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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.

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EDITORIAL

But It Isn't Used in Practice

The place of restorations of direct gold in the curriculum of a dental school and as a requirement of an examination for dental licensure has been under attack for many years. A reason sometimes given for eliminating restorations of direct gold from examinations for licensure is that often the results are bad enough to jeopardize the oral health of the patient. As all the candidates for these examinations are graduates of dental schools this sad state of affairs reflects the shortcomings of current dental education in preparing students adequately in operative dentistry—still the largest part of a dental practice.

A reason sometimes advanced for abolishing or curtailing the teaching of restorations of direct gold is that this material is no longer used in practice, or that the extent to which the material is used is so limited that time spent in teaching the technique cannot be justified. Unfortunately, this line of argument is espoused by too many dental schools today—and even by some teachers of operative dentistry!

Inclusion or exclusion of a particular form of therapy in or from the curriculum of a dental school should depend primarily on the demonstrated success or failure of the therapy when it is used to restore and maintain the form and function of teeth. From a scientific point of view, direct gold is still the best material for treating small carious lesions, erosions, and abrasions. Its physical properties approach those of an ideal restorative material more closely than do the physical properties of any other material available today—indestructibility in oral fluids, adaptability to walls of cavities, freedom from dimensional change on insertion or setting, resistance to forces of mastication and to wear, edge strength, a coefficient of thermal expansion close to that of tooth, and nontoxicity. Furthermore, the material has an enviable reputation for longevity of service. Of course we should like to have an even better material, and efforts to produce one continue, but none is available at present, and, until one is, we should use the best we have.

We rightly expect our universities to be centers of excellence, not mills of mediocrity. The university is the place where standards should be set and where dental students should expect to receive an education that prepares them to provide the best treatment for patients. Dental schools should lead, not follow; therefore it is a lame excuse of dental educationalists to recommend the deletion or curtailment of a particular technique just because it may not be used in practice. If direct gold as a restorative material is not used much in practice, dental schools should rectify the deficiency by ensuring that their graduates are able to use the material with confidence.

A Ian Hamilton
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OPERATIVE DENTISTRY, 1984, 9, 42-49.

LEGENDS OF OPERATIVE DENTISTRY

LLOYD BAUM

Gold Foil

In an era when computer science is blossoming and new products are being developed for the dental profession, it behooves us to take a backward look and review our heritage as operative dentists. Then as now the operative dentist practiced his therapy by placing a restoration and by preparing the tooth to receive it. It is to the preparation of the tooth that we will first direct our attention.

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Dr Baum is a member of the American Academy of Gold Foil Operators, the Academy of Operative Dentistry, the American Academy of Restorative Dentistry, and Omicron Kappa Upsilon honorary dental fraternity. He is a Fellow of the American College of Dentists. In 1982 Dr Baum won the Hollenback Memorial Prize.

Presented at Legends of Operative Dentistry, a program arranged by the Division of Continuing Education of Northwestern University and held 21 and 22 April 1983 at Northwestern University of Chicago.

Preparing the Tooth

Prior to the middle of the 19th century, dentists used a hand-held bur or a series of excavators and hand instruments to remove carious dentin and mortice out a kind of cavity preparation. Soft carious dentin provided little challenge, but hard sound dentin was most resistant to instruments or tools of the day.

Surprisingly, it was not until 1871 that the foot-powered dental handpiece came on the scene and opened up new vistas in operative dentistry (Black & Black, 1940). A hardened carbon steel bur could now be twirled mechanically and sound dentin could be cut at the will of the operator. And this occurred barely more than 110 years ago! A raft of patents for handpiece designs followed in the wake of the foot-powered, belt-driven handpiece.

It should be borne in mind that the basic components of modern science were discovered in the 19th century. Electricity, the telegraph, the electric motor, the incandescent light were all products of the ingenuity of that period.

Because this new method of applying power to a cutting bur occurred at a time when electricity was being harnessed, the electric engine soon supplanted the power of the foot treadle, and the foot treadle soon became obsolete.

Aside from a few minor improvements, the cutting of tooth structure remained more or less unchanged for another 70 years. If a substance harder than dentin, for example, enamel, had to be cut, one would resort to a "Joe Dandy" disk or a revolving stone to abrade away the enamel, or one might undermine it with a steel bur and break off the outer enamel crust. Many of the readers can recall the method of tooth preparation, even into the 1940s, where full crowns were prepared by heatless stones and carborundum disks. Despite the fact that air travel had become commonplace along with the automobile, dentistry still hadn't found a suitable way to cut enamel!

The history of operative dentistry, in many respects, is a history of industry. As soon as industrial technology had developed a tungsten carbide cutting tool that was hard enough to cut glass, the emergence of carbide burs was almost instantaneous. The same could be said for diamond-impregnated cutting tools, which made their debut in the mid 1940s.

Soon after the close of World War II another industrial development changed the face of clinical dentistry more than anything in many previous decades. It occurred in Keene, New Hampshire, and it did not cost the taxpayers a dime nor did it involve the National Institutes of Health or the International Association for Dental Research. It was the industrial development of the miniature precision ball bearing. Utilizing an assembly of these bearings on each end of a small air turbine, it was now possible with direct drive to eliminate all gear assemblies and achieve bur speeds of 200 000 and 300 000 rev min^{-1}.

With carbide burs and diamond stones, enamel could now be reduced with almost the ease of dentin. The spinoffs from this new tooth-cutting mechanism were multitudinous. The observing operator saw an opportunity to reshape tooth form, that is, to rebuild in gold a better occlusal surface with this cusp repositioned over that pit, or this ridge over that groove. In conjunction with newly refined elastic impression materials, quadrant dentistry and mouth reconstruction now became a reality. In a few short years an entirely new discipline was born, namely, gnathology—and all because of the development of a "tool" that would cut enamel! It is also sobering to realize that these developments took place during our present generation.

Gold Foil (Direct Gold)

Let us again look back to 100 years ago when the foot-powered handpiece was developed. Dentists of that era were very concerned with gold foil. Gold foil has been used in dentistry since "heaven knows when," however, its use as a tooth restorative material was first reported in the literature in 1530. One must realize that gold foil was the only permanent filling material that the dentist could depend upon. (Sponge gold was developed in the mid-19th century.) The magnitude of its use, as reported by Donaldson (1980), was published in the *Journal of the British Dental Association* in 1883 (Bate, 1883).

"We must congratulate ourselves on the great improvement that has taken place in the power of retaining diseased teeth and restoring to usefulness such as would, a few years ago, have been considered hopelessly irrecoverable. The extent of this process of repair can best be understood by saying that, independent of amalgam and cement stoppings, 20 000 ounces [620 kg] of fine gold is annually used in filling teeth."

Donaldson comments that:

"Unfortunately, there is no indication whether this was the amount used worldwide or whether it was only that used in Britain."

Bate further states that:

"As a cheaper form of restoration than one entirely of pure gold, for use in four-walled cavities, . . . some operators placed a sheet of tin foil between two sheets of non-cohesive gold foil and rolled their ropes or cylinders from the composite material."

We do know from museum specimens and from patient's records that during that era there were several mechanical mallets, which operated off the belt drive, invented expressly for the purpose of condensing gold foil. Not to be outdone by mechanical devices, Bonwill and Webb, in 1877, developed the first electromagnetic mallet with the plugger shaft being activated through a kind of solenoid at the base of the handpiece. Reputedly, it was through listening to a Morse telegraph sounder that Bonwill was led to design his electromagnetic mallet, which was later improved and successfully marketed by Dr M H Webb (Donaldson, 1980).

To show that there is "nothing new under the sun," a reciprocating pump was also developed which, through a closed tubular system, activated a weighty piston inside a cylinder to move back and forth and impart a blow to a condenser point—the first pneumatic gold foil condenser.

Without a doubt, a great deal of attention was directed toward gold foil and its use for filling teeth. To what limits exacting and dedicated practitioners would go to restore teeth is illustrated by the following narrative reported by Donaldson (1980) from a publication by Thorpe (1904).

"Dr Webb . . . did in my mouth [as told by Dr W H Trueman, another dentist] his last but one heavy job, filling four upper incisors using four books, one half ounce of gold foil. I went to Lancaster, arriving on a Monday afternoon; he had done the preliminary work in Philadelphia. He began the next morning and for two days I was in the chair, my mouth dammed from 8.30 a.m. to 5 p.m. I did not get out and Webb was at me all the time except fifteen minutes for lunch. I went hungry, not even a sip of water as we were both anxious that there should be no mishap. Another day he worked on me from three to five hours and finished about ten o'clock Sunday morning, altogether six days to fill four teeth."

The history of direct gold and the development of new products seems to have followed this line of energy conservation, in a search for a method whereby gold could be more easily compacted with less effort (Johnson, 1893; Porter, 1892). The methods of compacting gold—hand malleting, pneumatic, electric, hand pressure—were all directed toward this end (Figs 1,2&3). To squeeze air out of a porous mass and to distort gold leaf or gold particles so they will adapt and weld their adjacent surfaces together to form a solid mass were the basic objectives.

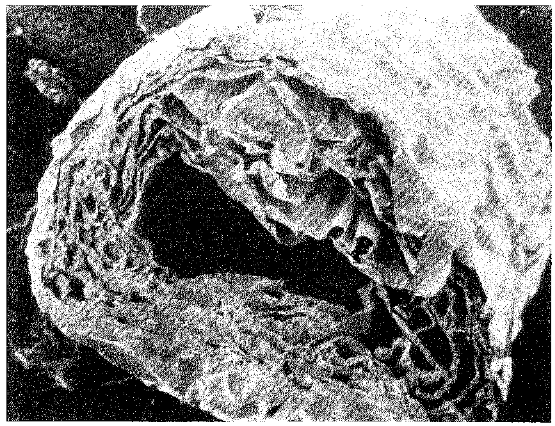

FIG 1. *Gold foil cylinder—a roll of miniaturized sheet metal. X15*

For sake of brevity, discussion here will be limited to the three basic kinds of gold, namely, foil, mat, and powdered. Although other types are in common usage, for example, Electralloy, platinized gold, and laminated gold, and have some unique characteristics and beneficial properties, they all fall within one of these three categories. The profession is indebted to Williams Gold Refining Company for making this broad spectrum of material available.

Operative dentists are also indebted to the late George Hollenback and to Earl Collard for conducting a most thorough study of physical properties of cohesive gold, which was published in the September 1961 issue of the *Journal of the Southern California Dental Association* (Hollenback & Collard, 1961). Their report will probably continue to be the standard by which all future studies will be compared.

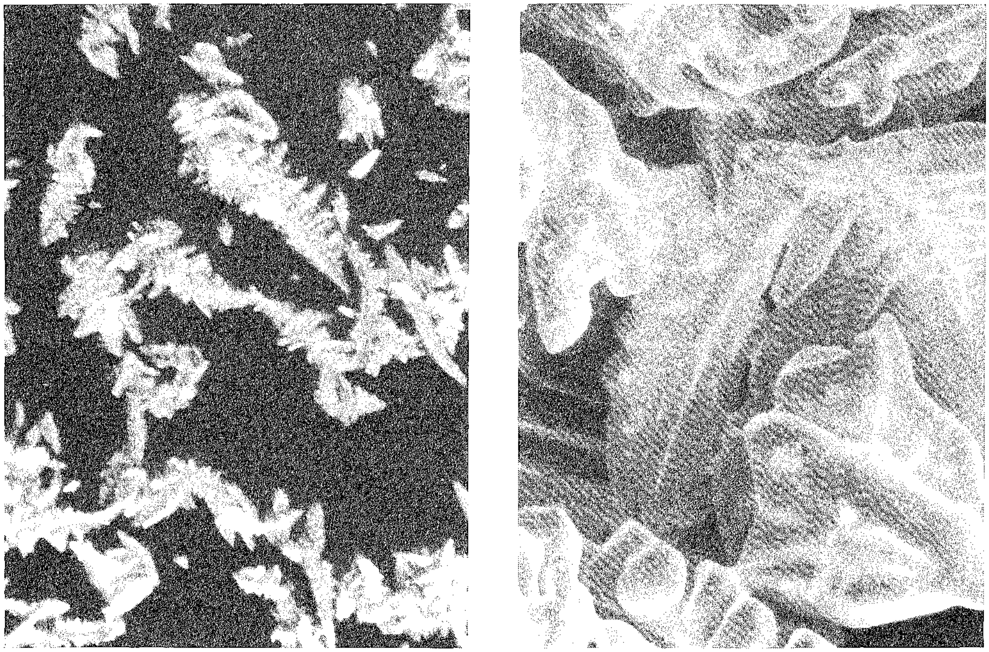

FIG 2. *Mat gold—a crystalline form of filling gold.* Left: *low magnification, X103.* Right: *high magnification, X1030. (Courtesy of Williams Gold Refining Co)*

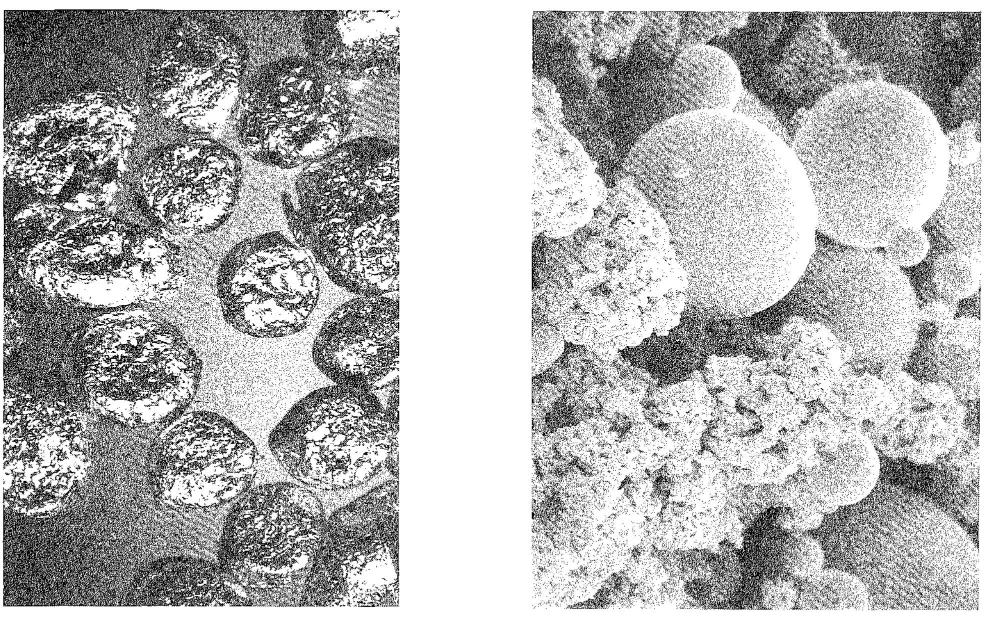

FIG 3. *Powdered gold—miniaturized sand and gravel.* Left: *Goldent pellets—powdered gold wrapped in gold foil.* Right: *Goldent powder, X640.*

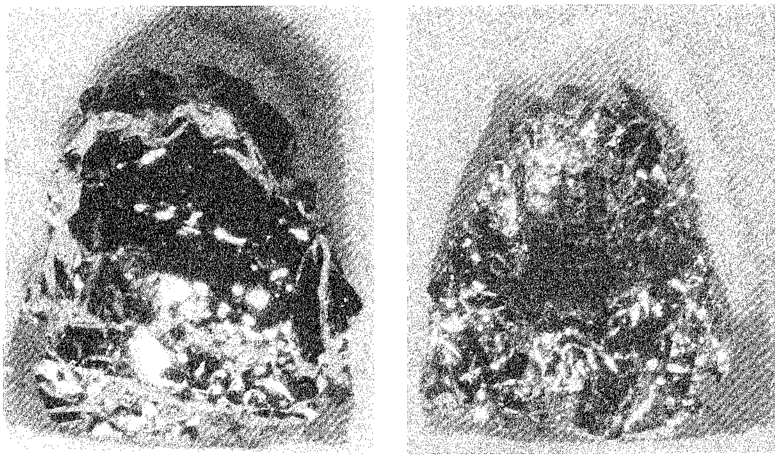

FIG 4. *Gold foil—a tough type of material* (left) *that tends to crinkle and pull together when condensed* (right). *X12*

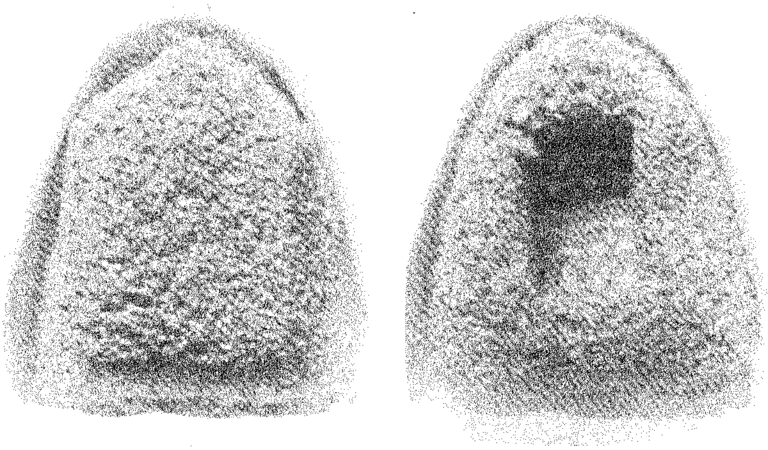

FIG 5. *Mat gold—a semi-tenacious conglomerate of crystals* (left) *that will condense without moving the material adjacent to the plugger* (right). *X12*

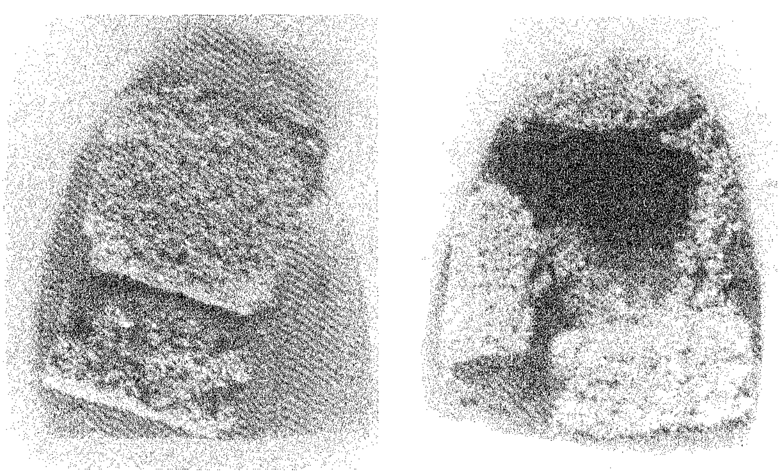

FIG 6. *Powdered gold—a granular substance* (left) *that tends to spread laterally when condensed* (right). *Without the foil wrapped during this stage the powder would be unmanageable within the cavity. As the particles weld together this "spreading" characteristic is lost. X12*

In its raw working state gold foil is tough; powdered gold is friable. It is necessary to crumple and tear the foil in order to position it within a cavity; powdered gold tends to flow ahead of the condenser (Figs 4,5&6). Friability (powder) versus toughness (foil) are contrasting features. The powder, because of its plasticity, spreads more readily and is applicable to boxlike cavities with a 90° cavosurface angle; the foil, because it is tough and not inclined to spread laterally, is more suitable for beveled margins and flared walls.

Because of these differences in spreading characteristics, gold foil and powdered gold are condensed differently in a cavity. Whereas gold foil is "stepped" from the center toward the margins, powdered gold is packed first into the retentive areas and then stepped toward the center.

The objective has been to make the material as plastic and as condensable as possible without it becoming so friable that it cannot be managed (Porter, 1892; Hollenback & Collard, 1961). For that reason Mat Foil and Goldent are encased in foil and each operator chooses the type of material and cavity preparation that best fits his operating style (Fig 7).

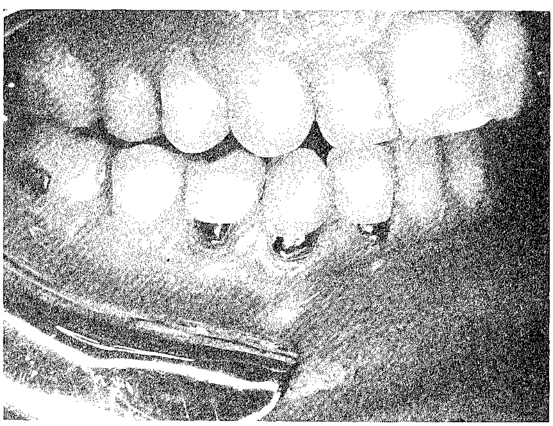

FIG 7. *Class 5 restorations. The cuspid restoration is made of powdered gold, the other two of gold foil.*

Variations in hand pressure that can be exerted on an instrument may determine the size of condenser used, whether or not the operator places a veneer of foil over a mat base, and whether or not he uses a malleting system. For example, some operators condense the gold more rapidly by hand pressure then they can by using a mallet.

In the final analysis, the basic principle of condensation still remains the same; packing gold into a cavity and welding it into a solid mass is a laborious task and it is quite unlikely that this will ever change.

Leadership at a Crucial Time

Throughout the 19th century operative dentistry **was** DENTISTRY, for all intents and purposes. The calibre of leaders of operative dentistry was very high. Intelligent, perceptive, dedicated, and unafraid of hard work, these men, too numerous to mention, shaped and molded the profession as we have come to know it here in the Western Hemisphere. Despite the fact that they were primarily operative dentists (clinicians) they were scientists and philosophers in their own right.

G V Black stands out as the leader of these pioneers. Lest his experience in amalgam research, dental education, and as a dental practitioner eclipse his scientific and organizational accomplishments, let us review some historical facts (Black & Black, 1940).

1. He owned one of the first microscopes in the state of Illinois.

2. He was conjointly involved with scientists in Europe in developing the germ theory of disease.

3. He observed and entered into his records the phenomenon of phagocytosis some years before it was reported by Mechnikoff, who was actually given the credit.

4. He was awarded an honorary medical degree from the Chicago Medical College.

5. He was largely responsible, because of his stature and influence, for establishing dentistry as an independent profession here in the United States.

Tremendous pressures were brought to bear on dentistry to become a specialty of medicine near the turn of the century, but Black, recognizing the curious blend of art and science that characterizes dentistry, was able to lead the profession down its own road. The pathway to an independent profession in America that the pioneers marked out for us was not followed in Europe where dentists were viewed more or less as stomatologists. The results of an independent dental profession in America is a matter of record, and all because of the foresight of our forefathers, operative dentists.

Gold Foil in Dental Education Today

Again our profession is at a time of decision. Operative dentistry now is only one of many disciplines. Aside from the eight dental specialties, many other groups (community dentists, consumer groups, commercial interests, Federal Trade Commission, and Federal Drug Administration are making their voices heard and are demanding a piece of the action. What can we do to keep the **art** of dentistry from being forced to the sidelines to make room for the more scientific and sociologic aspects?

Teachers of operative dentistry may not agree on everything, but there is no division among them as to whether or not fundamentals should be taught. We like conservation of tooth structure, clean-cut cavities, isolation of the working field, proper protection of the pulp, and good esthetics. Gold foil has been the avenue through which these basics were taught in the past and is equally effective today.

The allegation has been made that gold foil, by and large, is not used by dentists in practice, therefore it should not be taught in school. Related to this issue is a far greater one, namely, teaching fundamental principles to dental students. What other material can be better used as a vehicle for teaching these fundamentals? Cannot we use amalgam, for instance? In the pursuit of this question let us, for example, consider one basic principle, namely, condensation. If a student has reached his clinical years and his amalgam restorations are deficient and porous, especially along gingival corners, we as teachers are obliged to provide him with some finger exercises to develop new habits and his concern for details. And what finger exercise is recommended to get his attention so he will apply himself to correct the problem? An excellent remedial exercise is to have him condense gold into a plexiglass block under a binocular microscope (20X) with hand pressure (Fig 8). He will quickly

FIG 8. *Experimental condensation of gold into a cavity. Note the open spaces and the powder particles, which are not even packed together much less welded into a mass. A simulated cavity in a plexiglass block permits direct and reverse observation by the student. X50*

learn that there **is** a marked difference between properly condensed material and improperly condensed material. And because of its unforgiving nature, gold will drive home the point that with condensation you just can't cheat. In no way does amalgam accomplish this like gold does.

After a student has placed three or four gold foils in patients' teeth we rarely see him place porous amalgam restorations. Why? Because he has now learned to be attentive and careful when filling a cavity—regardless of what material he might be using.

Can we use composite resin to teach fundamentals? To some degree, perhaps, but isolation of the working field and developing expertise with rubber dam is not as religiously promoted when dealing with composites as with direct gold. Composite resin is promoted as a restorative substance because it is not as technique sensitive and is easier to place. For instance, look at the next advertisement for light-cured resins and see if a rubber dam is in place while the light is being used. The photographs appear as though one need not use even cotton rolls. Can gingival composites and newer cements be properly placed without isolation with a gingival retractor (212 type of clamp)? Yet show me some recent graduates who **know how** to place and adequately stabilize a class 5 clamp, show me some recent graduates who know how to apply a rubber dam around a bridge to repair a faulty margin on an abutment—and I will show you some dentists who learned, in dental school, how to do these things using gold foil, not composite resins.

We could go on and on ... What students learn how to apply a separator to place an amalgam or a composite? But proximal gold foils **require** separation for finishing. Try as we might, we cannot teach fundamentals without teaching gold foil. Correction, what we really mean to say is that we cannot teach gold foil without teaching fundamentals. **It just won't work!** The foil will end by being porous and it will leak, fall out, and become a real disaster if fundamental principles are not followed. Can we say that about any other material that can be squashed willy-nilly into a cavity or pasted submarine style onto a concave surface?

My primary intent is not to carry a torch for direct gold as a health service. I will leave that to many of my colleagues who are primarily involved in practice rather than teaching. I am carrying a torch, however, for good pedagogy, whether graduates end by being oral surgeons, periodontists, or whatever. I am carrying a torch for good training of clinicians who can evaluate a procedure, perform it with skill and dispatch—and with predictability. And making use of this traditional material (gold) makes my job as a teacher of operative dentistry much easier and gives me a greater sense of satisfaction in knowing that my students are prepared in basics to be of greater service to their patients as they go into practice.

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ORIGINAL ARTICLE

Cavity Designs for Composite Resins

An experimental cavity, cavities with long marginal bevels, and the use of a bonding agent give the best margins for restorations of composite and the least marginal leakage.

A PORTE • F LUTZ • M R LUND
M L SWARTZ • M A COCHRAN

Summary

Four designs of a cavity for composite: an experimental cavity, and cavities with long bevels, butt joints, and concave bevels were prepared in extracted teeth. The cavities were filled with composite both with and without the use of a bonding agent. Some were cycled thermally and some were not. The margins were then examined with a scanning electron microscope. After thermal cycling, some samples of each design of cavity were exposed to a solution of $[^{45}Ca]Cl_2$ and the amount of leakage assessed.

The experimental cavity, cavities with long marginal bevels, and the use of a bonding agent gave the best results.

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INTRODUCTION

The esthetic result and the longevity of anterior restorations of composite resin is directly related to the quality of the marginal adaptation. The margins can be evaluated for marginal seal and the micromorphology of the interface of restoration and tooth (Lutz, 1980). Six variables have a strong influence on marginal adaptation of restorations of composite resin: (1) preparation of the cavity, (2) technique of etching enamel, (3) use of a bonding agent, (4) technique of insertion, (5) procedure of finishing, and (6) restorative material (properties and curing mechanism).

The purpose of this laboratory study was to analyze the influence of the design of the cavity and the use of a bonding agent on the marginal adaptation of freshly finished restorations of composite resin that had been cycled thermally. Both marginal micromorphology and marginal seal were evaluated quantitatively.

MATERIALS AND METHODS

Ovoid cavities with four variations in design were prepared as uniformly as possible in the middle third of the facial surfaces of 48 extracted maxillary anterior teeth. The designs of the cavities, diagramed in Figure 1, were:

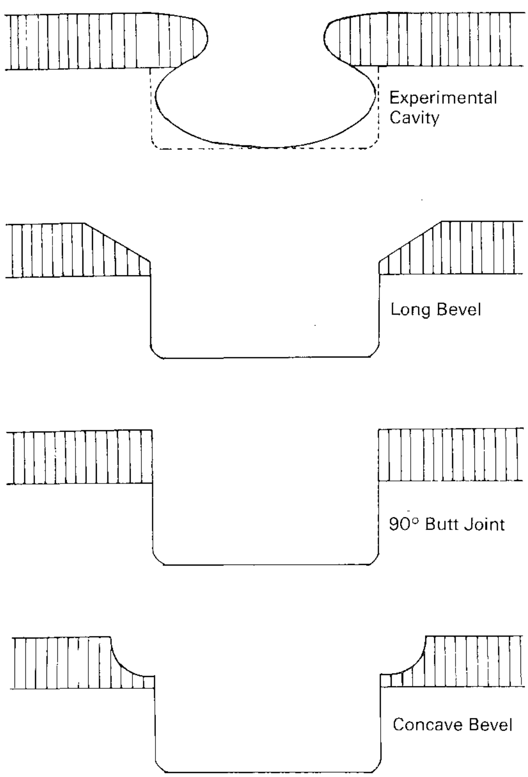

FIG 1. *Designs of cavities for studying the quality of margins and leakage around restorations of composite*

experimental cavity, cavity with a long bevel, cavity with a 90° butt joint, and cavity with a concave bevel. The experimental cavity, introduced in Switzerland in 1976 as an "adhesive preparation," has minimal reduction of enamel in the form of a thin and long bevel. Clinical experience in Switzerland has been generally favorable with this extremely conservative preparation, which abandons the box preparation for macromechanical retention. Only structureless enamel and carious dentin are removed (Lutz & others, 1976).

The margins of all cavities were finished with either Sof-Lex discs (3M Co, St Paul, MN 55144, USA) or 40-fluted tungsten-carbide burs and then examined under a light microscope at X50 magnification. Preparations with fractures within the enamel or with rough margins were discarded.

The enamel margins were etched for 60 seconds with 37% phosphoric acid, rinsed for 30 seconds, and the cavities filled, by a technique of bulk placement, with Silar (3M Co), a heterogeneous microfilled composite with splintered prepolymerized particles (Lutz & Phillips, 1983). For each design of preparation, six restorations were made with application of the homologous bonding agent, and six without. Exactly 30 minutes after the start of mixing, the fillings were finished dry with Sof-Lex discs.

Immediately after finishing, replicas of the restored teeth were prepared in resin for use in the scanning electron microscope (SEM) to examine the micromorphology of the margins. The teeth were then subjected to 2500 thermal cycles between two water baths differing in temperature by 40 °C. The time of immersion in each bath was 30 seconds, and the time of transfer between the baths was 10 seconds. Upon completion of thermal cycling, replicas in resin were again prepared. The restorations were isolated and then immersed in a solution of $[^{45}Ca]Cl_2$ for the leakage tests. After exposure to the isotope solution, the teeth were sectioned longitudinally and placed on x-ray film for production of autoradiographs.

Evaluation of Margins

The resin replicas of each restoration made before and after thermal cycling were examined at X300 magnification. The quality of the marginal morphology was categorized as: (1) marginal discrepancies, which encompassed open margin, margin fissure, and underfilled margin (Fig 2A & B), (2) overfilled margin (Fig 2C), and (3) excellent margin (Fig 2D).

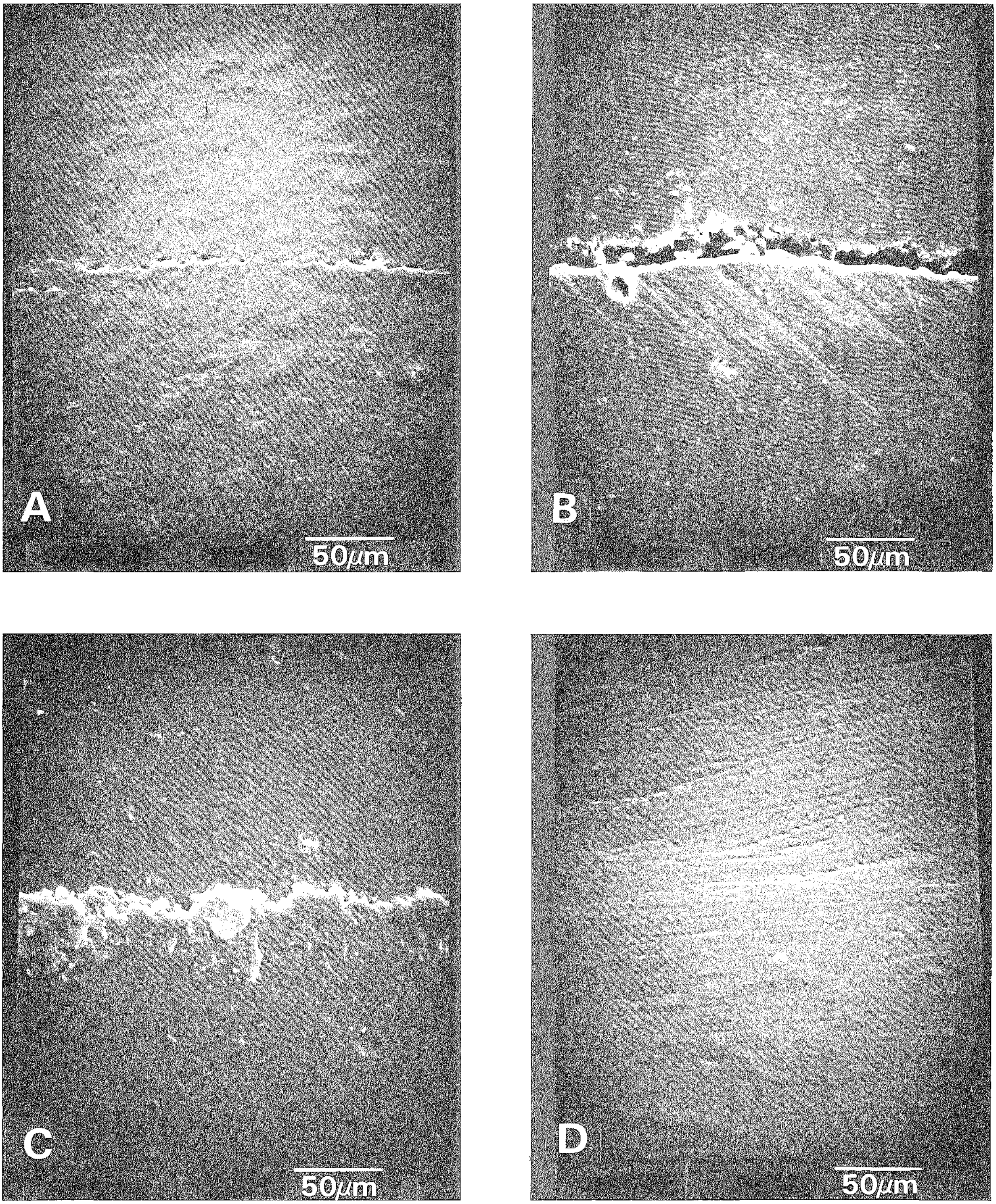

FIG 2. *Examples of the morphology of margins: A - open margin; B - fissured margin; C - overfilled margin; and D - excellent margin.*

The entire periphery of each restoration was examined under the scanning electron microscope (SEM), 25-30 fields per restoration. In each field the quality of the margins was determined as a percentage of each portion of the margin examined. The overall percentage of the margin that fell into each of the three categories was calculated for the entire length of the margin. Six replicas were evaluated for each subgroup (defined by design of preparation, use or nonuse of bonding agent, and status before or after thermal cycling (Lutz, 1980; Luescher & others, 1977).

For statistical comparisons of the quality of the margins, only the amount rated 'excellent margin' was considered. The data were separated into two general groups, with or without bonding agent, and each group was subjected to a two-way analysis of variance. The factors examined were design of cavity and thermal cycling. For comparisons among pairs of means, 95% confidence intervals by the T-method and *t*-tests were used (Sokal & Rohlf, 1981).

Evaluation of Leakage

The autoradiographs were analyzed by ridits (relative to an identified distribution) (Guzman, Swartz & Phillips, 1969; Ortiz & others, 1979). The test autoradiographs were compared to a set of standards and assigned numerical values in accordance with the following degrees of penetration by the isotope:

1 = no penetration
2 = slight penetration at the cavosurface margin
3 = penetration halfway to the axial wall
4 = penetration to the axial wall
5 = penetration to and along the axial wall

Upon completion of the ridit analysis (Bross, 1958), the data were subjected to a two-way analysis of variance. The factors examined were design of cavity and use or nonuse of bonding agent. For comparisons of pairs of means, confidence intervals of 95% by the T-method and *t*-tests were used (Sokal & Rohlf, 1981).

RESULTS AND DISCUSSION

Evaluation of Margins

The micromorphology of the different restorations, placed with a bonding agent and analyzed quantitatively in the SEM, is compared in Figure 3. With a bonding agent, both

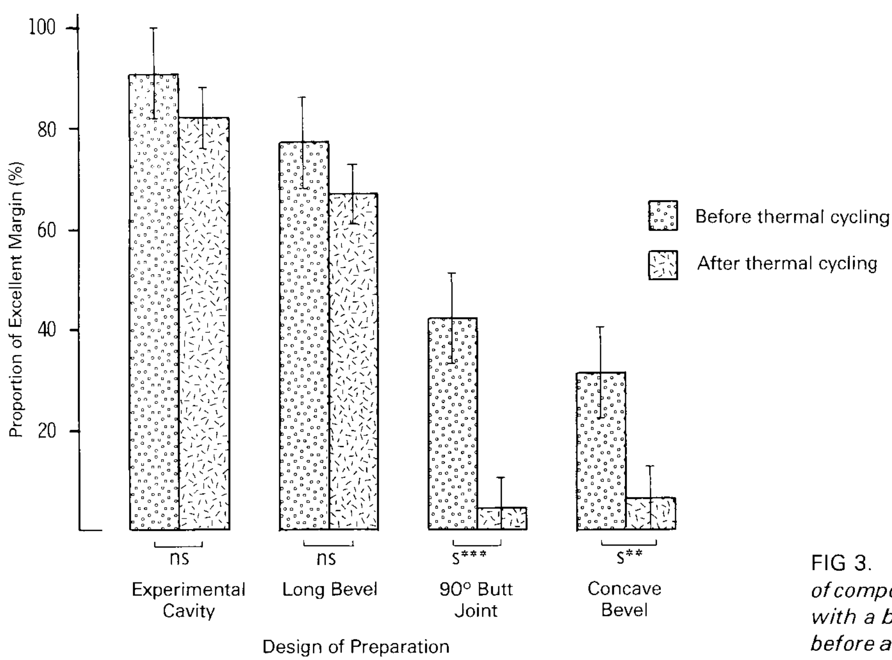

FIG 3. *Quality of the margins of composite restorations placed with a bonding agent and both before and after thermal cycling*

before and after thermal cycling, the restorations rank in sequence from the highest to the lowest percentage of excellent margin as follows: experimental cavity, long bevel, 90° butt joint, and finally concave bevel. The experimental cavity and the cavity with the long bevel were significantly superior ($P < 0.05$) to the cavity with a butt joint of 90° and the cavity with a concave bevel, in two respects: the percentage of excellent margin and the reduction in quality of margin due to thermal cycling (Longman & Pearson, 1982).

The cavity designed with a concave bevel demonstrated no advantage over the 90° butt joint in either leakage or micromorphologic adaptation of the margin. This design of cavity is less conservative than the others because more sound tooth structure is sacrificed, producing longer margins and larger restored surfaces. Therefore, since it was considered less than optimal for cosmetic reasons, it was not analyzed further.

The micromorphology of restorations placed without a bonding agent can be seen in Figure 4. Again, the experimental cavity was significantly better than the other designs of cavity. However, without the bonding agent, thermal cycling reduced the areas rated as 'excellent margin' to only 26% compared with 82% in the bonding agent group. With the long bevel, the rating was reduced to 10% and with the 90° butt joint to virtually nil.

The bonding agent has significant positive effects on marginal quality of all test groups, except the experimental cavity before thermal cycling and the 90° butt joint after thermal cycling. Although data from samples that had not been cycled thermally furnish information on the degrading influence of thermal stress, the data from thermally cycled restorations undoubtedly provide more clinically relevant information. From the standpoint of micromorphology of the adaptation of the margins, the two cavities with long bevels—the experimental cavity and the cavity with the long bevel—are superior to the butt joint design of cavity. The data also indicate that a bonding agent placed on the preparations improves the marginal relationship.

These data are in agreement with results of other studies on marginal integrity and cavity design (Lutz, 1980; Luescher & others, 1977; Sockwell, 1976; Welk & Laswell, 1976; Eriksen & Buonocore, 1976). It is possible that the design of the experimental cavity (decreased volume of the cavity and presence of

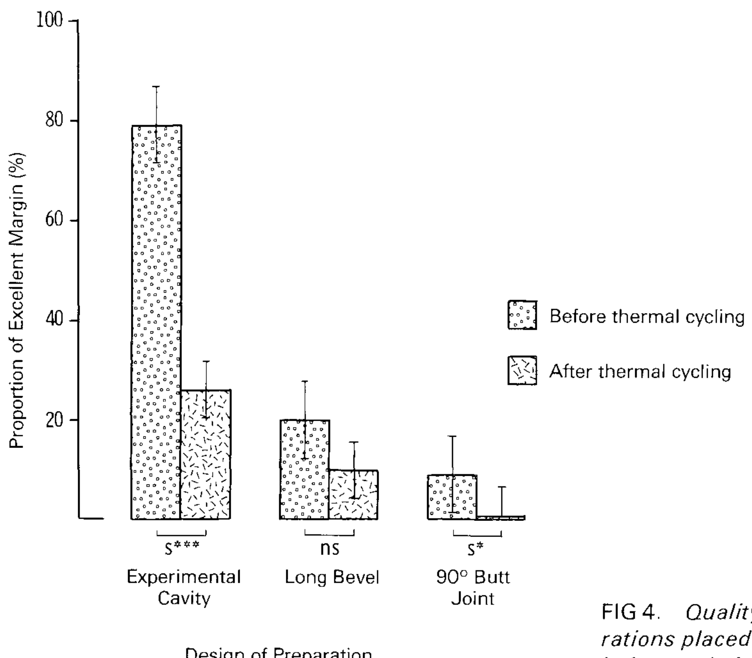

FIG 4. *Quality of the margins of composite restorations placed without a bonding agent and both before and after thermal cycling*

a shoulder of enamel and dentin between the surface of the restoration and main bulk) may reduce the tendency of the resin to draw away from the margin during polymerization (Øilo & Jørgensen, 1977; Torney, Denehy & Teixeira, 1977; and De Gee, Price & Davidson, 1983).

Evaluation of Leakage

Results of the microleakage tests are given in Figure 5. The statistical analysis showed a statistically significant difference at the 95% level of confidence between the experimental cavity and the 90° butt joint that favored the experimental cavity when the bonding agent was used. In the series with no bonding agent, the leakage with the experimental cavity was significantly less than that of the other three designs of cavity. Although the confidence intervals of 95% overlap in many instances, with and without bonding agent, less leakage occurred with the two beveled cavities, followed by the 90° butt joint. Leakage with the concave bevel was very similar to that with the 90° butt joint, being slightly less when the bonding agent was used, but slightly more when it was not. The positive influence of the bonding agent can be seen wherever leakage occurred and the difference is statistically significant ($P < 0.05$) for each of the three designs of cavity.

CONCLUSIONS

Based on both penetration of ^{45}Ca and quantitative analysis of the micromorphology of margin adaptation, the experimental cavity and cavities with a long bevel show better margins than cavities with right-angled butt joints or cavities with concave bevels. Furthermore, the quality of the margins of beveled cavities is greatly improved when a bonding agent is applied before the composite resin is placed.

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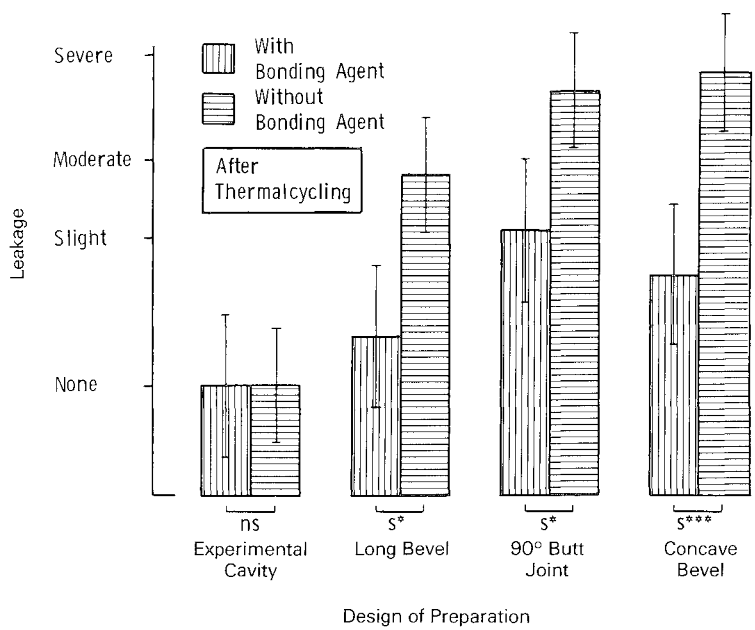

FIG 5. *Leakage of ^{45}Ca around margins of composite restorations placed with and without a bonding agent and after thermal cycling*

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BUONOCORE MEMORIAL LECTURE

Communication between the Oral Cavity and the Dental Pulp Associated with Restorative Treatment

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Presented on 16 February 1984 at the annual meeting of the Academy of Operative Dentistry.

INTRODUCTION

I met Michael Buonocore at the Eastman Dental Clinic in Rochester many years ago when I was favored with giving a course at that clinic, and for many years we corresponded through letters. His research and discoveries have been a base for many of our own experimental studies.

HYDRODYNAMICS AROUND RESTORATIONS

Before we examine factors that may cause complications to the pulp after a restoration has been placed, and before we discuss how to avoid them, let me summarize our knowledge and my personal view of the **hydrodynamics** in the tooth before and after the filling is in place. In the vital tooth there is a gradient of fluid pressure directed outward, because the pressure of fluid is higher in the pulp than in the oral cavity. Theoretically, an open tubule on a factured surface could be emptied 10 times a day (Johnson, Olgart & Brännström, 1973).

Due to caries, toxins from an exposed surface, drilling, or desiccation, many primary odontoblasts are lost. But, present or not, in a vital tooth there is a slow outward movement of tissue fluid in the tubules, and especially in areas where irregular secondary dentin is absent at the pulpal wall and where the outer surface of dentin is exposed and **sensitive** to mechanical stimulation, probing, drilling, and a blast of air. These stimuli remove fluid and mobilize capillary forces. The slow outward movement becomes **rapid** and may result in deformation of nerves, the mechanoreceptors present at the pulpal ends of the tubules (Brännström, 1982).

Sensitive dentin indicates that tubules are open to the pulp, which becomes accessible not only to stimuli producing pain but also to toxins and bacteria. Often we encounter sensitive dentin in cavities, especially at the cervical walls, not only in young teeth but also in teeth of adults. If the exposed dentin is kept wet, there will be a slow outward movement of fluid due to the higher pressure in the pulp, but this slow outward flow does not produce pain. On the other hand, if the exposed dentin is kept dry and isolated, the dentinal fluid will evaporate from the surface. The outward movement will then be rapid due to the capillary forces, and pain will occur. When we apply water to this surface the pain stops immediately, but the slow outward movement of fluid does not.

If we apply a film of resin to exposed dentin with opened tubules and let the resin set slowly, within a minute or two droplets appear within the resin film as seen in Figure 1 from a study in vivo. The cavity was etched with acid to remove smear and open the dentinal tubules. Then the cavity was desiccated for a few seconds before unfilled resin and composite were placed. After extraction of the tooth and decalcification, the filling was available for examination in the scanning electron microscope. On the surface are pits produced by the fluid from the dentinal tubules. When the dentinal tubules were not opened by acid and the cavity was properly desiccated, no such pits were seen.

This fluid appearing on the surface may be one reason it can be difficult to obtain a chemical bonding between a slow-setting resin filling or a luting cement and the surface of cut

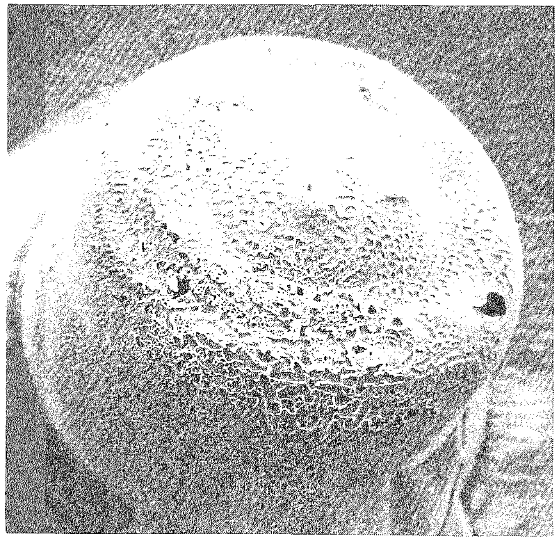

FIG 1. *Inner surface of a composite resin filling corresponding to a facial cavity, etched with acid, rinsed with water, and desiccated with a jet of air for five seconds. Numerous pits, caused by droplets of fluid, are seen. X38*

dentin. Too much fluid may appear and prevent good contact between dentin and resin. However, in the laboratory, where most bonding experiments are made, and on cervical erosions with sclerotic dentin underneath, it is easy to keep the dentin dry and also to obtain an acceptable bonding. However, the situation becomes complicated because usually our common filling materials contract during setting. For composites the main contraction occurs during the first 10 minutes after insertion. A gap about 5-20 micrometers wide develops. The gap will quickly fill with dentinal fluid from opened dentinal tubules or to some extent by saliva if it is present at the margin.

To show what happens when a liquid comes in contact with a narrow empty space like this gap, let me tell you about an experiment (Brännström, Torstenson & Nordenvall, 1984). Approximal fillings of composite resin were placed in extracted teeth with the cervical margin of the filling at the level of the root—a common situation in the clinic. Excess resin was removed after setting, and with a special technique we kept the margins open and the gap under the filling filled with air. Then we applied Enamel Bond resin (3M

Company, St Paul, MN 55144, USA) to the occlusal and cervical margins. To this resin had been added a fluorescent dye. Ground sections were made and the profile examined in the fluorescence microscope.

Before setting, perhaps within half a minute, the Enamel Bond resin with the fluorescent dye had penetrated from the surface and filled the contraction gap, and in some teeth also extended several millimeters onto the floor of the cavity. This was due mainly to capillary action. The size of the gap at the cervical wall varied from 8 to 16 micrometers when the lateral enamel walls had been etched. In unetched cavities the cervical gap was in general somewhat less but, on the other hand, in such cavities penetration also occurred at the occlusal wall. This technique can be useful in the evaluation of the size of contraction gaps and also clinically for the reduction of contraction gaps and for better sealing of the cervical wall.

This experiment may indicate what happens when a somewhat less viscous tissue fluid such as dentinal fluid comes in contact with the narrow air-filled gap around the filling. The gap could be quickly filled with fluid, and then, because of the higher pressure of the fluid in the pulp, there will be a slow outward movement of fluid around the restoration.

This means that the leakage of fluid around a filling may be directed outward. However, this outward flow will be reduced with time. First, solid material may accumulate on tubule walls and at the surface. Second, the gap may be reduced by expansion of the filling. Third, in some areas and in some teeth, a calcified pellicle may block the outer margin, and irregular dentin may block the pulpal ends of the tubules to some extent.

It is important to realize that this outward flow around the filling does not prevent a chemical gradient directed **inward**. For instance, a high concentration of sugar at the margin of a filling may lead to diffusion of small sugar molecules into the gap (Fig 2). If cariogenic bacteria are present on lateral walls, and possibly in a gap at the dentino-enamel junction where these microorganisms may easily be left behind after preparation of the cavity, the risk of secondary caries could be high.

Leakage, that is, the diffusion of particles inward, does not, except for sugar and possibly acid, seem to have much clinical relevance. Leakage has been studied in many experiments with high concentrations of isotopes and dyes, indicating the existence of a fluid-filled gap, but I have not seen any experimental evidence that bacterial toxin, the most important factor, may exist on the tooth surface and at the margin in concentrations great enough to reach the pulp to any appreciable extent. Saliva circulates at the tooth surface and reduces the concentration. Nor can I imagine how variations of intraoral temperature, which are usually of short duration and within a normal range, can have any

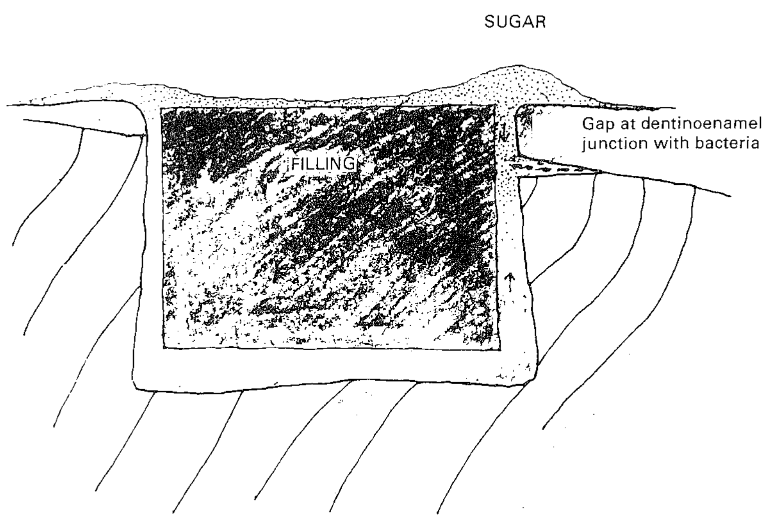

FIG 2. *Diagram illustrating a channel communicating between the surface of the tooth and the pulp and showing the region of the dentino-enamel junction where bacteria may not be removed in the preparation of a cavity.*

significant influence on the outward flow of fluid around the filling.

INFECTION IN THE GAP

However, a serious complication in our experiments, and also in experiments of others, has been the finding that bacteria may easily enter the gap around the filling and may even enter the dentinal tubules if they are open. The gap at the margin around a large restoration may represent in total a surface of, say, 1/10 or 1/20th of a square millimeter. On the other hand, the total area of the dentin surface under the filling may be a hundred times larger. Therefore, the multiplication of bacteria in the fluid-filled gap under the filling must be considered a problem; within a week there may be thousands of bacteria (Brännström, 1982) (Fig 3). We must

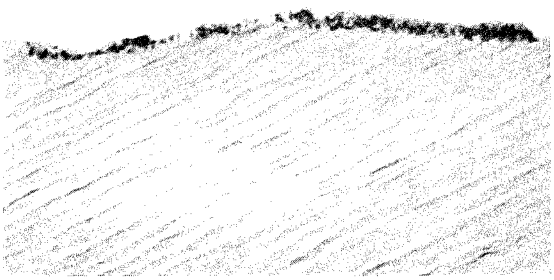

FIG 3. *Axial wall of facial cavity filled with Adaptic for four weeks. A bacterial layer is seen. Section stained for bacteria. X440*

also consider that the **concentration of toxins** in the gap can be significant compared with the concentration at the tooth surface where saliva is circulating. For comparison we should remember two other gaps that are common in teeth. One such gap concerns early caries. At the dentinoenamel junction a gap develops and the bacteria multiply in a lateral direction in the fluid-filled gap. It is this gap that we may leave behind after preparation of a cavity and that may lead to secondary caries. Usually the enamel surface looks intact in such an area (Brännström, 1982). The other gap is the dentinal crack. This gap also is filled with microorganisms (Brännström, 1982).

The subjacent pulp is inflamed as may also be the pulp under exposed sensitive dentin, such as at the neck of the tooth and under leaky fillings. In the pulp, leukocytes accumulate at the corresponding pulpal wall, and in the tubules cells are on the way outward. Already in the late 1950s there was histologic evidence of the outward flow of fluid in the dentinal tubules. Shortly after the placement of a resin filling, cells were found to be aspirated and nuclei were seen in the tubules. Fluid moved outward and drew these cells passively into the dentinal tubules. Meanwhile, toxins diffuse into the pulp and result in inflammation. This means that around a restoration with a fluid-filled space, pulpal elements—cells and fluid—move outward due mainly to the slow outward movement caused by the higher pressure in the pulp.

In several experiments we have observed the multiplication of microorganisms in the fluid-filled gap under fillings of silicate and composite resin. In addition, microbiologic studies in Sweden and at the University of Michigan have found that there may be both gram positive and gram negative anaerobes, and cocci as well as filaments (Mejàre, Mejàre & Edwardsson, 1979; Bergenholtz & others, 1982). Bacteria may enter from the tooth surface but equally they may multiply from single microbes entrapped and protected within the smear—the debris produced on the cavity walls during the preparation of the tooth. We do not work under sterile conditions, especially when grinding carious dentin. Bacteria may multiply from the smear layer even if there is a fairly good seal from the oral cavity (Brännström, 1982; Brännström & Nyborg, 1973). This may have some clinical relevance when we occasionally have complications under cemented crowns and bridges. Especially this may happen if we have had a poorly fitting temporary crown for a couple of weeks. Bacteria may have had the opportunity to enter dentinal tubules. We discovered this infection 14 years ago (Brännström & Nyborg, 1971) and I have received so much support of its presence from numerous experiments in our own laboratory and also from others, including microbiological experiments, that I do not hesitate to say: infection is the most dangerous factor for the pulp after the placement of the restoration.

PULP IRRITATION DUE TO FILLING MATERIALS

Some authors now seem to agree that infection is an important factor in causing pulpal damage under fillings but that this factor is not the only one. For several years I have wondered what the other factor or factors could be.

This leads to the question: does a filling material per se cause damage and pulpal inflammation? Our experiments of the last 13 years have been conducted mainly on pairs of human premolar teeth to be extracted for orthodontic reasons. We have used a special technique, which has been described and discussed elsewhere (Brännström, 1982). In one facial cavity in each pair of teeth the superficial smear was removed with a detergent and the cavity walls treated antibacterially. After the filling had set, the outer part was removed and replaced with zinc oxide and eugenol cement. In this way we prevented bacteria entering from the tooth surface. With this technique we have been able to find out if any chemical from pretreatment procedures or from the filling material might irritate the pulp. In total, we have examined hundreds of teeth with deep cavities—many with pulpal exposures. We have used various composite resins, silicate, glass-ionomer cement, and phosphate cements in a thin mix of cementation. The results have pointed to the same conclusion, namely: when infection is avoided there is no appreciable irritation to the pulp; pulpal damage is caused by infection and not by the filling material or the pretreatment procedures.

The primary odontoblasts seem to be end cells and probably do not contribute much to the production of irregular secondary dentin. They are easily removed during preparation and desiccation. Many of them are sucked into the dentinal tubules and disappear due to the rapid outward movement of the tubule fluid when fluid is removed during preparation of the cavity or desiccation with a jet of air. This does not greatly affect the pulp. Loss of cells does not produce inflammation, and the cells in the cell-rich zone, which are most important and have not been disturbed, may replace the odontoblasts and later produce irregular dentin, blocking the pulpal ends of the tubules.

To show you what happens after a filling has been placed and after pretreatment procedures, I shall give you an example from a recent study (Torstenson, Nordenvall & Brännström, 1982) of a Japanese composite resin called Clearfil (Kuraray Co Ltd, Osaka 530, Japan). A similar resin, Scotch Bond, has been introduced by the 3M Company (St Paul, MN 55144, USA).

Figure 4 shows a deep cavity extending to

FIG 4. *Control cavity prepared to the predentin but without any exposure of the pulp. The cavity was etched with acid and restored with Clearfil. Microbial invasion was avoided with an outer IRM filling. The odontoblast layer is strongly reduced in the deepest part, but in other areas there is no reduction of cells and a fairly intact cell-rich zone. The tooth was extracted after nine days. No microorganisms were present on cavity walls and no inflammatory reaction was present in the pulp. Eosinophilic material and cell nuclei were present on the cavity floor, indicating an outward flow in predentinal tubules to a gap between the floor and the restoration. X75 (Courtesy of the* Swedish Dental Journal*)*

the predentin in a tooth extracted after nine days that had been treated in the following way: the cavity was etched with 40% phosphoric acid for 15 seconds, rinsed with water, and then treated with the antibacterial detergent, Tubulicid (Dental Therapeutics AB, Nacka, Sweden) for one minute to remove any bacteria contaminating the surface. Thereafter, the cavity was desiccated with a jet of air and Clearfil adhesive and composite were placed without any protective liner. After nine days there was no inflammation or sign of necrosis, nor were there any microbes on cavity walls. The outer part of the cavity had been filled with zinc oxide and eugenol cement to prevent ingrowth of bacteria.

Of the 62 teeth available in this study with cavities treated in the same way, the same rather intact pulp was seen in all teeth when infection was avoided, even in those teeth with pulpal exposures. In the contralateral teeth an outer sealing with zinc oxide and eugenol cement was not applied nor were enamel walls etched. Under 24 out of 31 fillings in these teeth bacteria were seen to be multiplying and there was certainly also pulpal inflammation.

This was the case in the tooth seen in Figure 5. The tooth is from the same patient as the tooth in the previous illustration. Severe inflammation and small abscesses are evident.

As bacteria could enter from the surface of the tooth and could multiply in a fluid-filled gap between the cavity walls and the filling material, we may conclude that in such cavities Clearfil composite, and Scotch Bond as well, did not adhere sufficiently to the surface of dentin to resist the forces of contraction. A gap filled with fluid had developed, bacteria had entered and multiplied, and toxins had diffused to the pulp resulting in inflammation and destruction of pulpal tissue. We had also some teeth with pulpal exposures treated in the same way, that is, with acid etching and Clearfil resin. When infection was avoided there was no particular damage or inflammation in the pulp.

The fact that acid etching, even near the pulp, does not irritate the pulp has been noticed by us in two other series of experiments (Brännström & Nordenvall, 1978; Nordenvall, Brännström & Torstenson, 1979).

In many experiments we have had cavities with a very thin layer of dentin or even pulpal exposures. The cavities have been filled with composite resins, silicate cement, glass-ionomer cement, and inlays cemented with phosphate cement. Experimental periods of between one week and 12 weeks have shown practically no pulpal inflammation or necrosis when infection has been avoided. This seems to be true also for amalgam (Brännström, 1963).

From our own studies as well as from those of others I have not found any evidence that amalgam may chemically irritate the pulp (Brännström, 1963). Nor have I seen any experiment that has proved that thermal

FIG 5. *Test cavity, etched with acid for 15 seconds prior to the placement of the restoration. Tooth was extracted after four weeks. There was bacterial growth evident on the cavity walls. Small abscesses have begun to form at the corresponding pulpal wall and a heavy cellular infiltration is found in the adjacent pulp (severe inflammation). X75 (Courtesy of the* Swedish Dental Journal*)*

shocks great enough to cause damage can be produced under normal conditions. A few seconds of hot coffee or ice cream on the tooth does not affect the pulp much. The increase or decrease in temperature at the surface could be about 15 °C and for only two or three seconds. The thermal shocks used in laboratory experiments are not plausible in vivo.

When a sharp pain occurs due to cold, it usually means, at worst, an outward movement of 3-5 micrometers of the fluid in the dentinal tubules due to contraction of the fluid and capillary forces. This does not cause damage to the pulp, but mainly a deformation of the nerves and changes in blood flow.

However, sharp pain after recently placed restorations of amalgam or gold may indicate a fluid communication from the pulp to a fluid-filled gap somewhere at the surface of the cavity (Fig 6). Moreover, a local inflammation in the subjacent pulp, either because of earlier caries or bacteria present in a gap, contributes to an increased excitability of the nerves.

The situation is analogous to the syndrome of the dentinal crack. The cusp with the crack filled with microbes is usually hypersensitive to cold because of contraction of fluid in the dentin and possibly also in the crack. Inflammation is also present in the pulp under the crack. Normal sensitivity is present on the opposite side of the tooth, where inflammation is absent. Dentin is a good insulator and there is no need for thick insulating cements under amalgam. We have reason to believe that bacterial growth may occur frequently under amalgam in unlined cavities (Bergenholtz & others, 1982), therefore the situation under amalgam may be similar to that under resins and silicate.

Zinc Oxide and Eugenol Cements

Zinc oxide and eugenol cement is the only material I have found that might cause an early slight, occasionally moderate, inflammation in the pulp, especially when applied on a thin dentinal wall. This is obvious from three different studies of the material, including IRM (Brännström, Nordenvall & Torstenson, 1981). The cement in our experiments was used in a thick consistency as a temporary filling. A total of 55 out of 60 unlined cavities had signs of pulpal irritation and inflammation. The pulps in the contralateral teeth with a protective liner were without inflammation. There were certainly no bacteria involved. The effect of eugenol is limited and the reaction will subside fairly soon. Under zinc oxide and eugenol cement there is no contraction gap and no bacteria involved. Therefore the situation is much better than that under amalgam, composite resins, or silicate.

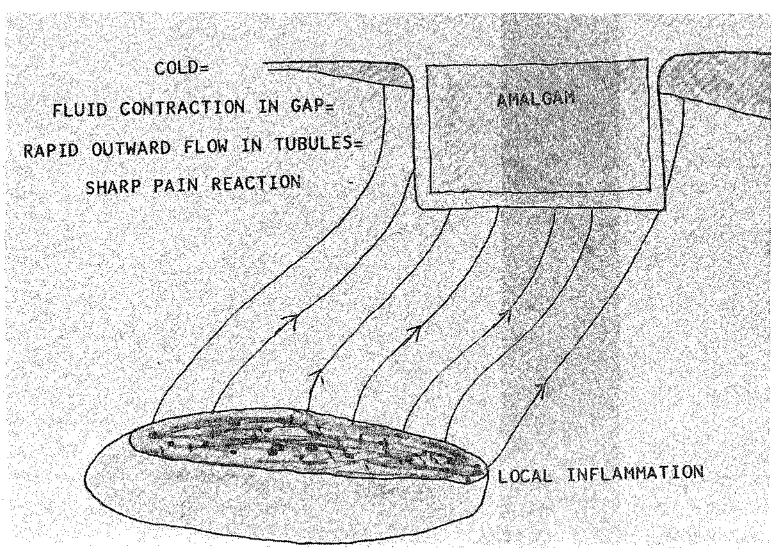

FIG 6. *Illustration of the mechanism by which cold elicits pain after recent placement of amalgam fillings. The fluid in the gap contracts, fluid flows outward in dentinal tubules resulting in a deformation of the nerves, and an inflammatory reaction in the corresponding pulp increases the excitability of the nerves.*

CLEANSING AND LINING OF CAVITIES

Obviously we have to avoid infection. We need a clean cavity, a lining on all cavity walls to prevent invasion of microbes, and a lining attached to the dentin so that bacteria have no place to multiply. This is true also for cavities in root-filled teeth. As bacteria are the main cause of pulpal irritation and also of secondary caries, we may reconsider our pretreatment procedures.

This brings me to a discussion of cleaning, desiccation, lining, and sealing. Earlier recommendations from several well-known colleagues, such as Massler, Seltzer, and Nygaard-Ostby, are still applicable—for instance, incomplete excavation of caries and placement of a dressing of calcium hydroxide over which zinc oxide and eugenol cement is placed for a few weeks. This can be especially recommended when we find sensitive dentin during excavation of soft carious dentin. Sensitivity in this area indicates the absence of irregular dentin, a poor response from the pulp, and an uncertain prognosis. A radiograph may sometimes be helpful and may tell us if there is irregular dentin and a good response. However, the information from the radiograph is not always available and therefore, if possible, we should not start with local anesthetic. First we should excavate the soft carious lesion. Insensitive dentin indicates a blockage of the dentinal tubules underneath, providing that in the periphery you find sensitive dentin indicating a vital pulp. On the other hand, encountering sensitive dentin under carious, soft dentin is a signal that there is no irregular dentin present.

If the response is poor, you should apply a temporary dressing and wait a few months for a second test. A dressing of calcium hydroxide may reduce the infection in the dentinal tubules nearest the surface.

Permeability of Dentin

The permeability of the dentin is an important factor to consider when we discuss pretreatment procedures. To a large extent the permeability depends on the number of dentinal tubules available and opened all the way to the pulp. At the floor of an occlusal cavity dentinal tubules are cut transversely and, in the middle, may number about 30 000 per square millimeter. However, from a facial or an approximal cavity, depending on the position of the cavity, the tubules may be cut obliquely or in places even parallel to the axial wall of the cavity (Fig 7). Thus sometimes the

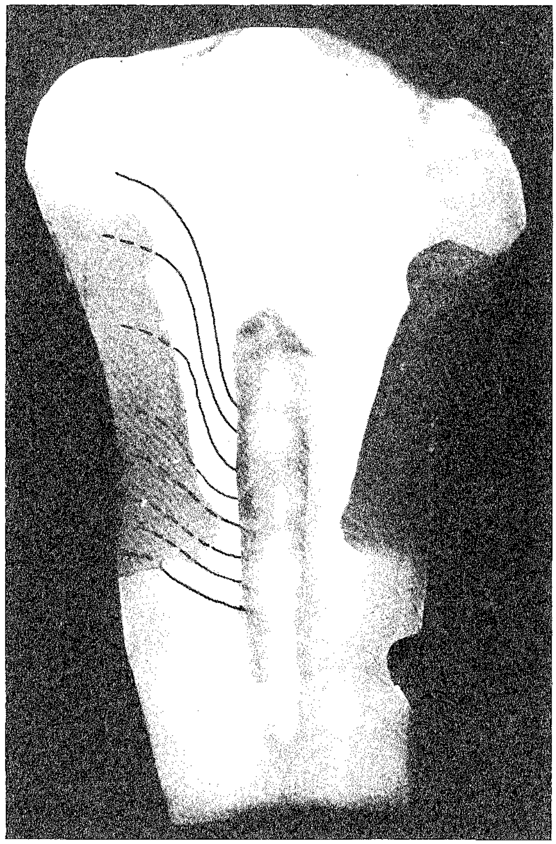

FIG 7. *Approximal cavities may have many tubules at the axial wall that are cut obliquely and longitudinally.*

permeability may be several times more pronounced at the cervical wall than at the axial wall. Moreover, the pulp subjacent to the dentinal tubules of the pulpal or axial walls may, during the caries attack, have developed irregular dentin blocking the tubules. In many teeth, this could mean that the floor—the axial or pulpal wall—may be the least dangerous of the walls.

Cleaning

We cannot predict the permeability of the cavity walls and, therefore, should treat all walls in the same way. Before the cavities are lined, all of the superficial smear layer should be removed except for the plugs of smear in the apertures of the tubules. At the same time we need a disinfection, an antiseptic treatment. This procedure should also be applied to the surrounding surface of the tooth. This may reduce the risk of contamination after cleaning. Moreover, if the superficial smear is removed, a lining or a luting cement will adapt better to the cut surface of dentin. Acid or a 15% solution of ethylenediaminetetraacetic acid (EDTA) are effective but cannot be used as cleansers, not because of pulpal irritation from the solutions but because the tubules become open and widened. This may occur after only five seconds of etching. In this way the dentin will be several times more permeable, as has been shown by Pashley, Michelich & Kehl (1981). The cut surface will also be much wetter. In the following desiccating procedure it is difficult to get the dentin dry because fluid continues to be supplied from below through the tubules. Smear plugs left in the apertures of the tubules (Fig 8) reduce their permeability and may prevent the growth of bacteria into the tubules but do not prevent toxins from diffusing to the pulp. But if the smear plugs are removed during etching or treatment with 15% EDTA, then there will be a massive invasion of microbes into the tubules if, for instance, we contaminate the surface after cleaning, or bacteria enter later on, say from the cervical margin of a filling.

From a study 10 years ago we found that common cleansers are not effective and do not remove superficial smear. After years of experimentation to find a cleanser that would remove superficial smear but leave the smear plugs, we finally found a surface active component combined with a small amount of EDTA, only 0.2%, to which benzalkonium chloride was added (Brännström, Nordenvall & Glantz, 1980). This solution can also be combined with 1% sodium fluoride, which is also antibacterial and may add fluoride to the hard tissue and the smear plugs.

Desiccation

To get good adaptation of a resin lining or a luting cement, including glass-ionomer cement, and to prevent the dentinal fluid from appearing on the surface during setting, desiccation is important (see Fig 1).

When a root canal is desiccated we apply a paper point in the canal and a jet of air at right angles to the direction of the canal. If we are going to empty the outer part of a dentinal tubule and stop the outward flow, the direction of the air stream should be at right angles to the direction of the dentinal tubule, that is, we should have an air stream with low pressure and high speed directed parallel with the cut surface or, in cavities parallel with the apertures, directed from various positions for at least 10-15 seconds. Desiccation with a jet of air does not irritate the pulp.

Alcohol is not effective and does not stop the outward flow in dentinal tubules.

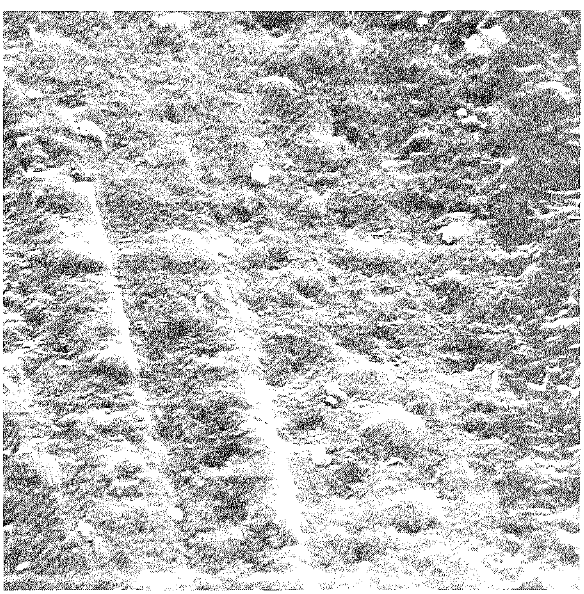

FIG 8. *A surface of cut dentin showing smear plugs, manifested by the elevations at the apertures of the tubules on a surface where superficial smear has been removed.*

Lining

The next step is lining. Before the placement of a temporary restoration, an amalgam, or a composite resin, a liner is applied to all the walls of the cavity to prevent the formation of a fluid-filled gap nearest the dentin, to avoid the invasion of bacteria through this gap from the tooth surface, and to reduce the risk of secondary caries.

In a recent study of composite resins we found that a double layer of Copalite (Bosworth Co, Skokie, IL 60076, USA) in cleaned cavities did not prevent bacterial leakage and growth on the cavity walls (Brännström & others, 1983). The situation was almost the same as having no lining at all. In the same study we tested a combination of two different resins as a lining material. First we applied, as a primer, shellac resin dissolved in alcohol with some benzalkonium chloride as an antibacterial component. It was spread and dried to a thin film with a gentle blast of air. This solution is hydrophilic and could be expected to flow easily and cover the surface. On this film we applied a polystyrene liner dissolved in ethyl acetate. This solution does not dissolve shellac. The polystyrene liner also has some other ingredients to make it more bacteriostatic and less brittle than the original liner composed by Zander, Glenn & Nelson (1950).

In our experiments we had an experimental period of up to 11 weeks. All cavities were free of bacteria and there were no pulpal changes or inflammation.

Tubulitec (Dental Therapeutics AB, Nacka, Sweden), the polystyrene liner, is, like Copalite, hydrophobic, and a shellac primer may improve the flow of the liner and the adhesion to cavity walls.

Thick bases, containing mainly calcium hydroxide, have been popular as protection. I have already mentioned that there is no need for thermal insulation. Thick bases of calcium hydroxide are antibacterial as long as calcium hydroxide disappears from the dressing, and therefore have been successful; but as a permanent lining they may have some disadvantages.

- Do they adhere sufficiently to the dentin surface? Slow setting may permit dentinal fluid to appear on the surface.
- They cannot be placed on all the walls of a cavity; mainly they are on the pulpal and the axial wall, which in many cavities can be the least dangerous.
- Small and shallow cavities or, for instance, a large but shallow cavity on a facial surface also need protection against infection, but thick cements take up too much space.
- In both small and large cavities, thick bases may impair both the retention and the strength of a restoration.
- If leakage occurs, as in the case of a base of calcium hydroxide under an amalgam filling, the liner may dissolve, leaving an empty space (Prosser, Groffman & Wilson, 1982; Fitzgerald & others, 1983).

We have been told that obliteration of dentinal tubules may occur under bases of calcium hydroxide. In several investigations this has not been confirmed. It may occur in some tubules if there is a leaky filling such as amalgam. Meanwhile the dressing may disappear, leaving an empty space (Brännström, Isacsson & Johnson, 1976). Nor is there any evidence that such a dressing applied to dentin will stimulate the formation of secondary dentin.

The positive effect in pulp capping depends mainly on two things: 1) a superficial necrosis is obtained, which fairly soon results in a dystrophic calcification, 2) initially the material has an excellent antibacterial effect, preventing bacteria from settling in the necrotic area. Unfortunately, at the same time, the dressing will disappear and, if leakage occurs, the dressing could be replaced by bacteria. Perhaps these aspects should be considered in clinical dentistry and future research. The problem with lining is a difficult one, and we have not yet seen the most effective and ideal liner.

ACID ETCHING AND COMPOSITE RESINS

Thanks to the discovery made by Dr Buonocore, we have at least the opportunity with composite resins of improving the seal at the enamel margins by the acid etching of beveled enamel. This procedure will reduce the risk of microbial invasion, but does not eliminate bacteria that may be present on cavity walls after etching with acid and rinsing with water. We have also the problem with sealing at the cervical wall, which is difficult to etch.

Five to 15 seconds with an acid gel is sufficient for etching beveled enamel. Fluoride pretreatment of the enamel does not impair the results. We have published the results of several investigations in which we have studied these problems (Brännström, Malmgren & Nordenvall, 1982). Moreover, we have found that exposing the polystyrene liner to acid for a few seconds does not impair the liner. A Swedish dentist, Dr Bengt Mattsson, has introduced a proper etching technique for composite resin (Brännström, 1982). His method is to coat the enamel surrounding the cavity with Tubulitec, after first cleaning the enamel with pumice and washing it with Tubulicid. Then the cavosurface margin is beveled with a diamond point. The advantage of this technique is that you do not contaminate intact enamel with acid, and the excess resin can easily be removed with hand instruments.

We have discovered a technique that makes it possible to seal at least the wall that cannot be etched. When the liner has been placed on all cavity walls and also on the surface outside the cavity, the liner can be removed from the edge of the margin with a sharp instrument or a small bur. After the filling has set, we wait another five minutes to allow more contraction to occur and then remove the excess material with a hand instrument. The contraction gap, 5-20 micrometers wide, is now filled with air. As the liner has covered the dentin, the gap can be impregnated with resin of low viscosity, such as Enamel Bond. The resin is applied slowly from one corner to the other so that the air within the gap is allowed to escape. You may not fill the whole contraction gap with resin, as in our experiments described earlier, but a large part of the gap at the cervical wall may be impregnated and sealed. However, to succeed you need a liner on all cavity walls and also outside the cavity. You cannot remove the excess composite with a bur because then you block the gap with debris; rather, the excess must be removed with a hand instrument. Then you should start to apply the resin from one side so that air can escape.

CONCLUSION

The experiments reviewed here have, to a great extent, been inspired by the discoveries of Dr Michael Buonocore. Perhaps, when you have seen so much infection as described here, you may conclude that it is indeed surprising that so many pulps have survived. The pulp survives thanks to a good response and the formation of irregular dentin, and perhaps also because of a calcified acquired pellicle at the surface. However, we may improve the prognosis by doing our best to prevent infection, because infection is the main cause of our failures. To prevent infection was also the aim of many experiments made by Dr Buonocore.

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PRODUCT REPORT

Mercury Leakage during Trituration: An Evaluation of Disposable Capsules

Leakage of mercury from capsules during trituration is being reduced by better capsules

CAMILLE B CAPDEBOSCQ, JR • WILLIAM N von der LEHR

Summary

A test of the leakage of 11 brands of disposable capsules for amalgam has shown that though there was some leakage from most capsules (none from Tytin or Valiant) the amount was remarkably low (except for Phasealloy).

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Introduction

With the increasing popularity of premeasured disposable capsules of amalgam and with the appearance on the market of several new alloys and capsules, the following study on leakage was done to provide a comparison for the practitioner. In two previous articles, reusable and disposable capsules were compared (Capdeboscq & von der Lehr, 1979; von der Lehr & Capdeboscq, 1979). The only alloy carried forward into this article for comparison is Tytin (Penwalt, S S White, Philadelphia, PA 19102, USA); all others are new alloys on the market, have a new design of capsule, or are now available in disposable capsules.

Materials

Eleven brands of alloy were tested (Table 1). The 600 mg size of capsule was used for testing. This is commonly referred to as the "two-spill" size, however, since "one-spill" is 400 mg, two-spill is actually 600 mg which is one and a half spills. This makes three-spill 800 mg, which is twice the size of one-spill. The manufacturers should change this misleading nomenclature.

Table 1 lists the brands tested and whether or not they are self-activating. Self-activating capsules place the mercury in a pillow within the capsule, the pillow bursting during trituration. The standard capsule must be activated before trituration so that the mercury is available for amalgamation. Either type works well, but this feature should be considered in selecting the alloy, as one type may suit the office personnel better than the other.

Methods

Six capsules of each brand were tested. The two-spill size was obtained and the manufacturers' recommended times and speeds of trituration were used. Where a range was given for the time the intermediate point was set on the timer of the Caulk Vari-Mix II (L D Caulk Co, Milford, DE 19963, USA). Each capsule was weighed on an analytical

Table 1. Brands Tested

Product	Manufacturer	Pestle	Self-Activating
Cluster	S S White — Penwalt Philadelphia, PA 19102, USA	no	no
Contour	Kerr Manufacturing Co/Sybron Romulus, MI 48174, USA	yes	no
Cupralloy	Star Dental/Syntex Dental Products Valley Forge, PA 19482, USA	no	no
Dispersalloy	Johnson & Johnson Dental Products East Windsor, NJ 08520, USA	yes	yes
Premalloy	Premier Dental Products Co Norristown, PA 19401, USA	no	yes
Phasealloy	Phasealloy, Inc El Cajon, CA 92021, USA	yes	no
*Sybraloy	Kerr Manufacturing Co/Sybron Romulus, MI 48174, USA	yes	no
*Tytin	S S White — Penwalt Philadelphia, PA 19102, USA	no	no
*Valiant	L D Caulk Division of Dentsply Int'l Milford, DE 19963, USA	no	yes
Valiant PhD	L D Caulk Division of Dentsply Int'l Milford, DE 19963, USA	no	yes
*Unison	Johnson & Johnson Dental Products East Windsor, NJ 08520, USA	yes	yes

*Spherical alloys — all others are dispersed phase alloys balance accurate to 0.1 mg (August Sauter Amerika, Inc, New York, NY 10036, USA) before and after trituration. An effort was made to prevent abrasion of the capsule during placement. Some capsules were placed in the triturator arms, then removed before trituration and weighed again to determine if there was loss of weight from handling. None was found.

If an office changes its selection to a new alloy in a premeasured capsule, the purchase of a new amalgamator may be necessary. Some of the older ones still in use today are too low in output of energy to mix the new alloys successfully. A new amalgamator would give the office better mixes in less time and make available for use a wider selection of brands.

Results and Discussion

Table 2 shows the results. All capsules gave good results except those for Phasealloy. These were difficult to operate and the range of leakage was wide. The company has announced that it will have a new capsule available in late 1983. The Valiant PhD capsule, though the same as the Valiant capsule, did show some leakage. We have found no explanation for this difference.

It is noteworthy that although there is still some leakage from most of the capsules the amount is remarkably low compared with the reusable capsules tested earlier (Capdeboscq & von der Lehr, 1979; von der Lehr & Capdeboscq, 1979). Also, when a practitioner uses premeasured capsules the bottle of mercury and the chance of spillage in transfer can be eliminated from the operatory. The manufacturers are to be complimented as they continue to produce better designs of capsule that exhibit much less leakage. The price differential has also been reduced, which is a help in selecting the method of packaging the alloy that one would prefer.

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Table 2. Mercury Leakage by Brand (two-spill)

Product	Range	Average	Time
	mg	mg	s
Cluster	0.2 - 0.6	0.40	16
Contour	0.4 - 1.8	0.97	17
Cupralloy	0 - 0.4	0.18	11
Dispersalloy	0.1 - 0.3	0.23	12
Premalloy	0 - 0.3	0.11	10
Phasealloy	0.3 - 8.7	2.1	11
Sybraloy	0 - 0.9	0.38	9
Tytin	0 - 0	0	4
Valiant	0 - 0	0	13
Valiant PhD	0 - 0.5	0.28	13
Unison	0.2 - 0.3	0.21	12

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Hollenback Prize

The Hollenback Memorial Research Prize for 1984 has been awarded to Kamal Asgar, who is Professor of Dentistry, Department of Dental Materials, at The University of Michigan, Ann Arbor. This prize is given annually by the Academy of Operative Dentistry to recognize excellence in research that has contributed substantially to the advancement of operative dentistry.

Dr Hollenback was a man with great appreciation for the scientific aspects of dentistry and for the materials that we as a profession use daily to restore oral health. He had a distinct ability to recognize the physical limitations of the materials then available to him and an inquisitiveness to pursue the development of new materials and modified techniques that would better serve the profession. These are the same attributes that characterize the winner of the prize in 1984. He cares; he works; he listens; he speaks out; he innovates; and he is a success in his own right.

Dr Asgar, a native of Tabriz, Iran, holds a BA degree in chemistry from the Technical College of Tehran. He came to the United States to further his studies and received both an MS in chemistry and a BS in chemical engineering. He then continued as a graduate student at The University of Michigan in the field of metallurgy; and it was during this period of study that Dr Asgar became associated with Dr Floyd Peyton, who was then chairman of the Department of Dental Materials. Through Dr Peyton's influence and encouragement, Dr Asgar maintained a dental orientation and received a combined PhD degree in metallurgy and dental materials.

Dr Asgar was first employed by The University of Michigan as a research assistant in dental materials while he was still a graduate student in 1949. He moved up steadily to research associate, instructor in dentistry, assistant professor, associate professor, and finally to his current professorship in 1966. In his long association with The University of Michigan, it is impossible to separate his desire to teach from his quest for knowledge. He spends long hours in the laboratory, but is

Photo courtesy Talbot, Ann Arbor

Kamal Asgar

always fresh and enthusiastic when he stands to lecture. His dedication to students has been an example to all of us in education and there are many in this Academy who have come to appreciate his ability by being either a student at Michigan or in one of Dr Asgar's many continuing education courses throughout the world. His students have honored him with the Paul Gibbons Award as an outstanding teacher in 1970 and again in 1980. His tireless efforts to pass on the results of current research to the practitioner have taken him throughout this country, to Canada, South America, South Africa, and to many countries in Europe. He was featured as a major essayist before our own Academy in 1980.

Dr Asgar's main contribution to dentistry has been in research on basic problems of materials science. Through individual effort, he has gained a keen awareness of the clinical environment and given all of his research a sound application in the practice of restorative dentistry. During his early interest in casting procedures he developed the water-added technic for controlling the expansion of investment. He holds patents which have led to the development of two alloys for partial dentures and at least two high-copper amalgam alloys (Tytin and Valiant). He has actively participated in the program to certify materials at the American Dental Association by chairing subcommittees to develop specifications for gypsum products, phosphate-bonded investments, calcium-bonded investments, and base-metal alloys. He has published over 90 scientific articles and contributed to several textbooks on dental materials.

Dr Asgar is a member of at least nine professional organizations and holds honorary membership in Omicron Kappa Upsilon and the International College of Dentists among others. He received the Wilmer Souder Award from the Dental Materials Group of the International Association for Dental Research in 1970 for outstanding research in the field of biomaterials. His care for others is exhibited in many years of service to the Cerebral Palsy Foundation at both the state and local level.

We honor today a man who has given of himself, many times at great personal sacrifice, in order to improve the quality of restorative dentistry and the qualifications of the restorative dentist. Through dedication, enthusiasm, innovation, and humble service he has made the science of materials an exciting aspect of dental practice.

JOSEPH B DENNISON

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POINT OF VIEW

Contributions always welcome

In Pursuit of Mediocrity

MICHAEL D SPEKTOR

Something is happening in this country and the ramifications are frightening. It seems that nothing is the way it used to be. Don't get me wrong, I am not referring to the "good old days." It's just that the good and the excellent are being replaced, gone in favor of the acceptable and mediocre. Observe the high school and college students that have increasingly lower levels of language skills, reading and mathematical comprehension, and creativity. After all, why work on these tasks if the microchip can do it for you? Consider the American manufacturer: build it cheap and fast to maximize profit. My General Motors X-car is an example of their commitment to excellence—it's been recalled only six times. Skimp on the quality and cut corners to make more money—WPPSS, the Hyatt Hotel in Kansas City, Three Mile Island, MGM Grand Hotel in Las Vegas. As long as you make a buck what difference does it make?

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While I have watched quality decrease in many areas, I have always felt that in the area of the health professions the pursuit of excellence was the paramount goal. But lately I'm not so sure. There are several issues which cause concern and make me question the future of the health professions—especially dentistry.

Economic Pressures

When I first entered dental school I was required to spend some time with a mentor, who was an alumnus of the school. This individual was to help me get through the early days of dental school. My first meeting with him was confusing and disconcerting. He told me about his gross salary and how much he needed to make every hour to pay for the house in Lake Forest, the cars, the schooling for his three daughters, and the pension plans. He looked at me and smiled. "Isn't dentistry a great profession?" Isn't it though?

I remember well my classmates discussing their futures. "Did you see Dr So-and-So's new Porsche? And the addition to the house is supposed to be great . . . He just got back from this condo in Aspen, three weeks of skiing . . . I can hardly wait for my turn." And so it went.

Yet it was a time of plenty. Just a few years before there was a shortage of dentists and the government gave capitation money (different 'capitation' but same problems) to the schools to push more and more dentists through. And through they came. Very few flunked, no matter how bad they were. Grades were inflated and 'satisfactory and clinically acceptable' were the buzz words of the day. We had a joke in school: "What do you call the student who graduates last in his class?" "Doctor." But it wasn't very funny.

All too soon there was an overabundance of dentists and their futures were not quite what was envisioned. The desire for the material goods was still there, but the economic realities would force a longer wait. Some could and some couldn't. The result in many cases was a decrease in quality for quicker profits and a shorter wait.

The Medical-Dental Dilemma

Having spent a good part of my training and professional career affiliated with a hospital and the hospital staff, I find the recent effort by physicians to exclude dentists from the medical staff an alarming development—especially relating to the care needed by the hospital population. The dentist is uniquely trained to deal with diseases of the oral cavity and the quality of care delivered to the hospital patient would be compromised without his presence.

Once again the physicians are worrying about themselves at the expense of quality health care. Their fears, that once dentists are entrenched in the hospital, podiatrists, opticians, and even chiropractors may not be far behind, are unfounded. The guidelines of the Joint Commission on Hospital Accreditation (JCHA) are very clear that only licensed physicians and dentists are entitled to be members of the active medical staff. It appears that the physician is anxious to undo the gains fought for by the dental community.

The chasm between the physician and dentist is increasing. We seem to be at odds on many issues at both the national and local levels—the tax cap, the JCHA guidelines, as well as Physicians & Dentists Credit Bureau. We need to redefine mutual goals in order to expand and increase the level and quality of health care.

Expanding Horizons

The most rewarding and exciting areas in dentistry revolve around dental research and continuing dental education. Although these areas appear diverse they are united by a search for knowledge. They are the basic *raison d'être* of the professional in dentistry and they are falling on hard times.

The funding and grants for research have been severely limited by the National Institutes of Health and other federal agencies. The Center for Research in Oral Biology at the University of Washington has lost its funding. Private foundations have less and less funds and more and more requests. The big pharmaceutical companies fund only what may be profitable for them in the long run without much concern for what the research will add to the state of the art.

This shrinking resource is making research harder and less desirable. Data are often made to look good and even changed to fit the hypothesis so further funding becomes available. Publications are pouring out to pad the promotional credentials of faculty. The cycle does not end, but the quality suffers.

The proliferation of Continuing Dental Education (CDE) courses is mind-boggling—their quality, however, is mind-wasting. Every day there are more and more courses on how to maximize office production; manage staff, patients, and money; market yourself for more patient flow. They tell you to computerize, streamline, collect, shelter, protect your practice with TMJ, and learn to bill medical insurance for it as well. The nonsense is making presentors rich and attendees frustrated. No one wants to learn about dentistry anymore—the clinical and science courses are the least attended of all courses in CDE (unless you can go to Vail, the French Riviera, or Maui). Are we all so sure that dentistry has not changed since we went to school? Are bonding agents and veneers all that are new? We look to get richer when we need to be looking to get better. It is a sad state of affairs when money means more than knowledge.

Capitation

Much has been written about capitation and the quality of health care. We certainly will not decide this issue in the next few lines, but there are a couple of things that are worth noting. In discussing these programs with their advocates one point is always hammered home: "We have been in business since nineteen seventy-something and we are here to stay." This is supposed to somehow legitimize these types of programs, since the philosophy of their existence is never discussed. In simpler terms, if it makes money how bad could it be? Bad enough, I fear, to make many complacent and comfortable, bad enough to remove the incentives to do better.

The impetus to strive for excellence comes from within. If we accept mediocrity we are entitled to no better.

GUEST EDITORIAL

Mercomania Strikes Again

WILMER B EAMES

The recent television "coverage" of supposed adverse psychic phenomenon, caused by mercury from amalgams, is a cheap shot at our entire profession.

It is going to get worse, since other documentaries are scheduled to discredit the use of our most-used and most useful dental material, silver amalgam.

There are individuals taking advantage of ill-conceived information, contrived by self-serving clinicians who have, without benefit of consideration of accepted, proven and well-documented evidence of toxic response to mercury, chosen to exploit our profession, and more seriously, at the risk of the health of our patients.

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Reprinted with permission from the *Journal of the Colorado Dental Association* (November-December 1983), **62**(3), 3.

FACTS . . . Directly from a paper by Dr P L Fan, assistant secretary of the Council on Dental Materials, in the ADA News (Nov 1981): After 100 years of careful study, documented research clearly repudiates any apprehension about potential health hazards from amalgam fillings.

The average level of mercury found in the general population is 3 micrograms per liter of urine. Repeated biological and central nervous system effects were not manifested . . . until levels reached 500 micrograms/liter.

Even tagged (radioactive) mercury only raised the urine level to 5 micrograms/liter when amalgams were removed (resulting from the emission of mercury vapor), and then the levels dropped to zero in two days.

Elemental mercury is not particularly toxic when ingested, and when absorbed is rapidly oxidized in erythrocytes to produce products which were biologically *inactive*.

Both the patch test and implying that the difference in the electric potential of metal fillings is an indicator of mercury release are tenuous and not recognized as a reliable source of information regarding amalgams.

Nor is the ambient air mercury "sniffer," when used in the mouth, reliable, because it needs constant calibration, and because it is subject to the movement of air and to humidity. The drama of using this device from mouth-to-mouth is at best an unreliable gimmick, if not downright unsanitary.

THE COMPOSITE QUICK-FIX... The most viable and up-to-date information available shows that up to 80 percent of the most-used posterior composites fail in 3 years, and an even more rapid increase in wear rate in 5 years is seen.

We have no business bilking our patients with temporary restorations on the basis of unfounded fear of amalgams. The profession isn't even adequately trained to use composites posteriorly, and the experts are agreeing that we are not ready for them except as temporary restorations.

One university professor expressed the feeling that it is a downright breach of ethics to disregard the admonitions of the ADA Councils warning us not to use them in the manner being touted in the media.

A local dentist was on camera recently, showing him placing posterior composites and stating that he was beginning a 2½-year clinical research study of composites . . . on his own patients.

That period of time is long enough, because he will then need to start replacing them. This must be disheartening for the conscientious fellows who are using *accepted* standards of experimental design, and who already know the pitfalls.

We would all do well to spend a little more time just reading the summaries of the literature, which is replete with all the evidence that we need of gross failure of these restorations.

The worry of at least one ADA Council member is that most of our profession is not trained nor equipped to diagnose mercury sensitivity or toxicity, and should not attempt indiscriminately to use test methods without complete medical histories. Isolated cases of mercury sensitivity are fraught with possible coincidental symptoms of illnesses, and spontaneous remissions when amalgams are removed.

It is common knowledge that very many illnesses respond to placebos, subliminal suggestions of cures, and of course there is a long record of cures through miracles.

The recent local coverage included a lady suffering from "hot flashes" . . . from the patch test, from the amalgams, or from the lights of the television camera.

There will be national TV coverage before long, not to overlook past press coverage in the *National Enquirer.*

WHAT IS "RIGHT"? The established ethical route for exploring new fields is not for self-aggrandizement by going before a TV camera and claiming "cures." It wasn't too long ago that the only coverage of dental health advancements for public information was channelled through publication in professional journals, followed by press coverage via established dental societies.

If our profession is not able to keep it clean, under the guise of the First Article of the Constitution, then we are in big trouble.

And, most of all, our patients' health and their confidence in us are going down the drain.

Given more time, our most reliable authorities and established investigators who are working under the disciplines of educational and research institutions, will provide us with most of the answers.

For the present, we are assured, and we must reassure our patients not to panic. Our whole professional reputation is at stake and we are obligated now to salvage it.

DEPARTMENTS

Book Review

FLUORIDE IN PREVENTIVE DENTISTRY

By James R Mellberg and Louis W Ripa

Published by Quintessence Publishing Co, Inc, Chicago, 1983. 277 pages. $78.00

It is the purpose of the authors of *Fluoride in Preventive Dentistry* to review and organize the mass of relevant literature published on fluoride into a format that will be useful for clinician and researcher alike. Mr Mellberg is a senior scientist at Colgate-Palmolive Company, and Dr Ripa is professor and chairman, Department of Children's Dentistry, School of Dental Medicine, State University of New York at Stony Brook.

The nine chapters in this text are self-explanatory and all-encompassing: Formation of Dental Caries, Anticaries Mechanisms of Fluoride, Fluoride Metabolism, Water Fluoridation, Dietary Fluoride Supplementation, Chemistry of Topical Fluoride, Professionally Applied Topical Fluoride, Fluoride Dentifrices, and Self-applied Topical Fluoride. Most chapters have more than one hundred references with many containing two to three times that number. The paper and print are of high quality as are the many color illustrations and graphs. The appendix is filled with helpful statistics. The index is thorough and very readable. In short, the layout and content of this book are excellent.

The information is presented in a very concise and complete manner. For instance, Chapter 5, "Dietary Fluoride Supplementation," states "...fluoride supplements are available as drops, tablets and lozenges, fluoride vitamin preparations and oral rinse supplements." Then Table 5-4 gives a comprehensive listing by product name and fluoride dosage. Likewise the chapter devoted to "Fluoride Dentifrices" describes the composition of toothpaste as consisting of "a solid abrasive suspended in a liquid phase...." Following this statement Table 8-2 presents a typical dentifrice formulation.

Fluoride in Preventive Dentistry is a must for any clinician who wants an accurate, ready source of information to pass on to patients. At the same time it offers in-depth information for the person wishing to substantiate his or her position on any issue involving fluoride. This book is unique in that it does an excellent job of carrying out its intended purpose.

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Announcements

NEWS OF ACADEMIES

Academy of Operative Dentistry

The thirteenth annual meeting of the Academy of Operative Dentistry was held 16 and 17 February 1984 in Chicago at the Westin Hotel. The program consisted of essays, table clinics, and limited attendance clinics. The third M G Buonocore Memorial Lecture was delivered by Martin Brännström.

At lunch on the first day the Hollenback Memorial Prize was presented to Kamal Asgar and the Student Achievement Award to

Gregory Mathews Brooks of the University of Southern California for his table clinic, "Esthetics in Dentistry: What Color Is a Tooth?"

Officers elected for 1984 are: president, William N Gagnon; immediate past-president, Robert L Kinzer; president-elect, Lawrence L Clark; vice-president, Frank K Eggleston; secretary-treasurer, Ralph J Werner; assistant secretary, Gregory E Smith; and councillors, Anna T Hampel, Barry O Evans, Allan G Osborn, Richard B McCoy, Glenn H Birkitt, and Eugene S Merchant.

Membership in the Academies

Information on membership in the academies may be obtained from the respective secretary.

American Academy of Gold Foil Operators
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(713) 664-3537

Academy of Operative Dentistry
Dr Ralph J Werner
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Wit and Wisdom

World Is Turning into a Cold, Cold Existence

To the editor:

It's getting to be a cold, cold world, in more ways than the weather, at times.

Government doesn't really care what the individual does or doesn't have. They build buildings that are never used. Also more buildings which were not done right, so couldn't be used, etc.

Then there are doctors, lawyers, dentists, and car mechanics, just to mention a few, and unless we are half as smart as they are about their trade, we get screwed. We're told to phone the Better Business Bureau, ask friends and neighbors, so we're not taken. It seems so ridiculous to have to work so hard to find out what someone is like. So many, so dishonest.

Everything is computerized. Nothing is done similar to what it was in the past. Sometimes it might be fine. But other times it is awful.

Such as the time I contemplated whether or not to get false teeth. Don't think it's uncomplicated. I had to shop and shop! Dentists make the plates, but send them to someone else for the teeth to be installed, like a new engine. There is no way you get the same size teeth, nor the amount. You are told it is only a matter of getting used to the false teeth, so "smile." No way do most of us get anything near what we started out with. Labs put the teeth in the plate, by a specific amount and what looks good to them is what we get. So many teeth in a small mouth and one looks like a baboon. I haven't heard of anyone complaining about small teeth, but I've sure heard the complaints, including my own. It's ridiculous!

The public is not about to win, the way things are.

Now, they are going to computerize the lottery. How about all the people who know nothing about computers. I have enjoyed the previous lotteries. But I will not play in the new computer lottery and most of my friends say the same.

Even banks want to go computerized. I won't have any more bank accounts if they do. I won't say how I'll handle it.

As life is now one would have to go to school and study law, computers, and all kinds of subjects. Also a year or so of doctoring and car mechanics.

Nuts!

THEDA BUTENKO

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INSTRUCTIONS TO CONTRIBUTORS

Correspondence

Send manuscripts and correspondence about manuscripts to the Editor, Professor A Ian Hamilton, at the editorial office: OPERATIVE DENTISTRY, University of Washington, School of Dentistry SM-57, Seattle, WA 98195, USA.

Exclusive Publication

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

Manuscripts

Submit the original manuscript and one copy; authors should keep another copy for reference. Type double spaced, including references, and leave margins of at least 3 cm (one inch). Supply a short title for running headlines. Spelling should conform to *Webster's Third New International Dictionary,* unabridged edition, 1971. Nomenclature used in descriptive human anatomy should conform to *Nomina Anatomica,* 4th ed, 1977; the terms 'canine', 'premolar', and 'facial' are preferred but 'cuspid', 'bicuspid', and 'labial' and 'buccal' are acceptable. SI (Système International) units are preferred for scientific measurement but traditional units are acceptable. Proprietary names of equipment, instruments, and materials should be followed in parentheses by the name and address of the source or manufacturer. The editor reserves the right to make literary corrections.

Tables

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

Illustrations

Submit two copies of each illustration. Line drawings should be in india ink or its equivalent on heavy white paper, card, or tracing vellum; any labeling should be on an extra copy or on an overleaf of tracing paper securely attached to the illustration, not on the illustration itself. Type legends on separate sheets. Photographs should be on glossy paper and should be cropped to remove redundant areas. For best reproduction a print should be one-third larger than its reproduced size. Maximum size of figure is 15x20 cm (6 x 8 inches). The cost of color plates must be met in full by the author. On the back of each illustration, near the edge, indicate lightly in pencil the top, the author's name, and the number of the figure. Type legends on a separate sheet. Where relevant, state staining techniques and the magnification of prints. Obtain written consent from holders of copyright to republish any illustrations published elsewhere.

References

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

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