of fluid from the pulp may have a beneficial effect, presumably by reducing intrapulpal pressure. If cementation of the final restoration were to block this drainage, the resultant increase in intrapulpal pressure could increase sensory nerve activity (Brännström, 1986). As a precaution, operators should place a provisional restoration that fits well and use a temporary cement which provides a perfect seal so as to prevent bacteria from infecting the dentin.

It is obvious from the results of our questionnaire that variability among operators is an important factor. The reasons why some dentists have more problems with postoperative sensitivity than others is an intriguing question, one that should provide a fertile area for further research.

CONCLUSIONS

Assessment of the marginal leakage around metal copings luted to prepared extracted teeth with various cements showed the following:

No significant leakage occurred with two luting cements, KetacCem and TempBond.

Slight to moderate leakage occurred with ZOE cement and thermocycled ChemBond.

Severe leakage occurred only when no cement was used or when ZOE cement was used in conjunction with thermocycling.

Contamination with moisture of the glass-ionomer cements did not increase leakage.

It appears unlikely that postcementation microleakage is the cause of tooth sensitivity associated with the use of glass-ionomer cements.

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Protective Effects of Cavity Liners on Dentin

E L PASHLEY • S E GALLOWAY • D H PASHLEY

Summary

Smear layers are very soluble in acidic solutions. Removal of smear layers increases dentin permeability and the potential for pulpal irritation. In this study, smear layers were treated with either saline, Barrier, Copalite, LC-Scotchbond, Hydroxyline, or DDS 1 & 2 to determine how well they protected the dentin from subsequent acid attack with 37% phosphoric acid for two minutes. Using both SEM and permeability measurements, the materials were ranked from least to most effective as: Saline < Barrier = Copalite < Hydroxyline = Scotchbond = DDS 1 & 2.

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INTRODUCTION

The smear layer represents a critical interface between most restorative materials and the underlying mineralized tooth (Pashley, 1984). The particles making up the smear layer are very small (Pashley & others, 1988), giving them a high surface-area-to-mass ratio. This makes them extremely soluble in acid (Pashley, Michelich & Kehl, 1981; Pashley & Galloway, 1985) and may contribute to the relatively short half-life of exposed smear layers. Smear layers created on exposed root surfaces may only survive for days (D H Pashley, unpublished observation). Smear layers covering the internal surfaces of root dentin in well-sealed canals may last a lifetime. The longevity of smear layers under restorative materials in coronal dentin probably depends upon the degree of microleakage that occurs around the restoration. As most restorative materials permit microleakage between the material and the cavity wall, oral fluids and microorganisms can move within available microgaps and may facilitate the solubilization of smear layers. Smear layers can also be inadvertently dissolved by acids used to etch enamel.

A variety of cavity varnishes and other agents have been advocated to protect both the dentin and the smear layer as well as to seal the dentin tubules. This protection presumably includes a reduction in dentin permeability brought about by "sealing" dentin tubules, protection of dentin from acid attack, and a reduction in microleakage brought about by the presence of the liner in the microspaces between the tooth and the restoration. Little quantitative information is available, however, concerning how well these agents actually reduce dentin permeability or protect dentin from acid attack.

The purpose of this study was to quantitate the effectiveness of several dentin treatments at reducing dentin permeability and to evaluate their efficacy at protecting smear layers from acid attack.

MATERIALS AND METHODS

A. Specimen Preparation

Dentin disks were prepared from extracted, unerupted human third molar teeth using an Isomet saw (Buehler Ltd, Evanston, IL 60204) as shown in Fig 1. The disks were 0.7 ± 0.2 mm ($\bar{x}$ + SEM, N = 60) thick. Two notches were made in each disk to permit identical orientation on pins in a split-chamber device. Both smear layers created by the Isomet saw on the cut surfaces were removed by dipping the disks into 37% phosphoric acid for one minute. A standard smear layer was then placed on the occlusal surface of each disk by sliding the disk along wet 320-grit SiC sandpaper a distance of 30 cm under finger pressure. Each disk was then rotated 90° and the process repeated. This procedure creates a smear layer that is similar with respect to permeability and bond strength to those created by burs operated at low or high speeds (Tao, Pashley & Boyd, 1988; Tao & Pashley, 1989).

B. Dentin Permeability Measurements

The disks were placed in a split-chamber device which permitted measurement of the permeability of each disk (Pashley & Galloway, 1985). As the dentin permeability of each sample varied widely, each disk served as its own control. That is, the acid-etched or maximum permeability of a disk was assigned a value of 100% and all subsequent measurements were expressed as a percent of that maximum value. Dentin permeability was measured after phosphoric acid treatment (maximum permeability of 100%), after creation of a 320-grit SiC sandpaper smear layer, after surface treatment with one of the protective agents, and finally, after challenge with 37% phosphoric acid for two minutes.

C. Scanning Electron Microscopy

Scanning electron microscopy was done on dentin disks in each group. The smear layer covered the entire upper surface of the dentin disk.

When a disk was placed in the split-chamber device to permit measurement of hydraulic conductance, the surface area (0.317 cm^2)

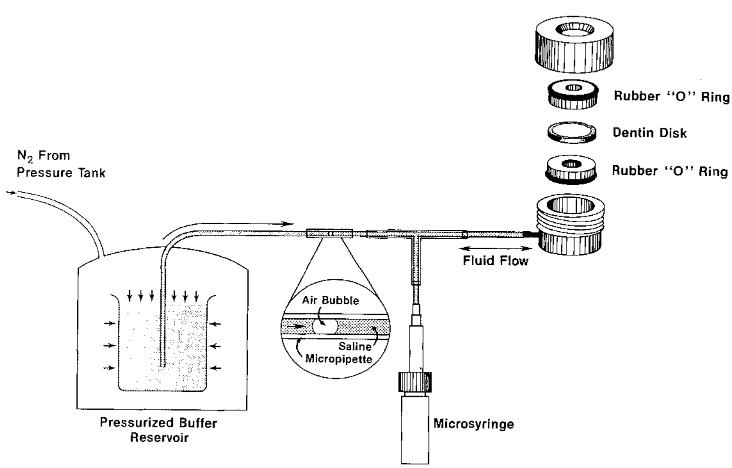

FIG 1. *Schematic of the apparatus used to measure dentin permeability before and after acid challenge*

measured was that portion of the surface within the confines of a pair of rubber O rings (Fig 1). The surface outside of the confines of the O rings served as a control during SEM studies of treatments of the smear layer. Similarly, when the treated surfaces were exposed to acid, that exposure was limited to the area within the O rings.

Scanning electron microscopic observations were made of treated smear layers within the middle of the O rings before and after exposure to acid. The periphery of the O ring allowed the formation of meniscus of material on the dentin that was much thicker than that found in the center. We avoided these areas during our SEM examination. All specimens were air-dried, coated with gold, and examined in an AMRAY 1000 scanning electron microscope.

D. Materials Tested

In order to screen a wide variety of agents used to treat dentin, we chose Barrier (Teledyne Getz, Elk Grove Village, IL 60007) as an example of a polyamide cavity liner, Copalite (H J Bosworth Co, Skokie IL 60076) as an example of a cavity varnish, original Scotchbond (light-cured; 3M Dental Products, St Paul, MN 55144; batch #P851206) as an example of an adhesive cavity liner, Hydroxyline (George Taub Products, Inc, Jersey City, NJ 07307; batch #274) as an example of a calcium-hydroxide liner, and DDS 1 and 2 (O-P Laboratories, Augusta, GA 30909; batch #23) as an example of a crystalline cavity liner.

E. Experimental Manipulation

Sixty dentin disks were randomly assigned to one of six experimental groups of 10 disks each:

1. Saline control: These smear layers were treated with isotonic saline (0.9% NaCl) for four minutes, followed by a five-second water rinse.
2. Barrier: These smear layers received a single coating of Barrier using the application brushes supplied by the manufacturer. The layer was dried under a gentle stream of air.
3. Copalite: Two layers of Copalite were applied 30 seconds apart using the disposable brush supplied with Barrier. Each layer was gently dried with a stream of air.
4. Scotchbond: A single layer of light-cured Scotchbond was placed over the smear layer using a small sable brush. The material was then cured for 10 seconds with a Visilux light (3M Dental Products).
5. Hydroxyline: A single layer of Hydroxyline was applied to the smear layer using the disposable brush supplied with Barrier. The layer was dried with a stream of air.
6. DDS 1 and 2: The dentin surface was treated with DDS 1 for two minutes using a cotton ball dripping wet with the solution. The residual fluid was removed with an air blast and DDS 2 was then applied in a similar manner for two more minutes. The surface was then rinsed with water.

F. Statistical Analysis

A four-factor repeat measure analysis of variance was used to analyze the data. The four factors were: smear layer values, treatment values, acid-challenge values, and type of protective material. Duncan's multiple range test was used to rank the efficacy of the treatments at protecting the smear layer.

RESULTS

The table lists the permeability of the dentin surfaces before and after the various surface treatments. All values are expressed as a percent of the control, an acid-etched maximum permeability of each disk which was assigned a value of 100. Creation of smear layers with 320-grit SiC abrasive paper reduced the hydraulic conductance (Lp) of the disks from 100% to 4.9% of the maximum acid-etched values. There were no statistically significant differences between the initial permeability of the smear layers and the subsequent data obtained after the various protective treatments (table). Also listed in the table are the permeability values of each group after acid challenge of the treated surfaces with 37% phosphoric acid for two minutes. The statistical significance of the differences in permeability before and after acid challenge are also shown in the table.

Treatment of smear layers with isotonic saline offered no protection from exposure to acid; however, all other dentin treatments gave protection from acid attack, although the degree of protection was variable. Barrier and Copalite offered the layer the least protection from acid attack (table). That is, after acid challenge, the

Protective Effects of Cavity Liners

	Dentin permeability as percent of maximum values		
Smear layer treatments	**Before etching**	**Significance**[‡]	**After etching**
None	4.9 ± 1.2(60)[†]	$P < 0.001$	100.0* (60)
Saline	7.4 ± 1.5(10)	$P < 0.001$	91.3 ± 10.0(10)
Barrier	1.5 ± 0.8(10)	$P < 0.001$	44.2 ± 7.9(10)
Copalite	6.0 ± 3.7(10)	$P < 0.001$	49.4 ± 9.9(10)
Scotchbond	0.9 ± 0.3(10)	$P < 0.05$	7.7 ± 4.1(10)
Hydroxyline	1.1 ± 0.6(10)	$P < 0.05$	11.8 ± 5.1(10)
DDS 1 and 2	1.8 ± 1.0(10)	NS	2.5 ± 0.8(10)

*Maximum permeability of disks after first acid etching and before creation of smear layer

[†] Permeability after creation of smear layer but before any treatments

NS = Not statistically significant

[‡] Significance: 1) Refers to before and after etching (horizontal pairs) 2) Vertical bars in the same plane connect groups that are not statistically different at $P < 0.05$. Groups that are not connected by vertical lines are different from the connected groups at $P < 0.05$.

permeability of the dentin with these treatments increased from 1.5 and 6% to 44 and 49%. Scotchbond and Hydroxyline provided good protection to smear layers, permitting only 7 and 10% increases in permeability following exposure to acid. The permeability of the dentin treated with the DDS solutions did not show any statistically significant change upon acid challenge. There was no statistical difference between the protection produced by Scotchbond, Hydroxyline, or DDS (table).

Scanning electron microscopic examination of control disks that were covered with a smear layer revealed a typical amorphous surface (Fig 2). When the smear layer was treated with isotonic saline, the SEM appearance of the surface was unchanged (not shown). Smear layers treated with Barrier were largely masked by the material except for frequent dimples and holes in the layer which appeared to have the dimension and density of the underlying tubules (Fig 3A). Figure 3B shows the appearance of Barrier after acid attack. Large circular cracks developed in the acid-treated surface. Figures 4A and 4B represent the appearance of dentin smear layer surfaces after Copalite applications to the disks and the acid challenge, respectively. The two layers of Copalite completely obscured the underlying smear layer. The layer of Copalite had a wavy appearance before exposure to acid. After acid challenge, there were numerous holes

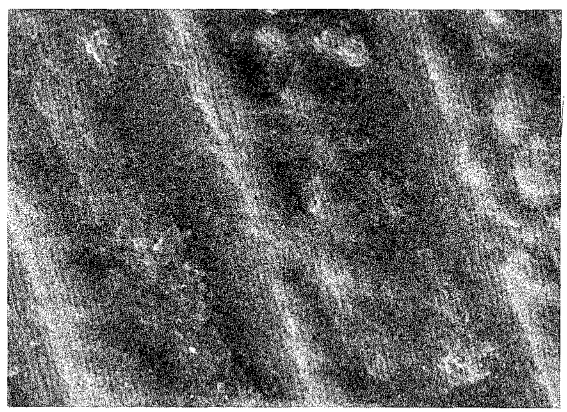

FIG 2. *Untreated smear layer created with 320-grit SiC abrasive paper (X1540)*

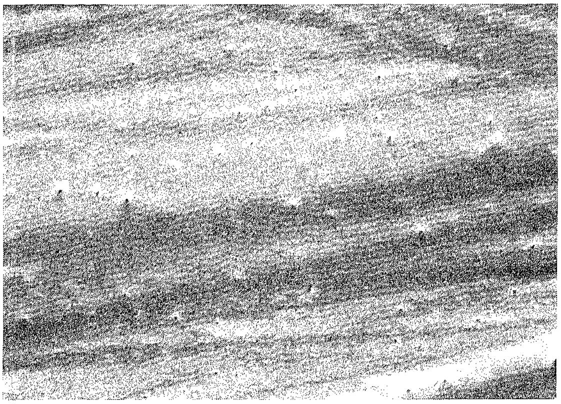

FIG 3A. *Smear layer treated with Barrier before acid challenge (X770)*

FIG 3B. *Smear layer covered with Barrier after acid challenge (X770)*

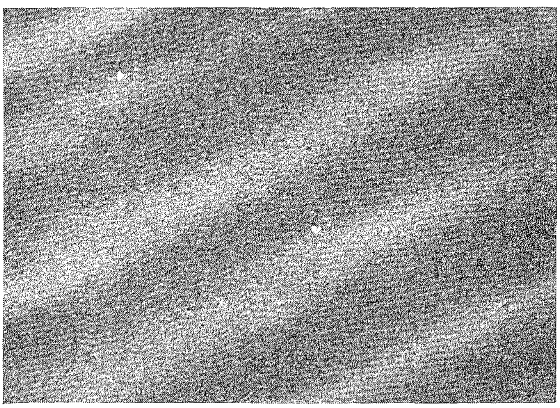

FIG 4A. *Smear layer covered with two layers of Copalite before acid challenge (X770)*

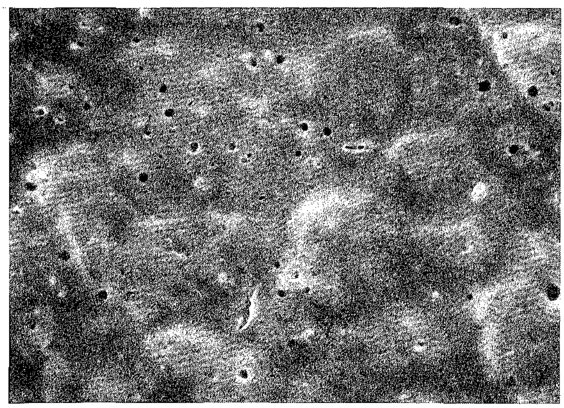

FIG 4B. *Smear layer covered with two layers of Copalite after acid challenge (X770)*

and tears in the Copalite layer. When the smear layer was treated with light-cured Scotchbond, the surface exhibited a wrinkled appearance (Fig 5A). After exposure to acid, the surface appeared flat and amorphous (Fig 5B). Figure 6A shows the dentin surface after treatment with Hydroxyline. This material completely covered the underlying smear layer. The surface exhibited small holes which apparently indicated where air bubbles had been. After acid etching (Fig 6B), the surface looked very similar to the pre-etched surface except for an occasional small crater-like defect. When dentin smear layers were treated with the DDS solutions, the surface was covered with crystals (Fig 7A) which did not change their appearance after acid attack (Fig 7B). The SEM appearance of the treated dentin tended to overestimate the effectiveness of most treatments. That is, the permeability of treated disks was far greater than the SEM micrographs suggested.

DISCUSSION

Many investigators have shown that copal varnishes decrease the penetration of various tracer molecules into dentin (Swartz & others, 1962; Barber, Lyell & Massler, 1964; Newman, 1984; Sneed, Hembree & Welsh, 1984). Some studies have compared the efficacy of different varnishes (Newman, 1984; Sneed & others, 1984), while others have shown differences within the

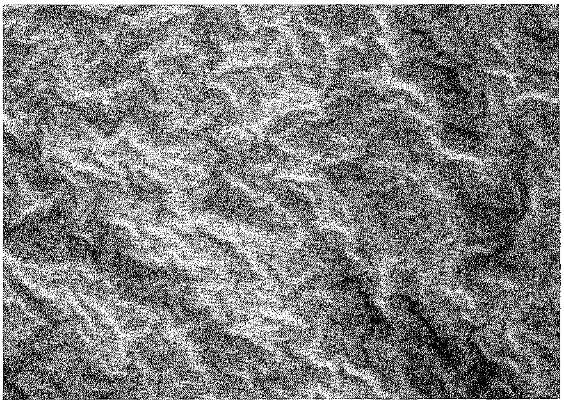

FIG 5A. *Smear layer treated with one layer of light-cured Scotchbond before acid challenge (X770)*

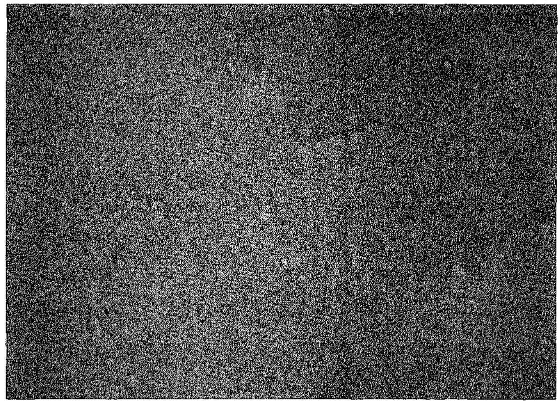

FIG 5B. *Smear layer treated with Scotchbond after acid challenge (X154)*

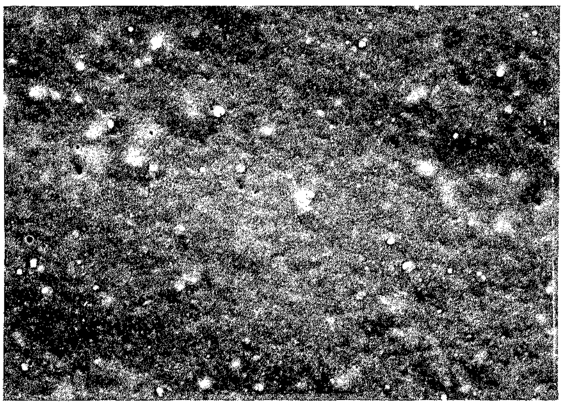

FIG 6A. *Smear layer treated with Hydroxyline before acid challenge (X770)*

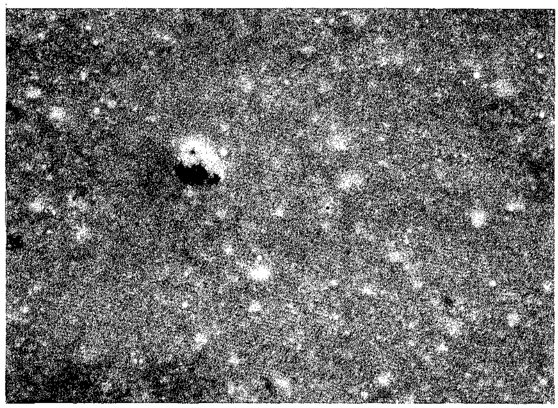

FIG 6B. *Smear layer treated with Hydroxyline after acid challenge (X770)*

FIG 7A. *Smear layer treated with DDS 1 and 2 before acid challenge (X1540)*

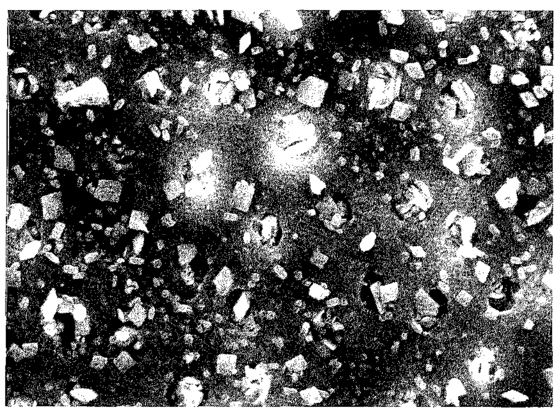

FIG 7B. *Smear layer treated with DDS 1 and 2 after acid challenge (X1540)* same material depending upon whether one or two layers were applied (Eames & Hollenback, 1966; Lund, Matthews & Miller, 1978; Newman, 1984). The observations of the effects of these agents on dentin permeability before etching confirm the cited reports.

Barrier was formulated to create a cavity varnish that was more compatible with composite resins (Tjan & Chan, 1987). In a semiquantitative study, Tjan, Grant & Nemetz (1987) reported that a cavity varnish now marketed as Barrier reduced the permeation of free monomer through dentin disks compared to untreated controls. Our SEM observations suggested that Barrier may have protected the smear layer, and our functional measurements indicated that it offered equivalent or better protection than Copalite (table).

Scotchbond has been suggested as a cavity liner of amalgam restorations (Yu, Wei & Xu, 1987). The SEM appearance of Scotchbond after acid challenge was not much different than it had been before. The permeability measurements before and after acid challenge, in this case, confirmed the SEM impression that Scotchbond was protective. In an SEM study, Eick and Welch (1986) demonstrated that Scotchbond was readily removed by an acid challenge. Our work reached the opposite conclusion. That is, that Scotchbond provided good protection to acid attack when examined by both SEM and functional measurements. Chan and Jensen (1986), in another functional study, also concluded that Scotchbond provided good protection to acid attack.

Hydroxyline has received mixed reviews as a cavity liner. Eames, Hendrix, and Cleveland (1978) reported that Hydroxyline gave excellent pulp protection to a two-minute acid challenge with phosphoric acid in a study in vivo. Grajower, Hirschfeld, and Zalkind (1976) reported that Hydroxyline folded into multilayered films when dried with air, and that it was frequently full of bubbles. We could not confirm their observations. We were impressed with the ability of Hydroxyline to seal dentin using both SEM and permeability measurements.

Oxalates represent a new type of cavity liner that is composed of microscopic crystals. In essence, soluble salts of oxalates are applied to dentin which contains ionized calcium in dentinal fluid. This leads to the production of insoluble crystals of calcium oxalate that can reduce dentin permeability (Pashley & others, 1978; Pashley & Galloway, 1985; Pashley & Depew, 1986). The marketed solutions, DDS 1 and 2, consist of 30% dipotassium oxalate (pH 7) and 3% half-neutralized oxalic acid, respectively. Their sequential use produces a crystalline-covered dentin surface that is resistant to acid attack (Pashley & Galloway, 1985). Chan and Jensen (1986) compared Scotchbond to DDS 1 and 2 for their ability to block hydrogen ion diffusion across very thin dentin disks. Their results indicated that the oxalate system was superior to Scotchbond in that respect. Sandoval, Cooley, and Barnwell (1989) reported that class 5 cavities prepared half in enamel and half in dentin showed the least microleakage when amalgam restorations were lined with DDS. They found DDS to be superior to cavity varnishes at minimizing dye microleakage on the gingival floor of class 5 cavities, a particularly difficult region to seal.

CONCLUSION

The results clearly indicate the susceptibility of the smear layer to acid challenge and the efficacy of a variety of liners at providing some protection to acids. All treatments provided some degree of protection against acid attack. The use of the original, light-cured Scotchbond, Hydroxyline, or DDS 1 and 2 as lining agents were clearly superior to the other agents tested at preventing the usual increase in dentin permeability that generally follows acid challenge.

ACKNOWLEDGMENTS

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Effects of Heterogeneous Layers of Composite and Time on Composite Repair of Porcelain

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Summary

Bond strengths of porcelain/composite resin repair samples, some homogeneous of conventional, hybrid, and microfill materials, some heterogeneous, made by incremental build-up of two of these composites, were evaluated. Samples were allowed to set without disturbance. After storage in 37 °C water for intervals of one day, seven days, and 28 days, the test samples were subjected to tensile force until fracture. There were significant differences in bond strengths of homogenous and heterogeneous samples after different storage periods. All mean repair bond strengths were significantly less at seven days than at one or 28 days. Heterogeneous repairs with larger-particle-size composite at the porcelain interface and overlayed with smaller-particle-size composites resulted in higher bond strengths than the homogeneous small-sized composite repairs. Failures of the repairs occurred at the porcelain/composite interface in a statistically significant number, implying that technique exactness at the interface plays an important role in the success of the technique.

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Introduction

Repair of fractured porcelain restorations by direct application of composite resin has become a commonplace procedure in restorative dentistry. The extensive use of porcelain for crown and bridge procedures has contributed to an increased incidence of failure of veneering porcelain. Surface loss of porcelain from full crowns due to trauma is not an unusual occurrence. As complete replacement of crowns and bridges is time-consuming and expensive, the direct repair of lost facing material with an application of composite resin is economically attractive. In addition to good color match, repairs of porcelain with composite resin ideally should provide (1) a high bond strength at the interface through good adaptation and rigidity of material and, (2) a surface with a smooth finish to enhance esthetics and resist plaque formation. However, intrinsic to this technique because of material deficiencies has been some compromise of end-result characteristics such as ultimate functional bond strength, wear resistance, surface texture, or color match. Physical properties and characteristics of composite resins filled with different sizes and amounts of organic particles allow each to address one or more, but not all, of these shortcomings with some measure of success (Boyer, Chalkley & Chan, 1982; Craig, 1980; Eames & Rogers, 1979; Gregory, Hagen & Powers, 1988; Newburg & Pameijer, 1978; Vanherle, Lambrechts & Braem, 1985).

This study was a continuance of an earlier evaluation of commercial porcelain repair products (Gregory & others, 1988). The purpose was to determine if the best characteristics of bond strength and polishability of different composites could be combined without compromise of the final repair. Repair bond strengths of layered combinations of macrofill, hybrid and/or microfill composite resins were compared to those of homogeneous repair samples. The testing was done over a 28-day period to evaluate the time-dependency of repair bond strengths.

Materials and Methods

One hundred fifty-five porcelain button specimens, 9.0 mm in diameter at one end, 12.0 mm at the other, and 7.0 mm in height, were condensed in a standardized lucite mold against 0.01-inch platinum foil, and fired per manufacturer's instructions (Vita, Unitek Co, Monrovia, CA 91016, batch 733-220).

The large-diameter end of each button was embedded in a cylinder of bioplastic resin with 3 mm of the button protruding above the resin base (Decracoat, Resco, Miami, FL 33054). The threads of a galvanized eye-hook were embedded in the opposite side of the resin cylinder. The face of the exposed porcelain was polished sequentially on a mechanical horizontal rotating grinder with silicon carbide sanding abrasives No 240, 320, 400, and 600 to remove the glaze and any surface scoring that might provide mechanical retention. The surfaces were evaluated for voids and imperfections and repolished or discarded. One hundred thirty-three acceptable samples were produced.

Delrin plastic tubes (AIN Plastics, Inc, Mount Vernon, NY 10500), internal diameter 4.0 mm, height 6.0 mm, were used to form the composite samples. These tubes were threaded externally to accept a plumbing pipe cap and were enlarged on one end internally to provide mechanical retention of the samples.

Table 1 lists the composites used in this study, a macrofilled composite, a hybrid, a microfilled, and their porcelain repair bonding components.

The porcelain samples were randomly divided into 12 groups of 11 samples each. Three groups of homogeneous samples of Concise, Herculite, and Silux Plus repairs were prepared as controls.

Three groups of 33 samples each were prepared in which Concise was applied to the

Table 1. Resin Materials Evaluated

Composite	Batch	Silane Bonding Agent	Batch	Manufacturer
Concise	7A02R	Scotch Prime	7F1P	3M Dental Products St Paul, MN 55144
Herculite	8 3125	Porcelain Repair Liquid	8 4137	Sybron/Kerr Romulus, MI 48174
Silux Plus	7Y1P	Scotch Prime	7F1P	3M Dental Products St Paul, MN 55144

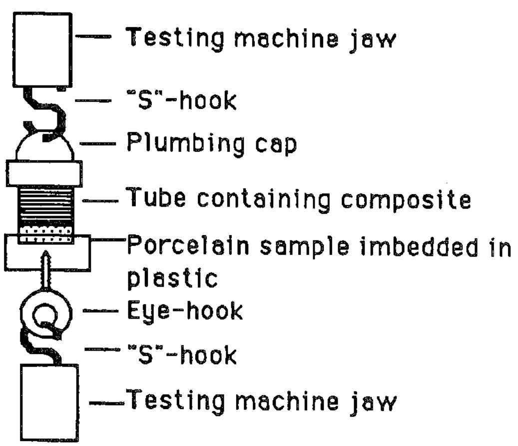
porcelain surface, cured, and overlaid with Herculite, Concise was similarly overlaid with Silux Plus, and Herculite overlaid with Silux Plus. The samples were stored in distilled water at 37 °C until testing. Eleven samples of each group were tested at one-, seven-, and 28-day intervals. The control samples were tested at 28-day intervals.

Prior to condensing composite within the tube against the porcelain, surfaces were cleansed using 37% phosphoric acid for a period of 60 seconds and rinsed for four seconds with distilled water. After drying the surface, the appropriate bonding agents were applied to the porcelain according to manufacturers' instructions.

Light-activated composites (Translux, Kulzer Inc, Irvine, CA 92718) were condensed in increments no greater than 2.0 mm and cured for 60 seconds. The air-inhibited layer was allowed to remain between layers of composite, and no more than 90 seconds elapsed before the next layer was condensed against it. Chemically activated composites were prepared and condensed in one increment and allowed to bench cure for 15 minutes.

Samples were held in an Instron Testing Machine (Model TT-BM, Instron Corp, Canton, MA 02021) for testing by S-hooks positioned through the eye-hook and plumbing cap (figure). Testing was done in tension at a crosshead speed of 0.05 cm/min until fracture. The fracture point was examined under magnification (X10) to determine its location.

The mean bond strengths of the 11 samples of each category were calculated and statistically evaluated through an analysis of variance using a factoral design (Dalby, 1968). Means were ranked by a Tukey interval calculated at the 95% level of confidence. The differences between two means that are larger than the Tukey interval are considered statistically significant. The fracture site data were analyzed by the chi-square test.



Testing arrangement for fracture in tension of porcelain/composite repair bonds

Results

The average tensile bond strengths of the homogeneous repairs and the combination repairs at one, seven, and 28 days and the Tukey interval are reported in Table 2.

The average repair tensile bond strength to porcelain of Silux Plus repairs at 28 days was 929 PSI; that of Herculite, 2452 PSI; that of Concise, 3121 PSI. The mean repair bond of the more rigid macrofill material was significantly higher than that of either of the smaller-particle-filled materials. Similarly, the hybrid product Herculite, filled with larger particles than the microfilled Silux Plus, demonstrated a significantly higher bond strength than Silux Plus.

Table 2. Mean Composite/Porcelain Tensile Repair Bond Strengths (PSI)

Composite	1 day	7 days	28 days
Concise	not tested	not tested	3121 (591)
Herculite	not tested	not tested	2452 (1031)
Silux	not tested	not tested	929 (507)
Herculite over Concise	2164 (977)	1055 (393)	3122 (956)
Silux over Concise	2560 (914)	1600 (341)	2514 (771)
Silux over Herculite	1974 (670)	728 (443)	1643 (621)

Differences greater than the Tukey interval of 470 PSI within columns or rows are statistically significant.

As was the case with single mixes, the macrofill composite/porcelain interface strengths, when overlaid with another composite, were significantly higher after the one- and 28-day immersion storage periods than those repairs with a smaller-particle-size material placed at the interface. There is no statistical difference between the bond strengths of Herculite layered over Concise and that of the homogeneous Concise sample at 28 days.

A statistical difference in repair bond strengths for all three heterogeneous repairs was demonstrated between one-day and seven-day samples, as well as 28-day and seven-day samples. The repair strengths at the seven-day interval were less than either the one- and 28-day samples for each material combination.

The four possible levels and percent occurrence of fracture were (1) adhesive fracture at the porcelain/composite interface (52%), (2) cohesive fracture in the initial composite (22%), (3) fracture at the composite/composite interface (17%), and (4) cohesive fracture in the secondary composite (9%). The number of failures at the porcelain/composite interface was statistically significantly higher than those occurring at any of the other three possible locations.

Discussion

As might be expected from the results of previous studies, the less-filled composite materials (Silux < Herculite < Concise), having a larger percentage of matrix material and greater flexibility, formed the weakest bond at the porcelain interface. The porcelain/composite 28-day bond strength of Herculite was more than twice as high as Silux. The bond to the porcelain of the macrofill composite Concise was significantly higher than either of the other two types. Though a preferred clinical result of surface texture would be attained using the microfill or hybrid, the tensile bond strength would be seriously compromised.

The repair of Concise overlaid with Silux Plus demonstrated significantly higher bond strengths after 28 days than did the homogeneous Silux Plus repair after that time period; so did the Concise/Herculite combination compared to Herculite alone. The mean bond strength of the Herculite/Concise combination was identical to the homogeneous 28-day Concise repair sample. These two combination repairs done with Concise were significantly stronger than the Herculite/Silux Plus combination.

Using these materials, repairs were made in combinations to provide a more pleasing esthetic result of the more polishable small-filler-size materials without loss of the initial bond strength advantage of the macrofill composite. Application of this technique to clinical repairs of porcelain restoration failures should provide the dentist with a result incorporating the best attributes of both large- and small-particle-size composites.

The one-day bond strengths were not indicative of ultimate repair strengths as seen from the results of seven- and 28-day storage interval tests. This agrees with other studies. (A period of continued cure and the effects of water sorption may contribute to these differences.) Indeed, at seven days the bond strengths were significantly less than at one day in each case. A clinically and statistically significant increase of strength occurred between seven and 28 days in each of the three combinations. The Concise/Herculite combination demonstrated a significant increase in 28-day strength over the one-day strength while the other combinations did not. Patients should be cautioned against use of these repairs in full function for several weeks until the bond strengths mature and to be particularly careful of the repair around the seven-day interval when the strengths have significantly decreased.

Fractures occurred significantly at the interface of the porcelain and composite. The incremental build-up of dissimilar composites did not cohesively weaken the mass relative to the bond strengths. The weak point in the repair procedure was the porcelain/composite interface. To maximize repair strengths care must be taken to properly prepare the porcelain surface, prevent any contamination by saliva, crevicular fluids, etc, and materials must be well-adapted to the porcelain surface and completely cured to the deepest portions of the composite. The manufacturers' directions for use of materials must be followed exactly.

Conclusions

1. Composite repairs of porcelain may be done with mixtures of larger-particle-sized, more rigid, macrofilled composites at the interface and smaller-sized hybrid or microfilled composites at the outer surface without significant loss of

repair bond strength.

2. One-day bond strengths of heterogeneous repairs are significantly compromised by seven days, but by 28 days are not significantly less and may be higher.

3. The weak point of a composite/porcelain repair is at the interface of materials. Careful techniques for preparation of the repair surface, its protection from contamination, and use of materials are important to maximize the success of the procedure.

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Fracture Resistance of Reinforced Glass Ionomer as a Buildup Material

J W ROBBINS R L COOLEY S BARNWELL

Summary

This study in vitro investigated the fracture resistance of two reinforced glass ionomers and amalgam when used as core-buildup materials. Four-pin buildups using the three materials were placed in human molar teeth and prepared for gold crowns. The crowns were cemented and the teeth were compressed at 45° to failure. There was no significant difference found in the fracture resistance of the three materials.

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Introduction

Several materials have been advocated for use as a core-buildup in teeth with severe destruction. In recent years, glass ionomers have experienced a significant increase in use. A recent survey (Charbeneau, Klausner & Brandau, 1988) revealed that 86.4% of dentists questioned had used a glass ionomer in some form. Another survey (Matson, 1986) reported that 50% of the dentists surveyed were using glass ionomer as a buildup material; however, there has been minimal laboratory research to support this use of glass ionomer.

The ability of reinforced glass ionomer to resist displacement and fracture when used as a core-buildup was investigated by Taleghani and Leinfelder (1988). They reported no difference in fracture resistance between a cast gold post and core and a Parapost (Whaledent International, New York, NY 10001) with a reinforced glass-ionomer (Ketac-Silver, ESPE-Premier, Norristown, PA 19401) buildup. When the Ketac-Silver (ESPE-Premier) was used as a core material without a post, the resistance to fracture decreased significantly. Brandal, Nicholls and Harrington (1987) compared the fracture resistance of three different types of core-buildups in anterior teeth. The groups were: Parapost (Whaledent) with a composite core, a pin-retained amalgam buildup, and a reinforced glass-ionomer coronal-radicular buildup without auxiliary retention and resistance form. They reported that the glass-ionomer buildup was significantly less resistant to fracture than the other methods. The purpose of this study was to investigate the fracture resistance of reinforced glass ionomer as a buildup material in a wet environment.

Materials and Methods

Two reinforced glass ionomers, Ketac-Silver (ESPE-Premier) and Miracle Mix (G-C International Corp, Scottsdale, AZ 85260), and one amalgam, Tytin (Sybron/Kerr, Romulus, MI 48174), were compared with respect to fracture resistance. Thirty extracted human molar teeth were mounted in PVC rings with polymethylmethacrylate, placed in a lathe, and the crowns removed 3 mm above the cementoenamel junction, producing a flat dentin surface. The remaining tooth structure was then machined to a round configuration (7.2 mm + 0.5 mm diameter). Four Minim pins (Whaledent) were placed in each tooth 1 mm from the outer surface of the preparation, 2 mm deep into the dentin, and cut off 2 mm out of the tooth (Fig 1). The prepared teeth were divided into three groups of 10 so that each material was used as a buildup material in 10 specimens. A copper band matrix was placed over each specimen and stabilized with compound. The dentin surface of each of the specimens to receive the glass-ionomer materials

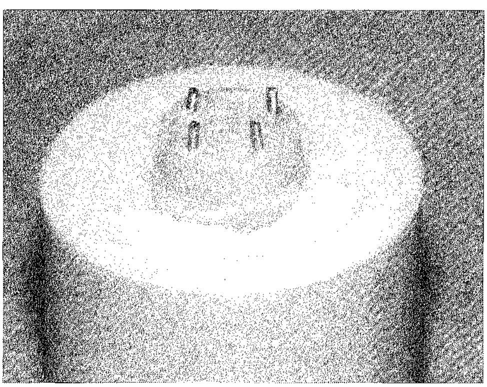

FIG 1. *Specimen with pins in place and mounted in a PVC ring*

was conditioned with 10% polyacrylic acid (G-C Dentin Conditioner, G-C International) for 15 seconds. The Miracle Mix was mixed using a 3:2 powder-to-liquid ratio and inserted with a Mark III C-R Syringe (Centrix Inc, Milford, CT 06460). The other materials were mixed and inserted according to the manufacturers' instructions. All of the glass-ionomer specimens were coated with Ketac Varnish (ESPE-Premier). The specimens were allowed to set undisturbed for 24 hours and then returned to the lathe and machined to produce a core-buildup 4 mm in height with a combined taper of 10°. While mounted on the lathe, a light chamfer was placed 1 mm below the buildup on natural tooth structure (Fig 2).

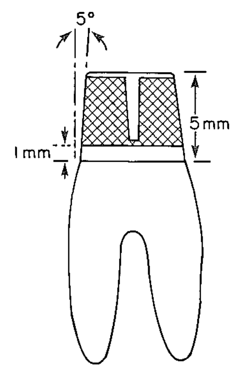

FIG 2. *Diagram of prepared specimen illustrating the taper and height of the core-buildup*

An impression was made of each core-buildup with Impregum (ESPE/Premier) and a master die produced with Velmix (Sybron/Kerr). A gold casting (Type 3) which covered the chamfer was made for each core-buildup by wax-up on the die. The castings were fitted first on the dies, and subsequently on the core-buildups. The buildups were then placed in water at 37 °C. After seven days, the specimens were removed from the water and lightly dried. The castings were cemented onto the buildup specimens with glass-ionomer cement (Fuji I, G-C International) and allowed to set for 24 hours. A seating jig was fabricated to hold each casting on the core-buildup during cementation with a uniform 2.5 kg pressure. The teeth were then mounted at a 45° angle and stressed in compression to failure at a crosshead speed of 0.5 mm per minute on an Instron Testing Machine (Instron Corporation, Canton, MA 02021) (Fig 3).

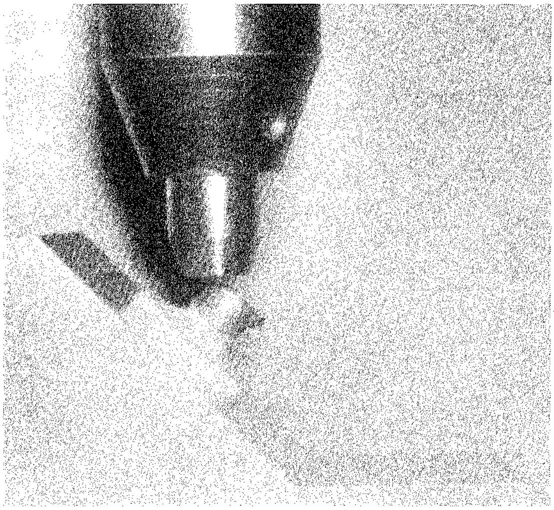

FIG 3. *Specimen mounted at 45° angle in Instron Testing Machine*

Results

The fracture resistance results are listed in Figure 4. The mean failure rates (newtons) were: amalgam--1936, Miracle Mix--2042, and Ketac-Silver--2184. The data were analyzed using an analysis of variance (ANOVA). There was no statistically significant difference in fracture resistance between the three groups ($P < .05$).

FRACTURE RESISTANCE (Newtons)

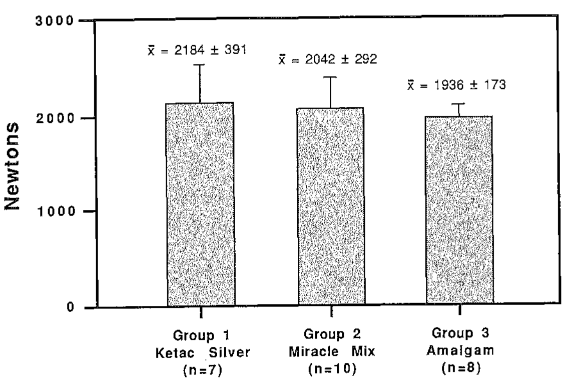

FIG 4. *Results of fracture resistance for three groups*

Discussion

The most common pattern of failure for all groups is shown in Figure 5. The two pins nearest the force were bent but remained in the tooth. One or both of the pins distant from the force either fractured at the interface or remained in the buildup, resulting in the fracture of tooth structure.

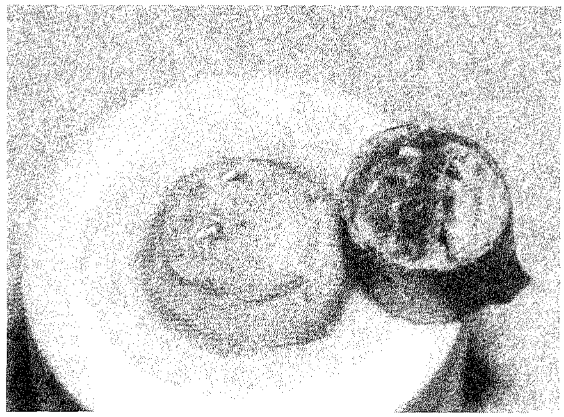

FIG 5. *Miracle Mix specimen illustrating typical fracture pattern*

Several specimens failed due to fracture of the embedded root rather than fracture of the buildup material. These failures occurred at much lower values and reflected the fracture resistance of the tooth root rather than the buildup material; therefore, the data from these specimens were discarded.

This study only investigated the fracture resistance of these materials with a luted casting in place. When choosing a buildup material, other parameters must be considered, such as fracture resistance during removal of the provisional restoration. Additionally, Lloyd and Adamson (1987) studied the fracture toughness (K_{1c}) of reinforced glass ionomer (Ketac-Silver), composite, and amalgam. This parameter helps to predict how a material will function under tensile and flexural stress: the higher the K_{1c}, the more resistant the material is to stress failure. They found the K_{1c} of

Ketac-Silver to be no greater than that of conventional glass ionomer and very low in comparison to composite and amalgam. Although glass ionomer appears to be a potentially useful material, its success must first be confirmed with controlled clinical studies.

Conclusion

The fracture resistance of reinforced glass ionomer as a buildup material in a wet environment was studied. Under the conditions of this study, there was no significant difference between the fracture resistance of the two reinforced glass-ionomer materials and amalgam.

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The Prevailing Academic Environment for Faculty in Operative Dentistry: Recommendations for Change

NEREYDA P CLARK • GREGORY E SMITH
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Summary

All dental schools in the United States were surveyed to determine the academic responsibilities and expectations for promotion and tenure for faculty who teach operative dentistry. Forty-six of the 59 schools responded. Questions were asked concerning job responsibilities for faculty who teach operative dentistry and the requirements for academic promotion and tenure for those faculty members. Most operative dentistry faculty are required to devote extensive time to teaching with modest time allocations and minimal support for research. Promotion and tenure requirements tend to stress research productivity. Recommendations are made for future change.

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INTRODUCTION

Teachers of operative dentistry are faced with competing factors in the performance of their academic duties (Albino, 1984; Bales, 1988). Students and course responsibilities demand attention, and committee work and patient care take time; however, research activity is thought to be a primary criterion by which faculty are evaluated for the granting of academic promotion and tenure (Kalkwarf, 1986; Bawden, 1987).

The purpose of this study was to survey the dental schools in the United States to determine the academic responsibilities and expectations for promotion and tenure for faculty who teach operative dentistry, to report the results of that national survey and to make recommendations for change where appropriate.

METHODS

A questionnaire was mailed to the operative dentistry department chairperson at 59 schools of dentistry in the continental United States. Respondents were asked to relate their answers to those faculty who teach operative dentistry. Questions were asked in several categories: general background regarding the number of students in the undergraduate program, the number of full- and part-time faculty in the department, and the number of weeks the preclinical and clinical programs operate per year. Percentages were requested for the amount of time assigned to typical faculty members for teaching operative dentistry, for research, and for service. Questions were asked about teaching responsibilities, research responsibilities, and the college expectations for faculty research productivity. The service assignment was examined for faculty who teach operative dentistry. Finally, questions were asked regarding the requirements for appointment and/or promotion to the rank of assistant, associate, or full professor, and for tenure. Schools which have created so-called "clinical tracks" for faculty (Smith, 1984) were asked to explain the criteria and general operation of these programs.

RESULTS

General Information

Forty-six of the 59 surveyed schools responded to the questionnaire. Throughout this paper the word "schools" refers to the 46 schools of dentistry which responded.

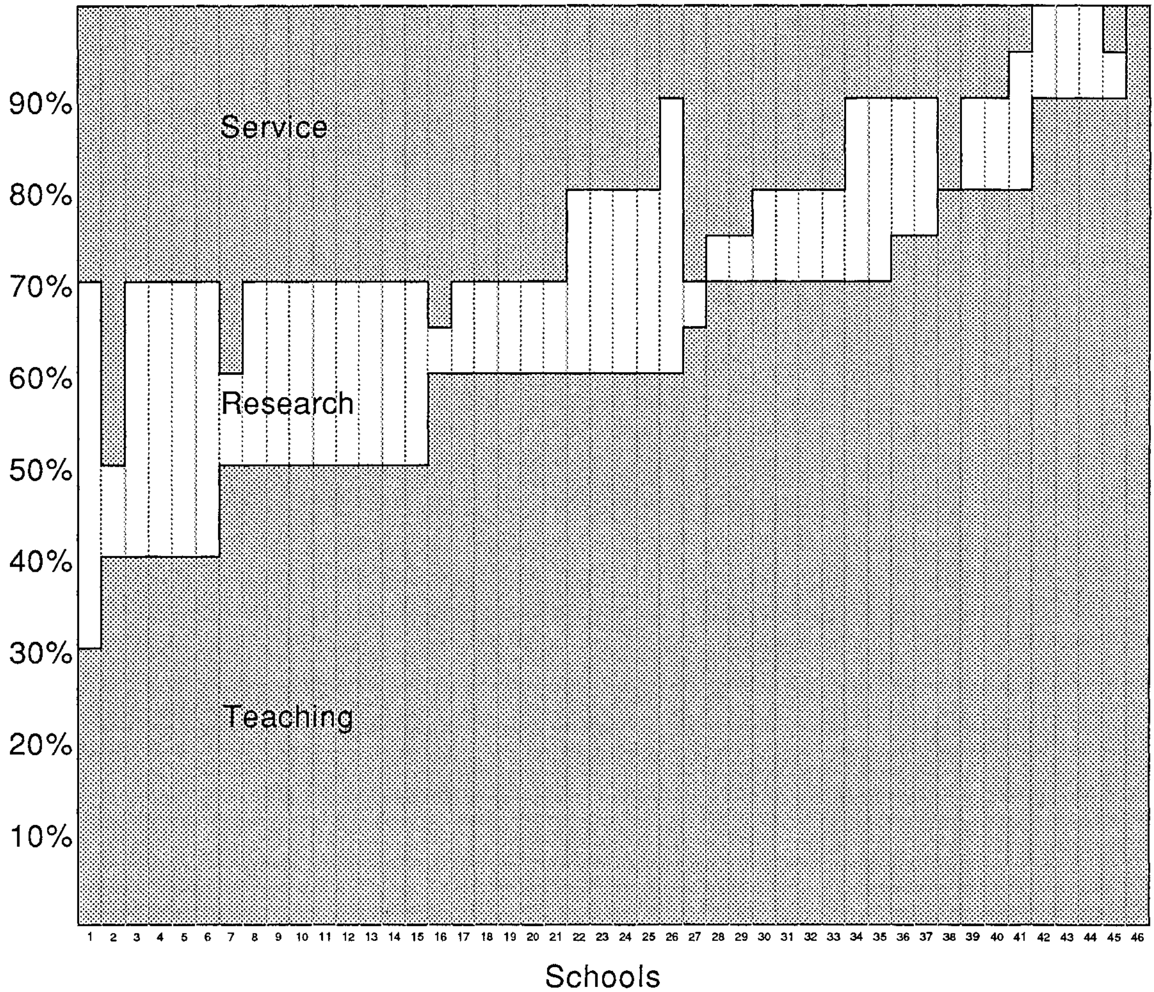
Student enrollment varies among schools from a low of 23 students per class to a high of 156 students per class, with a mean of 80.6. The number of full-time operative dentistry faculty members per school varies from a low of two to a high of 12 with the mean at 6.5. Departments report an average of 14 part-time faculty teaching operative dentistry, with a range of 2-33. Only a few operative dentistry departments employ more than 20 part-time faculty members.

The ratio of full-time operative dentistry faculty members to students per class averages 1:12 with considerable variation among schools. Five schools report an overall operative dentistry faculty-to-student ratio of less than 1:8. Sixty-four percent of the schools (30) report an operative dentistry faculty-to-student ratio in clinics of 1:8, although the range is 1:5 to 1:15. The mean faculty-to-student ratio is 1:11 in preclinical laboratories.

Patient care clinics are open for students in operative dentistry for 40 to 45 weeks per year at 62% of the schools. Generally these clinics operate yearly eight to 12 weeks more than preclinical laboratories. Clinics at some schools are open for as few as 36 calendar weeks, others for up to 50 weeks per year. Fifty-seven percent of the schools report the student clinical operatory utilization in operative dentistry ranges between 71% and 90%. Eight schools report less than 70% utilization of available operatories by students while nine schools report greater than 90% operatory utilization.

Teaching

Operative dentistry faculty members are assigned to teaching duties for 50-70% of their time at most (66%) of the schools. Most schools which assign faculty in operative dentistry to 50% time or more for teaching reserve only 10% time for research. Those schools which assign less than 50% time to teaching typically increase the research time assignment to approximately 20%. The remaining time at all schools is used for service functions (figure). National figures broken down into hours per week indicate that faculty members in operative dentistry spend an average of 12.5 hours teaching in patient care clinics, 6.5 hours in preclinical teaching, three hours in lecture/seminar preparation and course administration, and 1.5 hours advising students, for a total of 23.5 hours per week. Typically, the remainder of the week is apportioned into eight hours for the practice of dentistry, with the remainder of time for committee work and



A comparison of time allocations for faculty who teach operative dentistry at 46 U S schools of dentistry. The dark lower area represents teaching time, the white center area the time the respective school assigns for research. The dark top section shows time allocation percentages for the service component of job descriptions.

research activity.

Research

Most schools encourage annual publication of scholarly manuscripts by full-time faculty. Eighty-nine percent of responding schools report that most junior faculty members in operative dentistry lack research training, and only 55% of the schools report that junior faculty are able to obtain needed research training in-house. Ninety-one percent of the schools believe junior faculty in operative dentistry would benefit from courses designed to provide training in research methodology and scientific writing, and 51% of these schools would commit travel funds to send selected faculty to such courses. Seventy percent or more of the schools report that insufficient time or technical assistance is available for faculty in operative dentistry to perform productively in research, and approximately half of the schools note severe research limitations for these faculty due to lack of support of some kind (Table 1). Twenty-one schools report that a maximum 10% of faculty in operative dentistry submit research abstracts yearly to the International or American Association for Dental Research.

Table 1. Research Support Availability for Faculty in Operative Dentistry at US Schools of Dentistry (n = 46)

Research support item	Schools reporting sufficient support		Schools reporting insufficient support	
	n	%	n	%
Instruments and equipment	24	53	22	47
Statistical advice and assistance	27	60	19	40
Laboratory space	24	53	22	47
Secretarial support	24	53	22	47
Advice and counsel	25	55	21	45
Technical assistance	11	26	35	74
Time available	12	30	34	70

Over half of the schools surveyed report that 80 to 90% of submitted manuscripts are accepted by the first journal to which they are submitted. Ten percent of submitted manuscripts are never published.

Service

At most schools faculty members in operative dentistry serve on one or two school committees each year while at a few schools faculty generally serve on three committees.

The practice of dentistry by faculty, be it intramural or extramural, is typically considered in the service category of academic responsibility. Sixteen schools offer either intramural or extramural practice options, while 13 offer only an extramural practice option and 15 offer only intramural practice. Two schools offer no opportunity for dental practice. The disbursement of revenue generated by faculty who practice intramurally varies considerably from school to school. Most schools award a salary supplement to the participating faculty member. The supplement is computed from a predetermined percentage (mean = 47%) of practice funds generated. The remaining funds pay practice overhead charges, and/or are assigned to higher administration. At six schools faculty who do not practice are allowed to receive salary benefits from the funds generated by the practicing faculty.

Continuing education courses provide additional income for faculty at many schools. Faculty at 43 schools present courses sponsored by the dental school. Thirty-three of these schools pay faculty to present continuing education courses at locations other than the school itself and 28 also pay faculty for such courses when presented at the school. Four of the schools which pay their faculty for continuing education programs place an annual monetary limit on faculty earnings from school-sponsored continuing education courses.

Promotion of Faculty

Several factors are considered in the appointment or promotion of regular full-time faculty in operative dentistry. The requirements become more rigorous the higher the rank. Most schools require a dental degree from a U S-recognized school of dentistry. A national reputation is more heavily weighted the higher the proposed rank. Most schools do not require private practice experience for promotions or the granting of tenure; however, many specify a certain requisite time-in-rank before promotion to the next higher level (Table 2).

Seventy-four percent of schools report that all promotions must be approved at an administrative level above the dental dean. The remaining schools require higher level approval only for promotions to associate or full professor, enabling the dental dean to promote instructors to assistant professor. Forty-four percent of the schools report that the health center administration or the university imposes a more rigorous standard for promotion than the school of dentistry imposes. Therefore, some applicants who successfully meet dental school requirements for advancement fail to meet the standards imposed by a higher authority. Fifty-six percent of the schools report that the committee charged with final recommendation for promotion and/or tenure is a university-wide committee made up of faculty who are not health sciences faculty.

The publications record of the individual faculty member is a major concern to many faculty. Faculty holding full-time positions in operative dentistry have demonstrated difficulty in meeting publications or research requirements for promotion and/or tenure at 76% of the schools. Sixty-five percent of the schools set a specific number of publications required for promotion to a specific academic rank (Table 3). The mean number of publications required for promotion to assistant professor is 1.5, for promotion to associate professor 5.5, and for full professor 11. Refereed publications are generally weighted more heavily than non-refereed publications. Sixty-one percent of dental schools consider all state dental journals to be non-refereed journals.

Table 2. Number of Years Required in Rank for Promotion of Operative Dentistry Faculty (n = 46)

Promotion to the rank of:	Mean number of years required at previous rank
Assistant Professor	3.00
Associate Professor	4.31
Full Professor	4.45

Table 3. Number of Publications Required for Promotion of Faculty in Operative Dentistry (n = 46)

	Requirements	Number of schools
Minimal	Average of 0-1 publications required for promotion to any rank	4 (9%)
Moderate	Average of 1 publication for promotion to assistant professor, 5 for associate professor, and 10 for full professor	16 (35%)
Significant	Average of 3 publications for promotion to assistant professor, 8 for associate professor, and 15 for full professor	7 (14%)
Extensive	Average of more than 5 publications for promotion to assistant professor, more than 10 for associate professor, and more than 20 for full professor	3 (7%)
Not Specified		16 (35%)

Table 4. Tenure vs Years of Employment at US Schools of Dentistry

Years	Mean	Range
The number of years in full-time academic tenure-accruing positions before tenure is granted	5.97	3-10
Maximum number of years a faculty member can remain untenured before being terminated	7.12	3-11

Tenure

Tenure and promotion are linked together at 26 schools of dentistry. Most schools (79%) require that full-time faculty be tenured at some point to continue employment; however, the number of years allowed before tenure is required varies from school to school (Table 4). Most schools suggest that tenure be granted at least one year prior to the year in which the acquisition of tenure is essential in order to maintain employment. At 35% of the schools tenure is usually granted only during the final year of eligibility, and failure here results in termination of the faculty member. Letters of recommendation in support of tenure applications are required at 90% of the schools, and most schools require both student and faculty peer evaluations as a part of all tenure applications.

Clinical Tracks

A clinical track has been developed by 23 schools of dentistry, in part as an effort to obviate the research requirements for some clinical teachers. Seventeen schools require no research from appointees who hold clinical tracks. Twelve schools allow regular faculty to switch to clinical tracks if faculty do not or cannot meet the more stringent requirements needed for acquisition of tenure in the regular faculty academic tracks.

DISCUSSION

The typical full-time faculty member in operative dentistry at most dental schools devotes much time to teaching and, with a modest time allocation, is expected to complete scholarly research projects and publish the results of that work in refereed scientific journals. This survey did not address the quality of teaching effort provided by faculty nor the quality of dental care provided by students. One may argue that a primary function of a dental school (perhaps the most important in terms of our nation's dental health) is the quality of dental care taught by clinical faculty and learned by students. It should be axiomatic that excellence in research is appropriate to academic life regardless of discipline, but faculty in operative dentistry must give considerable emphasis to the creation of excellence in therapeutic skills and diagnostic skills among students, and time is often scarce for faculty to be productive in quality research work.

Regular full-time faculty appointments and promotion and tenure decisions for operative dentistry faculty at most reporting schools involve a consideration of a broad range of activities in teaching, research, and service functions. Evidence from this survey supports the often-heard contention that research time and support are in short supply for faculty in operative dentistry (Bales, 1988). Shortages of time for scholarly activity may lead to faculty disinterest in teaching and advising students, poor quality in research, and unsuccessful attempts at gaining promotion and/or tenure. Changes in university expectations may be appropriate (Kennedy, 1984).

A major value of quality research lies in the stimulation it provides for faculty members to explore scientific concerns of a clinical nature, to improve dental care and to facilitate the teaching of clinical dentistry (Bawden, 1983; Mackenzie, 1984). Publication of the results of relevant research is essential, not only for the promotion of faculty members, but also for the dissemination of new information. While faculty in operative dentistry are expected to publish an average of only one to 1.5 papers per year, some schools require a much greater number for academic promotion and/or tenure (Table 3). Schools which require the greater number of publications do not necessarily provide the greatest amount of time to accomplish the necessary scholarly research.

CONCLUSIONS

The issues discussed in this paper relate to the responses of department leaders in the field of operative dentistry at 46 schools of dentistry in the United States. Based upon those responses the following recommendations are made:

1. To achieve a balanced and highly qualified faculty, schools of dentistry should assess their goals and needs before recruiting and tenuring individual faculty members. Most faculty members cannot excel in teaching and research and service, since few departments have the luxury of assigning sufficient allocation of time for meritorious work in all three areas by all faculty members. Schools should attain high levels of quality by supporting the individual strengths in each faculty member. Only mediocrity is reached when the academic strengths of individual faculty go unrewarded, and when all faculty are required to excel at everything! Faculty should be given an annual written job description and evaluation, and appropriate time should be allocated to support the successful completion of job expectations.

2. Excellent research potential of faculty members should be encouraged and developed because research is a vitally important aspect of academic life and it warrants university support. Where appropriate, additional full-time faculty positions should be allocated to departments of operative dentistry to free individual faculty from exhaustive teaching and course administrative responsibilities with an eye to stimulating creative scholarly work and productive research efforts.

3. Promotion and tenure decisions should be based upon work related to stated job descriptions. Realistic time allocation should be made in keeping with stated job descriptions. Faculty who are expected to devote most of their time to teaching matters should be evaluated for promotion and/or tenure based principally on an

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Distinguished Member Award

It is both fitting and proper that this Academy have an honor that recognizes excellence not only in the delivery of dental care but also in the provision of service according to the tenets of our Academy, for excellence is the warp of our fabric. It is the foundation, yes, the heart of our Academy. Gold Foil operations just simply require excellence. It is also proper and fitting that we give this honor to a charter member, Robert B Wolcott, but first a bit of background.

Wisconsin, the Badger State, is the home of such individuals as Robert La Follette, Senator Proxmire, the Green Bay Packers, the Milwaukee Bucs, and Ralph Werner. Born in Janesville, educated at Beloit College, Bob received his dental degree at Marquette University, and was called, almost immediately, to duty with the United States Navy. His unique talents as a clinician and leader earned him an assignment to the United States Naval Dental School at the National Naval Medical Center, Bethesda, Maryland. Here, as chairman of the Operative Department, he not only taught clinical sciences and skills but also indoctrinated recently enrolled dental officers. His insistence on perfection was applied first to his own efforts and then to those of his associates. Excellence--who could teach it better than one who displayed it?

Bob was also selected by the Navy for graduate training at Georgetown University, and at the same time he was loaned to the National Bureau of Standards to conduct research and to carry out clinical procedures for evaluation by the Bureau staff. He earned a Master of Science degree at Georgetown. His first publication was the classic study on percolation with Bob Nelsen. This work is frequently referenced because Nelsen and Wolcott were the first to demonstrate clinically the microleakage of restorations because of the difference in thermal expansion of tooth and restorative materials.


Robert B Wolcott

Dr Wolcott's research efforts really never ceased. He was active not only at Bethesda but evaluation of teaching; those who are primarily assigned to research should be measured against a high standard in that realm. When evaluating scholarly productivity, schools should place maximum emphasis on the quality of effort and quality of research work and place minimal emphasis on the number of publications, since relentless pressure on faculty to publish a stated number of articles leads to cluttering the literature with articles of modest scholarly value.

4. Schools of dentistry and parent universities should reconsider the matter of requiring tenure for all faculty after only a few (the national mean is six) years of employment, and parent university policy should be changed when needed to support a realistic approach to the promotion and tenure of dental faculty. Tenure should be achieved only when outstanding faculty effort and ability has been demonstrated over a number of years. Some faculty positions appropriately require job descriptions which leave little time, if any, for research; other positions may require extensive time allocation for research with little emphasis on teaching or service. At the time of hiring, a projection should be made indicating the number of years expected before tenure is likely for a given faculty member. That projection should be in writing and modified annually as the reality of job responsibilities dictates. Some faculty members should be allowed to continue on tenure-accruing lines beyond current university minimums. Those faculty should be given extended tenure-accruing time, projected in advance in their job descriptions, to allow timely accrual of university expectations for scholarly or other academic credentials prior to rendering "up-or-out" decisions regarding tenure. It may be well to uncouple promotion and tenure decisions.

5. Some departments of operative dentistry should create new graduate programs to expand the clinical expertise and research training available to potential new faculty members in this discipline.

(Received 25 November 1988)

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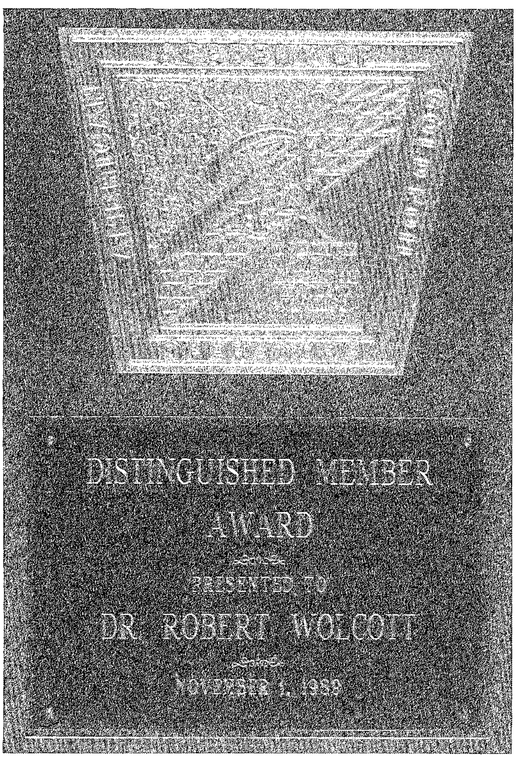
at several other Navy activities. His teaching was not confined to the Naval Dental School; wherever he was assigned, he guided those less experienced and knowledgeable. He inspired countless young dentists whose professional lives were changed by his influence and guidance.

After his retirement from the Navy, Dr Wolcott was faced with a dilemma of choice: Where to teach? There was a long list of possible schools anxious to employ highly desirable Bob. He chose the University of California at Los Angeles. Lucky UCLA!

Dr Reider F Sognnaes had been selected as the dean with the assignment to form this new dental school. One of his first recruits for the faculty was Dr Wolcott. Bob was given the tasks of recruiting the clinical faculty and designing the clinical facility. These two tremendous responsibilities he completed with such success that he is considered by those close to the school as the one responsible for its excellence. It is correct to say that Bob Wolcott built much of the greatness that has been and is UCLA--sort of like John Wooden and the UCLA basketball program. While active as the chairman of the Department of Operative Dentistry at UCLA, Bob constantly urged the California State Board to keep gold foil as a requirement for the Board exam. His main point was that he taught gold foil because of its excellence as a restorative material and not as popularly claimed--"because it was a State Board requirement." Another of Bob's successes was the organization of a gold foil study club among his faculty members, one of the few such study clubs in a dental school.



Distinguished Member Award for 1989

This Distinguished Member Award is for excellence, and nowhere is excellence more in evidence than in Bob's clinical and academic teaching and administrative roles. His programs were imaginative in depth and broad in spectrum. He is a sharing teacher. This was quite evident in his great efforts in bringing the interschool Project Accorde to success. And since that time, he has devised a teaching exchange program of operative teachers throughout the United States.

Dr Wolcott, a charter member of our Academy, has served us long and well. He has been its President and has completed many other assignments. He served for 12 years as the Editor of the *Journal of the American Academy of Gold Foil Operators*. Not only was this an important service, but just imagine facing that deadline for all those years of editing and publishing this frequently referenced journal. When the Academy of Operative Dentistry was formed, the two academies joined to publish the journal *Operative Dentistry*.

He was always dedicated to operative dentistry and to all its many facets. If excellence is your standard, it is always demanding. He picked the tough ones: gold foil, amalgam, inlays, onlays--yes, and resin, too. He was also a devoted "dam" man. In fact, he developed courses and techniques for teaching the use of the rubber dam.

Today we are an academy dedicated to excellence, and we are proud to carry out a fundamental part of our charter by honoring Dr Robert Wolcott with our Distinguished Member Award.

GEORGE W FERGUSON
NELSON W RUPP
TED RAMAGE

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Clinician of the Year Award

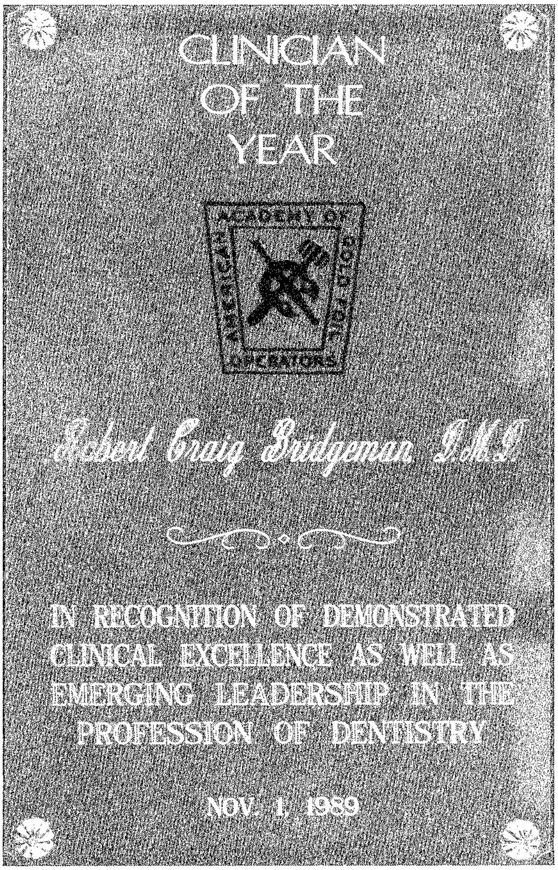
A couple of years ago at our annual meeting in Denver, Vic Williams suggested to the Academy that although it was great to be honoring long-standing members with a Distinguished Service Award, it really would be nice to recognize some of the younger individuals. He committed the Williams Gold Company to sponsoring some type of award. A committee was formed to develop guidelines; these include emphasis on the "younger" dentist--one who has been out of school at least five years, is a member of this Academy, and has demonstrated leadership and growth potential in the profession. The committee elected not to give an actual commercial endorsement or monetary award. It was thought better to recognize the individual selected by the committee with a suitable presentation and plaque at our annual meeting. Rather than call it the "Young Dentist Award," it was decided to name the individual "Clinician of the Year," since our members are clinicians first.

The first recipient to be selected for this distinction is Robert Craig Bridgeman. A number of worthy candidates were considered, but Craig became the overall choice. He humbly suggested that he didn't qualify as a "young" member, but then youth is a relative term, and not necessarily a chronological one. There are a lot of folks in this Academy who would quickly agree that

Robert Craig Bridgeman

anyone under age 40 or 50, or even 60, is young.

Craig has not wasted much time in his life, if the curriculum vitae he submitted is really his. It was interesting to learn that he had taught José Medina all that he knows about gold foil. His interest in dentistry dates back to his early teens when he helped out in his dad's office. We are truly sorry that Bob couldn't have been with us to see Craig accept this honor.



Clinician of the Year Award

After being asked to leave Marshall University, Craig followed his sweetheart, Rose, to West Virginia University, then on to the University of Florida as a member of their first class of dental students. He talks about a "class of 24"--he really doesn't seem that old. Next, having a basic fear of tall buildings and loud noises, Craig and his bride moved to Boone, North Carolina. He is currently practicing dentistry in Boone, in hopes of getting it right one day.

Craig has been very active in dental society activities, usually progressing to the level of leadership. He is currently president-elect of the Academy of Operative Dentistry. He has been showered with accolades and awards most of his life, and has seen no reason to quit. This year, he successfully completed the examination for certification with the Board of Operative Dentistry.

Craig and Rose have two children, Robert and Casey. Craig enjoys golfing, but has decided not to try to make a living from it. As his friends and ex-friends well know, he likes to talk, and has received a number of awards for public speaking, as well as a few for keeping quiet.

In summary, Craig Bridgeman is an excellent combination of clinician, speaker, organizer, humorist, and family man. His CV is extensive and only a few of his many contributions to our profession have been mentioned here. We are proud to include him in our numbers, and pleased to offer this award as a small token of recognition.

On behalf of the American Academy of Gold Foil Operators and Williams Gold, it gives me pleasure to present this plaque, with our congratulations, to Robert Craig Bridgeman.

RONALD K HARRIS, DDS, MSD

DEPARTMENTS

Press Digest

Pulp capping: Conserving the dental pulp--Can it be done? Is it worth it? *Stanley, H R (1989) *Oral Surgery, Oral Medicine, Oral Pathology* 68(5) 628-639.

(*Department of Oral Diagnostic Sciences, College of Dentistry, University of Florida, Gainesville, FL 32610)

The purpose of this superbly written article was to review the era of vital pulp capping as mediated by the use of calcium hydroxide (CH). All of the factors that are usually considered liabilities to direct pulp capping are reviewed and countered; e g, pulps contaminated with saliva, previously cariously exposed or periodontally involved, etc. The essential steps for successful direct pulp capping are emphasized, such as making certain that the CH contacts vital-pulp tissue, controlling bleeding, minimizing dentinal chip invasion, and avoiding embolization of CH particles.

The tensile strength of the union between various glass ionomer cements and various composite resins. *Mount, G J (1989) *Australian Dental Journal* 34(2) 136-146.

(*King William House, 25 King William Street, Adelaide, South Australia, 5000)

This project in vitro was designed to test a broad variety of glass ionomer/ composite resin combinations using the concept of a "sandwich technique," i e, glass-ionomer cement liner, resin restoration. The author suggests the following factors as the most important in the success of this type of restoration: tensile strength of the glass-ionomer cement, wettability of the resin bonding agent, polymerization shrinkage of a less heavily filled composite resin, and adaptation of a more heavily filled resin to the cement liner. Of the 15 anterior and posterior resins and eight glass-ionomer products evaluated, Ketac-Fil glass ionomer and Visio-Fil resin produced the greatest resistance to tensile stress. Most of this resistance was provided by the tensile strength of the Ketac-Fil. This finding confirms similar results reported by other investigators.

Comparative evaluation of three resin inlay techniques: microleakage studies. Sheth, P J, Jensen, M E & *Sheth, J J (1989) *Quintessence International* 20(11) 831-836.

(*Hazelton Laboratories, 900 Osceola Drive, Suite 107, West Palm Beach, FL 33409)

The purpose of this investigation in vitro was to measure the marginal leakage of three resin inlay systems and to compare them to a conventional direct-filling technique. The three inlay systems were: Coltene-DI 500, SR-Isosit, and P-50; the control was P30 posterior resin placed directly. Following thermocycling, the sample resins were stained and sectioned. The effect of the microleakage revealed that the direct P30 restorations leaked the most, followed by restorations made using the indirect DI-500 Coltene system. The indirect SR-Isosit system and indirect P-50 system leaked the least and were not significantly different from each other. All systems showed a similar pattern of greater leakage at the gingival margins in comparison to the occlusal.

Rehabilitation of partially edentulous patients using cantilever bridges: A retrospective study. *Strub, J R, Linter, H & Marinello, C P (1989) *The International Journal of Periodontics & Restorative Dentistry* 9(5) 365-375.

(*Professor and Director, Department OPC of Prosthodontics and Dental Materials, Albert Ludwig University, Hugstetter Strasse 55, Freiburg, West Germany)

This retrospective study evaluated 96 cantilever bridges on 80 patients classified according to type and design: 63 unilateral and/or bilateral distal extension designs, 19 long-span bridges, and 18 designs using one cantilever unit as a retainer for the fixed partial denture. The failure rate of the bridges in this study was 36%, with 23.3% due to biologic causes and 12.7% stemming from technical causes. Of the biological failures, 14.7% were due to pulp-tissue deaths in the abutment teeth necessitating endodontic therapy. There were no crown fractures. Other causes for failure were distributed across a number of parameters. In view of the risks of various biological and technical failures, the authors suggest that "the long-term success of cantilever bridges largely depends on regular and professional dental aftercare."

Book Review

DENTAL MATERIALS: PROPERTIES AND SELECTION

Edited by William J O'Brien, PhD

Published by Quintessence Publishing Co, Inc, Chicago, 1989. 603 pages, indexed. 221 illustrations. $68.00.

This new dental materials text is a revised version of the earlier text *An Outline of Dental Materials and Their Selection* (W B Saunders Co, 1978) edited by William O'Brien and Gunnar Ryge. Much of the content of the former text has been retained and improved by combining topics into a single chapter (e g, high- and low-temperature investments, denture polymers and liners). In addition, several topics have been added or significantly revised, such as the chapter on implant materials and a chapter devoted to a comparison of metals, ceramics, and polymers.

Each chapter was written by an expert on the subject matter covered, with a total of 28 contributors. The format varies somewhat from chapter to chapter because of the diverse authorship. For example, the section on amalgam discusses the clinical and laboratory data and biocompatibility, whereas other chapters do not. These are important factors to be addressed for a text that aims to aid in the selection of materials. Some chapters contain extensive lists of products (e g, composite, cements), whereas others do not (e g, investment, porcelain, impression materials). The risk of listing products is that the text may become outdated more rapidly.

References are supplied at the end of most chapters; however, the chapters entitled "Biological Responses" and "Appraisal of Current Dental Materials" are not referenced. Both require references to support statements made. In addition, the chapter on "Biological Responses" is virtually identical to that of the 1978 text and much can be added to this section based on recent research in this field. The chapter on "Selecting Dental Materials" was very thorough, exceedingly well written, and helpful to clinicians. Given this chapter, there is no need for the chapter "Appraisal of Current Dental Materials."

Finally, "Appendix A: Tabulated Values of Physical and Mechanical Properties" was good originally and has been improved measurably. Values for 23 different properties are given for many dental materials and all values are referenced. This section alone makes the text worth buying, especially for anyone in need of accurate information on properties of dental materials.

Overall the text is useful principally as a reference or a supplement to more exhaustive texts on dental materials.

GLEN H JOHNSON, DDS, MS
Department of Restorative Dentistry
School of Dentistry, SM-56
University of Seattle
Seattle, WA 98195

LETTERS

ANTIMICROBIAL PROPERTIES OF GLASS-IONOMER CEMENTS AND OTHER RESTORATIVE MATERIALS

I would like to call your attention to an error I noticed in the article by Scherer, Lippman and Kaim, 14(2): 77-81. There are several values reported in the text which differ from the results in Figure 2.

Also, a question I have concerns the way the names of microorganisms are typed in *Operative Dentistry*: Why is it that the journal follows the standard practice of italicizing the letters in the text but when the names appear in the figure captions they are never italicized?

I would like to suggest that more care be taken in future editions of your journal.

YOSHIRO FUJII
Kōpo Mariina 102
Inokoshi 1-125
Meitōku, Nagoya
JAPAN, 465

RESPONSE

I appreciate your letter pointing out the error. I am most grateful. The error was on my part and not the authors'. You are indeed correct, such errors should not occur and we will do our best to ensure it does not happen again.

Concerning the way we set the type when naming microorganisms, we always italicize the letters when in the body of the text. The reason we do not do the same for figure captions is that figure captions in this journal are always italicized and therefore we return the name of microorganisms to standard type to accentuate them, which is the reason for italicizing in the first place.

DAVID J BALES
Editor

Corrections

To allow you to correct the figure in your journal which had the errors cited in the letter above, we are providing a corrected version of that figure to be inserted in your own copy of the journal.

My sincere apologies to you our readers and to the authors for the error.

DAVID J BALES
Editor

Announcements

PUBLICATION SCHEDULE TO CHANGE FOR *OPERATIVE DENTISTRY*

Volume 15, 1990, of *Operative Dentistry* will be published as six issues. We are pleased to announce that our publication schedule is now set for January, March, May, July, September, and November.

We have reduced the number of pages in this issue but there will be an overall increase in the number of printed pages for the year.

Our backlog of manuscripts awaiting publication is now down to 10-13 months. With the reality of six issues each year we will be looking forward to more manuscript publications.

Your continued support is appreciated.

NEWS OF THE ACADEMIES

American Academy of Gold Foil Operators

The 39th annual meeting was held 31 October-2 November 1989 at the University of Washington School of Dentistry and the Four Seasons Olympic Hotel, Seattle, Washington. The Board of Directors meeting was held on Tuesday afternoon followed by a salmon bake at the Kiana Lodge. On Wednesday morning, clinical demonstrations were given with 32 clinicians presenting a variety of procedures. A scenic boat cruise of Seattle's harborfront was enjoyed by many during the afternoon, followed by the annual banquet in the evening.

Thursday morning found the participants listening to a series of lectures illustrating "Gold Foil Today and in the '90s."

The officers of the Academy for the forthcoming year are: president, William H Harris; immediate past president, Richard V Tucker; president-elect, Michael A Cochran; vice president, Alfred C Heston; secretary-treasurer, Nelson W Rupp; and councillors Richard J Hoard, Ralph L Lambert, and Maurice E Logan.

This year's meeting was truly outstanding. Plan now to attend the session in Boston, 10-12 November 1990.

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

Send manuscripts and correspondence about manuscripts to the Editor, David J Bales, at the editorial office: Operative Dentistry, University of Washington, School of Dentistry SM-57, Seattle, WA 98195, USA.

Exclusive Publication

It is assumed that all material submitted for publication is submitted exclusively to *Operative Dentistry.*

Manuscripts

Submit the original manuscript and one copy; authors should keep another copy for reference. Type double spaced, including references, and leave margins of at least 3 cm (one inch). Supply a short title for running headlines. Spelling should conform to Webster's *Third New International Dictionary*, unabridged edition, 1971. Nomenclature used in descriptive human anatomy should conform to *Nomina Anatomica*, 5th ed, 1983; the terms 'canine', 'premolar', and 'facial' are preferred but 'cuspid', 'bicuspid', and 'labial' and 'buccal' are acceptable. SI (Système International) units are preferred for scientific measurement but traditional units are acceptable. Proprietary names of equipment, instruments, and materials should be followed in parentheses by the name and address of the source or manufacturer. The editor reserves the right to make literary corrections.

Authors who prepare their manuscripts on a word processor are encouraged to submit an IBM compatible computer disk of manuscript (3½ or 5¼ inch) in addition to original typed manuscript; authors need to identify the word processing program used.

Tables

Submit two copies of tables typed on sheets separate from the text. Number the tables with arabic numerals.

Illustrations

Submit two copies of each illustration. Line drawings should be in india ink or its equivalent on heavy white paper, card, or tracing vellum; any labeling should be on an extra copy or on an overleaf of tracing paper securely attached to the illustration, not on the illustration itself. Type legends on separate sheets. Photographs should be on glossy paper and should be cropped to remove redundant areas. For best reproduction a print should be one-third larger than its reproduced size. Maximum size of figure is 15x20 cm (6x8 inches). The cost of color plates must be met in full by the author. On the back of each illustration, near the edge, indicate lightly in pencil the top, the author's name, and the number of the figure. Type legends on a separate sheet. Where relevant, state staining techniques and the magnification of prints. Obtain written consent from holders of copyright to republish any illustrations published elsewhere.

References

Arrange references in alphabetical order of the authors' names at the end of the article, the date being placed in parentheses immediately after the author's name. Do not abbreviate titles of journals; write them out in full. Give full subject titles and first and last pages. In the text cite references by giving the author, and, in parentheses, the date, thus: Smith (1975) found ...; or, by placing both name and date in parentheses, thus: It was found ... (Smith & Brown, 1975; Jones, 1974). When an article cited has three authors, include the names of all of the authors the first time the article is cited; subsequently, use the form (Brown & others, 1975). Four or more authors should always be cited thus: (Jones & others, 1975). If reference is made to more than one article by the same author and published in the same year, the articles should be identified by a letter (a, b) following the date, both in the text and in the list of references. Titles of books should be followed by the name of the place of publication and the name of the publisher.

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Reprints can be supplied of any article, report, or letter. Requests should be submitted at the time the manuscript is accepted. Reprints ordered after the date set for printing of the journal cost substantially more.

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