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EDITORIAL

Fragmentation of the Profession

The profession of dentistry is currently threatened with yet another form of fragmentation. This one comes from the organized efforts of dental hygienists to secure legislation allowing for the independent private practice of hygienists. The American Dental Association has recently joined the Colorado State Dental Association in challenging new legislation in that state which allows for the independent practice of dental hygienists. The hygienists' group has made several attempts to secure such legislation in other states, including the state of Washington.

Organized dentistry is pulling out all the stops to prevent the independent practice of hygienists. However, there are a number of dentists who feel just the opposite. In this issue of the Journal, Carlson (p 118) states that the independent practice of dental hygienists will be a boon to both the patient and the dentist. Most knowledgeable dentists would say he is wrong.

The number of hygienists has increased significantly in recent years. Up to the present, hygienists have been restricted to providing support to the dentist in the care of patients and have not been permitted to conduct a solo practice. Dentists are to provide the supervision and direction for the hygienist. How often does this occur? Many dentists allow the hygienist to decide on the type of home care philosophy being espoused in the office. Others allow them to chart and diagnose, and the dentist does not bother to confirm. Is not the dentist failing in his own professional responsibility when he neglects to provide guidance or supervision of the hygienist?

As in the case of the denturists, the hygienists have noted the lack of supervision provided by many, if not most, dentists and wondered why they should not provide the care on their own. Such is the seed for independent practice. When dentists fail to fulfill their obligations, the profession and the patients they serve are bound to suffer.

Even though it may be that dentists have brought this movement upon themselves, the real question should be: Will the profession and the patients be better served by permitting independent practice of dental hygienists?

Hygienists claim that they will provide better access to health care and at a lesser cost. Will they? Certainly not. They will need to invest in offices and equipment, hire support staff, and provide all that goes with office management. Such a duplication of the capabilities of the regular dental offices will only serve to increase the cost of such services to the patient. An even more basic issue to be settled is quality. Hygienists say that the quality of care will be going up; in reality, without the diagnostic and treatment capability of the dentist, it will be lowered.

Once hygienists have secured legislation permitting independent practice they will want to expand their clinical sphere. One could speculate they will want to do operative procedures and sealants for children and young adults, along the lines of the New Zealand dental nurse plan. In some states hygienists are already licensed to give their own local anesthetic injections, take radiographs, place rubber dams, place matrix bands, place and carve any of the direct restorative materials, and use rotary instruments to carve and adjust the occlusion when done. How many dentists are providing the required supervision?

Hygienists have a place in the profession, but not as the primary providers of direct patient care. Let us be firm in our commitment of quality care and ensure that the hygienist remains in the dentist's office where the dentist is the primary provider of the care. Dentists should take a closer look at the way they manage such support staff. Are you providing the supervision required? Or are you letting these subordinates take the practice away? Quality care is the issue; let us not drop the ball.

DAVID J BALES
University of Washington
School of Dentistry, SM-56
Seattle, WA 98195

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ORIGINAL ARTICLES

Cavity Varnish and Bacterial Cross-Contamination

This study indicates little possibility of cross-contamination of bacteria with the use of cavity varnishes. However, all procedures that maintain sterile conditions in the dental office are nonetheless strongly recommended.

G LYNN POWELL • JOANN P FENN

Summary

The ability of cavity varnish to serve as a bacterial reservoir and a potential of bacterial cross-contamination from bottles of cavity varnish was evaluated. The results indicate that, generally: (1) cavity varnish does not sustain the growth of bacteria, and (2) there is little opportunity for bacterial cross-contamination to occur through the use of cavity varnish.

INTRODUCTION

Cavity varnish is widely advocated for use in dental restorations to help reduce early marginal leakage and reduce the penetration of deleterious materials into the dentin (Going, 1972; Phillips, 1976; Sneed, Hembree & Welsh, 1984). At least two applications of the cavity varnish are usually recommended (Lund, Matthews & Miller, 1978; Gilmore & others, 1982). Although most dental operators change cotton pellets between applications, the dentist who redips the same cotton pliers or brush into the bottle of cavity varnish may be creating a source for bacterial cross-contamination. Recent reports (Bagga & others, 1984; Manzella & others, 1984) remind us of the need for control of infection during dental procedures and the possibility of cross-contamination between patients and/or dental staff in the dental office.

Two reports on the ability of cavity varnish to support the growth of micro-organisms produced differing results. One concluded that the cavity varnish "... did not support the growth of microorganisms" (Fuller & Hormati, 1980), while the other study stated, "Cavity varnish can serve as a bacterial reservoir if not treated aseptically" (Lindemeyer, 1983). These reports did, however, have two things in common. All samples were taken from a dental school clinic environment and only one type of cavity varnish (Copalite) was investigated. Neither study investigated the ability of cavity varnish to sus-

University of Utah, Department of Pathology, Dental Education, Building 518, Salt Lake City, UT 84112

G LYNN POWELL, DDS, associate professor

JOANN P FENN, MS, MT(ASCP), research instructor

tain the growth of known organisms seeded into the varnish.

This project was conducted to investigate the ability of several varnishes to support or sustain bacterial growth of selected organisms, and to assess the degree of bacterial contamination of cavity varnish from private dental offices.

METHODS AND MATERIALS

Three components of the study were set up to determine the ability of cavity varnish to support the growth of micro-organisms.

Part 1: Effect of serial dilution on the ability of cavity varnish to support the growth of selected micro-organisms.

Part 2: Effect of evaporation on the ability of cavity varnish to support the growth of selected micro-organisms.

Part 3: Culture of cavity varnish from bottles collected from area dental offices.

Part 1: Effect of Dilution

Three cavity varnishes, as supplied by the manufacturers — Cavi-Line (L D Caulk Co, Milford, DE 19963, USA), Copalite (H T Bosworth, Skokie, IL 60076, USA), and Varnal (Cetylite Industries, Pennsauken, NJ 08110, USA) — were diluted with Mueller-Hinton broth to give serial dilutions of 1:0, 1:2, 1:4, 1:8, 1:16, 1:32, 1:64. *Pseudomonas aeruginosa* and *Staphylococcus aureus* were used as the test organisms. They were selected because they are standard test organisms in the microbiology laboratory, they are nonfastidious, and can be found in the oral environment.

The varnish-broth dilutions were placed in individual screw-cap sterile test tubes, and 0.5 ml of a $5x10^5$ concentration of *Pseudomonas aeruginosa* was added to each test tube in the dilution series. A second set of dilution tubes for the varnish was inoculated with 0.5 ml of a $5x10^5$ concentration of *Staphylococcus aureus.* The inoculation of two series of dilution tubes with these two organisms was repeated for each of the three cavity varnishes.

The dilution tubes were incubated at 37 °C for 18–24 hours. Contents of each test tube were then inoculated to 5% sheep blood agar plates and incubated for 18–24 hours at 37 °C. Results of growth/no growth were recorded.

Controls were employed to confirm the vitality of the test organisms and to check for contamination of the three cavity varnishes. A 0.5 ml sample of test bacteria was placed into a tube of broth, with no varnish, then incubated and inoculated to culture plates as described above. Samples of uninoculated and undiluted varnish, from freshly opened bottles, were also incubated and inoculated to culture plates.

Part 2: Effect of Evaporation

Samples of four manufactured cavity varnishes — Cavi-Line (L D Caulk Co), Copalite (H T Bosworth), S S White Cavity Varnish (S S White, Philadelphia, PA 19102, USA), and Varnal (Cetylite Industries) — were used in Part 2. Each type of cavity varnish was tested separately with *Pseudomonas aeruginosa* and *Staphylococcus aureus*, as in Part 1, as well as with *Fusobacterium nucleatum* and *Peptostreptococcus anaerobius,* which are anaerobic bacteria that can be isolated from the oral cavity. Samples (1.0 ml) from freshly opened bottles of cavity varnish were inoculated with 3–5 colonies of the organism and the samples incubated both aerobically and anaerobically at 37 °C. This procedure was repeated after 2, 4, 6, and 8½ hours of evaporation for each of the four varnishes. Evaporation was accomplished, simulating clinical conditions, by removing the lid from the bottle and allowing the cavity varnish to be exposed to the air for the specified amount of time.

Cavity varnish tubes inoculated with *Peptostreptococcus anaerobius* and *Fusobacterium nucleatum* were placed in anaerobic GasPak jars (BBL, Division of Becton, Dickinson and Co, Cockeysville, MD 21020, USA) and incubated for 96 hours. Tubes inoculated with *Pseudomonas aeruginosa* and *Staphylococcus aureus* were incubated at 37 °C under normal atmospheric conditions for 72 hours. A sample from each test tube was then subcultured to 5% sheep blood agar plates and incubated as previously described at 37 °C. The plates were read for results of growth/no growth and results recorded.

The incubating of samples from freshly opened cavity varnish bottles, both aerobically

and anaerobically, and then the subculturing, as above, served as negative controls. Sample bacteria colonies were incubated and subcultured to verify vitality and serve as positive controls.

Part 3: Office Samples of Cavity Varnish

Twenty bottles of cavity varnish were randomly collected from private dental offices in the area. They included 19 bottles of Copalite and one bottle of Varnal. These were examined macroscopically; several appeared turbid and varied in color and viscosity. No attempt was made to determine the age, duration of usage, or the amount of evaporation or dilution of each bottle.

A 0.1 ml sample of cavity varnish was inoculated to each of several plates, as follows:

(1) Sheep blood agar was incubated aerobically at 37 °C for 10 days (for recovery of aerobic micro-organisms.

(2) Anaerobic plate systems, including Brucella blood agar, Phenylethyl alcohol agar (PEA), and Laked blood with Kanomycin and Vancomycin (LKV) were incubated in anaerobic Gas-Pak jars (Anaerobic Systems, Santa Clara, CA 95050-7960, USA) at 37 °C for 10 days (for recovery of anaerobic micro-organisms).

(3) Sabourauds dextrose agar (for isolation of yeasts and molds) was incubated at room temperature for 30 days.

(4) Brain-heart infusion agar was also inoculated and incubated aerobically and anaerobically at 37 °C for 10 days to duplicate the methods of a previous study by Lindemeyer (1983).

All plates were examined periodically throughout the incubation period. The plates were read for growth/no growth and the results recorded.

RESULTS

Part 1: Effect of Dilution

No growth of the selected bacteria was observed in the undiluted varnish supplied from the manufacturer, as evaluated in Part 1. Growth of *Pseudomonas aeruginosa* was not observed until a dilution of 1:4 (one part varnish to four parts broth) was reached in one cavity varnish. Sustained growth of this organism was not found in the other cavity varnishes until a 1:16 and 1:32 dilution was reached. The sustained growth of *Staphylococcus aureus* was observed in one cavity varnish beginning at a 1:4 dilution but was never observed in the other two varnishes even at a 1:64 dilution. See Table 1.

Table 1. Growth of Bacteria in Broth-diluted Varnish

Dilution Varnish:Broth	*Pseudomonas aeruginosa* Varnish			*Staphylococcus aureus* Varnish		
	Cavi-Line	Copalite	Varnal	Cavi-Line	Copalite	Varnal
1:0	0	0	0	0	0	0
1:2	0	0	0	0	0	0
1:4	+	0	0	+	0	0
1:8	+	0	0	+	0	0
1:16	+	0	+	+	0	0
1:32	+	+	+	+	0	0
1:64	+	+	+	+	0	0

Table 2. Growth of Bacteria in Evaporated Varnish

Hours of Evaporation	Varnish	Aerobic		Anaerobic	
		Pseudomonas aeruginosa	*Staphylococcus aureus*	*Fusobacterium nucleatum*	*Peptostreptococcus anaerobius*
0	Cavi-Line	0	0	0	0
	Copalite	0	0	0	0
	S S White	0	0	0	0
	Varnal	0	0	0	0
8.5	Cavi-Line	0	0	0	0
	Copalite	0	0	0	0
	S S White	0	0	0	0
	Varnal	0	0	0	0

Note: Results were the same for 2, 4, and 6 hours of evaporation

Part 2: Effect of Evaporation

In Part 2, no bacterial growth was observed on any aerobic or anaerobic cultures from freshly opened samples of cavity varnish from the four manufacturers. No bacterial growth was observed in samples of cavity varnish inoculated with known micro-organisms, following prescribed periods of evaporation of the cavity varnish. These results are summarized for all four varnishes in Table 2.

Part 3: Office Samples of Cavity Varnish

The results of Part 3 of the study indicated that in general the office samples demonstrated no bacterial contamination. Only one culture demonstrated significant growth. It was an anaerobic gram positive rod, identified by the University of Utah Medical Center Microbiology Laboratory as *Proprionibacterium acnes.* This was isolated on the Brucella agar plate in a quantitation of 2+. Cultures from five other bottles each grew one colony of *Staphylococcus.* These bottles were subcultured again on two different occasions, with no growth occurring at either time. All other cultures from the remaining varnish bottles presented no growth. These results are shown in Table 3.

Table 3. Growth of Micro-organisms from Dental Office Cavity Varnish

Culture Media	Positive Growth	Negative Growth
Aerobic		
Sheep blood agar	0	20
Brain-heart infusion	0	20
Anaerobic		
Brucella blood agar	1*	19
PEA	0	20
LKV	0	20
Molds and yeast		
Sabourauds dextrose agar	0	20

*Proprionibacterium acnes (gr+)

DISCUSSION

The results of this study are consistent with those reported by Fuller and Hormati (1980): bottles of cavity varnishes generally do not support bacterial growth even when subcultured to enriched media and tested both aerobically and anaerobically.

This study involved three and four different cavity varnishes, rather than only one as in previous studies, and relied on inoculation of each with known, live bacteria, rather than on the possibility of contamination from an unknown source. The use of samples from private offices reduced the potential of institutional resistant strains of bacteria contaminating the study and also provided varnish in a condition as it is used in practice. Microbiology and clinical laboratory methods followed standard protocol and techniques as used at the University of Utah Medical Center (Lennette & others, 1985).

Although this study shows little opportunity for cross-contamination of bacteria to occur with the use of cavity varnishes, procedures that maintain sterile or disinfected conditions are advocated for use in the dental office. This concept must be emphasized, especially when the limitations of the study are noted. First, only selected micro-organisms were tested with the cavity varnishes. Second, the culturing of viruses was beyond the scope of this study. Therefore, we urge dental staff to continue to be conscientious in hand washing, proper cleaning of instruments, and using clean techniques in the dental office.

CONCLUSION

Four commonly used cavity varnishes did not support the growth of micro-organisms. Furthermore, cavity varnishes from randomly selected private dental offices were found generally not to contain bacteria.

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Effects of the Smear Layer, Copalite, and Oxalate on Microleakage

DAVID H PASHLEY • D DOUGLAS DEPEW

Summary

In vitro studies on dentin permeability and on microleakage indicate that oxalate salts deserve consideration as potential cavity liners and may decrease patient sensitivity to freshly placed amalgams.

INTRODUCTION

Dentin permeability has been defined as the movement of fluids or chemicals such as microbial products through dentin. This movement may be in the nature of bulk fluid flow (filtration) or the diffusion of substances in solution along a concentration gradient (Pashley, 1984; Pashley & others, 1985). Permeability is dependent upon the surface area of the exposed or cut dentin, remaining dentin thickness, and the degree of tubule occlusion. As remaining dentin thickness decreases, tubules are more numerous per unit area and wider in diameter, permitting increased fluid flow. Fluid movement across dentin is the basis for the hydrodynamic theory of dentin sensitivity (Brännström, Lindén & Åström, 1967).

Medical College of Georgia, School of Dentistry, Departments of Oral Biology and Physiology, Augusta, GA 30912

DAVID H PASHLEY, DMD, PhD, professor

D DOUGLAS DEPEW, BS, undergraduate dental student, class of '88

The smear layer may be defined as mineralized dentin matrix which tenaciously adheres to the dentin surface and is produced whenever dentin is cut or abraded. The smear layer is extremely important as it results in a significant decrease in dentin permeability. It may also harbor bacteria (Brännström & Nyborg, 1973; Bergenholtz & others, 1982). Since a smear layer is produced any time dentin is cut, its positive and negative effects on the success of any restoration must be considered.

Microleakage has been defined as the passage of bacteria, fluids, and chemical substances between the tooth and restorations of any type (Bauer & Henson, 1984). It is generally clinically undetectable; however, patients sometimes report restorations that are sensitive to thermal or osmotic stimuli. Microleakage results in the presence of a fluid-filled space at the interface of the restoration and the tooth. This space may be the result of the initial adaptation of the restoration to the cavity interface; the solubility of cements, liners, or bases; or the differences between the coefficients of expansion of restorative materials and the tooth. With composites, the polymerization shrinkage of the setting materials results in tensile forces greater than the bond strengths between resins and teeth (Davidson, deGee & Feilzer, 1984). In amalgam restorations, microleakage is due to inadequate adaptation of the material to the cavity walls since, at constant temperature, leakage can be demonstrated immediately after placement. The adaptation of amalgam to the irregularities of cavity preparations is an

operator-sensitive procedure that is difficult to master, even under ideal laboratory conditions. Many clinical conditions make it nearly impossible to condense amalgam restorations properly (Mahler & Nelson, 1984). The work described in this paper is based on a modification of the method described by Derkson, Pashley and Derkson (1986).

Dentin permeability and microleakage are related in that together these processes provide a continuous, microscopic, fluid-filled route between the oral cavity and pulpal tissue of the tooth, allowing pulpal irritation by bacteria or their products, and sensitivity to masticatory, osmotic, or thermal stimuli.

The purpose of this study was to: (1) quantitate the effects of the smear layer on dentin permeability in empty versus filled class 1 cavities and to compare the effects of cavity liners; and (2) to quantitate the influence of the presence or absence of the smear layer and the influence of cavity liners on the degree of microleakage around amalgam restorations placed in class 1 cavities in human teeth in vitro.

MATERIALS AND METHODS

Teeth

Human, extracted, unerupted third molars were stored at 4 °C in phosphate buffered saline (PBS) containing 0.2% sodium azide to inhibit microbial growth. The teeth were used within one month of extraction. The roots of the teeth were removed at the cementoenamel junction using a slow-speed diamond saw (Isomet, Buehler Ltd, Evanston, NJ 08520, USA). The coronal pulp tissue was removed with a cotton forceps and the crown mounted on a 2 x 2 x 0.6 cm piece of plexiglass containing a length of 18-gauge stainless steel tubing in its center (Figs 1 & 2).

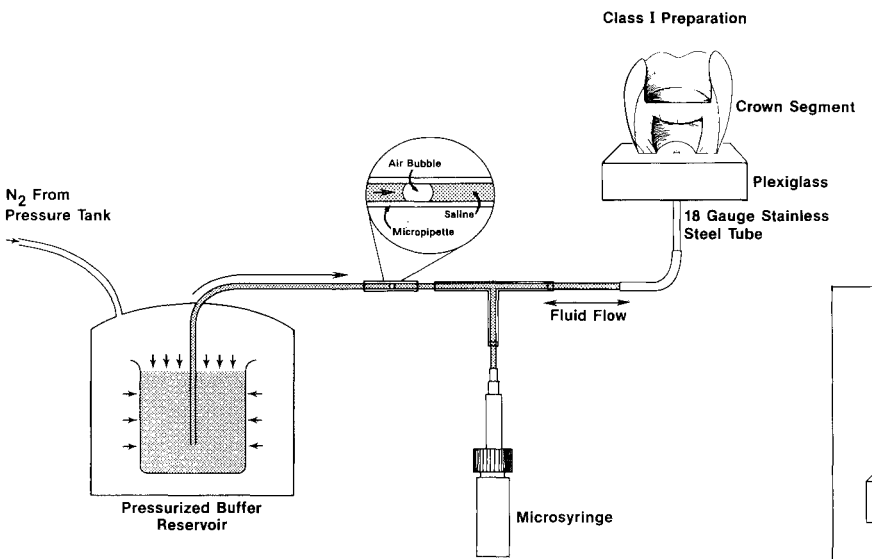

FIG 1. *Diagrammatic representation of the apparatus used to measure dentin permeability. Buffered saline was forced from the reservoir, through the micropipette and then through the dentin to the cavity surface. The rate of movement of the tiny air bubble in the micropipette quantitated the degree of dentin permeability.*

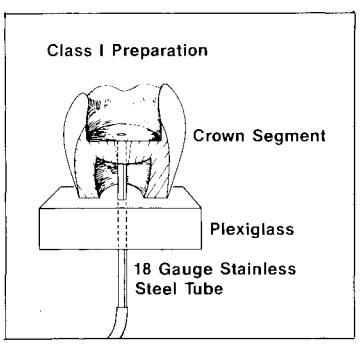

FIG 2. *The same apparatus was used to measure microleakage around amalgam restorations, differing only in that the stainless steel tube passes through the dentin to end at the pulpal floor of the cavity. Microleakage was quantitated by following the rate of movement of the air bubble in the micropipette.*

PART 1: DENTIN PERMEABILITY

The tubing within the plexiglass mounting block was cemented in place so that one end was flush with the top of the plexiglass (Fig 1). The crown was cemented in place with cyanoacrylate cement. Class 1 cavity preparations were made well into the dentin using a No 558 fissure bur in a high-speed handpiece with copious air-water spray.

The cavity preparations were treated as follows:

Group I — Smear layer intact (no treatment)
Group II — Acid etched with 6% citric acid for two minutes
Group III — Acid etched, plus two layers of Copalite
Group IV — Acid etched, plus treated with 3% half-neutralized oxalic acid for two minutes
Group V — Acid etched, plus amalgam
Group VI — Acid etched, plus two layers of Copalite, plus amalgam
Group VII — Acid etched, plus 3% half-neutralized oxalate, plus amalgam

Copalite (H J Bosworth Co, 7227 N Hamlin Avenue, Skokie, IL 60076, USA) was applied in two layers and air dried between applications. The oxalate solutions (3% w/v aqueous half-neutralized oxalic acid) were applied to all cavity surfaces by filling the cavity with several drops for two minutes, then rinsing for 15 seconds.

Dentin permeability measurements (fluid filtration rates) were made before and after cavity treatment. Following this, the cavities were filled with Dispersalloy (Johnson & Johnson Dental Products, East Windsor, NJ 08520, USA) amalgam and the fluid filtration rates redetermined one hour later. The amalgams were placed incrementally, using small condensers, condensing toward the cavity walls. The condensation was probably superior to that usually done clinically because of the perfect accessibility of the teeth in vitro.

PART 2: MICROLEAKAGE

The 18-gauge stainless steel tubing was passed through the plexiglass mounting block and the dentin until the tubing was flush with the pulpal floor of the cavity (Fig 2). The tooth and tubing were cemented in place with cyanoacrylate. While amalgam was being condensed into the cavity, the lumen of the tubing was occluded with a length of wire which was subsequently removed to permit fluid flow from the pulpal floor around the amalgam.

To quantify microleakage around amalgams, the tubing was connected to a pressurized buffer reservoir to permit fluid flow rates to be measured as in Part 1. Cavities with and without smear layers were treated with different liners before the amalgam (Dispersalloy, Johnson & Johnson) was condensed, creating the following experimental groups:

Group I — Smear layer intact, plus amalgam
Group II — Acid etched for two minutes with 6% citric acid, plus amalgam
Group III — Smear layer intact, plus two layers of Copalite (H J Bosworth Co), plus amalgam
Group IV — Acid etched, plus two layers of Copalite, plus amalgam
Group V — Smear layer treated with 3% half-neutralized oxalic acid for two minutes, plus amalgam
Group VI — Acid etched, treated with 3% half-neutralized oxalic acid for two minutes, plus amalgam
Group VII — Smear layer treated with 30% dipotassium oxalate for two minutes, followed by 3% half-neutralized oxalic acid for two minutes, plus amalgam
Group VIII — Acid etched, treated with 30% dipotassium oxalate for two minutes, followed by 3% half-neutralized oxalic acid for two minutes, plus amalgam

The data were expressed as $\mu l\ min^{-1}\ 10\ psi^{-1}$ hydrostatic pressure.

Determination of Dentin Permeability

Dentin permeability was measured as a hydraulic conductance (Reeder & others, 1978). Fluid, under a constant pressure, was delivered from a pressured buffer reservoir through a micropipette and polyethylene and steel tubing to the pulp chamber. Fluid, from the pulp chamber, then flowed through the dentinal tubules to the cut surface of the cavity. By following the progress of a small air bubble in the micropipette, the rate of fluid flow (in $\mu l/min$)

was used as a measure of dentin permeability. As each cavity is unique in terms of its surface area, thickness of remaining dentin, and so forth, the rate of fluid flow recorded in the acid-etched cavity was assigned a value of 100% and all subsequent changes in permeability were expressed as a percent of the acid-etched or maximal value. In this manner, each tooth served as its own control. Dentin permeability was measured first in cavities with an intact smear layer and then again after removal of the smear layer by acid etching to maximize their permeability (Bowen, 1978; Pashley, Michelich & Kehl, 1981).

Determination of Microleakage

Part 1 represented the measurements of fluid filtration rate across intact dentin and around restorations and measured the sum of both dentin permeability plus microleakage. In Part 2 the dentin was by-passed to permit measurement of microleakage alone.

DATA ANALYSIS

Part 1: Dentin Permeability

Statistical differences between treatments were evaluated using Student's one-tailed *t*-test for paired data. Multiple comparisons were done using ANOVA and Duncan's Multiple Range test.

Part 2: Microleakage

Statistical analysis of the results used Student's *t*-test for unpaired data, ANOVA, and Duncan's Multiple Range test.

RESULTS

Part 1: Dentin Permeability

The results of the effects of surface manipulation of Class 1 cavities on dentin permeability are shown in Fig 3. When the smear layer was intact (Group I), dentin permeability was very low ($6.32 \pm 2.5\%$, $\bar{X} \pm$ SEM, $N = 13$) in relation to the acid-etched values of the cavities. Acid

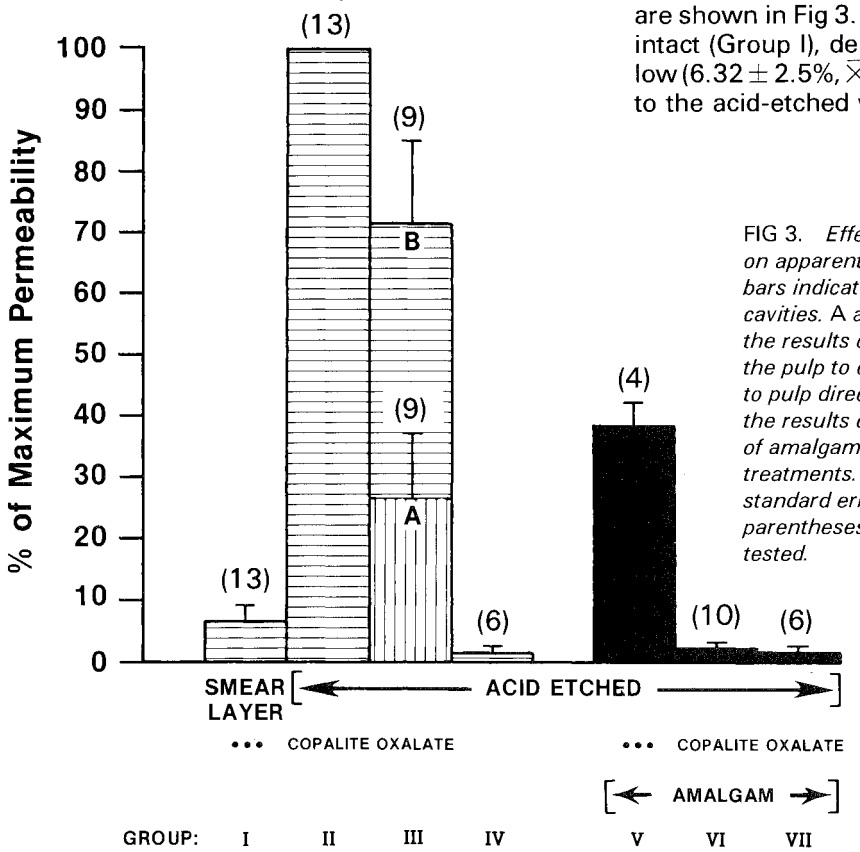

FIG 3. *Effect of various cavity treatments on apparent dentin permeability. Hatched bars indicate the results obtained in empty cavities.* A *and* B *in Group III refer to the results obtained when filtering fluid in the pulp to cavity direction* (B) *versus cavity to pulp direction* (A). *Solid bars indicate the results obtained following placement of amalgam restorations over the cavity treatments. Brackets indicate size of one standard error above the mean. Number in parentheses indicates number of samples tested.*

etching with 6% citric acid for two minutes (Group II) led to a very large, statistically significant increase in dentin permeability (100%, $\bar{X}$, $N = 12$; $P < 0.0005$). A value of 100% was assigned to the acid-etched dentin specimens to represent maximum permeability.

All other measurements were expressed as a percentage of the maximal amount of fluid movement across the dentin, thereby permitting each tooth to serve as its own control. When the acid-etched dentin was treated with two layers of Copalite, dentin permeability dropped 28% when fluid was filtered from the pulp to the cavity direction (Group IIIB). However, when the filtration direction was reversed — that is, from cavity toward pulp — dentin permeability fell 73% (Group IIIA).

Treatment of acid-etched cavities with 3% half-neutralized oxalic acid (w/v) for two minutes (Group IV) led to a 98.25% reduction in dentin permeability which is highly significant ($P < 0.0005$) ($1.75 \pm 0.9\%$, $\times \pm$ SEM, $N = 6$). Reversal of fluid flow direction did not change the results.

When amalgams were placed in acid-etched cavities (Group V) without any further surface treatment, the apparent dentin permeability was higher than those amalgams lined with Copalite or with oxalic acid, but lower than unfilled acid-etched cavities (Group V vs Group II). That is, placing the amalgam caused a decrease in apparent dentin permeability of 61%. Placement of amalgams over cavities treated with 3% half-neutralized oxalic acid (Group VII) produced no more change in apparent dentin permeability than that seen in cavities treated with oxalate (Group IV) but not restored with amalgam. There was no statistical difference between amalgams lined with either Copalite or oxalate. Either treatment resulted in much lower (19-fold reduction) apparent dentin permeability than unlined amalgams (Group V vs VI and VII).

Part 2: Microleakage

The results of these experiments (Fig 4) demonstrated that the amount of microleakage around Class 1 amalgams in the presence of a smear layer (Group I) was fourfold higher than that around amalgams placed in acid-etched cavities (Group II) ($P < 0.005$).

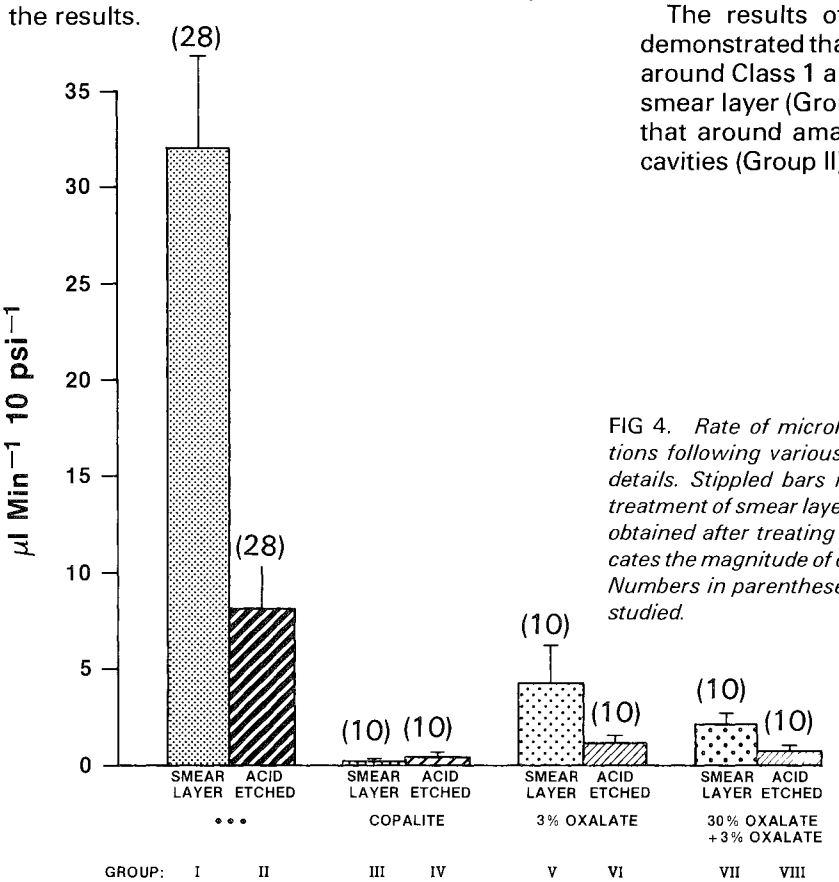

FIG 4. *Rate of microleakage around amalgam restorations following various surface treatments. See text for details. Stippled bars represent data obtained following treatment of smear layer. Hatched bars indicate the results obtained after treating acid-etched cavities. Bracket indicates the magnitude of one standard error above the mean. Numbers in parentheses indicate the number of samples studied.*

Treatment of the smear layer with two layers of Copalite (Group III) produced a highly significant reduction in microleakage around the amalgam compared to cavities covered with a smear layer alone (Group I, $P < 0.0005$).

When acid-etched cavities (no smear layer present) were treated with two layers of Copalite before insertion of the amalgams (Group IV), there was a further reduction in microleakage relative to acid-etched cavities alone (Group II, $P < 0.001$). In both cases, the amalgam restorations lined with Copalite were effectively sealed.

When cavities covered by a smear layer were treated with 3% half-neutralized oxalic acid (Group V), microleakage around the amalgam restorations was significantly reduced ($P < 0.005$) when Group V data were compared to Group I data (that is, the microleakage found in the presence of an untreated smear layer).

When acid-etched cavities were treated with 3% half-neutralized oxalic acid (Group VI), there was a further decrease in microleakage ($P < .005$) compared to untreated acid-etched cavities (Group II).

Successive applications of the two oxalate solutions (Group VII) to cavities covered with a smear layer produced a statistically significant ($P < 0.001$) reduction in microleakage compared to Group I.

When both oxalate solutions were applied in succession to acid-etched cavities (Group VIII), there was a decrease in microleakage ($P < .001$) compared to Group II controls (acid-etched cavities alone).

DISCUSSION

Part 1: Dentin Permeability

Several recent papers (Bergenholtz & others, 1982; Browne & others, 1983) suggest that the histopathologic reactions in the dental pulp to many restorative materials may be due not to the materials themselves but to leakage of microbial products around materials through the dentin to the pulp. If this is true, then more efforts need to be made to minimize this leakage and/or to reduce dentin permeability.

The problem of pulpal irritation under any restoration is caused by the two related factors of microleakage and dentin permeability. The first line of defense against movement of substances around the restoration and into the pulp is, of course, the integrity of the seal or adaptation of the restorative materials. The high level of apparent dentin permeability around unlined amalgams (Fig 3, Group V) demonstrates the ineffectiveness of the first line of defense in these experiments. Obviously a second line of defense is needed, such as blockage of the dentinal tubules to prevent movement of solutes or solvents from the cavity into the pulp or vice versa.

Since a smear layer is produced virtually every time dentin is cut, it serves as a natural cavity liner, blocking the dentinal tubules (Fig 3, Group I) and thus greatly reducing permeability. Although the smear layer adheres rather well to dentin, it is acid labile and therefore its influence may be altered over time. Further, the smear layer may actually increase the degree of microleakage around amalgams (see Part 2). For these reasons and because of other negative properties of the smear layer, alternate methods of reducing permeability of dentin are needed.

Cavity varnishes such as Copalite have been cited for their effects in reducing microleakage and permeability (Pashley & others, 1985). This study has shown that Copalite reduces permeability to some degree. Copalite residue is hydrophobic and tends to lie on top of cavity surfaces much like a gasket. This quality may be responsible for the influence of the direction of fluid filtration on dentin permeability (Fig 3). Filtering fluid from the pulp to the dentin surface tends to lift Copalite and other varnishes that lie on dentin surfaces from the dentin. When fluid is filtered from the dentin surface toward the pulp, the fluid forces the varnish down onto the dentin. However, Copalite's maximum reduction in dentin permeability was only 73%, whereas oxalate produced a much higher reduction (98%).

Numerous earlier papers have demonstrated the efficacy of oxalate at decreasing dentin permeability; see Pashley and Galloway (1985) for review. The results of our experiments using cavities with intact dentin floors confirm the superiority of oxalate over Copalite (Fig 3, Group IV vs III). This is probably because the aqueous oxalic acid solution reacts with ionized calcium in dentinal fluid to form crystals of insoluble calcium oxalate on the enamel and

dentin surfaces which are themselves crystalline. Since the calcium oxalate crystals are insoluble and acid resistant, they may tend to remain in place longer than the smear layer which is acid labile. The permeability of dentin with oxalate as a liner was lower than any other liner previously tested. Oxalate was so effective in reducing the amount of fluid that could be moved across dentin that when amalgams were placed over oxalate-treated dentin the amount of microleakage could not be determined (Group VIII). This is why the second model to measure microleakage independent of dentin permeability was developed.

Part 2: Microleakage

In a semi-quantitative study using monkeys, Jodaikin and Austin (1981) suggested that the smear layer hinders the sealing process of amalgams. In this experiment the smear layer actually increased the amount of microleakage around amalgams relative to the amounts of microleakage observed in acid-etched cavities that were free of smear layers (Fig 4, Group I vs II). This is possibly because the amalgam may adapt better to acid-etched cavity walls and therefore the space between the wall and restorative material is smaller. Alternatively, the presence of a smear layer may permit fluid to pass around smear layer particles at the amalgam-smear layer interface more easily than around the interface of an amalgam and acid-etched dentin.

This creates a paradox in that, while the smear layer greatly increased the amount of microleakage (Fig 4), it decreased the amount of dentin permeability (Fig 3). On the other hand, if the smear layer was removed by acid etching, microleakage was decreased (Fig 4) while dentin permeability was increased (Fig 3).

A conventional cavity varnish such as Copalite creates a good seal against microleakage (Fig 4, Groups III and IV) while it produces only a modest decrease in dentin permeability. Although Copalite greatly reduced microleakage (Fig 4), it tended to permit increased leakage after three months (Derkson, Pashley & Derkson, 1986). Derkson and others showed that acid-etched, unlined amalgams leaked at a rate that was 24% as much as the empty cavity (24 hours after placement). Copalite reduced the microleakage around amalgams to $2 \pm 1\%$ of the empty cavity, which subsequently increased to $18 \pm 6\%$ after three months of storage in 1% NaCl, a value that was not statistically different from fresh, unlined amalgams. Therefore, Copalite may reduce microleakage only for a limited time.

Treatment of cavities with oxalate before placement of the amalgams did not create nearly as good a seal as did Copalite (Fig 4, Groups V, VI, VII, VIII), but oxalate did reduce microleakage as compared to cavities containing a smear layer. The decrease in these values may result because the 3% half-neutralized potassium-oxalate solution is acidic and may remove some of the smear layer, thus allowing better adaptation of the amalgam. The calcium oxalate crystals produced a modest reduction in microleakage (Fig 4) although they greatly decreased dentin permeability (Fig 3).

If cavities were treated with 3% half-neutralized oxalate for two minutes prior to the application of Copalite, a double layer of protection would result. The oxalate treatment greatly reduces dentin permeability so that even if Copalite-lined amalgams slowly begin to leak, the calcium oxalate crystals in the tubule orifices would tend to prevent oral fluids and microbial products that may percolate around the restoration from diffusing across the dentin to the pulp.

The application of two layers of a cavity varnish compatible with the restorative material reduces microleakage more than it reduces dentin permeability. The restorative material should be inserted in such a way as to minimize microleakage. For amalgam restorations, this can be accomplished by careful attention to the plasticity of the amalgam, use of small increments, small condensers, overlapping condensation imprints, and so forth. For composites, this can be accomplished by use of cavosurface bevels, acid etching, and the use of bonding agents. In this way, it may be possible to restore the cavity from the inside to outside, laying a careful foundation for the restorative material, and for its clinical success.

CONCLUSION

As a result of this study, it is suggested that oxalate salts be carefully evaluated as potential

cavity liners. If future studies demonstrated biocompatibility, cavities could be treated with oxalic acid to reduce dentin permeability before placement of the restorative material. This may reduce patient reports of sensitivity under freshly placed amalgams.

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DENTAL REVIEW

Temporary Restorations: A Review

J L LUI • J C SETCOS
R W PHILLIPS

Summary

Temporary restorations play a vital role in the long-term success of fixed restorations. The health and integrity of the pulp and gingival tissues depend on the quality of these interim coverage restorations during the interval prior to the placement of the permanent prostheses. The various types of temporaries and the methods used for their construction are described. Materials commonly used for their fabrication are reviewed.

***University of Malaya, Department of Conservative Dentistry, Faculty of Dentistry, Malaysia**

Indiana University School of Dentistry, Department of Dental Materials, Indianapolis, IN 46202, USA

*J L LUI, BDS, MSc, associate professor

J C SETCOS, BDSc, MSc, assistant professor

R W PHILLIPS, MS, DSc, professor and chairman of Dental Materials

INTRODUCTION

The demand for fixed prosthetic treatment necessitates good temporary restorations. Temporary restorations are sometimes called treatment restorations, provisional crowns, interim crowns, and intermediate restorations. They may be used individually on single or multiple prepared teeth or they may provide coverage for abutment teeth as part of a splint or fixed partial denture prior to placement of the permanent prosthesis. They sometimes have to function for extended intervals while adjunctive treatment such as periodontics, endodontics, orthodontics, or oral surgery is performed. Besides protecting the teeth against caries and oral irritants, temporary restorations also prevent drift, rotation, and eruption. They should restore and improve esthetic appearance and provide for normal function. Gingival health is maintained with accurate marginal fit and correct contour. As temporary crowns they serve as trial crowns for evaluation and patient acceptance and provide a template for the final prosthesis. It is an advantage for temporary restorations to remain intact upon removal as they can be reused if necessary.

Two broad groups of temporary restorations

are available; preformed stock crowns and customized temporary crowns or bridges.

PREFORMED STOCK CROWNS

Preformed stock crowns generally consist of a shell of plastic or metal and may be cemented directly onto the prepared teeth following adjustments or after lining with a resin. They are indicated for individual tooth coverage for single or multiple crown preparations.

Aluminum Shells

Aluminum shells are available in two forms: a flat-topped cylindrical shell and a morphologically contoured shell. An anodized aluminum shell of appropriate size is selected and the cervical aspect trimmed to conform to the gingival margin of the preparation and to accommodate the vertical height of occlusion. Aluminum shells are soft and may perforate in function, resulting in fracture of the cement lute if left longer than a few days. The longevity of the aluminum shell may be reinforced by lining with a self-cure resin, trimming the cervical excess, and replacing the crown to check for fit and occlusion prior to cementation. Since the wide occlusal tables of the flat-topped aluminum shells tend to cause cheek biting, the morphologically contoured shells are preferred. The softness of the aluminum shells allows rapid wear that may result in supereruption of teeth and may produce an unpleasant taste and unesthetic appearance. Thus aluminum shells are restricted for temporary coverage of posterior teeth for short periods only.

Acrylic Shells

A suitable size and shade of acrylic shell are chosen from a stock selection. The shell is trimmed to fit the gingival margins of the preparation. Occlusal and proximal contacts are checked and adjusted where necessary and, following polishing of the trimmed areas, the acrylic shell can be cemented. However, if the fit is poor or the cervical margin is inadequate, a reline of the shell, using acrylic resin, is indicated. Acrylic shells are used for anterior temporary coverage as esthetics and satisfactory form and fit are readily obtained.

Celluloid Crown Forms

The celluloid crown form made from a very thin shell of cellulose acetate provides a mold for the construction of the temporary crown. A suitable crown form is selected and trimmed to fit the gingival margin of the preparation. By means of a sharp probe, small escape holes are made at both incisal corners of the crown form to allow extrusion of excess material and to avoid entrapment of air. The tooth preparation is thinly coated with petroleum jelly to protect the underlying pulp and to facilitate removal of the crown. Resin of a suitable shade is mixed and loaded into the prepared crown form. When it reaches the doughy stage it is seated over the tooth preparation. At the semiplastic stage the crown is removed from the tooth, the cervical excess quickly removed, and the crown repositioned a couple of times. Polymerization is allowed to complete either on the bench or in warm water. The cellulose acetate mold is then peeled off, and because the mold imparts a well-polished surface to the resin, the crown is usually left undisturbed unless the morphology requires adjustment. After trimming to the correct cervical contour, the crown is returned to the mouth to check for fit, occlusion, and morphology. It is then polished and luted with a suitable cement. A temporary crown fabricated within a celluloid crown form is usually not as esthetic as one made from a preformed stock acrylic shell. However, the celluloid crown form is less expensive than the acrylic shell and more convenient to make.

Polycarbonate Crowns

These fabricated shells are made of a polycarbonate plastic combined with microglass fibers. They are available for anterior and premolar teeth. Using a guide, the correct size shell is selected and trimmed at the cervical to conform to the preparation outline. The trimmed shell is then lined with a suitable shade of resin. The number tab attached to the incisal edge of the shell facilitates removal. Following

adjustment for fit, occlusion, and esthetics, the finished temporary crown is then luted to the preparation. Microglass fibers within the polycarbonate impart a high impact strength to the crown, making it hard yet sufficiently flexible. The polycarbonate exhibits a low coefficient of thermal expansion as well as low water absorption and the thin yet translucent shell complemented by a suitable shade of reline resin enhances its esthetic appearance. Besides being functionally acceptable to the patient, the polycarbonate crowns are also easy to adapt and manipulate and require relatively short chair time (Nayyar & Edwards, 1978).

Stainless Steel Crowns

Stainless steel crowns, comprised of 67% iron, 10% to 13% nickel, and 17% to 19% chromium, were originally introduced to conserve deciduous molars with extensive caries (Humphrey, 1950) and found to be far more successful than multisurface amalgams (Braff, 1975). Although excellent for deciduous dentition and in certain cases, such as interim restorations for vital permanent first molars that are grossly carious (Albers, 1979), the stainless steel crowns are generally contraindicated for use in the permanent dentition because of their poor marginal adaptation. Despite this, they may be used with confidence in the permanent dentition as long-term temporaries. Such crowns possess tenacity and durability, are relatively cheap, sufficiently ductile for easy manipulation, require short chair time, and are resistant to tarnish and corrosion. Because they are contoured, smooth, and can be adequately adapted, they feel comfortable to the patient and, unlike some other metallic shells, they have no metallic taste.

Ni-Chro Crowns

These crowns differ from the stainless steel crowns in that they contain a relatively small amount of iron (Nash, 1981). The preformed nickel-chromium (Ni-Chro, 3M Co Dental Products, 211 McGaw Ave, Irvine, CA 92714) crown is made from an alloy called Inconel 600, comprised of 72% nickel, 14% - 17% chromium, and 6% - 10% iron, with trace amounts of other elements, which allows the crown to be fully shaped and strain-hardened without defects during manufacture. This makes the adaptation of the crown very simple, with relatively little adjustment required. The Ni-Chro crowns exhibit surface hardness and smoothness superior to the stainless steel crowns. The decreased cervical wall thickness provides better flexibility and adaptability at the cervical margins and produces a better fit. They have been used with a high degree of success for long-term temporary coverage in permanent molars. A two-year clinical assessment has shown that they did not exhibit any sign of adverse tissue reaction or deterioration and patient acceptance was found to be high (Gordon, 1979).

Iso-Form Crowns

The Iso-Form (3M Co Dental Products, 211 McGaw Ave, Irvine, CA 92714) temporary molar and premolar crowns are manufactured from high purity tin-silver and tin-bismuth alloys. These crowns are reinforced by thickening at the occlusal surfaces and rounding at the cervical edges. They are soft and ductile and will stretch easily to fit the tooth preparation. During cementation it is possible to "bite in" the contoured and festooned crown, whereupon the cervical margin will expand over the margins of the preparation. At the same time, contact with adjacent teeth is established due to the prebelled contact areas on the crown. While the cement is setting, the expanded cervical margin can then be burnished to a feather edge without wrinkling. These crowns are nongalvanic and therefore functional movements against opposing and adjacent permanent metallic restorations do not give rise to galvanic shocks nor unpleasant metallic taste. Iso-Form temporary crowns are also compatible with surrounding soft tissues.

CUSTOMIZED TEMPORARY RESTORATIONS

Customized temporary restorations are indicated for coverage of multiple individual crown preparations, a single tooth preparation which is unusually large or of a special design (Nieten,

1980), and abutment preparations for a fixed prosthesis. The fabrication of a customized temporary crown or bridge involves the construction of a mold of the patient's original or adjusted dentition into which is placed a polymeric resin material, which is held directly on the prepared teeth until the resin has polymerized beyond the semiplastic stage, or indirectly against a model of the prepared teeth until complete polymerization under pressure has occurred.

Generally, the indirect technique is preferable to the direct technique because the direct application of resin materials to the prepared teeth and surrounding soft tissues may produce an adverse pulpal reaction and sometimes even a hypersensitivity reaction. The exothermic heat of reaction of some polymerizing resins can result in untoward consequences to the pulp. If the resin is allowed to completely polymerize in the mouth, undercut areas can be a problem. To offset this, the mold carrying the resin needs to be removed so that final polymerization can take place on the bench. However, once the mold is out of the mouth, there is no compensation for polymerization shrinkage. The indirect technique, which allows polymerization to occur against a model of the prepared teeth, thus produces temporary restorations with marginal accuracy significantly better than those produced by the direct technique (Crispin, Watson & Caputo, 1980). The indirect technique also has the advantage that part of the procedure may be carried out by ancillary staff which saves the clinician some chair time.

Impression Method

A preoperative impression with alginate or silicone is made of the arch or adjusted study model and carefully stored until completion of tooth preparation. For the direct technique, the prepared teeth and surrounding soft tissues are coated with petroleum jelly. A mixture of a suitable shade of polymeric resin is loaded into the corresponding preparation area of the previously indexed impression and seated fully into the mouth. It is removed before the resin has polymerized beyond the semiplastic stage. It may then be allowed to polymerize completely outside the mouth, but poor fit of the restoration can result. To minimize this, the temporary restoration may be worked on and off the preparation until final polymerization has occurred.

For the indirect technique, an additional impression is taken immediately following tooth preparation and then cast in fast-setting stone. The initial impression loaded with resin is seated over the stone preparation model and maintained in place until polymerization of the resin is complete. Ancillary staff may carry out this indirect procedure while the clinician obtains the master impression. The fully polymerized temporary restoration is trimmed, shaped, adjusted for occlusion, and then polished. After a final check it is cemented.

Template Method

A stone duplicate is made of a corrected initial study cast which may include wax-up of pontic areas. By means of a thermal vacuum machine, a template or splint of cellulose acetate is obtained which can be used as a mold for fabricating the temporary restoration. This method has advantages over the impression method in that the accurate and close adaptation ensures duplication of the occlusion, the clear, trimmed template allows visible checking of extruded resin, facilitating a check for initial hardening of the resin to allow its early removal, thus minimizing the effect of the heat of polymerization. The template is easy to construct and the esthetic result is enhanced with accurate duplication of the teeth (Fiasconaro & Sherman, 1968; Sotera, 1973).

Polycarbonate Matrix Method

This is similar to the template method except that the clear polycarbonate matrix becomes incorporated as part of the temporary restoration (King, Young & Cleveland, 1973). A stone duplicate of a cast with corrected occlusion or added pontics is made. The section with the involved teeth is separated from the rest of the cast. Modifications are made to the contours and margins of these teeth and their contact areas reduced by at least a quarter of a millimeter to accommodate the thickness of the polycarbonate matrix. By means of a thermal

vacuum machine, a clear polycarbonate resin sheet is adapted to the cast. It is then trimmed, contoured, and kept aside until completion of the preparation. Resin of a suitable shade is then loaded into the polycarbonate matrix and seated onto the previously lubricated preparations. Exothermic heat can be controlled by frequent rinsing and reinsertion which will also minimize distortion. The resin unites chemically with the polycarbonate, and on completion of polymerization the excess is removed, occlusion checked, and the temporary restoration polished and luted with a suitable cement. The polycarbonate resin has high impact strength, excellent creep and abrasion resistance, hardness, and other mechanical properties superior to the common temporary crown and bridge materials. The matrix is relatively easy to construct; occlusion, proximal contacts, and gingival margins are accurately and easily established; polishing is not required in untrimmed areas; and the esthetics is satisfactory with the correct shade of reline resin.

Acrylic "Shell" Method

This direct technique is a modification of the alginate impression method. The impression method presents certain difficulties in that the resin is not visible during its setting reaction and may lead to poor repositioning of the tray, resulting in high occlusion requiring considerable adjustment. An alginate impression is first obtained from the mouth or from a modified study cast. Liquid monomer is dripped into the area of the impression where teeth are to be restored. Polymer powder is sprinkled into it to completely absorb all the monomer. This process is repeated until the desired thickness is achieved, creating a shell covering the walls and occlusal areas. It is allowed to set in a humidor to prevent the alginate from drying out. Once set, the acrylic shell of about ½ - 1 mm thickness is teased out and trimmed to remove any excess at the margins. Following tooth preparation, the shell is filled with the appropriate shade of acrylic and seated over the lubricated preparation. The shell is removed at least once and allowed to polymerize on the tooth preparation. Following any needed adjustments, the temporary restoration is polished and cemented into place. If light-colored acrylic had been used at the incisal edges in the shells, the restorations can exhibit excellent lifelike esthetics. This method also has the advantages of accurate marginal adaptation, little or no occlusal adjustment, reproducibility of occlusal morphology and tooth contour, and reduced chair time (Ferencz, 1981).

Laboratory Method

A simulated preparation with minimal reduction is made on a duplicate study cast. From this an indirect temporary restoration of an appropriate shade is constructed from an impression of the unprepared study cast. Following tooth preparation, it may be necessary to adjust the internal surfaces of the prefabricated temporary to accommodate the actual preparation. A reline with resin will result in good fit and adaptation of the laboratory prefabricated restoration.

A heat-cured resin temporary restoration fabricated in the laboratory will provide superior physical properties compared to a cold-cured temporary. However, an interim restoration constructed at the chair side may be completed in much less time than the heat-processed temporary.

POLYMERIC RESINS FOR TEMPORARY RESTORATIONS

Different types of polymeric resin materials are available for the construction of temporary crowns and bridges. The following four materials are used at the present time.

Polymethylmethacrylate

This acrylic resin, also called 'autopolymerizing', 'self-cure', or 'cold-cure' resin, was used in the early days of fixed prosthodontics for the fabrication of temporary crowns and bridges and is still popular today. It is inexpensive, easy to manipulate, and has good thermal insulating properties but suffers from a number of serious drawbacks. Most notable is the high concentration of free monomer in the setting material which is toxic to the pulp, especially when placed in direct contact with freshly cut vital

dentine (Dahl, Tronstad & Spangberg, 1974). The excessive exothermic heat of polymerization makes it advisable to remove the resin at the point of noticeable heat. However, this can result in poor fit of the temporary restoration because of high and unrestricted polymerization shrinkage (Robinson, Hovijitra & Meyer, 1979).

These resins have a high coefficient of thermal expansion and low strength and modulus of elasticity. If the temporary restoration is allowed to remain in the oral cavity for a long time, the initial esthetic appearance will deteriorate with discoloration and staining (Wozniak & others, 1981; Pipko & El-Sadeek, 1972) resulting from the presence of porosity and surface roughness. However, compared to other temporary resin materials, acrylic resin seems to be the most color stable (Crispin & Caputo, 1979). In general, acrylic resins seldom cause allergic hypersensitivity reactions and, if they do occur, it is most often the self-polymerizing resin which is incriminated. There are only a few documented cases of allergic stomatitis to the self-polymerizing resin (Samuels, 1960; Nealey & del Rio, 1969; Stungis & Fink, 1969; Giunta & Zablotsky, 1976) and one report of dermatitis in a dental practitioner (Hollander & Kennedy, 1951). The majority of soft tissue lesions are due to chemical burns resulting from toxicity of the monomer or the effect of the heat of reaction.

Epimine Resin

A new material (Braden, Causton & Clarke, 1971) comprised of a base paste of an ethylene imine derivative of bisphenol-A containing crystalline polyamide filler particles and a catalyst liquid of benzene sulphonate was introduced to compensate for the many disadvantages of the polymethylmethacrylates. The epimine resin has some major clinical advantages over polymethylmethacrylate: it has a much lower exothermic reaction, and it has no free monomer present resulting in far less detrimental effects on the pulp and the adjacent soft tissues (Dahl & others, 1974). Polymerization shrinkage is much less, ensuring a better fit of the temporary restoration (Robinson & others, 1979).

It is moderately easy to handle and manipulate, moisture has little effect on its physical properties, and water sorption is lower than with acrylic resin. Young's modulus and shear or rigidity modulus is comparable to the polymethylmethacrylate. It is inert to eugenol, making selection of a temporary luting medium less of a problem. Its impact strength, tensile strength, abrasion resistance, and extension to break are decidedly inferior to acrylic resins. Its use should be avoided for thin, intricate temporary restorations and long-term coverage. It is relatively expensive and limited to only one shade. Color matching can be difficult and it is subject to darkening and staining (Crispin & Caputo, 1979).

A problem which is causing some concern to the profession is the relatively high incidence of hypersensitivity reactions. In the first 10 years since its introduction, several cases of allergic stomatitis and contact dermatitis have been reported (Hartmann & Vollrath, 1971; Döser, 1972; Stratemann, 1973; Dahl, 1978; Lui, 1979; Duxbury, Turner & Watts, 1979; Tobias, 1980). The aromatic sulphonate catalyst is the implicated allergen and it is interesting to note that the similar catalyst in the related polyether impression material also causes the same hypersensitivity reaction (Nally & Storrs, 1973; Dahl, 1978; Duxbury & others, 1979). There is also "cross allergy," in which an allergic reaction may be set up during impression making and become evident on placement of the temporary restoration. The epimine resin should be used and handled with caution to minimize the risk of allergic hypersensitivity reactions to the patient, dentist, and dental assistant, particularly avoiding addition of an excess of catalyst over the recommended amount.

Polyethyl(butyl)methacrylate

Recently new temporary crown and bridge materials based on the higher alkyl-polymers have been developed (Braden & others, 1976). They consist of polyethymethacrylate polymer powder and a monomer liquid of either n-butylmethacrylate or iso-butylmethacrylate. These materials exhibit very desirable handling characteristics and, like the epimine resin, possess a very low polymerization exotherm and are very well tolerated by both the dental pulp and adjacent soft tissues. The polymerization

shrinkage is intermediate between the polymethylmethacrylate and the epimine resin, hence the marginal fit is also intermediate (Robinson & others, 1979). Another advantage is the toughness of these materials, when compared to either the acrylic or epimine resin, as greater energy is necessary to cause fracture. The lower Young's modulus gives it more flexibility and this property can be desirable for a temporary bridge. However, the tensile strength of the n-butyl and iso-butyl varieties is substantially lower than that of acrylic and epimine resins. Another disadvantage is that these materials are available in limited color shades and the esthetic result is inferior compared to acrylic resin. They are less color stable, and discoloration and staining occur more readily than with acrylic resin but less when compared to the epimine resin (Crispin & Caputo, 1979). Like the polymethylmethacrylate, they are affected by the eugenol content of temporary cements. There has been no report of allergic hypersensitivity reaction to the use of this material.

Bis-acryl-composite Resin

With the development of the bis-GMA resin, composite resins were introduced for use in temporary crown and bridge construction in the late sixties. The temporary crown and bridge variety differs from the filling materials in that it is based on multifunctional methacrylic acid esters. It is a three-component system comprising a base paste containing filler particles and two catalyst pastes containing the initiator and activator separately. The multifunctional acrylic monomers produce cross-linkages of rather high density during the setting reaction. This is exhibited as a distinct rubbery stage which allows removal of the polymerizing material from the mouth. Composite resins are easy to manipulate and the heat of reaction and polymerizing shrinkage is low in comparison with the polymethylmethacrylates. The composite temporary restoration possesses good mechanical and thermal properties and is indicated when a long-term temporary is required. Like the epimine resin, it is also relatively expensive and limited to only one "universal" shade, which can make color matching difficult. Also it does not polish to as high a gloss finish as the other resin materials. Detrimental effects on the pulp or sensitization to soft tissues is a possibility with the use of this material.

CONCLUSION

For fixed prosthodontics, a variety of materials and techniques for fabricating temporary restorations are available. By careful selection of the type of material, combined with proper technique, the requirements for temporary coverage can readily be satisfied. An awareness of the limitations and adverse effects of the polymeric resin materials is of special importance to avoid further aggravation of traumatized prepared teeth and their supporting tissues.

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PRODUCT REPORT

Effects of 15 vs 60 Second Enamel Acid Conditioning on Adhesion and Morphology

Scanning electron microscopy and bond strength tests did not reveal any significant morphological or retentive differences in enamel acid conditioning for either 15 or 60 seconds

WAYNE W BARKMEIER • SCOTT E SHAFFER
A JOHN GWINNETT

Summary

The in vitro effect of acid conditioning enamel surfaces with a 37% phosphoric acid gel for 15 seconds and for 60 seconds was evaluated for differences using scanning electron microscopy and composite bond shear strength tests.

The morphology of enamel surfaces following acid conditioning for either 15 or 60 seconds was essentially the same and no differences in the pattern or character of etched enamel rods were observed. Retentive characteristics of the acid-conditioned surface were determined by comparing the shear force required to remove resin-bonded composite cylinders from flat ground enamel surfaces of premolar teeth. No difference was found for shear strength required to remove composite cylinders from enamel etched for 15 or for 60 seconds.

Creighton University, Boyne School of Dental Science, Omaha, NB 68178, USA

Division of Dentsply International, Milford, DE 19663, USA

School of Dental Medicine, State University of New York at Stony Brook, NY 11794-8700, USA

WAYNE W BARKMEIER, DDS, MS, assistant dean for research; associate professor of operative dentistry

SCOTT E SHAFFER, MS, research chemist, Caulk/Dentsply

A JOHN GWINNETT, PhD, BDS, LDSRCS, professor of oral biology and pathology

Introduction

In 1955, Buonocore introduced a method of mechanical adhesion of restorative resin to enamel surfaces. This method, now commonly referred to as the acid-etch technique, is used

throughout the world for bonding resin restorative materials to acid-conditioned enamel surfaces.

Standard treatment time for enamel acid conditioning of adult teeth has routinely been 60 seconds. Recently, several studies have indicated that a reduction in etching time will reduce enamel loss and save chair time without affecting clinical performance. Scanning electron micrograph studies (Brännström, Malmgren & Nordenvall, 1982) have shown no difference in the etch pattern of enamel surfaces of young permanent teeth treated for either 15 or 60 seconds with a 50% phosphoric acid gel. In addition, no difference in etching pattern was found when a liquid acid etchant was compared to a gel type etchant or for teeth treated with topical fluoride versus teeth not treated with fluoride prior to etching.

Orthodontic resin adhesive bonding to enamel treated for 5 or 15 seconds was reported as not being significantly different from that obtained after a one-minute etch (Beech & Jalaly, 1980). A recent study (Barkmeier, Gwinnett & Shaffer, 1985) also found that the shear bond strength of orthodontic brackets bonded to enamel surfaces which had been etched for 15 or 60 seconds was not significantly different. In addition, examination by scanning electron microscopy of the etched surface did not show any qualitative differences in surface morphology of enamel etched for 15 or 60 seconds.

Other studies have also shown that clinical retention of fissure sealant was not significantly different when an etching time of either 20 or 60 seconds was used (Stephen & others, 1982; Eidelman, Shapira & Houpt, 1984).

The purpose of this study was to evaluate enamel etching times of 15 and 60 seconds by observing the resultant morphological characteristics and determining the shear bond strength of a visible-light-polymerized restorative resin.

Materials and Methods

Retentive characteristics of acid-conditioned enamel surfaces were evaluated by bonding composite cylinders to enamel surfaces. Forty extracted human premolar teeth stored since extraction in distilled water were used in this study. The teeth were prepared prior to bonding by sanding the buccal enamel surface with carbide abrasive paper to create a flat surface. The teeth were wet sanded with a low-speed rotating wheel, carbide grit sizes 240 and 600. The teeth were divided into two treatment groups of 20 teeth each. Specimens in Group I received a 15-second etch while Group II was designated to receive a 60-second etch.

For specimens in both Groups I and II the following procedure was used. A flour of pumice slurry in water and a soft rubber prophylaxis cup rotating at slow speed were used to clean the teeth. A 37% phosphoric acid conditioning gel (Tooth Conditioner Gel, L D Caulk Company, Milford DE 19963, Batch No 010885) was applied with a small brush to the prepared and cleaned enamel bonding sites (flat surface). For Group I, the gel was left undisturbed for 15 seconds, rinsed with an air-water mist for 20 seconds, and air dried for 20 seconds; for Group II, a 60-second acid-conditioning time was used.

A thin layer of visible-light-cure bonding agent (Prisma-Bond, L D Caulk Co, Batch No 052284) was applied to the acid-conditioned enamel surface with a brush followed by an air blast to further thin the unfilled bonding agent. The bonding agent was cured for 10 seconds with a visible-light-cure unit (Prisma-Lite, L D Caulk Co). Bonding of the composite cylinder to the enamel surface was achieved by placing a visible-light-cure composite (Prisma-Fil, Shade L, L D Caulk Co, Batch No 1127842) into a small cylindrical plastic matrix (3 mm height x 3.7 mm diameter) which was then placed onto the bonding site. The composite-filled cylinder was then covered with cellophane and carefully seated with finger pressure. The light guide was placed on the top of the composite cylinder, under slight pressure, and the specimens were light-cured for 20 seconds, then placed in distilled water for 7 days at 37 °C.

An Instron Universal Testing Machine (Model 1123, Instron Corp, Canton, MA 02021, USA) was used to apply a shear force to remove the bonded composite cylinders from the teeth. Each specimen was mounted vertically, in a plastic bottle cap (one-inch diameter) embedded with a self-cure polymethyl methacrylate resin, so that the force from the Instron's crosshead was parallel to the flat tooth surface. The composite cylinder was placed under a continual

load rate of 5 mm/minute until a breaking point was reached. The shear strength was recorded in megapascals (MPa). Student's *t*-test was used to determine any statistically significant difference between the two groups.

The effect of acid treatment time on the morphology of both flat sanded (ground) enamel surfaces and intact enamel was studied using scanning electron microscopy. To achieve side-by-side comparison on the same tooth, a slit was made in the surface of both flattened and intact enamel specimens with a diamond wafering blade (Buehler Ltd, Lake Bluff, IL 60044, USA). An index card was inserted to allow acid gel treatment of one side of the specimen for 15 seconds and the other side for 60 seconds. The specimens were coated with gold in a sputtering device equipped with a water-cooled anode and examined in an AMRAY 1000 (AMRAY Inc, Bedford, MA 01730) scanning electron microscope operating at 20 Kv. Observations were recorded on Type 52 Polaroid film (Polaroid Corporation, Cambridge, MA 02139, USA).

Results

Mean shear strength of composite cylinders bonded to enamel surfaces following 15-second acid conditioning and storage at 37 °C for one week was 19.5 ± 8.1 MPa. Mean shear strength for the 60-second acid-conditioning group was 21.3 ± 7.4 MPa (see table). No significant differences were found between the treatment groups (95% confidence level) when compared by Student's *t*-test.

Shear Bond Strength following 15 or 60 Seconds Acid Conditioning

Enamel Acid-Conditioning Time	Shear Strength (MPa) Range	Mean	SD
15 seconds	9.9 – 39.7	19.5	8.1
60 seconds	11.5 – 37.1	21.3	7.4

Figures 1 and 2 illustrate the typical appearance of enamel etched for 15 and 60 seconds, respectively. The micrographs also demonstrate the difference in pattern of etch between

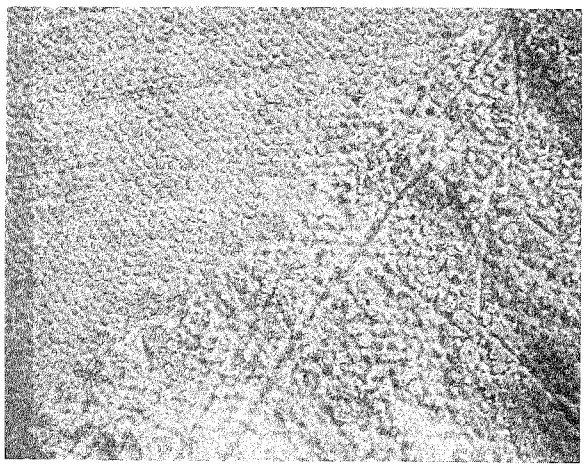

FIG 1. *Scanning electron micrograph shows the uniformity of etching pattern of ground enamel* (top left) *compared to that found for unground enamel* (bottom right). *The etching time was 15 seconds. X280 (original magnification X400)*

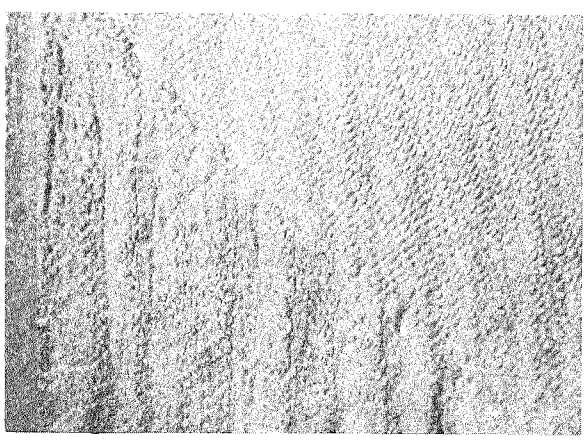

FIG 2. *Scanning electron micrograph shows the uniformity of the pattern found on ground enamel etched for 60 seconds* (top right) *compared to that found for unground enamel* (bottom left). *X280 (original magnification X400)*

ground and unground enamel surfaces. The uniformity of the etch pattern, seen with ground surfaces, contrasts with the variation in pattern found for unground surfaces. The latter is exemplified in Figures 3 and 4. It is evident that a significant increase in surface area results from etching either for 15 or 60 seconds when the enamel is ground or unground. Figures 5-8 demonstrate the preferential etching of the enamel rods and the resultant microporosity.

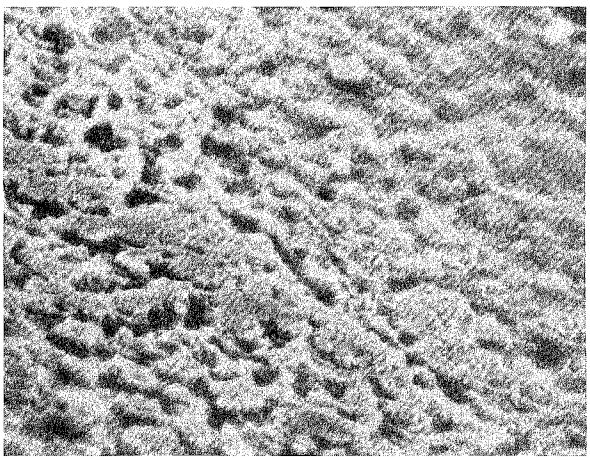

FIG 3. *Unground enamel surface etched for 15 seconds*

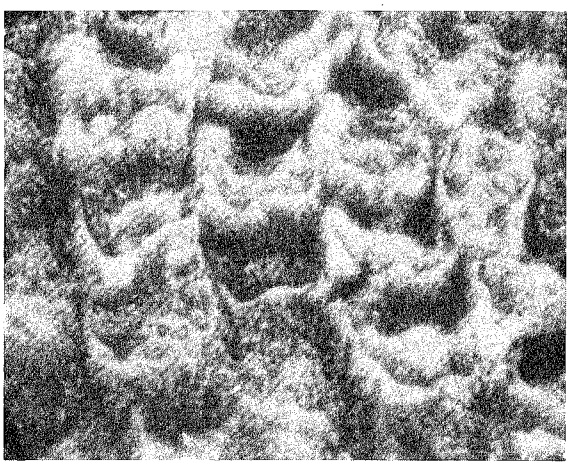

FIG 5. *Unground rods etched for 15 seconds*

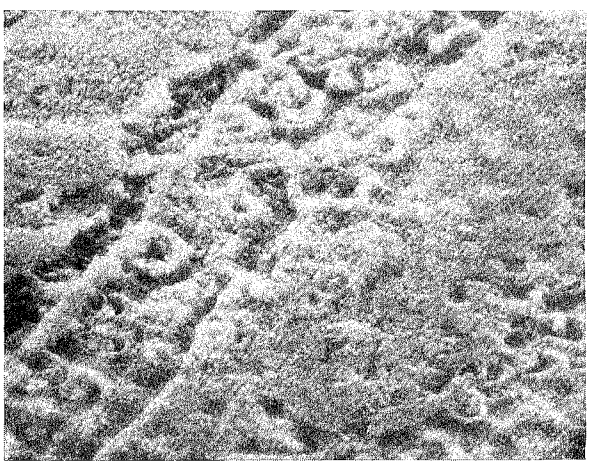

FIG 4. *Unground enamel surface etched for 60 seconds*

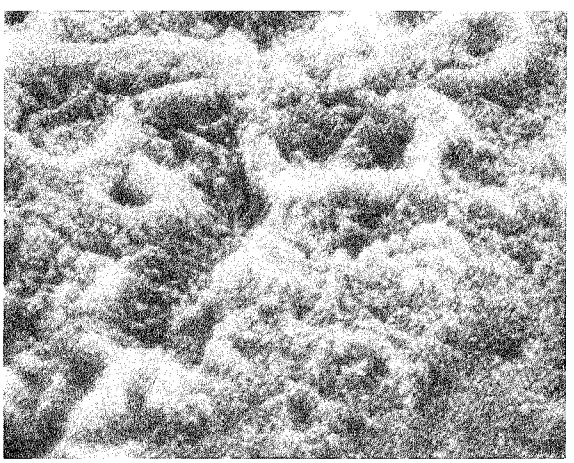

FIG 6. *Unground rods etched for 60 seconds*

FIGS 3 & 4. *Note the variation in the degree to which enamel is etched and the extent to which its micromorphology is disclosed in the form of preferentially demineralized rods. Scanning electron micrographs at X1120 (original magnification X1600)*

FIGS 5-8. *Scanning electron micrographs depict the increase in surface area and porosity of enamel rod structure following etching. At this magnification, striking similarities exist. X2800 (original magnification X4000)*

Discussion

Adhesion of restorative dental resins to acid-conditioned enamel surfaces has enhanced clinical performance. The principal advantages

FIG 7. *Ground enamel rods etched for 15 seconds*

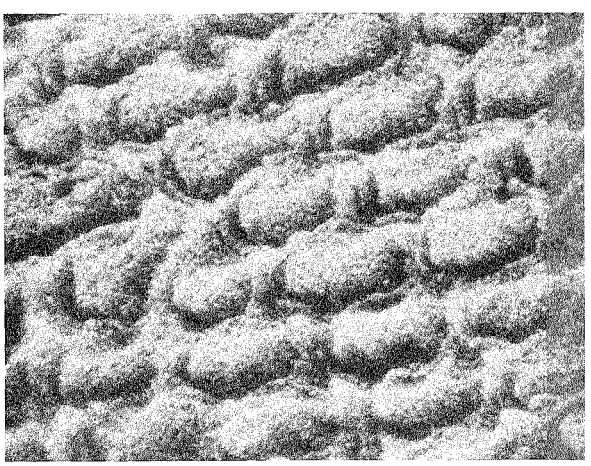

FIG 8. *Ground enamel rods etched for 60 seconds*

of the acid etch/resin technique are retention of the resin to the tooth and the reduction or elimination of marginal microleakage. Other benefits are conservation of tooth structure and excellent esthetic results. In recent years, use of this technique has proliferated markedly in dentistry with the introduction of resin laminate veneers, posterior composites, and resin-bonded appliances.

For many years acid-etching solutions ranged from 37-50% (wt) phosphoric acid and were liquid formulations. Currently, several gel type etchants are also marketed. Primary advantages of the gel type are the controlled placement on enamel surfaces to avoid inadvertent dentin contact and potential pulpal irritation with subsequent tooth sensitivity, and eliminate unnecessary etching of adjacent tooth enamel.

Standard treatment time for acid conditioning of enamel, for adult restorative procedures, has been 60 seconds. Usually recommended in the techniques for the use of liquid etchants is agitation of the acid on the tooth and warnings not to let the solution dry on the tooth surface. Recent research in orthodontic bonding (Barkmeier, Gwinnett & Shaffer, 1985) and sealant placement (Stephen & others, 1982; Eidelman, Shapira & Houpt, 1984) indicates that reduction of etching time from 60 seconds to 15-20 seconds may produce adequate retention characteristics for clinical success.

There has been a tendency to equate the depth of resin penetration into enamel with bond strength. This might be inferred from the work of Rock (1974) who demonstrated an increase in sealant resin bond strength when enamel was conditioned with a 30% phosphoric acid solution as compared to a 50% acid solution. Silverstone (1974) has shown that porosity was enhanced to twice the depth in enamel when a 30% solution was used, compared to a 50% phosphoric acid solution. The increased porosity and, therefore, deeper resin penetration might explain Rock's findings. Since the publication of these two pieces of pioneer work, the literature has become equivocal on the subject with a tendency to infer that no significant gain in bond strength is achieved with a reduction in acid concentration from 50% to 30%.

The present study, coupled with previously reported laboratory and clinical research data, further challenges that not only acid concentration but also conventional etching time may be reduced. This study shows that while topographical differences may exist in etched enamel which has been ground compared to unground it was clear that a comparable pattern was present for surfaces etched for 15 and

60 seconds. The uniformity of the pattern for the ground surfaces was in stark contrast to the unground surfaces. The chemical and micromorphological features of unground enamel probably account for such a difference. In the context of resin bonding, the rheological properties of the resin and of the increase in surface area from acid etching may be as or more significant than the depth of resin penetration. This is to be inferred from the present laboratory investigation since the depth of change in enamel after a 15-second acid application would be expected to be less than that with a 60-second application. The bond strengths were nonetheless statistically not different. This finding has significant clinical implications and strongly suggests the need for further research into the area of reducing etching times and its effect upon clinical performance. Clinical results already reported for sealants (Stephen & others, 1982) support the use of reduced conditioning time for this acid-etch procedure involving intact (unground) enamel surfaces.

Conclusions

Scanning electron microscopy showed essentially no difference in the type of enamel etch pattern between a 15 or 60 second acid-conditioning time. Ground enamel surfaces, however, produced a more uniform pattern than unground (intact) surfaces. No difference ($P < .05$) was found for shear strength required to fracture composite cylinders from enamel etched for 15 or 60 seconds.

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POINT OF VIEW

Contributions always welcome

Keeping Dentistry on the Professional Track

MELVIN H CARLSON

INTRODUCTION

For dentistry, motivation, objectives, and methodology are in greater flux than at any time in the history of the profession. If we see the practice of dentistry as a marriage of art and science that together create a profession of service and craftsmanship and if we keep in mind the unchanging aspects of both art and science, then we can find our perspective. We can look backward, down the road of historical beginnings which we cannot change, and we can see forward into our future, which we can change.

At this point, several important areas of change are now upon us.

11 North 11th Avenue, Yakima, WA 98902

MELVIN H CARLSON, DDS, is in private practice

THE PROPER ROLE OF PROFESSIONALS

Watch out for the Bandwagon

The promotion of restorative products by manufacturers to the public is a recent and disturbing development. Dentists have fallen over backward getting on the temporary dentistry bandwagon and seem to have forgotten some of the facts they were taught in their basic sciences as to the properties of dental materials, being influenced instead by advertising and patient pressure.

It is absurd to remove fine amalgam restorations and replace them with composites in response to a scare campaign perpetrated for unseemly motives. To replace serviceable amalgams for reasons other than proven allergies, proven toxicity, or other detrimental effects, or to upgrade permanent restorations in gold or porcelain, is unwarranted, unjustified, and mercenary. The vested interests have manipulated dentists into using inferior and untested materials for pecuniary reasons, hoping that ease of

application and esthetic results will override the cautious good judgment of the operators.

The blasé acceptance of advertising of ethical dentists is disturbing. The yellow pages of the phone book, the daily newspaper, and the television screen contain slick ads implying the superiority of skills and technics employed by a particular dentist or group of dentists. The implication of advertisements that the provision of stereo earphones, country music, babysitting service, and video rooms accompanies improved diagnostic or restorative skills is wrong. It appears that financial strategies and marketing supersede professional skills as the goal of the profession.

Guardians of the Qualified

A vital aspect of the art of dentistry is precision. Whatever restorative material is selected for use, bringing out its inherently good qualities demands adherence to definite rules for optimum benefit. All restorative materials are designed to be placed in a clean, dry environment. This is accomplished by the use of a rubber dam, which provides numerous other benefits that are obvious. Surgical removal of tooth structure should be done as conservatively as possible. The use of gold inlays and onlays saves tooth structure and challenges the dentist to provide oral jewelry rivaling that produced for ornamentation. Conservative amalgam restorations are an economical, effective service. Experimental materials have no place in an approach to therapy which utilizes the best qualities of materials for the appropriate situation. High quality dentistry does not make use of gimmicks and does not substitute salesmanship for craftsmanship.

There are few lab people who wish to deal directly with the public and the lab people assume that to mechanically construct dentures is the only qualification necessary. The public, being superficial in research and reactive to what they consider excessive fees, has approved denturism by plebiscite by large pluralities in all the states and Canadian provinces surrounding Washington. Some alternatives should be promoted by the profession to educate and assist the elderly and regain respect in this facet of dentistry. The elderly are increasing in numbers, and giving appropriate care will become a greater challenge. An alternative is to control entrepreneurs among the dental family who allow unqualified people to construct dentures, and to offer dentures for a modest fee to qualified and deserving patients. Perhaps we have priced ourselves out of range of those who need our services.

The recent activism by dental hygienists toward autonomy should be applauded and encouraged by the dental profession. Their training, devotion to ethics, and professional pride are inspirations to those who wish to improve their position within the system. This is the American dream. The hygienist produces a significant portion of the dentist's income, and when hygienists are accepted as preventive care professionals, in a variety of practice settings, their referrals to dentists will outweigh objections to autonomy. Their training, licensure, and acceptance as full professional partners are in sharp contrast to the blatant disregard of legality by the so-called denturists.

Keeping Up Our Skills

Dentistry is a visual occupation and dentists achieve a critical eye by observing restorations performed by skilled operators who can teach those skills. Almost all practicing dentists are solo practitioners, and the challenge of competition with peers or the direct observation of procedures and operations performed by even their closest professional neighbors is lacking. As a result, the sharply honed skills begin to imperceptibly dull. Didactic courses taken for a few hours of credit may add to the facts a dentist may use, but do little to sharpen clinical skills. Active participation in an organized clinical study club that meets regularly, employs a mentor with the ability to demonstrate exquisite dentistry as well as teach it, and a critique by the mentor and peers are excellent ways to maintain and increase skill level. Performing for peers also establishes one's position on the proficiency ladder of the community, and each operator realizes what he must do to achieve recognition on that ladder of craftsmanship. The fact that a small minority of practicing dentists take advantage of the opportunity to hone their skills and learn technics from their colleagues is an enigma.

Graduation from dental school does not confer everlasting wisdom in a profession that learns as it earns, or by storing facts when the hands and mind should be performing. When excellence is the professional priority, the individual must assume responsibility.

USING OUR RESOURCES

Making Use of Our Specialists

Too many patients are being treated by undertrained dentists in circumstances that warrant referral. Ethics and honesty require that whatever treatment is contemplated it is the best that the dentist can provide and, if it is outside the expertise of the individual, the patient be referred to one trained in that discipline.

Specialties that require years of training in graduate school are presented these days in weekend "courses," usually taught by clinicians whose limited experience is outweighed by their personal ambition and desire for remuneration. Obviously, this is not the answer.

The specialties exist to provide the best possible care for the public through additional training and experience, and certification boards examine the candidates to fulfill these objectives. Dentistry should make use of its specialties on a cooperative basis and not as a bailout when disaster strikes. Many dentists, unfortunately, are unaware of the scope of specialty practices, and it could be enlightening to them and beneficial to patients for dentists to become better informed on this aspect of their profession.

The State Boards, Revised

In many of our universities, clinical mock boards are practiced regularly in preparation for one examination, the state boards. The emphasis is keyed to requirements established in antiquity that have little resemblance to the present-day practice of dentistry. Perhaps the examination should be a surprise to the candidate, testing reaction to stress and general knowledge. Judging by recent examination results, preparation is lacking even when emphasized. Perhaps responsibility lies with faculties which may be out of touch with clinical excellence or the ability to teach excellence. It appears that many faculties are nepotistically stacked by friends and cronies with an influx of faculty members using the clinical staff as a second career.

Perhaps an entirely different process of state board examination is in order: the board would present to the candidate a patient who has been diagnosed and for whom a treatment plan has been set up, and offer a selection of specific clinical challenges to be completed by the candidate. This would give the board the opportunity to appraise the candidate on far more extensive knowledge, and would give the candidate the opportunity to demonstrate his ability to recognize and treat existing disease and to diagnose and plan treatment in totality. The profession needs to be challenged to continue to grow as a learned profession, with growth commensurate with current professional requirements and not dependent on the whims and caprices of the political bureaucracy.

Go National

The other learned professions enjoy the confidence placed in the various states to test applicants for licensure and grant licensure by credentials or reciprocity. Dentistry is obviously lagging behind in providing its membership with the confidence that education provided by the universities of this country is equivalent to the training provided other professions.

Dentistry must attain the stature necessary to negate the inbreeding that potentially exists in regionalization. Such stature is achieved by freedom of movement of dentists, and the salutary effect mobility has on awareness and objectivity in evaluating the quality of dentists trained in regions other than our own. Within specialties of dentistry, dentists train in hospitals and universities far removed from their matriculating institution. Almost universally, these dentists achieve a greater appreciation of variety by training in other facilities. No region or state or university or individual has all the truth, though many perceive their training and locale as evidence of divine manifestation and revelation.

The purity of the profession depends upon each individual's acceptance of the fact that the

profession is larger than any individual, and upon his endeavor to leave the profession better than before. Honesty, integrity, and veracity are accurate descriptions of a sensitive, caring, and ethical profession. Each dentist must do his utmost to typify these virtues to everyone he meets or cares for to assure the succession of trust and confidence we inherited from our professional forefathers.

MAINTAINING THE STANDARDS

Dentistry is on the brink of many decisions, not the least of which is how to govern its members for the greater good of dentistry. Reexamination or recertification at appropriate times would greatly upgrade the effort to maintain skill levels. We must initiate quality assurance mechanisms to assess professional competency throughout the dentist's productive years. Disenfranchising of licensees who by their own actions are unworthy of the rights and privileges the states have granted them is necessary to maintain the high standards of the profession. The inept, the voluntarily impaired, and the charlatans among us must be removed for the good of the whole. The problems confronting dentistry are in their infancy.

CONCLUSION

Is dentistry a "sunset profession"? Or can we ourselves begin now to bring about the changes essential in the next 50 to 100 years to accommodate the technological and biological advances that are already affecting dentistry so that our profession goes the way we want it to go!

Whatever the future unfolds, and in spite of scientific and political changes, human beings will continue to be treated by dentists. The new is up for inspection but need not be hailed as progress. We should accept it as challenge and move with the times to our own goals.

DEPARTMENTS

Book Reviews

METAL-CERAMICS: Principles and Methods of Makoto Yamamoto

Makoto Yamamoto

Published by Quintessence Publishing Co, Inc, Chicago, 1985. 526 pages, hundreds of illustrations, indexed. $140.00

This volume is a compilation of theory and technique that allows the fabrication of the strongest and most lifelike restorations possible. The author discusses in extraordinary detail the factors affecting the strength and marginal integrity of metal-ceramics. He explores the esoteric and nebulous concept in esthetics of individual perception, then develops guidelines for and techniques of creating the esthetic qualities of natural teeth using glass ceramics. He investigates the effects of various condensation techniques on the strength, shrinkage, and color fidelity of the fired restoration. He examines the causes of discoloration and offers methods to avoid it. In the final chapter he offers his rationale and technique for the fabrication of porcelain butt labial margins.

This book is unparalleled in its treatment of the subject. The restorations illustrated demonstrate extremely high quality and depth of understanding. The quality of the photographs convey the most subtle variations in color and texture. The reader will find truly masterful craftsmanship in all respects. The written text is also exceptional in its thoroughness. The author has gone to extraordinary lengths to examine even the most remote possibilities which might effect a specific area of concern.

This book should be mandatory reading for anyone who is involved with metal-ceramics. Both dentists and technicians will benefit by reading it. Our patients certainly will enjoy the benefits! Although reading this book cannot guarantee mastery of the complex subject of metal-ceramics, it certainly offers the reader more insight in one volume than was ever available before.

ROBERT R FAUCHER, DDS, MSD
19505 76th Avenue West
Lynnwood, WA 98036

CARIES RISK A Practical Guide for Assessment and Control

Bo Krasse

Published by Quintessence Publishing Co, Inc, Chicago, 1985. 113 pages, 14 color photographs. $18.00

As the author states in the preface, *"Caries Risk* is not a textbook on cariology. It is intended primarily as a manual for dentists, dental students and auxiliaries." The subtitle accurately describes the book — a practical guide for the assessment and control of dental caries — which the author hopes will encourage the application of existing knowledge in the diagnosis, treatment, and prevention of caries. This publication is an English translation of the original Swedish version which was first published in 1981.

Professor Krasse, internationally recognized for his extensive experience in the field of cariology, presents a compilation of practical advice. His methods, described in this book, have been successfully employed for many years at the Göteborg University Clinic for patients with high caries activity.

Caries Risk begins with a short review of the pathogenesis of dental caries. Each of the succeeding five chapters concisely describes an aspect of the evaluative and diagnostic means that can be used to determine caries risk: case history and clinical examinations; dietary, sali-

vary, and microbiological examinations; and the assessment of these findings. The next four chapters present practical methods to manage dietary problems, to treat poor salivary values, to reduce cariogenic micro-organisms, and to apply fluoride prevention. A chapter is directed to the detailed diagnostic evaluation and treatment of six patients with high caries activity. The effectiveness of each method employed to control dental caries is determined by the changes in salivary values and numbers of cariogenic bacteria. The last three chapters are devoted to a discussion of the value of using objective testing methods for the identification of high caries-risk individuals and the use of those same methods to monitor the patient's compliance with interceptive and preventive measures.

The format of this soft-cover, chairside guide to the assessment and management of dental caries allows for unstrained, rapid reading. The information is clearly presented in concise language. References and footnotes, which would not increase the usefulness for a publication of this type, are not included. Instead, a section at the end of the book lists suggestions for further reading for each topic in the text. The fourteen color photographs that illustrate the case history descriptions present excellent contrast and color.

The only significant criticism of this book is the omission of a product list of the numerous materials described. Although the formulations for many types of solutions are given, these are useful only to those dentists who use a pharmacist to prepare the material. However, since the majority of practitioners, auxiliaries, and patients generally prefer to obtain prepared substances, the addition of a product list indicating the concentrations of effective agents and their manufacturers would have greatly increased the usefulness of this otherwise excellent publication.

This book represents an outstanding contribution to the dental literature. It is the first practical guide to the clinical management of patients with high caries activity. As such it belongs in the office of every dentist and hygienist, and on the required reading list of every student pursuing these careers.

JOHN D TOWNSEND, DDS, MSD
University of Washington
School of Dentistry
Department of Restorative Dentistry
Seattle, Washington 98195

GNATHOLOGIC TOOTH PREPARATION

Charles L Stuart

Published by Quintessence Publishing Co, Inc, Chicago, 1985. 159 pages, 281 illustrations. $68.00

Dr Stuart's main emphasis in this book is that dental restorations should maintain or create organic occlusions. He attests to the fact that the successful use of cemented restorations, whether single units or as retainers for fixed prostheses, is founded upon proper diagnosis and treatment planning. Logically he asserts that some steps precede others and that the tooth preparation is the first step in the implementation of the restorative treatment planned for the tooth (teeth) in question. Yet we must recognize that having selected the proper restoration and preparation design is not enough. The tooth must be prepared with meticulous skill and attention to detail. If the preparation is poorly executed, all that follows is much more likely to fail than if the preparation were done well.

This book recognizes these fundamental concepts, but falls short of delivering the information necessary to implement them. The first half of the text is devoted to mechanical principles, devices, and techniques intended to develop a stable occlusion and nontraumatizing articulation. Then, in an attempt to address the basic principles of tooth preparation, the author restates the principles of G V Black. To relate his concept of occlusion to tooth preparation, the author re-emphasizes the role of planned occlusal morphology in occlusal reduction.

The single chapter devoted to actual tooth preparation does little to provide the reader with either logical sequence or the technical details of instrumentation in cavity preparation. Instead the author wanders back to the influence of occlusal geography on occlusal reduction. While credence is given that this aspect deserves attention, it is only one of many that must be satisfied to effect successful preparations/restorations. A final chapter is another reiteration of the goals of gnathology.

The format of this manual is more that of an atlas than that of a textbook. The illustrations are numerous but many are of poor quality. The appeal of the book would most likely be to those

who knew Dr Stuart and would recall him when reviewing the material. It offers little else than to serve as an escutcheon. Perhaps that is why the title, inappropriate for the content, was chosen.

ROBERT R FAUCHER, DDS, MSD
19505-76th Avenue West
Lynnwood, WA 98036

FACIAL GROWTH AND FACIAL ORTHOPEDICS

Frans P G M Van der Linden, DDS, PhD

Published by Quintessence Publishing Co, Inc, Chicago, 1986. 245 pp; indexed. $46.00

For the dentist seeking a clear and concise summary of craniofacial growth and development, Van der Linden's paperback text will provide an excellent source. The author assumes an understanding of the basic aspects of head and neck anatomy, histology, and physiology and deliberately omits information that adds complexity without adding to a working knowledge of the subject.

In the first half of the book, Van der Linden discusses general physical growth, growth of bone and cartilage, functional and anatomical aspects of the head, and postnatal development of the craniofacial skeleton. In the last half of the text, the author discusses the relationship between facial growth and the development of the dentition and the numerous functional factors that affect facial growth and development. In the last chapter there is a discussion of the adaptability of the musculoskeletal complex and the effects of orthopedic forces.

The text is well organized and indexed. The figures and figure legends are numerous, clear, and easy to understand. The typeface and overall layout makes for easy reading. Rather than listing references at the end of each chapter, the references for the whole book are listed alphabetically at the end. The text is recommended highly as a concise and up-to-date overview of current concepts of facial growth.

PETER SHAPIRO, DDS, MSD
University of Washington
School of Dentistry
Department of Orthodontics, SM-46
Seattle, WA 98195

Announcements

Subscription Rate Increases for the Journal

At the annual meeting of the Board of Directors of *Operative Dentistry,* in February, the subscription rate for the Journal was increased to $35.00, an increase of $10.00 annually. The Board was reluctant to take such a step but was driven to do so by the economic reality of rising costs.

The Journal has not increased its subscription rate since 1982, when it was raised to $25.00 from the previous $20.00. The costs of producing the Journal have risen substantially, as have other aspects of our economy. The major costs of producing the Journal are: salaries (editorial and secretarial support), typesetting, printing, and mailing costs. All have gone up considerably. If the Journal is to remain solvent, it needs an infusion of capital and, to carry on the mission, it requires increased income. The only solution was to raise the subscription rate and to solicit capital funds from the sponsoring academies. The American Academy of Gold Foil Operators and the Academy of Operative Dentistry have assured the Journal of their support by voting to provide needed capital investment and concurred with the need to raise the subscription rate.

Academy members of both supporting academies will see an increase in their dues, as all members receive the Journal as part of their membership. Nonmembers and institutions will be billed at the new rate beginning with Volume 12.

For the long run, we are endeavoring to cut our production costs. One plan, currently in progress, is to reduce a major portion of the typesetting costs by entering all the manuscripts on a microcomputer and transferring the data to the typesetter via a telephone modem. This will save about 35%, as the typesetters charge us $50.00 an hour for typing the data into their computers.

Some of you may wonder why we do not accept advertising to help defray the costs. With our limited subscription, it is not economi-

cally feasible to do so. The cost of printing the advertisements would be as much, or more, than any publisher could pay for a limited audience.

You, the subscribers, could help a great deal by promoting the Journal. If all of the academy members could get at least one new subscriber the Journal would remain solvent for many years to come. An additional benefit would be returned to our regular subscribers in the form of more supplemental issues. Enough material is available for more supplemental issues and we would be pleased to provide them if enough additional subscriptions were received to readily pay for the added costs. We need your support. We appreciate the support you have given, and the Board of Directors is now actively soliciting your help in making the Journal grow.

Private Sector Is Theme for Academy of Dental Materials

The annual meeting and symposium of the Academy of Dental Materials will be held January 3-4, 1987, at the Walt Disney World Conference Center, Orlando, Florida. The theme of this year's meeting is "The private sector's role in the future of dental materials research."

The symposium is being coordinated by Dr Lyle Zardiackas and involves representatives of industry. Emphasis will be placed on the role which large and small businesses and foundations may play in the future of dental materials research.

For additional information, please write to Ms Sybil Greener, Executive Secretary, Academy of Dental Materials, Dept of Biological Materials, Rm 10-019, Northwestern University Dental School, 311 E Chicago Ave, Chicago, IL 60611, or call her at (312) 642-9570 from 9:00 am to 3:00 pm CST.

American Academy of Gold Foil Operators
Annual Meeting: 15-17 October 1986
University of Puerto Rico
San Juan, Puerto Rico

Academy of Operative Dentistry
Annual Meeting: 12 and 13 February 1987
Westin Hotel
Chicago, Illinois

Letters

What Can We Do about the Mercurophobes?

The editorial opinion of Dr Gettleman in the preceding issue of *Operative Dentistry* (Spring 1986 pp 78–80) was excellent! The several points he made are right on the mark. The many long-term successful amalgams, as stated, are difficult if not impossible to count and document. By the same token the cause of failure of those amalgams that last only 5 to 10 years are being identified by Mjör and separately by Charbeneau as operator shortcomings and not material failures. I certainly would not want the operator whose amalgams last only five years to place a composite in the same tooth.

As Dr Gettleman pointed out, the various forms of mercury and their relative toxicity along with extremely sensitive testing instruments get all mixed up in the minds of the press and other ill-informed individuals. These factors are well known to the antiamalgamists, but they intentionally and purposefully confuse the public as well as many dentists who want to use anything to increase their business.

Dr Gettleman highlights another major area of concern — the damage done by nonprofessional, unethical dentists in the publicity they generate on national television. Such irresponsible behavior runs counter to one of the precepts in the ADA Code of Ethics that holds "it is not ethical to prescribe and perform unnecessary treatment."

More of these types of opinion articles should be solicited by the journal.

NELSON W RUPP, DDS, MS
Associate Director
American Dental Association
Health Foundation
Paffenbarger Research Center
National Bureau of Standards
Gaithersburg, MD 20899

Perseverance is more prevailing than violence; and many things which cannot be overcome when they are together, yield themselves up when taken little by little.

Plutarch, *Sertorius*

RECIPIENTS OF 1986 STUDENT ACHIEVEMENT AWARDS

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The following name and affiliation were omitted from the list of recipients of the 1985 Student Achievement Awards for the American Academy of Gold Foil Operators:

Oregon Health Sciences University	Arthur O Lyford

GIES FOUNDATION ASKS SUPPORT FOR ENDOWMENT FUND

The Board of Directors of the William J Gies Foundation for the Advancement of Dentistry invites members and friends of dentistry to join in a very special campaign initiated to ensure the continuing work and influence of this important and far-reaching foundation dedicated to dental health service.

Begun in 1950, the Foundation's role over the years has expanded to include, besides its original financing of the *Journal of Dental Research,* the administering and funding of several prestigious awards. They are the William J Gies Editorial Award (1958), Oral Surgery Award and Periodontology Award (1968) in cooperation with the respective academies, and the Award for Latin American Dental Research (1972), which fosters relations among Pan-American nations. The Foundation also supports an annual Dental Teacher Training Fellowship, various special projects for the International Association for Dental Research, and other special projects.

To preserve and extend the positive influence of Dr Gies on dental ethics, education, research, and practice, the Board of Directors of the Foundation has authorized a three-year fundraising campaign with a goal of $300 000 to double its present endowment. Virtually all of the endowment income is used to support projects; no offices or board members receive compensation for work or travel.

The success of this campaign will allow the Foundation to maintain the programs already cited, and will enable the establishment of new programs. These are: a Gies Dental Research Fellowship in conjunction with a recognized and accredited school of dentistry; a program to encourage the authorship of historical works on the contributions of dentists to society, arts, sports, literature, and public service; completion of a biography of Dr Gies; a rotating lectureship on dental ethics in conjunction with another dental organization; and publication of biographies of dentists prominent in pursuits other than dentistry.

William J Gies

The Gies Foundation was named after the late Professor William J Gies, PhD (1872-1956) of Columbia University, in its goal of continuing the work and spirit of the man who has left a significant impact on the profession of dentistry and in every aspect of dental health service.

In 1919, Dr Gies founded and edited the *Journal of Dental Research,* financing its annual deficits from his own salary and with contributions of friends until 1935. The following year, he founded the International Association of Dental Research, today an organization of 6 000 members in 49 countries.

The Carnegie Commission Report of 1926, written by Dr Gies, reorganized dental education under the aegis of universities, emphasizing biological science and research as the basis of dental education.

In 1931, Gies was one of the key organizers of the American Association of Dental Editors. In 1934 he was the moving force behind the establishment of the *Journal of the American College of Dentists.*

During the same period, Dr Gies provided the impetus for the establishment of the Dental Section of the American Association for the Advancement of Science.

As a testimony to his service as president of the Pan American Odontological Association, the Foundation established the Dr William J Gies Award for Latin American Dental Research in 1972 to foster research and international relations among Pan-American nations.

Through his interest in dentistry and his accomplishments on its behalf, Dr Gies uplifted the dental profession, guaranteeing its role today as a scientifically professional provider of health care for the American public. The Gies Foundation now seeks your support in continuing and extending its important work for dentistry.

For further information contact:

William J Gies Foundation for
the Advancement of Dentistry
Suite 352N
7315 Wisconsin Avenue
Bethesda, MD 20814
(301) 986-0555

Wit and Wisdom

Speaking of Outdoorsmen

I am reminded of a backpacking trip/photography expedition into the Davis Mountains a few years ago in which I learned a lesson which still has not become totally clear to me. A guy named J T and his brother Stooge were along, and as the members of the group got to know each other better we all shared some of our past with the others. Now, having been around hunters and fishermen all my life, I was aware that recalling tales of the past can be a splendid way to spend the evening, but J T and Stooge told a story to top all campfire stories.

It seems that as young men, J T and Stooge grew up in West Texas on a dry-land farm that never quite hit a real good year, but at the same time managed to provide enough for salt and flour and a few bullets. Well, the boys grew up and J T went off to school and ended up in the North married to the heiress of a large and profitable business, while Stooge stayed home on the dry-land farm.

The boys learned one day that a relative had died and left each of them a million dollars. Now in their own ways, neither had just a whole lot of use for a million dollars, but since it was there they each resolved to handle it in the best way they knew.

With all his contacts, J T knew of a small manufacturing firm that seemed to have potential, so he bought it with his million. He devoted all his time to it, employing several hundred people, running it himself, developing markets, and so on. By the end of the second year, he ended up with a 10% profit on his invested capital after his workers had paid federal, state, and local income taxes and his company had paid all the fringe benefits, Social Security, property taxes, licensing fees, and so on.

Out of the $100 000 profit, the city took 5% and the state took 12%, leaving the company owing roughly $38 000 to the IRS. The remaining $45 000 J T paid to himself as a dividend.

Now being a rich man, J T enjoyed the higher tax brackets. Consequently, the city hit him for $2000, the state for about $6500, and the IRS nicked him for 70% of the remaining $36 500, leaving him with $11 950 of his original $100 000 profit. After investing a million and fighting city hall, the EPA, unions, buyers, and tax collectors for two years, J T had earned himself a tidy $5975 a year on his million-dollar investment.

Not being overly bright where business and high finance are concerned, Stooge in the meantime had taken his million and stashed it in the local savings and loan. He had gone right on with his farming, and devoted a few minutes each quarter to endorsing his interest checks, which totalled about $55 000 a year.

Well, we never did establish which of them was the smarter, although the discussion continued on late into the night. The gist of the conversation, however, centered on a thing called incentive, and I seem to recall that most of us agreed that incentive is getting harder and harder to find these days.

WILLIAM F WATHEN, DMD

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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.

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 (6 x 8 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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University of Washington
School of Dentistry SM-57
Seattle, WA 98195 USA