OPERATIVE DENTISTRY

AMERICAN ACADEMY OF GOLD FOIL OPERATORS

ACADEMY OF OPERATIVE DENTISTRY

spring 1979 • volume 4 • number 2 • 49–88

(ISSN 0361-7734)

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SPRING 1979 • VOLUME 4 • NUMBER 2 • 49–88

Aim and Scope

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

Publisher

Operative Dentistry is published four times a year: Winter, Spring, Summer, and Autumn, by the American Academy of Gold Foil Operators and the Academy of Operative Dentistry.

Subscriptions

Yearly subscription in U.S.A. and Canada, $20.00; other countries, $24.00 ($27.00 air mail); dental students, $13.00 in U.S.A. and Canada; other countries, $17.00; single copy in U.S.A. and Canada, $7.00; other countries, $8.00. Make remittances payable (in U.S. dollars only) to *Operative Dentistry*.

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Second-class postage paid at Seattle, WA.

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EDITORIAL

Are Prices Really Determined By Costs of Production?

Is the fee for an amalgam restoration $25.00 because the materials cost $5.00, the overhead $8.00, and the dentist's time $12.00? Or is it because patients are willing to pay $25.00 for an amalgam that the dentist can afford to pay $5.00 for the materials, $8.00 for overhead, and charge $12.00 for his time? In other words, do costs of production determine prices or is it the other way around? The view commonly held is that prices are determined by totaling the costs of production; but there are some difficulties with this notion.

An example of one such difficulty is when a commodity, such as a shipment of perishable fruit that is in danger of spoiling, is sold at a price below cost to minimize what otherwise could be a total loss. Clearly in this instance price is not determined by cost. Another example is provided by a company that makes several different products yet does not realize the same rate of return on each. Finally, we know that a useless product, such as a plastic bur, could not be sold for any price, let alone its cost of production. These examples show that at least sometimes costs do not determine prices. On the other hand, costs of production and price of product often coincide; this is merely an equivalence, however, and does not explain the causal relation between the two.

A more useful explanation suggests that it is what consumers are willing to pay for goods and services that determines their prices and ultimately, in a roundabout way, their costs of production. Producers can afford to pay the prices they do for the factors of production because consumers will pay enough for the products. If consumers are unwilling to pay this price the commodity will not be produced, or will be produced only until bankruptcy of the producer intervenes. This notion of the relation between costs and prices is based on the premise that value is a personal matter and therefore determined subjectively. Values, in economic terms, are the prices people are willing to pay for commodities.

This theory of value offers a good explanation for some of the seeming inconsistencies in dental fees, such as different rates of remuneration from various types of treatment, where differences may not correspond with the relative difficulties of providing the treatment. Thus the reason a dentist can earn a higher hourly income from prosthodontics than from operative dentistry, even though the restoration of teeth is accomplished for the most part directly on the patient and within the difficult confines of the oral cavity rather than on a laboratory bench, is that by the time a patient needs dentures he is likely to appreciate the gravity of his dental problem and is willing to pay the dentist a higher rate for his service. The esthetic appearance of dental restorations is also valued highly by patients, and that is why they are willing to pay at a higher rate for composites than for amalgams even though serviceability is much less. Nevertheless, patients are also interested in the longevity of restorations and many, if they were aware of the advantages of restorations of direct gold, would be willing to pay substantially more for them than for the composite substitute. On the supply side, however, the difficulty of placing a class 3 restoration of direct gold is substantially greater than that of placing a class 3 composite. This and the lower hourly revenue obtained from a direct gold restoration does not encourage many dentists to provide this valuable form of therapy. Thus we see that the type of dental treatment and the fee depend upon supply as well as demand.

The largest part of the cost of a restoration is the charge for the time and skill of the dentist. A dentist generally bases his schedule of fees on the type of operation and ordinarily, because of competition, does not deviate markedly from the fees of other dentists in the community. Dentists usually aim at achieving a particular hourly revenue. From this the time available for the operation can be determined if the projected hourly income is to be attained at the going fee. Thus the fee, or price, can influence the cost of the restoration by determining the amount of time allotted to it, and in this way we can see that the price does determine the cost.

Although it is economically sound for dentists to provide the type of service that realizes the greatest hourly revenue, this premise is based on the assumption that the consumer has the information he needs to make the best choice. In dentistry, however, this is generally not true. The patient should be given the facts—economic, practical, esthetic. Then the patient is able to make the best decision for himself, with the help of a dentist interested primarily in the welfare of his patients and not in selling one type of treatment because it is most remunerative or is more easily provided by him—or his assistant.

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Dear Woody — A New Feature

An innovation beginning with this issue should provide the readers of *Operative Dentistry* a valuable service. Many of us have questions about theory or technique that remain unanswered for want of a good source of information. On the other hand, by dint of genius or serendipity, others have found solutions to such problems. This new feature is an attempt to provide the missing link of communication between those with the queries and those with the answers.

This new feature is the idea of Woody Rupp, who has offered to organize this section to be a regular part of the journal. He will receive the questions, which will be published to give those of you with the answers an opportunity to respond. Woody will select the most suitable answers and comments, which will then be published in the journal. We hope in this way to stimulate a lively discussion of current problems in operative dentistry. The inaugural question can be found on page 84 of this issue.

OPERATIVE DENTISTRY, 1979, **4**, *51–55.*

ORIGINAL ARTICLES

Effects on Microleakage of Intermixing Intermediary Bases and Cavity Varnish

Resinous varnish should be applied only to enamel and dentin because if the varnish is applied to bases of calcium hydroxide or zinc oxide and eugenol a viscous substance is usually produced that may contribute to microleakage.

GILBERT H LARSON III • GEORGE N MOYER • RICHARD B McCOY
GEORGE B PELLEU, JR

Summary

A total of 64 extracted human teeth were used to investigate the effect on microleakage of the viscous material produced by intermixing cavity varnish and an intermediary base of either calcium hydroxide or zinc oxide and eugenol. The results show more leakage around specimens prepared with this intermixing than around those lined with cavity varnish alone. Specimens prepared with a base of zinc oxide and eugenol leaked more extensively than those with calcium hydroxide.

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Reprint requests to Dr Pelleu

Introduction

It has been observed clinically that when a resinous varnish is placed in a prepared cavity containing an intermediary base, a viscous milky substance is frequently produced. This substance tends to cover not only the walls of the cavity but also the margins. Since microleakage is believed to be a primary cause of failure of restorations, this material may contribute to the problem.

Margins of dental restorations are not fixed, inert, and impenetrable borders, but are dynamic microsystems of ions and molecules (Going, 1972). When resinous varnishes are applied to the walls and margins of cavities prepared for amalgam, microleakage is reduced significantly (Charbeneau & others, 1975; Craig & Peyton, 1975).

Cavity varnishes are thin film-forming solutions composed of one or more natural or synthetic resins dissolved or suspended in a volatile organic solvent (Charbeneau & others, 1975; Craig & Peyton, 1975). The thin, resinous film that remains on the tooth is insoluble in oral fluids. Some commercial cavity varnishes also contain calcium hydroxide or zinc oxide. These varnishes produce a thicker film, which disintegrates and dissolves in oral fluids. When these films cover the margin, severe leakage may result. These thicker varnishes should not be applied at the margins of cavities (Charbeneau & others, 1975; Craig & Peyton, 1975). Intermediary bases of materials such as calcium hydroxide and zinc oxide and eugenol are frequently used in prepared cavities to insulate the pulp from thermal, chemical, and biotic irritants. Cavity varnish applied over an intermediary base best fulfills the requirements of a good cavity liner (Going, 1964). How the visible film produced by intermixing base and varnish affects microleakage, however, has not been determined. The purpose of this study was to investigate what effect this intermixing has on microleakage at the interface of tooth and amalgam of restorations placed in extracted human teeth.

Materials and Methods

A total of 64 extracted human posterior teeth without restorations were selected and thoroughly cleaned with a curette, soap, and water. Class 5 cavities with all cavosurface margins in enamel were prepared in facial or lingual surfaces. Caries was removed and, with a 330 bur in a high-speed handpiece, the axial wall was extended to a depth of 0.5–1.0 mm into dentin. The types of base used for the restorative preparations were calcium hydroxide—Dycal (L D Caulk Co, Milford, DE 19963, USA) and zinc oxide and eugenol—Cavitec (Kerr Mfg Co, Romulus, MI 48174, USA). The varnish used was Copalite (Harry J Bosworth Co, Skokie, IL 60076, USA).

The bases were allowed to set for at least 7 minutes after being applied. In teeth receiving cavity varnish, three coats were placed according to the manufacturer's instructions, each coat being dried with warm air before a subsequent application. Two pellets of silver alloy–Optaloy (L D Caulk Co, Milford, DE 19963, USA)—were mixed with mercury from a dispenser with an OP plunger (L D Caulk Co), the ratio of mercury to alloy being 54:46. The mix was then triturated in screw-top capsules for 9 seconds in a Vari Mix II (L D Caulk Co). The cavities were filled one at a time and carved with a one-half Hollenback carver. The teeth were stored for 72 hours in high humidity in an incubator at 37 °C.

The 64 teeth were divided in three groups of 20 teeth and one group of four teeth according to the type of base used: (1) cavity varnish only (control), 20 teeth; (2) calcium hydroxide plus varnish, 20 teeth; (3) zinc oxide and eugenol plus varnish, 20 teeth; and (4) no base or varnish, 4 teeth.

A solution of ^{45}Ca was used to determine microleakage. Before the prepared teeth were soaked in the radioisotope they were sealed according to a modification of the autoradiographic method described by Phillips & others (1961). The modification consisted of sealing with red sticky wax the apices of all roots before coating the teeth with clear nail polish. Aluminum foil was adapted to the teeth while they were still tacky, leaving only the amalgam exposed. A final coat of nail polish was applied over the foil and allowed to dry. The specimens were then immersed for 2 hours at room temperature in a solution of ^{45}Ca at a concentration of 1 mCi/ml adjusted to pH 5.5. This was followed by a thorough rinsing for 1 hour in running tap water maintained at 37 °C.

After the foil was removed, the specimens were cleaned thoroughly with soap and water and mounted in autopolymerizing acrylic, Fastray (Harry J Bosworth Co, Skokie, IL 60076, USA), for sectioning. Each tooth was sectioned with a diamond saw blade (Bronwill Thin Sectioning Machine Universal Model 77, B Braund Instruments, San Francisco, CA 94080, USA) approximately through the middle of the class 5 restoration. The sectioned tooth was scrubbed free of debris with a toothbrush and detergent; pulpal remnants were removed; and each specimen was thoroughly dried. One half of each specimen was then placed on ultraspeed film, Ansi Type 1.2 Safety Film (Eastman Kodak Co, Rochester, NY 14650, USA), and the combination held in position by securing it with a rubber band to a clear acrylic square 5 cm × 5 cm. The specimens were separately wrapped in aluminum foil to prevent the penetration of light, and stored in the dark for 17 hours before developing and fixing.

The autoradiographs were evaluated for microleakage by the use of criteria slightly modified from those of Going (1972). This modified evaluation includes categories of 'no leakage' (class 0 and class 1) and three different degrees of leakage (classes 2, 3, and 4) according to the depth of penetration of the radioisotope. Class 0 leakage (Fig 1) and class 1 leakage (Fig 2) differ in that class 1 has a slight radiolucent area barely extending into the enamel

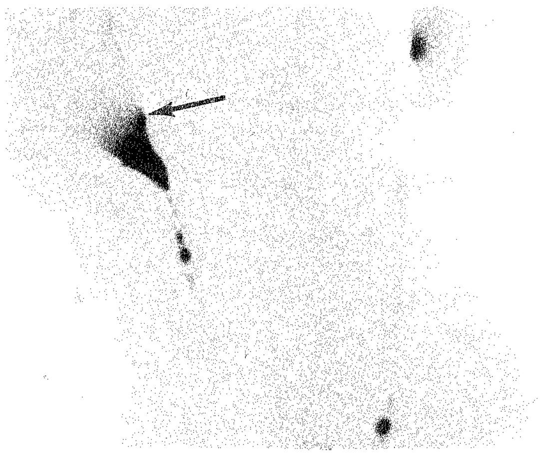

FIG 1. Class 0 leakage

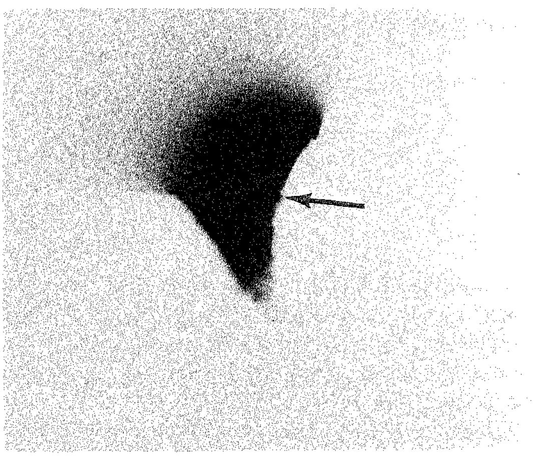

FIG 2. Class 1 leakage

FIG 3. Class 2 leakage

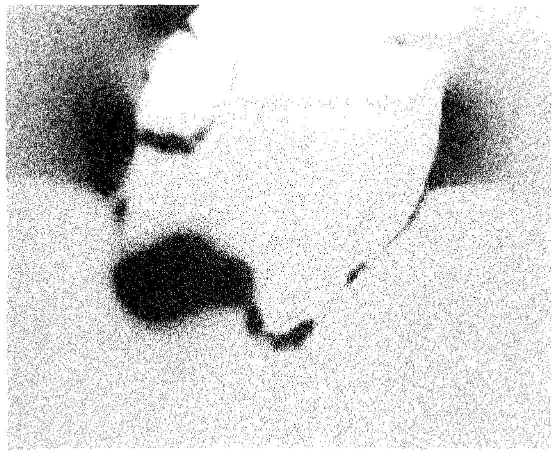

FIG 4. Class 3 leakage

FIG 5. Class 4 leakage

prisms (Roydhouse, 1968). Class 2 leakage penetrates the occlusal or gingival walls (Fig 3); class 3 penetrates the pulpal floor or around the entire restoration (Fig 4); and class 4 penetrates beyond the pulpal floor into the dentinal tubules (Fig 5).

Results

The effect on microleakage of intermixing bases and varnish is shown in the table. Of the 20 specimens in the control group where cavity varnish only was used, none leaked. In the calcium hydroxide

Effect on Microleakage of Intermixing Bases and Varnish

Restorative Procedure	Number of Teeth			
	Leakage	No Leakage	Total	Leakage in Class 3 or 4**
Cavity varnish (control)	0	20	20	0
Calcium hydroxide + varnish	11*	9	20	4
Zinc oxide and eugenol + varnish	20*	0	20	17
No base—no varnish	4	0	4	0

*Statistically significant difference from control ($P < 0.01$ by χ^2 analysis).

**Total number of similarly prepared teeth showing class 3 or class 4 leakage.

and varnish group, 11 specimens leaked and nine did not. The zinc oxide and eugenol and varnish group exhibited leakage in all 20 specimens. The difference in leakage around the restorations in both these groups compared with controls was statistically significant by χ^2 analysis ($P<0.01$). All four specimens with no base or varnish showed leakage.

Extensive leakage, as indicated by class 3 or 4, was more prevalent for teeth prepared with the base of zinc oxide and eugenol than with the base of calcium hydroxide. This is noted by the finding that 17 out of 20 teeth prepared with zinc oxide and eugenol leaked with class 3 or 4 type leakage compared with four of 11 teeth for calcium hydroxide.

Discussion

Our results indicate that instead of the resinous varnish decreasing microleakage it was increased around restorations where cavity varnish had been placed over bases of either calcium hydroxide or zinc oxide and eugenol. Although the cause of this increased microleakage has not been established, this study strongly suggests that the viscous film produced by combining the intermediary base and cavity varnish is related to microleakage. Further study of the physical and chemical properties of this viscous film is needed to clarify its role in microleakage of amalgam restorations.

The depth of marginal leakage also supports the clinical significance of the reported results. Eleven samples of the calcium hydroxide-varnish group showed leakage, with four being in class 3 or 4. The samples of zinc oxide and eugenol all showed leakage, 17 of 20 exhibiting class 3 or 4 penetration. These findings parallel our clinical observation that bases of zinc oxide and eugenol seem to produce this milky film more easily than bases of calcium hydroxide.

Extensive application of cavity varnish to the entire preparation after placing a base of zinc oxide and eugenol or calcium hydroxide appears to be undesirable. More emphasis should be placed on careful, exact placement of cavity varnishes on the exposed dentin and enamel to ensure maximum sealing of margins.

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

This study was supported by the Bureau of Medicine and Surgery, Navy Department, under Research Work Unit M0095–PN.04–3014.

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Scanning Electron Microscopy of Self-threading Pins in Dentine

A close look at self-threading pins and their effect on dentine

A BOYDE • K S LESTER

Summary

Self-threading pins inserted into prepared cavities in extracted teeth were examined in the SEM.

The thread of pins as obtained from the manufacturer is often flattened or blunt and the metal coating wrinkled and partly detached. Extensive voids exist between inserted pin and dentinal pin-hole. Radiating dentinal cracks associated with the pins are considered to be an artefact of drying, reflecting points of high strain in the dentine associated with pin insertion.

Changes in the structure of the dentine and of the pins are discussed in the light of optimal use of pins.

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Introduction

Pins make possible the application of nominally intracoronal materials to grossly decayed teeth. The resulting pinned restoration is effected with minimal loss of the usually fragile tooth structure remaining. The restoration may serve satisfactorily in the short term, or act as a foundation for an extracoronal cast veneer prepared without resort to the pulp canal for retention. Several types of pins have been devised for this method of augmenting retention for restorations.

Review of the Literature

Davis in 1875 placed gold screws in teeth to help retain gold foil (Duperon & Kasloff, 1971). How (1889) applied a similar technique to retain amalgam. Markley (1958, 1966) has popularized the approach in more recent times, drawing attention to the use of cemented threaded pins in conjunction with amalgam. Subsequently, Goldstein (1966) and Going (1966) have described friction-lock pins and self-threading pins respectively as we know them today.

Previous studies have shown the installation of pins to be capable of crazing and cracking enamel and dentine (Dilts & others, 1970; Standlee, Collard & Caputo, 1970; Collard, Caputo & Standlee, 1970; Trabert & others, 1973; Chan & Svare, 1973; Chan & others, 1974). Photoelastic studies have shown self-threading pins to transmit substantial stress pulpally when seated completely, and laterally when not seated completely (Standlee, Caputo & Collard, 1971; Caputo, Standlee & Collard, 1973).

This article reports an examination of the morphological relationship between pin and tooth for a system of self-threading pins in wide use at the present time.

Materials and Methods

The material consisted of sound, extracted, human teeth stored in 70% ethanol. Extensive cavities involving three surfaces were prepared with ultrahigh speed in 14 teeth. Two TMS Minim 2 in 1 pins (Whaledent International, New York, NY 10001, USA) were placed in drill holes in each of 12 cavities according to the manufacturer's instructions. The diameter of the drill was 0.525 mm and the pins were placed with an Auto Klutch Drive with a 10:1 reduction gear (Whaledent International, New York, NY 10001, USA). The pins were placed more than 0.5 mm from the dentinoenamel junction, more than 1 mm from the pulp, and at least 2 mm from each other to avoid, as far as possible, damage to the teeth (Moffa, 1971). Friction-lock pins (Unitek Corp, Monrovia, CA 91016, USA) were placed in cavities in the remaining teeth for comparison.

Shortly before insertion in the scanning electron microscope (SEM), the specimens were taken from 70% ethanol, rinsed in 100% ethanol, and blown dry superficially by the jet from a laboratory Freon gas duster. They were then fastened to specimen stubs of aluminum with very rapid-setting epoxy adhesive (UHU Sofortfest, West Germany, D-7580 Bühl/Baden) and placed one at a time in a sputter coating unit. We used two sputter coaters in this work. The Polaron E5000 was used with a gold target, 1.2 kV, 20 mA for 30 to 60 seconds. The Balzers Union device was used with a silver target, high voltage not indicated, 10 mA for 20 seconds. This unit was fitted with permanent magnets to deflect electrons and negative ions away from the specimen during coating, thus greatly diminishing the chance of heating. In both cases the vacuum during coating was about 0.1 Torr (13.3 Pa) and the exposure in vacuum lasted about 4 minutes. These technical points are emphasized because of the probability of superdrying under vacuum and the related generation of artefacts in the form of cracks or splits.

The specimens were then transferred to an SEM and examination of the critical areas around the pin holes begun as soon as possible. The SEMs used were Cambridge Stereoscans Mk S1 and Mk S4-10 and Philips PSEMs 500 and 501. Images were recorded through the use of the following accelerating voltages: 10 kV (S1 and S4-10, Figs 10-14), 12 kV (PSEM 500, Fig 3), and 7.2 kV (PSEM 501, Figs 1, 2, 4-9).

After initial examination, the specimens were sectioned longitudinally close to the pins with a carborundum disc in a conventional handpiece. They were then ground and smoothed by hand on successively finer grades of wet emery paper so as to provide a longitudinal section of the pin in place. The sectioned surfaces were coated and examined as described above.

Results

The edge of the thread of the self-threading pins as obtained from the manufacturer is often flattened or blunt. The metal coating appears wrinkled in the grooves where the thread meets the shaft and is sometimes seen to be partly detached, particularly where the pins have been screwed into the dentine (Figs 1-4, 9, 10).

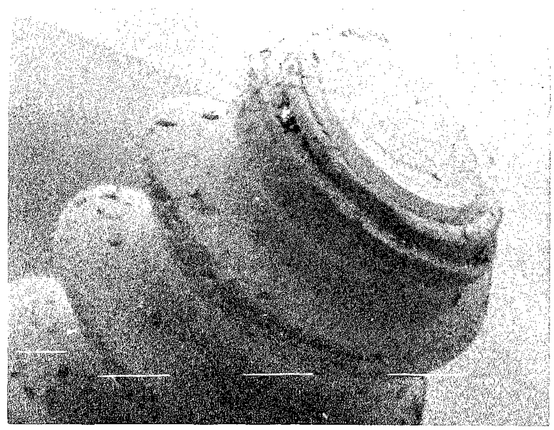


FIG 1. Fractured end of first part of Minim 2 in 1 self-threading pin. Marker shows 100 μm intervals.

Intact specimens are seen in Figs 2 and 5 where the two parts of single pins are embedded in the floors of prepared cavities. It is often possible to see a small space between the pin and the dentine at the entrance to the pin hole. The observation that the pins do not completely occlude the holes is confirmed by examination of the longitudinal sections of

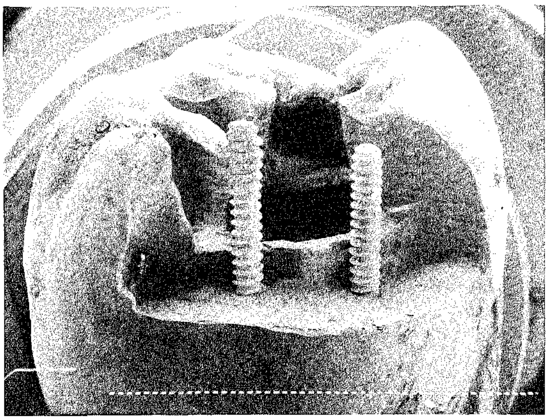


FIG 2

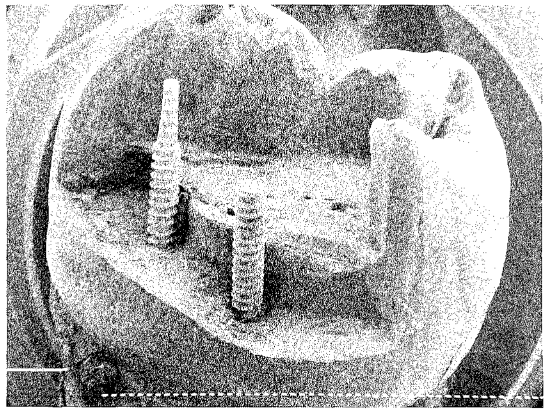


FIG 5

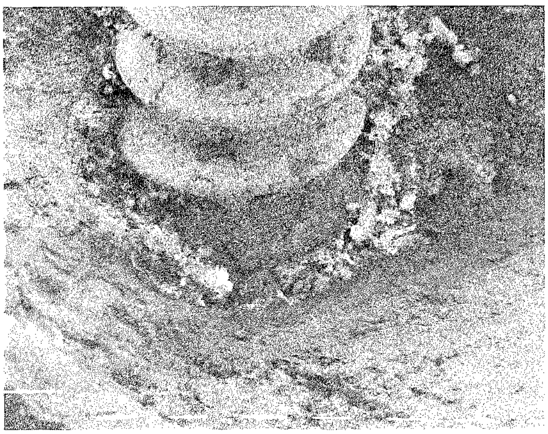


FIG 3

FIG 6

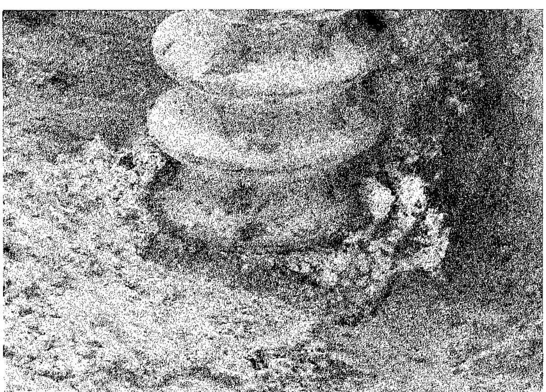


FIG 4

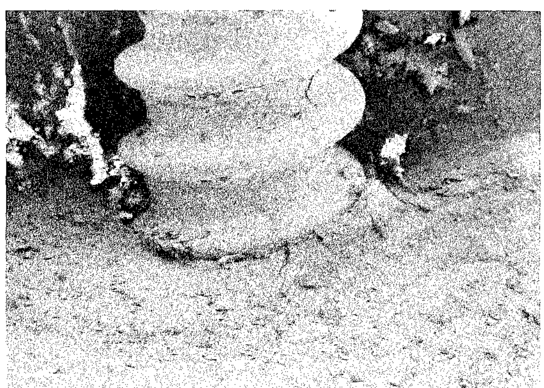
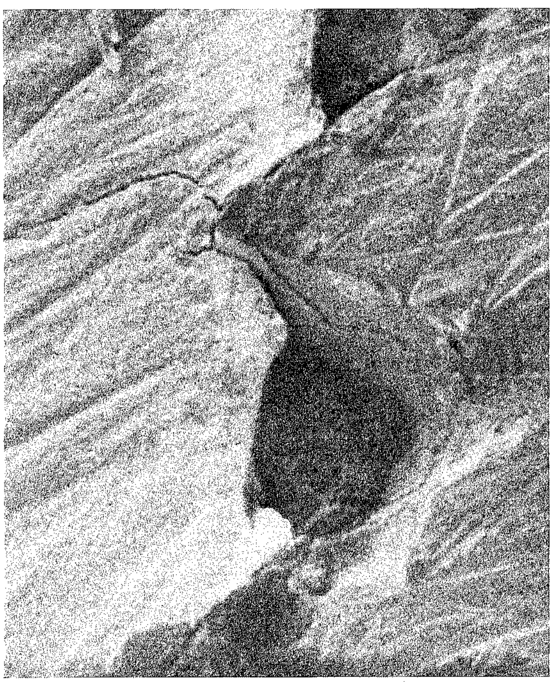


FIG 7

FIGS 2, 3 & 4 (left column, top to bottom): Typical specimen showing the two parts of a self-threading pin embedded in dentinal floor of cavity. No attempt was made to shorten inserted pins as would be normal clinical procedure. First part of pin appears at right of Fig 2 and as Fig 3, and second part at left of Fig 2 and as Fig 4. Note dentinal debris about point of entry of pin into dentine. Second part of pin also engaged axial wall of cavity (Fig 4). Magnification markers show 100 μm intervals.

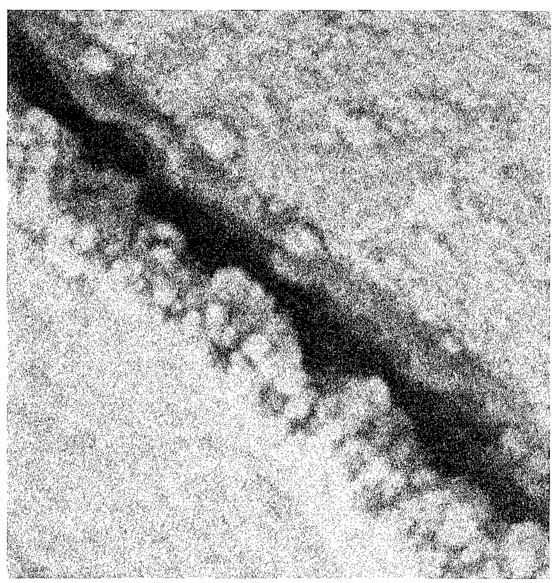
FIGS 5, 6 & 7 (right column): A similar specimen allowed to dry for a longer period shows cracks radiating around first part of pin (Fig 6) and flakes of dentine lifting from dentine floor (Fig 7). Marker shows 100 μm intervals.



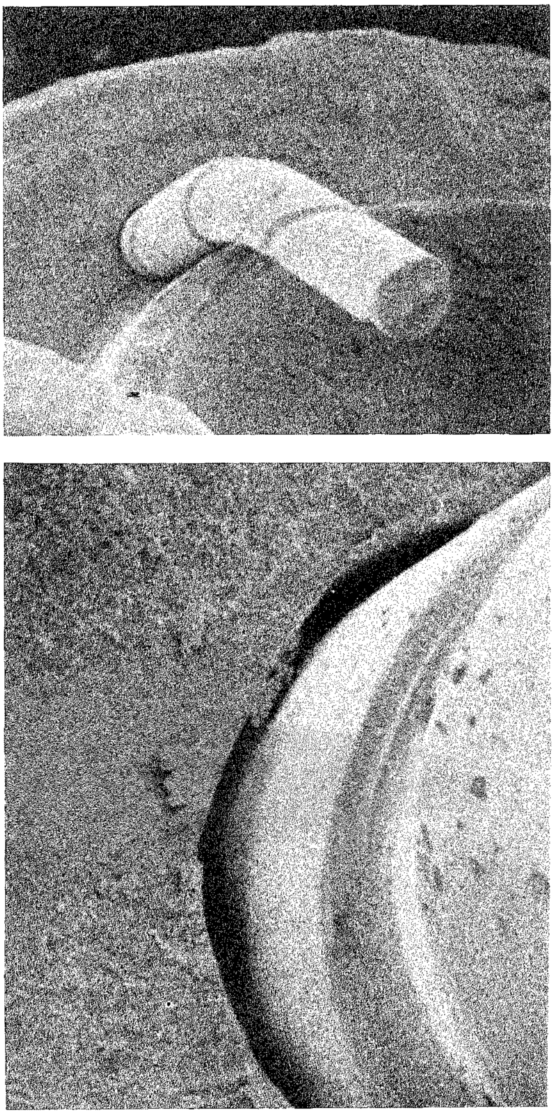
the pins in place (Figs 8, 9). There are also substantial gaps between the friction-lock pins and the walls of the drill holes when the pins are placed according to the manufacturer's instructions (Figs 11, 12).

The debris resulting from the self-threading pins cutting into dentine can be seen in Figs 3 and 4 especially where the unburied part of the shaft of the second part of the pin engaged against the axiopulpal wall of the cavity. Similar debris must be formed within the pin hole from where it cannot be discharged. This at least partly accounts for the material filling the gap between the pin and the dentine in the specimens sectioned longitudinally (Figs 8, 9). However, we cannot be sure that part of this debris did not originate from the sectioning procedure.

Small cracks are often seen in the dentine immediately surrounding the self-threading pins (Figs 6-9). These and the small flakes of dentine seen originating at the level of insertion of the pin (Figs 6, 7) are considered to be artefacts of drying. They nevertheless reflect points of high strain in the dentine resulting from the deformation caused by inserting the pin. Our interpretation of them as artefacts of drying is based on the absence of such cracks from specimens examined within a few minutes of insertion into the SEM and for which precautions had been taken to prevent drying before insertion into the SEM. Cracks were rarely found around drill



FIGS 8 (top), 9 (bottom left) & 10 (right): Self-threading pins in dentine after longitudinal sectioning. Note cracks in dentine opposite pulpal end of pin (Fig 8) and edge of thread (Fig 9). Fig 10 is a higher magnification of pin surface where the gold coating is separating from the stainless steel body of the pin. Width of field of view is 2 mm in Fig. 8, 270 μm in Fig 9 and 8 μm in Fig 10.

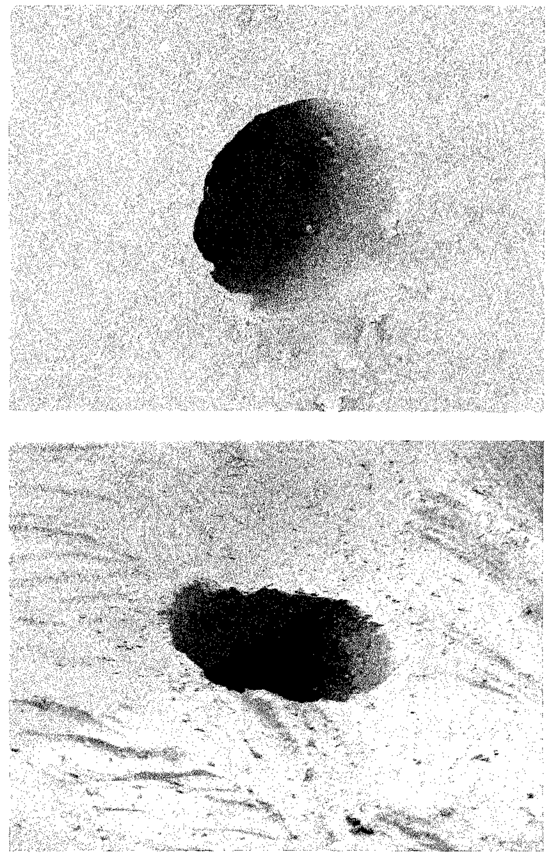


FIGS 11 & 12 (left column): Friction-lock pin in drill hole bent as suggested to aid retention of restorative. Note extent of void between pin and drill hole wall in this well-dried specimen. Width of field is 3 mm in Fig 11 and 160 μm in Fig 12.

holes which had not been filled with self-threading pins, even in thoroughly dried specimens (Figs 11-14).

Discussion

The present results indicate that the dentine shrank onto the self-threading pins, which were inserted when it was wet. Shrinkage along the length of the pins caused flakes to break away at the free surface of the dentine. Presumably, the component of shrinkage perpendicular to the pins resulted in the development of radial hairline cracks. The importance of the shrinkage of drying in creating a distorted view of anatomical reality is therefore emphasized by this study.



FIGS 13 & 14: Drill holes before insertion of pins. Surrounding dentine is free of cracks.

Such shrinkage would, however, tend to decrease the extent of the voids between pin and dentine, which are greater than one would expect from the appearance at the cavity floor (see Figs 7, 9). These voids are large because the pins do not engage deeply in the dentine. Oversize pin holes with threads only slightly embedded in the dentine have been noted previously by Standlee & others (1971) and Perez, Schoeneck & Yanahara (1971). The drill used in the present studies has a nominal diameter of 0.525 mm whereas according to the manufacturer's specifications the pin has a diameter of 0.575 mm. Theoretically at least, this should leave 25 μm of thread to engage the dentine beyond the margins of the drill hole. However, others have measured actual drill holes at 0.530 mm and the pins at 0.544 mm (Perez & others, 1971). This of course leaves only 7 μm on either side. A lack of control of quality in manufacture of pins has been noted elsewhere (Standlee & others, 1971). Further, because of the flaring of the drill channel toward the occlusal, the depth of embedment of the pin thread lessens occlusally. This flaring of the drill hole has been ascribed to the hand-held nature of the operation and is regarded as characteristic even of experienced operators (Collard & others, 1970; Hanson, Caputo & Trabert, 1974).

Some of the debris found between the threads of the sectioned pins (Figs 8, 9) would result from the preparation of the section. Some debris must, however, be generated by the process of cutting the dentine with the thread of the pin. This debris is thought to be a useful stimulant to healing of the pulp in case of its accidental exposure during the insertion of the pin (Schuchard & Reed, 1973; Dolph, 1970). Retention of debris in the pin hole rather than routine removal with the air syringe has been advocated for this reason. Also having merit is the suggestion of coating the end of the pin with a quick-setting lining of $Ca(OH)_2$ prior to insertion (Suzuki, Goto & Jordan, 1973).

The self-threading pins are coated with gold by the manufacturer in an attempt to develop an adhesive bond between the pin (stainless steel) and the amalgam packed around it (Duperon & Kasloff, 1971). Moffa, Going & Gettleman (1972) have demonstrated voids at the gold-amalgam interface and report the lack of an adhesive bond at this site. This lack of bonding could only be further hampered by the lack of adhesion of the gold coating to the stainless steel as demonstrated in the present material (Figs 8-10).

The extent of the void about the pins raises the question of potential leakage. Self-threading pins have been shown to exhibit the least marginal leakage of the various types of pin (Chan & Svare, 1975). A surface view of an embedded friction-lock pin showing the degree of separation of pin from tooth is included for comparison (Figs 11, 12). Cavity varnish has been shown by experiments with radioactive isotopes to eliminate virtually all leakage associated with the self-threading type of pin (Moffa, Pazzano & Folio, 1968).

Parmeijer and Stallard (1972) have employed replica techniques for SEM to study the process of pin insertion in dentine and have concluded that the cracks observed in dried specimens are the result of drying. Cracks have, however, been observed by other workers using other techniques.

It must remain an open question whether some of the cracks seen adjacent to the base of the pin hole, and radiating from the high points of the pin thread into the dentine, were not there in the wet condition (see Dilts & others, 1970; Standlee & others, 1970, 1971; Chan & Svare, 1973; Caputo & others, 1973; Trabert & others, 1973).

Conclusion

The majority opinion holds that screwing pins into dentine damages it. In contrast it has not been shown that cemented pins damage tooth structure as a result of their installation. This is not to state that no damage is to be expected to dentine deep in the pin hole close to the pulp, since substantial hydrostatic pressure could be generated when inserting the pin with a viscous cement lute. Nevertheless, cemented pins seem to be safer in this respect (Caputo & others, 1973). They should be recommended particularly for nonvital teeth as a 100% incidence of dentinal crazing has been reported for self-threading pins in dried, endodontically treated teeth (Chan & others, 1974). Modified cemented pins (Courtade, 1971) and cemented mismatched pins (Hanson & others, 1974; Trabert, Caputo & Hanson, 1975) offer great scope for optimal use of pins. This allows increased retention for the restoration with minimal trauma to the tooth.

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Two Layers of Carious Dentin: Diagnosis and Treatment

Only the infected layer of carious dentin need be removed.
It can be disclosed by staining with basic fuchsin.

TAKAO FUSAYAMA

Summary

Carious dentin consists of two distinct layers having different ultramicroscopic and chemical structure. The outer carious dentin is irreversibly denatured, infected, not remineralizable, and must be removed. The inner carious dentin is reversibly denatured, not infected, remineralizable, and must be preserved. The two layers can be differentiated clinically by a 0.5% solution of basic fuchsin in propylene glycol, which stains only the outer carious dentin. This differentiation permits complete removal of the infected layer with complete preservation of the remineralizable layer. The stain does not harm the pulp.

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INTRODUCTION

The removal of all soft carious dentin before restoring a carious cavity has long been stressed in many dental textbooks. It is impossible, however, to differentiate clinically the soft dentin to be removed from the sound dentin to be preserved because hardness and appearance vary continuously from soft dentin to hard dentin. We have found that carious dentin consists of two layers with remarkably different morphological, biochemical, bacteriological, and physiological characteristics. This article first clarifies the characteristics of the two layers of carious dentin and then presents a new technique of differential diagnosis and clinical treatment of the two layers.

TWO LAYERS OF CARIOUS DENTIN

Hardness of Carious Dentin

Color and hardness have generally been used as criteria for the clinical diagnosis of carious dentin. The soft dentin, which is felt to be soft when touched with a cutting instrument, is a very small part of the pathologically softened or demineralized dentin. The hardness of the dentin remaining after the clinical removal of soft dentin has been measured and found to be as soft as 22.8 ± 9.65 Knoop Hardness Number (KHN) when a spoon excavator was used and 28.4 ± 16.36 KHN when a round steel bur with an electric engine was used (Terashima & others, 1969), compared with the normal hardness of dentin—about 69 KHN. The large standard deviations also indicate that the hardness felt by the hand through an instrument can never be a reliable guide for the clinical removal of caries.

The depths of the fronts of softening, discoloration, and bacterial invasion in the carious dentin have been compared by bisecting freshly extracted human teeth vertically through their carious lesions and examining the hardness and discoloration on the sectioned surface of one half of each tooth and the bacterial invasion on histologic sections of the other half (Fusayama, Okuse & Hosoda, 1966). When thus compared, softening was always deepest, discoloration next, and bacterial invasion last. The hardness of the dentin at the bacterial front was lower in acute caries (minimum 4.4 KHN) and higher in chronic caries (maximum 61 KHN). The distance from the bacterial front to the softening front was greater in acute caries (maximum 1750 μm) and less in chronic caries (minimum 50 μm). This is further proof that hardness is not a reliable guide in removing carious dentin.

Discoloration of Carious Dentin

In chronic decay, discoloration is considered to be a reliable guide in removing infected dentin because the discoloration is usually marked and the bacterial invasion is usually demarcated and follows closely the discoloration front, whereas in acute decay, discoloration is often not marked and the bacterial invasion is usually diffuse and far behind the front of discoloration (Fusayama & others, 1966; Sato & Fusayama, 1976). Therefore, discoloration also is not generally a reliable guide for the clinical removal of infected dentin.

Two Layers of Artificially Demineralized Dentin

Two layers of softened dentin have been found in dog teeth that have been demineralized by dropping a demineralizing solution in experimentally prepared cavities (Kato & Fusayama, 1970). The dogs were sacrificed within varying periods of time—immediately, or after exposing the cavities to the oral environment, or after sealing the cavities with a zinc oxide and eugenol cement, with or without calcium hydroxide, for two to four weeks. Sections through the dentin of the floor of the cavity were examined by optical microscopy, microradiography, and electron probe microanalysis. The following features were observed:

Two layers were clearly distinguished in the artificially demineralized dentin and named the first and second decalcified layers. The first, outer layer was highly demineralized and could not be remineralized even in a living tooth, though a slight accumulation of mineral occurred on or in this layer when exposed to saliva or cement containing calcium hydroxide. The second, inner layer was less demineralized and could be remineralized to the level of normal dentin when cavities in living teeth were adequately protected for a given period.

Two layers have also been found in the dentin of extracted human teeth that was demineralized in the same way (Ohgushi & Fusayama, 1975). When observed with an electron microscope for inorganic substance, there was a scarcity of inorganic crystals in both the peritubular and intertubular dentin of the outer layer, whereas in the inner layer there were numerous apatite crystals in both peritubular and intertubular dentin, with a definite boundary between the layers. When the intertubular dentin was examined for organic substance with an electron microscope, the outer layer contained few fibers that resembled collagen fibers and these were without the distinct crossbands and interbands characteristic of sound collagen fibers. The inner layer, on the other hand, contained sound collagen fibers with definite crossbands and interbands closely resembling those in normal dentin.

Two Layers of Carious Dentin in Human Teeth

Two layers have been found also in the carious dentin of human teeth (Fusayama & Terashima, 1972). To differentiate remineralizable from unremineralizable carious dentin a variety of dyes in various solvents was used. It was found that a 0.5% solution of basic fuchsin in propylene glycol applied to the surface of the section for 10 seconds and washed with streaming water stained the outer layer of carious dentin distinctly but the inner layer not at all. The boundary between the stained and unstained layers was clear though, previous to staining, the hardness and appearance varied continuously from the cavity floor to the pulp without any recognizable boundary between the two layers.

Hereafter, the two layers are called outer and inner carious dentin.

The character of the collagen fibers in the two layers of carious dentin has been investigated histochemically by the Mallory-Azan technique of staining (Ohgushi, 1973). The outer carious dentin stained red by fuchsin was also stained red by the Mallory-Azan technique indicating denatured collagen fibers, whereas the inner carious dentin unstained by fuchsin was stained blue by the technique indicating sound collagen fibers as in normal dentin.

The fuchsin solution has been applied to carious cavities in extracted and living human teeth and the depths of the stained dentin and the bacterial invasion compared on histological sections (Sato & Fusayama, 1976). It was found that the stained outer carious dentin was infected whereas the unstained inner carious dentin was not. Excavation guided by this method of staining was always slightly deeper than the bacterial invasion, even in acute decay in which bacteria are scattered widely. This staining was thus proved to be a reliable clinical guide for the complete removal of infected dentin.

Ultramicroscopic Morphology of the Two Layers

Observation with the electron microscope of the structure of inorganic and organic substances in the two layers of carious dentin in human teeth (Ohgushi & Fusayama, 1975) showed that the intertubular dentin of the outer carious dentin was more demineralized and contained granular and leaflike crystals irregularly scattered. Few collagen fibers remained and they showed no distinct crossbands. The odontoblastic processes and the peritubular dentin had disappeared and the tubule spaces were filled with bacteria or loosely scattered crystals of various form.

In the inner carious dentin the intertubular dentin was partly demineralized but the apatite crystals were found like fringes bound to collagen fibers having the proper crossbands similar to those in normal dentin. The peritubular dentin was also partly demineralized. The odontoblastic processes remained as in normal dentin.

Biochemistry of the Two Layers

The organic substance of the two layers of carious dentin in human teeth has been investigated biochemically (Kuboki, Ohgushi & Fusayama, 1977). No difference was found in the pattern of the constituent amino acids between the collagen fibers of the outer carious dentin, the inner carious dentin, or sound dentin. When compared by column chromatography, however, there was a marked difference among the three layers in the intermolecular cross-links of collagen fibers. Compared with sound dentin, the inner carious dentin had fewer cross-links (dihydroxylysinorleucine and hydroxylysinorleucine) and more precursors (dihydroxynorleucine and hydroxynorleucine). This change is considered to be reversible, depending on the pH (Mechanic, 1971). In contrast, in the outer carious dentin, both the cross-links and the precursors decreased markedly. In addition, hexytollysines (protein-saccharide compounds probably related to bacterial metabolism) were found and several peaks of unknown materials appeared. This indicates irreversible destruction of cross-linkages. Such a biochemical finding corresponds with the morphological findings by electron microscopy of typical cross-banding and interbanding of collagen fibers only in the inner carious dentin and the sound dentin (Ohgushi & Fusayama, 1975). Such a biochemical finding suggests that remineralization can occur only in the inner carious dentin with reversibly denatured collagen, because collagen fibers are believed to play an important part in the remineralization of carious dentin (Johnson & Parks, 1961; Johnson, Taylor, & Berman, 1969).

Remineralization of Carious Dentin

The remineralization of the inner carious dentin has been confirmed in human teeth (Miyauchi, Iwaku & Fusayama, 1978). The fuchsin stainable outer carious dentin was removed from pairs of bilateral vital human teeth with symmetrical cavities and the inner carious dentin preserved in the cavity floor. One of each pair of teeth was immediately extracted and the other extracted after capping with polycarboxylate cement, Carlon (Sankin Dental Mfg Co, Tokyo, Japan), for three months. Sections of the pairs were compared for calcium content as determined by an electron probe microanalyzer and for Knoop hardness as determined by a microhardness tester.

The inner carious dentin, without exception, increased markedly in calcium content and hardness after three months (Fig 1). The calcium content and hardness eventually reached the normal level, as previously observed in dog dentin. This remineralization that occurs only in the inner carious dentin of vital teeth is the only remineralization that is signifi-

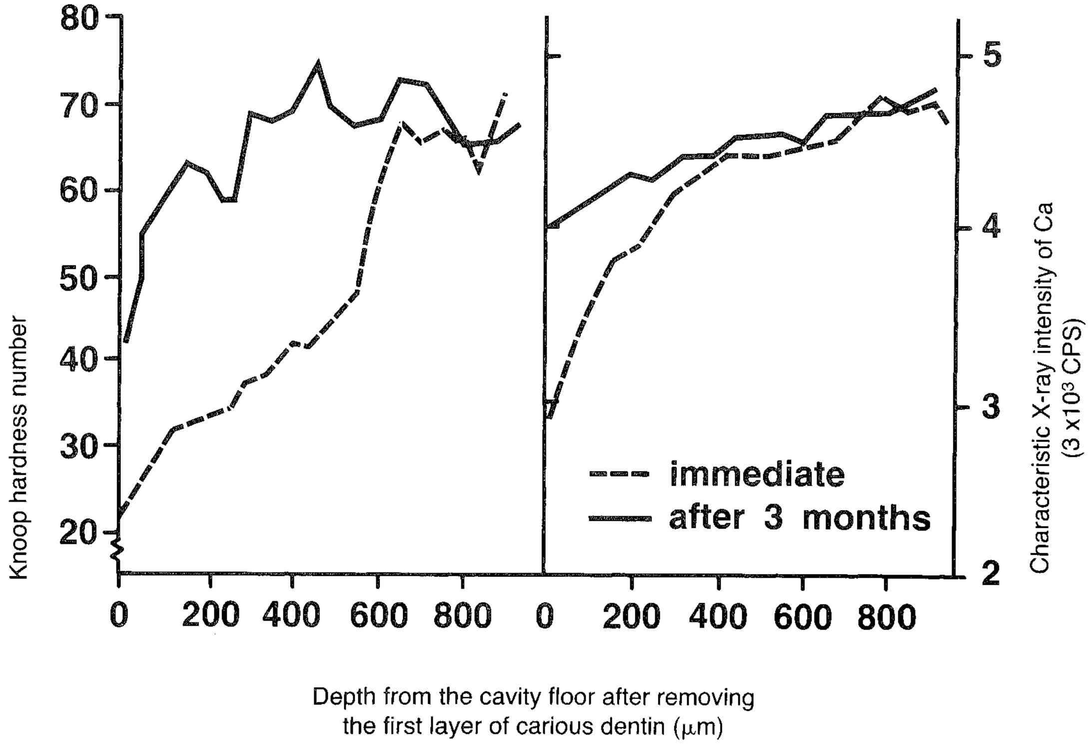

FIG 1. Calcium content and hardness of the inner carious dentin of human teeth before and after remineralization for three months. Remineralization occurred from inside, returning to the level of normal dentin.

cant as far as carious dentin is concerned. The slight increase in calcium content or x-ray opacity, which occurs on or in the outer carious dentin even of nonvital teeth, is considered to be due to penetration of inorganic substance from outside and is of little clinical significance.

DIAGNOSIS AND TREATMENT

Treatment of the Two Layers

The characteristics of the two layers of carious dentin and sound dentin are summarized in Table 1. This summary leads to the following conclusions:

Regardless of hardness and color, the outer carious dentin, which is stainable with fuchsin, must be removed, since it is infected, denatured irreversibly, and unremineralizable. In contrast, the inner carious dentin, which is not stainable with fuchsin, must be preserved as far as possible, since it is not infected, only reversibly denatured, and remineralizable.

The newly developed adhesive composite resin, Clearfil Bond System-F (Kurarey Co, Osaka, Japan) adheres to the inner carious dentin as strongly as to sound dentin (Fusayama & others, 1979). Preservation of the inner carious dentin provides increased protection to the pulp by leaving an increased thickness of dentin without weakening the retention of the restoration. Preservation of the inner carious dentin is recommended also for better pulp protection in cavity preparations for other restorative materials.

Differential Diagnosis of the Two Layers

In chronic decay, natural discoloration can be a guide in the removal of carious dentin, but in acute or moderately acute decay removal of carious dentin must be guided by staining with fuchsin since the

Table 1. Three Layers of Dentin of Caries Teeth

Items Compared	Outer Carious Dentin	Inner Carious Dentin	Sound Layer Normal Dentin
Between Tubules			
Inorganic crystals			
= quantity	much decreased	decreased	unchanged
= form	deformed	slender plate	slender plate
= arrangement	irregularly scattered	attached to collagen	attached to collagen
Collagen fibers			
= crossband structure	unclear or lost	clear	clear
= intermolecular cross-links	irreversibly broken	shift to precursor	sound
In Tubules			
Peritubular dentin	lost	partly demineralized	normal
Odontoblastic processes	lost	sound	sound
Bacteria	infected	uninfected	uninfected
Characteristics			
Remineralization	not remineralizable	remineralizable	———
Hardness	greatly softened	intermediate	normal
Natural discoloration	discolored	partly discolored	not discolored
Diagnosis			
Fuchsin-stainability	stainable	unstainable	unstainable

natural discoloration is not clear and the range of the softened but uninfected and remineralizable layer of dentin, which is to be preserved, is broader (Fusayama & others, 1966; Sato & Fusayama, 1976). If guided by the staining the sacrifice of dentin can be minimized and even decay very close to the pulp can be treated adequately without exposing it (Fig 2).

Effect of Fuchsin Stain on the Pulp

The effect of the stain on the pulp has been investigated (Shimizu & others, 1977). Class 5 cavities of standard depth were prepared on 40 bilateral pairs of dog teeth and filled with polycarboxylate cement, Carlon, after applying the 0.5% solution of basic fuchsin in propylene glycol in one of

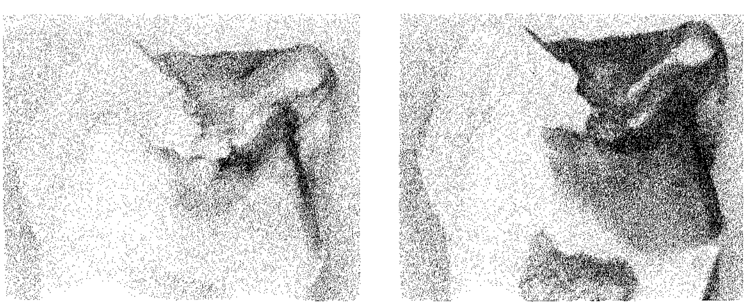

FIG 2. The outer carious dentin to be removed is difficult to distinguish by natural discoloration (left) but very clearly disclosed by the fuchsin staining (right). Even such a deep lesion very close to the pulp horn can be adequately treated without exposing the pulp if guided by this staining.

Table 2. Pathohistologic Pulp Changes after Cavity Preparation and Application of the Caries-Detecting Fuchsin Solution in Dog Teeth

Changes	After 3 days						After 2 weeks					
	Fuchsin group			Control group			Fuchsin group			Control group		
	−	±	+	−	±	+	−	±	+	−	±	+
Change in odontoblasts	4	1	0	4	0	1	5	0	0	5	0	0
Change in predentin	4	1	0	4	1	0	5	0	0	5	0	0
Hemorrhage	4	1	0	5	0	0	4	1	0	4	1	0
Cell infiltration	5	0	0	5	0	0	5	0	0	5	0	0

Figures indicate the number of cases showing individual changes.

each pair and physiological saline solution in the other for 30 seconds. The pulp response was examined histologically after three days and after two weeks. No significant difference in the pulp response was found between the experimental and control groups (Table 2). It was concluded that staining with fuchsin does not harm the pulp.

Technique of Staining with Fuchsin

Markedly softened or discolored dentin is first removed from the carious cavity. A drop of the fuchsin solution is placed in the cavity for approximately 10 seconds and washed with water from a syringe (Fig 3). Only the outer layer of carious dentin is stained

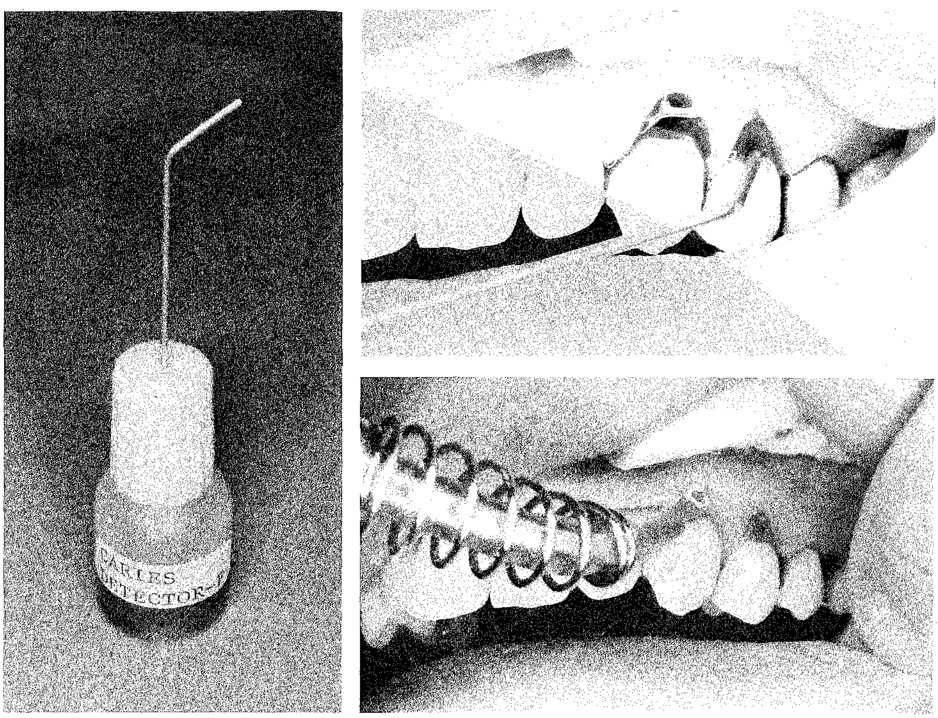

FIG 3. The 0.5% solution of basic fuchsin and propylene glycol, Caries Detector-F (Kurarey Co, Osaka, Japan), for detecting the outer carious dentin (left). After removing the bulk of the softened dentin, a drop of the solution is applied to each cavity (top) for approximately 10 seconds and washed with water (bottom). The residue of the outer carious dentin, stained scarlet, is then removed. This check and removal is repeated until complete removal of the outer carious dentin is confirmed by lack of staining.

red (Fig 4). Do not leave the dye in the cavity too long or the inner carious dentin will be stained also. The stained tissue is completely removed and the unstained tissue carefully saved. Enamel with residual caries, and dental plaque on the surrounding surface of the tooth, will also be stained and must be removed. The solution is applied again and any stained dentin removed. This check is repeated until complete removal of stainable dentin is confirmed. By this technique, the operator can be sure he has removed all infected carious dentin and preserved all remineralizable carious dentin and sound dentin.

This technique has been used routinely in the clinic of the Tokyo Medical and Dental University since 1973 with favorable results. Careful removal of the outer carious dentin without cutting the inner carious dentin or sound dentin does not cause any pain. The chemically adhesive restorative resin mentioned above, which is adhesive even to the inner carious dentin, can be placed immediately without cutting retention form in the remaining dentin (Fusayama, Iwaku & Kurosaki, 1978). Painless restoration of carious cavities is thus possible with no anesthesia. Careful preservation of the inner carious dentin and sound dentin, guided by fuchsin staining, also will minimize pulp irritation for restoration with other materials.

Note added in proof:

Since the completion of this study we have noted references in the literature to the suspected carcinogenicity of fuchsin (Poole-Wilson, 1960; Shubik & Hartwell, 1969). In particular, tumors have been produced in the lymphatic glands of two out of 30 mice by massive doses of fuchsin, doses 17 million times the amount a patient might swallow during the use of the dye for detecting carious dentin. Though it is hardly conceivable that the use of fuchsin for staining dentin could lead to cancer, nevertheless we have looked for a substitute dye to eliminate the fear even of the possibility of carcinogenesis. Acid red ($C_{27}H_{29}O_7N_2S_2Na$) is a dye that has long been used in foods and there are no reports of it being carcinogenic. Used as a 1% solution in propylene glycol, acid red is a satisfactory substitute for fuchsin as a stain for carious dentin.

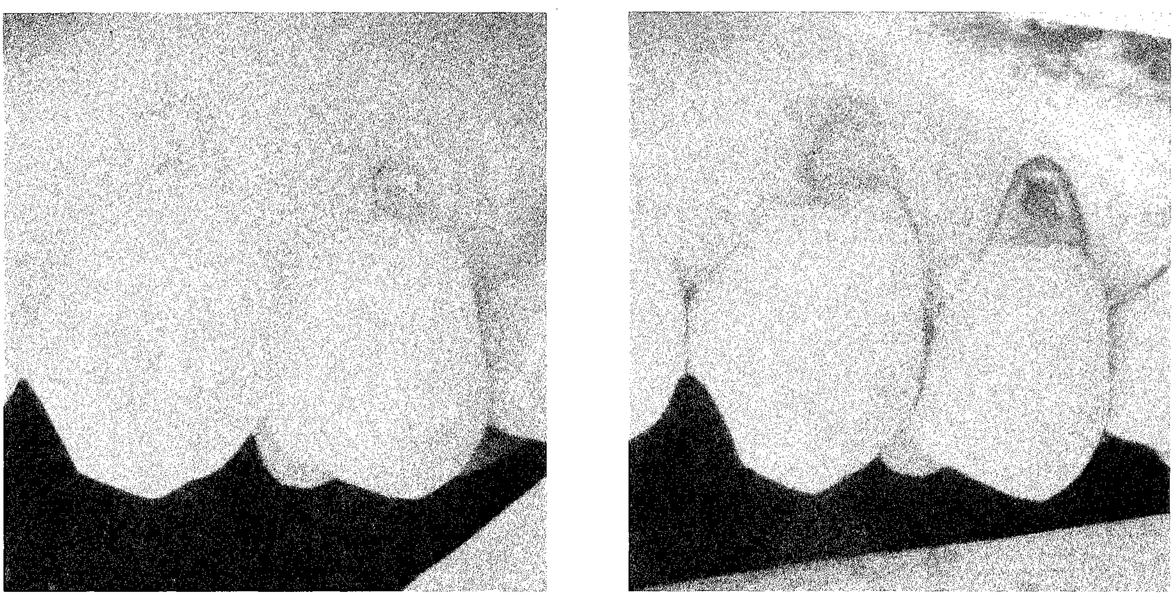

FIG 4. An example of a decayed wedge-shaped defect before (left) and after (right) the staining. The residue of the outer carious dentin is stained red.

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PRODUCT REPORTS

Physical Properties of Two High-Copper Amalgams and a Conventional Amalgam

More confirmatory evidence for the superiority of physical properties of amalgams with added copper

BARBARA F RHODES • MARJORIE L SWARTZ
RALPH W PHILLIPS

Summary

The physical properties of dimensional change, compressive strength, creep, and flow were determined for amalgams made of Dispersalloy, Tytin, and Fine Cut, respectively. Dispersalloy had expanded by about 3 μm/cm at the end of 24 hours whereas Tytin had contracted about 6 μm/cm and Fine Cut about 16 μm/cm. The compressive strengths of the amalgams at a month were approximately: Tytin—86 000 lbf/in² (5934 MPa), Dispersalloy—67 000 lbf/in² (4623 MPa), and Fine Cut—63 000 lbf/in² (4347 MPa). Creep was determined to be 0.07 for Tytin, 0.25% for Dispersalloy, and 1.96% for Fine Cut, and flow to be 0.10 for Tytin, 0.70 for Dispersalloy, and 0.95 for Fine Cut.

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Introduction

Most of the published data on the classical properties of amalgam, such as dimensional change and compressive strength as related to time, were obtained in tests with alloys that differ substantially from those now currently available (Phillips, 1949; Ward & Scott, 1932; Jarabak, 1942). Today's high-copper alloys differ greatly in composition; they differ also from each other in the means by which the content of copper is increased, the configuration of the particles, and other procedures of manufacture. Even present-day alloys of conventional composition may differ from their predecessors in heat treatment and in the size and distribution of the particles. Furthermore, much of the earlier data on these alloys were obtained from amalgams prepared with a higher ratio of mercury to alloy than those in general use today, and by hand mixing if tested according to older versions of Specification No 1 of the American Dental Association (American Dental Association, 1964).

The purpose of this research was to obtain information on dimensional change, compressive strength, creep, and flow of two representative high-copper alloys and a conventional alloy, when mixed mechanically at a low ratio of mercury to alloy.

Materials

The three alloys tested, Dispersalloy, Tytin, and Fine Cut, are listed in Table 1. Dispersalloy is a conventional lathe-cut, silver-tin alloy with an admixture of spherical particles of silver-copper eutectic. Tytin, composed of spherical particles, is a single-phase alloy containing a high content of copper. Fine Cut is a lathe-cut alloy of conventional composition.

Methods

In each instance the ratio of mercury to alloy and the time of trituration were those recommended by the respective manufacturer (Table 1). The specimens for all tests were condensed by a dead load according to the technic prescribed in the current Specification No 1 for Dental Amalgam (American Dental Association, (1969).

Dimensional change was measured at 37 °C with a dental interferometer. The initial reading was taken 5 minutes after completion of trituration and at intervals of 2.5 minutes during the first 30 minutes and at intervals of 5 minutes during the next 30 minutes. Thereafter, readings were taken hourly up to 6 hours, with a final reading at 24 hours. Four specimens of each material were tested.

Specimens (4 × 8 mm) used for determining compressive strength were kept at room temperature until tested. Compressive strength was measured on groups of six specimens of each alloy at 15 minutes, 30 minutes, and 1, 2, 4, 6, 8, and 24 hours. Additional tests were run at 1 week and 1 month. All specimens were loaded, until they failed, at a cross-head speed of 0.02 in/min (0.51 mm/min).

Creep was measured 7 days after the preparation of the specimens. The lengths of the specimens were measured and the specimens then placed under a load of 100 lbf/in^2 (690 kPa) in an incubator at 37 ± 0.5 °C. After an hour the lengths were measured again and a final measurement was made at 4 hours. Creep of the specimens was calculated on the change that occurred between 1 and 4 hours. Each test group consisted of 10 specimens.

Flow was tested according to the specification of the American Dental Association.

Table 1. Alloys Tested, Mercury:Alloy Ratio, and Trituration Time

Alloy	Manufacturer	Hg:Alloy Ratio	Trituration* Time s
Dispersalloy	Johnson & Johnson East Windsor, NJ 08520, USA	1:1	10
Tytin+	S S White Philadelphia, PA 19102, USA	0.77:1	3
Fine Cut	L D Caulk Co Milford, DE 19963, USA	1:1	10

*Caulk Vari-Mix—M2 setting
+Precapsulated

Results

The curves of dimensional change for the three alloys are shown in Figure 1. Dispersalloy displays the classical pattern of dimensional change—an initial contraction followed by expansion. Neither Tytin nor Fine Cut show this type of change. Both alloys show a rapid initial contraction and, though the rate of contraction levels off, there is no expansion. However, all three alloys fall within the limits of acceptability as designated by the specification.

The curves for compressive strength obtained for the three alloys are shown in Figure 2. Results within each test group deviated by less than 10%. The strength of the conventional alloy, Fine Cut, levels at approximately 4 hours and that of the two high-copper alloys after approximately 8 hours. However, the strength of all three alloys gradually increases thereafter. The strength at a month exceeds that at 24 hours by approximately 10 000 lbf/in^2 (69 MPa). The curves for compressive strength for these alloys, with respect to time, are similar to those published for older amalgam alloys (Phillips, 1949).

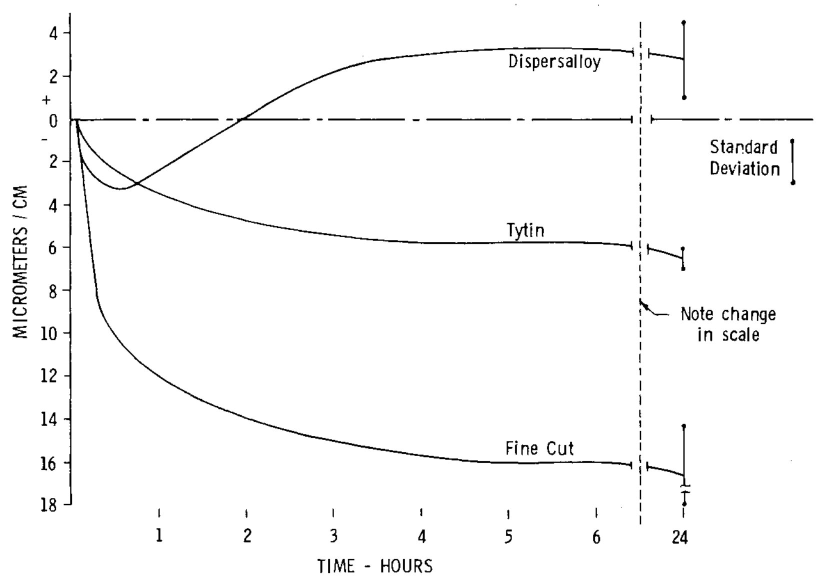

FIG 1. Dimensional change curves for three amalgam alloys

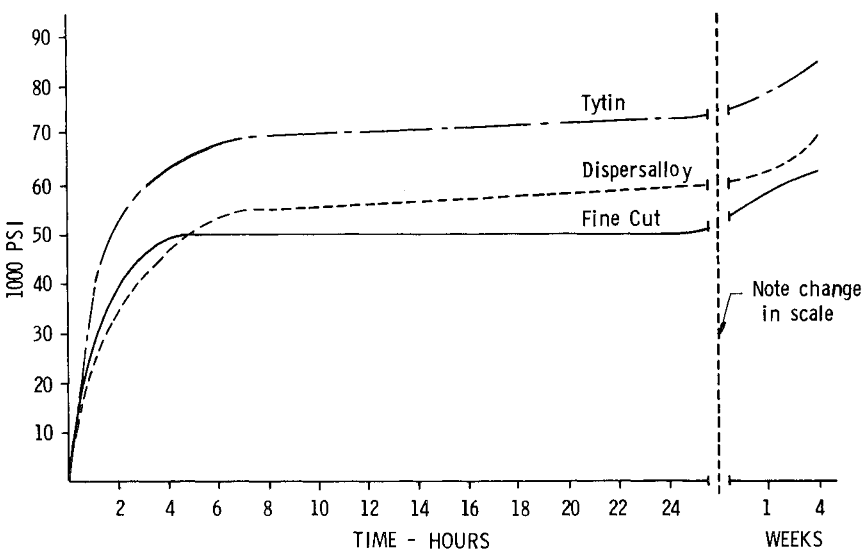

FIG 2. Compressive strength of three amalgam alloys as related to time

The data on creep and flow are given in Table 2. As has been shown in other studies, the two high-copper alloys have less creep and flow than does the conventional alloy (Osborne & others, 1977).

Table 2. Creep and Flow of Amalgams

Alloy	Creep %	Flow %
Dispersalloy	0.25	0.70
Tytin	0.07	0.10
Fine Cut	1.96	0.95

Conclusions

The pattern of the dimensional change of Dispersalloy during setting is classical, a contraction followed by an expansion, whereas Tytin, the other high-copper alloy tested, exhibits no expansion. The conventional alloy, Fine Cut, when mixed mechanically at a low ratio of mercury to alloy, does not expand during setting. The behavior of these two high-copper alloys, as well as that of the traditional silver-tin alloy, used with a low mercury:alloy ratio, does not differ appreciably from the behavior of various alloys used in the past with higher ratios of mercury to alloy. The differences observed between the physical properties of the various alloys, other than perhaps creep, undoubtedly have little or no clinical significance.

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Porcelain Repairs: Retention after One Year

Porcelain repairs with bonding agents and composite become more retentive after one year.

WILMER B EAMES • LARRY B ROGERS

Summary

In a 12-month follow-up of an earlier study, Den-Mat and Fusion were compared as materials for repairing porcelain. After 27 specimens were soaked in water at mouth temperature for over a year, retention increased appreciably and gave credence to claims of the manufacturers.

Fusion gave the greatest retention when used with either Concise or Den-Mat composites, in all cases resulting in failure of the porcelain rather than separation at the repaired interface.

Den-Mat also gave much better retention after the one-year bath, but the retention was less than that of Fusion and the breaks appeared most often at the interface or repaired junction.

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LARRY B ROGERS, BA, research assistant

In a Product Report published approximately a year ago, two bonding agents for repairing porcelain were found to enhance the retention of composites that were used to repair fractured dental porcelain (Eames & others, 1977). In the interest of conserving space the details of the laboratory techniques will not be repeated here, but the investigation was conducted under carefully standardized conditions. Fresh materials were used and each product was tested under identical conditions.

These two products, Den-Mat (Den-Mat, Inc, Santa Maria, CA 93454, USA) and Fusion (George Taub Products, Jersey City, NJ 07307, USA), were both found to give clinically acceptable retention when tested dry, when soaked in water at mouth temperature for 24 hours and for seven days, and when cycled for 24 hours in temperatures ranging from 2 °C to 60 °C.

Den-Mat bonding agent was used with Den-Mat composite and Fusion with Concise composite (3M Co—Dental Products, St Paul, MN 55101, USA). Although the Fusion/Concise combination gave somewhat better retention than the Den-Mat product, it was felt that both products are valuable for repairing porcelain and can be used with confidence in lieu of the removal and replacement of fractured porcelain crowns, veneered crowns, and fixed prostheses.

The Follow-Up

Although successes as well as failures in repairing porcelain have been reported over many years, in most instances it was felt that the successes and failures were not caused by inadequate skills or poor techniques. It has now been well established that the bonding agents have a limited shelf life and, as is true of most chemicals, are best kept refrigerated.

Specimens of both products were prepared as before and kept in water at 36.7 °C for 12 months. The strengths of the bonds were then tested as before.

The results are shown in the table.

The results for the specimens in which the fracture was in the porcelain rather than at the interface are included in the data because this represents the ultimate expectancy under clinical conditions.

The unexpected increase in bond strength, and fracture of many of the porcelain teeth themselves, gives credence to these repair techniques.

We have no explanation for the increase in retention compared with that reported over a year ago, but the results are encouraging. The ultimate test, of course, is in the mouth. We feel that failures most often are caused by the deterioration of these chemical products before they are placed. This can result either from the length of time they are stored by the dealer or from the lack of cool storage by the dentist.

Retentive Strength of Bonding Agents

	7 Days*		One Year	
Materials	No of Specimens	Pounds SD	No of Specimens	Pounds SD
Den-Mat Composite with Den-Mat Bonding Agent	10 (no porcelain failures)	92 ± 26	5 (2 porcelain failures)	122 ± 30
Concise Composite with Den-Mat Bonding Agent	8 (no porcelain) failures)	42 ± 7	6 (1 porcelain failure)	122 ± 63
Concise Composite with Fusion Bonding Agent	10 (10 porcelain failures)	188 ± 16	9 (9 porcelain failures)	216 ± 42
Den-Mat Composite with Fusion Bonding Agent	12 (5 porcelain failures)	189 ± 13	7 (7 porcelain failures)	206 ± 63

*Comparative data from a Product Report in *Operative Dentistry* (1977), **2,** 118–124, by Eames & others.

"Porcelain failures" indicate fracture of the specimen itself. When "no porcelain failures" were found, the failure occurred at the interface where the repair material was used.

The several combinations of the materials tested show bonding to be significantly more effective when Fusion is used with either Concise or Den-Mat composite than when the Den-Mat bonding agent is used with its companion composite or with Concise.

Presumably other composites could be used successfully with either bonding agent, since the resinous matrix is essentially the same. Den-Mat is sold as a complete repair product, including the composite veneering material. Fusion, sold only as a bonding agent for many years, provided a bond strength of porcelain to composite in excess of the shearing resistance of the porcelain itself.

This study was supported in part by the National Institutes of Health, National Institute of Dental Research, Research Grant No 5–RO–1–DE03504–09 and by the Fifth District Dental Society.

We wish to express our appreciation to Paul Feller, Emory class of 1979, for his technical participation in this study.

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OPERATIVE DENTISTRY, 1979, 4, 78–80.

POINT OF VIEW

The British National Health Service in Dentistry: A Nonworking Model

ALLAN G OSBORN

In an era of instant solutions to instant problems, it is salutary to look at the results of a particular system that has attempted to achieve instant cures to some real—and some imaginary—problems. That system is the dental component of the British National Health Service. This service was set up to be all-encompassing, but obstacles placed by government between the practitioners and the delivery system have rendered such a claim either farcical or a gross deception, depending on one's point of view.

Production Up, Quality Down

In the process of setting up the scheme, the government first prescribed the annual net income it felt a dentist should earn. Then from information obtained by government officers on the time required to complete the various treatments, the government set a fee for each type of procedure so that dentists could attain the target net income if they used the time allocated by the government to complete the service. The government, however, allowed inadequate time for the procedures to be done properly. This in turn led to excessive production in trying to reach the target net income, and standards began to fall at an alarming rate—five class 2 amalgams or eight silicate cements being required per hour, on average, to achieve the target net income. In other instances, porcelain-bonded crowns for example, the fee allowed by the government is frequently less than the laboratory fee, sometimes by a substantial margin. By allocating inadequate time to procedures, by controlling access to other than simple procedures, by global financing or setting target net incomes, and further by late or inadequate compensation for increasing overhead, government has effectively controlled patterns of practice, and thwarted progress and improvement of clinical performance.

In the late 40s and early 50s dentists faced a cut in net income of above 40% on each occasion, thus forcing increased production and a concomitant lowering of standards. This government action was unilateral, arbitrary, taken without consultation, and repeated again in the early 60s. Incomes at the time were far from excessive, but hours of work were,

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due to the limited manpower, postwar backlog of work, and a population that was becoming increasingly aware of its dental health.

Politicians have proudly boasted, in reports to Westminster, that ever-increasing volumes of work are being accomplished at ever improving cost-benefit ratios. The obverse side of the coin, not being publicized when I left the unhappy scene, was that these restorations are lasting only six to nine months. One wonders what this factor might do to a cost-benefit analysis.

With preauthorization of treatment required, the equation is weighted in favor of bureaucratic whim or convenience, the state of the budget, and the calendar of elections, rather than the clinical requirements of the patient—it being markedly easier to obtain authorization before elections than afterward. This leaves the patient in a position where he is likely to pay privately for anything beyond simple treatment. As a result he receives no benefit from the government and is thus subjected to double taxation.

Dental School Curriculum Weakened

Because it does not want to finance more advanced procedures, the government has put pressure on the universities to dilute their curricula to suit its concept of practice. Schools have resisted the pressure to cease the teaching of inlays and onlays and deserve much credit for their position.

Gold foil, long since proven to be the closest to an ideal restorative medium, has been discarded by all schools. Even in North America we have deans that prefer gimmickry to proven performance, that deny their students access to an important body of knowledge, and compromise not only their clinical judgment but even their ability to complete state examinations for licensing.

Attention to detail is the factor above all that makes operative dentistry successful. The insidious tendency to enhance production by simplifying procedures and omitting detail has greatly weakened the service to the patient by both the National Health Service and, in North America, the disciples of those false prophets that espouse production at the expense of careful clinical performance.

Government bureaucracy becomes set in comfortable patterns over the years making change virtually impossible, or at least very difficult. Thus the patterns of practice that emerge are not progressive; in fact they are severely limited. We have only to look at periodontal health, preventive dentistry, and root canal therapy to see that the first two are essentially not practiced under the scheme and that root canal therapy is primitive. As we observe the system we see that the public is receiving no benefit from the superb research that is being carried out in Britain, or from the excellent science that is generated in the dental schools. We see instead a concerted effort to compartmentalize into the simplest possible terms both the standards of operation and the procedures that may be performed under the scheme—effectively the lowest common denominator.

Government Attacks Dentistry

During the 50s and 60s the profession was frequently subjected to vitriolic attack by the government. Any intended investigation, any shortcoming, whether real or imaginary and regardless of merit, was given maximum exposure by the press. The government was undeniably successful in undermining public respect and sympathy for, and confidence in, the profession. Though the government has recently admitted that this had been its policy and has apologized, I fully believe the government would resort to such tactics again, and I doubt that it will be easy to undo the damage that has been caused to dentistry, or the damage caused to the value people place upon oral health. This could be viewed as a form of negative education to reduce demand for treatment.

Terms and conditions of practice under the National Health Service preclude drawing the attention of patients to the shortcomings in the scheme. Criticism is not allowed. Furthermore, the patient must accept the practitioner's view of what must be done whether the patient is in accord or not. In a scheme that leads to the lowest common denominator, searching for another or yet another practitioner is likely to lead to the same unsatisfactory answer. This leaves the patients little choice but to seek treatment by private contract if they want to retain their natural dentition for the maximum period.

Crisis Management

The government system represents nothing more than crisis management, leading inevitably to many extractions and simple forms of plastic partial dentures, commonly referred to as gum strippers, and leading finally to that stoniest of all deserts, complete dentures.

As the term 'crisis management' indicates, the scheme is based upon a concept of dentistry that views teeth as expendable. Diagnosis itself was severely compromised by the required preauthorization for anything beyond three x-rays during the time I spent in practice. This is clearly untenable and is particularly sad in an era that has seen many advances in dental materials and preventive dentistry and has the potential for greater precision in our work. Perhaps as never before we can promise people that they need never lose their dentition, only to have them wear their teeth in their hip pocket.

Though the discussion here has centered on the British National Health Service, several governments have equally unsuccessful systems.

Conclusions

Politics is the art of promising "pie in the sky" and being in a position to blame someone else when the sky falls on our heads.

A system free from government interference remains our patients' best hope of maintaining high quality service at a reasonable cost.

We can in no way be complacent but must aggressively inform and educate our patients as to just what high quality dental care can do for them. We must also ensure that our dental schools do not let us down by failing to teach a full and complete discipline.

Letter from Europe

Adam J Spanauf

The second European Conference of Teachers of Conservative Dentistry organized by the British Society of Restorative Dentistry took place at the University of Newcastle-upon-Tyne Dental School on 19-20 September 1978. It was attended by one hundred representatives from Great Britain, France, The Netherlands, Belgium, Sweden, and West Germany. The conference was devoted to lectures and discussions on the following topics:

1. Teaching methods
2. Student assessment 1978
3. Planning a new department of conservative dentistry

Much of the conference stressed the use of modern teaching aids. Impressive examples were shown of audio-visual machines, modern methods of projection, computer-assisted education, and a self-paced course in preclinical operative dentistry. These modern aids are necessary because of large classes and a shortage of teachers. However, I should point out that the word 'constructive', as related to the new teaching methods and media, should be taken as a statement of good intentions, not as a promise of blinding insights that will open up the prospects of a new dawn.

It was clearly stressed at the conference that when talking about teaching methods we must not forget some of the effects of the money crisis, difficulty in obtaining qualified staff, need for better use of resources, and larger and more bureaucratic dental schools.

Dental educators would be wise to revise some of the definitions of terms such as 'predicament', 'mistake', and 'failure'.

A predicament is a situation we find difficult or impossible to control, so that, in either case, we are at a disadvantage and in addition may be seen to be at a disadvantage by others.

A mistake is an act that is incorrect in the light of knowledge and unwise or inappropriate in the circumstances in which it is being performed.

A failure is an inability to bring a project to a successful conclusion, sometimes due to an error of planning, sometimes due to lack of application of the required degree of technical skill, but sometimes due to a combination of circumstances that might reasonably not have been expected.

Most of the European dental schools are revising their curricula. They would be wise to heed the warnings and comments given in the editorial section of *Operative Dentistry* as, for example, "Is Dental Education Regaining its Sanity?" by A Ian Hamilton (*Operative Dentistry,* 1978, Vol 3, p 121). It will be some time before the European community reaches uniform agreement on what should be the starting point in dental education and what should be its end. Each European country has a different and specific organization of its dental body that governs the right to practice.

It is to be hoped that by such conferences we will make some progress in finding a common ground of recognition for each other's diplomas and educational problems.

ADAM J SPANAUF

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He has participated in postgraduate study at the University of London and in general practice under the British National Health Service. He is a member of the British Society of Periodontology, the British Society of Restorative Dentistry, and the Academy of Operative Dentistry.

OPERATIVE DENTISTRY, 1979, **4**, 82–83.

Hollenback Memorial Prize

Wilmer B Eames

Wilmer B Eames has won the Hollenback Memorial Prize for 1979. The prize is given annually by the Academy of Operative Dentistry to honor the recipient for accomplishments that have contributed substantially to the advancement of operative dentistry. Dr Eames won the prize for advocating the use of a low mercury:alloy ratio in amalgam, for providing the practicing dentist with evaluations of the performance of dental products, and for encouraging dental students to engage in research.

Dr Eames received his DDS degree from Kansas City-Western Dental College in 1939 and practiced in Colorado for 22 years. He joined Northwestern University Dental School as professor of operative dentistry in 1961 and subsequently became associate dean. In 1967 he accepted an appointment at Emory University where he is now professor of operative dentistry and director of the division of applied dental materials.

Dr Eames is well known for his studies on amalgam, particularly for his early advocacy of approximately a 1:1 ratio of mercury to alloy to avoid having to remove excess mercury by squeezing. He has also designed a contoured matrix band for amalgam, known as the Dixieland Band, and dental wedges, Wedg-eze, both of which are currently available. He is a lecturer of international stature and reputation as well as the author of many publications. His years in practice gave him an appreciation for the value of good instruments and equipment, and as a result he has devoted a substantial part of his research to the evaluation of dental products. His research has been practical and thus has provided a valuable service to the dental practitioner. As a dedicated teacher he understands the importance of research in teaching and has successfully interested his students in research, thus enhancing their education.

Dr Eames has received the Science of Dentistry Appreciation Award of the Georgia Dental Association, the Golden Eagle Award for films on amalgam (twice awarded), and last year received the Man in Dentistry award from the Northern District Dental Society of Georgia. He has recently been given a certificate of appreciation by the American Student Dental Association. He has also received other awards, fellowships, citations, honorary citizenships, and offices and memberships in several dental organizations.

Dr Eames is a member of the American Academy of Restorative Dentistry, the Academy of Operative Dentistry, and the honor societies of Omicron Kappa Upsilon and Sigma Xi. He is a fellow of the American College of Dentists and the International College of Dentists, an honorable fellow of the Georgia Dental Association, and an honorary member of Alpha Omega.

DEPARTMENTS

Dear Woody

Dear Woody:

With the universal acceptance of the conservative preparation for amalgam restorations, the centric and working areas are more frequently being maintained in natural tooth structure. When it is essential, however, to restore these occluding surfaces with amalgam, how can the operator carve and shape those surfaces to ensure proper occlusal function?

Perry Don Titus
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Editor's Note: Dear Woody is a new feature designed to provide a service for the readers of the Journal by seeking answers to questions about dentistry that most of us have but to which we have been unable to find answers. Nelson W Rupp, the originator of the idea, has agreed to coordinate this section. Send your questions, and your answer to the above question if you have one, to:

Dr Nelson W Rupp
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Dental Research Section
Washington, DC 20234

Press Digest

Immunity conveyed by sodium fluoride supplement during pregnancy: part II. Glenn, T B (1979) *Journal of Dentistry for Children* (46) 17–24.

In a study of three groups of children (771 children in all) it has been found that of those (36) whose mothers ingested 2.2 mg of sodium fluoride daily during pregnancy, 97% were free of caries at an average age of four years compared with those (16) whose mothers ingested a tablet combining vitamins with 1.0 mg of sodium fluoride (69% free of caries) and with those (719) whose mothers drank fluoridated water only (23% free of caries). The teeth of the group that was 97% free of caries were structurally and esthetically superior. The author suggests that the fluoride tablets should be taken between the third and ninth months of pregnancy.

Elastomeric impression materials: effect of bulk on accuracy. Eames, W B, Sieweke, J C, Wallace, S W & Rogers, L B (1979) *Journal of Prosthetic Dentistry* (41) 304–307.

Polysulfide, polyether, and silicone impression materials were found to give the greatest accuracy when they were used in a thickness, between the tray and preparation, of 2 mm.

Pin vs slot retention in extensive amalgam restorations. Outhwaite, W C, Garman, T A & Pashley, D H (1979) *Journal of Prosthetic Dentistry* (41) 396–400.

The strength of amalgam cores retained with either four self-threading pins or a circumferential slot cut with a 33½ inverted cone bur were compared. The depth of the pins was 2 mm and that of the slot was the depth of the head of the bur. Under the same type of stress there was no significant difference between the methods in the force needed to cause failure of the core.

Book Review

THE BAR-JOINT DENTURE

by Eugene J Dolder and Gustav T Durrer

Published by Quintessence Publishing Co, Chicago, Berlin, Rio de Janeiro, and Tokyo, 1978. 112 pages. 150 illustrations, 80 in color. $42.00

More than 25 years ago the senior authors developed the bar-joint denture known as the Dolder Bar. At last they have compiled their techniques and knowledge into a complete textbook. Interest in the overdenture concept has grown increasingly in the last decade, yet one of the problems in the use of the bar-joint denture in the United States has been the lack of clearly written description of the procedures involved. This text will help correct that problem and will be of interest to the practicing dentist, the dental teacher, and those involved in prosthodontic research.

The bar-joint denture is a combination of a modified fixed bridge and a removable prosthesis. Two or more remaining teeth are treated endodontically, shortened, and splinted with cast restorations joined by a straight metal bar. The denture is placed over this splint and retained by a metal clip, which fits over the bar.

The authors cover all important aspects of the bar-joint denture including the rationale, indications, preparatory treatment, construction details, management of special problems, and repair and relining. The result is an excellent clinical reference for the practicing dentist that is interested in providing this type of service to patients. A list of suppliers who will have the necessary materials is provided at the end of the book.

Unlike many clinical manuals, this text includes clinical research evaluating the effectiveness of the bar-joint denture. Documentation is presented to show that mobility of abutment teeth decreases after placement of bar-joint dentures. Studies on biting force, bar deformation, chewing efficiency, ridge resorption, and stress distribution all show advantages for the bar-joint concept. Three longitudinal studies indicate that the bar-joint denture offers a method of treatment that can provide long-term success.

The quality of the illustrations is excellent, particularly those presented in color. The authors make very effective use of drawings. The number of illustrations makes it relatively easy for the reader to grasp the concepts presented.

Although the authors try to present only factual information, they are understandably enthusiastic about the bar-joint denture and the reader must recognize that their viewpoint is a biased one. Other approaches that are not as technically complex can also provide a clinically successful service for patients with few remaining teeth. Specifically, the overdenture without a bar or attachments has been shown by clinical studies to be such a treatment.

For those who are interested in the bar-joint denture, this text is a complete, clearly written, well-illustrated text and reference.

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Department of Prosthodontics
School of Dentistry
University of Washington

Announcements

NOTICE OF MEETINGS

American Academy of Gold Foil Operators

Annual Meeting: October 18 and 19, 1979
Baylor College of Dentistry
Dallas, Texas

Academy of Operative Dentistry

Annual Meeting: February 14 and 15, 1980
Hyatt Regency Hotel
Chicago, Illinois

NEWS OF THE ACADEMIES

Academy of Operative Dentistry President's Comments

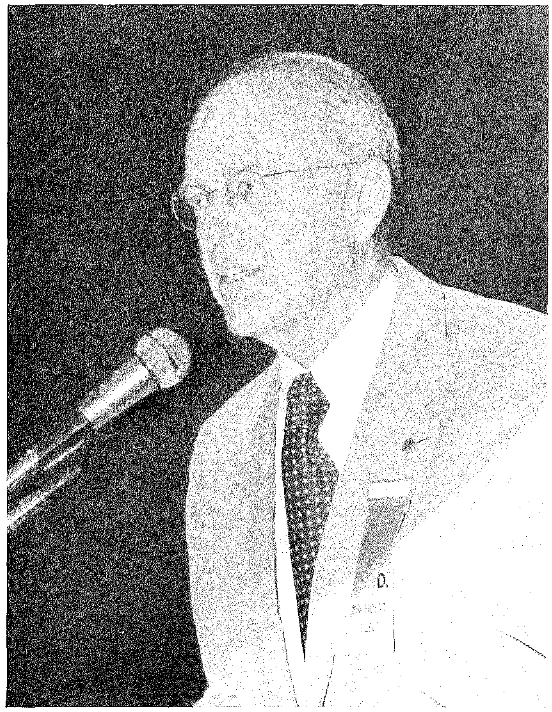
In 1972 Dr David A Grainger gave the keynote address for the organizational meeting of our Academy of Operative Dentistry. He charted a course that will serve as a guide and a challenge for many years. I could repeat his thoughts because they are as timely today as when given seven years ago. Instead of that I will dedicate my year to David's memory and to the goals he set forth.

If we, as an organization, can adopt his concept of "serial career" goals, we will be able to set a number of goals as an overall pattern for growth. To do this we must have a thorough grasp of the entire trajectory or path from our starting point seven years ago through our position today and to the ultimate goal, as we see it now. As we proceed to that point in the future, we must continue to make sightings to set our position and ensure progress toward our goal. It is these intermediate points which are the "serial goals" Dr Grainger mentioned.

Today we do have a viable organization as evidenced by, one, the attendance at this meeting; two, the journal, *Operative Dentistry,* which is a joint project with the Academy of Gold Foil Operators; and three, a good start on obtaining greater recognition through our "hoped-for" specialty status. These "serial goals" are all on the course toward that principal objective, promoting excellence in operative dentistry for all patients.

This delivery of professional services, however, is meeting resistance from several directions. Consider the Federal Trade Commission, which judges dentistry as a store selling "fillings" and "plates." Another, along the same line of marketing dentistry, are corporations such as Sears, which are setting up dental departments alongside the shoe, housewares, and clothes departments where "fillings," "cleanings," and "plates" are sold. And a third point of resistance are patients who either expect to lose their teeth by 40 or 50 years of age or whose lifestyle demands clothes or new cars in preference to their or their family's health needs.

Where does that leave us who look on dentistry as a profession interested in the whole patient and the coordination of diagnosis with treatment planning? We must move off our apathy and accept the challenge. We must move into the future and bring with us the dental schools, the state boards and all the dentists, and with them the patients for whom we are responsible. Operative dentistry, as we well know, is a biologic and restorative multispecialty. We must emphasize the need to understand each patient as an individual who has placed his or her health squarely in our hands. In order to fulfill that trust we must have a deep understanding of, and experience in, microbiology, anatomy, pathology, chemistry, nutrition, biomaterials, and so forth. Then we must be able to use that knowledge and experience for the benefit of the periodontium, pulp, occlusion, and the promotion of oral health in the *professional* care which is *unique* for each individual.



Nelson W Rupp, President, Academy of Operative Dentistry

We dentists as a group are only an extension of attitudes within the general population. Many in all walks of life have been turned off by the required paperwork and mountains of red tape. As a result it is all too common to hear from dentists in all parts of the country the following moan, "If everything can just hold together for six more years, or eleven more years (or however many years that individual plans to practice), by that time I will be out of the profession." Twice during this meeting I have heard this from fellow members. We cannot tolerate that expression. We must face our problems head on.

One of the threats we need to overcome is the steady and apparently inexorable slide toward accepting the concept that the dental profession is an industry and that our patients are customers.

Another problem that we cannot ignore is brought to focus—sharp and clear—by this quote from *Newsweek* (page 11 in the March 28, 1977 issue): "Isn't the assurance of good medical and dental care as important to you as the assurance of adequate protection by the police and military? Should not physicians and dentists be trained in the areas of medicine where they are needed and stationed accordingly? Shouldn't their income be geared, not to what they want, but to what we can afford and the value we place on their work?" This is still quoting, "If people don't like public control, they can choose not to become doctors or dentists."

Our struggle to overcome these threats is not limited just to stirring us into action but includes several courses which that action can take. The Federal Trade Commission must be fought, as it is by the American Dental Association, the Indiana State Dental Society, and other component societies, through the courts to preserve the professionalism of dentistry and to eliminate the concept of dentistry as an industry that is marketing products.

The planners in Congress and the Department of Health, Education, and Welfare must be educated to the true professional concept of the delivery of health care. They must learn that dentists are educated, not trained; that diagnosis and treatment are multiphasic and dependent on a careful blend of the knowledge of basic sciences to prevent diseases, and that skills are required to restore and replace damaged oral structures.

Also we must educate our patients to the proven fact that teeth are the most durable human tissue and there is no reason to lose a tooth, other than through trauma. Each patient should know that with proper care his or her own teeth will last a lifetime—a full and complete lifetime.

Now, that is a big order and will require many steps or "serial goals" to complete. The first step was started several years ago within the Study Club Committee under the chairmanship of Dr William N Gagnon. He has compiled a directory of study clubs and from these clubs obtained guidelines for organizing additional groups. With that information, members and nonmembers can receive assistance in organizing study groups in their community. Also, the directory will identify clubs, in the vicinity of the group being started, from which personal guidance can be obtained.

In addition to fostering new study clubs and injecting new life into faltering ones, this directory will be helpful in developing regional organizations. We must find a way to recognize the abilities of all members so new names and faces with their fresh ideas can become a contributing part of our Academy. A regionalization will give all members the exposure needed so they will be identified and be given the opportunity to grow. The Academy will grow in its influence only as long as all members are vigorous and contributing.

Another area in which the Academy as an organization can contribute to each member is as a consultant or troubleshooter. The journal *Operative Dentistry* is indirectly doing that now with the excellent articles on treatment and product evaluations. It is asking too much for the editor to respond with articles concerning individual problem areas; however, a section in *Operative Dentistry* will be devoted to problem solving. There is no one member who can spend the time or has the information to reply fully to such questions, but our membership consists of a wide diversity of special interests, teachers, researchers, and private practitioners; members who have the answer can surely be found. I will volunteer, for one year as a starter, to act as the coordinator for such a project. Send your questions or problems to me and I will find someone who can give a practical and thorough response.

These "serial career" goals, (1) encouraging study clubs, (2) developing regional organizations, (3) arranging a "troubleshooting" service, and (4) continuing to pursue the specialty status will keep us growing and maturing as a fully effective Academy of Operative Dentistry. In this way we will be living up to our dedication: "To promote excellence in Operative Dentistry by exerting our influence in the practice of the health professions, in organized dentistry, in health science education, in research and in any other realm where dentistry is involved."

Nelson W Rupp, DDS, MS
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Washington, DC

Academy of Operative Dentistry

The eighth annual meeting of the Academy of Operative Dentistry was held 15 and 16 February 1979 in Chicago at the Hyatt Regency Hotel. The program comprised essays, table clinics, and limited attendance clinics.

At luncheon on the first day the Hollenback Memorial Prize was presented to Wilmer B Eames and the Student Achievement Award to C Owens Palmertree.

Officers elected for 1979 are: Nelson W Rupp, president; Richard V Tucker, president-elect; Harold R Laswell, vice president; Ralph J Werner, secretary-treasurer; Gregory E Smith, assistant secretary; and Norman C Ferguson and William N Gagnon as new councilmen.

Wilmer B Eames receiving the Hollenback Prize from Anna Hampel

Anna Hampel presenting the Student Achievement Award to C Owens Palmertree

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, Washington 98195, U.S.A.

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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.

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OPERATIVE DENTISTRY

SPRING 1979 • VOLUME 4 • NUMBER 2 • 49–88

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