OPERATIVE DENTISTRY

winter 1988 • volume 13 • number 1 • 1-48

(ISSN 0361-7734)

OPERATIVE DENTISTRY

WINTER 1988 • VOLUME 13 • NUMBER 1 • 1-48

Aim and Scope

Operative Dentistry publishes articles that advance the practice of operative dentistry. The scope of the journal includes conservation and restoration of teeth; the scientific foundation of operative dental therapy; dental materials; dental education; and the social, political, and economic aspects of dental practice. Review papers and letters also are published.

Publisher

Operative Dentistry is published four times a year: Winter, Spring, Summer, and Autumn, by:

Operative Dentistry, Inc
University of Washington
School of Dentistry SM-57
Seattle, WA 98195 USA

POSTMASTER: Send address changes to this address. *Operative Dentistry* is the official journal of the American Academy of Gold Foil Operators and the Academy of Operative Dentistry.

Subscriptions

Yearly subscription in USA and Canada, $35.00; other countries, $45.00 (sent air mail); dental students, $22.00 in USA and Canada; other countries, $31.00; single copy in USA and Canada, $12.00; other countries, $15.00. Make remittances payable (in US dollars only) to *Operative Dentistry* and send to the above address.

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University of Washington, School of Dentistry SM-57, Seattle, WA 98195, USA.

Printed in USA

EDITORIAL

Scholarly Activities: Boon or Bane?

Most dental schools are now ascribing to a basic research/teaching/service requirement for faculty members. Some require that faculty demonstrate significant accomplishments in two of the three areas, while others require significant contributions in but one area. Of concern is the increasing number of dental schools that are establishing requirements of research and publication of scientific papers--generally being referred to as "scholarly activities"--for academic appointment and promotion of faculty members. This is not a new phenomena but one which is rapidly changing the type of faculty being recruited and retained by more and more schools. Those who institute these requirements and those who support them are typically researchers themselves or administrators who realize that research activities can bring recognition and outside funding in an austere climate. No one can deny that research is the basis for almost all progress. On the other hand, faculty responsible for clinical training complain they do not have sufficient time to provide quality teaching and to be involved in significant research.

The question is: Is this pressure to be involved in scholarly activities a boon or a bane to the primary objective of dental schools, which should be to train competent clinical dentists in the skills of quality clinical dentistry and to give them the necessary didactic background to make sound pragmatic decisions?

To look at the problem as it exists, we must address the following: Are scholarly activities beneficial to the dental school and society at large? What effect does this impetus have on a dental school's faculty and its students?

It is doubtful that few would challenge the basic premise that research and related scholarly activities should be an integral part of the activities conducted in schools of dentistry. Without such activities there would be no progress, no resources for clinicians regarding which materials, drugs or techniques are preferred or proven superior for adoption into clinical practice, no new cures. We would certainly all agree that allowing developers of products and equipment to be our only source of information would be totally unacceptable. Also, few would disagree with the need for basic research, of a purely scientific nature. Scholarly activities can then be said to be beneficial, highly desirable, and, in fact, something which should be required of all dental schools.

When schools adopt the research-and-publish-or-perish syndrome, what happens to our educational objectives concerning the training of the undergraduate dentist? In days gone by, faculty members were primarily teachers, but with today's research and publication requirements they are required to serve two masters. Can they do so? In all probability they can serve neither one well.

To conduct meaningful research resulting in significant publications requires a dedicated effort of time and resources. Can teaching faculty do this and still maintain a quality level of teaching? I seriously doubt it. As the editor of *Operative Dentistry*, I see on a regular and increasing basis the results of this new "scholarly activity" being instituted in more and more schools. This journal, and I am certain all of the rest, receives poorly written manuscripts from junior faculty in which the research was poorly designed and poorly conducted. The vast majority of these come from schools where the department and other senior faculty have not had the same requirements, have never been involved in research, and have never published scientific papers. It seems obvious that the scenario goes something like this: The senior faculty person tells the junior faculty that the new rules call for "scholarly activities", meaning research and publication. The junior faculty are told that their fate as faculty depends upon it, both for promotion to a tenured position and, for most, for future pay raises. Of course, the chairman or advising senior faculty will indicate that the department is behind them and will support them in every effort. But can this be done? The results generated by these actions result in frustration and wasted time on the part of the junior faculty as most of their efforts wind up in rejection. With knowledgeable leadership junior faculty would be instructed to scrap unacceptable manuscripts before submission, to change the protocol, and how to prepare quality papers which referees would find acceptable for publication.

To be a dedicated teacher, one must devote him/herself to being the best there is. Providing quality education to our students requires time for study, lecture and laboratory preparation, test preparation, grading, and student counseling. As the major component of the undergraduate and graduate curriculum is clinical in nature, there is also an absolute need for time for clinical practice to maintain competency and proficiency.

Let us now look at the effect on the faculty member of being compelled to do "scholarly activities." Senior faculty, now full professors of many years' standing, are told that in order to qualify as well-rounded faculty eligible for "merit raises," they must begin doing research and generating publications. How is it that they were good, qualified teachers for many years and now they need to take on a new endeavor? Are they relieved of any teaching or administrative load? Certainly not! As a result, there are many senior faculty who do not receive merit raises and are unhappy, or they get involved in the research-or-perish-syndrome and time is stolen from the students they originally aspired to serve.

Junior faculty have it even tougher. When they are appointed at the rank of instructor or assistant professor, they are given the requirements for promotion and what is expected of them in the educational arena. Most junior faculty are given major courses to develop and conduct, requiring a great deal of time. They will also be required to serve as clinical instructors, and they usually will be given a day for private practice, either intra- or extramural. Let us say they have a one-day-a-week preclinical course for which they are responsible, such as operative dentistry or fixed prosthodontics. That leaves three days available. It takes at least one and one-half days to prepare for the lectures associated with their all-day class and to prepare the laboratory syllabus, leaving two and one-half days remaining. Library time to keep current for the course work is roughly one-half day, leaving two days. Clinical instruction on the clinic floor requires one day, leaving one day. Departmental and school committees and meetings require one-half day, leaving one-half day. Usually there are numerous other requirements laid upon most faculty to consume the remaining half-day. Doing any type of research, no matter how small, must take a minimum of one day a week. Where is it to come from? We don't allow the time, but still have a research-and-publication requirement. To do it well takes time. If the school, as many now do, puts more weight on research than it does on teaching, then the teaching is going to suffer.

I recently was informed by the Director of Minority Affairs, Health Sciences Division, University of Washington, that one serious problem with this dental school is the lack of faculty availability for student counseling outside of class. The primary reason, as perceived by students, for this lack of availability is the amount of time the faculty spend on research. Rather exemplifies the point, doesn't it?

Overemphasizing research and publication is certainly costing the educational process a great deal. Dental schools exist to train dentists, and yet that primary objective is being sacrificed at the expense of another cause. It seems that the pragmatic approach would be to have both--have researchers do research, and educators do the teaching. Researchers would be judged primarily on grants received and resulting publications and also for service and educational endeavors. Teachers would be judged for teaching contributions, with research and publications playing a much lesser role. This would allow clinicians to teach and to conduct research if they so desire and have the time. Of course, to do this would require more funding for additional faculty positions. Some schools have the wisdom to evaluate faculty in this manner, but the trend toward "scholarly activities" is making that aspect the most important.

"Scholarly activities" should be the boon of our existence, but instead it is costing us too much. Can we really afford the price? Is it not turning out to be our bane? Do you want your school continuing down this path? If not, **SPEAK UP!**

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ORIGINAL ARTICLES

Surface Deterioration of Glass-ionomer Cement during Acid Etching: An SEM Evaluation

GREGORY E SMITH

Summary

Ketac-Bond and Ketac-Cem glass-ionomer cements were subjected to gel or liquid acid etching for varying time intervals. SEM photomicrographs revealed rapid surface deterioration with crack formation after 20 seconds of etching time. By 60 seconds of etching, the surfaces were destroyed. No observable differences were found between Ketac-Bond and Ketac-Cem surfaces before or after etching. Gel and liquid etchants acted with equal speed to dissolve cement surfaces. Short etching times of 30 seconds or less are advocated to increase surface roughness for resin bonding without destroying the integrity of the glass-ionomer cement.

Introduction

Glass-ionomer cements have potential as esthetic restorative materials. Recently, interest has been focused on the use of these cements as liners under composite resin restorations (Norling & Duke, 1985), and products have been marketed for that purpose. Glass-ionomer liners are advocated because they bond both to dentin and to composite resins. Glass-ionomer/composite resin sandwich restorations utilize the pulpal protection and the fluoride content present in the ionomer and, at the same time, the color selection and surface properties offered by small particle or microfilled composite resins. The setting reaction of glass-ionomer cements has been shown to proceed slowly and these cements are readily susceptible to hydration and dehydration in early stages of set (Mount & Makinson, 1982). Studies have demonstrated improvement in glass ionomer to composite resin bond strengths when the glass ionomer was etched for 60 seconds (McLean & others, 1985). However, shorter etching times may be optimal clinically to reduce both the dissolution of the glass ionomer and the potential for acid penetration to the dentin.

The purpose of this investigation was to compare the surface of unetched glass-ionomer specimens, after initial set, to the surfaces of specimens which were etched for various time intervals. Glass-ionomer specimens were etched with either a liquid or gel etchant and the progressive surface degradation was evaluated at 5, 10, 15, 20, 30, and 60 seconds of etching. The scanning electron microscope was used to photograph and compare the surfaces studied.

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Materials and Methods

Two glass-ionomer products, Ketac-Bond, gray color, and Ketac-Cem (ESPE-Premier Corp, Norristown, PA 19404), were evaluated in this study. Specimens were mixed on a glass slab and allowed to set according to the manufacturer's time specifications of four minutes for Ketac-Bond and seven minutes for Ketac-Cem. Set cement specimens were then immediately divided into two groups: those to be etched with 37% phosphoric acid gel, and those to be etched with 37% phosphoric acid liquid. Unetched specimens served as controls. The etching times for the different specimens in the two groups were: no etch or 5, 10, 15, 20, 30, or 60 seconds duration. Additional specimens were etched 120 seconds to simulate the time of etching used clinically for deciduous teeth. Two specimens of each product were tested at each time interval.

After etching, specimens were rinsed for 45 seconds in tap water and dried with compressed air. Immediately thereafter, impressions were made in vinyl polysiloxane impression material (Mirror 3 Wash, Kerr/Sybron, Romulus, MI 48174) and replicas were poured in resin (Araldite 502 Resin, E F Fullom Inc, Schenectady, NY 12301), after the technique developed by Fischlschweiger and Antonson (1983). Replicas were plated with silver-palladium and evaluated in the Nova Scan 30 scanning electron microscope (Zeiss Instruments, West Germany) using an acceleration voltage of 15 kV. Photographs were made at X400 and X2000 magnification for comparative study.

Results

Replicas of unetched Ketac-Cem glass ionomer showed the anticipated irregular surface at X400 magnification (Fig 1). This untreated surface was relatively smooth and free of void spaces. Individual glass particles were not distinguishable although some of the surface convolutions undoubtedly represented coated particles lying within the gel matrix (Fig 2).

The surface roughness of the cement increased appreciably after the initial five seconds of etching as some of the gel matrix dissolved, leaving clusters of glass particles coated with gel matrix (Fig 3); however, identifiable surface porosity was not yet evident.

A dramatic change in surface morphology occurred by 10 seconds of etch as extensive surface porosity appeared (Fig 4). A network of small void spaces was seen surrounding clumps of intact glass-ionomer cement. Clearly, considerable dissolution of gel matrix had occurred by this stage.

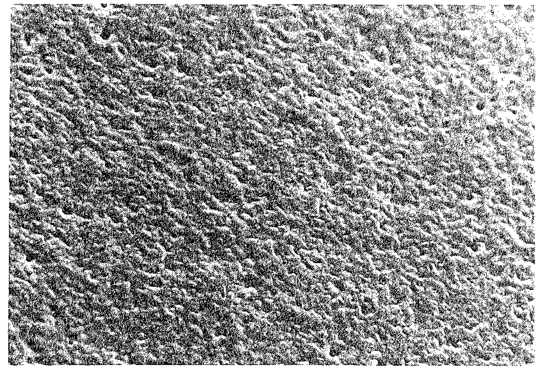

FIG 1. *Unetched surface of Ketac-Cem glass-ionomer cement after initial set. Relatively smooth intact surface of cement is seen at this low magnification. X232 (original magnification X400).*

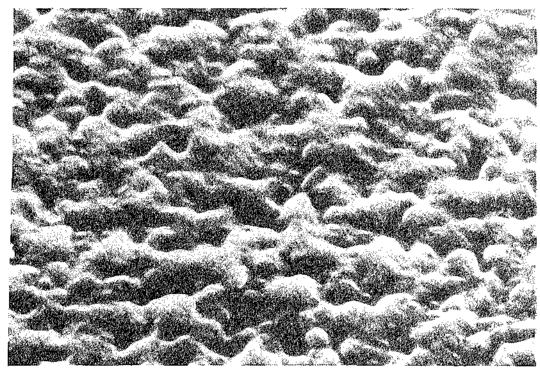

FIG 2. *Unetched surface of glass ionomer after initial set. This intact surface shows degree of surface smoothness typical at high magnification. Dark areas represent depressions between clusters of coated glass particles. X1160 (original magnification X2000).*

The size of the surface voids increased further after a 15-second etch (Fig 5) and the individual particles gained greater definition. Here, considerable void space existed between glass particles; however, the particles remained attached to one another by the semi-intact matrix coating.

Surface cracking became evident at low magnification after 20 seconds of etch (Fig 6). Dissolution of the matrix, cracks, and an increased surface porosity were evident at high magnification upon the completion of 20 seconds of etching time (Fig 7).

At 30 seconds etch, low magnification revealed the ionomer surface to be replete with multiple surface cracks (Fig 8). Where cracks formed,

FIG 3. *Photomicrograph of Ketac-Cem surface after five seconds of etch. Note increased surface roughness compared to unetched surface (shown in Fig 2). The acid has dissolved some gel matrix from the glass-ionomer surface. X 1160 (original magnification X2000).*

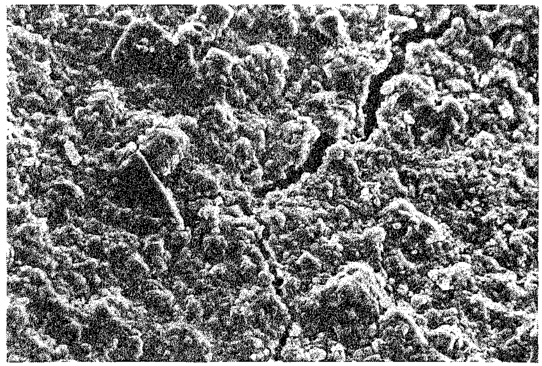

FIG 6. *Low magnification of glass-ionomer surface showing crack formation after 20 seconds etch. Note deep crack running from upper right to lower left in this photograph. X232 (original magnification X400).*

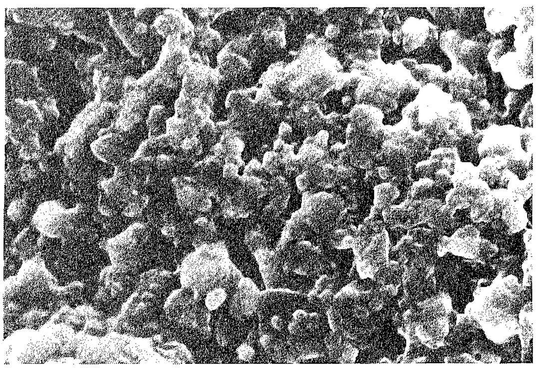

FIG 4. *Surface of glass ionomer after 10 seconds etch. Dark areas are void spaces where gel matrix has dissolved. X1160 (original magnification X2000).*

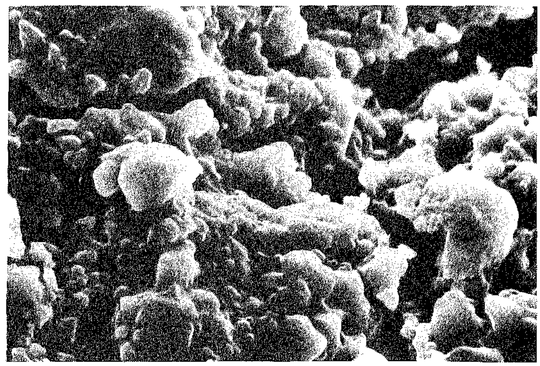

FIG 7. *High magnification of the same glass-ionomer surface shown in Figure 6. Note width of cracks in relation to individual particle sizes. X1160 (original magnification X2000).*

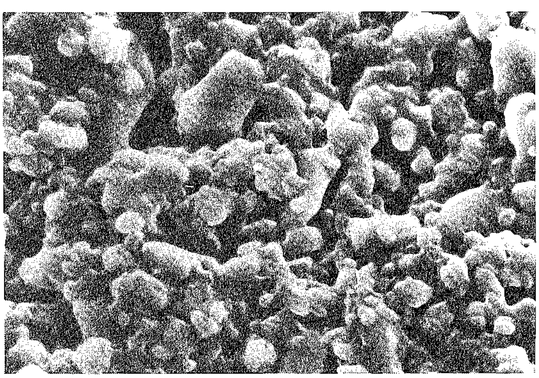

FIG 5. *Glass-ionomer surface after 15 seconds of etch. Individual particle boundaries are clear as surface dissolution has created multiple void spaces. X1160 (original magnification X2000).*

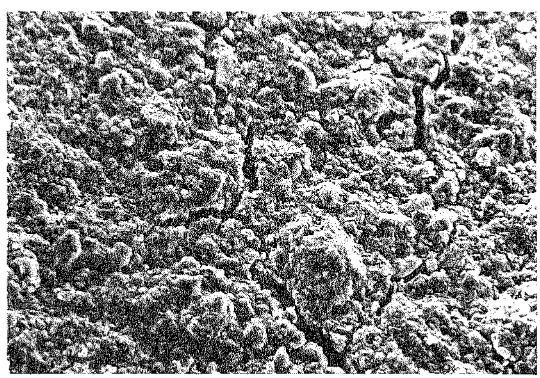

FIG 8. *Ketac-Cem specimen after 30-second etch. Cracks have proliferated across the glass-ionomer surface. X232 (original magnification X400).*

All photos are scanning electron micrographs glass particles were separated from one another by deep void spaces (Fig 9). Elsewhere, particles remained attached to juxtaposed particles by gel matrix bridges.

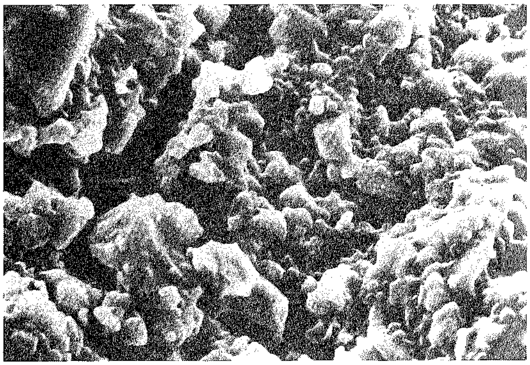

FIG 9. *Individual particles held together by strands of gel matrix appear in this high magnification of a Ketac-Cem cement surface after 30 seconds of etch. Note wide crack and deep voids in upper left. X1160 (original magnification X2000).*

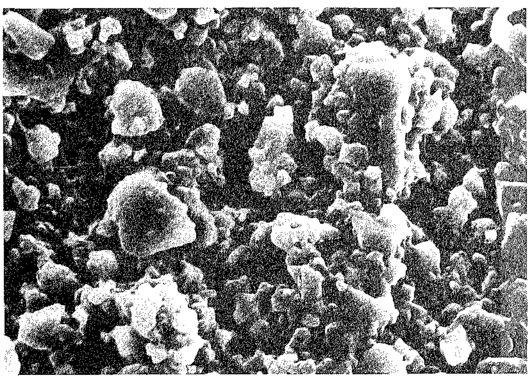

FIG 10. *At 60 seconds of etching time, gel matrix is destroyed on the surface of this glass-ionomer cement. Glass particles are no longer held in place by gel matrix bridges. X1160 (original magnification X2000).*

After 60 seconds of etch, the glass-ionomer surface integrity was essentially destroyed (Fig 10). Individual particles disassociated from each other as the gel matrix dissolved.

Specimens etched for 120 seconds closely resembled the 60-second specimens in terms of surface destruction and the prevalence of large void spaces. Ketac-Bond specimens resembled the Ketac-Cem specimens at each etching time and no difference was seen between liquid-etched and gel-etched specimens of either of the glass-ionomer cements tested.

Discussion

Deterioration of glass-ionomer surface is a rapid process when the cement is subjected to 37% phosphoric acid liquid or gel etchant immediately after initial cement set. Surface roughness increases rapidly during the first 15 seconds as the gel matrix begins to dissolve and leaves particles attached by thin gel matrix bridges. Multiple small surface void spaces enlarge rapidly as etching time is increased from 10 to 30 seconds. Crack formation begins by 20 seconds and proliferates as 30 seconds of etching are approached and passed. Individual particles of glass ionomer become separated and loosened from one another as etching time approaches 60 seconds.

During this investigation, once the etching time was allowed to proceed beyond 30 seconds, the surface particles of glass ionomer were so loose that they became embedded in the impression material and were lifted off the cement specimens during the impression procedure. The blue surface of the Mirror Wash-3 impression material turned white with glass-ionomer particles. These particles were subsequently embedded into the die material, plated, and seen in the photographs of 60-second etched specimens. Particles remained sufficiently embedded in specimens etched for 30 seconds or less that they were not removed from the surface by the impression material during replication procedures.

From a clinical perspective, dentists prefer that the time lag be rather short between liner placement and restoration completion. A loss of glass-ionomer liner thickness during etching is undesirable. Based upon this study, etching times in excess of 30 seconds are to be avoided since they result in extensive dissolution and loss of the glass-ionomer surface. Clinically, such dissolution may result in undesirable exposure of the dentin to acid etchant and a possible reduction in resin to glass-ionomer to dentin bond strengths within the so-called sandwich restorations.

Conclusions

Based upon the morphological findings in this SEM study, the following conclusions may be drawn:

1. Phosphoric acid etching of the two glass-ionomer cements tested results in rapid surface deterioration.

2. Extensive loosening of surface particles occurs after 30 seconds of etch as a result of dissolution of the gel matrix.

3. Surface morphological changes indicate that it is advisable to limit acid etching to 30 seconds or less to avoid extensive dissolution and destruction of the cement.

4. Thirty-seven percent phosphoric acid gel and liquid act with equal speed on the glass-ionomer surface.

Received 16 December 1986)

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Microleakage of Ketac-Silver in the Tunnel Preparation

JAMES W ROBBINS • ROBERT L COOLEY

Summary

A silver-glass-cermet material (Ketac-Silver, ESPE-Premier, Norristown, PA 19401) was tested in vitro for microleakage in tunnel preparations and in class 5 preparations. Restored teeth were soaked in methylene blue dye, thermocycled, and sectioned to assess microleakage. Microleakage was observed in both types of preparations.

Introduction

Since the development of glass-ionomer restorative material (Wilson & Kent, 1971), the indications for and usage of this material have increased significantly. A recent survey (Matson, 1986) reported that glass ionomers were used by 71% of the respondents as a luting cement, by 50% as a base and core material, by 61% as a liner, and by 57% as a restorative material. The advent of adhesive dentistry has made it necessary for the profession to re-evaluate many long-held principles of cavity preparation.

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One of these newer preparations, the "tunnel preparation" (Knight, 1984), is a radical departure from the conventional class 2 preparation. Occlusal access is prepared 2 - 3 mm from the marginal ridge (Fig 1) and carried under the marginal ridge, exiting on the carious approximal surface (Fig 2). A matrix is then placed and the restorative material is inserted from the occlusal access. Consequently, the marginal ridge is not disturbed, leaving the natural approximal contact and contours intact. Because of their cariostatic properties and their potential for adhesion, glass ionomers have been advocated as the material of choice for the tunnel preparation.

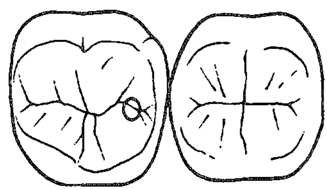


FIG 1. *Occlusal access for the tunnel preparation should be 2 - 3 mm from the marginal ridge.*

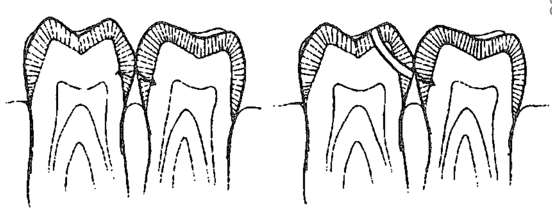


FIG 2. *The tunnel preparation should pass under the marginal ridge and exit on the approximal surface.*

More recently, McLean (1986) has advocated the use of a silver-glass-cermet cement (Ketac-Silver, ESPE-Premier, Norristown, PA 19401) because of its purported increased resistance to abrasion.

Although extensive research has been conducted on most of the physical properties of glass ionomers, there is much less information available on microleakage. Using ^{45}Ca isotope, Hembree and Andrews (1984) reported minimal leakage up to five years, in vitro, with ASPA (L D Caulk Co, Milford, DE 19963). Welsh and Hembree (1985) reported similar results at six months with the same autoradiograph technique using Fuji glass ionomer (G C Dental Industrial Corp, Tokyo, Japan). Alperstein, Graver, and Herold (1983) investigated microleakage in vitro with ASPA, using 20% aqueous fluorescein dye and ultraviolet light. They found that a significant number of samples demonstrated moderate leakage, which was defined as dye penetrating along the gingival and incisal walls but not reaching the axial wall. Herrin and Shen (1985), using a radioactive tracer, compared Fuji glass ionomer, amalgam (Dispersalloy, Johnson & Johnson, Windsor, NJ 08520) placed in wet and dry fields, and a microfill composite (Silux, 3M, St Paul, MN 55144) with and without bonding agent (Scotchbond, 3M, St Paul, MN 55144). Amalgam condensed in a wet field displayed the greatest microleakage, followed by the glass ionomer which demonstrated a greater component of microleakage during the first 40 days. Baez, Weed, and Morales (1984) tested two glass-ionomer materials, Chemfil (De Trey Division, Dentsply Ltd, Weybridge, England) and Hybond (Shofu Dental Corporation, Menlo Park, CA 94025), in class 3, class 5, and simulated abrasion lesions, in vitro, using a 5% aqueous solution of methylene blue. They found significant leakage regardless of the material or the type of preparation.

The authors were unable to find any microleakage studies on the silver-glass-cermet material. Therefore, it is the purpose of this study to test the microleakage of Ketac-Silver in tunnel preparations, in vitro.

Materials and Methods

Twenty-two extracted noncarious human teeth stored in 10% buffered formalin were used in this study. After cleaning, a thin layer of polysulfide rubber was placed on the roots of eight teeth to allow mobility for finishing. The teeth were then mounted in stone so that each tooth had an adjacent tooth for approximal contact. Two tunnel preparations were made on each test tooth (mesial and distal) with a high-speed handpiece and #330 bur. The preparation extended from the occlusal surface, under the marginal ridge onto the approximal surface beneath the approximal contact area. All study restorations were surrounded by enamel. The preparations were treated with polyacrylic acid (Durelon Liquid; ESPE-Premier, Norristown, PA 19401) for five seconds to remove the smear layer and washed for 20 seconds. A matrix band (Dixieland Band, Teledyne Getz Dental Products, Elk Grove, IL 60007) was placed and wedged, then Ketac-Silver was mixed according to the manufacturer's instructions and injected into the preparation from the occlusal access and the material gently patted with a cotton pellet. Ketac Varnish (ESPE-Premier, Norristown, PA 19401) was placed on the occlusal portion of the restoration after placement.

Matrix removal and finishing of the restorations was performed at five, 10, and 15-minute intervals. After matrix removal, the gingival margin was smoothed with an interproximal carver and finished with a wet finishing strip moved slowly to minimize heat production. Ketac Varnish was then placed on the restoration surface and floss was used to carry the varnish interproximally. The specimens were then placed in distilled water.

Since no other data were available on microleakage of silver-glass-cermet cement, two additional groups of teeth were used to determine microleakage in conventional class 5 restorations. The conventional samples were used as controls for the tunnel preparation technique. Class 5 preparations approximately 2 mm x 3 mm wide and 1.5 mm deep were placed on the facial surfaces of 14 teeth. All control restorations were surrounded by enamel. The preparations were conditioned with polyacrylic acid for five seconds and thoroughly washed for 20 seconds. Ketac-Silver was mixed according to the manufacturer's recommendations, placed in the preparations, covered with a mylar matrix, and varnished around the edges. At 10 minutes, the restorations were finished with Sof-Lex discs

Table 1. Leakage of Class 5 Preparations

Sample	Varnish-covered Preparation	Cocoa Butter Removed
1	0	3
2	0	3
3	0	1
4	0	2
5	0	3
6	0	2
7	3	3

0 = no leakage.
1 = subsurface to one-fourth distance from surface to axial wall.
2 = one-fourth to one-half distance from surface to axial wall.
3 = greater than one-half distance from surface to axial wall.

Table 2. Leakage of Tunnel Preparation

Sample	5-minute Finish	10-minute Finish	15-minute Finish
1	1	3	1
2	1	2	1
3	1	1	3
4	1	0	2
5	2	2	
6	2	1	

0 = no leakage.
1 = subsurface to one-fourth internal length of preparation.
2 = one-fourth to one-half internal length of preparation.
3 = greater than one-half internal length of preparation

(3M, St Paul, MN 55144) under a water spray.

Seven of the restorations were covered with Ketac Varnish. The other seven were covered with cocoa butter so that the protective covering over the restoration could be easily removed prior to placement in the dye. All control teeth were then placed in distilled water for 24 hours. The teeth were removed from the stone blocks and thermocycled for 24 hours in distilled water maintained at 6 and 60 °C with an immersion time of one minute. After thermocycling, all surfaces of the teeth receiving the tunnel preparations were sealed with sticky wax and fingernail polish except the approximal portion of the restorations and 1 mm surrounding it. The control teeth were sealed in the same manner. The cocoa butter was removed from the control group that had received the protective coating after restoration placement.

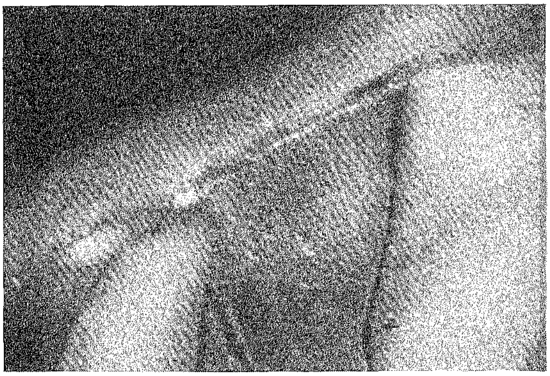
All teeth were placed in 5% methylene blue dye for four hours. The teeth were embedded in clear casting resin (Chemco Resin Crafts, Dublin, CA 94568) and sectioned with a diamond saw (Isomet Saw, Buehler Ltd, Evanston, IL 60204). The teeth with tunnel preparations were sectioned mesiodistally, revealing a cross-sectional view of the entire restoration. The class 5 restorations were sectioned buccolingually. Each restoration was examined with an optical microscope (X4) for dye penetration along the tooth-restoration interface. The control teeth receiving the class 5 restorations were graded using the scale in Table 1. A different scale, Table 2, was used to grade the microleakage in the tunnel preparations since the preparations were different in design (no axial wall). Therefore, direct numerical comparisons cannot be made between experimental and control groups.

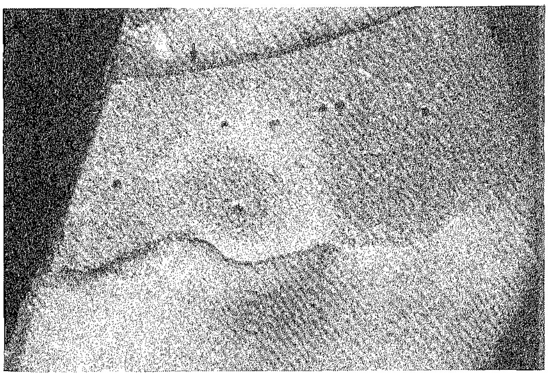
Results

The results of this study are illustrated in Tables 1 and 2. All but one of the tunnel preparations restored with Ketac-Silver exhibited leakage (Figs 3 and 4); one restoration finished at 10 minutes exhibited no apparent leakage. However, one restoration in the 10-minute group and one restoration in the 15-minute group had the most extensive leakage. In the control group receiving the varnish, only one restoration exhibited microleakage. However, in the control group which had the cocoa butter removed prior to placement in the dye, all of the samples exhibited leakage, with four of the samples producing severe leakage.

Discussion

The results of this study indicate that both tunnel preparations and class 5 preparations exhibit leakage when restored with Ketac-Silver. One of the advantages of glass ionomer is its





FIGS 3 & 4. *Dye leakage can be seen as a black line along the tooth-restoration interface*

ability to bond to enamel and dentin. In this study, the bond did not effectively prevent dye penetration. This inability to seal may be attributed to several factors: (1) The bond occurs in some but not all areas of the preparation. (2) The material is mishandled before, during, and after insertion. This material is very technique-sensitive during the placement and gelation phase. However, in this study, manufacturer's instructions were followed with strict attention to detail. (3) The thermocycling procedure used was too severe.

It appears from the previous microleakage studies that the experimental method employed has a significant effect on the results.

The time between placement of the restoration and finishing did not have an effect on leakage. Restorations finished at five, 10, and 15 minutes demonstrated leakage, except for one in the 10-minute group. The Ketac varnish was found to form a tenacious, thick, protective film over the restoration. When left undisturbed, the varnish provided an excellent barrier against leakage. Only one restoration in this group exhibited leakage. However, the protective film would eventually wear off in the oral environment, leaving the restoration unprotected. For this reason, a second group of controls was dye treated after the protective layer of cocoa butter was removed. All samples in this group demonstrated significant leakage.

Conclusions

Under these experimental conditions, Ketac-Silver exhibited microleakage in both the tunnel preparations and the class 5 preparations. The clinical significance of these findings is unknown. Further studies, in vivo, should be carried out to make this determination.

(Received 2 January 1987)

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Cavity Design and Placement Techniques for Class 2 Composites

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Summary

Four different types of cavity design were prepared in groups of extracted molar teeth, and restored with either condensable or syringeable versions of a composite resin. Marginal integrity was determined by quantitatively evaluating margin quality by SEM and by degree of radioisotope microleakage.

There was no significant difference between the results for the syringeable and condensable composite resins. For all the preparation styles, the marginal integrity at the cervical region was significantly inferior to the occlusal and approximal areas. Comparing preparations, the adhesive style and conventional style with a bevel were significantly superior to both the conventional style without bevel and Black's style of cavity preparation.

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INTRODUCTION

Composite resins are becoming more widely used as posterior restorative materials and recent advances in composite development are being carefully evaluated.

Marginal adaptation is considered an important clinical requirement. Among other factors, the longevity of composite restorations is directly related to the quality of the marginal adaptation, because poor adaptation may result in hypersensitivity, marginal staining, discoloration, secondary caries, and pulp pathosis (Going, 1972; Tani & Buonocore, 1969; Brännström & Nyborg, 1971, 1973; Brännström & Vojinović, 1976; Roydhouse, 1968). Marginal adaptation is influenced by the following variables: (1) preparation of cavity, (2) technique of enamel etching, (3) use of a bonding agent, (4) technique of insertion, (5) procedure of finishing, and (6) the restorative material itself.

Several investigators have compared the microleakage of composite restorations placed with various cavosurface designs (Hembree, 1984; Lüscher & others, 1977; Porte & others, 1984; Hembree, 1980). However, most of these investigations have been conducted on small, simple cavities in extracted teeth, and may not reflect the actual leakage pattern of class 2 cavities. There are also differing opinions on placement techniques for the class 2 composite restoration.

The purpose of this laboratory study was to evaluate the margin quality and microleakage associated with different cavity designs and

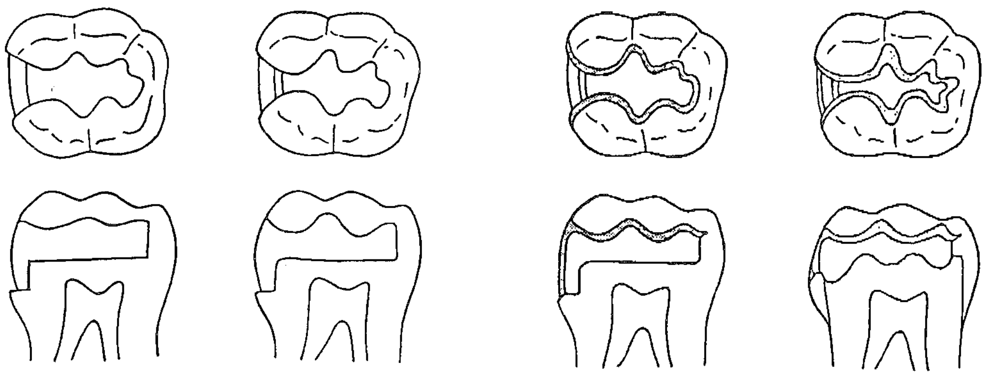


FIG 1. *Occlusal view (top row) and mesiodistal cross sections (bottom row) of cavity preparations used*

placement techniques used to restore class 2 molar cavities. Four types of cavity design were compared. Two types of composite resin were used, one of low viscosity, suitable for placement with syringes, and the other of a higher viscosity material which is condensable.

MATERIALS AND METHODS

Human mandibular molar teeth, stored in water, were mounted in pairs contacting each other to simulate clinical conditions during restoration. Class 2 cavities with four variations in design were prepared in 80 teeth. The designs of the cavities, diagrammed in Figure 1, were: standard Black's style without bevel; a modern, more conservative conventional style both with and without a bevel; and the adhesive style with a bevel. The adhesive style, described in Switzerland in 1974 as an "adhesive preparation," has minimal access for removal of caries and slight reduction of enamel in the form of a long, thin bevel. For all preparations, the cervical margins of the approximal boxes did not extend as far as the cementoenamel junction; therefore the entire cavosurface margin was prepared in dental enamel.

After preparation, each cavity was washed and dried for 15 seconds by means of compressed air, lined with a hard-setting calcium hydroxide liner (Life, Kerr Mfg Co, Romulus, MI 48174), and a contoured and wedged metal matrix band was placed. The marginal enamel was etched for one minute using 37% phosphoric acid, washed carefully for 20 seconds, and dried for 15 seconds. Next, Kerr bonding resin (Bondlite, Kerr Mfg Co) was applied and a gentle stream of air used to eliminate pooling of the excess resin in the cavity corners.

The low viscosity, light-cured composite resin (Herculite Syringeable, Kerr Mfg Co) was syringed into the approximal box first up to the level of the floor of the occlusal box, and then condensed. This increment was polymerized by 30 seconds of exposure to the Command visible-light-curing unit (Kerr Mfg Co). Further material was added and carefully condensed, contoured, and then cured with the light for 30 seconds.

The high viscosity light-cured composite resin (Herculite Condensable, Kerr Mfg Co) was placed into the approximal box with a plastic instrument and condensed up to the level of the occlusal box with amalgam condensers. This increment was exposed to the visible light for 30 seconds. Further material was added, carefully condensed, contoured, and then cured for 30 seconds.

Finishing was accomplished with Compo-shape Superfine diamond finishing burs (Densco, Teledyne Densco, Denver, CO 80207) and Sof-Lex (3M, St Paul, MN 55144) aluminum oxide finishing strips used interproximally. There were 20 teeth for each of the four preparation designs. For each design, 10 teeth were restored with low viscosity (syringeable) resin, and 10 with high viscosity (condensable) resin.

When the restoration was complete, the restored tooth was separated from the approximating tooth, washed in tap water, and then stored in distilled water at 37 ± 1 °C for three weeks. During the three weeks of aging, the restored teeth were thermocycled (2500 cycles between temperature baths at 5 ± 1 °C and 45 ± 1 °C).

Marginal Micromorphology Analysis

After thermocycling, the teeth were momentarily dried and individual addition-type silicone impressions were made. The teeth were then returned to water. The impressions were poured using Stycast 1266 (Adhesive Packaging, Peabody, MA 01960) casting resin. The micromorphology and margin quality of each group of 10 replicas were quantitatively studied by means of scanning electron microscopy (SEM). For the SEM investigation, consecutive fields along the margin were examined by the same evaluator at X200 magnification. The percentage of margin quality in each field was assessed as exhibiting, at the tooth-restoration interfaces: (a) excellent margin; (b) marginal fissure; (c) underfilled margin; and (d) overfilled margin, as shown in Figure 2.

The assessments from the fields were recorded as percentages of the margin and grouped according to the regions examined, namely: (1) occlusal; (2) buccoproximal and linguoproximal; (3) cervical, including the rounded cervicoproximal "point angle."

Isotope Penetration

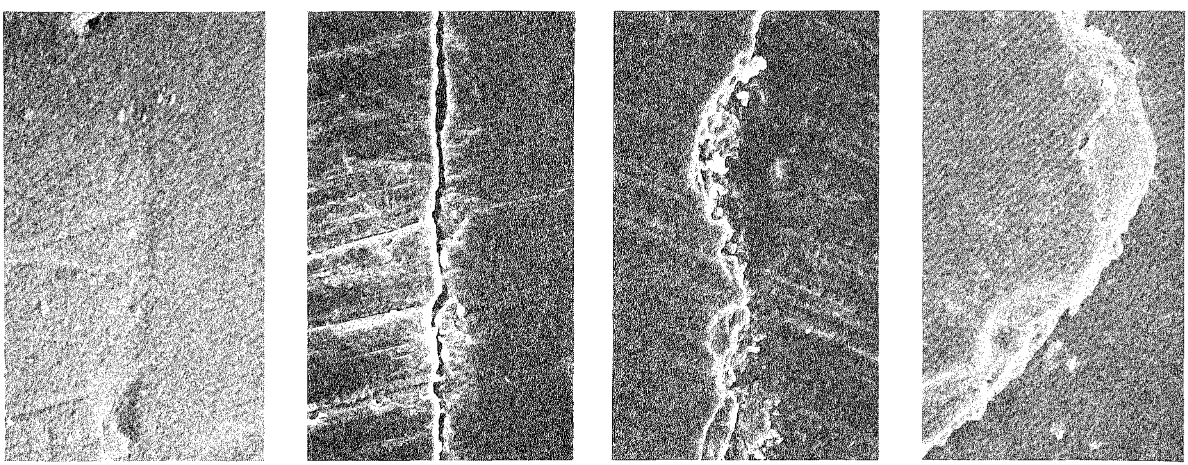
To study the degree of isotope penetration, the teeth were removed from the water and carefully sealed with a combination of nail polish and tin foil, except at the margins of the restorations. The sealed teeth were then immersed for two hours in a solution containing radioactive $Ca^{45}Cl_2$ in a concentration of 0.1 millicurie per milliliter, which was adjusted to a pH of 5.5. The teeth were then washed and sectioned longitudinally through the restorations in the mesiodistal direction. The hemisections were placed on radiographic film for 17 hours to produce an autoradiograph, which registered the degree of isotope penetration along the tooth-restoration interface. The autoradiographs were scored by two independent evaluators.

Each autoradiograph was evaluated first at the cervical and then at the occlusal aspect of the restorations by comparing two respective series of autoradiographs chosen as representative of increasing isotope penetration. Each standard autoradiograph demonstrated one of the following categories of isotope penetration along the tooth-restoration interface:

I - No evidence of penetration

II - Evidence of slight penetration at the cavosurface angle

III - Evidence of penetration, but not including the axial wall or occlusal floor



Excellent margin — Marginal fissure — Underfilled margin — Overfilled margin

FIG 2. *Margin quality as shown in representative scanning electron micrographs*

IV - Evidence of partial penetration along the axial wall or occlusal floor

V - Evidence of penetration along the entire axial wall or occlusal floor

The evaluations were tabulated and a ridit analysis (Bross, 1958) performed to determine the ridit mean, standard deviation, and variance for each group. The data were analyzed using the Neuman-Keuls method of the Welch test.

RESULTS

Margin Micromorphology Analysis

The results of the micromorphological quantitative study of the various groups of composite restorations are presented in Figure 3. Figure 4 compares the percentages of "excellent margin" of the different preparation groups at their occlusal, B-L approximal, and cervical margins, respectively.

The marginal integrity of adhesive style and conventional style with bevel were comparatively superior to those of conventional style without bevel and to Black's style at the occlusal, B-L approximal, and cervical. For all groups the cervical marginal adaptation was significantly inferior to both the occlusal and the approximal areas.

Isotope Penetration

Tables 1 and 2 show the pooled data indicating the number of restorations for each material or

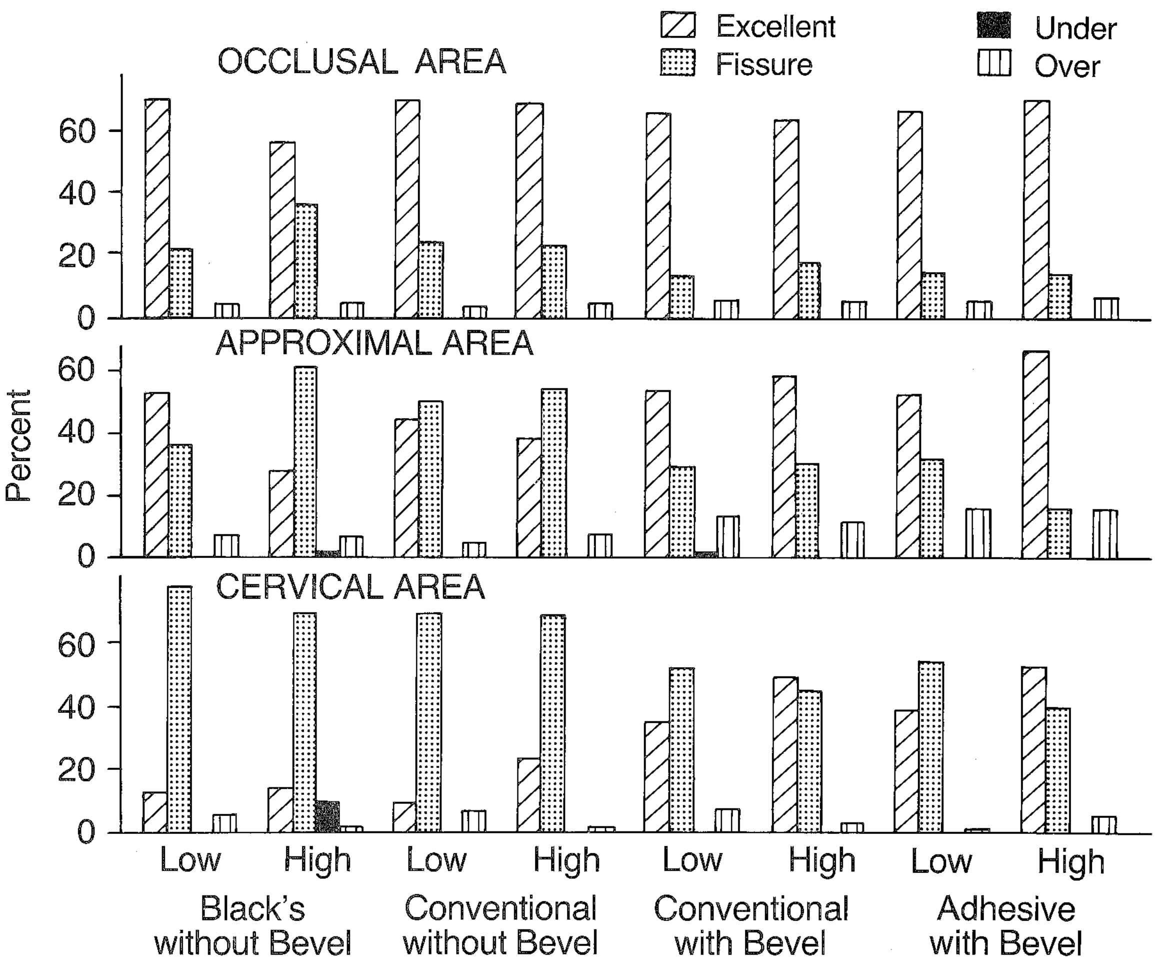


FIG 3. *Histogram showing percentages of categories of margin quality at each region*

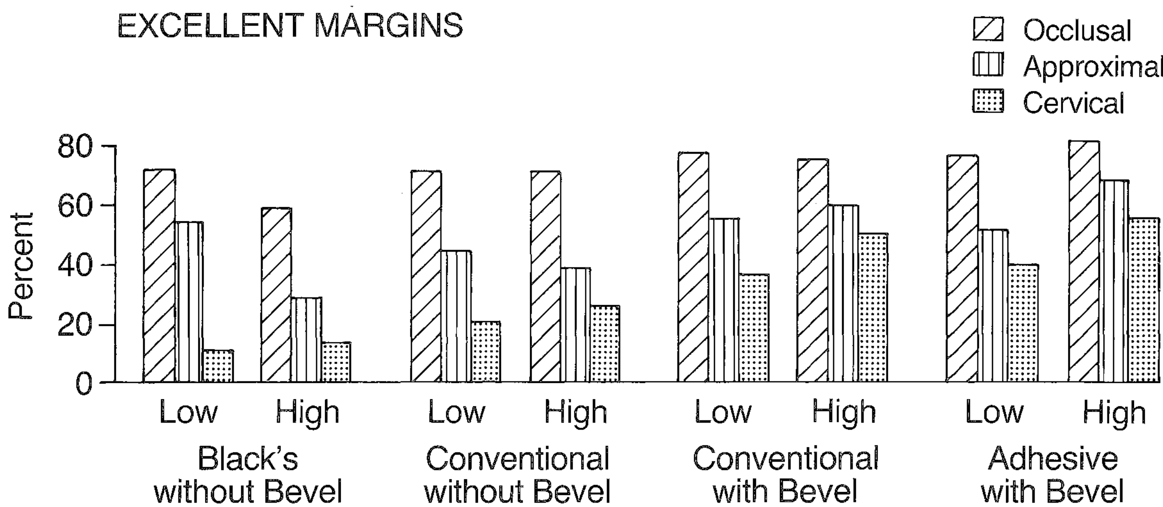


FIG 4. *Percentages of excellent margin quality at each region*

placement technique in each category of isotope penetration at the occlusal and at the cervical margins of the restorations. The ridit means ($\bar{x}$) show the distribution of the restorations in their various categories, with lower or no isotope penetration indicated by a lower ridit mean, whereas a higher ridit mean indicates that a large number of the restorations demonstrated a higher degree of isotope penetration. Table 3 compares the number of specimens showing microleakage to those with no microleakage.

DISCUSSION

Marginal leakage is a potential fault of all restorative materials and techniques traditionally used in operative dentistry (Going, 1972). This concerns not only the percolation of fluid (Swartz & Phillips, 1961), but also invasion by a variety of molecules, ions, enzymes, acids, and bacteria (Ayres, 1971; Crim & Mattingly, 1980). Microleakage around dental restorations has been implicated as playing a role in a variety of clinical conditions such as recurrent caries (Tani & Buonocore, 1969; Ellis & Brown, 1967) and adverse pulp response (Brännström & Nyborg, 1973; Brännström & Nyborg, 1971; Brännström & Vojinović, 1976; Phillips, 1982). Furthermore, hypersensitivity, marginal discoloration, and hastened breakdown of certain materials have been attributed to marginal leakage and could contribute to failure of the restoration (Going, 1972; Tani & Buonocore, 1969; Brännström & Nyborg, 1971, 1973; Brännström & Vojinović, 1976; Roydhouse, 1968).

There is an increasing interest in the effect of cavity design on composite resins. However, the principles governing cavity preparation for these materials have remained essentially the same as those for amalgam (Khowassah & Denehy, 1972). Operative dentistry texts (Howard, 1973; Gilmore & Lund, 1973) initially recommend as the standard preparation a box-shaped cavity with a cavosurface margin of 90° that results in a butt joint for the restorative materials. This design has long been clinically acceptable for dental amalgam.

On the other hand, the adhesive preparation for composite resin was described by Lutz and Burkhart in 1974 and 1976 (Lutz & others, 1976 a & b). This adhesive preparation is extremely conservative, abandoning the box design and adopting a round/ovoid shape (which remains after caries removal) with a long bevel.

When the four types of restorations were compared, it was found that both adhesive and conventional with bevel showed highly significant results indicating better marginal adaptation than either conventional without bevel or Black's style without bevel. This indicates that the bevel is an important factor in establishing a good marginal adaptation. It has been demonstrated

Table 1. Distribution of Occlusal Isotope Penetration, Ridit Means, and Variances

Preparation Style	Viscosity	Categories I	II	III	IV	V	n	$\bar{x}$	SD	S^2
Black's without bevel	Low	4	3	1	2	0	10	0.568	.3120	.0973
	High	3	4	1	1	0	10	0.611	.2891	.0835
Conventional without bevel	Low	3	6	1	0	0	10	0.551	.2314	.0535
	High	3	4	1	2	0	10	0.611	.2891	.0835
Conventional without bevel	Low	6	3	0	1	0	10	0.431	.2723	.0741
	High	6	3	1	0	0	10	0.432	.2568	.0659
Adhesive with bevel	Low	5	5	0	0	0	10	0.443	.2239	.0501
	High	7	3	0	0	0	10	0.358	.2052	.0421
Totals		37	31	5	7	0	80			

Table 2. Distribution of Cervical Isotope Penetration, Ridit Means, and Variances

Preparation Style	Viscosity	Categories I	II	III	IV	V	n	$\bar{x}$	SD	S^2
Black's without bevel	Low	0	0	0	2	8	10	0.795	.1159	.0973
	High	0	0	0	3	7	10	0.767	.1328	.0176
Conventional without bevel	Low	0	0	3	2	5	10	0.658	.2128	.0452
	High	0	0	2	5	3	10	0.621	.1735	.0301
Conventional without bevel	Low	1	3	1	4	1	10	0.437	.2309	.0533
	High	2	3	1	4	0	10	0.360	.2048	.0419
Adhesive with bevel	Low	5	4	1	0	0	10	0.18	.1125	.0126
	High	4	4	1	0	0	10	0.18	.1125	.0126
Totals		12	14	9	20	24	80			

Table 3. Number of Specimens with and without Microleakage

Preparation Style	Viscosity	Number of Specimens	Occlusal Margins No Leakage	Occlusal Margins Leakage	Cervical Margins No Leakage	Cervical Margins Leakage
Black's without bevel	Low	10	4	6	0	10
	High	10	3	7	0	10
Convention without bevel	Low	10	3	7	0	10
	High	10	3	7	0	10
Conventional with bevel	Low	10	6	4	1	9
	High	10	6	4	2	8
Adhesive with bevel	Low	10	5	5	5	5
	High	10	7	3	5	5
Totals		80	37	43	13	67

that beveling of cavity enamel margins, the acid-etch technique, and use of a resin bonding agent are all factors enhancing adaptation of selected composite resin to the margins of class 2 cavities (Lüscher & others, 1977; Pahlavan, Dennison & Charbeneau, 1976; Voss & Charbeneau, 1979; Buonocore, 1981; Simonsen, 1981).

As analyzed by the SEM, there is no significant difference between the adhesive style and the conventional preparation with bevel. But when we examine the category showing "no evidence of isotope penetration," it is interesting to note that there are more "perfect" margins in adhesive with bevel than conventional with bevel. The best results in marginal adaptation and resistance to microleakage were obtained from the adhesive with bevel. The good results of this group were due not only to the conditioning of enamel but also to the new cavity preparation which may have reduced shrinkage because of decreased cavity volume. In addition, maintaining an elevated enamel shoulder seemed to prevent the overlapping cervical part of the restoration from being drawn away from the cavity margin by polymerization shrinkage. Finally, more complete curing might also be expected from a light-activated material in an adhesive-style cavity which has less occluso-gingival depth.

Class 2 amalgam restorations sacrifice a large amount of sound tooth tissue if the dentist adheres to Black's principles of cavity preparation as originally delineated. Even though cavity designs have recently become more conservative, extension for prevention and resistance and retention forms still probably account for a great amount of hard tissue loss. The adhesive preparation saves sound, hard tooth tissue. Enamel conditioning may also have a protective effect against caries because the etched enamel surfaces adjacent to the cavity margins are sealed.

Black's preparation resulted in significantly higher percentages of the underfilled margins. This may be due to the polymerization shrinkage and the difficulty of fully placing the restorative material at the tight acute angles formed by the matrix strips and the cavosurface margins.

Polymerization shrinkage is one of the undesirable characteristics of resin restorative materials even though shrinkage has been reduced to a range of 1.5 to 2.5% by volume in many modern composite resins (Lee & Orlowski, 1973; Goldman, 1983). In the Black's design without bevel, a large volume of tooth structure is removed, so there is a larger total polymerization shrinkage.

For the light-cured material, the polymerization starts from the surface in proximity to the light source ahead of the rest of the material within the cavity (Hansen, 1982). Therefore, the direction of polymerization shrinkage is toward the surface of the resin irradiated by the light and the "open space" appears in the cervical area (Lui & others, 1987). This is supported by the fact that we find that the cervical area produces significantly higher numbers in the marginal fissure category.

Marginal adaptation judged to be the poorest in the cervical area was attributed to the difficulty of placing the composite in the approximal box area. Because the cervical portion of the box presents a relatively thin enamel available for bonding, the marginal adaptation in that area is a very serious problem. The typical margin shows large discrepancies extending from one end of the proximocervical line angle across the length of the cervical margin to the other line angle.

Significantly higher numbers of the "overfilled" margins were produced in the approximal areas. The fluid material flows beyond the approximal cavosurface margin in spite of careful wedging of the matrix. It is difficult to remove the excess, even if finishing strips are used. On the occlusal area, overfilled margins were produced in the anatomic groove areas where the rotary instruments used were too large to finish them.

In this study, comparison of high viscosity condensable resins and low viscosity syringeable resins showed no significant difference, indicating a greater influence in the cavity design than in the filling technique when using different viscosity resins.

CONCLUSIONS

The marginal integrity of composite resins placed in cavities prepared in the adhesive style and conventional style with bevel was superior to those of conventional style without bevel and Black's style at all margin areas. There was no significant difference between adhesive style and conventional style with bevel, or between conventional style without bevel and Black's style. There was no significant difference between the results seen with low viscosity and high viscosity resins. For all groups the cervical margin was significantly inferior to both the occlusal and the approximal areas.

Based on both penetration of Ca^{45} and quantitative analysis of the micromorphology of margin adaptation, class 2 cavities prepared in the adhesive style and conventional style with bevel show better margins than conventional style without bevel and Black's style.

(Received 2 January 1987)

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Use of a Two-stage Composite Resin Fill to Reduce Microleakage below the Cementoenamel Junction

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G B PELLEU JR

Summary

The effect of a two-stage composite resin fill technique compared to a one-stage fill technique (control) on microleakage with a chemically cured and a light-cured dentin bonding agent was tested in class 5 preparations extending apical to the cementoenamel junction. When the chemically cured bonding agent was used, there was no significant difference between leakage results for the control (50%) and experimental restorations (30%). When the light-cured bonding agent was used, there was a significant difference between leakage results for the control (95%) and experimental restorations (50%). None of the restorations leaked at the enamel margin. A two-stage fill technique with Scotchbond light-cured dentin bonding agent will reduce microleakage in class 5 composite resin restorations that extend apical to the CEJ.

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Introduction

Clinical experience indicates that class 5 composite resin restorations frequently fail when they extend apical to the cementoenamel junction (CEJ). Research has shown that all composite resin materials now in use leak significantly if extended onto the root surface (Phair & Fuller, 1985; Retief, Woods & Jamison, 1982; Hembree, 1980; Gillette & others, 1984). Pulpal inflammation and recurrent caries are believed to be caused by percolation of ions, enzymes, and bacteria along the walls of the cavity preparation (Crim & Mattingly, 1980; Brännström, 1984).

Filled resins with superior physical properties have replaced unfilled resin restorative materials (Craig, 1980; Rupp, 1979). Although the filled resins overcome many of the problems of the unfilled resins, several problems remain, including marginal leakage below the CEJ. Studies in vitro (Craig, 1980; Eriksen & Pears, 1978) have demonstrated that the acid-etch technique reduces or eliminates enamel margin leakage and caries, but this technique cannot be used on dentin because of the acid's deleterious effect on the pulp (Stanley, Going & Chauncey, 1975).

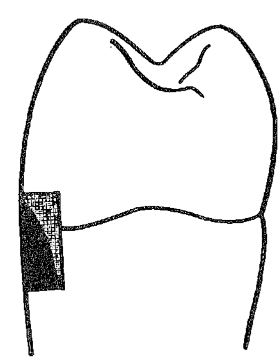
A one-stage fill technique bonding resin to both enamel and dentin has been shown to reduce marginal leakage apical to the CEJ (Gillette & others, 1984; Brännström, 1984). Dogon, van Leeuwen & Giordano (1984) used Scotchbond and Silux to restore teeth with cervical erosion. They found that a two-stage fill technique resulted in less microleakage than a one-stage technique. However, microleakage patterns may differ between composite resin restorations placed in eroded areas and those placed in preparations for several reasons. (1) Dentin in class 5 cavity preparations is freshly cut, whereas eroded areas are often sclerotic and uncut. (2) Restorations placed in class 5 cavity preparations rely on undercuts for most of their retention, whereas restorations placed in eroded areas rely totally on bonding for their retention. (3) The different shapes of the restorations may alter setting properties such as polymerization shrinkage. These differences point out the need for additional study of the two-stage technique. The purpose of this study was to determine the effects on microleakage of two-stage and one-stage composite resin fill techniques with either a chemically cured or light-cured dentin bonding agent.

Materials and Methods

Both chemically cured Scotchbond (Batch #102984, 3M Dental Products, St Paul, MN 55144) and light-cured Scotchbond (experimental clinical sample, product ID EXI Lot 5) were tested. The research design for both materials was identical, but they were tested in two separate groups. In each group, 20 noncarious and nonfractured extracted teeth stored in a 2% sodium azide solution (a bactericidal agent) were rinsed in running distilled water for 15 minutes to remove residual sodium azide. Class 5 cavity preparations measuring 3 x 3 mm and 1.5 mm deep were placed on the buccal and lingual surfaces of all teeth with a #35 high-speed friction-grip bur with air-water spray. Each preparation was placed so that half was coronal and half apical to the CEJ. The enamel margins of the preparations were beveled with a #7803 high-speed bur. A notch was placed alternately across either the buccal or lingual surface to identify the one-stage technique (control) side of the tooth. The teeth were then rinsed and dried with an air-water syringe.

A CaOH base (Life, Batch #100484, Kerr, Romulus, MI 48174) was placed on the pulpal floor of each preparation. The enamel surfaces of all preparations were acid etched (Scotchbond etching gel, Batch #102984, 3M) for one minute according to manufacturer's instructions. The teeth were then rinsed with water from an air-water syringe for 30 seconds and dried.

Chemically cured or light-cured Scotchbond was applied to the entire preparation according to manufacturer's instructions. In the control preparations (notched side), universal shade Silux (Batch #021485, 3M) was placed with a one-stage bulk fill. The resin was held under pressure with a Mylar strip and cured with a Command visible-light source (Kerr/Sybron, Romulus, MI 48174) for 60 seconds (Swartz, Phillips & Rhodes, 1982). A two-stage fill technique was used on the experimental side of the tooth (no notch). In stage one, the coronal portion was filled and cured, and in stage two, the remainder of the preparation was filled and cured (see figure). In both stages, the material was held in place with a Mylar strip and cured for 30 seconds with the Command visible-light source. The total curing time, 60 seconds



The two-stage fill technique. In the first stage (light shading) the coronal portion was filled and cured and in the second stage (dark shading) the remainder was filled and cured.

(longer than the manufacturer's recommendation), was the same for the control and experimental restorations.

After restoration, the teeth were stored in tapwater at 35°C for two weeks. The restorations were then finished with Sof-Lex (3M) discs, and alternately thermocycled in water for one minute at 5 °C and 55 °C for 500 cycles. With the exception of the restoration and a 1.0 mm surrounding area, the teeth were sealed with modeling plastic and two coats of fingernail polish. In a darkroom, the specimens were immersed in a 50% aqueous solution (by weight) of silver nitrate for three hours. After being rinsed for one minute with running distilled water, the samples were immersed in a Kodak Mix Developing Solution (Eastman Kodak Co, Rochester, NY 14650). The petri dish containing the teeth in the solution was placed on a lighted viewbox and covered with aluminum foil for one hour to facilitate the precipitation of silver ions. The teeth were rinsed again with distilled water for one minute. Each tooth was placed in an autopolymerizing resin block for sectioning with a diamond saw cutting machine (Bronwill TSM-77, VWR Scientific, San Francisco, CA 94119). The teeth were longitudinally positioned so that both restorations could be sectioned with the same cut (each tooth was cut only once). Each section was then viewed under a dissecting microscope (Bausch & Lomb, Rochester, NY 14604) at a magnification of X30 and the sections were scored for the degree of microleakage.

The degree of microleakage was determined by the extent of silver nitrate penetration as follows: 0 degree = no leakage; 1 degree = penetration of silver nitrate along, but not to, the axial wall; 2 degrees = penetration of silver nitrate to the axial wall or beyond. Statistical comparisons between degrees of microleakage of the control and experimental groups was made with chi-square and McNemar analyses.

Results

Comparisons between one- and two-stage fill techniques are shown in the table. When the chemically cured bonding agent was used, there was no significant difference ($P > .05$) between leakage results of control (50%) and experimental restorations (30%). When the light-cured bonding agent was used, there was a significant difference ($P < .005$) between leakage results of control (95%) and experimental restorations (50%). None of the restorations leaked at the enamel margin. The only restorations that showed two-degree leakage were those placed with the one-stage technique.

Discussion

The current thinking of many investigators and clinicians is that in earlier biocompatibility studies the microleakage of toxic substances may have been mistaken for toxicity of the material itself. Polymerization shrinkage may account in part for the microleakage that occurs with filled resin restorations. Most leakage occurs in areas not bonded to enamel, such as the root surface (Phair & Fuller, 1985; Retief & others, 1982; Hembree, 1980; Gillette & others, 1984). The bond of resin to enamel is stronger than the bond of resin to dentin-cementum. Gillette and others (1984) hypothesized that resin restorations shrink toward the strongest bond when polymerizing and that the two-stage fill may compensate for shrinkage toward the stronger bond. We believe that the two-stage fill technique does compensate for such shrinkage. In addition to the fact that there is less material to shrink in the second stage, the

Microleakage with One- and Two-stage Composite Resin Fill Techniques

Fill Technique	Number of Samples with Leakage* Degree 1	2	3	% Leaking
Chemically cured				
Scotchbond				
One-stage (control)	10	7	3	50*
Two-stage	14	6	0	30**
Light-cured				
Scotchbond				
One-stage (control)	1	15	4	95***
Two-stage	10	10	0	50***

*As indicated by penetration of silver nitrate for a total of 20 samples for each of the four techniques.
**Not significantly different ($P > .05$).
***Significantly different ($P < .005$).

material may slide across the first stage's air-inhibited layer (the surface layer of resin that does not cure) before it completely cures. If microleakage below the CEJ is significantly reduced by the two-stage fill technique, patients would benefit from the reduced percolation of ions, enzymes, and bacteria along the cavity wall.

Our results confirm those of earlier studies (Phair & Fuller, 1985; Retief & others, 1982; Hembree, 1980; Gillette & others, 1984) showing that a significant number of class 5 restorations that extend onto the root surface leak, even when a dentin bonding agent is used. Because the chemically cured and light-cured Scotchbond were tested separately, we cannot statistically compare them. However, in the one-stage fill group, 50% of the chemically cured Scotchbond restorations leaked as compared to 95% of the restorations with light-cured Scotchbond (which has a greater dentin bonding strength). This finding was interesting and deserves further analysis. It also suggests that other factors, such as polymerization shrinkage, may be more important than bond strength in reducing microleakage in such restorations. If resin restorations shrink toward the strongest bond, then a proportionally stronger bonding to enamel could increase leakage at the gingival margin. Our results suggest that the two-stage technique can partially compensate for this problem.

(Received 27January 1987)

Acknowledgment

This project was supported under Naval Medical Research and Development Command Work No M0095-003-3014.

The opinions or assertions contained in this article are those of the writers and are not to be construed as official or as reflecting the views of the Department of the Navy.

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Contraction Gap under Composite Resin Restorations: Effect of Hygroscopic Expansion and Thermal Stress

BODIL TORSTENSON • MARTIN BRÄNNSTRÖM

Summary

A resin impregnation technique was used in this study to measure changes of the gap width between the composite and the cavity walls during the application of cold and heat. Gap width did not change much for heat; cold increased gap width by about 5 μm. A large reduction of the gap width was found for Silar and for Palfique with this technique, and in 12 of 19 restorations no penetration occurred. In cavities restored with hybrid composites, the gap width was only slightly reduced. As serious clinical problems may result due to gaps remaining at the cervical and axial walls, the use of a thin layer may solve the problems of hypersensitivity and infection within the gap.

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INTRODUCTION

All composite resins shrink during polymerization and a contraction gap forms between the composite and the cavity walls. Earlier studies demonstrated that the gap could be impregnated with a low viscosity resin and the addition of a fluorescent dye to the resin made it possible to study and measure the extent of penetration and the width of the gap in sectioned teeth (Brännström, Torstenson & Nordenvall, 1984; Torstenson & Brännström, 1987; Torstenson & Öden, 1987). Composite resins are known to absorb water from tissue fluids and expand hygroscopically (Pearson, 1979; Bowen, Rapson & Dickson, 1982; Hirasawa & others, 1983), reducing the magnitude of the gap (Asmussen & Jörgensen, 1972; Hansen, 1982). Furthermore, it has been suggested that thermal changes, by impairing adaptation of the composite to the cavity walls, might have some effect on the gap width (Crim & Mattingly, 1981; Staninec & others, 1986).

In a pilot study, teeth with composite restorations were immersed in water. This caused fluid to fill the contraction gap. It was found that the fluid could be removed from the gap by an air blast applied parallel to the cavosurface, after which the gap could be impregnated with resin, providing a method for studying the effect of hygroscopic expansion on the gap width. It was also thought that the resin impregnation technique could be useful in examining changes of the gap width during the application of cold or heat.

MATERIALS AND METHODS

In 92 human premolars, kept frozen until use, rectangular cavities were prepared on both approximal surfaces. One cavity in each tooth was randomly chosen for the test restoration and the other served as the control. The cavities were prepared with a fissure bur in a high-speed handpiece and a small undercut was made at the inner angles with low speed. Water cooling was used throughout the cavity preparation. The approximate size of the cavities was 4.5 - 5 mm high and 3 mm wide. Cavity depth at the cervical wall was approximately 1.5 mm and at the occlusal approximately 2 mm. The cervical margin was placed approximately 1 mm apical to the cementoenamel junction.

The cavities were cleaned with Tubulicid Blue Label (Dental Therapeutics Co, Nacka, Sweden) to remove the superficial smear layer, followed by water rinsing to ensure that no traces of cleanser remained on the cavity walls. The beveled enamel margins were acid etched with an etchant gel (Brilliant, Coltène, Altstätten, Switzerland) for 15 seconds and the cavities were thoroughly water sprayed, followed by an air blast for 10 seconds. To facilitate removal of excess composite from intact surfaces after setting, a thin polystyrene liner (Dental Therapeutics Co) was applied beyond the cavity margins.

The prepared teeth were divided into two groups, one to evaluate the gap size after storage in water and the other to evaluate gap size during the application of cold and heat.

Group 1: Gap Size after Storage in Water

To reduce the risk of pulp remnants diffusing into the contraction gap during the storage period and impairing impregnation, the apical one-third of the root was cut off to facilitate removal of the pulp tissue. At the time of restoration, one cavity in each tooth was filled with a composite resin and the accompanying bonding agent. The materials tested are shown in Table 1. The number of teeth filled with the same materials varied between eight and 10. The Palfique System (Tokuyama Soda Co, Kamagawa, Japan) includes a resin liner which was applied according to the manufacturer's instructions. The light-cured materials--Brilliant (Coltène), Command Ultrafine (Kerr Europe, Basel, Switzerland), Occlusin (ICI, Macclesfield, England), and P-30 (3M Co, St Paul, MN 55144)--were cured under a plastic matrix band. Polymerization was initiated with a Visilux II lamp (3M Co), except for Command Ultrafine where the Command II lamp was used (Kerr/Sybron, Kerr Europe, Basel, Switzerland). The chemically cured materials, P-10 and Silar (3M Co) and Palfique, were allowed to cure under a metal matrix band held with finger pressure. Excess was removed with a sharp instrument.

The teeth were stored at 37 °C for 2 - 3 weeks in water in which a small amount of chlorhexidine had been added in order to eliminate bacterial growth in the fluid-filled gap. The gap was then impregnated with Enamel Bond resin (3M Co), made fluorescent by adding Zyglo Penetrant ZL-22A (Magnaflux Co, Chicago, IL 60656). The gap was impregnated by the following technique. The restoration was covered with tape, but the cervical and occlusal margins were left unprotected. The tape served to protect the composite from desiccation when the water in the gap was eliminated with an air blast. The air stream was placed parallel to the cervical and occlusal margins and applied for one minute, followed by the application of fluorescent Enamel Bond to these margins.

Table 1. Materials and Manufacturers

Silar and Scotchbond	3M Dental Products St Paul, MN 55144
Palfique, Liner, and Bonding Agent	Tokuyama Soda Co Kamagawa, Japan
P-10 and Scotchbond	3M
P-30 and Scotchbond	3M
Occlusin and Bonding Agent	ICI, Macclesfield, England
Brilliant and Margin Bond	Coltène, Altstätten, Switzerland
Command Ultrafine and Bonding Resin	Kerr Europe, Basel, Switzerland

After the occlusal and cervical margins of the test restoration had been impregnated, the control cavity on the opposite side of the tooth was restored using the same materials and techniques. For light-cured materials, impregnation with fluorescent Enamel Bond took place 1 - 2 minutes after curing of the composite was completed. The chemically cured composites were impregnated 13 minutes after placement of the composite.

The teeth were ground longitudinally from one approximal surface to the other at right angles to the approximal restorations. The surfaces were ground and polished under water cooling. Each tooth was examined and microphotographed at three levels with reflected UV-light at a magnification up to X210. A microscale was photographed at the same magnification and the width of the fluorescent resin at the cervical and axial walls was measured. The width was determined by calculating the mean of the greatest two widths measured. No penetration occurred from the occlusal margin. The extension of the fluorescent Enamel Bond penetration from the cervical margin was therefore scored using the following criteria:

1 - penetration to include half the cervical wall

2 - penetration up to axial wall

3 - penetration to include half the axial wall

4 - penetration up to the occlusal wall

5 - penetration up to the etched occlusal enamel

Group 2: Gap Size during the Application of Cold or Heat

Cold. Eight test cavities were filled with Silar and six with P-10. Scotchbond (3M Co) was used as the bonding agent and the restorations were accomplished in the same manner as in Group 1, but no pulpectomy was performed. Thirteen minutes after insertion of the composite, the tooth crown was placed up to, but not including, the cervical margin in ice cream taken directly from the freezer. After 15 seconds, fluorescent Enamel Bond was applied to the cervical margin of the test cavity. The tooth was kept in the ice cream for another 60 seconds to ensure complete curing of the fluorescent Enamel Bond. The control cavity was then filled with the same materials and impregnated after 13 minutes at room temperature.

Heat. Silar was used in seven cavities, P-10 in eight. Both composites were combined with Scotchbond. Heat was applied by using a boiled potato 75 - 85 °C into which the tooth crown was placed up to, but not including, the cervical margin. The resin was applied to the cervical margin of the test cavity after 15 seconds and the tooth retained in the hot potato for an additional 30 seconds to allow for the curing of the fluorescent Enamel Bond. The control cavity was then restored and impregnated as described earlier.

RESULTS

Group 1

Microfilled composites. As seen in Table 2, after two to three weeks' storage in water a considerable reduction in width of the gap at the cervical wall had occurred for the microfilled composites Silar and Palfique. For seven of the nine Silar restorations and half the Palfique restorations, no penetration of fluorescent Enamel Bond could be detected at the interface in the test group. For comparison, only one control filling lacked penetration, and this was excluded. However, the test restorations showing no penetration of fluorescent Enamel Bond were not excluded, since with microfilled composites it was possible that a complete reduction of the gap had occurred.

Hybrid composites. For the hybrid composites, no reduction at all or only a slight decrease of the gap width was observed after water storage. The mean maximum reduction was 7 μm, which was found for Brilliant. A decrease of the extent of penetration was also observed. The degree of penetration is seen in Table 2. In four restorations, two tests and two controls, no penetration of the fluorescent Enamel Bond could be found, and these were excluded. Failure to impregnate the gap may have occurred either because large amounts of excess composite remained over the margin or because entrapped fluid or air within the gap prevented the penetration of the fluorescent Enamel Bond.

Table 2. Group 1: Extent of Fluorescent Enamel Bond Penetration and Gap Width at the Cervical Wall.

Materials Used	Impregnation after 1 - 13 minutes (control): Extension Score Mean (µm)	Impregnation after 1 - 13 minutes (control): Gap Width at Cervical Wall Mean (µm)	Impregnation after 1 - 13 minutes (control): Gap Width at Cervical Wall Range (µm)	Impregnation after 2 - 3 weeks (test): Extension Score Mean (µm)	Impregnation after 2 - 3 weeks (test): Gap Width at Cervical Wall Mean (µm)	Impregnation after 2 - 3 weeks (test): Gap Width at Cervical Wall Range (µm)
Silar and Scotchbond	2.3	13	7-17	0.2*	1*	0-7*
Palfique, Liner, and Bonding Agent	2.1	13	9-17	0.6*	2*	0-6*
P-10 and Scotchbond	2.3	16	13-21	2.4	16	14-20
P-30 and Scotchbond	2.1	15	13-17	2.7	10	8-13
Occlusin and Bonding Agent	4.5	15	10-23	2.5	12	8-17
Brilliant and Margin Bond	4.6	19	13-25	2.7	12	7-13
Command Ultrafine and Bonding Resin	4.0	18	12-30	4.1	19	16-22

* Includes restorations with no penetration of Fluorescent Enamel Bond resin.

Table 3. Group 2: Extent of Fluorescent Enamel Bond Penetration and Gap Width at the Cervical Wall for Restorations Exposed to Cold and Heat

	Silar/Scotchbond: Extension Score Mean (µm)	Silar/Scotchbond: Gap Width at Cervical Wall Mean (µm)	Silar/Scotchbond: Gap Width at Cervical Wall Range (µm)	P-10/Scotchbond: Extension Score Mean (µm)	P-10/Scotchbond: Mean (µm)	P-10/Scotchbond: Gap Width at Cervical Wall Range (µm)
Cold						
Test	2.9	22	17-27	3.3	22	19-26
Control	2.6	15	10-22	2.3	18	15-20
Heat						
Test	1.7	15	14-17	2.0	18	15-26
Control	2.3	14	10-17	2.4	19	16-25

Examples of the gaps found at the cervical area for restorations in Group 1 are seen in Figures 1 and 2.

Group 2

The results are shown in Table 3. It was found that both Silar and P-10 restorations when exposed to cold showed a small enlargement of the gap width at the cervical wall. The penetration was also somewhat more extensive, particularly for P-10. The application of heat did not alter the gap width.

Examples of the gaps at the cervical area from Group 2 can be seen in Figures 3 and 4.

In both groups it was found that when the fluorescent Enamel Bond reached the axial wall, the width was, in general, about half of that seen at the cervical wall. Impregnation of the gap from the cervical margin to the occlusal wall occurred only when Brilliant, Command Ultrafine, or Occlusin were used and irrespective of whether

The contraction gap under composite resin restorations

Detail of cervical wall, dentin is below
Group 1 (stored in water)

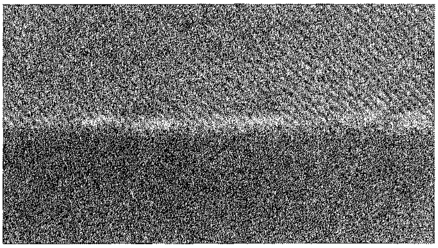

FIG 1A. *Silar and Scotchbond, stored 2-3 weeks. Gap width - 3 µm.*

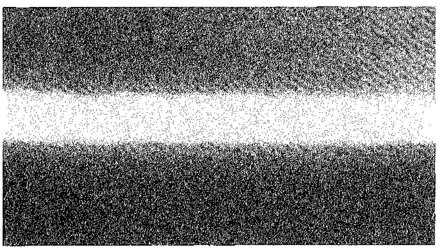

FIG 1B. *Same tooth as Figure 1A, shows cervical wall, impregnated after 13 minutes. Gap width - 13 µm.*

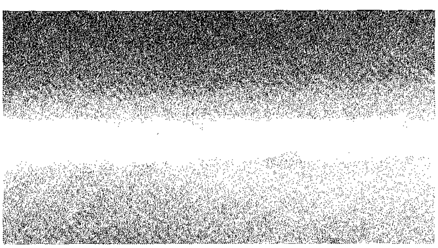

FIG 2A. *Brilliant and Margin bond, stored 2-3 weeks. Gap width - 13 µm.*

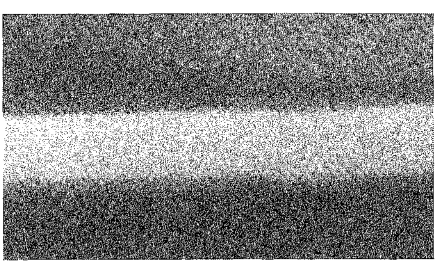

FIG 2B. *Control restoration, impregnated after 13 minutes. Gap width - 20 µm.*

Group 2 (subjected to cold and room temperatures)

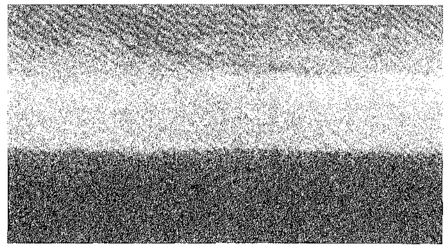

FIG 3A. *Restoration exposed to cold. Restored with Silar and Scotchbond. Gap width - 22 µm.*

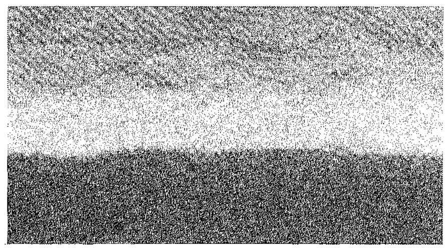

FIG 3B. *Control restoration, impregnated after 13 minutes at room temperature. Gap width - 15 µm.*

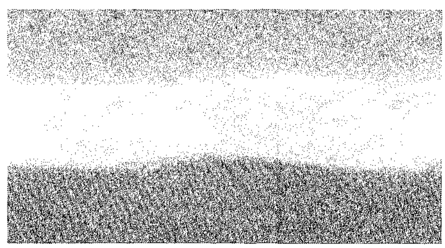

FIG 4A. *Restoration exposed to cold, P-10 and Scotchbond. Gap width - 26 µm.*

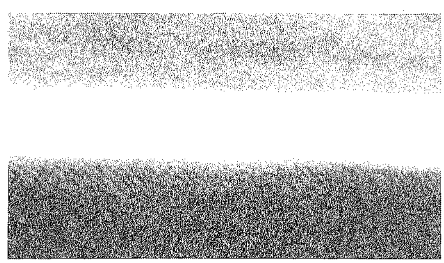

FIG 4B. *Control restoration, impregnated after 13 minutes at room temperature. Gap width - 20 µm.*

they had been stored in water or not. In these teeth the occlusal gap width was somewhat smaller than at the axial wall. Fluorescent Enamel Bond was not found at the etched beveled enamel at the occlusal wall in any of the restorations.

DISCUSSION

A storage time in water of two to three weeks was chosen since it has been shown that most expansion of composites due to water sorption occurs within the first two weeks and equilibrium is reached after about eight weeks (Pearson, 1979). Since the polymer matrix absorbs water, microfilled composites with a high amount of matrix show a greater hygroscopic expansion than macrofilled and hybrid composites (Hirasawa & others, 1983). Thus, a closure of the contraction gap was found for Silux restorations after one week's storage in water (Hansen, 1982). In contrast, when macrofilled composites were used, gaps could be observed after four weeks (Asmussen & Jörgensen, 1972). In the present study, a large reduction of the gap width was found for Silar and Palfique, and in 12 out of 19 restorations no penetration at all occurred. This does not necessarily mean that gaps had been completely closed at the time of impregnation. Small gaps may easily be blocked, thus preventing penetration of fluorescent Enamel Bond. Furthermore, when fluorescent Enamel Bond is absent at the interface, a small persisting gap can be difficult to identify. In cavities restored with hybrid composites, the gap width was only slightly reduced and a persistent gap varying between 7 - 22 μm was found at the cervical wall.

In this context the biological consequences should be considered. A large gap remaining at the cervical and axial walls may lead to serious clinical problems. The contraction gap will be filled by tissue fluid and bacteria. The pulp and the oral cavity are accessible nutrient sources. The sequelae may be secondary caries, pulpal inflammation, and hypersensitivity. Another consequence of a persistent fluid-filled gap is that a cavity lining may be partly washed out after one to two years. This phenomenon has been observed for amalgam restorations when Dycal or Life was used as the lining material (Grajower, Bielak & Eidelman, 1984; Cox & others, 1985). The situation is potentially more serious for composites with persisting gaps than amalgams where the gaps may be smaller and partly blocked by corrosion products. As seen from the results for microfilled composites, a gap up to 7 μm may remain after two to three weeks and may be packed with bacteria. In fact, bacterial layers on cavity walls and pulpal inflammation have been reported under Silar and Silux restorations (Heys, Heys & Fitzgerald, 1985; Hörsted, Simonsen & Larsen, 1986).

Thermocycling is frequently used in microleakage studies and relatively long application periods, one to three minutes, are often used. This procedure does not relate well to the clinical situation nor for the present experiments. Clinically relevant thermal stress involves a change of about 30 °C applied for three to five seconds only (Crim & Mattingly, 1981). Nevertheless, the width did not change much for heat. Only cold produced an increase of about 5 μm in gap width. One reason for this could be that the setting time for the fluorescent Enamel Bond is dependent upon temperature. Therefore, the "registration" of the gap, the width of the fluorescent Enamel Bond, probably occurred later for cold than for heat. On the other hand, the temperature change was about three times more for heat than for cold. In a recent study by Staninec and others (1986), comparing the gap width after the application of cold and heat for 15 minutes, respectively, only small changes of the gap width were observed. If a fluid-filled gap exists, normal temperature changes for three to five seconds do not seem to have much clinical relevance. This may be true particularly if we consider that due to the higher fluid pressure within the pulp there is a continuous, slow, outward flow of fluid within the gap. However, considering the poor thermal conductivity of composite resins, the question remains: Does a temperature change of about 30 °C for four seconds at the tooth surface result in a gap at the enamel-resin interface where no contraction gap has developed? In microleakage studies using dyes and isotopes, changes of fluid volume within the gap and an increase in particle flow due to temperature changes may explain why more leakage has been observed at the cervical wall during thermocycling (Crim & Mattingly, 1981). On the other hand, in other studies where the teeth were immersed into the dye solution after thermocycling, no significant difference in microleakage could be found between teeth that were thermocycled and teeth that were not thermocycled (Retief, Rutland & Jamison, 1981; Eakle, 1986).

When a fluid-filled gap exists nearest the dentin in communication with the pulp via dentinal tubules, the reduction of the fluid volume within the gap due to cold may initiate a rapid outward flow in the tubules due to capillary action and hence a sharp pain reaction (Brännström, 1986). In other words, hypersensitivity to temperature changes need not necessarily mean that temperature variations of short duration may result in changes in gap width. The use of a thin, compressive liner, not detached from the dentinal walls during polymerization and subsequent impregnation of the gap with a resin, may solve the problem of hypersensitivity and infection within the gap (Torstenson, Brännström & Mattsson, 1985). Possibly, composite resins with some hygroscopic expansion are also preferable in cases where the above-mentioned precautions may fail. On the other hand, it has been shown that mechanical properties may be impaired by water sorption. This must be considered when selecting a composite resin for posterior teeth in high-stress-bearing areas (Söderholm, 1981, 1984; Öysaed & Ruyter, 1986).

CONCLUSION

Contraction gaps between the composite and the cavity walls are formed by composite resin shrinkage during polymerization. Impregnating the gap with resin in vitro provided a method for studying the effect of hygroscopic expansion on the gap width. This technique also provided a means of studying changes in gap width during the application of cold and heat. Heat did not change the gap width, but cold increased it by 5 μm. Of the composite materials used in the study, Silar and Palfique produced a large reduction of the gap width, but in cavities restored with hybrid composites, the gap width was only slightly reduced. Gaps remaining at the cervical and axial walls may result in problems of hypersensitivity and infection within the gap. The use of a thin liner may solve these problems.

(Received 6 February 1987)

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REVIEW OF LITERATURE

Amalgam Toxicity: A Review of the Literature

JOHN E DODES

"Theory like mist on eyeglasses. Obscure facts."
Warner Oland as Charlie Chan
(*Charlie Chan in Egypt,* 1935)

Summary

The mercury controversy is on the rise again and this paper presents a realistic approach to answering the questions arising from the misinformation being provided to the news media by the anti-amalgamists.

INTRODUCTION

Mercury and its compounds are ubiquitous in our environment. The toxicity of mercury to humans was known to Hippocrates (Goldwater, 1936). Mercury has a long history of use in medicaments and is currently widely used in electrical applications, chlorine production, and dental restorations.

Recently a small but vocal group of dentists, physicians, and "holistic" health care advocates have declared the mercury in dental silver-amalgam fillings to be a major factor in numerous diseases and chronic conditions such as emotional problems, multiple sclerosis, Parkinson's disease, and diseases of the immune system. It is the purpose of this paper to critically examine the scientific basis of these claims and theories.

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HISTORY

There are reports of tin-mercury dental fillings being used in China in AD 600 (deMaar, 1973). Silver-mercury fillings were first introduced in France in the 1830s. In the 1850s, there was a heated debate over the use of amalgam in the United States. Dentists were threatened with malpractice actions if they refused to sign an agreement not to use amalgam. In 1896, Dr G V Black published a detailed scientific report on the values of amalgam (Black, 1896) but it took many years for Dr Black's findings to be universally accepted.

In 1926, Dr Stock, a German chemist, published several articles critical of amalgam fillings (Stock, 1926). This led to a commission being established in Germany to investigate Dr Stock's allegations. In 1930, the commission issued its report which supported the safety and continued use of amalgam (Harndt, 1930).

MERCURY AND ITS COMPOUNDS

In 1963, an international committee (Berlin & others, 1969) classified mercury and its compounds according to their order of decreasing toxicity: (1) methyl and ethyl mercury compounds, (2) mercury vapor, and, least, (3) inorganic salts as well as a number of additional organic forms such as phenyl mercury salts. Certain bacteria are able to transform inorganic mercury to methyl mercury which in turn concentrates in fish and moves up the food chain to humans. Fish contaminated with methyl mercury were responsible for both acute poisonings, resulting in death, and chronic poisonings, resulting in central nervous system disturbances. In Minamata, Japan, where such poisonings occurred, there was also a teratogenic effect now called Minamata disease (Kurland, Faro & Siedler, 1960). It was estimated that the minimum dose needed to develop symptoms was 5 mg/day methyl mercury (Tsuubaki & Irukayama, 1977).

The half-life of methyl mercury is about 70 days in adults and slightly longer in the fetus (Berlin & others, 1969). Approximately 15% of the body burden is in the brain (Newman, 1984). The maximum allowable concentration (MAC) is set at 10 $\mu g/m^3$ of alkyl mercury. Heintze and others (1983) reported the methylation of mercury in vitro by oral streptococci. Their technique yielded 0.029 mg methyl mercury per gram of powdered amalgam after 35 days of a complicated procedure. Although it does not appear possible to recreate this process in vivo, this study is often cited as proof that mercury is converted to methyl mercury in the mouth. A close look at this study shows that the methyl mercury was intracellular and that the bacteria would have to be digested before the methyl mercury would be free. If this did happen, the amount of 0.029 mg/g is a fraction of the minimum safe level (Rupp, 1984). Birke and others (1967) reported no symptoms of poisoning with levels of 0.8 mg of methyl mercury per day for five years through the consumption of contaminated fish.

Elemental Mercury

Elemental mercury is the major source of concern to the dentist and patient. Mercury has a high vapor pressure (.005 mg Hg at 37 °C) and almost 100% will be absorbed through the lungs (Berlin, Nordberg & Serenius, 1969). The absorption through the gastrointestinal tract is 0.01% and is also low through the skin although the precise level has not been determined (Newman, 1984 p 98). Mercury accumulates in the kidney and brain and is excreted in the urine, bile, and lungs (*ibid* p 99). There is little correlation on an individual basis between sampling of hair, blood, or urine and toxic effects at target organs (p 99). The toxicity of elemental mercury probably is a result of its affinity for sulfhydryl groups on proteins, but the results of studies in vitro do not relate to conditions in vivo where distribution and accumulation of elemental mercury ions vary immensely from one tissue to the next (p 99). Acute toxic exposures are rare and there are many cases of elemental mercury being accidentally released into the bloodstream, as in the breakage of a rectal thermometer, without adverse effects. Chronic toxicity results in a condition called erethism, with symptoms of insomnia, irritability, loss of memory, lack of self-control, timidity, drowsiness, depression, and eventual tremors (p 99). The renal effects lead to proteinuria and a diagnostic discoloration of the lens of the eye may also develop.

Maximum Responses to Mercury Levels

The International Committee on Maximum Allowable Concentration of Mercury Compounds gives a threshold limit value of 50 $\mu g/m^3$ of mercury vapor. This value is a time-weighted average based on constant exposure for eight hours per day.

It would seem logical and prudent to first look for evidence of disease among those dentists who have been shown to have a much higher and consistent exposure to elemental mercury than the general public. A recent survey of dentists by the American Dental Association (Naleway & others, 1985) disclosed a mean urine mercury level of 15.3 $\mu g/L$ among dentists in general practice. The general population has an average of from 1-3 $\mu g/L$ (*ADA News*, 1985). Although urine mercury levels can vary greatly from day to day and person to person, on a group basis urine concentrations have been found to show good correlation with exposure to mercury vapor (Cooley, 1984 p 192). Dentists have a much higher level of urine mercury and yet exhibit no higher levels of morbidity or mortality (Report of the Councils, 1983).

Allergy to the mercury in fillings does exist. The reaction may be local or more widespread. The skin is the most common site and the reaction may be self-limiting and subside within two to three weeks even without the removal of the filling. The percentage of people who are allergic to mercury has been shown to be under 1% (Bauer & First, 1982; Frykholm, 1957).

Eggleston (1984) has reported a reduction in T-lymphocytes after insertion of silver-amalgam fillings and an increase in T-lymphocytes after amalgam removal. This is a seriously flawed study; only three patients were involved and there were no controls. In addition, the T-cell assay is a relatively new and inaccurate procedure which can have large variations even from the same specimen. Even so, the values given both before and after amalgam removal or insertion are all within normal levels (Robert Baratz, Boston University, Schools of Medicine and Dentistry; personal communication, 1986).

The inorganic mercury salts and some other organic forms of mercury are the least toxic group. Since they are not used in dentistry today they will not be discussed.

Questionable Screening Measures

Anti-amalgam dentists use many screening measures for diagnosis of mercury toxicity: (1) symptom questionnaire, (2) electrical reading of the fillings, (3) urine mercury analysis, (4) skin patch testing, (5) blood serum profile, (6) complete blood count with differential and platelet count, (7) hair analysis, and (8) a device which measures the mercury vapor level in the mouth.

The symptom questionnaire often lists over 100 questions, from heart problems to general history, and includes questions on skin problems, nervous disorders, digestion, blood diseases, cancer, endocrine problems, and emotional problems, occurring now or in the past. The list is so inclusive that any healthy person would find it hard not to confirm the presence of some of the symptoms or conditions.

The electrical reading of fillings is done with a metering device and provides the basis for the sequence of removal of the amalgam fillings, negative fillings being removed first (Huggins & Huggins, 1985). According to Miroslav Marek, PhD, of the Georgia Institute of Technology (1984), the electrical device records the "difference between the corrosion rate without that contact of two materials and with the contact of two materials. It is not the corrosion rate, and there is no way by simple measurement to determine the corrosion rate or the release rate of ions from a metal in the mouth" (pp 349-350). Because mercury is a more noble metal than the other components in the amalgam filling, its long-term dissolution rate in saliva "is not high enough to be a reason for concern" (*ibid* p 143).

The skin patch test is meaningless without proper training in the interpretation of the complex results of testing for metal allergy and may in fact be harmful. The reaction of the skin and oral mucosa are often different. It is possible for (1) the skin to be sensitized but not the oral mucosa, (2) concurrent sensitization of both the skin and the mucosa, and (3) the oral mucosa to be sensitized, but not the skin (a rare occurrence) (Cooley, 1984 p 183). Interpretation of patch test results is difficult and requires expertise. There are numerous situations which can lead to false positive or false negative reactions (Fregert & Bandman, 1975). The amount of variation which anti-amalgam dentists interpret as positive validation of mercury allergy all fall within the normal range of daily body function. As Cooley (1984) states:

> The three vital signs (BP, pulse, temperature) fluctuate during the day and may vary depending on the ambient temperature and the individual's recent activity level, emotional state, or ovulation period. Blood pressure may fluctuate from day to day or even hour by hour, and also has a regular daily (circadian) rhythm. It has been found to be lowest in early morning upon waking, increases during the day, and then begins to drop in the evening hours. In addition, there are factors which may produce different BP readings on the same individual. These include observer bias and variability, observer number preferences, cuff size, stethoscope placement, and differences in activity states. It has been observed that the BP readings may vary from 10 to 40 mm Hg on the same subject when doing multiple readings at the same session. Blood pressure readings from one session to another are also not consistent. Body temperature also varies between individuals and in the same individual. Some healthy persons consistently have temperatures elevated above what is considered normal, or may be as low as 96.5 ^{o}F. There is also a circadian rhythm of body temperature, in which the oral temperature is 97 ^{o}F upon awaking in the morning. The temperature steadily rises during the day to reach a peak of 99 ^{o}F or greater between 6 pm and 10 pm. It then slowly declines to reach a minimum between 2 am and 4 am. (pp 187-188)

Hair is analyzed for its calcium, manganese, mercury, zinc, and potassium levels (Huggins & Huggins, 1985). Numerous studies have shown hair analysis to be of no value in assessing the nutritional status of a patient (Barrett, 1986; Herbert, 1982).

Numerous food supplements, vitamins, minerals, and "chelating agents" are often prescribed to a patient during and particularly after "amalgam detoxification." Therapies such as insulin injections, vitamin and mineral megadoses, and avant-garde diets are also recommended. The vast majority of experts on nutrition have declared these practices as unproven, disproven, and/or dangerous (Underwood, 1973; Herbert & Barrett, 1982; Marshall, 1983; Pollack & Kravitz, 1985).

Many dentists are using a device which can measure very low mercury vapor levels. The patient is asked to chew gum for 10 minutes and then a probe is placed in the patient's mouth. Dr Carl Svare, who has done some of the major research in this field and whose research is often cited by the anti-amalgam dentists as "proof" of amalgam toxicity, has said: "I think it's not appropriate to use, perhaps, mouth level mercury levels diagnostically in terms of what the effect might be on a particular individual...it has certain inherent errors in it because the exposure that you get from your amalgams can be rather continuous or it may be rather intermittent. That is, a person may not generate these levels more than 4 or 5 minutes during the day" (Svare, 1984 pp 320-321). In addition, the Jerome Gold Film Mercury Detector multiplies the amount of mercury it actually measures by a factor of 8000, so that the reading will give the amount of mercury in a cubic meter (Baratz, personal communication, 1986). This is fine for a factory but not for the human mouth.

Hallmarks of Pseudoscience

• In the book *Science and Unreason* (1982), Radner and Radner discuss some of the hallmarks of pseudoscience. These are:

• Holding on to old rejected theories; for example, the rejected theory that hair analysis is accurate for determining the nutritional status of a patient.

• Redefining terms, such as using 'optimum' rather than 'normal'.

• Depending upon tests that are open to bias and are therefore irrefutable and pseudoscientific.

• Refusing to revise in light of criticism; for example, continued use on the part of anti-amalgam dentists of discredited fad diets and nutrition advice.

• Displaying what Radner and Radner call the "grab-bag approach to evidence"-- using sources such as the *Journal of Orthomolecular Psychiatry*, letters to the editor, and the *Journal of the International Academy of Preventive Medicine* as well as unsubstantiated testimonials to support their theories.

I find all these hallmarks of pseudoscience in the anti-amalgam "literature."

DISCUSSION

Controversy is defined as a disputation of opinion. Once there are facts, opinions disappear and so should controversy. If I say the earth is flat and you say it is a sphere, there is no controversy; I am merely wrong. The amalgam "controversy" is analogous to this. A comprehensive review of the scientific literature establishes the safety of silver-amalgam fillings. The basic assumptions, tests, and treatment methods advocated by those opposed to silver-amalgam fillings are invalid, unsupported, discredited, and/or unnecessary.

The lack of training in the evaluation of ideas and the absence of criteria by dental schools for those lecturing in postgraduate courses have given "holistic" advocates access to many converts and to the media. In the last several years there have been many stories in the media on the "amalgam controversy." The media has not been responsible and has not checked the facts. In one case, on the New York nightly news, a dentist with a spurious degree in nutrition was allowed to terrorize the public with allegations of the toxic effects of amalgam fillings.

CONCLUSIONS

The review of the literature on amalgam fillings and mercury establishes the safety and continued usefulness of silver-amalgam fillings. In critically evaluating some of the theories, diagnostic tests, and treatments promoted by the anti-amalgam fringe, I have found a lack of any valid, scientifically sound data to support the contention that amalgam is dangerous, much less that it causes serious disease. H L Mencken said: "For every complicated problem there is a simple solution, but is wrong."

(Received 13 April 1987)

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Direct Gold as a Practice Builder

R CRAIG BRIDGEMAN

Summary

The knowledgeable use of direct golds in a private practice can build a practice today despite today's crisis situations brought about by an oversupply of dentists and an undersupply of new patients. An 11-year veteran of practice building presents his experience, citing his methods of sharing the values of direct gold and high dental standards with patients, arriving at cost effectiveness, and creating a desired reputation for excellence in the community.

INTRODUCTION

My views, reflections, and experiences, from the past 11 years of building a private general practice, are presented during what many consider to be the greatest crisis brought about by an oversupply of dental manpower in the history of our profession. Those of us in full-time private practice know that new patients are at a premium. The majority of practicing dentists may legitimately ask: "Why would one want to use direct golds as a practice builder?" The answer is: "Because it works"-- but only when used properly. As for the comments from those dentists who assert that gold foil is just an ego builder, I would counter that I am proud that I have invested the time, and am still investing the time, to allow the masters to teach me the techniques of gold foil restorations. Because of my commitment, I am able to offer that service option to my patients, which may be construed as egotism, but it is certainly a patient-centered egotism. So, then, I shall suggest why one would one want to use direct golds as a practice builder.

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Presented on 1 November 1986 at the annual meeting of the American Academy of Gold Foil Operators in San Francisco.

WHY USE DIRECT GOLD?

Value in the Changing Market

Emerson's advice to build a better mousetrap and the world will beat a path to your door is still true today, and applies easily to dentistry. The problem arises in the public's perception of exactly what constitutes a better mousetrap. Is it a pretty, low-cost, tooth-colored, plastic mousetrap, or is it a painstakingly created mousetrap of durable materials with a potential of lifetime service? We all know that our marketplace is driven by the law of supply and demand. We also know that the effective and efficient use of direct golds is not a capability of every practitioner. We can bemoan what we judge to be the quality of service delivered by those practitioners, or we can accept it, and use it to our advantage. The very fact that direct golds are not a routine part of every practice tilts the supply side of the supply/demand equation overwhelmingly in our direction. When our patients understand the values of direct golds in relation to our modern-day substitutes, the demand side of the equation can become unlimited. In theory, this should produce a marketplace situation so advantageous to us that its potential would surely provide us with an abundance of patients. That, then, is the first reason for using direct golds as a practice builder--the law of supply and demand indicates that it is logical.

Cost Effectiveness

The second reason is that direct gold restorations are cost effective. Obviously, a direct gold restoration can be placed faster and more economically than a cast gold restoration. But what about the relative cost of a class 3 or a class 5 gold foil compared to a composite resin? At first glance, the resin appears to be much more economical, but if one considers the cost and time involved in replacement, the cost of a foil and several resins over a lifetime will probably even out. Furthermore, replacement cost is not only measured in dollars and hours but also in tooth structure lost and by the potential for increased pulpal trauma at each subsequent replacement.

Connection to Excellence

The third reason for using direct golds as a practice builder is to acquaint the community with the dentist's commitment to excellence. If a patient is aware that he is receiving a service which not likely to be available elsewhere, he will tell others. I frequently give patients a hand mirror so that they can watch the placement of a foil. It not only keeps them from being bored, it also gives them a great deal more to talk about after leaving the office. When patients begin to sense and understand the level of care being delivered in a practice, the practice itself naturally evolves in that direction. The patient's referrals will reflect his concept of the dentist's values. As I began to educate my patients about the benefits of conservative restorative dentistry, I began to see through their referrals new patients who came for that type of service. Of course, we still get those patients who want emergency-only care, exodontia, dentures, and the like, and we look forward to the challenge of educating them.

As a Response to the Oversupply Dilemma

We in dentistry today are faced with a serious manpower dilemma. Government projections of the 1960s of increased demand for dental care have not materialized. At that time the machinery was put in motion to increase substantially the annual number of dental school graduates, many of whom are now working in volume clinics for an hourly wage, are being employed as hygienists, or are seeking employment in other fields.

As is characteristic of our free enterprise society, problems seem to stimulate creative instincts, and the result is that we now have a subculture of people who travel around the country proposing to teach us how to fight the competition and become the most successful dentist in town. Some of these programs are oriented toward making ourselves more visible in order to increase our share of the market, while others are oriented toward changing the public's perception of the traditional dental practice in order to create a brand new marketplace. State licensing boards complain about a decline in ethical practice. Practitioners who cannot succeed in one state complain about state licensing boards. We have growing evidence of overtreatment of patients.

All these issues appear to be problems, when in fact they are not the problem at all. They are merely the symptoms of one problem--an oversupply of dentists. As a result, we find ourselves trying to nurture our dental practices in an atmosphere which sometimes makes us feel as though the actual practice of clinical dentistry is the least important ingredient in the recipe for success.

PRINCIPLES OF PRACTICE BUILDING

Having explored some of the reasons for using direct golds as a practice builder, I would like to discuss briefly the general principles of practice building, and then apply these principles in the use of direct golds in our practices.

Robert Levoy (1970) has written what I consider to be one of the best treatises in practice building. For those who have never read *The Successful Professional Practice* I would highly recommend it. And when you have finished reading it, read it again. In my opinion, Levoy's principles for success are based on effective, honest communication, and a sincere concern for the welfare of the patient. Nowhere in this text will one find the means to capitalize on new, unproven clinical modalities that happen to have mass public appeal, nor will one find the guidelines for a television blitz campaign. What one will find is an excellent course in human relations.

Your Goals

Before one can formulate a route to one's destination, one must first know where one is going. There are many ways to measure success in dentistry-patient loyalty, gross income, pride in the ability to sense and provide for patients' needs, longevity of the services provided, or any other tangible or intangible entity. How one assesses the growth or maturation of the practice is an individual decision, which every individual must make for himself in a manner consistent with his own values. If my values are different from the reader's, I cannot measure my success or failure using his value system. The only true way to measure success is to compare one's present performance against one's past performance within the parameters of one's personal definition of success.

The Importance of Skill: Communication

Successful dental practice is built upon three major skills--clinical skills, interpersonal skills, and business management skills. If any of these skills is significantly lacking, the practice will have a difficult time progressing as a successful venture. I believe that communication skills are paramount for successful practice building, for even with excellent clinical skills the dentist will have a difficult time building a practice if he and his staff lack this capability.

MARKETING DIRECT GOLDS

Internal Communication

We hear a great deal today about marketing in the dental practice--internal (sometimes referred to as in-house marketing) and external (advertising). I use strictly internal marketing in my practice. The basis of good internal marketing is communication--both verbal and nonverbal. Verbal communication is simply conversation between the doctor and patient, doctor and staff, and most importantly, staff and patient. It is no secret that a well-trained staff will sell more dentistry than the doctor.

"Selling" is a word that bothers many dentists. They have taken perhaps too literally the concept that a health professional should not have to sell anything. It is true that the patient's welfare and not our personal interests should be the foundation of our treatment recommendations, yet we must be salesmen for our goals. The educational process that enhances the patient's understanding of his problems and his appreciation for the recommended solutions is nothing but good salesmanship.

Patients are usually much more open when talking with staff because they do not feel threatened. They also feel the doctor is a busy professional whose time is valuable, whereas the staff seems to be more accessible. Why not use human nature to our advantage? If patients are more comfortable talking with staff, then why not let the staff be the sales force? I do this routinely in my practice. At an examination I merely suggest the type of restorative services that will best serve the patient, possibly answer a few brief questions, and then leave the patient with the chairside assistant or the hygienist to continue the conversation. It is imperative that the staff be knowledgeable and enthusiastic about the merits of direct gold services. When the dental auxiliary understands and believes in the service being presented, he or she will be successful in gaining patient acceptance. If, however, the auxiliary does not believe in the service, patient acceptance will be low.

Another principle that I put to work daily in my practice is "seed planting." We always try to present the patient with the optimum treatment plan, but if the patient requests another option, or chooses to do nothing, we do not get huffy or visibly upset. We respect the patients's decision, suggesting that the optimum services will be available in the future. Our objective is, of course, to keep the patient in our recall system so that we can continue the educational process. Eventually most of these individuals begin to accept optimum care, and it is very fulfilling to watch the change occur. We have had many people with low dental IQs who started out with emergency-only care, and three to five years later opted to have their teeth restored with gold. The seeds planted daily concerning quality may take months or years to reap in harvest, but that is all part of the challenge.

Clinical Skills

The first requirement for the marketing of direct golds is clinical skills. One cannot sell direct golds if one does not possess the skills. One must be able to deliver the goods, and do so effectively.

Where does one acquire the skills? It used to be that one could get a good working foundation in the clinical manipulation of direct golds at virtually any dental school. Unfortunately, that is no longer the case. Although many schools have retained direct golds in their operative core curriculum, many others have demoted it to an elective status or eliminated it altogether. The most unfortunate students are those at schools which have completely obliterated it from the curriculum. For the serious student of direct golds, a good starting point is participation in a two-week course offered by the Associated Ferrier Clubs. The best way to upgrade skills is through regular attendance and participation in a clinical gold foil study club. Some of these groups have closed memberships, and others, like the George M Hollenback Operative Dentistry Seminar, are open. Regular participation will keep one in contact with other believers in direct gold, who will not only teach techniques but share their experiences with, enthusiasm for, and commitment to the use of direct golds in private practice.

For the young practitioner, participation in a group such as this may represent a substantial investment of both time and dollars, but it is one that is very worthwhile. I would recommend to any young graduate on a budget that he or she consider continuing education objectives similar to those I pursued upon leaving dental school. For the first three years of practice, 80% of my continuing education budget was spent on courses that would help me become a better clinical dentist. My reasoning was that if I could not deliver the service, I was only asking for trouble if I tried to sell it. Eighty percent of not much is even less, so most of that budget went to the gold foil study club. But I did not just learn about foils. I gained valuable insights into how to run a practice simply by rubbing elbows with other successful practitioners who shared a common goal of delivering high-quality care.

Besides gaining a knowledge of clinical skills from a study club, those attending will absorb enthusiasm for the technique--the second requirement for the effective marketing of direct golds. Once we master the principles, placing foils becomes fun, and fun generates enthusiasm. Patients who witness an operator thoroughly enjoying his work are bound to talk about that operator with their friends and neighbors.

While discussing the subject of improving clinical skills, it is a common argument that gold foils are a good teaching medium--that they allow the clinical faculty to assess a student's manual dexterity; however, if one flips the coin, foil is not only an excellent teaching medium but is also one of dentistry's finest learning mediums. By learning the discipline required to place serviceable foils, one improves his or her skills in all phases of restorative dentistry. One of my role models, Dr Miles Markley, emphatically stated that using gold foil made him a better restorative dentist. I do not have to accept that as gospel simply because Dr Markley said it, because I can testify to it firsthand. By using foil, I have learned to pay more attention to the intimate details of cavity preparation--both intra and extracoronal. I have learned to use the rubber dam as an invaluable aid, rather than a hindrance. I have learned the importance of a dry field, about soft tissue management, and about finishing techniques that carry over into cast gold procedures. All in all, gold foil has come to be the standard by which I measure my growth or stagnation in clinical abilities. If one concedes that clinical abilities are vital in the building of a successful practice, and I believe that they are, then it follows logically that a successful practice with clinical excellence at its heart would be very difficult to achieve without the use of direct golds in the practice. To those who will inevitably contend that they enjoy clinically excellent practices without the use of direct golds, I offer the following challenge: "Why not add direct golds and improve your level of excellence!"

Another basic requirement for the effective marketing of direct golds is a firm belief in their value. Patients will quickly pick up on the dentist's values. The staff's attitudes and values are usually a direct extension of the dentist's. It is very important that the dentist and his staff believe in the value of direct golds because, just as insincerity will show through, so will belief. (Does the car salesman himself drive what he is trying to sell you?) We can sell what we believe in regardless of merit. A prime example is the use of posterior composite resins, often promoted by those who have trouble placing serviceable amalgams and who shift responsibility for choice to the patients--"they don't want gold, they want plastic." Since we program our patients with each visit, why not program them to accept and expect quality dentistry? The dentist who truly believes in the effectiveness of gold foil will have little problem with patient acceptance. Since your staff can probably sell more dentistry than you do, try some foils and castings on staff members. Their subsequent appreciation will generate enthusiasm among your patients.

Including Gold Foil in Treatment Planning

Another area that I consider to be one of practice-building potential is treatment planning, and the use of direct golds in their proper indications. The first rule of thumb is that restorative modalities should be selected to fulfill the needs of the patient, and not the needs of our egos. Foils are not always my treatment choice. A notable example is the large class 3 situation. In today's society, cosmetics is a major consideration. In my practice, class 3 preparations which violate the facioproximal line angle of anterior teeth will likely be restored with a nonmetallic material. Placing a conspicuous foil in a very self-conscious patient may well deprive that patient of the benefit of my future services. This situation is certainly not a practice builder.

There is a certain myth about direct golds that needs to be addressed. We all need to recognize that a restoration is not "excellent" simply because it is fabricated of 24-carat gold. Excellence is the result of the attention given to detail in the placement and finishing of the restoration, rather than the material that is used. A tiresome, heroic effort devoted to a large foil may well result in a less serviceable result than a well-placed amalgam or casting. Heroics aside, though, there are still many ideal indications for direct golds. If one combines the use of this material with the proper prior education of the patient so that he knows what he is receiving, it can only enhance the latter's perception of the dentist's keen judgment and remarkable clinical abilities.

Dr Hunter Brinker taught me years ago that by delivering excellent dentistry for patients one does them a service that far exceeds the parameters of the service itself. Dr Brinker states that because dentists are somewhat egotistical, when a new patient presents a mouth restored with fine dentistry, the new dentist is likely to go to extremes to match what is already there. I do not accept that rationale completely, because not all dentists are capable of delivering the level of care that Dr Brinker renders. But I do know that when patients have been accustomed to receiving fine restorative care and appreciate what they have, they will go to extremes to seek out a practitioner who can continue the tradition for them. If the practitioner has that ability and reputation, he will find these kind of patients attracted to his office. The joy is that the dentist does not have to educate such patients, he does not have to sell them on quality restorations, because they are already sold, and he does not have to feel unappreciated, because they appreciate the attitude and efforts of the dentist. This is the ultimate in practice building--the patient seeking out the dentist because he knows the dentist can deliver the level of care he values.

I sometimes use direct golds as a way of saying thank you to my patients. I have placed them at no charge upon completion of considerable fixed restorative dentistry. Patients become fascinated by the technique, are appreciative of our efforts and often become a valuable sales force in the community.

CONCLUSIONS

The question "Are direct golds really a practice builder?" can indeed present a paradox. Such restorations have a remarkable track record for longevity. If direct golds were universally well taught, thoughtfully treatment planned, and used extensively in everyday general practice, a substantial amount of our daily efforts would not be necessary. If our goal is simply to stay busy, then direct gold treatments would definitely be self-defeating.

On the other hand, proper use of direct golds can increase our patient population by spreading the word about the technical excellence and long-term predictability of today's dentistry.

Reference

LEVOY, ROBERT P (1970) *The Successful Professional Practice* Englewood Cliffs, NJ: Prentice-Hall.

OPERATIVE DENTISTRY, 1988, 13, 42-43

Distinguished Member Award

I recall some years ago in Florida when this Academy recognized the need, and implemented the procedure for, recognizing certain senior members who were good citizens and who had served this organization in an extraordinary way.

When Chester Gibson was notified he had been chosen for the Distinguished Member Award, he was taken unawares. "I'm not good enough, I haven't been around that long, and I haven't done that much!" he proclaimed.

But you do qualify, Chet--eminently! Because, number one, I know your birth date and you are a senior member. I only wish I knew how you and Paul Dawson can remain so youthful. Number two, you have done, and continue to do, a great deal in and out of dentistry. Number three, I know you are a good citizen because I called the sheriff at McMinnville, and except for a few colorful incidents, you have a fairly good record.

Dr Gibson has contributed to organized dentistry in an outstanding fashion--like being president of his local society, receiving a Mastership and Fellowship from the Academy of General Dentistry, and being elected a Fellow in the American and International Colleges. He is a highly respected dental practitioner whom I have often heard say, "I go to the office to see my friends," and he has served his community in many ways--but other outstanding dentists have done the same thing. What makes Chet different is that he has done some things that make him outstanding among outstanding dentists.

Chester Gibson is an exquisite operator. He has the fanciest homemade rubber dam napkins in all of dentistry. He has designed a most useful set of amalgam pluggers. Chet was

Chester Gibson

one of 18 dentists selected from across the country to establish the American Board of Operative Dentistry. When the rigorous tests for certification were formulated, he was not satisfied just being a founding member of the board, so he applied to take the written examination. After being out of dental school for 35 years, he passed it--a feat deemed most difficult by recent master's degree graduates. Recently, Chet went on to pass the other components of the certification examination: case presentation, oral examination, and clinical examination. He is now the first founding member in history to become a fully certified member of the American Board of Operative Dentistry.

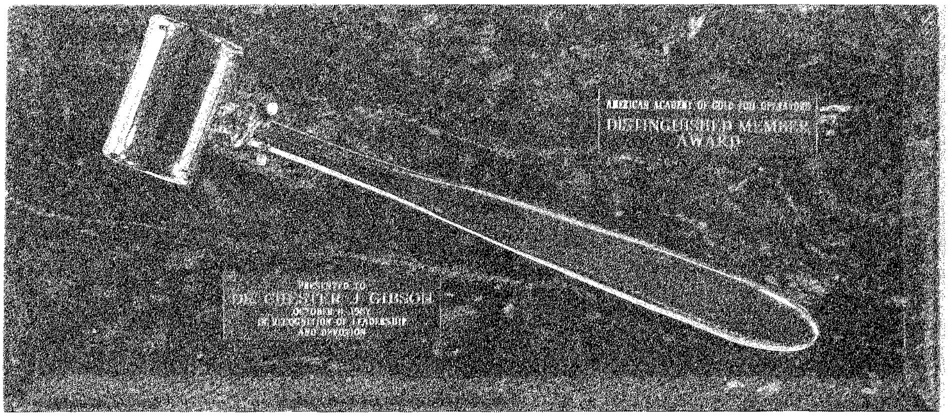

Photo of the newly designed Distinguished Member Award

Chet has had the responsibility of directing three different study clubs. Tomorrow we will learn from our lecture program how indebted we are to our early teachers and leaders. We must realize our debt to present-day study club directors who carry on and even embellish the work of earlier mentors.

Chet has been a tremendously supportive and influential member of the American Academy of Gold Foil Operators. He has served in many capacities, including editor of *Gold Leaf* and president of the Academy. When he was program chairman he arranged, in Hawaii, one of the finest meetings the Academy has ever seen.

There are many other things in dentistry that should be said about Chet but there is more to Chester J Gibson than dentistry. He worked hard to earn his education. In his youth he was a logger and because of his agility he was selected for climbing and topping those huge Oregon trees. He loves to fish, and he is the luckiest fisherman I've ever seen. He repeatedly gets the biggest fish and then modestly attributes it to skill. He has a greenhouse and loves to garden. He operates a hazelut farm and an agate mine! He is one of the most well-versed individuals on trees that I've known. I have seen him identify trees previously completely unknown to him merely because they were related to trees he did know. He has a deep interest in wild flowers and birds and he does pretty well but, just between you and me, he needs a lot more work on the varying plumage of Pine Siskens.

Now, I must point out that Chet doesn't do all this by himself. His great wife Fairy keeps him in the right orbit, and she still had enough time to raise two children, Sue and Scott. And, of course, Barbara is his competent and faithful assistant at the office.

Let me give you an insight into his Oregonian politeness--in most matters. One day last summer on a fishing trip in Canada, he summed up his feelings after a rather animated and unrewarding discussion between us concerning Golden and Bald Eagles:

"That Romano's all right--he said."

"You can *listen* to him--about 40%!"

"Well," I responded, "that's better than you can do in most gold mines!"

But, Dr Chester J Gibson is our gold mine, and it is with a great deal of pleasure and admiration that I present to him the American Academy of Gold Foil Operator's Distinguished Member Award.

ANTHONY D ROMANO

DEPARTMENTS

Book Reviews

BLEACHING TEETH

Ronald A Feinman, DMD, Ronald E Goldstein, DDS, and David Garber, DMD

Published by Quintessence Publishing Co, Chicago, 1987. 104 pages, 137 color photographs. $54.00.

This book is essentially an atlas for the technique of bleaching teeth. The text is prepared for the practicing clinician but is not so technical as to exclude appreciation by dental auxiliaries. Certain sections (chapter 5, "Bleaching Vital Teeth") may even be useful in patient education and preparation for bleaching procedures.

The text is clearly presented and nicely highlighted with color inserts for emphasis of important points or procedures. In addition, appendices are included to outline specific procedures, such as "vital bleaching of fluorosis staining" and "nonvital, nonthermal bleaching." The strongest area of the book is the color photography. Clinical examples are beautifully reproduced. Vital bleaching is presented well with a detailed series of clinical photographs. Unfortunately, nonvital bleaching, especially the "walking bleach" techniques, is not presented as well. More clinical photographs would have been helpful.

This book is recommended for the office which practices cosmetic dentistry. For the dentist, the armamentarium and procedures are aptly discussed. For the auxiliaries, the sequence of treatment is well outlined, and for the patient, a preview of events and outcomes are provided.

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ESSENTIALS OF DENTAL TECHNOLOGY

Katsumi Tamura
English translation by James A Fowler

Published by Quintessence Publishing Co, Inc, Chicago, 1987. 549 pages, 2317 illustrations, 7 in color. $78.00

The purpose of this book, as stated in the preface, is to be an atlas-type reference for dental student, dentist, and laboratory technician in the area of prosthodontics. Chapters include fundamentals of occlusion; simple and complex articulator systems; functional waxing techniques; porcelain-fused-to-metal crowns and fixed partial dentures; gold, porcelain, and acrylic resin crowns; and removable partial dentures.

The author attempts to address all levels of basic knowledge in each section beginning with definitions pertinent to that section. Definitions are quoted from the *Glossary of Prosthodontic Terms* (1977) and *Current Clinical Dental Terminology* (1974). Some of these definitions are not current, but this format provides clarity and avoids confusion for the technician and student offering the opportunity for review - not a bad idea, especially if, like this reviewer, your forgetting curve has intersected your learning curve.

Many areas of treatment procedures, such as pantography, capturing centric relation, and so forth, are described sufficiently for familiarization but are inadequate as a tool for actually learning the technique. In areas where differing philosophies or techniques are commonly accepted, more than one is described. Adequate references are provided.

Laboratory procedures are described in almost infinite detail, as typified by the over 2300 illustrations, and again more than one method is detailed.

For the accomplished dentist this book is certainly too basic to be of much value but, as a bridge of understanding between dentist and laboratory technician, it can serve an area of great need--if read by both parties.

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MODIFICATION AND PRESERVATION OF EXISTING DENTAL RESTORATIONS

D W Fisher and W W Morgan

Published by Quintessence Publishing Co, Inc, Chicago, 1987. 208 pages, indexed, 304 illustrations, 43 in color. $62.00

This book is a compilation of trouble-shooting procedures, designed as a step-by-step manual for the general practitioner. Techniques are offered, along with alternative methods, to modify defective or broken restorations that are in most respects suitable, saving time and expense for the patient.

Emphasis throughout the nine chapters is on verifying the quality of the original restoration, and then proceeding to replace it if all criteria of fit, function, and esthetics have not been met.

The text combines many illustrations--few colored photographs intermingled with the majority in black and white. The line drawings used to illustrate techniques are adequate for the most part, though several captions have been reversed.

The authors preface the text by emphasizing that techniques presented are not meant to be "quick fix" methods, and questionable procedures which do not conform to basic principles have been excluded. The modified restorations must be as good as or better than the original.

These techniques for modifying restorations are generally not new, but collected into one volume. They advise the practitioner to keep up to date and strive for quality, with the use of good materials and rubber dam whenever possible.

Chapter 2 deals with removal of existing restorations and offers a number of techniques which could help in a difficult situation. In this and several other chapters, there is a lot of repetition which makes reading a bit cumbersome, but may be helpful when referring back to a specific situation.

There are techniques offered for replacement of facings, usually employing light-cured composite resins. They are even suggested for repair of methyl methacrylate facings, which may not be as effective as suggested.

Chapter 4 deals with restoring abutments under existing removable partial dentures, which can be a dentist's nightmare. Practical solutions are presented to this situation. It is a common sense approach to a difficult appearing problem.

In other chapters, the authors deal with crown margin repairs, perforations, and endo access openings. They suggest using amalgam, resins, and gold inlays, but give very little credit to the more effective direct filling golds. Though emphasizing excellence in technique, they admit amalgam is quicker and cheaper. They point out the need to avoid situations requiring repair in the design and fabrication of the original restoration.

A chapter dealing with modifications of removable appliances is of interest, but a great deal of space is dedicated to procedures which are to be carried out by the lab. It might have been condensed somewhat.

All in all, the book is a very nice collection of helpful hints, useful in dealing with troublesome situations. It is presented in a well-organized, easily readable fashion, and quick reference style. It would be a good adjunct to have close at hand in any restorative general practice.

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Announcements

NEWS OF THE ACADEMIES

American Academy of Gold Foil Operators

The 37th annual meeting was held 7-9 October 1987 at the University of Colorado, School of Dentistry and the Brown Palace Hotel, Denver. The board meeting on Wednesday was followed by a "Welcome Party" in the hospitality suite. On Thursday morning, clinical demonstrations were given, with 14 clinicians presenting a variety of class 3 and 5 procedures to an enthusiastic group.

During the afternoon, members and guests enjoyed a tour to Central City, Colorado, a historic "Gold Rush" mining town. The day concluded with a reception and banquet at the Brown Palace Hotel featuring entertainment "Gold Rush Review" followed by a salute to the founders of the Academy by Julian Thomas. Dr Thomas' salute was responded to by Bruce Smith. The evening concluded with the presentation of the Distinguished Member Award for 1987 to Chester "Chet" Gibson of McMinnville, Oregon. The next morning reports and essays on the theme "The Development of Excellence in Dentistry" were given by Ludlow Beamish and Ron Zokol.

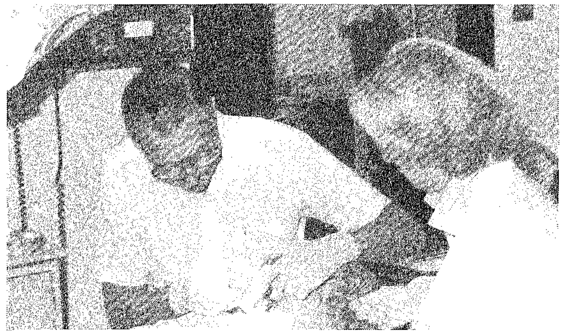
This year's local arrangements committee and the Academies' host for the session was chaired by Ralph Lambert, for which the Academy is very appreciative.

The officers of the Academy for the forthcoming year are: president, Allan G Osborn; president elect, Richard V Tucker; immediate past president, Julian J Thomas; vice-president, William H Harris; secretary-treasurer, Ralph A Boelsche; and councillors, Michael H Harris, Alfred C Heston, and Richard J Hoard.

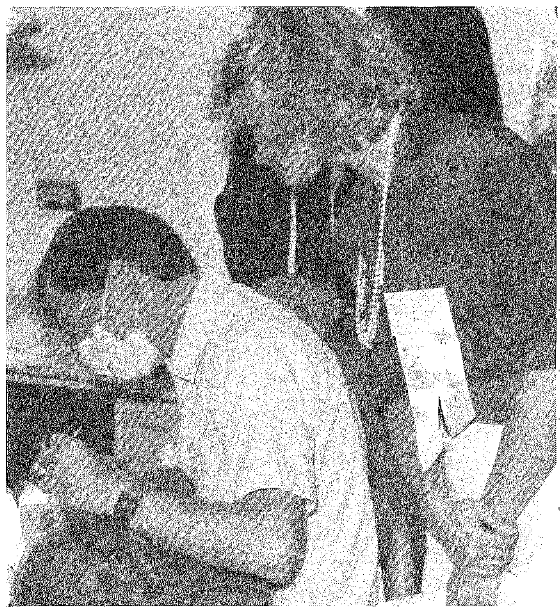
Next year's annual meeting will be held in Washington, DC, at Georgetown University School of Dentistry. Make your plans to attend!

Dr Warren K Johnson assisted by Mrs Johnson condensing his class 3 direct gold restoration

Dr Harold Schnepper discussing the merits of instrument making with Tom Thompson of Thompson Dental



Dr Ted Ramage of Vancouver, BC, assisted by Mrs Ramage in the performance of a class 5 demonstration



Dr Richard Tucker demonstrating a class 3 direct gold restoration, Dr Werner observing

American Board of Operative Dentistry

The American Board of Operative Dentistry is pleased to announce that two more distinguished members of the profession have successfully completed all phases of the board's certifying examination. They are: Drs David Moline of Iowa City, Iowa and Chester Gibson of McMinnville, Oregon. Both completed the clinical and oral phase of the examination, given at the University of Washington, Seattle, Washington, this past September and will be inducted as certified members of the board at its annual meeting in Chicago.

RETIRING

Joan Manzer, Editorial Associate, *Operative Dentistry*, retired from the Office of Scholarly Journals, Graduate School, University of Washington, on December 31, 1987. Joan's contributions to this journal are too many to list. She was the quiet, dedicated worker who influenced the journal since its inception. She saw to it that the journal kept its style and reviewed each publication carefully while it was in the process of being printed. Her efforts in editing and formating the journal resulted in a journal unsurpassed in quality and accuracy. Joan not only was a dedicated worker but a true friend. She has worked with the journal since it began, some 13 years ago.

It is with sincere gratitude and appreciation that we recognize Joan at this time for her many years of dedication and loyalty to her work. Joan, we wish you and your family all the very best for the years yet to come.

Judy Valela is retiring from her job as the Managing Editor's secretary. Judy has served *Operative Dentistry* since its inception and organization in 1975. Her diligence and faithful service in handling the many tasks assigned to her throughout the past 12 years have greatly enhanced the operation and management of our Journal. Judy has been responsible for managing the circulation, address cards and address changes, renewal notices, Journal revenue, accounting reports, invoices, refunds, back issues, reprint and interest income, bank deposits, and IRS reports. She has skillfully managed the secretarial correspondence of our business operations.

It is with sincere gratitude and appreciation that we recognize Judy at this time for her many years of dedication and loyalty to her work. Her skills and abilities and perpetual optimism will be greatly missed. Thank you, Judy!

NOTICE OF MEETINGS

Academy of Operative Dentistry

Annual Meeting: 18-19 February 1988
Westin Hotel
Chicago, Illinois

American Academy of Gold Foil Operators

Annual Meeting: October 1988
Georgetown University
Washington, DC

American Board of Operative Dentistry

Annual Meeting: 19 February 1988
Westin Hotel
Chicago, Illinois

OBITUARY

Richard James Miller, DDS

Our profession and the members of the Academy of Operative Dentistry lost a dear friend, colleague and dedicated professional with the passing of Dr Richard Miller who died on October 6, 1987, in Desplaines, Illinois, following an illness.

He was born in Chicago, July 24, 1930, and attended schools there, including his professional education at Northwestern University

Richard James Miller

Dental School, where he graduated with honors in 1955.

Shortly before graduation he met Thelma Armstrong, and their friendship developed while he was serving as a dental officer in the United States Navy stationed at Great Lakes, Illinois. This relationship was interrupted for one year when Richard was transferred to the Third Marine Division and sent to Okinawa. In June of 1957 he returned and a month later he and Thelma were married. They settled in Desplaines, where he began his dental practice in association with Dr Robert Hattenhauer.

In 1960 Richard and Thelma became the proud parents of Scott, their only child, and moved to Mount Prospect. Dr Miller maintained his practice through the years in Desplaines, where his patients considered him not only their dentist, but also their friend. Always striving for perfection, he was never content until he was satisfied that he had done the very best work of which he was capable.

Dr Miller was a member of the American Dental Association, the Illinois State Dental Association, Chicago Dental Societies, the Academy of Operative Dentistry, a charter member of Xi Psi Phi fraternity, a member of Omicron Kappa Upsilon honorary fraternity, and the G V Black Society. He gave unselfishly of his time, serving for many years as chairman of the Local Arrangements Committee of the Academy of Operative Dentistry and actively managed the local arrangements for the Academy's annual meeting.

Dr Miller loved to fish, hunt, and to play golf. In later years he felt that he obtained his greatest spiritual strength by being out in the open, exploring nature's wonders. He would gain great peace of mind and soul watching a few ducks working into a group of decoys or seeing a flight of geese testing their wings in preparation for the long flight south for the winter. His love of hunting grew three years ago when he acquired an American Water Spaniel puppy that they named Rebel. Richard worked hard with Rebel and trained him to be a fine hunter as well as a devoted family pet. Watching the dog work the fields for pheasants added a new dimension to the hunting experience in terms of joy and personal satisfaction.

The tensions and pressures from a busy week at the office could also be quickly dispelled by the gentle rock of a boat while he drifted across Lake Geneva fishing for small mouth bass. He liked to excel in whatever he did, and fishing was no exception. He was an avid student of the art and science of fishing and worked hard learning the structure of each lake and the most scientific way of catching fish. As a result he was very successful. His golf prowess was somewhat more erratic, but only because his other interests took away the time needed to practice in order to fine-tune his game to the low handicap of which he was capable.

Richard was a family man. He was not interested in nightlife and actually dreaded going down to the city for any reason. Once or twice a year for a special occasion or dental meeting was quite enough for him. He preferred being home of an evening with his family, reading or watching television. He was a real student of the Civil War and read virtually everything written on the subject. Some of his favorite and most memorable vacation experiences were traveling to the Southeast and visiting the historic landmarks and battlefields of the Civil War years. He would take photographs and then match them with the narrative contained in the texts which he had on the subject.

Richard lived a rich, full, and happy life. Until this final illness, he had not experienced sickness or major setbacks in the fulfillment of his goals. He was respected in the profession and in the community and loved by all those who had the good fortune of really knowing him well. He will be missed!

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OPERATIVE DENTISTRY

WINTER 1988 • VOLUME 13 • NUMBER 1 • 1-48

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