OPERATIVE DENTISTRY

AMERICAN ACADEMY OF GOLD FOIL OPERATORS

ACADEMY OF OPERATIVE DENTISTRY

summer 1976 • volume 1 • number 3 • 81-128

OPERATIVE DENTISTRY

SUMMER 1976 • VOLUME 1 • NUMBER 3 • 81-128

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, in January, April, July, and October, 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; undergraduate 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*. Mail to:

OPERATIVE DENTISTRY
University of Washington
School of Dentistry SM-57
Seattle, WA 98195, U.S.A.

Contributions

Contributors should study the instructions for their guidance printed inside the back cover and should follow them carefully.

Permission

For permission to reproduce material from *Operative Dentistry*, please apply to the University of Washington, Office of Scholarly Journals, 4045 Brooklyn Avenue NE JA-15, Seattle, Washington 98105, U.S.A.

Application to mail at second-class postage rates is pending at Seattle, Washington.

Editorial Office

University of Washington, School of Dentistry SM-57, Seattle, Washington 98195, U.S.A.

OPERATIVE DENTISTRY, 1976, 1, 82–90.

ORIGINAL ARTICLES

Clinical Evaluation of Two Glazing Agents for Composite Resin: A Preliminary Report

LUIS CALATRAVA • JOSEPH D. DENNISON • GERALD T. CHARBENEAU

Attempts to use two resin glazes to improve the surface finish of composite resin restorations have not been fruitful. There are problems associated with their application, and their effectiveness upon placement is short-lived.

Luis Calatrava, D.D.S., M.S. Universidad Central de Venezuela, Faculdad de Odontologia, Department of Operative Dentistry, Las Chaguarames, Caracas, Venezuela.

Joseph D. Dennison, D.D.S., M.S. University of Michigan, School of Dentistry, Departments of Operative Dentistry and Dental Materials, Ann Arbor, MI 48109, U.S.A.

Gerald T. Charbeneau, D.D.S., M.S. University of Michigan, School of Dentistry, Department of Operative Dentistry, Ann Arbor, MI 48109, U.S.A.

Dr. Charbeneau is professor of dentistry and chairman of the Department of Operative Dentistry.

Send requests for reprints to Dr. Charbeneau.

A disadvantage of composite resin as a restorative material is the roughness of its surface. The roughness results from the particulate form of the inorganic filler, such as quartz, borosilicate glass, lithium aluminum silicate, or borium glass, which protrudes through the softer resin base. When a composite resin restoration is finished, the resin is abraded more rapidly than the filler and thus the surface becomes rougher. Roughness of the surface also increases with time as the restoration wears.

Rough surfaces on teeth and restorations are undesirable because they facilitate accumulation of plaque and bacteria which, in turn, irritates the gingivae, predisposes to recurrence of caries, and absorbs stain (Swartz & Phillips, 1957; Waerhaug, 1956; Glickman, 1972; Waerhaug & Zander, 1957; App, 1961; Zander, 1957). It is not so much the roughness that irritates the gingivae, but the plaque which accumulates on the rough surface (Rosenburg & Ash, 1974) and tends to remain even after vigorous brushing (Swartz & Phillips, 1957).

The smoothest possible surface on a composite resin is obtained when the material is cured against a matrix strip (Macchi & Craig, 1969; McLundie & Murray, 1974; MacConnachie *et al.*, 1971; Dennison & Craig, 1972; Ribbons & Pearson, 1973; McLundie & Murray,

EDITORIAL

High-handedness of HEW

This issue of the Journal contains several accounts of activities of the Department of Health, Education and Welfare. The lengths to which HEW is willing to go to assert its will, even to subverting laws, is alarming. The incidents reported are mainly from the Pacific Northwest, but one wonders how many similar incidents there might be throughout the country.

The need for government bureaus to deal with affairs that the private sector of the economy is not equipped to undertake, such as national defense, law and order, and administration of justice is, of course, accepted. However, wherever it is possible, private industry must be allowed to produce the goods and services that consumers demand, not only because private enterprise is more efficient, but because an equally vital concern must be safeguarded—the capacity of citizens to manage their own affairs.

Under private enterprise the dentists of the United States have provided a dental service second to none. Improvement is needed, of course, but government control would do nothing to make the service better. On the contrary, government interference, as we have witnessed elsewhere, would make the service only worse, *and more expensive*. The inefficiency of government is well known. For example, in fulfilling its obligation to protect its citizens from criminals the government's performance has been anything but comforting. Between 1969 and 1974 the incidence of violent crime rose 47%, and still is rising. It would be better for the government to direct its resources to solving some of our truly serious social problems, such as crime, than to meddle unnecessarily with established professions, such as dentistry.

It is unfortunate, but true, nevertheless, that bureaucrats, in general, favor extension of government control over the economy, even beyond that provided by law. But bureaucrats should be reminded that they are servants of the law and should operate within it. Wherever they attempt to extend their power beyond that intended by legislation they should be resisted and opposed. Otherwise they may achieve a cherished aim of Lenin, which was "to organize the *whole* national economy like the postal system. . . ."

Good grief! Not that!!

A. IAN HAMILTON

Lenin, V. I. (1918) *State and Revolution*. 2nd edition, 1974 printing. New York: International Publishers.

1972). However, Hannah & Smith (1973) have shown that a composite resin that has set in contact with a matrix strip reveals disruption over some parts of the surface and corresponding areas of composite resin on the matrix. These findings do not support suggestions that an ideal finish of the surface can be obtained by curing the resin against a matrix strip even though carefully positioned and maintained. Peterson (1973) has concluded that the surface immediately under a matrix strip is rich in resin, is weaker than the underlying material, and is more easily worn away, leaving a rough surface. Furthermore, Pameijer & Stallard (1973) have concluded that the production of a smooth surface may not be realistic clinically because, though the matrix confines the restorative material within the boundaries of the preparation, overhanging margins and surplus contours usually result. As a consequence, at least part of the composite resin must be disturbed to shape the restoration properly.

A wide variety of instruments has been suggested for finishing composite resins (Macchi & Craig, 1969; MacConnachie *et al.*, 1971; Johnson, Jordan & Lynn, 1971; Chandler, Bowen & Paffenbarger, 1971; Dennison & Craig, 1972; Butler, Ward & Eames, 1971; Glantz & Larsson, 1972; Lee, Orlowski & Luebben, 1974). The techniques of finishing have been reviewed by Calatrava (1975). All these studies have demonstrated that there is no technique available to produce a smooth, wear-resistant surface on composite resin restorations. Even if it were possible, the surface would likely roughen soon when subjected to the stresses of mastication and brushing.

As a solution to the problem, materials have been developed to glaze or veneer the finished or abraded surfaces of composite resin restorations. Appelbaum (1974) has suggested that epoxy or polyurethane sealants be placed over composite resin restorations as a veneer because a chemical bond is created between the restoration and the sealant and a smooth surface can be produced on the composite resin by filling the voids and irregularities. However, no experimental findings have yet been presented to document this smooth surface clinically, nor is there evidence as to the durability of such coatings in the oral environment. In this article we present the findings of a pilot clinical study that evaluated the effectiveness of two resin glazes by comparing composite resin restorations finished by standard procedures with those similarly finished but covered with a glaze or resin veneer.

MATERIALS AND METHODS

The study comprised 13 patients, seven female and six male, undergoing treatment at the University of Michigan School of Dentistry. Their ages ranged from 19 to 57 years, with a mean age of 28 years. Twenty-six restorations were placed on maxillary incisors and canines, selected according to the following criteria: (1) cavities on proximal surfaces from the mesial of the right canine to mesial of the left canine; (2) sufficient facial extension of the cavities to permit observation of the effect of surface treatment; (3) two suitable cavities within the same mouth. The Committee To Review Grants for Clinical Research and Investigation Involving Human Subjects reviewed and approved the proposed project and informed consent was obtained from each patient.

Each patient received two restorations, one serving as the unglazed control, the other receiving a coating of the test material. They were placed in similar teeth, symmetrically disposed when possible, by the same operator at the same appointment. Typical Class III and IV cavities were prepared.

The composite resin selected for the restorations was Concise (3M Company Dental Products, 3M Center, St. Paul, MN 55101, U.S.A.). It is supplied as two pastes. Equal amounts by volume of each paste were used in every mix. All mixes were made according to manufacturer's directions, with a 30-second mixing time. The mass was pressed firmly into the cavity with a Mylar strip within one minute after completion of mixing. Five minutes were allowed for setting before the matrix was removed.

The restorations were finished to a contour and a marginal adaptation that were clinically acceptable. Finishing was begun 10 minutes from the start of mixing. Clinical acceptability was determined by checking margins with a sharp No. 3 cowhorn explorer until no catch could be obtained while moving the point of the explorer across the margin in either direction. Stones of green silicon carbide were used to remove gross excess that was away from the enamel margin. White Arkkansas stones and disks of silicon carbide (fine, X fine, and XX fine) (E.C. Moore Company, Dearborn, MI 48126, U.S.A.) were used for the final finish of the restorations.

After both restorations of a given pair were finished, the test restoration was veneered with the coating agent. Two different types of coating material were used, Enamel Bond (3M Company, Dental Products, 3M Center, St. Paul, MN 55101, U.S.A.) and Nuva-Seal (L.D. Caulk Company, Milford, DE 19963, U.S.A.). Enamel Bond was used in seven and Nuva-Seal in six patients.

Enamel Bond is an unfilled dimethacrylate resin similar to that of the base composite and cured by a chemical catalyst. All mixes were made according to the manufacturer's instructions. Equal amounts (one drop) of catalyst resin and universal resin were dispensed onto a mixing pad and mixed carefully for 10 seconds with a folding action to avoid incorporating air bubbles. The material was then applied over the surface of the restoration with a fine brush. Three minutes were allowed for the veneer to bond to the composite and then the air-inhibited layer was removed with a damp cotton roll, or gauze square, followed by washing with an air-water spray.

Nuva-Seal is also an unfilled dimethacrylate resin, but is cured by exposure to ultraviolet (UV) light. A layer of this material was applied to the surface of the restoration with a brush and the surface then exposed to a beam of UV light for 30 seconds. The air-inhibited layer of polymer was removed as for Enamel Bond.

Care was taken not to contaminate the surface of the restoration during finishing and prior to the application of the glaze.

The texture of the surface of the restorations was evaluated by two methods: (1) visually during a clinical examination, and (2) under magnification in a scanning electron microscope (SEM).

During the clinical examination, photographs of the restorations were taken in Ektachrome (Eastman Kodak Company, Rochester, NY 14650, U.S.A.). The surfaces of the 13 pairs of restorations were evaluated subjectively at intervals of one week, one month, and three months (Enamel Bond only) after insertion. At each evaluation the condition of the surface was assessed visually and correlated with the microscopic appearance of a silicone replica. The progressive loss of the coating agent over the time span and the corresponding development of roughness or irregularities in the surface texture were observed. An effort was also made to compare the relative roughness of the surfaces on the matched pair of coated and uncoated restorations exposed to the same oral environment.

For examination in the SEM, a replica was made of the surface of each finished restoration. The replica was prepared by spreading a small quantity of silicone elastomer, Silastic 382 (Dow Corning Corporation, Medical Products Division, Midland, MI 48640, U.S.A.), over the surfaces of the teeth which were kept dry by isolating with cotton rolls and the use of a saliva ejector. The Silastic 382 was spread on the teeth with a flat-bladed instrument; a wooden mixing stick was used as a tray. After being given ample time to harden, the impression was removed from the teeth and prepared directly for observation in the SEM. Impressions for SEM examination were repeated at intervals of one week, one month, and three months. A preliminary impression was taken each time to remove debris from the surface of the restorations; this impression was then discarded.

RESULTS

In six of the seven pairs studied, the Enamel Bond coating appeared to have little or no effect, and, judged visually, both the test and the control restorations possessed a similar surface texture. After three months, the surface texture of the coated restorations was considered equal to that of the control or uncoated restorations in six of the seven patients. In the seventh patient, the control restoration was considered smoother than the coated test restoration.

The UV activated coating, Nuva-Seal, seemed to have a somewhat more positive effect, although the final assessment of these restorations was made after only one month. In three of the six pairs coated with Nuva-Seal,

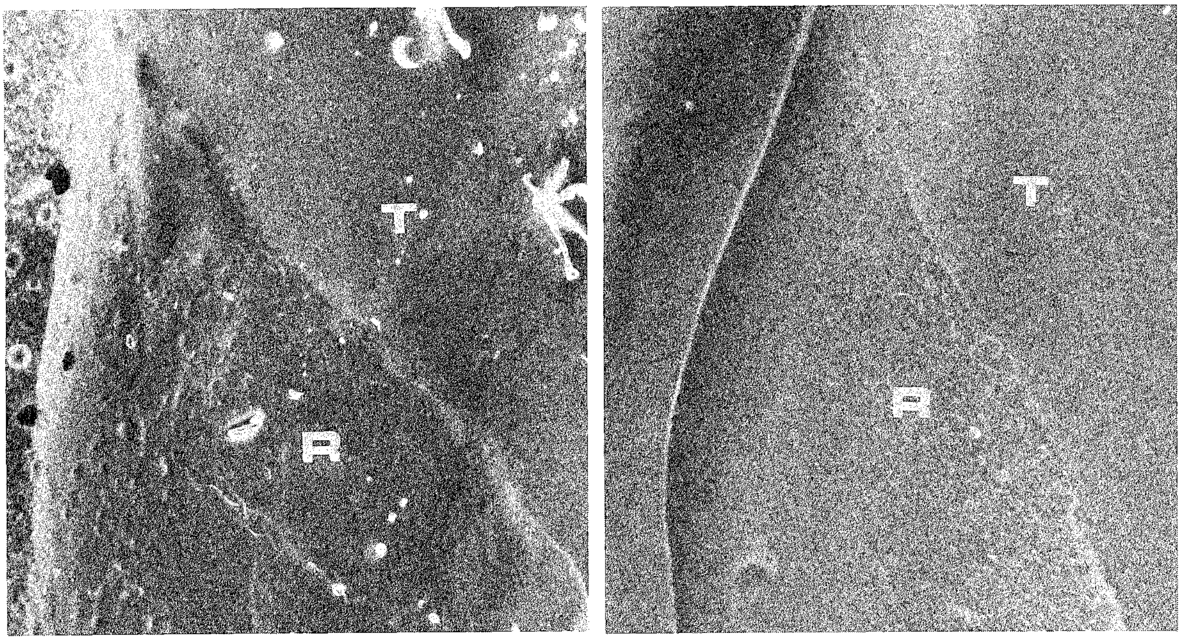


FIG. 1. Above, left: scanning electron photomicrograph of a replicated restoration surface newly covered with Enamel Bond. On right, same area at three months. R, restoration; T, tooth surface. 50x

there was evidence from the SEM of a smoother surface on the coated restoration than on the unglazed control. This was not, however, usually evident on the clinical examination or from the color transparencies. The remaining three pairs possessed similar surface texture on both the coated and control teeth after the one-month period.

Figure 1A is a scanning electron photomicrograph of the surface replica of a freshly placed restoration finished with a standard procedure and then coated with Enamel Bond. Surface texture of the same surface after three-months exposure to the oral environment is shown in Figure 1B. The surface appears to have undergone considerable change, and increased roughness is evident throughout.

Figures 2A, B, and C show the same restoration, at baseline, one week, and three months, respectively. At baseline the surface had a somewhat matte appearance. One week after placement the surface was dull and irregular, some loss of the coating being obvious. After three months, the surface appeared sufficiently rough to conclude that the entire coating had been lost and that the surface texture was equivalent to that found on the unglazed control.

Figure 3A is a replica of the smoothest surface found on a freshly placed uncoated restoration. After three months, the surface texture appears to depict an increased roughness and irregularity (Fig. 3B), with filler particles protruding through the surface in an irregular pattern.

Another example of surface loss is shown in Figure 4. Figure 4A is a replica of the restoration immediately after coating. Note the surface defects, particularly the three hemispheres at the bottom of the picture. The groove at the top served as a reference line to orient the specimens in the scanning electronic microscope. Surface texture after one week is shown in Figure 4B. The restoration has apparently lost the surface glaze; the reference groove is visible and the original three hemispheres look shallower. The evaluation after one month, Figure 4C, shows that abrasion has continued in this short period of time and the three hemispheres used as a reference have almost disappeared. The surface shown in Figure 4D reveals more uniform wear; the orientation groove is no longer as clearly discernible, and the other details have partly worn away.

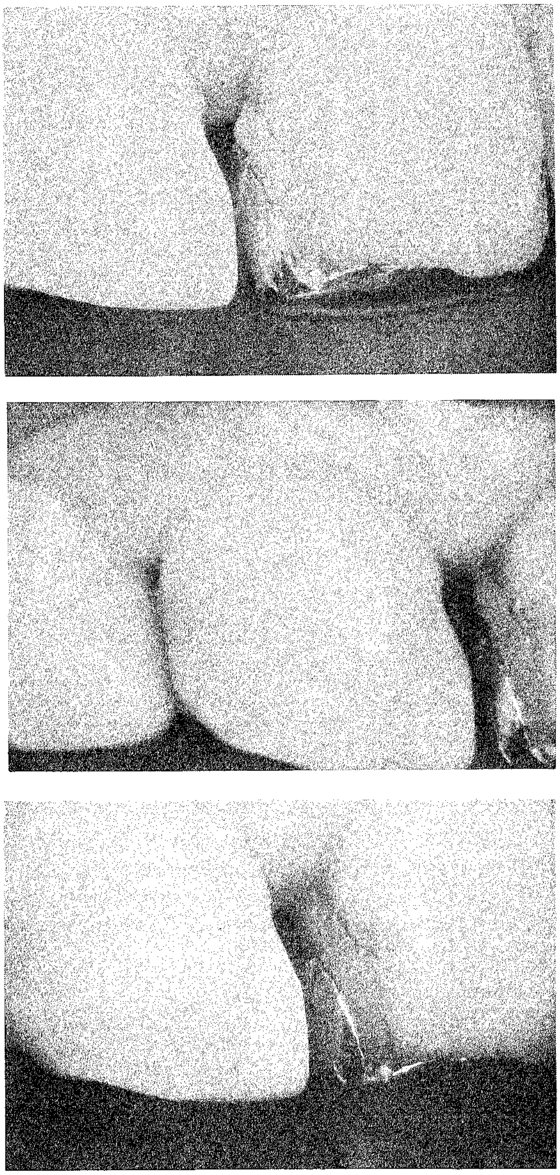
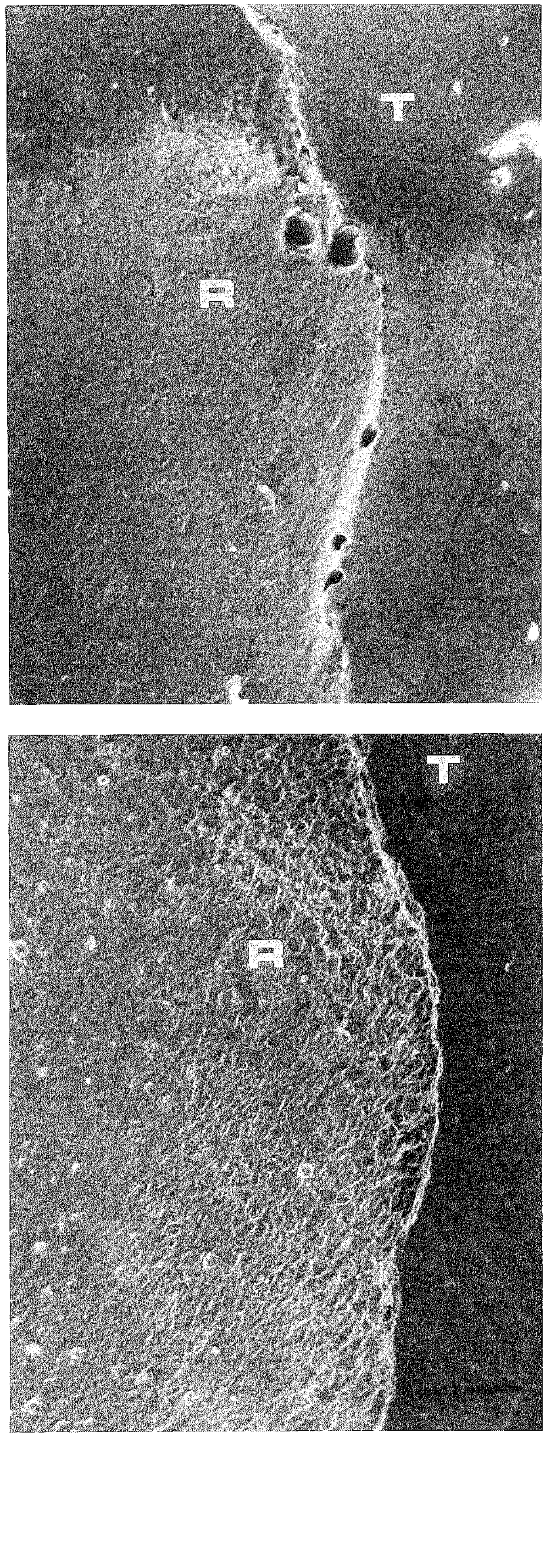


FIG. 2. Clinical view of restoration seen in Fig. 1: (top), baseline; (center), at one week; (bottom) at three months.

FIG. 3. At right: scanning electron photomicrograph of a replicated surface of an uncoated composite restoration. (Top): immediately following finishing; (bottom) at three months. 50x



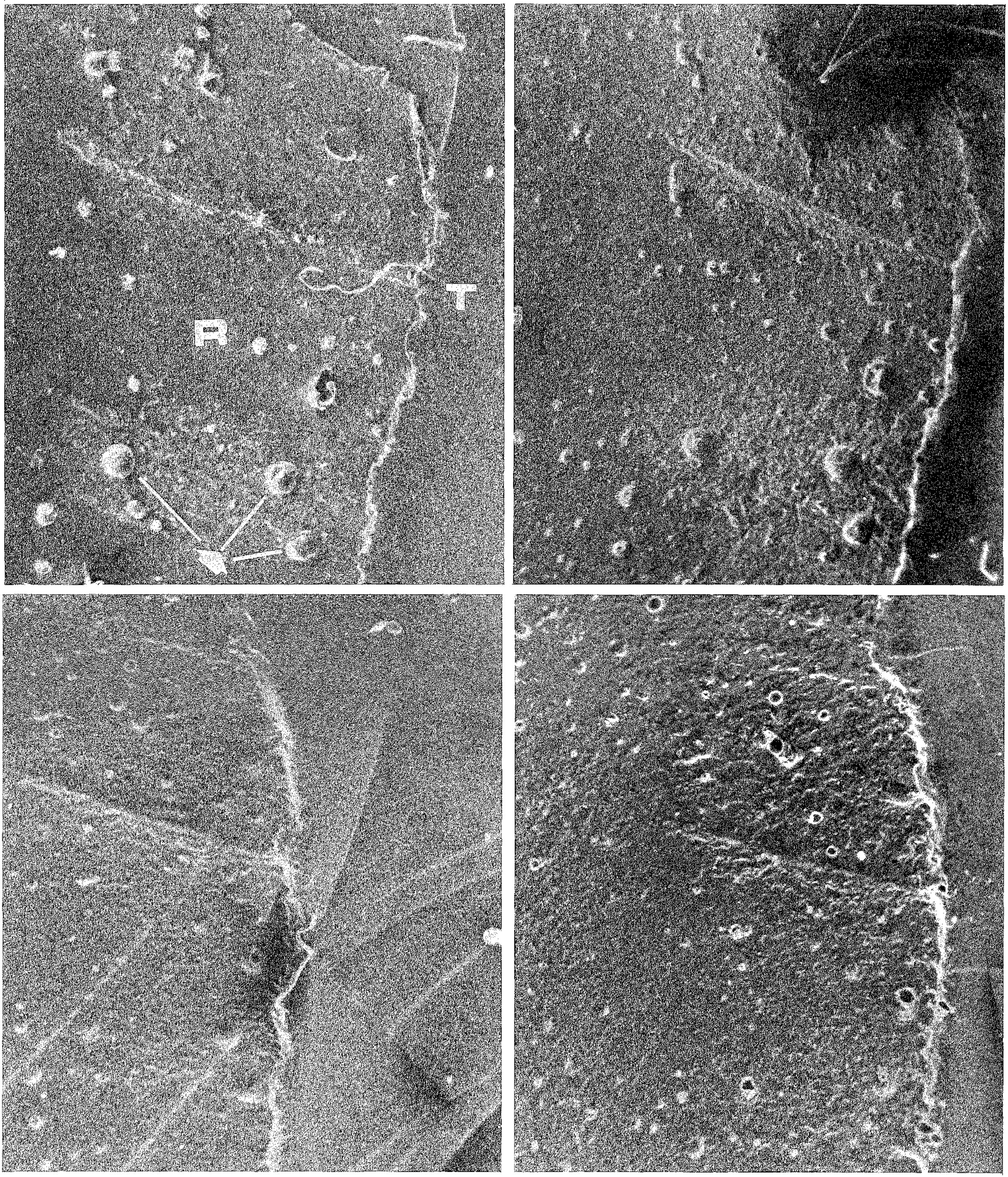
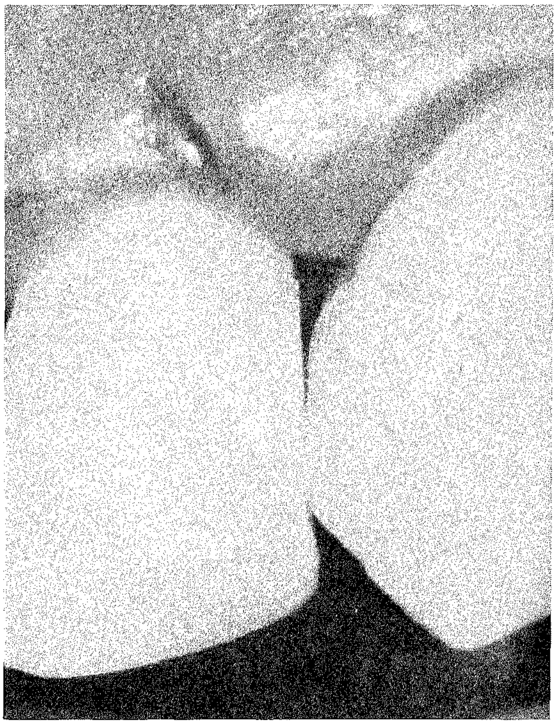


FIG. 4. Scanning electron photomicrograph of a replicated composite restoration. Above left: immediately following finishing and coating with a glaze material; above right: at one week; below left: at one month; below right: at three months showing progressive loss of the surface. Note the progressive loss of surface substance from the reduced size of hemispheres. 50x



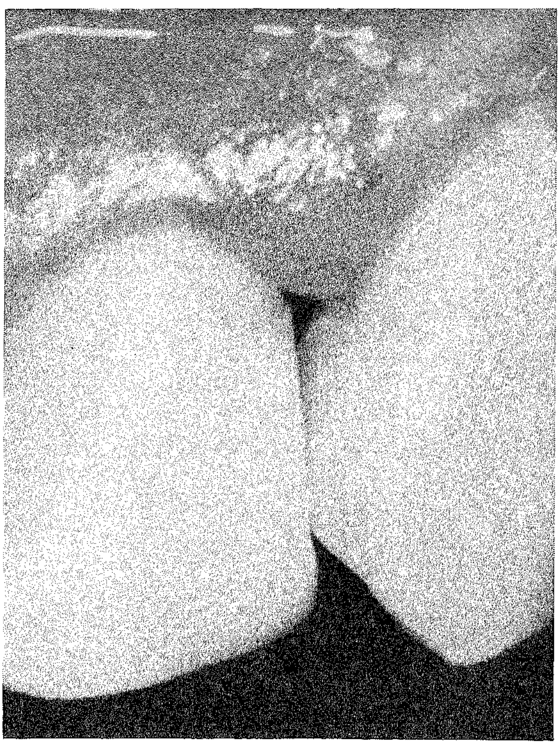


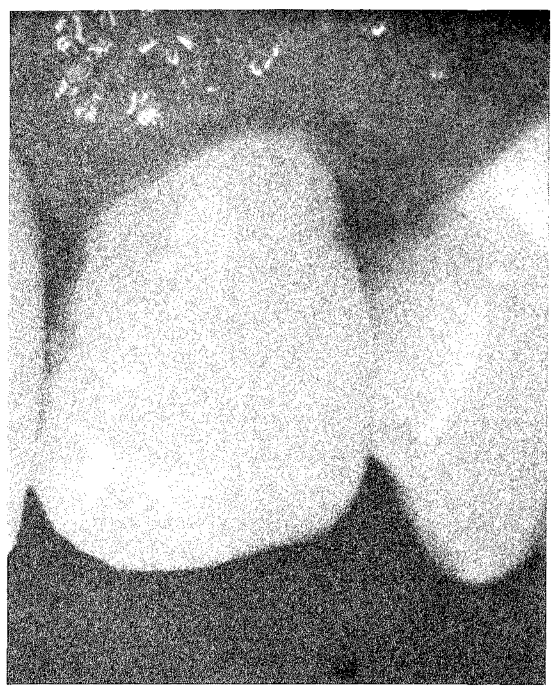
FIG. 5. Clinical view of restoration. Top: immediately following finishing and coating with resin. Note the glossy surface. Above: at one week showing loss of gloss; right: at three months showing dull surface.

Figure 5A shows a restoration immediately after coating. The glaze has filled the irregularities in the composite resin and produced a glossy surface. The same restoration one week later is shown in Figure 5B. It readily can be seen that the superficial layer (glaze) covering the restoration has disappeared, exposing the composite resin. After three months (Fig. 5C), the loss of surface glaze makes the restoration appear dull.

DISCUSSION

Observation of surfaces undergoing wear reveals that the loss of substance is generally uniform rather than localized. We assume that since the loss of surface material occurs rather uniformly, this loss is not related to a specific problem of manipulating the material.

Both glazing materials are difficult to apply in other than a thin coating. Therefore, upon removal of the air-inhibited surface, at times there appeared to be no change in the texture of the surface from that which was merely finished. Furthermore, often the glaze materials did not coat or "wet" the surface of the restoration uniformly, resulting in a patch-like appearance. A second application of material was used in some instances. Figure 6A



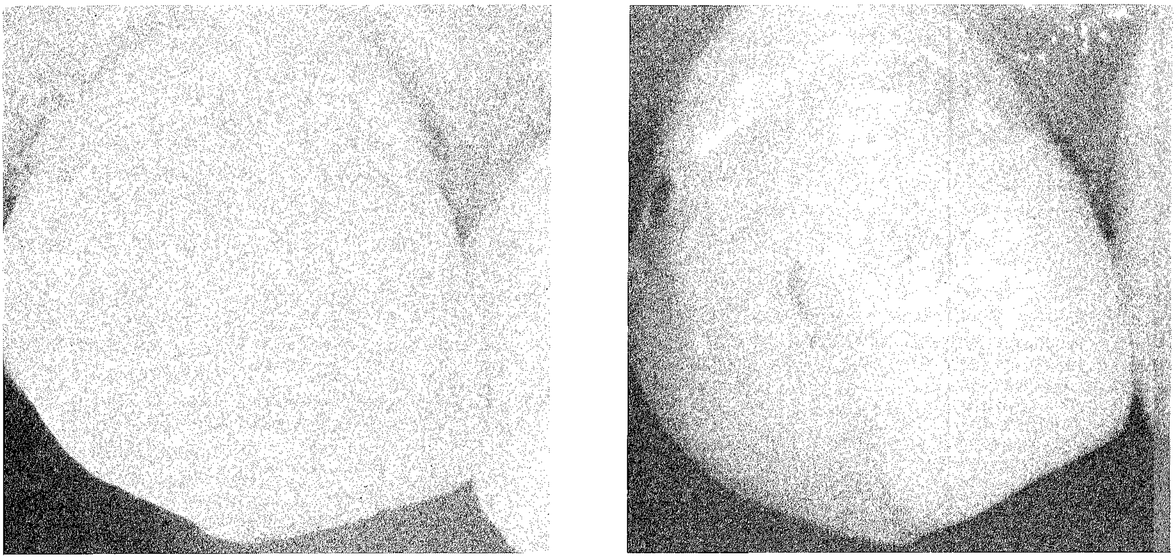


FIG. 6. Clinical view of restoration showing, at left, pooling of glaze material at time of placement; on right, stain penetration at interface of nonetched enamel and glaze at three months.

shows the pooling of the glaze material at the margin. Coverage of the large remaining part of the restoration was not possible.

The resin system that makes use of ultraviolet light to initiate polymerization provides maximum working time and can be used at higher viscosity. The higher viscosity may have resulted in a thicker layer of glaze which could account for some of it still being present after a month.

Figure 6B shows the penetration of stain into the interface between the resin glaze and the enamel. The resin had not bonded since the enamel had not been etched previously with acid. Manufacturer's instructions state that the resin coating be applied only to the surface of the restoration; no etching of adjacent enamel is suggested after finishing. Inadvertent extension of the resin glaze onto the enamel is very probable, however, while attempting to cover just the restoration. Finishing the restoration can conceivably remove the resin down to the enamel surface. A veneer of Nuva-Seal, if permitted to extend onto any such resin-denuded area or onto adjacent enamel, would be subject to stain penetration at this interface, since bonding of the resin would not have occurred.

CONCLUSION

On the basis of the findings of this pilot study, the following conclusions can be made:

1. It was difficult to create a uniform smooth surface over the entire restoration using either Enamel Bond or Nuva-Seal as a glaze, although the latter material was more consistently uniform and smooth.
2. Both materials required that a thick enough layer be applied to allow for a polymerized layer to occur beneath the air-inhibited surface.
3. There was no clinical or SEM evidence of Enamel Bond glaze after one month; Nuva-Seal was evident from the SEM as producing a smoother surface than its unglazed control in three of six pairs.
4. Over the three-month observation period even the control (unglazed) restorations appeared to increase in roughness as judged by visual observation.
5. Margin discoloration and stain penetration was observed when glaze material was extended onto adjacent unetched enamel surfaces.
6. Further clinical research is indicated with other glaze materials using additional well-defined criteria.

REFERENCES

App, G. R. (1961) Effect of silicate, amalgam, and cast gold on the gingiva. *Journal of Prosthetic Dentistry,* **11**, 522-532.

Appelbaum, M. (1974) A procedure for finishing composite restorations. *New York State Dental Journal,* **40**, 15-16.

Butler, M. F., Ward, R. B., & Eames, W.B. (1971) Surfaces of filled resins produced by several finishing techniques. Microfilmed Paper No. 429 presented at the Annual Meeting of the International Association for Dental Research, Dental Materials Group, Chicago, Ill.

Calatrava, L. A. (1975) Clinical evaluation of roughness on composite resins utilizing surface glazing agents. A thesis accepted by the University of Michigan for the degree of Master of Science.

Chandler, H. H., Bowen, R. L. & Paffenbarger, G. C. (1971) Method for finishing composite restorative materials. *Journal of the American Dental Association,* **83**, 344-348.

Dennison, J. B. & Craig, R. G. (1972) Physical properties and finished surface texture of composite restorative resins. *Journal of the American Dental Association,* **85**, 101-108.

Glantz, P.-O. & Larsson, L.-Å. (1972) Surface roughness of composite resins before and after finishing. *Acta Odontologica Scandinavica,* **30**, 335-347.

Glickman, I. (1972) *Clinical Periodontology.* 4th edition. Philadelphia: W. B. Saunders Company.

Hannah, C. M. & Smith, G. A. (1973) The surface finishing of composite restorative materials. *British Dental Journal,* **135**, 483-489.

Johnson, L. N., Jordan, R. E. & Lynn, J. A. (1971) Effects of various finishing devices on resin surfaces. *Journal of the American Dental Association,* **83**, 321-331.

Lee, H. L., Orlowski, J. A. & Luebben, G. E. (1974) Use of abrasive pastes in polishing composite restoratives. *Journal of the Academy of General Dentistry,* **22**, 34-36.

Macchi, R. L. & Craig, R. G. (1969) Physical and mechanical properties of composite restorative materials. *Journal of the American Dental Association,* **78**, 328-334.

MacConnachie, H. J., Legatte, B.D., Gourgley, J. M. & Shaffner, V. B. (1971) Surface finishing of composite resin restoration. Microfilmed Paper No. 436 presented at the Annual Meeting of the International Association for Dental Research, Dental Materials Group, Chicago, Ill.

McLundie, A. C. & Murray, F. D. (1972) Silicate cements and composite resins—a scanning electron microscope study. *Journal of Prosthetic Dentistry,* **27**, 544-551.

McLundie, A. C. & Murray, F. D. (1974) Comparison of methods used in finishing composite resin—a scanning electron microscope study. *Journal of Prosthetic Dentistry,* **31**, 163-171.

Pameijer, C. H. & Stallard, R. E. (1973) The fallacy of polishing composite restorations. *Dental Survey,* **49**, 33-36.

Peterson, R. H. (1973) The placement and finishing of composites. *Greater Milwaukee Dental Bulletin,* **39**, 47-50.

Ribbons, J. W. & Pearson, G. J. (1973) A composite filling material; a two year clinical assessment. *British Dental Journal,* **134**, 389-391.

Rosenberg, R. M. & Ash, M. M., Jr. (1974) The effect of root roughness on plaque accumulation and gingival inflammation. *Journal of Periodontology,* **45**, 146-150.

Swartz, M. L. & Phillips, R. W. (1957) Comparison of bacterial accumulations on rough and smooth enamel surfaces. *Journal of Periodontology,* **28**, 304-307.

Waerhaug, J. (1956) Effect of rough surfaces upon gingival tissue. *Journal of Dental Research,* **35**, 323-325.

Waerhaug, J. & Zander, H. A. (1957) Reaction of gingival tissues to self-curing acrylic restorations. *Journal of the American Dental Association,* **54**, 760-768.

Zander, H. A. (1957) Effect of silicate cement and amalgam on the gingiva. *Journal of the American Dental Association,* **55**, 11-15.

Microleakage of Several Acid-etch Composite Resin Systems: A Laboratory Study

JOHN H. HEMBREE, JR. • JAMES T. ANDREWS

A laboratory evaluation using a radioisotope indicates that marginal leakage after one year is significantly reduced or eliminated in those restorations in which the enamel surface surrounding the cavity preparation and the cavosurface angle is etched and a layer of sealant is placed before and after the insertion of the restoration.

John H. Hembree, Jr., D.D.S., University of Tennessee College of Dentistry, Department of Biomaterials, Memphis, TN 38163, U.S.A.

Dr. Hembree is associate professor and chairman of the Department of Biomaterials.

James T. Andrews, D.D.S., University of Tennessee College of Dentistry, Department of Operative Dentistry, Memphis, TN 38163, U.S.A.

Dr. Andrews is professor and chairman of the Department of Operative Dentistry.

An important advance in restorative dentistry would be the development of methods and restorative materials that would prevent leakage around restorations (Chandler *et al.,* 1974). The inability of most materials and techniques to seal cavities against microleakage may be the cause of pulpal irritation and recurrent caries (Going, Massler & Dute, 1960; Phillips *et al.,* 1961; Going & Sawinski, 1966; Buonocore, 1968; Tani & Buonocore, 1969). Several investigations have demonstrated reduction or elimination of microleakage around a composite resin, activated by ultraviolet light, when the tooth has been etched by acid and a sealant used in conjunction with the composite resin (Buonocore, Sheykholeslam & Glena, 1973; Dogon & Henry, 1975; Brose *et al.,* 1975; Hembree & Andrews, 1976).

The purpose of this study is to evaluate, in extracted teeth, the marginal leakage of several commercially available composite materials for acid etching after being inserted by several different techniques.

Materials and Methods

The filled resin and unfilled sealant combinations for acid etching selected for the study were: (1) Nuva-Fil/Nuva-Seal (L. D. Caulk Co., Milford, DE 19963, U.S.A.), a resin system activated by ultraviolet light; (2) Concise/Concise Enamel Bond (3M Co., Dental Products Div., St. Paul, MN 55101, U.S.A.), an autopolymerizing resin system; (3) Prestige/Finite (Lee Pharmaceuticals, South El Monte, CA 91733, U.S.A.), an autopolymerizing resin system; and (4) Restodent (Lee Pharmaceuticals, South El Monte, CA 91733, U.S.A.), an autopolymerizing composite material. Nuva-Seal and Concise Enamel Bond are both unfilled resins designed to be used as a layer between the etched tooth and the composite resin. Although designed as a composite glazing material, Finite was used as an interface layer of resin in conjunction with Prestige. Restodent was used alone, as its technique does not require a layer between the etched tooth and the composite resin. The material was inserted without the use of a matrix and the restorations were finished with a super-fine diamond.

Two hundred and seventy-two Class V cavities were prepared with a No. 35 inverted cone bur in sound anterior and bicuspid teeth that had been extracted. The teeth had been stored in tap water following extraction. Eighty teeth were restored with each material in the study except Restodent, which was used in only 32 teeth. The 80 teeth were divided into five groups in which different techniques for placing each test material were used.

Group 1—The composite resin was inserted without etching or application of an unfilled resin. This group acted as a control.

Group 2—The composite resin was inserted after etching the cavosurface angle and adjacent enamel of the tooth, but without the use of an unfilled resin.

Group 3—The composite resin was inserted after etching the cavosurface angle and adjacent enamel of the tooth. A layer of unfilled resin was placed only on the internal walls of the preparation prior to the insertion of the composite resin.

Group 4—The composite resin was inserted after etching the cavosurface angle and the adjacent enamel of the tooth. A layer of unfilled resin was placed on the surface of the composite resin and surrounding enamel.

Group 5—The composite resin was inserted after etching the cavosurface angle and the adjacent enamel of the tooth. A layer of unfilled resin was placed both on the internal walls of the preparation and the surface of the composite resin and surrounding enamel.

In the Restodent group, only two techniques were used. The material was inserted without etching the enamel, and after etching the cavosurface angle and adjacent enamel. All etching and polymerization of each material in the study were accomplished following the manufacturers' directions. The teeth were stored in distilled water at 37°C prior to testing.

Prior to testing, each specimen was cycled thermally by alternately dipping the teeth for one minute in water at 4 and 58°C for 100 cycles. Each group of specimens was tested at time intervals of one day, three months, six months, and one year. The above procedure produced four specimens of each technique of insertion at each time interval.

The procedure used to determine marginal leakage is one that has been previously described by Swartz and Phillips (1961). The marginal adaptation of each specimen was determined by the presence of an isotope at the interface of the tooth and the restorative material as shown on an autoradiograph. Each specimen was soaked for two hours in ^{45}Ca isotope solution. The concentration of isotope employed was 0.1 Ci/ml of solution, in the form of calcium chloride with the pH adjusted to 7.0. Prior to soaking the teeth in the isotope solution, the surface of the root was carefully sealed with a combination of nail polish and tinfoil. After removal from the isotope, the tinfoil was stripped from the tooth and the tooth brushed with a detergent. The teeth were then sectioned longitudinally through the restoration by grinding on a wet wheel of aluminum oxide. The sectioned surface of the tooth was placed on an ultra-speed periapical dental x-ray film for 17 hours to produce the autoradiographs. The films were developed in an automatic developer.

Results

The marginal leakage at the interface of the tooth and the restorative material were evaluated by using a scale to indicate the degree of penetration of the isotope:

0— No evidence of the isotope at the interface of the tooth and the restorative material on the autoradiograph.

1— Evidence of the isotope penetrating the interface of the tooth and the restorative material at the cavosurface angle on the autoradiograph.

2— Evidence of the isotope at the interface of the tooth and the restorative material along the gingival and incisal or occlusal walls, but not penetrating to the axial wall of the preparation.

3— Evidence of the penetration of the isotope to the axial wall of the preparation.

Four autoradiographs were prepared for each of the five restorative techniques and each of the restorative materials except Restodent, at each time interval. Typical one-year autoradiographs are illustrated (Figs. 1-5). An arrow points to the restoration, and a white line at the interface of the tooth and the restoration indicates the degree of penetration of the isotope. Some of the autoradiographs were not satisfactory due to technical difficulties. The table shows the degree of penetration of the isotope on a scale of 0-3.

Group 1 restorations were inserted without etching the tooth or without the application of an unfilled resin. Autoradiographs of these restorations exhibited significant penetration of the isotope along the interface of the tooth and the restorative material up to and including the axial walls of the preparations at all time intervals.

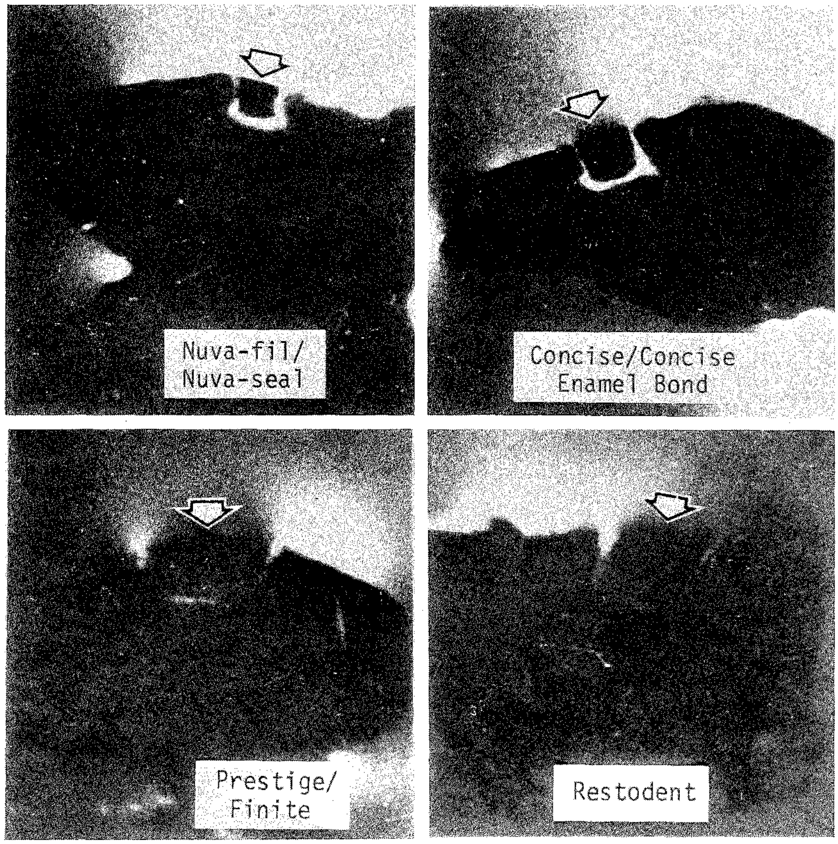
Group 2 restorations were inserted after etching the cavosurface angle of the tooth and the adjacent enamel. An unfilled resin was not used with Group 2 restorations. Autoradiographs of Group 2 restorations showed significant penetration of the isotope along the interface of the tooth and the restorative material. The penetration of the isotope in Group 2 restorations was comparable to the penetration of the isotope in Group 1 restorations.

Group 3 restorations were placed after etching the cavosurface angle and the adjacent enamel and the placement of a layer of unfilled resin only on the cavity walls. Autoradiographs of Group 3 restorations exhibited significant penetration of the isotope along the

DEGREE OF PENETRATION OF ISOTOPE
BETWEEN RESTORATION AND TOOTH

Group	Nuva-Fil / Nuva-Seal				Concise / Concise Enamel Bond				Prestige / Finite				Restodent			
	0	*1*	*2*	*3*	*0*	*1*	*2*	*3*	*0*	*1*	*2*	*3*	*0*	*1*	*2*	*3*
1																
1 day			3	1			4				3	1			4	
3 months			4				3	1				4			4	
6 months			2	1			3	1			4				4	
1 year			1	2				4			2	2			3	1
2																
1 day			3	1			4				4				4	
3 months			4				4				4				3	
6 months			3	1			4				3				4	
1 year			2	2			4				1	3			3	1
3																
1 day			4				4			2	2					
3 months			4			2	1				3	1				
6 months			1	3		1	3				3	1				
1 year			1	3		2	2					3				
4																
1 day			4			1	3			3						
3 months			4			3	1				3	1				
6 months			1	3		1	3				3	1				
1 year			4			2	2				3	1				
5																
1 day	4				3	1			2	2						
3 months	4				4				3	1						
6 months	3				2	2			3		1					
1 year	3	1			2	1	1		3	1						

FIG. 1. One-year autoradiographs of Group 1 specimens (composite only)



interface of the tooth and the restorative material. The degree of penetration of the isotope in Group 3 restorations was comparable to the penetration of the isotope in Group 1 and Group 2 restorations.

Group 4 restorations were inserted after etching the cavosurface angle and the surrounding enamel. A layer of unfilled resin was placed on the surface of the restoration and the surrounding enamel. The penetration of the isotope in Group 4 restorations was comparable to the marginal leakage demonstrated in the restorations in groups 1, 2, and 3.

Group 5 restorations were inserted after etching the cavosurface angle and the adjacent enamel and placing a layer of unfilled resin on the cavity walls. A layer of unfilled resin was placed on the external surface of the restoration and the adjacent enamel. Penetration of the isotope in Group 5 restorations ranged from none to slight with only two specimens showing penetration along the cavity walls. We appreciate that the unfilled resin placed on the external surface of the restoration and enamel is unlikely to remain long but enough resin is probably retained in the interface to provide a seal.

It should be noted that the use of Finite, a slightly filled glazing resin, was used in conjunction with Prestige, a composite restorative material that is not designed for acid etching. Clinically, this combination would not be recommended as Finite is too viscous to be used as a layer between the cavity walls and composite resin.

Restodent, though not designed to be used in conjunction with an unfilled resin, probably would appear better had it been used with a layer of unfilled resin on the cavity walls and on the surface of the restoration. As it was used in this study, the material demonstrated significant leakage at all time intervals.

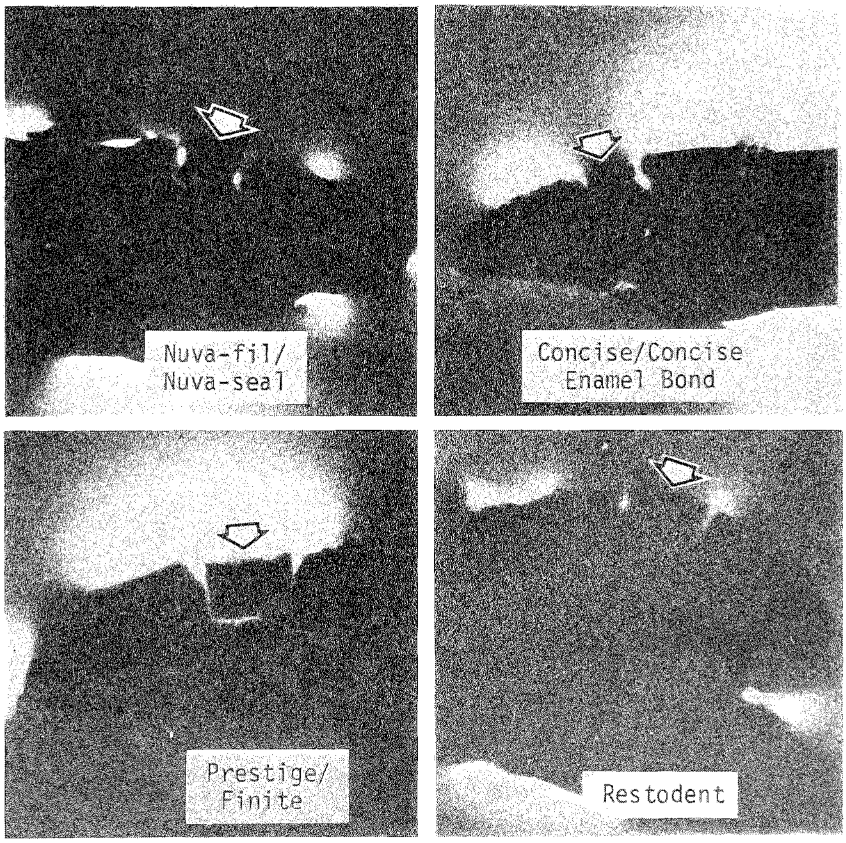


FIG. 2. One-year autoradiographs of Group 2 specimens (enamel etched and composite)

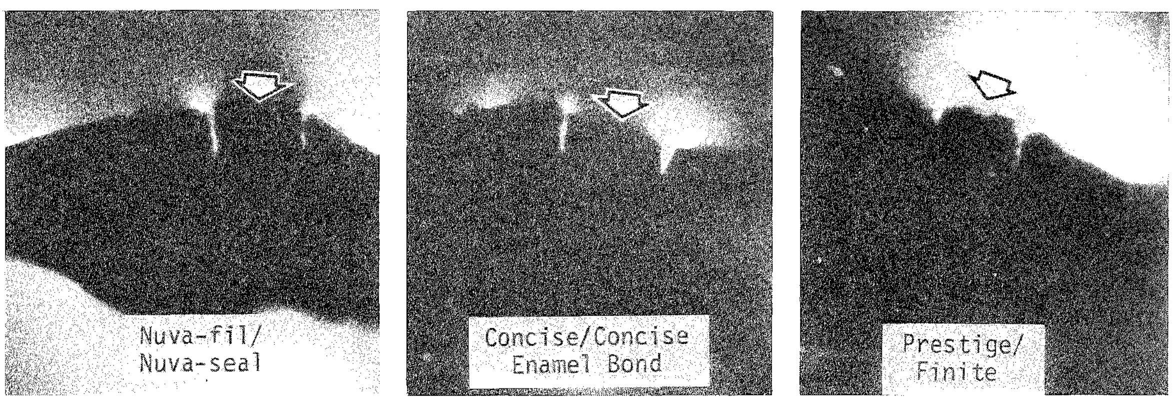


FIG. 3. One-year autoradiographs of Group 3 specimens (enamel etched, sealant on walls of preparation, and composite)

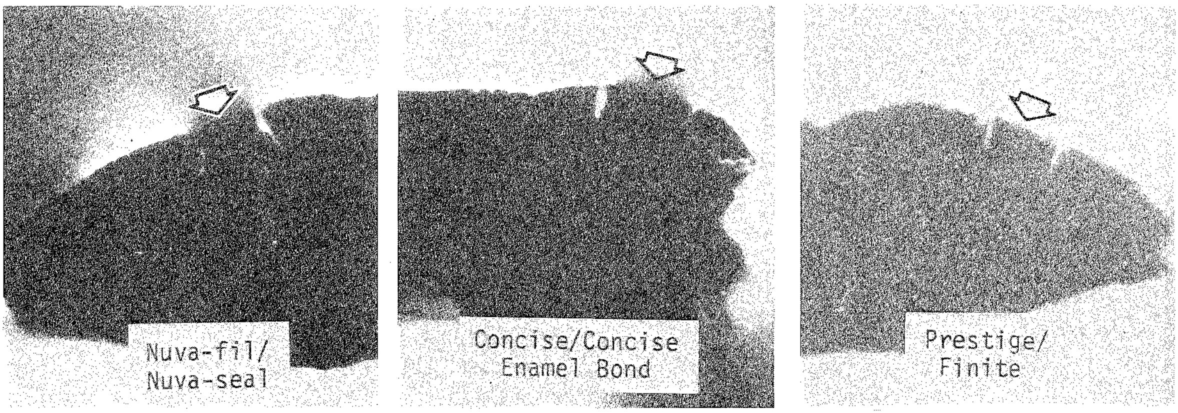


FIG. 4. One-year autoradiographs of Group 4 specimens (enamel etched, composite, and sealant on surface of composite)

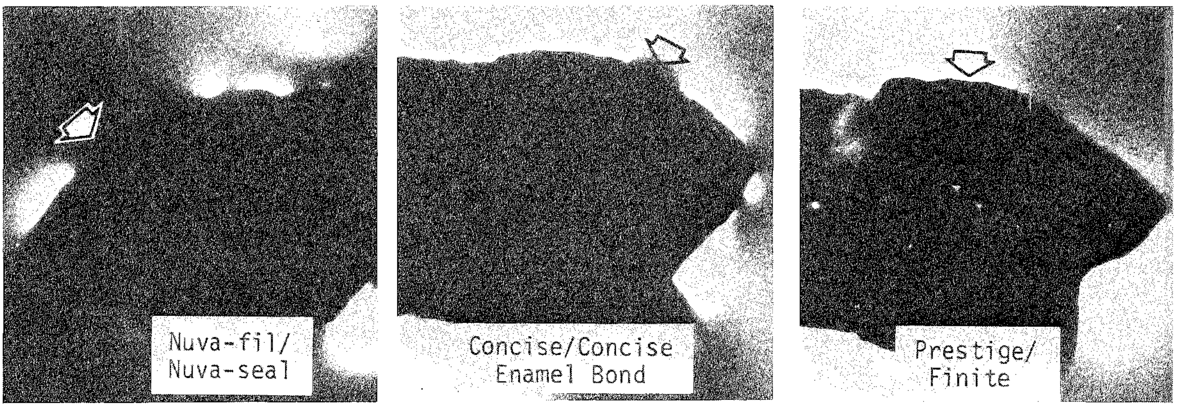


FIG. 5. One-year autoradiographs of Group 5 specimens (enamel etched, composite and sealant placed on walls of preparation and surface of composite)

Conclusions

The purpose of this study was to evaluate in the laboratory marginal leakage of the commercially available composite materials for acid etching, using five different restorative techniques.

Restorations placed with the restorative techniques employed in groups 1, 2, 3, and 4 showed approximately the same degree of marginal leakage as demonstrated by the penetration of the isotope. Group 5 restorations showed very little marginal leakage at any time interval.

The results of this study and of a previous study (Hembree *et al.*, 1976) indicate that marginal leakage is reduced significantly or eliminated in restorations where the cavosurface angle and the enamel is etched and a layer of unfilled resin is placed before and after the insertion of the restoration.

The autopolymerized resins appear to be as effective in preventing marginal leakage as those polymerized with ultraviolet light when the restorative technique for Group 5 restorations is utilized.

REFERENCES

Brose, J., Martinez, C., Cooley, R. & Greener, E. H. (1975) In vitro microleakage of repaired fractured incisors. *Program and Abstracts of Papers, International Association of Dental Research, Special Issue A, 53rd General Session*, Abstract No. 21, **54**, 50.

Buonocore, M. G. (1968) New anterior restorative materials. *International Dental Journal*, **18**, 406-420.

Buonocore, M. G., Sheykholeslam, Z. & Glena, R. (1973) Evaluation of an enamel adhesive to prevent marginal leakage: An in vitro study. *Journal of Dentistry for Children,* **40**, 119-124.

Chandler, H. H., Bowen, R. L., Paffenbarger, G. C. & Mullineaux, A. L. (1974) Clinical evaluation of a tooth-restoration coupling agent. *Journal of the American Dental Association,* **88**, 114-118.

Dogon, I. L. & Henry, P. (1975) Calcium 45 penetration and scanning electron-microscopy study of the acid etch system. *Program and Abstracts of Papers, International Association of Dental Research, Special Issue A, 53rd General Session,* Abstract No. 19, **54**, 49.

Going, R. E., Massler, M. & Dute, H. L. (1960) Marginal penetrations of dental restorations as studied by crystal violet dye and I^{131}. *Journal of the American Dental Association,* **61**, 285-300.

Going, R. E. & Sawinski, V. J. (1966) Microleakage of a new restorative material. *Journal of the American Dental Association,* **73**, 107-115.

Hembree, J. H. & Andrews, J. T. (1976) In situ evaluation of marginal leakage using an ultraviolet-light-activated resin system. *Journal of the American Dental Association,* **92**, 414-418.

Phillips, R. W., Gilmore, H. W., Swartz, M. L. & Schenker, S. I. (1961) Adaptation of restorations in vivo as assessed by Ca^{45}. *Journal of the American Dental Association,* **62**, 9-20.

Swartz, M. L. & Phillips, R. W. (1961) In vitro studies on the marginal leakage of restorative materials. *Journal of the American Dental Association,* **62**, 141-151.

Tani, Y. & Buonocore, M. G. (1969) Marginal leakage and penetration of basic fuchsin dye in anterior restorative materials. *Journal of the American Dental Association,* **78**, 542-548.

 OPERATIVE DENTISTRY, 1976, 1, 98–107.

Eight High-copper Amalgam Alloys and Six Conventional Alloys Compared

W. B. EAMES • J. F. MACNAMARA

Compared with conventional amalgam alloys, high-copper alloys show a decrease in dimensional change, lower flow at three hours, lower static creep at seven days, increased early tensile strength, and higher compressive strength at one hour, twenty-four hours, and at seven days. The high-copper alloys showed the greatest improvement in static creep at seven days. These alloys offer the practitioner a variety of handling characteristics and setting times.

W. B. Eames, D.D.S., Emory University School of Dentistry, Division of Applied Dental Materials, Atlanta, GA 30322, U.S.A.

Dr. Eames is professor of operative dentistry and is the director of the Division of Applied Dental Materials.

J. F. MacNamara, Emory University School of Dentistry, Atlanta, GA 30322, U.S.A.

Mr. MacNamara is a student in the class of 1978 at the Emory University School of Dentistry.

Probably no other dental material has been investigated as much as the dental amalgam alloy. However, in the past decade many important advances have been made in the composition of this material. One such improvement was the inclusion of spheres of silver-copper eutectic in the product Dispersalloy, first described in 1963 as an experimental material with improved properties (Innes & Youdelis, 1963). In 1968 it was launched as a commercial product in Canada, and in 1974 Johnson and Johnson acquired the rights and now manufactures the product.

Recently several new alloys with a high content of copper have been introduced. The manufacturers claim these alloys have superior and improved compressive strength, low static creep, and reduction or elimination of the gamma 2 phase, advances they believe will lead to improved clinical performance.

Dispersalloy's tensile and compressive strengths were not found to be exceptional in our earlier experiments (Eames & Cohen, 1974), though they were comparable with any good amalgam alloy. However, clinical studies (Mahler, Terkla & Reisbick, 1970) have shown a marked decrease in marginal fracture when compared with conventional alloys, and this is thought to be correlated with low static creep.

The inclusion of copper to replace a part of the tin component allows the copper to react with remaining free tin, thus reducing the amount of gamma 2 phase in the final restora-

Table 1. *Conventional and High-copper Alloys*

Alloy	Manufacturer	Particle Shape	Copper Addition	Copper in Alloy (percent)	Lot Number
Conventional:					
New True Dentalloy	S. S. White Philadelphia, PA 19102	fine cut			106712
Optaloy	L. D. Caulk Milford, DE 19963	fine cut			7624A
Spheraloy	Kerr Romulus, MI 48174	spherical			1193 T00A
Shofu Spherical Alloy	Shofu Dental Corp. Menlo Park, CA 94025	spherical			317504
Aristaloy MS	Baker Dental Carteret, NJ 07008	blend			012975
Accusphere	Litton Dental Products Toledo, OH 43615	blend			405C
High copper:					
Aristaloy CR	Baker Dental Carteret, NJ 07008	spheroidal	ternary alloy	13.0%	none
Cupralloy	Weber Consumable Products Mount Vernon, NY 10553	spheroidal	admixture	21.0	677512
Dispersalloy	Johnson & Johnson East Windsor, NJ 08520	blend	admixture	12.0	none
Indiloy	Shofu Dental Corp. Menlo Park, CA 94025	spheroidal	quaternary alloy	13.0 +5.0 indium	D1
Micro II	L. D. Caulk Co. Milford, DE 19963	blend	admixture	9.0	75239
Optaloy II	L. D. Caulk Co. Milford, DE 19963	blend	admixture	9.0	75238
Sybraloy	Kerr Romulus, MI 48174	spherical	ternary alloy	29.0	0612751143
Tytin	S. S. White Philadelphia, PA 19102	spherical	ternary alloy	12.0	R75815

tion. It has been shown that a decrease in the gamma 2 phase is related to a decrease in corrosion of Dispersalloy (Duperon, Nevile & Kasloff, 1971), a significant improvement over the conventional alloys which contain the more easily corroded gamma 2 phase. In this experiment, the physical properties of eight high-copper alloys and six conventional alloys are compared.

MATERIALS AND METHODS

The conventional alloys chosen for this study are listed in Table 1. These represent the three major types of alloy particle presently on the market: fine-cut, spherical, and a blend of fine-cut and spherical particles. All have less than 6% copper as currently required by ADA Specification No. 1.

Table 2. *Values for Physical Properties of Amalgam Alloys*

Alloy	Flow 3-24 hours *percent*	Dimensional Change during Hardening *percent*	Diametral Tensile Strength at 15 minutes *psi*	Compressive Strength			Static Creep at 7 days *percent*
				at 1 hour *psi*	at 24 hours *psi*	at 7 days *psi*	
New True Dentalloy	1.00 ± 0.38	−0.12 ± 0.06	672 ± 64	21,400 ± 418	62,750 ± 866	58,900 ± 3612	2.36 ± 0.22
Optaloy	1.47 ± 0.09	−0.05 ± 0.01	1185 ± 73	25,250 ± 935	54,100 ± 1039	55,150 ± 2571	3.72 ± 0.21
Spheraloy	1.46 ± 0.25	−0.21 ± 0.02	567 ± 30	20,600 ± 1069	59,150 ± 1547	63,650 ± 1194	1.54 ± 0.15
Shofu Spherical Alloy	0.28 ± 0.04	−0.04 ± 0.02	866 ± 113	26,000 ± 1510	52,850 ± 1009	54,000 ± 1945	0.32 ± 0.02
Accusphere	0.75 ± 0.20	−0.11 ± 0.01	943 ± 30	21,500 ± 467	54,100 ± 2104	59,100 ± 1755	2.52 ± 0.14
Aristaloy MS	0.84 ± 0.22	−0.08 ± 0.01	876 ± 34	21,900 ± 1506	54,200 ± 1565	57,900 ± 2853	1.53 ± 0.16
Aristaloy CR	0.26 ± 0.07	−0.09 ± 0.01	1319 ± 186	33,000 ± 1172	68,250 ± 1262	73,800 ± 1815	0.28 ± 0.04
Cupralloy	0.74 ± 0.12	−0.04 ± 0.02	580 ± 49	18,200 ± 600	62,400 ± 2265	63,850 ± 1506	0.22 ± 0.01
Dispersalloy	0.46 ± 0.09	+0.05 ± 0.02	1314 ± 98	32,800 ± 1350	63,750 ± 5068	64,500 ± 7905	0.25 ± 0.03
Indiloy	0.16 ± 0.04	−0.08 ± 0.01	642 ± 27	31,600 ± 2655	65,875 ± 3886	62,600 ± 3555	0.06 ± 0.02
Micro II	1.13 ± 0.30	+0.02 ± 0.02	946 ± 50	25,500 ± 1944	61,350 ± 1207	66,300 ± 3813	1.40 ± 0.15
Optaloy II	1.04 ± 0.21	+0.03 ± 0.02	1063 ± 98	28,800 ± 2901	61,500 ± 2417	63,450 ± 2642	1.77 ± 0.15
Sybraloy	0.15 ± 0.06	−0.06 ± 0.04	1533 ± 213	46,500 ± 3488	63,400 ± 2725	67,000 ± 7176	0.02 ± 0.01
Tytin	0.12 ± 0.03	−0.08 ± 0.01	538 ± 111	34,850 ± 1464	73,950 ± 1987	77,500 ± 3162	0.07 ± 0.03

Note: Alloys were prepared in the ratios and trituration times suggested by the manufacturers.

Three of the eight high-copper alloys listed in Table 1 are spheroidal (a mixture of odd-shaped rounded particles and spheres of varying sizes), three are blends of fine-cut particles and spheres, and two are spherical. The amount of copper in these alloys ranges from 9% to 29%, with half of the alloys at 12 to 13%.

There are three different systems for adding copper. Three alloys are ternary alloys in which the copper is combined with silver and tin; four are admixtures to which particles of copper-containing alloys are added to a matrix of conventional alloy; and one alloy is a quaternary alloy of silver, tin, copper, and indium.

In this study, all alloys, excepting the control, were manipulated in accordance with the manufacturers' instructions regarding mercury-alloy ratio, trituration time, capsule, pestle, and amalgamator used. New True Dentalloy, the control, was prepared using a Kerr capsule and 3.5 g pestle on a Wig-L-Bug LP60 set at 1,400 rpm to calibrate the experiments to previous studies.

All specimens were prepared by the all-mechanical method outlined in ADA Specification No. 1. Specimens were tested in accordance with ADA Specification No. 1 for dimensional change during hardening, flow, and diametral tensile strength at 15 minutes, and, in accordance with the proposed A.D.A. specifications, for compressive strength at one hour, and static creep at seven days. Specimens were also tested for compressive strength at 24 hours and at seven days.

A Johannsson Mikrokator was used to measure dimensional change at 37°C, and a pneumatic universal testing machine (Allied Research Associates, Inc.) was used for strength tests with a load rate of approximately 10 pounds per second. Flow and static creep were calculated on a Cady Exact Automatic Micrometer which was modified by attaching a dial gauge of 10 micrometers (μm) (microns) per division to facilitate accurate measurements.

The handling characteristics of the new high-copper alloys may be more important to the practicing dentist than their physical properties, therefore a highly subjective assessment was also made of these alloys in an effort to give the operator a basic "feel" for these new materials.

Amalgam was prepared for testing with the equipment described and by the techniques recommended in each case by the manufacturers.

The cohesive test (Eames & Skinner, 1965) is thought to be akin to the working time exhibited by each amalgam. The thumb-forefinger plasticity test (Eames, 1976) is included to help determine the character of the amalgam, that is, its crepitance or fluidity, both of which are familiar to the experienced dentist. Condensing was done by hand. Carving time was judged by the maximum time after trituration that each specimen could be cleanly cut with a sharp instrument.

The data from which the following results are derived are collated in Table 2.

CORROSION TESTING

In an analysis of seven recently introduced high-copper alloys, Dr. Miroslav Marek, Senior Research Scientist, Georgia Institute of Technology, has stated that, "X-ray diffraction and tests by polarization predicting corrosion revealed that most high-copper amalgams exhibited either no gamma 2 phase or only small traces. In Optaloy II and Micro II the amount was reduced from the earlier products but was not eliminated. All were compared with the earlier Optaloy as a control which typically contains gamma 2 as is found in all conventional amalgam alloys."

Dispersalloy has been found to be virtually free of gamma 2 by several investigators during the past few years. Aristaloy CR has been determined to be free of gamma 2 by the University of Virginia.

After prolonged periods, investigators have identified another corrosion factor, the Cu_6Sn_5 phase, which may appear as a problem of less significance.

W.B.E.

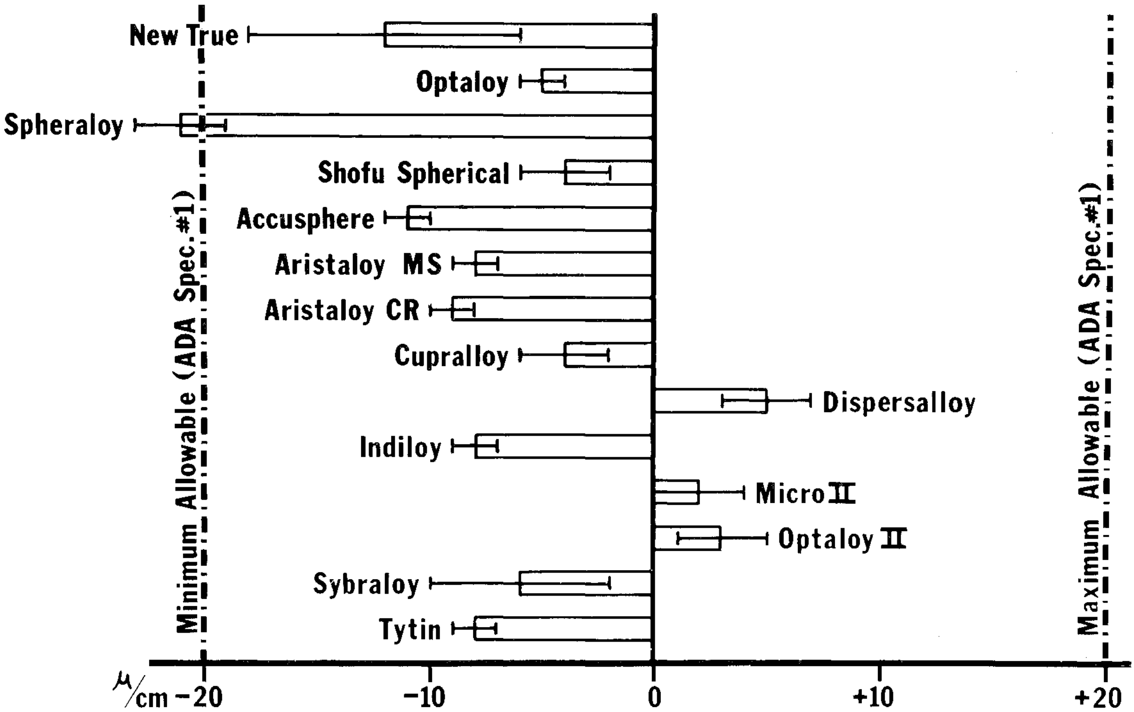


FIG. 1. Dimensional change during hardening

RESULTS

Dimensional Change during Hardening

The results are depicted in Figure 1. All conventional alloys contracted upon hardening, with one spherical alloy, Spheraloy, contracting more than the acceptable 20µm/cm. All the high-copper alloys were within the limits, five alloys contracting and three expanding. High-copper alloys as a group exhibited 40% less dimensional change than the group of conventional alloys.

Flow at Three Hours

The results are shown in Figure 2. The flow of all alloys was well within the allowed maximum of 3%. High-copper alloys showed 47% less flow than conventional alloys. Within the high-copper group, Optaloy II and Micro II showed the greatest flow, both in excess of 1%, with five alloys exhibiting flow of less than 0.5%. Shofu Spherical Alloy was the only conventional alloy to show less than 0.5% flow.

Diametral Tensile Strength at 15 Minutes

The results are shown in Figure 3. The acceptable minimum of diametral tensile strength at 15 minutes is 290 psi, and all of the alloys easily exceeded this minimum. The high-copper alloys had an early tensile strength 14% greater than conventional alloys. Sybraloy, Aristaloy CR, Dispersalloy, and Optaloy II all exceeded 1,000 psi. Optaloy was the only conventional alloy to exceed 1,000 psi.

Compressive Strength

The results may be seen in Figure 4. The minimum compressive strength at one hour stated in the proposed specification is 11,600 psi. All of the alloys tested had one-hour strengths in excess of 18,000 psi. The high-copper alloys had compressive strengths 27% higher than the conventional alloys. Sybraloy exhibited the highest compressive strength at one hour—46,500 psi.

Twenty-four hours after trituration, strengths of conventional and high-copper al-

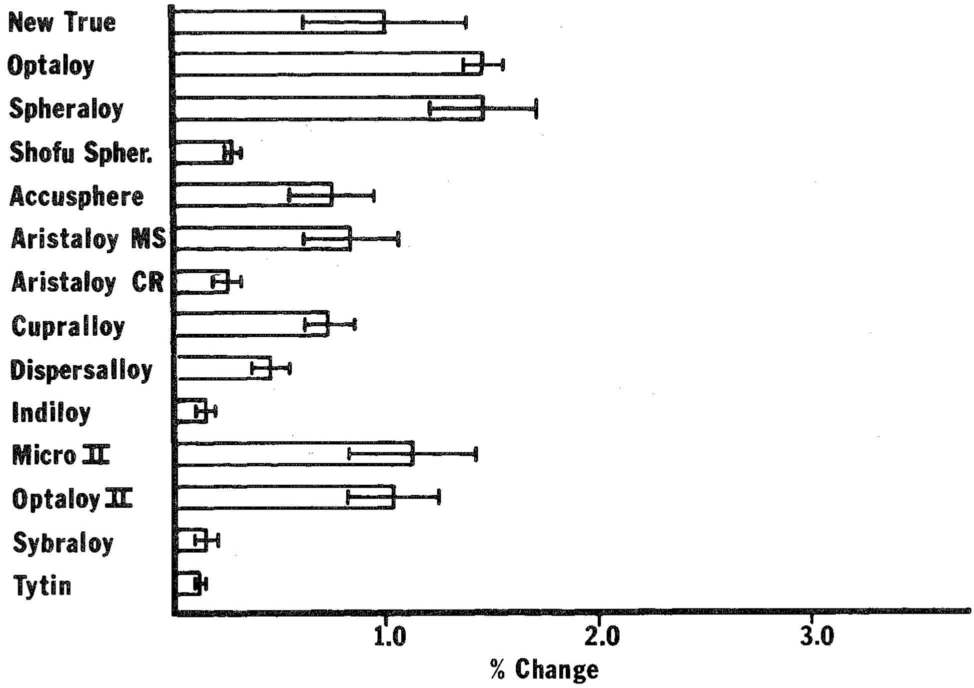


FIG. 2. Flow at 3 to 24 hours

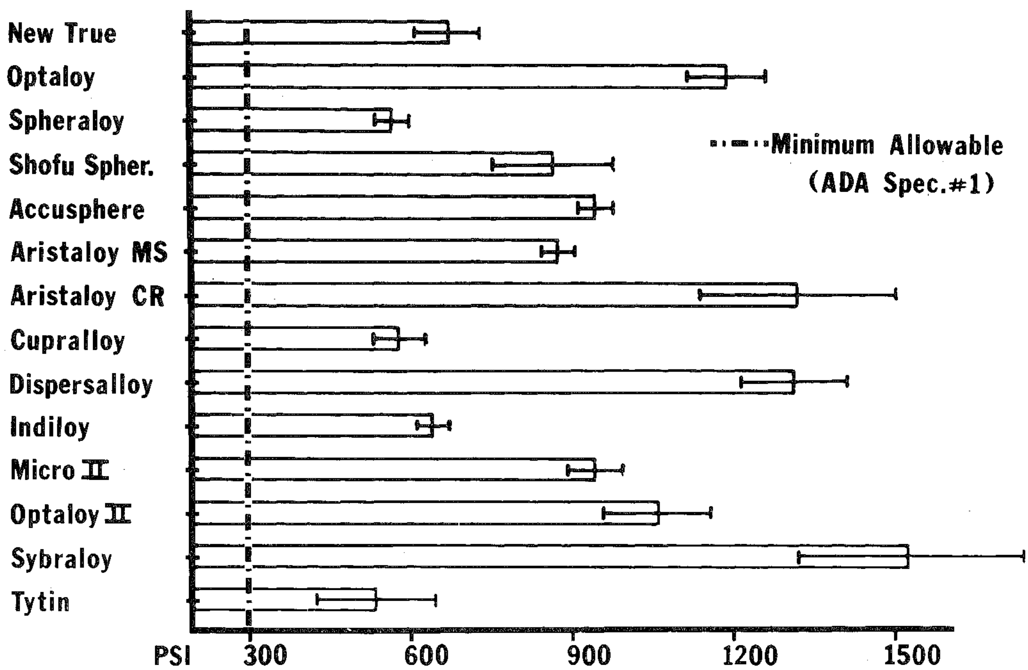


FIG. 3. Diametral tensile strength at 15 minutes

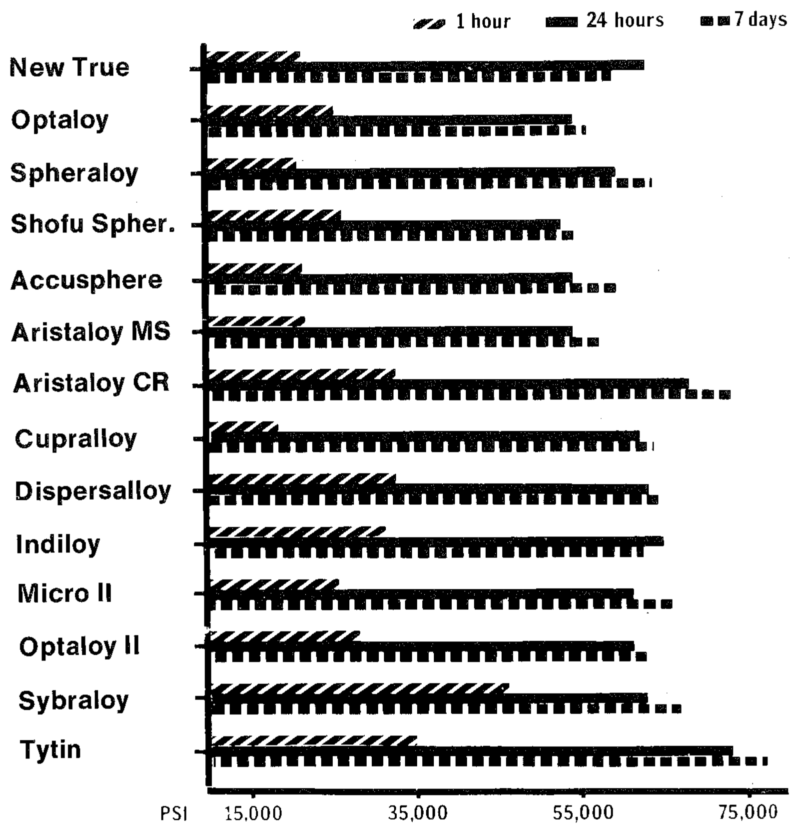


FIG. 4. Compressive strength

loys were more comparable, the high-copper alloy being stronger by only 14%. Only Tytin had a compressive strength greater than 70,000 psi at 24 hours. All of the high-copper alloys, but only one of the conventional alloys, New True Dentalloy, exceeded 60,000 psi. All alloys produced amalgams with strengths in excess of 50,000 psi.

At seven days the ultimate strength developed by high-copper alloys was also 14% greater than that of the conventional alloys. Only Tytin and Aristaloy CR exceeded 70,000 psi. Once again the strengths of all the high-copper alloys were greater than 60,000 psi whereas the strengths of the conventional alloys, excepting Spheraloy, were less than 60,000 psi. For New True Dentalloy and Indiloy, compressive strengths at seven days were less than they were after 24 hours, but the difference is not significant.

Static Creep

See Figure 5. High-copper alloys have shown a dramatic reduction in static creep, 75% less than the conventional alloys. Sybraloy, Indiloy, and Tytin all had creep values of less than 0.1%. Micro II and Optaloy II showed values in excess of 1%, but even so, creep has been reduced appreciably from the 3.72% of the earlier Optaloy. Shofu Spherical Alloy had a low creep of 0.32% which is considerably less than any other conventional alloy and more nearly equal to high-copper alloys.

Handling Properties of High-copper Amalgams

In general, amalgams of spheroidal alloy condensed with more resistance to the condenser than did those of spherical alloy, but there is less resistance than with blends of cut alloys. The special characteristics of each

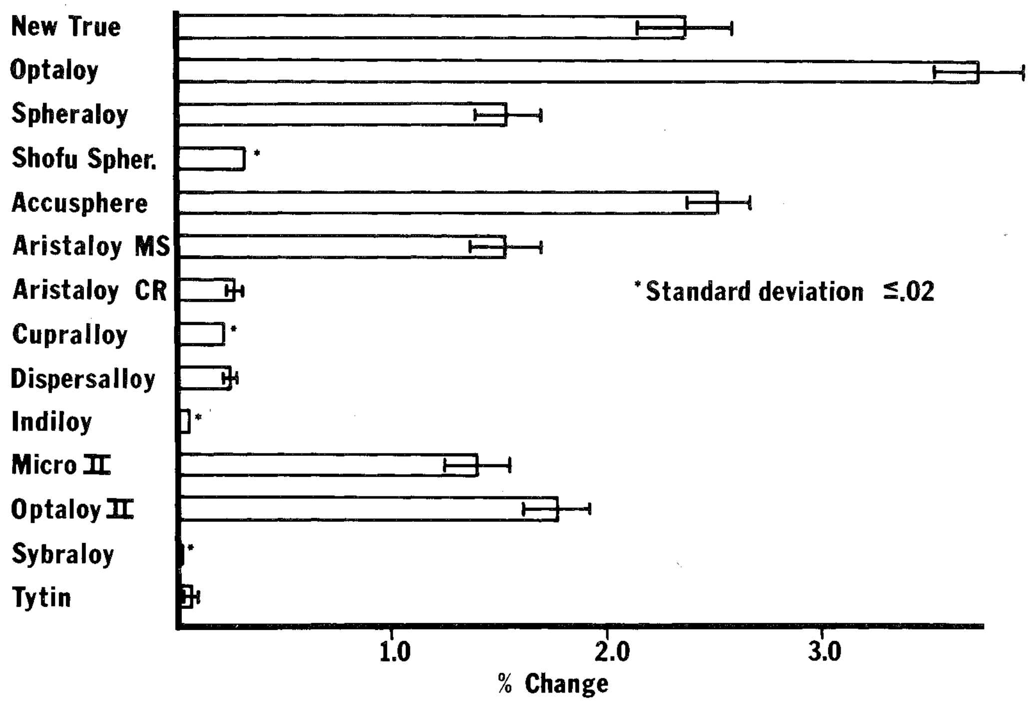


FIG. 5. Static creep at seven days

alloy are discussed below. The alloys are listed in alphabetical order.

• *Aristaloy CR* AND Tytin, formulated by Kamal Asgar, University of Michigan, differ in particle shape, mercury ratio, and handling characteristics. Aristaloy CR is sold in both disposable and pellet form at a recommended mercury:alloy ratio of 1.1:1 (52.4% mercury), and a trituration time of 12 seconds with a Wig-L-Bug AR5. The amalgam remains plastic and cohesive for approximately 3 to 4 minutes. Aristaloy CR is smooth, plastic, and registers fingerprints easily. At this ratio it appears "wetter" than Tytin, which embodies the same metallurgical formula. Aristaloy CR condenses with more resistance than (spherical) Tytin though its physical properties are similar and each holds the same patents. Aristaloy CR carves with difficulty after 5 or 6 minutes. When tested at the University of Virginia, this alloy was found to be free of gamma 2.

• *Cupralloy* has a recommended mercury:alloy ratio of 1:1 and a trituration time of 18 seconds with a Wig-L-Bug AR5, using a Caulk capsule with plastic dumbbell pestle. The amalgam appears plastic with an optimum of excess mercury appearing with the thumb and finger test. Its cohesive time is 4 minutes. Cupralloy condenses with some resistance and less excess mercury is seen during condensation than in other spheroidal alloys in spite of its higher mercury:alloy ratio. It becomes difficult to carve after 6 minutes.

• *Dispersalloy* is available in both disposable and pellet form. Its recommended mercury: alloy ratio is 1:1. Triturated in the Wig-L-Bug LP60 set on high for 20 seconds for the disposable form, it remains plastic for 4.5 minutes. It is smooth to manipulation by the finger and registers fingerprints at this ratio. Dispersalloy condenses with some resistance but more easily than Micro II or Optaloy II, which are also blends. Dispersalloy carves with difficulty after 5 or 6 minutes. Dispersalloy has the advantage of several years of successful clinical use (Mahler, Terkla & Van Eysden, 1973).

• *Indiloy* is spheroidal and the manufacturer recommends triturating for 20 seconds in a Wig-L-Bug capsule without a pestle, with a Torit amalgamator. At 46% mercury (mercury:

alloy ratio 0.81:1), the amalgam mass remains cohesive for 3.5 minutes. It is as smooth as other amalgams and registers fingerprints. Being spheroidal, it condenses with more resistance than do spherical alloys. It remains carvable for about 8 minutes. The 5% indium is said to be in solidus solution throughout the mass. The manufacturer claims it is able to render copper, silver, and tin chemically passive, as if inert.

- *Micro II.* Manufacturers recommend approximately 54% mercury (mercury:alloy ratio 1.17:1), using an OP plunger, with the Caulk mercury dispenser for 14 seconds with a Vari-Mix amalgamator (M2 setting), using the plastic dumbbell pestle. It remains cohesive for 3 to 3.5 minutes. Micro II appears smooth, registering fingerprints in its freshly mixed form. It condenses similarly to cut alloys, and is crepitant, a characteristic of the earlier Micro alloy. Excess mercury is readily expressed during condensation. It is hard to carve after 5 minutes and appears to harden a little more slowly than Optaloy II.
- *Optaloy II.* The disposable capsule is proportioned at 54% mercury (mercury:alloy ratio 1.17:1). Its recommended trituration time is 11 seconds at the M2 setting of the Vari-Mix and remains plastic for 3.5 minutes. Optaloy II is not as smooth in the finger test as amalgam from spherical alloy, but registers fingerprints. It condenses similarly to alloys of conventional cut, and allows the bringing up of excess mercury. It is difficult to carve after 4 minutes, and is very hard at 5 minutes.
- *Sybraloy.* Manufacturers recommend 45% mercury (mercury:alloy ratio of 0.81:0). In a disposable capsule, the triturating time is 25 seconds with a Torit amalgamator. It remains cohesive for 4.5 minutes. Sybraloy does not appear to be fully amalgamated and exhibits a lusterless, dull appearance not characteristic of other alloys. However, it is plastic, and even longer triturating times do not change its appearance. In spite of its low mercury:alloy ratio, some excess mercury emerges during 2 minutes of condensation. Sybraloy carves readily after 6 minutes.
- *Tytin.* The recommended proportion of mercury is 43.5% (mercury:alloy ratio 0.76:1). Tytin is sold in disposable capsule form, without a pestle, and requires only 10 seconds trituration with the Wig-L-Bug AR5. The amalgam remains cohesive for 3 minutes. Tytin is slightly less resistant to the condenser than Sybraloy, though both are spherical, and it registers fingerprints easily. Although the patent formulation is the same as Aristaloy CR, Tytin, because of its particle shape, carves with less resistance. Tytin is more resistant to the carver after 6 minutes than is Sybraloy. Sarkar and Asgar have completed corrosion testing and have found Tytin to be free of gamma 2.

DISCUSSION

Although the physical properties of all of the high-copper alloys are generally superior, in using these alloys the dentist may not necessarily reduce the number of failures. Care in the fundamentals of proper cavity preparation and meticulous and thorough condensation of the alloy can assure a higher degree of success.

It is our opinion that the least important characteristic of the new alloys is strength itself. Strength has long been used as a criterion for success or failure, but in clinical experience strength appears to exceed the demands placed upon it, that is, the conventional amalgam is strong enough when handled properly.

Although the correlation is not fully understood, there is mounting evidence that from low values of creep we may predict better marginal integrity. If this is true, we should expect that five of the alloys tested would have the same marginal integrity after several years that Dispersalloy has exhibited. Micro II and Optaloy II should be expected to show much improvement over the conventional low-copper Micro and Optaloy.

It is important to appreciate that laboratory testing requires the corroboration of several years of clinical testing in the environment of the mouth. In our ongoing clinical studies, using the alloy containing the highest percentage of copper, tarnish was not clinically visible after nine months.

It is our opinion that an amalgam that is least subject to corrosion may in the long term produce the most stable restoration, with better marginal adaptation and less interface corrosion. It is this corrosion that leads eventually to total breakdown in strength and in the integrity of the surface and the margins.

An "inert" amalgam would be the most ideal material conceivable. It may be that we are approaching this and as the amalgam improves, so will its esthetic image, and it will come to provide the profession with a new potential in superior service.

This study was supported in part by the National Institutes of Health, National Institute of Dental Research, Research Grant No. 5 RO 1 DE 03504-06 and by the Fifth District Dental Society of Atlanta.

REFERENCES

American Dental Association (1974) *Guide to Dental Materials and Devices.* 7th edition, pp. 170-173. Chicago: American Dental Association.

Duperon, D. F., Nevile, M. D. & Kasloff, Z. (1971) Clinical evaluation of corrosion resistance of conventional alloy, spherical-particle alloy, and dispersion-phase alloy. *Journal of Prosthetic Dentistry,* **25**, 650-656.

Eames, W. B. (1976) A clinical view of dental amalgam. *Dental Clinics of North America,* **20**, 385-395.

Eames, W. B. & Cohen, K. S. (1974) A product report on a dispersed phase amalgam. *Journal of the Georgia Dental Association,* **47**, 22-27.

Eames, W. B. & Skinner, E. W. (1965) A possible test for working time of dental amalgam. *Program and Abstracts of Papers, International Association for Dental Research, 43rd General Meeting,* Abstract No. 94, p. 60.

Innes, D. B. K. & Youdelis, W. V. (1963) Dispersion strengthened amalgam. *Journal of the Canadian Dental Association,* **29**, 105.

Mahler, D. B., Terkla, L. G. & Reisbick, M. H. (1970) Marginal fracture vs. mechanical properties of amalgam. *Journal of Dental Research,* **49**, 1452-1457.

Mahler, D. B., Terkla, L. G. & Van Eysden, J. (1973) Marginal fracture of amalgam restorations. *Journal of Dental Research,* **52**, 823-827.

OPERATIVE DENTISTRY, 1976, 1, 108–115.

DENTAL PRACTICE

The Class II Gold Foil: A Flexible and Durable Restoration

BRUCE B. SMITH

Considering the current trend of excessive cutting with high-speed procedures, the Class II foil is a welcome conservative operation that gives the patient one of the best services known to dentistry.

Bruce B. Smith, B.Sc., D.M.D., 110 Cobb Medical Center, Seattle, WA 98101, U.S.A.

Dr. Smith conducts a private practice full time. He is past president of the American Academy of Gold Foil Operators and of the Academy of Operative Dentistry. He is director of the John Kuratli Crown and Bridge Seminar in Oregon and director of the Bruce B. Smith Crown and Bridge Seminar in Seattle. He is a member of the American Academy of Restorative Dentistry and the University Ferrier Study Club.

Carious lesions found in dental practice today are frequently smaller than those found in the past. This may be attributed to fluoride in drinking water and dentrifrices, and to better control of plaque. As a result, more than ever before, small restorations are indicated. Unfortunately, the ease of cutting teeth with ultraspeed burs and the accuracy of elastic impression materials has tended not only to make gold inlays more popular, but has even encouraged the use of full crowns instead of inlays.

In dentistry the greatest art is to conceal art and thus allow the patient a pleasant, natural smile. If delicate and precise foil operations are performed, it is only when the dentist picks up his mouth mirror to examine the teeth that he is suddenly aware of the fine care the patient has received through the years. With foil, patients have received the finest possible service. They have been allowed to keep more of their hard dental tissue. They have restorations with the finest and most permanent margins known to restorative dentistry. This is conservative dentistry at its best.

For a Class II cavity the most conservative restoration is a gold foil. Gold foil restorations require less destruction of tooth tissue than do gold inlays. Good candidates for Class II gold foil restorations are bell-crowned teeth with large undercut areas which could distort flexible impression material; rotated teeth; and teeth with a sound previously placed gold foil or gold inlay in the opposite proximal surface.

The Class II gold foil can and should be a service provided by every dental practice of high quality. The purpose of this article is to describe the author's concept and technique of the Class II gold foil operation with the hope that the information will help others to a greater facility with the procedure.

Cavity Preparation

Open the cavity through the occlusal pit with a No. 170 carbide bur at ultraspeed. Establish occlusal outline and prepare a proximal 'T'. The bur proceeds gingivally on the proximal and runs out through the enamel to allow a visual depth guide. Here the bur weakens the walls enough for later planing with chisels or enamel hatchets. After establishing the gingival wall, replace the bur with a shortened No. 170 carbide bur which, at slow speed, provides a more accurate depth guide in refining the occlusal portion. This bur will automatically give the necessary divergence to the buccal and lingual walls of the isthmus. Plane and refine the buccal and lingual walls of the proximal portion with enamel hatchets of suitable size or binangle chisels. These instruments may also be used to sharpen the occlusal outline and give proper divergence to the wall adjacent to the marginal ridge. Frequently a Wedelstaedt chisel assists in refining the outline. Define the sharp occlusal angles with an inverted cone bur held at an angle and with slow speed. The rotation of the bur may be reversed from one side to the other to prevent "runout." The proximal walls should twist slightly as they approach the gingival to give a complete boxing. This boxing may be enhanced, if desired, by accentuating the axioproximal line angles by turning the enamel hatchet slightly. Another instrument useful for gaining this effect, particularly in cavities on the mesial of the mandibular first bicuspid, is the gingival margin trimmer, as well as the miniature gingival margin trimmers No. 28° and No. 29°. These are the same instruments, designed by C. T. Fleetwood, which are so indispensable in preparing Class III cavities for the lingual approach.

The fine finishing of the walls of the preparation should be done with very sharp instruments (Hamilton, 1975). The use of these will automatically impart a slight bevel and will correct any slight irregularities in outline form. To be most effective, the instruments should be sharpened frequently while in use. The gingival wall is not beveled in the Class II foil preparation, as the soft foil which will rest against this wall must be properly supported.

There is a slight variance in the cavity preparation in the mandibular and in the maxillary arches. This variance is based on the dental anatomy of the area, that is, the position and size of the teeth, and especially the form of the embrasures. The variance also allows the operator to take advantage of the flexibility of the material. In the maxillary arch, the lingual embrasure opens occlusally from the gingival and greatly diminishes the amount of lingual extension needed. Practically, the effect on the outline form is to make the gingivolingual angle an acute angle, whereas the buccal is usually a right angle. The reverse is true in the mandibular arch where this effect is on the buccal aspect instead of the lingual. An exception, however, is the mesial of the mandibular first bicuspid. Here tooth structure may be saved on both the buccal and the lingual with acute angles used at both gingival angles. This is possible because of the shape of the adjacent surface of the mandibular cuspid. Indeed, the form of the mandibular first bicuspid is like a cuspid in the mesial half and a bicuspid in the distal half. Because of this and because there is no occlusion on the mesial (as its antagonist is the maxillary cuspid), no pulpal wall is necessary in the normal mesial cavity.

The distal cavity on this tooth is also prepared in a special manner. Here an occlusal step is necessary but, due to the large buccal cusp with the accompanying pulpal extension, it is wise to slope the pulpal wall occlusally as it extends to the buccal, affording greater protection to the pulp.

The occlusal outline in all the Class II preparations for foil need not be overly wide but should present a small and neatly cut dovetail. At one time, in the 1930s, some dentists were making excessively small occlusal outlines, so restricted as to make the strength of the restoration almost marginal. Through the years it has been observed in study clubs that some dentists gradually drift in their preparation forms and procedures to a point where they may overaccentuate, or even overrestrict, certain forms. When this has occurred and the error become apparent, or is mentioned by the

Drawings for this and opposite page by Capt. James V. Gourley, D.C., U.S.N.

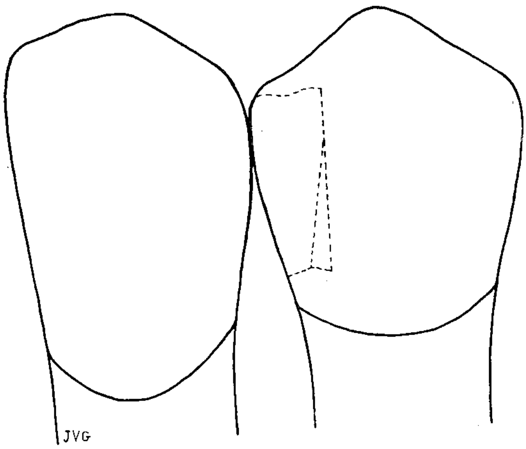


FIG. 1. Placement of retention areas on the mandibular first bicuspid mesial preparation.

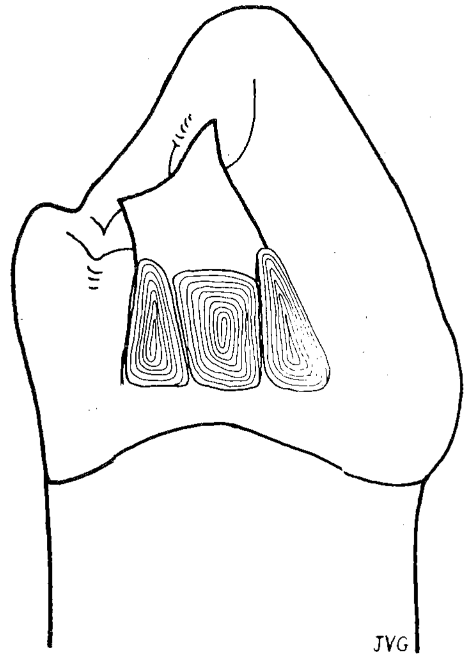


FIG. 2. Initial placement of noncohesive cylinders.

instructor, the correction is made and the extension, or the pendulum so to speak, swings back to a normal area. Normally, the occlusal outline presents a slight reverse curve at the buccoproximal area with the linguo-occlusal outline being almost straight, for with foil one does not face quite the same problem as in seating a single-step inlay. With the inlay, no retention other than the dovetail is used. Here, if the linguo-occlusal does not have an adequate dovetail form to match that on the buccal, the hydraulic pressure of the cement may cause a slight linguoproximal displacement when the inlay is seated. The foil, on the other hand, has slight but definite retentive areas placed at the expense of the lingual and buccal walls where they reach the slightly divergent wall of the marginal ridge. These areas also help in starting the occlusal phase of the foil.

As indicated previously, the proximal walls should be well boxed to the gingival, but actual retentive areas here are seldom necessary, particularly if one has not extended too far into the proximal embrasures. Overextension here can make the condensation of the foil into the proximal much more difficult, allowing the gold to slip out of the cavity under occlusal pressure if extra care is not used. William H. Gyllenberg has demonstrated, in contrast to J. M. Prime's statements, that retention areas on the proximal walls may be justified when needed and that the foil readily enters these areas. However, these retention areas should be placed thoughtfully and delicately to ensure strength of the walls (Fig. 1).

Locks in previously placed restorations, whether foil or inlay, may be used to secure the occlusal of a later Class II foil, assuming that one has thoroughly examined the existing restoration and found this procedure to be advisable. This must be done with some consideration. In a bicuspid, the size of the occlusal area involved is very important because of the limited amount of tooth structure. If the union is to be made with a single-step inlay, one must not destroy the dovetail retention of the inlay nor break the cementing agent. Usually, the occlusal depth of the existing inlay will vary sufficiently from the design of the foil so that one may create adequate retention for the foil without damaging the dovetail of the inlay. A carbide bur used at slow speed here will be less damaging to the cement bond than at high speed.

When the union is to be established with another gold foil, the problem is simplified and

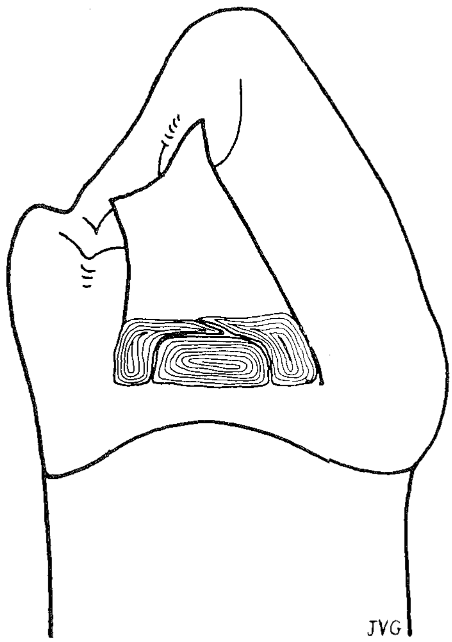


FIG. 3. Noncohesive cylinders condensed.

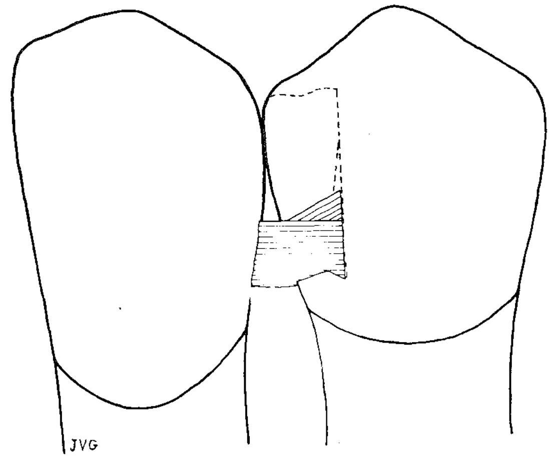


FIG. 4. Placement of initial cohesive foil.

can be achieved simply and directly. The occlusal of the existing foil is cut with a long bevel from buccal to lingual and the new restoration placed with a matching bevel. The wedging action of foil and the compressibility of dentine result in a strong and permanent restoration with the outline form of a normal M.O.D.

Condensation

A fine cavity preparation is the foundation of a good restoration, but the condensation procedures make the foil a success or a failure.

It is almost axiomatic that it is much easier to condense foil well on mesial preparations and to finish it more expeditiously on distal preparations. The angle of condensation is more natural on the mesial and requires less use of the highly offset bayonet condensers. In addition, it is easier to detect any marginal or gingival deficiencies and to correct them more easily. One of the most common problems is the failure to condense the gold completely into gingival angles.

Although it is a little slower and more awkward to fill distal preparations, they have one distinct advantage in that the finishing strips and disks tend to lay in to the tooth and finish the gold more quickly and with greater efficiency. Electromatic or pneumatic condensers are very useful in obtaining the proper angle to condense the gold along all buccal walls as well as along the mesial wall on distal cavities.

Condensation or compaction is the heart of all foil work, especially so in the Class II. Though an all-cohesive gold technique may be used, the most efficient method, both from the standpoint of excellent adaptation of the gold to the walls and from the standpoint of time consumed, is the use of noncohesive cylinders. Usually three hand-rolled cylinders are used (see Figs. 2, 3, & 4); typically, two are made from one-eighth of a sheet, and one from one-quarter, using No. 4 gold (four grains to a sheet). The one-eighth cylinders are swept firmly into position along the proximal walls and into the gingival angles with the Nos. 13 and 14 parallelogram condensers. The one-quarter cylinder is shaped into a wedge with the college pliers and pressed directly between the two eighths. The mass is condensed vertically, using the No. 10 square bayonet condenser of the Ferrier Study Club set. It has been our experience that this large square bayonet is sometimes a little too large for convenience. Occasionally a modified No. 13 or No. 14 parallelogram condenser, particularly the hoe shape (No. 14), will give better condensation and access into the cavity (Fig. 5). To modify this instrument, one decreases the angle to the shaft from 12 centigrades to 6 or 7 centigrades. (This is the same angle employed in most binangle chisels, whereas the 12 centigrade angle is used primarily in hatchets and the Nos. 41 and 42 modified Gillette type chisels.) Hand malleting is employed and the soft noncohesive foil should, when condensed, reach a height two-thirds that of the normal axial wall. This allows room for the following cohesive foil to aid in the retention of the proximal and to form a solid contact point.

The cohesive gold should be placed in a sloping manner, first up the lingual wall and then up the buccal wall, with a slight wedging effect. The vertical condensation should step out slightly beyond the cavosurface angle to give good union with the noncohesive gold and to give proper adaptation to the walls. The contact point should be well formed and condensed against the adjacent tooth. A matrix has no place in this technique, as lateral condensation later with foot condensers (both the large interproximal types and the small No. 12 or F condensers) will use the excess gold to gain density and good coverage in finishing the proximal and gingival margins. A Searl swager will confirm the condensation.

It cannot be overemphasized that overextension proximally can allow noncohesive cylinders to slip out of the cavity; and, because it makes it easier for the operator to place foil on the lingual, he tends to add an excessive amount. Time is wasted not only in adding the excess gold but often to a much greater extent in reducing it when finishing.

Proper layering of the gold buccolingually as described by Black (1908) is of great assistance in adaptation to walls in the occlusal area also. Yet care should be exercised not to produce an excess of wedging and pressure as this can cause hypersensitivity or even crack teeth.

In considering these biologic factors, the sound precautions that one usually takes in operative procedures are of course required. Adequate pulpal protection from thermal shock during preparation should be provided as well as suitable bases or medicaments to prevent postoperative complications. Most foil cavities are not extensive; however, gum copal varnish and cement bases should be used when necessary. If a large base is needed, one should consider the condensing pressures on the base. Sometimes a stronger base of zinc phosphate cement with alloy fillings is indicated.

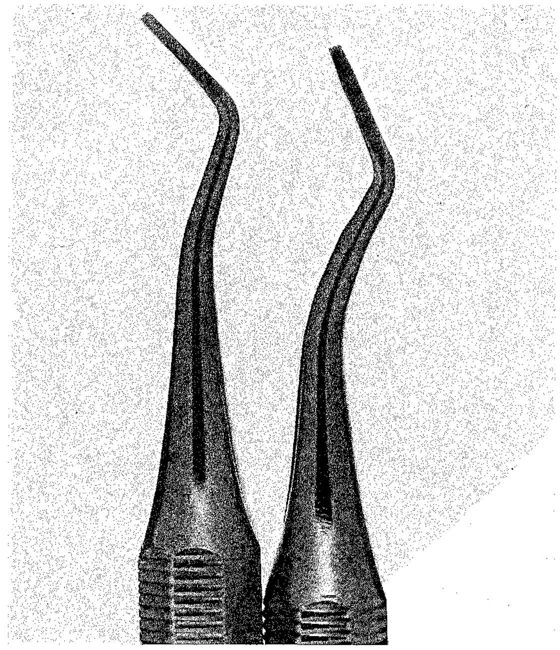


FIG. 5. Angle modification of No. 14 hoe-shaped parallelogram condenser.

Finishing

Finishing is a discipline; it is a series of good habits set into a progressive rhythm; it is the reward for previous conscientious and careful detail. In other words, *finishing* is the payoff. It is not vacillation, or back-and-forth corrections which waste time, effort, and tire the patient. It is essential to the work that has gone before.

After condensation, all areas should first be burnished to explore the possibility of pits or undercondensed areas. These, of course, should be corrected. Special burnishers, such as an extra-small type and a T-shaped form, are often helpful. The Spratley burnisher is usually helpful later to accentuate grooves and to shave off excess fins. A sharp cleoid or discoid is also good.

At this point, it saves time to disk all available areas, including the proximal, to remove excess gold. Fine or medium garnet disks should be used in the proper angles to help set the planes of the cusps and grooves.

Now the anatomy which was carefully built in during condensation is accentuated with a shortened No. 700 or 170 bur, moistened and at slow speed. This will set the central groove and the escape gate through the embrasure. The opposite side of the occlusal may be finished to margin the same way, but frequently a slightly larger round bur such as a No. 4 will run along the margin and remove the excess gold without cutting the enamel as a stone could.

When finer disks complete the surfaces except for polishing, it is time to place the separator, usually a No. 4 or 3 Ferrier. The separator should be a finely proportioned, delicate instrument with which the operator can feel and see the separation of the teeth.

The jaws should be reduced to minimal but uniform dimensions where maximum clearance is obtainable in using gold knives, files, disks, or strips. So that we can feel the separating action upon the teeth, the screws of the separator must be free and not bind in their tracks (Fig. 6). There should be enough "play" in the instrument so that a definite looseness will allow minor adjustments in positioning the separator more easily to the teeth.

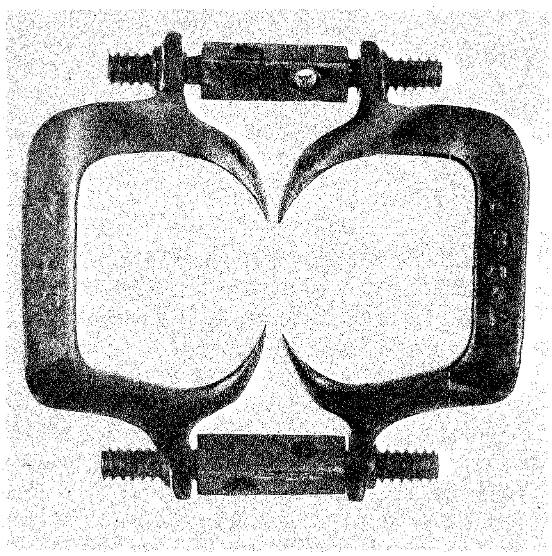


FIG. 6. No. 4 Ferrier separator with refined jaws for better access.

The separator is applied in a passive state and stabilized with compound to avoid tissue damage. The compound also aids in distributing the pressures over several teeth. Only slight separation is necessary as the teeth have already been forced apart a little during condensation. Usually a strip of matrix band may be slipped through the contact area and worked back and forth buccolingually to shape the gold a little and give clearance for an abrasive steel strip. But, if the contact is extremely tight, a Gordon-White saw or Kaber saw will cut through to initiate the action of the strips. Inasmuch as the unfinished gold has assumed the shape of the proximal of the opposite tooth, if the strips are first started with a reverse pull toward both sides of that tooth, they will start more easily. As the extra-long, garnet, medium cuttle, fine, and extra-fine linen strips bring the surface to contour, they should be relieved at either the buccal or lingual to maintain proper contact point and embrasure form. An adequate amount of cooling air should be applied during these procedures and the result should be a beautifully finished and finely polished interproximal surface.

The marginal ridge and occlusal embrasure require special attention. A sharp gold knife or cleoid may be drawn across the embrasure to relieve the acuteness, followed by a large ⅞-inch, extra-fine cuttle disk which will bypass the frame of the separator easily and leave a smooth and rounded ridge. The separator is now removed, after being in place only a short time.

Final polishing is achieved with lap emery No. 303 and optical rouge No. 309W. These are manufactured by the American Optical Company (San Francisco, CA 94119, U.S.A.) and have been popularized and introduced to dentistry by Gerald D. Stibbs.

Finished restorations are illustrated in figures 7-10.

Durability of Foil

The durability of foil is legendary through dental history. Class II foils, with their narrower occlusals, serve patients through their lifetimes. As an example, one of my patients, who recently died at age 70, had had all bicuspids restored with Class II foils, all eventually

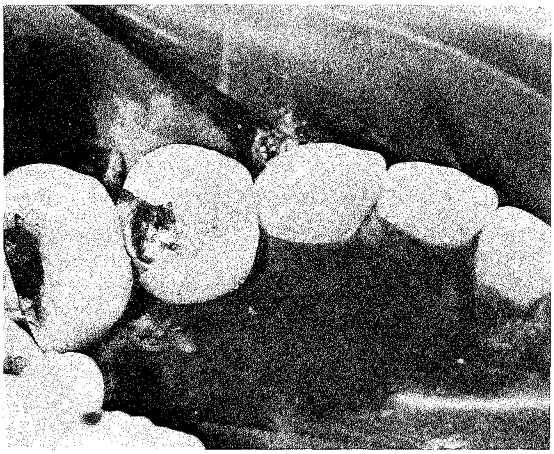


FIG. 7. Disto-occlusal gold foil restoration in the special form for a mandibular first bicuspid. Placed by Ludlow W. Beamish.

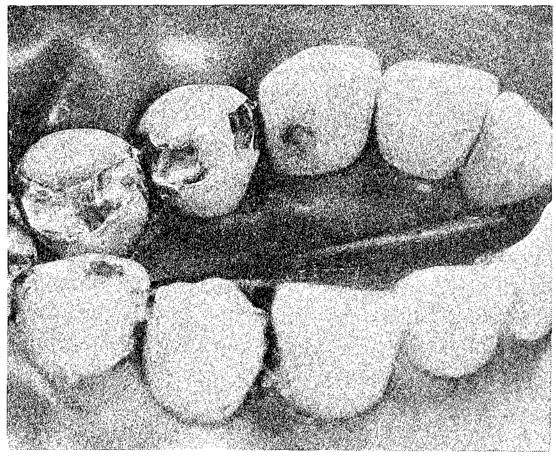


FIG. 8. Mesial gold foil restoration for a mandibular first bicuspid. Note lack of occlusal extension necessary in this area as this tooth occludes with the maxillary cuspid. Placed by Kenneth E. Murchie.

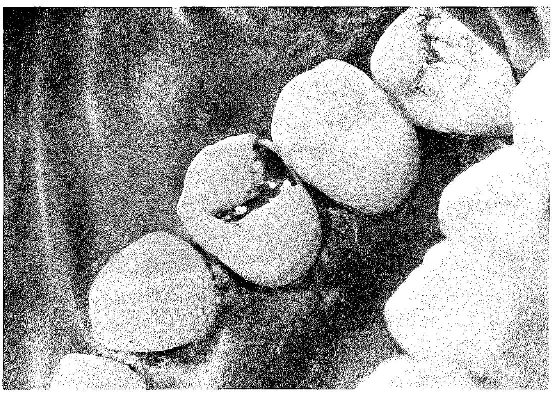


FIG. 9. The classic Class II gold foil restoration as seen in the maxillary bicuspid. Placed by Basil M. Plumb.

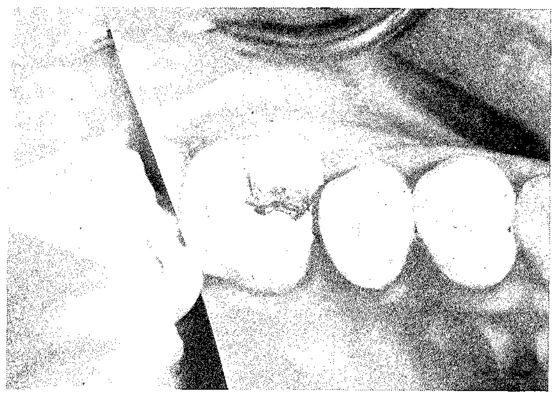


FIG. 10. Delicate and adequate extension combined with proper anatomical features. Placed by Norman C. Ferguson.

M.O.D.s in form. Many had been placed during his early thirties. He was fortunate to have retained a full dentition, without partial dentures or bridges. The cause of his death was sarcoma of the liver. Surely fine operative dentistry through the years contributed to his comfort, health, and ability to nourish himself.

Common Faults

Some criticism of Class II foil operations may help in our quest toward better service for our patients. Common faults are deficiencies at the gingival angles, ragged outlines, and undercondensation. One seldom sees a loose Class II in contrast to the occasional Class III, and some dentists prefer the Class II on state board examinations for this reason. Another occasional fault is failure to gain the proper angle of condensation and correct inclination of the gold to a wall which can result in improper adaptation and voids or leakage. The proper layering and wedging effect of the gold and the proper angle of the condenser will ensure a tight seal and the finest margin in dentistry (Smith, 1959).

Conclusion

Let us remind ourselves, to quote Ferrier (1959), that a tooth is an organ of the body not capable of regeneration. Conservation of dental tissues, hard or soft, is in the best interest of our patients. Gold foil is far superior to an inlay if excessive stress is not a factor. The margins are the finest known. Gold foil is less costly than an inlay which requires not only laboratory time for its creation, but also a second session of clinical time for seating it. For the patient, a gold foil means no second appointment, no second administration of local anesthetic, and no second application of the rubber dam. The patient receives better service and the dentist adequate compensation. We should consider this operation a flexible and durable adjunct to our therapy.

REFERENCES

Black, G. V. (1908) *Operative Dentistry,* Vol. 2. Chicago, Ill.: Medico Dental Publishing Co. Pp. 271-272.

Ferrier, W. I. (1959) *Gold Foil Operations.* Seattle: University of Washington Press.

Hamilton, A. Ian (1975) Cavity walls and margins. *The Journal of the American Academy of Gold Foil Operators,* **18,** 22-28.

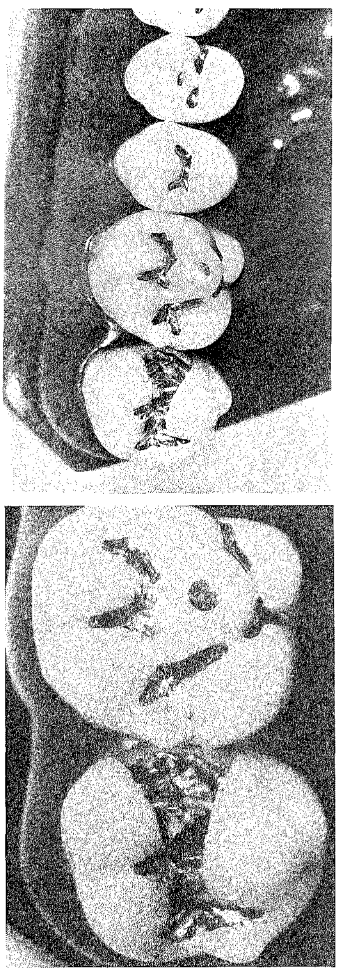
Smith, Bruce B. (1959) Finer operative dentistry with minimal tooth destruction. *Journal of the Southern California State Dental Association,* **27**, 6-10.

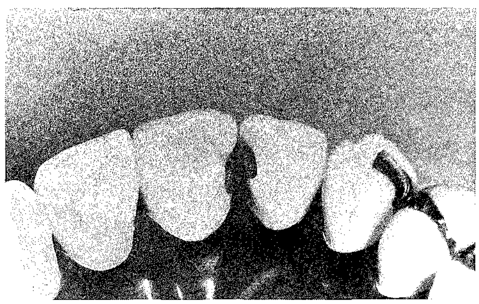
OPERATIVE DENTISTRY, 1976, 1, 116–117.

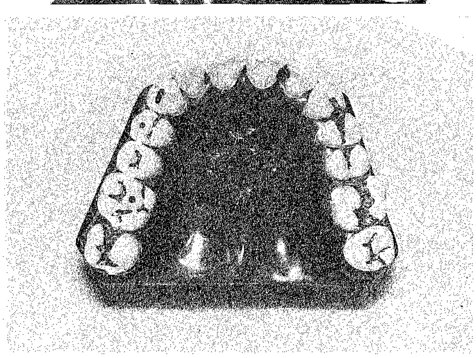
ITEM OF INTEREST

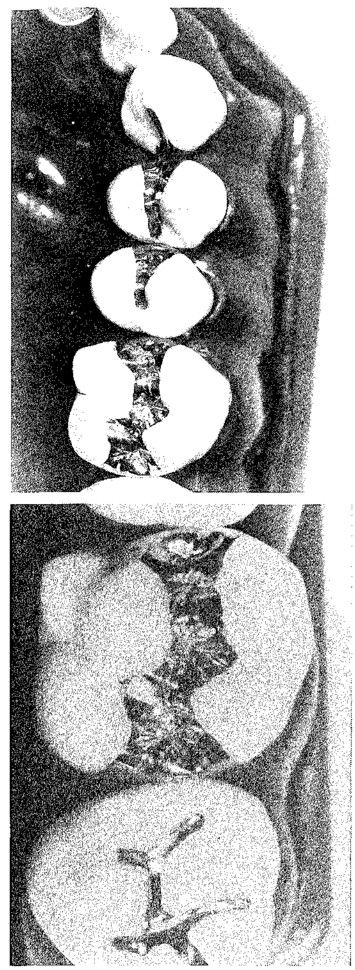
Dave Shooshan and Gold Foil

BRUCE B. SMITH









A complete arch of natural teeth restored by David Shooshan with a combination of gold and platinum foil. Some segments are shown at higher magnification.

There have been relatively few truly great dentists in the United States. One of these, a man who is thought of primarily as an outstanding individual in crown and bridge procedures and noted, among other things, for promotion of the technique of the reverse pin porcelain pontic, was Dave Shooshan. His infinitely accurate castings and displays of 2½- and 3-dimension gold restorations have been marvels of skill and a pleasure to see. Many of the profession have had a chance to witness these castings at the various clinics he presented, some of the most recent being before the Academy of Operative Dentistry and, finally, the American Academy of Restorative Dentistry.

One of the most beautiful examples of the fine work of this great man is an arch of natural teeth, all in the same mouth, that he restored in cohesive gold and platinum (see photographs). This unique work of dental art was done in the thirties when studies of platinum and gold foil were popular. They demonstrated the harder character of this material when compared to cohesive gold used alone, indicating the suitability of the combination of platinum and gold for surfaces under the stress of mastication. Some of these foils were placed while the teeth were in the mouth and others later after an accident forced extraction of the entire arch.

It is indeed a privilege to see such an unusual demonstration of talent. Though Dave passed away last year, his work will always be an inspiration.

It is not surprising that the David Shooshan Memorial Student Loan Fund was established at the University of Southern California this year in his honor. Those desiring to do so may send funds to or communicate with:

Dr. Eldon Parminter, General Chairman
David Shooshan Memorial
Student Loan Fund
University of Southern California
School of Dentistry
925 West Thirty-fourth Street
Los Angeles, CA 90007

OPERATIVE DENTISTRY, 1976, 1, 118–121.

POINT OF VIEW

Is HEW Endangering Professional Quality?

GEORGE R. OLFSON

In important areas of the dental profession, HEW is attempting to effect permanent changes. A concerned dentist describes the current state of affairs and asks for immediate action from the membership.

George R. Olfson, D.D.S., 1212 N.E. 7th Street, Grants Pass, OR 97526, U.S.A.

Dr. Olfson is president of the Oregon State Board of Dental Examiners. He conducts a private practice full time. In 1972 he was selected as general dentist of the year by the Oregon Section of the Academy of General Dentistry. He is a Fellow of the International College of Dentists.

From a paper read at the Western Conference of Dental School Deans and Examiners, July 1975, Flagstaff, Arizona.

Are you aware, as I am, of the leverage exerted by the Department of Health, Education and Welfare on the dental profession and against the programs of the dental schools today? In several areas HEW is actively pursuing a course designed to put national dental controls in the hands of the federal government. As a practicing dentist and a dental examiner who is very concerned, I would like to cite some alarming examples clearly showing HEW's intention and direction.

HOW HEW IS CHANGING THE DENTAL PROFESSION

Federal intrusion into the profession of dentistry and the diverting of state controls is evidenced in several vital areas. They are: (1) federally funded training programs for dental auxiliaries; (2) federal funding of dental schools; (3) programs of aid to minorities; and (4) health-related legislation now before Congress.

By Aiding and Supporting Auxiliary Expansion

The federally funded programs for the training of auxiliaries threaten to include all but three of the dentist's duties. Last year I was invited by HEW to visit the Dental Manpower Development Center where auxiliaries are being trained in expanded duties. The following selection, taken from a list supplied by HEW, is a partial list of the duties being assigned to auxiliaries there.

(1) Impressions for diagnostic casts
(2) Allergy testing (disc and scratch)
(3) Scale and prophylaxis
(4) Matrix band and wedge selection and application
(5) Insert, condense, carve, finish, polish, and recontour alloys
(6) Insert and finish synthetics and composites
(7) Check occlusion
(8) Mixed dentition analysis
(9) Insertion of pulp caps and pulpotomy dressings
(10) Chrome crown selection, adaptation, and cementation
(11) Gingival retraction
(12) Make direct wax patterns
(13) Construct and cement temporaries
(14) Try-in, adapt, and cement castings
(15) Transfer impressions and occlusal records
(16) Primary impressions, mold and shade selection, and laboratory order preparation for removable prosthetics
(17) Functional tissue conditioner placement
(18) Orthodontic band selection, adaptation, and cementation
(19) Space maintainer cementation and removal
(20) Tie in arch wires
(21) Compound and alginate impressions
(22) Place root canal medication
(23) Determine root canal length
(24) Select, fit, insert, and condense root canal points
(25) Insert final restoration for endodontics

That leaves diagnosis, cavity preparation, and surgery for the dentist, but HEW is considering the assignment of even these operations to auxiliaries. It is of interest to note that this demonstration group of auxiliaries has had six years training in these duties. Dentists, on the other hand, require only four years of training, but they are then qualified to treat a patient comprehensively rather than for selected operations only. Though six years is not the length of the normal course for auxiliaries, when we consider the comparatively short time they are likely to remain in practice we are justified in asking where is the economy in this assignment of duties. Moreover, preliminary results of research done in Virginia indicate that there will be a potential surplus of dentists by 1980 (Leyes & Kilby, 1974). So where is the necessity of the assignment?

• *How HEW Implements the Training Program:* HEW grants money to dental schools on the basis of the number of these duties that are taught to auxiliaries and the cost of teaching them. Schools that teach the largest number of these duties at the lowest cost receive the money. HEW then requires that the auxiliaries so trained be employable, consequently the state laws must be changed to allow performance of these duties. The carrot is offered, then the club is used.

By Federal Funding of Dental Schools

In the federal capitation program, a dental school must expand the size of its class to receive grants. In each of the last two years the size of the grant has been reduced by approximately 30% without the government allowing a proportionate reduction in size of class. Schools first are made dependent on federal funds and then must comply with federal directives.

By Federal Aid to Minorities, Eroding Professional Control

Another area of leverage is through aid to needy minority groups. In 1974 a group called the Organization of the Forgotten American was formed in Klamath Falls, Oregon, to secure health and social services for Indians in the area. A National Health Service Corps grant was obtained and a dentist was assigned to the area by HEW. This man did not have a license to practice in any state, so the Oregon State Board of Dental Examiners insisted that he take the Oregon examination since he would be treating Oregon citizens and collecting fees for his services. HEW debated the point for about three months on the basis of federal supremacy, but finally agreed to the examination. The dentist failed every section but one, in which he received a grade of D. The Oregon board insisted that he be replaced. HEW refused to comply and implied that the board's judgment was not fair. However, HEW finally agreed to send the man to the University of Oregon Dental School for a two-week evaluation. The faculty and the public health staff agreed with the judgment of the board, but, nevertheless, HEW sent the man back to Klamath Falls. The Oregon board then contacted the state senators and threatened legal action. The dentist was finally reassigned. The Oregon board told HEW that it would accept only a dentist with an Oregon license. The board even went so far as to find three men licensed in Oregon who would accept the position. HEW finally accepted one of these—about a year after the incident began.

• *HEW Backs Down Before State Boards and Senators:* In March, 1975, representatives of 11 state boards—Alabama, Florida, Georgia, Louisiana, Minnesota, North Carolina, Oregon, South Carolina, Tennessee, Texas, and Virginia—and their senators met in Washington, D.C., to confront HEW about exceeding its legal authority and the intent of Congress. The following statement was read and delivered by hand to 24 senators and their aides:

DENTAL CARE IN OUR STATE
A Statement from our State Dental Board

"We are present today as representatives of the people of our States, as the duly constituted authority for the control and regulation of the practice of dentistry within our State. It is our statutory duty to protect our citizens from the illegal and unethical practice of dentistry. We do this by examination and licensure of qualified people, the investigation and prosecution of those individuals in violation of our State laws. We provide standards by which dental educational institutions are approved. All of this is to protect the consumers of dental care and the health, safety and welfare of the general public.

"We are here today because the Division of Dentistry of the Department of Health, Education and Welfare is making it impossible for us to continue to protect the citizens of our State and to guarantee them that those who provide dental care are qualified and competent.

"The Department of Health, Education and Welfare and its Division of Dentistry have exceeded the intent of Congress by implementing Federal law with rules, regulations and guidelines which require the subordination of State laws in order for dental educational institutions to qualify for Federal funds. Such subordination of State laws is demonstrated by the HEW requirement that unlicensed persons be taught dental functions which are illegal in forty-three States; for example, the placing of final dental restorations (fillings). Otherwise, funds are withheld. HEW is spending vast amounts of tax dollars on programs which are ineffective in resolving the dental problems of the consumers of dental care. In the granting or withholding of Federal funds, HEW is in effect coercing dental educational institutions to advocate the revision of State laws in such a manner as to allow non-professionals who have not been required to attain the same standards previously required of professionals to provide dental care to consumers. Obviously, it is not the proper function of unelected officials in HEW to influence or structure State laws.

"We believe that such action on the part of HEW will result in the deterioration of the quality of dental care. Of course, the poor, the disadvantaged, the minorities with less economic flexibility, will be the primary recipients of such lower quality care. It is our view that the traditional American free enterprise system has provided the highest level of dental care in the world, with the greatest availability of such care to the most consumers. Future plans in the field of dental development should be consistent with this concept, and with a minimum of Federal intervention."

This statement with supportive comment was then placed in the *Congressional Record* by Senator Jesse Helms of North Carolina. Because of this pressure brought to bear on it, HEW reluctantly agreed to consult with the board examiners.

By Health-related Bills Aiming for Federal Control

Through health-related legislation, such as Senate bill 3 introduced by Senator Edward Kennedy—one of several bills now before Congress—the federal agencies seek to divert controls from the states and the professional dentists to themselves.

Some of the provisions of S.B. 3 are:

(1) National reciprocity

(2) Federal licensure

(3) Effective elimination of state licensure

(4) Control of types of drugs and prosthesis used

(5) Control of fees charged

(6) Establishment of a "super board" in Washington to run the entire program

COURSES OF ACTION DENTISTS CAN TAKE

If this is what you want, relax and wait a minute, because it will come. If you are opposed to this, concerted effort will be required to alter the thrust of national legislation. This thrust *can* be altered and the dental profession is the only group that has the necessary expertise to do so.

Deans, read Louis Terkla's address given before the Academy of Operative Dentistry in 1965, and published in the *Journal of the American Dental Association* (Terkla, 1975).

Examiners, remember that you are the legally constituted authority for the preservation of quality dental care in your state. Licensure and revocation of license are the strongest means of preserving quality. Don't relinquish this strength.

HEW has agreed to contact state boards for their comments on these issues. Please reply when they contact you, and reply strongly, since HEW states that if no response is received from the various boards, HEW will assume that their policies are being supported.

When we were in Washington, D.C., congressmen and their aides listened when we talked about quality of dental care. Content of legislation is determined by input. Call and write your senators and representatives. Discuss these issues with them. Get influential people in your states to do the same. A few people can make a great difference. We are the professionals who have the responsibility and privilege of patient care; we must make this difference. Let us not shirk our responsibility or allow this privilege to be removed.

REFERENCES

Leyes, J. M. & Kilby, N. C. (1974) *Health Manpower Study: Dental Manpower.* Technical Report Series 5, No. 4. Richmond, VA: State Council of Higher Education for Virginia.

Terkla, L. G. (1975) Independent thoughts on dental education. *Journal of the American Dental Association,* **90**, 959-963.

 OPERATIVE DENTISTRY, 1976, 1, 122–124.

EDITORIAL OPINION

Is It Federal Aid? . . . or Federal Control!

Three editorials spell out the absurd situations into which HEW involvement has led federal aid far beyond its legal directive, yet federal law is clear that civil rights administrators are to "operate in a spirit of conciliation and good faith, exhausting all possible means of obtaining voluntary compliance and avoiding a usurpation of local control over education programs."

HEW and Private Education. By H. C. Gordon From the *Sun* (Jamestown, N.D.) Friday, December 26, 1975; reprinted in the (February 1976) *Journal of the Seattle-King County Dental Society* (14), 10-11.

Two decades ago, when federal aid for higher education became a reality, thoughtful individuals expressed grave doubts as to the wisdom of accepting such assistance. Federal aid, they warned, would sooner or later mean federal control, and no institution that allowed itself to become dependent on massive handouts from the government could possibly hope to retain its academic freedom and integrity.

Such warnings, disregarded at the time, have been more than justified by the events of the past few years. Increasingly, government agencies—notably the Department of Health, Education and Welfare—have used the threat of withholding federal funds to impose their own standards on recipient colleges and universities.

First, there was "affirmative action," which compelled quota hiring of minority and women instructors without regard for qualification or ability. More recently, there have been "guidelines" governing admissions, student conduct, curriculum, "sexual discrimination" and other areas. In short, the same college administrators who once scoffed at the idea that federal aid would lead to controls, now find that virtually every aspect of their campuses are subject to bureaucratic intervention.

While such sweeping authority over our educational system—presently extending to 2,500 of the nation's 3,000 campuses—would be cause for concern under any circumstances, it is doubly so since the social technicians at HEW have indicated that they will be satisfied with nothing less than total control.

In a recent statement, HEW has claimed that if so much as one single student at a particular college or university is a recipient of veteran's benefits, a federal student loan, or any other federal assistance, then all programs at that institution are to be considered federally funded and therefore subject to the jurisdiction of the Department. In the event that the institution still fails to comply with its policies, the Department will retaliate against the students by cutting off their federal scholarship funds.

The practical effect of this power play, if it is allowed to stand unchallenged, will almost certainly be the elimination of independent private education in this country. Where private institutions were once able to retain their own standards simply by refusing federal money, they will now be forced either to fight HEW's ruling through the courts, or else to protect their students from the loss of federal aid by offering comparable private scholarships.

Thus far, one institution—Hillsdale College in Michigan—has announced that it is prepared to do both, if necessary. In a ringing statement, the trustees of Hillsdale have resolved "that Hillsdale College will, to the extent of its meager resources and with the help of God, resist by all legal means this and all other encroachments on its freedom and independence."

Hillsdale affords a perfect example of what is at stake. Discrimination is not the issue; not only was Hillsdale one of the first colleges in the country to admit women, but it has been admitting women and minority students on their merits for well over a century. The issue is rather one of free choice; whether a private institution is free to maintain its own values, principles, and standards of excellence, or whether it can be forced to conform to the blueprints of some bureaucratic mastermind.

Throughout its 131-year existence, Hillsdale College has stood proudly for individual achievement, personal responsibility, and traditional moral and religious values. If a government agency, acting on the flimsiest of pretexts, can force this or any other private institution to compromise its ideals in the name of equality, it is an open question as to how long private standards of any kind will be permitted to endure.

By its courageous action, Hillsdale has drawn the line between free choice and government-imposed conformity. The battle is joined, and the outcome may well prove crucial to the fate of freedom itself.

Ludicrous Civil-rights Rules

Editorial, the *Seattle Times,* Monday, December 8, 1975.

The ludicrous lengths to which federal bureaucrats will go in using statistics rather than common sense in enforcement of equal-opportunity laws are illustrated anew in an extraordinary report from the University of Washington campus.

University officials are still trying to straighten out the kinks and curls in the coils of red tape festooned around the institution's anti-discrimination program by the regional Office of Civil Rights, an arm of that bastion of bureaucracy in Washington, D.C., the Department of Health, Education and Welfare.

H.E.W. has contended for some time that the U.W.'s program for eliminating bias against women and minority employes is out of whack, and is threatening again that federal contracts will be withdrawn unless there is compliance with new government guidelines laid down last August.

This effort, no matter how well-intentioned, is producing preposterous results.

Consider, for example, the citation that the university's nursing faculty has too few women. Never mind that the faculty already is 95 per cent female. The "deficiency" occurs because the national average for nursing faculties is 98 per cent female and the regulations prescribe that the university compare its staffing patterns with the country as a whole.

At the other end of this absurd spectrum, meantime, is the engineering faculty, which the Office of Civil Rights insists has "too many" women—at least by the statistical yardstick.

The U.W. has three females on the engineering faculty, two more than the government would expect to be employed. Why? Nationwide, the number of women in engineering is less than 1 per cent, but the U.W. figure is about 2 per cent.

Little wonder that university administrators here and elsewhere in the country have been complaining of government harassment on matters that go far beyond reason and the original intent of anti-discrimination laws.

Striking down barriers to equal opportunity is, of course, an activity to be pursued with vigor and dispatch.

But the government's pressures to compel statistical compliance on a no-matter-what-basis is simply inane. Commenting on the $40,000 U.W. effort to comply with H.E.W.'s demand for a "secondary analysis" of percentages in the hiring, wage scales, etc., of women and minorities, a university official noted, accurately enough, that "you can't compare percentages when you're talking about one case."

The situation would be merely laughable were it not for two grave concerns:

This brand of government interference poses a threat to the university's efforts to maintain academic excellence.

Carrying enforcement activities to absurd extremes will rob the government's civil-rights program of the public respect and credibility it needs to carry on the equal-opportunity crusade.

Congress Should Probe School Funds Dispute
Editorial, the *Seattle Times*, Sunday, May 2, 1976.

The dispute between the Seattle School District and the Department of Health, Education and Welfare over the latter's attempts to deny Seattle millions of dollars in federal-aid funds, has spotlighted issues that cry out for a full-scale congressional investigation.

Since Seattle is not the only school district menaced with a fiscal sledgehammer wielded by H.E.W.'s Office of Civil Rights (similar conflicts are in progress all over the country), the high-handedness of the federal bureaucracy is a matter of nation-wide significance.

The federal agency's performance against the Seattle School District indicates repeated instances in which regional officials appear to have gone far beyond what Congress intended when it passed the Civil-Rights Act of 1964.

Those excesses are particularly evident in H.E.W.'s blunderbuss insistence that Seattle's well-reasoned policy decisions affecting the assignment of minority teachers to schools with large minority enrollments, and its handling of bilingual-education classes, violate federal statutes.

Federal law is clear that civil-rights administrators are to operate in a spirit of conciliation and good faith, exhausting all possible means of obtaining voluntary compliance and avoiding a usurpation of local control over education programs.

In Seattle, there has been precious little good-faith negotiation. The tone has been more of an adversary, do-it-our-way-or-else nature. This has created a confrontation that jeopardizes some $10 million in desperately needed federal assistance, money that ironically would be of primary benefit to minority children.

Seattle is among several school districts seeking relief in the federal courts.

In a case bearing striking resemblances to the Seattle situation, a judge in Maryland blocked H.E.W.'s attempts to cut off nearly $60 million in federal grants to Baltimore's public schools and Maryland's state colleges and universities. That decision turned on a finding that H.E.W. and its Office of Civil Rights had acted arbitrarily and whimsically, going far beyond its statutory authority.

But local school districts should not be compelled to go to court to fend off the abuses of regulatory officials who, as a "shadow" arm of government subject to inadequate congressional oversight, often pursue the interpretation and application of federal law to absurd extremes.

H.E.W.'s civil-rights operation should be subjected to a searching examination of its own compliance with Congress' intent.

DEPARTMENTS

Press Digest

A 24-month old evaluation of fissure sealing with a diluted composite material. Harald Ulvestad (1975) *Scandinavian Journal of Dental Research* (84), 51-55.

Concise Enamel Bond was diluted by mixing Universal Paste with an equal volume of Universal Resin and by mixing Catalyst Paste with an equal volume of Catalyst Resin. The two mixtures were then incorporated and applied on etched and dried occlusal surfaces of permanent premolars and first molars of 69 children aged 6 to 12 years. The duration of the experiment was two years. Sealant was lost during the first three months from two distal fissures and five distolingual fissures of maxillary first molars. Between the 21st and 24th months sealant was lost from the central fossa in three maxillary first molars. In mandibular first molars the sealant was lost from two teeth during the first 12 months. The author concludes that a diluted composite sealant is a suitable alternative to other sealants.

Bacterial contamination and the exposed pulp. Patterson, R. C. (1976) *British Dental Journal* (140), 231-236.

Pulps of molar teeth of germ-free rats and of normal rats were exposed. Each exposure was covered with one of the following medicaments: (1) Dycal, (2) Ledermix cement, and (3) ethoxybenzoic acid cement. The cavities were then filled with silver amalgam. Dycal produced a favorable response in 70% of the teeth of normal rats and almost 100% of the teeth in germ-free rats. Ledermix cement produced poor results—50% apical abscesses—in control rats and excellent results in germ-free rats. Ethoxybenzoic acid cement gave very good results in normal rats, and excellent results in germ-free rats. This experiment demonstrated the importance of bacterial contamination in the response of the exposed pulp and suggests that the use of corticosteroid preparations as pulp capping agents is contraindicated.

Experimental studies on dental implants. Johns, R. B. (1976) *Proceedings of the Royal Society of Medicine* (69), 1-7.

Fourteen cuneiform blade vent implants were inserted in the jaws of *Macaca irus* monkeys. Eight implants were exfoliated or had to be removed during the course of the experiment. An implant that had been in place for 18 months and one for eight weeks appeared to be successful. In a second series of experiments the implants were modified with a coat of porous titanium over the body and a fused glass collar. One of these remained firm for 11 months. On examination subsequently with a scanning electron microscope the glass was seen to have undergone erosion. The author concludes that although these implants do not evoke an adverse reaction from bone they do not promote the formation of a normal junctional epithelium, even when the neck is coated with glass. The widespread use of implants of this type does not seem to be based on sound experimental evidence.

Letters

Can You Believe Bitewings?

Dear Sir:

My attention has been directed to a lack of correspondence between the radiographic view and the sectioned view of the mandibular first premolar (Spring, 1976, p. 44). The sectioned premolar has been reversed on the print and thus the lesion appears to be in the distal surface when in fact it is the mesial. This applies also to the corresponding drawing. I thank those who were perceptive enough to notice the discrepancy.

Sincerely,

Christopher T. Herron
5235 17th N.E.
Seattle, WA 98105

(continued)

Dear Sir:

Operative Dentistry is a refreshing new creation! Please keep up the good work for better dentistry.

Robert D. Earl, Editor
Houston District Dental Society Dental Journal
6442 FM 1960 West
Houston, TX 77079

Dear Sir:

Just a note to congratulate you on an excellent Number 2 issue of *Operative Dentistry*.

I particularly like your editorial. Well expressed and—unfortunately—too prophetic!

Keep up the good work.

Gerald D. Stibbs
433 Medical & Dental Building
Seattle, WA 98101

Book Review

OPERATIVE DENTISTRY

By H. William Gilmore & Melvin R. Lund

Publisher: The C. V. Mosby Co., St. Louis, 1973. 671 pages, illustrated and indexed. Price $21.00

Numerous books on operative dentistry have attempted to unite the principles of both technique and theory into one cohesive package. While the desire to merge both the science and art of dentistry is a noble one, the actual realization of such a venture is a much more difficult task. The tendency has been to emphasize or treat preferentially either the art or the science at the unfortunate expense of the other. Drs. Gilmore and Lund have written a book that, for the most part, is a unified and fairly comprehensive approach to operative dentistry both as an art and as a science.

The book, however, does have a definite slant toward operative technique and practice, an approach strongly emphasized in the Foreword of the text which asserts that depreciation of the importance of manual tasks in operative dentistry is unrealistic and deplorable. But science or theory is equally important and cannot be ignored. Coverage of technique is excellent in this book; coverage of theory is good but in some areas incomplete.

The noteworthy treatment given to particular areas in the field of operative dentistry is a major strength of this work. Particularly worth mentioning is the comprehensive manner in which direct filling golds are covered. With present-day controversies over the relative merits of including direct filling golds in dental school curricula, it is refreshing to find a book that gives due recognition to these beleaguered materials. Also of considerable value, particularly to the dental student and neophyte practitioner, is the discussion of proper working positions, instrument arrangements, and utilization of auxiliary personnel. Usually, such material is presented in the form of lectures or "how-to" manuals. The dearth of coverage of this area in many other texts would alone make this book invaluable as a teaching aid or reference manual. Other areas covered in very good detail include the rubber dam and operating field, pin-retained amalgam restorations, separation procedures for restoring proximal surfaces, and ceramic restorations.

One considered weakness of the book is the relative lack of adequate emphasis on the periodontal structures as they relate to and are affected by operative dentistry procedures. In addition, the phenomenal growth of interest in preventive dentistry and adjunctive preventive measures will soon call for a revision of the section pertaining to that area. The discussions of the design of cavity preparations are somewhat provincial but are very adequate as bases from which to expand or modify principles and practices in other regions throughout the country.

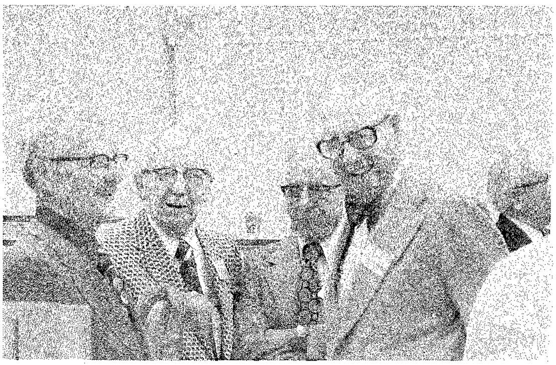
The text is detailed and often too wordy; the illustrations and drawings are generally vague. It is frequently hard to refer to a particular picture and follow what the authors are attempting to point out. In spite of these weaknesses, this reviewer believes that the strengths of the book as noted above are far more in evidence. With the addition of Dr. Lund as coauthor, the inclusion of a fine chapter on ceramic restorations, and the revisions from the previous edition, the scope and clarity of this book have been increased tremendously. Its inclusion in any operative dentistry library and its use as a reference textbook in dental schools is strongly recommended.

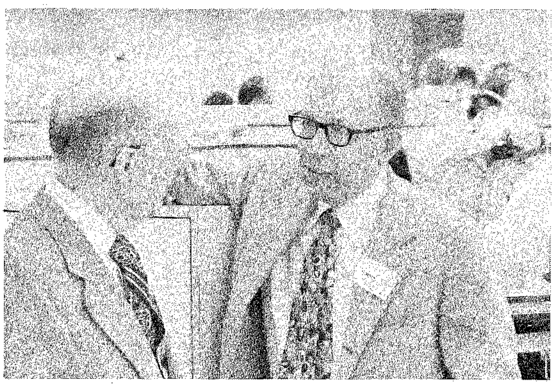
F. J. Miranda

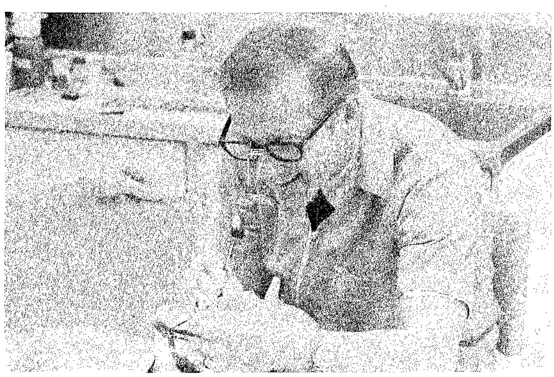
NEWS OF STUDY CLUBS

Associated Ferrier Study Clubs

The 47th annual meeting of the Associated Ferrier Study Clubs was held in Seattle on May 14, 1976. During the morning there were 20 clinical foil demonstrations. The afternoon was devoted to golf, trap shooting, and tennis. A dinner meeting was held in the evening with Allan G. Osborn as the speaker. The meeting was graced by the attendance of Jack Seymour, president of the American Academy of Gold Foil Operators, and Chester Gibson of the Alex Jeffery Study Club in Oregon.

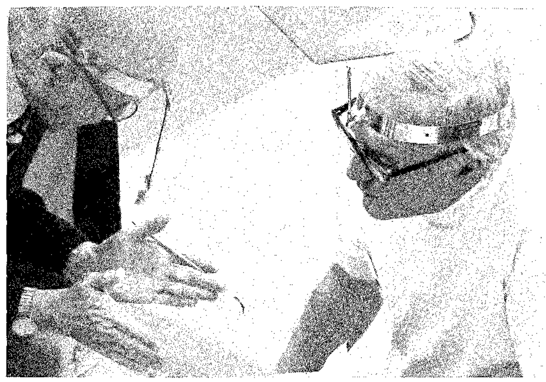




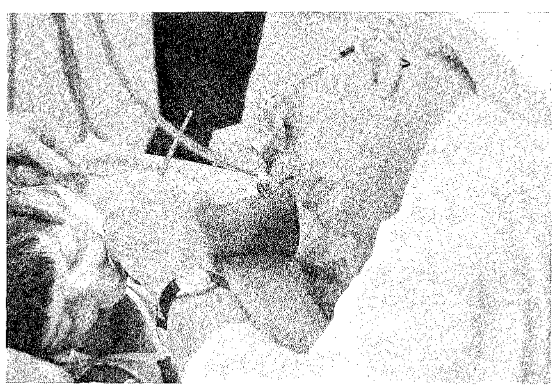


Announcements

Floyd Hamstrom, observed by Al LaBounty, condensing a Class III foil in the mesial of the lower right canine.



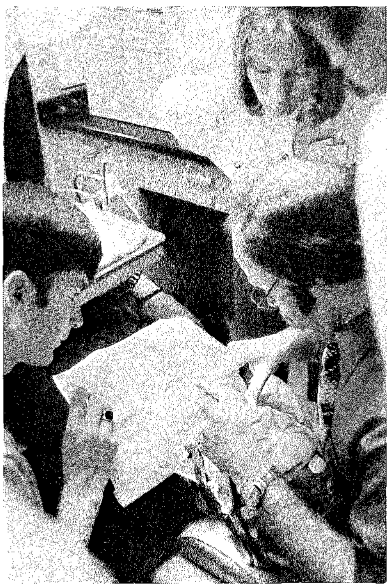
Gerry Stibbs emphasizes to Earl Maston the proximal boxing of a Class II foil in the mesial of an upper right first premolar. Below: Ian Hamilton concentrates on condensing a Class III foil in the distal of an upper left canine.



Left column, top: Howard Gilbert, Jim Chilson, Mel Bleakney, and George Ellsperman enjoy the proceedings. Center: Lyle Ostlund, right, discusses state board examinations with John Cook. Bottom: Al Brown displays satisfaction in condensing a Class V foil on an upper right canine.

Associated Gold Foil Study Clubs of Southern California

The 15th annual meeting was held May 23 at the University of California at Los Angeles. Twenty-five operators, representing the four study clubs, demonstrated gold-foil operations during the morning. Many dental students served as assistants, others as observers. Lectures were presented during the afternoon by Nelson W. Rupp and H. William Gilmore on "Operative Dentistry—Dental Materials: A Symbiotic Relationship."



Doug Roberts performing a Class IV pin-retained foil.

Students observing Keith Green demonstrating a Class III gold foil.

Robert Wolcott trying to recall what a Class II preparation looks like.

Jack Seymour discussing with Bruce Ellis how they do it in Fresno.

Oregon Associated Gold Foil Study Clubs

The annual meeting was held in Portland on May 4. Clinical demonstrations were held during the morning. Louis G. Terkla spoke to the members at lunch.

NOTICE OF MEETINGS

American Academy of Gold Foil Operators
Annual meeting: November 11 and 12, 1976
Loma Linda University
Loma Linda, California

Academy of Operative Dentistry
Annual meeting: February 17–18, 1977
Hyatt Regency Hotel
Chicago, Illinois

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.

Exclusive Publication

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

Manuscripts

Submit the original manuscript and one copy; authors should keep another copy for reference. Type double spaced 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,* 3rd ed., 1966, and *Nomina Histologica,* 1975; 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 by the name and address of the source or manufacturer, in parentheses. The Editor reserves the right to make literary corrections.

Tables

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

Illustrations

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

References

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

Reprints

Reprints can be supplied of any article, report, or letter. Requests should be submitted at the time of manuscript acceptance.

OPERATIVE DENTISTRY

SUMMER 1976 • VOLUME 1 • NUMBER 3 • 81–128

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