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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.

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The views expressed in *Operative Dentistry* do not necessarily represent those of the Academies, or of the Editors.

EDITORIAL

Restorative Dentistry: Chairmanship

Operative dentistry came into its own when G V Black published the first edition of his classic textbook on operative dentistry in 1908.

Operative dentistry continues to be the primary focus of dental practice. Its scope has increased, as has the complexity of the care provided, the variety and type of materials available, and the knowledge and skills required to provide quality care. Concomitant with the increased need for new skills and knowledge has been a decreased emphasis within dental schools in operative dentistry. Along with the decreased emphasis within curricula has evolved the idea that operative dentistry is no longer important — after all, since it is performed by general dentists without graduate training, and in today's world the need for operative dental care is decreasing along with the reduction in caries rate — it can't be all that significant anyway.

Associated with the reduction of operative curriculum time and the denigration of the importance of operative dentistry within many schools yet another limitation has emerged. Some institutions are asking that training in fixed prosthodontics be a requirement for the position of chairman in restorative dentistry.

What an absurd requirement! Most of us would recognize the need for graduate education in either fixed prosthodontics or operative dentistry as a requirement to hold such a position. Both of these disciplines are primarily concerned with the restoration and preservation of the patient's dentition. If schools are to eliminate one of these disciplines from consideration for chairing restorative dentistry, then it might be more correct to consider only the operative dentist. Operative dentistry is grounded in the use of materials, occlusion, consideration of the supporting structures, and the prevention of dental disease. The same can be said for fixed prosthodontics.

One additional aspect should be considered. Fixed prosthodontists are well schooled in variations of extracoronal restorations but receive little, if any, training in intracoronal restorative procedures. There are more variations in cavity preparations and more material differences which affect the restoration design for intracoronal restorations than for extracoronal restorations. Operative dentists are trained to provide quality restorations for both intracoronal and extracoronal restorations. Operative dentists are capable and have had the required training to provide quality instruction and understand the problems associated with fixed-prosthodontic instruction in the undergraduate curriculum. The same may not be said of fixed prosthodontists. Their training does not usually include the multiple variables which must be taught in the undergraduate operative dentistry curriculum.

To consider the merits of operative dentistry above that of fixed prosthodontics would be as wrong as the other way around. It is time that we, in operative dentistry, pay more attention to what is going on in our schools and vocalize our sentiments. If operative dentistry has a rightful place in our curriculum, we should see that the deans of our schools are made aware of the inequities fostered by concepts which allow one discipline to become subservient to another.

Let us be stalwart guardians of our professional world and insist on the rightful place of operative dentistry. We now have a certifying board — the American Board of Operative Dentistry. We should encourage our members to challenge that examination and promote graduate education in the field of operative dentistry. Operative dentistry was the major discipline in the dental school curriculum for many, many years. Other divisions evolved and eventually required graduate education. Why not operative dentistry?

Operative dentistry will be with us for many more years. We should ensure that our schools give it the credibility it should have. Watch and be on your guard.

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ORIGINAL ARTICLES

Effect of a Rubber Dam Clamp (Retainer) on Cementum and Junctional Epithelium

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LARS MATSSON

Summary

When modified Ivory 1 rubber dam clamps were applied to the teeth of monkeys, and the teeth and periodontium examined histologically after six weeks, it was found that there was no statistically significant difference between experimental and control teeth in the downgrowth of junctional epithelium or in defects in cementum.

Introduction

The rubber dam, first used more than one hundred years ago, offers advantages for both patient and clinician. Improving access; retracting and protecting soft tissues; maintaining a dry, uncontaminated field; preventing aspiration of foreign bodies; and facilitating management of patients are all valid reasons for its use (Braham, 1980; Kennedy, 1976).

Clamps frequently recommended for young permanent teeth are the Ivory 14A and 8A (Columbus Dental, Columbus, OH 43206, USA), which are designed so that the jaws extend subgingivally to engage the tooth below the height of contour. Light finger pressure is usually advocated to ensure proper seating (Davis, Law & Lewis, 1981; Furnish, 1980; Jinks, 1966; Shelton, 1981). Even with careful placement, the clamp may impinge on and traumatize the periodontium (Jinks, 1966; Sim & Finn, 1973).

The literature reveals a lack of definitive research into the consequences of the placement of clamps. Therefore, our objective in this study was to determine the detrimental effects, if any, of a rubber dam and clamp on the cementum and epithelial attachment (now called junctional epithelium), in monkeys.

Materials and Methods

The permanent maxillary and mandibular first, second, and, if present, third molars of four *Cercopithecus aethiops* monkeys were used for the experiment. Two monkeys were randomly selected with experimental teeth located on the maxillary and mandibular left, and the controls on the right. On the other two

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monkeys, this arrangement was reversed.

The animals were fed Primate Chow (Lab Chow, Ralston Purina Company, Checkerboard Square, St Louis, MO 63164, USA), ground to a grainy consistency, during the entire experimental period. No procedures for oral hygiene were used during the experimental period.

An important feature of this study was to replicate as closely as possible the mechanical trauma that an Ivory 14A clamp and rubber dam might have on a permanent molar and its surrounding tissue in a human. The clamp that seemed to fit the tooth best and imitate the effect of a 14A clamp was an Ivory 1, modified to cause the points of the clamp to penetrate well into the gingival sulcus (Fig 1).

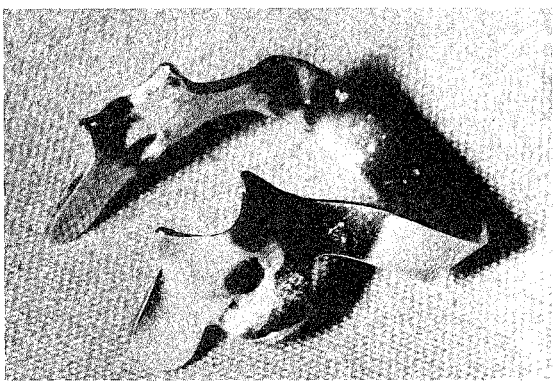

FIG 1. *Ivory 1 clamp modified to cause the jaws of the clamp to penetrate well into the gingival sulcus*

Each animal was anesthetized by an intramuscular injection of Ketamine Hydrochloride (Vetalar, Park Davis & Co, Detroit, MI 48232, USA).

Then, the modified Ivory 1 clamp and a rubber dam (green, medium dental dam, pure latex, 6 x 6 in, Hygenic Corp, Akron, OH 44310, USA) were placed on the experimental molars and held in position for one hour with a contoured rubber dam holder (Young Dental, Maryland Heights, MO 63043, USA) (Fig 2).

After six weeks, biopsies were taken for histologic studies. The biopsies consisted of block sections of individual teeth and contained all but the apical one-third of the root with all the surrounding bone and periodontal tissue. The tissue was immediately placed in 10% buffered formalin. The hard tissues were completely

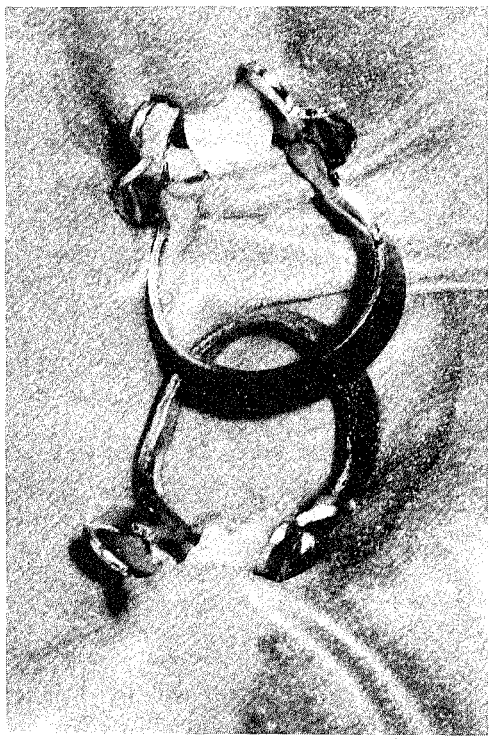

FIG 2. *Rubber dam and clamps in place with the jaws of the clamp pressed well into the gingival sulcus*

demineralized in 5% formic acid.

Serial sections, 7 μm thick, were cut in a faciolingual direction parallel to the long axis of the tooth. Every fourth section was stained with hematoxylin and eosin. Facial and lingual surfaces of each tooth were then examined under the light microscope. Sections showing either one of the following features were scored as positive:

(1) location of the junctional epithelium apical to the cementoenamel junction;
(2) a break in the regular morphology of the surface of the cementum.

Every other positive section with either of the above features was measured with an ocular grid under 40 magnification. If both facial and lingual surfaces of the same tooth showed presence of one of the features, that surface showing the largest measurement was used. The calculated means of the measurements were based on a varying number of positive sections for each tooth. The results were then analyzed statistically, using the chi-square test.

Results

All biopsies from both the control and clamped areas showed a clearly defined inflammatory infiltrate of the connective tissue adjacent to the junctional epithelium. This inflammatory infiltrate consisted primarily of mononuclear inflammatory cells.

In the control group of 20 teeth, the junctional epithelium of 11 teeth extended apically to the cementoenamel junction to an average depth of 0.44 mm. In the same control group, the cementum of five teeth had defects with an average size of 0.54 mm, measured along the long axis of the root (see table).

In the experimental group of 19 teeth, the junctional epithelium of 13 teeth extended apically to the cementoenamel junction to an average depth of 0.34 mm. In the same experimental group, the cementum of 7 teeth had defects with an average size of 0.38 mm (see table). Examples of epithelial downgrowth and defects in cementum are seen in Figs 3 and 4.

Neither epithelial downgrowth nor defects of cementum showed dependence on the placement of the rubber dam and clamp ($P < 0.05$).

Discussion

Placing a rubber dam clamp on a tooth so that the jaws of the clamp penetrate into the sulcus risks traumatizing the periodontal tissues and the root surface. This is particularly true if the clamp is placed carelessly.

The question to be investigated in this study was whether this acute traumatic incident had

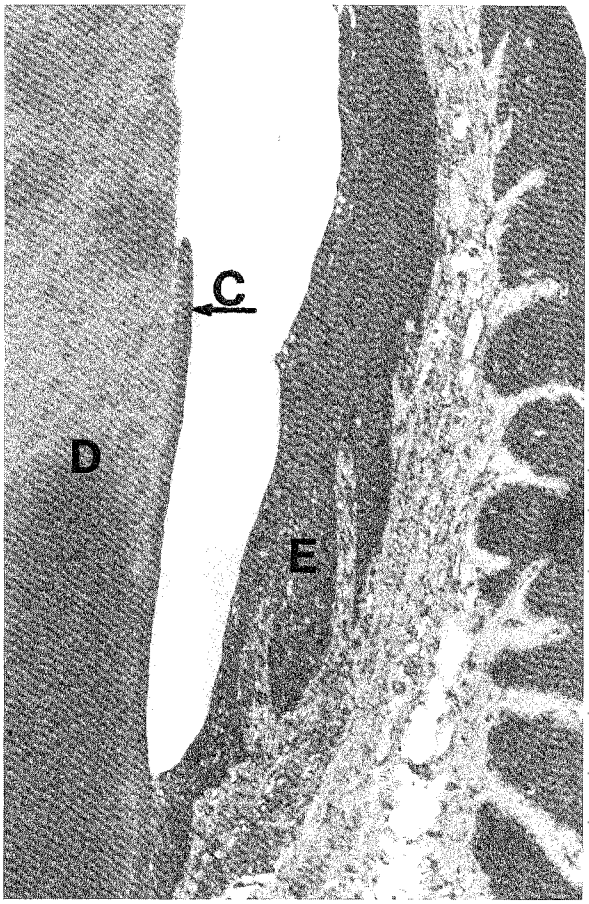

FIG 3. *Apical termination of junctional epithelium below cementoenamel junction as seen in both experimental and control biopsies.* C = *cementum;* D = *dentin;* E = *epithelium. Stain: hematoxylin & eosin. Approximate magnification X45*

Downgrowth of Epithelium and Defects in Cementum

		Epithelial Downgrowth		Cementum Defect	
		Number of Teeth	Mean Growth	Number of Teeth	Mean Size
	n		mm		mm
Control teeth	20	11 (55%)	0.44	5 (25%)	0.54
Experimental teeth	19	13 (68%)	0.34	7 (37%)	0.38

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Iatrogenic Fracture of Roots Reinforced with a Cervical Collar

HARRY ROSEN • MARIA PARTIDA-RIVERA

Summary

The purpose of this study was to determine whether root fracture could be prevented by protection with cervical collars or aprons of cast gold. Seventy-six upper lateral incisors were tested; 38 with collars and 38 without. To provoke root fracture, expansive forces were applied to each root with a tapered self-threading post of large diameter, and a precision torque wrench was used to measure the torque applied to each root while inserting the post.

The 2 mm gold collars used in the study were found to be significantly effective in preventing root fracture. Teeth with narrow mesiodistal diameters demonstrated a fracture potential significantly greater than for those with wide mesiodistal diameters.

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INTRODUCTION

Crown fractures appear commonly in unprotected endodontically treated teeth. Split roots appear from time to time in teeth restored with posts. The unique characteristics of endodontically treated teeth are described in the literature. These are:

1. Brittleness. Authors (Helfer, Melnick & Schilder, 1972) claim that brittleness is a manifestation of decreased moisture content within the remaining dentin due to loss of the pulp and the central blood supply.

2. Loss of internal and external tooth structure. Tooth structure may be lost as a result of trauma, caries, and/or multiple restorations. Further loss of coronal dentin and enamel occurs with the access opening and during biomechanical preparation of the root canal(s).

These inherent characteristics of the pulpless tooth must be considered and compensated for in the procedures, methods, and materials utilized in the restoration of its crown.

Rosen (1961) stated that a well-designed

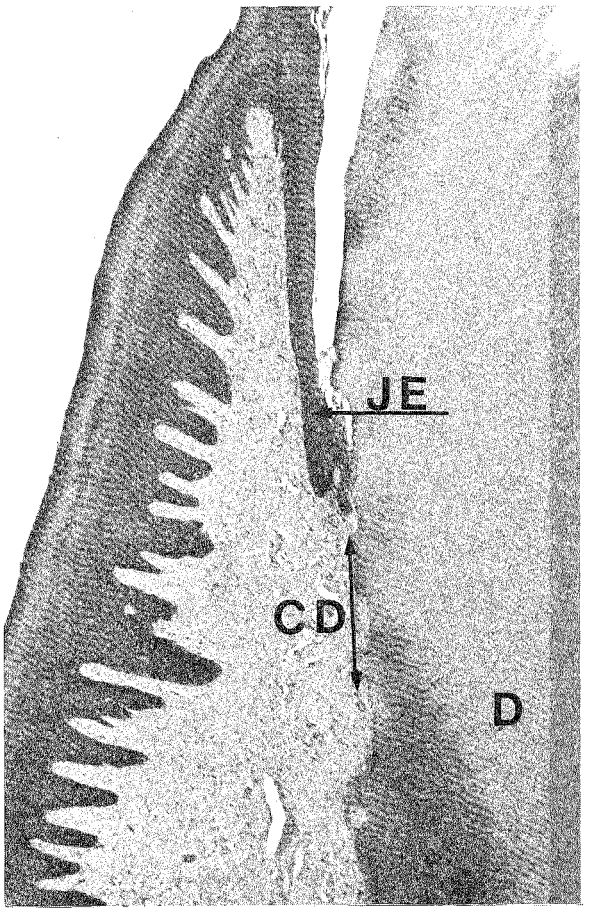

FIG 4. *Cementum defect as seen in both experimental and control biopsies.* CD = *cementum defect;* D = *dentin;* JE = *junctional epithelium. Stain: hematoxylin & eosin. Approximate magnification X20*

any long-term effect on the periodontium or root surface.

In several experimental and contralateral control teeth, the junctional epithelium was situated apical to the cementoenamel junction. There were also several areas of cemental defects in both groups. However, since a statistically similar result was found in the experimental group, any relationship between the placement of the rubber dam and clamp and the pathological findings can be excluded. The downgrowth of epithelium was thought to be the result of prior chronic inflammation of the gingival tissue which continued on through the duration of the study. The presence of pre-existing defects in cementum is unexplained.

Conclusion

The results of this study show that six weeks after the placement of modified Ivory 1 clamps on teeth of *Cercopithecus aethiops* monkeys there was no difference between these teeth and control teeth in the downgrowth of junctional epithelium, or in defects in cementum, and thus offer no evidence to discourage the careful and appropriate use of the rubber dam and clamps.

(Received 22 April 1985)

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post enhances retention and can function as an intracoronal or intraradicular crutch. He also described the "extracoronal brace, subgingival collar, or apron of gold which, by its hugging action, prevents vertical shattering of the root."

More recently, other authors (Shillingburg, Fisher & Dewhirst, 1970; Steele, 1973; Lau, 1976) have mentioned the gold collar. A review of the literature, however, does not reveal reports of any investigation that substantiate the mechanical advantages of the gold collar.

It is the purpose of this investigation to determine whether a gold collar or cervical brace included in the coronal restoration or in a post-and-core foundation casting provides resistance to vertical fracture of deliberately stressed roots.

MATERIALS AND METHODS

Since the object of this laboratory investigation was to evaluate the resistance of braced roots to fracture, a method was selected that enabled measurable stresses to be exerted within the coronal portion of the roots to be tested, namely, expansive forces applied with an especially designed torque wrench (Fig 1).

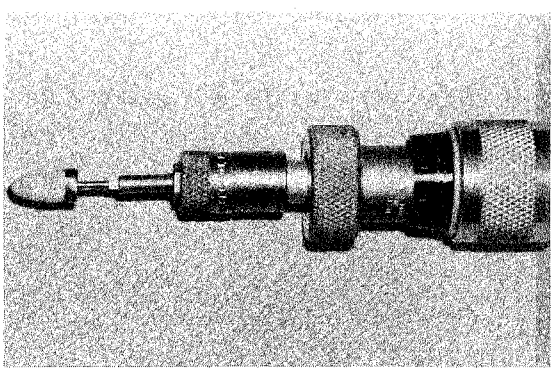

FIG 1. *Torque wrench — a modified precision adjustable screwdriver.*

Post Selection

Based on the information gleaned from pilot studies, posts were selected that would likely provoke root fracture when overmanipulated. These were the No 13 (diameter 1.65 mm, length 14.2 mm) screw posts from the Dentatus system (Dentatus, Weil Dental Supplies Ltd, Toronto, Ontario, L3T 2A1, Canada) which were to be inserted into a post space prepared with a No 4 Peeso reamer (Produits Dentaires, S A Vevey, Switzerland) (diameter 1.1 mm).

Specimen Selection and Storage

The experiment was performed with extracted human teeth, appreciating that certain variables existed with their use. These variables were: time of extraction, size, shape, pulp chamber dimension, degree of calcification, water content, and physical properties.

Upper lateral incisors were selected for this study since teeth of this narrow diameter can be deliberately fractured with greater ease.

The extracted teeth were maintained in 100% relative humidity except during preparation and testing procedures to avoid desiccation. The teeth were prepared with the following standardized technique.

The coronal portion of each tooth was sectioned 1 mm coronal to the cementoenamel junction, measured at its most coronal interproximal level and perpendicular to the long axis of the tooth. The root canals were cleaned and shaped using standardized techniques, enlarging the canals to receive a No 35 reamer 0.5 mm short of the apex. The post space was prepared while using a rubber instrument stop set at 8 mm from the tip. The post space was irrigated subsequent to each enlarging procedure.

Trypan blue 1% (Zigma Chemical, P O Box 14508, St Louis, MO 63178-4508, USA) was used to stain the roots to facilitate crack detection. Each root was immersed for five minutes, rinsed in tap water, and wiped dry with a gauze swab. This procedure was followed by systematic inspection for possible defects.

The roots were randomly assigned to one of two test groups:

Group I - 38 roots to be tested

Group II - 38 roots to be prepared for the gold collar

The roots were individually stored in labeled plastic bottles (6 cc) which contained saline solution and zephiran chloride to avoid desiccation.

Cavity Design and Casting Preparation

The roots of Group II were prepared with a shoulder 2 mm high and 0.25 mm wide at the base. This was achieved by cutting a shoulder into root dentin that was one-half the width of a 699 tapered fissure carbide bur. The 2 mm height was selected because it is the height empirically recommended by clinicians. A greater height rarely can be obtained clinically without gingival and osseous surgery.

The preparation was performed with an angle of convergence of 6 °C. A short bevel was prepared apical to the narrow shoulder.

While holding the root with a humid gauze swab, a direct wax pattern was fabricated on the periphery of each root previously lubricated. A No 12 plastic sprue was attached to the pattern, which was vacuum invested, and a casting was made for each root, using Type III gold.

The thickness of each casting (0.25 mm at the shoulder) was checked with an Iwansson gauge (Henry Schein, Inc, Port Washington, NY 11050, USA) at eight predetermined points of the gold collar. Each casting was precisely fitted, polished, and cemented with zinc phosphate cement on roots whose surfaces had been previously dried.

Testing

A precision adjustable screwdriver (Torque Control Inc, Utica, Orangeburg, SC 29115, USA, converted to function as a torque wrench, supplied the wedging forces. Its range is from 0 to 100 ounce inches (ozf inch), and is adjustable by increments of 2 ozf inches of increasing or decreasing force (see Fig 1).

A machine-shop vise (both members covered with a sheet of rubber dam) was used to stabilize each root during testing. In previous laboratory studies (Kanacri & Rosen, 1978; Durney & Rosen, 1977) it was reported that microfractures could be demonstrated at 6 ozf inch in some vulnerable roots. Consequently, a torque wrench setting at 6 ozf inch was selected to start the insertion of the Dentatus post. The torque was increased incrementally by 2 ozf inch until clinical root fracture was achieved or failure of the post was observed.

RESULTS

Group I - without Collars (see table).

- Twenty three of the 38 roots tested demonstrated fracture. The torque necessary to produce fracture ranged from 16 to 40 ozf inch, with an average of 28.3 ozf inch.
- In 15 samples, the post fractured before producing root fracture. The torque average for post failure was 37.1 ozf inch.
- The highest fracture rate was found in the group of roots with narrower mesiodistal width (4.0 mm). In the group with a wider mesiodistal width (4.5 mm), the fracture rate for roots was equal to the fracture of posts. In the still wider mesiodistal width group (5.0 mm), the root fracture rate was lower, while the failure rate for posts was higher. See Figure 2.

Group II - with Collars (see table)

- Only three of the 38 samples of this group demonstrated fracture. The torques necessary to produce fracture were 30, 34, and 38 ozf inch, with an average of 34 ozf inch. See Figure 3.
- The post fractured in 35 of the samples. The range of torques to produce post fracture was 36 to 42 ozf inch, with an average of 38.8 ozf inch.

A chi-square test (χ^2 test) was employed to correlate the data of both Group I and Group II. The gold collars were found to be highly significant in preventing root fracture. The mesiodistal width was found to be significant as a factor in fracture potential.

DISCUSSION

The split root is a fairly common occurrence in teeth restored with posts. Improper design and faulty technique obviously contribute to many failures. However, masticatory and parafunctional forces are capable of producing lateral stresses that can produce fractures in spite of the presence of a properly designed post.

Several authors (Rosen, 1961; Shillingburg, 1970; Baraban, 1972; Steele, 1973; Gutmann, 1977) have recommended gold collars or apical extensions beyond gingival seats of foundation

Fracture Values

Number of Samples	Mean M-D mm	Number of Posts Fractured	Fracture of Post Mean Ounces of Torque (ozf inch)	Number of Roots Fractured	Fracture of Root Mean Ounces of Torque (ozf inch)
GROUP I — without Gold Collar					
38	4.4	15	37.1	23	28.3
GROUP II — with Gold Collar					
38	4.5	35	38.8	3	34.0

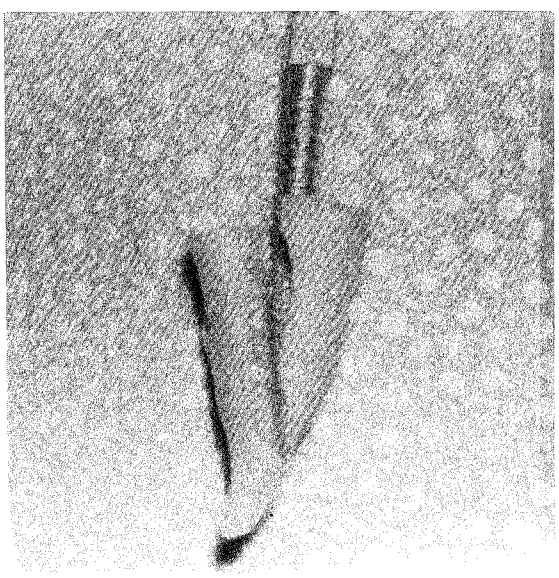

FIG 2. *Typical root with tapered self-threading post that applied expansive force to produce fracture (Group I)*

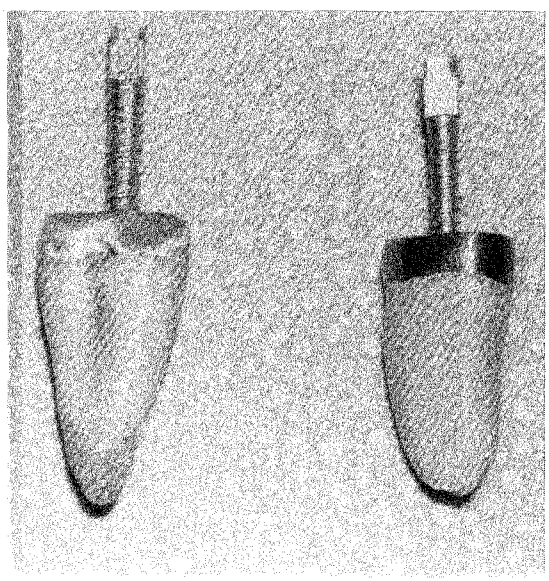

FIG 3. *Typical roots with protective 2 mm cervical collars of cast gold that could not be fractured with expansive forces (Group II)*

preparations to brace roots and to enhance retention of short restorations. No studies substantiating the validity of these recommendations as they relate to the bracing of roots have been reported in the literature.

In this study, a number of factors were considered to be potential sources of variation. One of these was overdesiccation of dentin. Precautions taken in this regard precluded desiccation as a factor.

An expansive force was selected because it could be measured easily, and comparative results were all that were needed in this experiment.

The 2 mm gold collar was found to be highly effective in preventing root fracture within the

parameters of this study. The 2 mm height was selected because it is the height empirically recommended by clinicians. A greater height rarely can be obtained clinically without gingival and osseous surgery.

Future research should investigate the relative effectiveness of a shorter gold collar.

CONCLUSIONS

Within the parameters of this laboratory study:

- The smaller the mesiodistal diameter of roots, the greater the incidence of fracture.
- A 2 mm gold cervical collar that braces the root is highly significant in preventing root fracture.

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Polymerization of Composites by Sequential and Continuous Irradiation with Visible Light

The total time of irradiation is more important than the mode though sequential irradiation is better for large restorations

CLARK M STANFORD • PUI L FAN
RALPH L LEUNG • RAY KNOEPPEL
JOHN W STANFORD

Summary

Composites activated by visible light, when irradiated continuously or sequentially for the same total exposure, polymerize to a similar extent when the time of irradiation is adequate. Sequential exposure is a viable method for photopolymerizing large restorations or preparing samples of large dimension for tests.

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Introduction

The degree of polymerization of a photoactivated composite increases with longer exposure to a photoactivating light (Swartz, Phillips & Rhodes, 1983; Leung, Fan & Johnston, 1982). Composite resins are sometimes activated by sequential irradiation. Sequential irradiation is defined as any application of the photoactivating light where total time of light application is the same as the recommended light activation time but the light is applied in two or more increments, with a period of interruption between applications.

Examples: when additional exposure time is desired by the clinician after initial exposure; the use of curing units with short exposure time settings; or when curing class 2 and 4 restorations from both the facial and lingual surfaces, as has been suggested, to ensure adequate polymerization (Swartz & others, 1983).

Sequential irradiation also occurs when the light wand must be moved one or more times to cover the entire dimension of the cavity. It may also be used in the curing of large restorations and in the preparation of samples for testing in the laboratory. Sequential exposure is necessary when the dimensions of the restorations or samples are larger than the cross section of the photoactivating beam. Reduced polymerization, as indicated by the hardness of the surface, has been reported when samples of unfilled resin were polymerized by sequential exposure or slow repeated scan of the photoactivating light (Reinhardt & Vahl, 1981; Asmussen, 1982). This investigation is to compare the effect of sequential and continuous irradiation on the extent of polymerization of photoactivated composites.

Materials and Methods

Five composites activated by visible light — Command Ultrafine Dark Grey (Kerr Division of Sybron Corporation, Romulus, MI 48174, USA); Heliosit Shade 36 (Vivadent [USA], Inc, Tonowanda, NY 14150, USA); Silux Dark Grey (3M Company, St Paul, MN 55144, USA); Spectrafil Grey (Pentron Corporation, Wallingford, CT 06492, USA); Visiodispers Brown (ESPE-Premier Sales Corporation, Norristown, PA 19401, USA); and one unfilled resin, Silux Bonding Agent (3M Company) — were used in this study. A Command Light (Kerr Division of Sybron Corporation) was used to activate the Command Ultrafine composite. A Heliomat light (Vivadent [USA], Inc) was used to activate all the other materials. Irradiation for polymerization was either continuous or sequential in two or four segments with an interval (△) of 60 seconds between irradiation. For Silux and Visiodispers, intervals of 300 seconds were also used. Total time of exposure for each product was determined by the manufacturer's directions for a depth of cure of a minimum of 2 mm. Extended times of exposure were also used to determine if more extensive polymerization might be obtained.

Samples were prepared by filling stainless steel molds (4 mm in diameter x 2 mm thick) with composites, covering with mylar strips, backing with white filter paper, and polymerizing by irradiation from a photoactivating unit. The samples were stored at 37 °C in 100% relative humidity in the absence of light until the end of the test. Hardness of the top and bottom surfaces at 5, 20, and 60 minutes, and 1 day after irradiation was measured by means of a Barcol hardness tester, Model GYZJ 934-1 (Barber-Colman Company, Rockford, IL 61101, USA). Three samples were tested for each condition. Five readings were taken for each surface of each sample. The results were analyzed statistically by analysis of variance and a multiple comparison test (Student-Neuman-Keuls) at $\alpha = 0.05$.

Results and Discussion

The hardness of the top surface of each composite varied little with the mode of exposure to irradiation, that is, continuous or sequential, or with the total time of exposure. The hardness, however, was slightly greater at 20 minutes, 30 minutes, 60 minutes, and 1 day than at 5 minutes. The values for the hardness of the top surfaces at 1 day are shown in Figure 1. Even

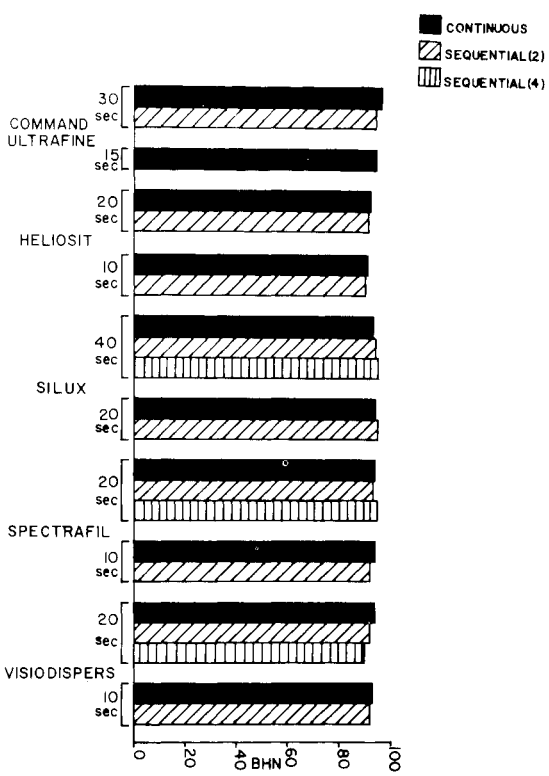

FIG 1. *Hardness of top surfaces 1 day after irradiation*

when statistically significant differences (α = 0.05) existed, the values were less than two Barcol units of hardness, or about 3%. This is probably of little clinical significance.

The hardness of the bottom surfaces increased slightly with longer times of exposure to the light, and this is in agreement with Leung, Fan and Johnston (1983), but the differences between the results of continuous exposure and sequential exposure were slight. The values at 1 day after irradiation (Fig 2) are indicative of the resultant polymerization. Even in the case of Command Ultrafine, where the difference was statistically significant, the differences in hardness were only four Barcol units, or about 4%. These are not likely to be clinically significant. Visiodispers showed slightly lower values of hardness, greater than two Barcol units, when the interval between exposures was 50 minutes.

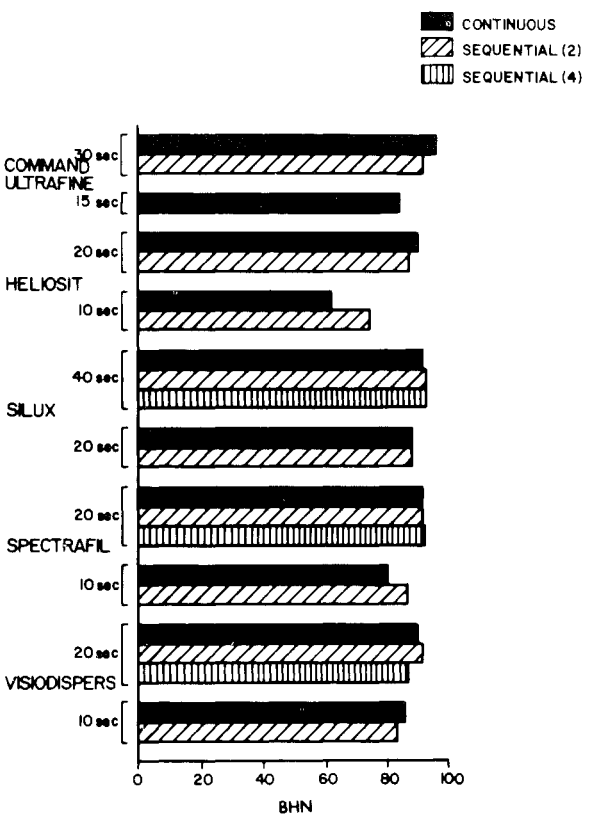

FIG 2. *Hardness of bottom surfaces 1 day after irradiation*

The difference in the hardness resulting from continuous or sequential exposure was not as great as the difference obtained by longer times of irradiation. Thus the mode of irradiation is less important than the total time of exposure. Shorter total times of exposure resulted in underpolymerized composite at shallower depths, and thus would compromise the properties of the restoration and lead to inferior clinical performance.

The influence of duration of exposure and mode of irradiation on the clear, unfilled resin has little similarity to their effects on composites. The absence of particles of filler precludes multiple scattering of light in the clear resin. In composites, multiple scattering and absorption of light are associated with lower translucency and smaller coefficients of transmission (Tirtha & others, 1982). Multiple scattering results in multiple passage of light through the matrix of the resin and probably enhances the extent of polymerization in composites by increasing the formation of initiating free radicals.

The observed results of no differences in hardness of composites irradiated by either continuous or sequential exposure differ from the observations of Reinhardt and Vahl (1981) and of Asmussen (1982) on unfilled resins, but the experimental conditions are quite different. The present study used a static exposure or multiple exposures, and not slow scans. This is closer to the type of usage in clinical situations and the preparation of samples for testing in the laboratory.

Conclusions

The results of this laboratory study show that the hardness of the top surfaces of samples, and thus, by implication, restorations, is not appreciably influenced by the total time or mode of exposure to light, namely, continuous or sequential, provided that adequate exposure time is used. For the bottom surfaces, when total exposure times are long and adequate, the hardness is not appreciably different for samples irradiated continuously or sequentially, indicating similar extent of polymerization. Thus it may be expected that there would be little clinical difference. However, this does not

replace the need for incremental layering and photopolymerizing each layer in deep cavities. Furthermore, shorter total times of exposure, either in sequential or continuous exposure, are associated with lower hardness, indicating less extensive polymerization. Thus short total times of exposure could possibly result in underpolymerized composites and might affect their clinical performance.

The use of adequate total time of exposure sequentially for large clinical restorations as suggested by Swartz and others (1983) is a viable method of photopolymerization. Furthermore, sequential exposure might reduce the effect of heat generated by the visible-light-curing units (Bodkin & Share, 1984; Bennett & others, 1984), which may cause damage to the pulp. Sequential exposure is also acceptable for the preparation of samples of large dimension for testing in the laboratory.

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BUONOCORE MEMORIAL LECTURE

Clinical Assessments of Amalgam Restorations

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Introduction

Dental amalgam has served the practitioner for many years and still remains the treatment of choice for most routine operative procedures in premolars and molars. The multiple factors involved in evaluating the amalgam restoration in terms of serviceability or replacement are discussed in this paper.

Clinical Techniques

Clinical assessments of restorations are based to a large extent on empiricism; however, scientifically valid methods have been developed, particularly during the last 15 years, to bring such clinical assessments to our notice.

Undoubtedly, the correlation between the laboratory parameter "creep" and the clinical condition "marginal degradation" of amalgam demonstrated by Mahler and his group (Mahler & van Eysden, 1969; Mahler & others, 1970) triggered a great number of clinical studies. At about the same time, the USPHS criteria for clinical evaluation of restorations were developed (Cvar & Ryge, 1971; Ryge & Snyder, 1973), using a system based on two clinical

qualities: the restoration is satisfactory or it is not acceptable. The criteria employed are those employed by clinicians when assessing the status of any restoration. The system has been adopted by the FDI as a system suitable for quality evaluations of the clinical performance of restorations (Fédération Dentaire Internationale, 1980).

The USPHS system is a direct evaluation system, that is, the evaluations are made with the patient present, in a typical mirror and probe examination. The criteria used include only three characteristics for evaluating the clinical performance of amalgam restorations: secondary caries, loss of anatomical form, and marginal integrity. Attempts to develop more detailed systems (e g, Mjör & Haugen, 1976) have shown that when more detailed criteria are used, less reproducibility is obtained between clinicians using the system. In other words, an assessment using detailed criteria is often more an evaluation of the clinician's abilities to record rather than a recording of the characteristics of the restorations.

The Mahler group and others focused on indirect clinical techniques, that is, the assessments of the restorations were made on a certain amount of recording of the clinical condition without the patient being present. The most common indirect techniques involve taking photographs of the restorations at defined time intervals (Fig 1). The comparison may be based on a 1:5 or 1:6 scale. The photographs from the experimental series are then categorized into the appropriate subgroups. However, more detailed analyses on a 1 to 11 scale are more frequently used. The photographs in such series rarely represent conditions which call for replacement of restorations. Only those categorized as 11 may, therefore, be considered as clinically significant. Statistical methods based on nonparametric analysis, of which ridit analyses (Bross, 1958) are frequently employed, may be used to show significant differences between groups of restorations. Other statistical techniques involve ranging of the photographs progressively from the best to the worst. This technique also allows the discrimination of small differences between groups of restorations. However, it is important to differentiate between statistical differences and clinical differences. Undoubtedly, statistically significant differences in quality between two series of restorations may be demonstrated — for example, between grade 2 and grade 4 in a 1:11 scoring system — but such a difference would not call for any clinical action. Two clinically significant differences exist if one of these calls for a clinical action, such as replacement of the restoration, while the other does not require any action.

Replicas or models of the teeth made from impressions are commonly employed as indirect techniques. A scoring system has been developed to compare the marginal integrity of restorations to selected degrees of degradation

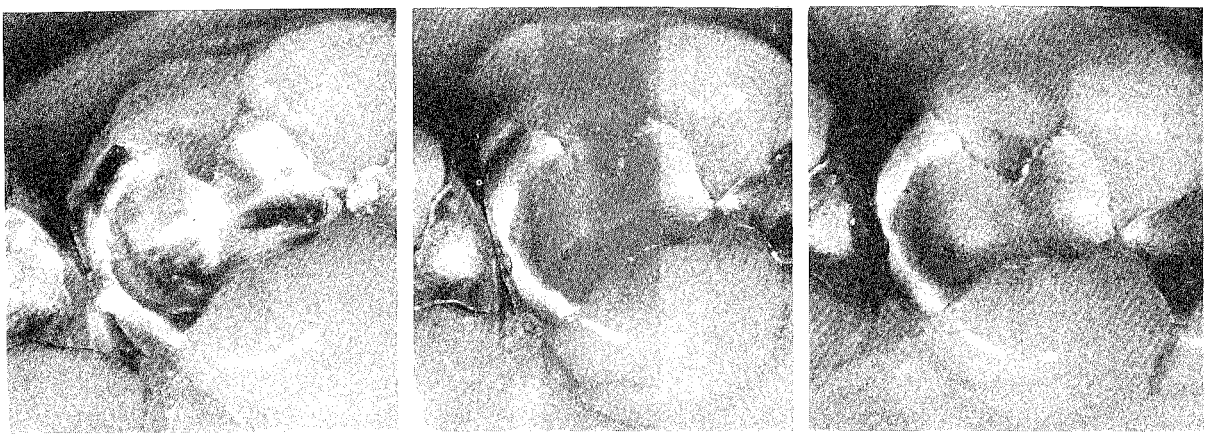

FIG 1. *Clinical photographs of the same class 2 amalgam restoration taken immediately after polishing* (left); *after one year* (center); *and after two years* (right). *Note the progressive degradation of the restoration over time.*

on a 1:6 scale (Mjör & Espevik, 1980). The numbers 1 to 6 indicate progressively larger degradations. It is important to note that in this scoring system, using SEM photomicrographs at low magnification, stage 5 represents the borderline between acceptable and unacceptable conditions. Using two conventional amalgams with creep values of 1.3 and 5.5, a high replacement rate could be demonstrated (see table). The cost of a replaced restoration is at least as high as that of the originally placed restoration; thus a significant difference in expenses for the treatment may be created by differences in the qualities of the materials. However, we feel that many studies have overemphasized marginal degradation as a clinical problem (Mahler & others, 1970; Letzel & others, 1978; Osborne, Binon & Gale, 1980). Information about the situation as present in everyday practice was therefore obtained.

Replaced Restorations

Material	Number of Restorations Initially	After 3 years	Replaced
Amalgam A	62	39	23
Amalgam B	67	65	2

(From Mjör & Espevik, 1980)

Questionnaires

Questionnaires may be used to record the reasons for the placement and replacement of restorations in clinical practice (Mjör, 1981; Klausner & Charbeneau, 1985; Boyd & Richardson, 1985). Such surveys clearly show that secondary caries is the main reason for replacement of amalgam restorations, amounting to 50-60% of all replacement. However, the type of patients treated is important, as somewhat different reasons for replacement of amalgam restorations are found in pedodontic practice (Dunston & others, 1978; Mjör & Åsenden, 1986), although secondary caries was also the most frequent reason for the replacement of amalgam restorations in deciduous teeth.

Secondary Caries

The possibility that marginal degradation is a predisposition to secondary caries has been suggested (O'Brien, Mahler & Greener, 1985). The ditching was considered to create sites for plaque accumulation and thus predispose them to secondary caries. This hypothesis was claimed to be supported by studies by Jørgensen and Wakumoto (1968) and Goldberg and others (1981). A cross-sectional survey designed to map out the location of secondary carious lesions indicates that the most frequently sited locations for secondary caries are found gingivally and interproximally (Mjör, 1985). The distribution of the secondary carious lesions on class 2 restorations is shown in Figure 2. It is apparent that the link between ditching and the development of secondary caries is weak. Thus, it is essential to emphasize the importance of selection of appropriate techniques for clinical evaluations and the limitations of the various techniques. The important point is that any indirect technique for assessment of restorations evaluates the occlusal surface only. If we design studies using indirect clinical techniques for assessments, the major problem, at least for amalgam restorations,

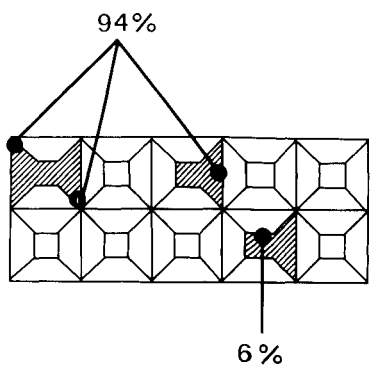

FIG 2. *Diagram showing the most common locations of secondary caries of class 2 and MOD restorations*

which is secondary caries at the gingival margins interproximally, is not accessible for evaluation. In other words, we tend to focus on the minor details and neglect the major problems.

It is likely that improvements in amalgam therapy may be obtained if secondary caries became a major research theme in operative dentistry. Very scanty information is available on secondary caries, despite the fact that it has been reported on several occasions to be the major reason for replacement of amalgam restorations during the last 40 years (Leinfelder & Mjör, 1985). However, it should be noted that the term secondary caries used in the clinical diagnostic sense of the term is rather ill defined. It encompasses remaining caries and recurrent caries. Often it cannot be satisfactorily differentiated from a crevice which is not accessible for visual inspection and where the probe catches or sticks.

Antibacterial Properties

Bacteria probably play a central role in the development of secondary caries as they do for primary caries. It may be that even specific bacteria are involved, possibly *Streptococcus mutans;* however, information in this area is largely lacking. Bacteriological studies may, therefore, give answers to important features in restorative therapy.

The survival of mixed salivary bacteria following exposure to different alloys has been studied to assess differences in the antibacterial properties of the alloys (Ørstavik, 1985). The antibacterial effect ranged from 2% to almost 50% growth reduction of bacteria (Fig 3). The addition of a saliva filtrate to the test system increased the antibacterial effects of the extracts of all alloys, and one alloy showed a 30% survival of bacteria exposed to the extract of the alloy and salivary components (Fig 3).

The effect of the alloys on the growth of *Strep mutans* showed that two alloys exhibited a total growth inhibition while the other alloys had a very small effect (Fig 4).

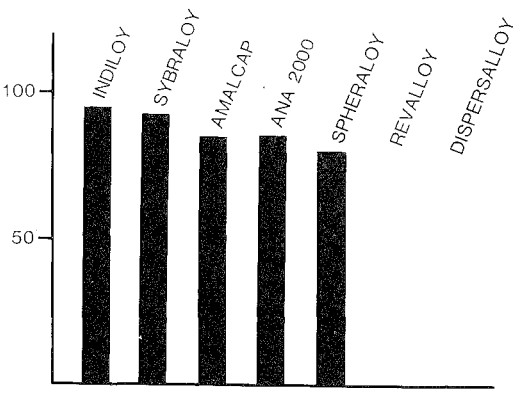

FIG 4. *Growth of* Streptococcus mutans *in the presence of various alloys. (From Ørstavik, 1985)*

The clinical significance of these data on the antibacterial properties of dental amalgams has never been ascertained. Clinical studies relating the antibacterial properties of the amalgam to the frequency of secondary caries has not been established despite the fact that information on their antibacterial properties has been available for a long time (Turkheim, 1953; Updegraff, Chang & Joos, 1971; Nunez & others, 1976).

A longitudinal microbiological study which has been designed to assess the development of secondary caries involves the sampling of bacteria interproximally at the gingival margin (Ørstavik, 1986, unpublished data). This may be done by sterile dental floss or by using a sterile needle or root canal instrument.

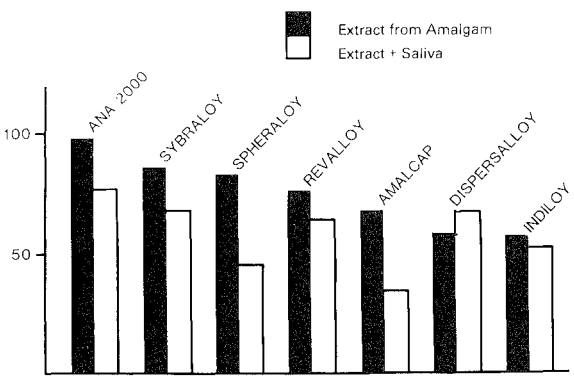

FIG 3. *Survival of salivary bacteria in the presence of extracts from various alloys (filled bars) and in the presence of extracts and saliva filtrate (open bars). (From Ørstavik, 1985)*

The Tooth-restoration Interface

Studies of the tooth-restoration interface using scanning electron microscopy show defects which indicate that the amalgam is not always condensed properly against the wall of the cavity preparation (Mjör & Smith, 1985). A great number of porosities within the adjacent amalgam substantiate the observation that the condensation of the alloy has not been adequate.

These observations led to further studies on the effect of condensation on the setting mechanisms of dental amalgams (Herø & Jørgensen, 1985; Jørgensen & Herø, 1986). These laboratory experiments have shown that hardening of amalgam accelerates markedly if it is put under pressure and deformed plastically, that is, mercury and alloy particles are moved relative to each other. An increased reaction rate between the alloy particles and the mercury, rather than compression of pores and squeezing out redundant mercury, is the most likely explanation for this fast hardening of the amalgam. The result is that the amalgam immediately subjacent to the instrument used for condensation sets faster than the surrounding amalgam. Little amalgam is pressed to the sides of the instrument. The findings presented in this laboratory experiment suggest that condensation should be carried out with rapid compression movements on small increments of amalgam in order to reduce the development of localized hard areas within the mix, which will prevent optimal condensation.

A number of other factors will also affect adaptation of the amalgam to the cavity walls. Obviously, the dimensional changes of the amalgam must be important. The ADA specification for amalgam alloys allows for a 0.2% expansion and contraction. The present international standard does not accept amalgams which contract during setting, but this requirement is not maintained in the revised standard. Amalgams contracting up to 0.6% have been tried experimentally, and then crevice formation at the tooth/filling interface may be noted clinically (Rupp, 1975, personal communication).

Finishing of the cavity walls may also be important for good adaptation of the amalgam. Voids between the cavity and the amalgam are often noted at irregularities of the cavity margin. Several large areas of porosities may also be found adjacent to voids. Obviously, more clinical studies are needed to ascertain the optimal conditions for condensation, both with respect to cavity preparation design and finishing of the walls, and also to establish how the condensation pressure should be exerted in order to minimize porosities and voids, especially at the tooth/restoration interface. Studies so far indicate that optimal condensation is the key to successful, long-lasting amalgam restorations.

Cavity Preparation

The importance of cavity preparation is emphasized in the teaching of operative dentistry. Textbooks on the subject describe line angles, isthmus dimensions, retention form, and so on in great detail. However, the importance of specific details described by Black and other authorities are difficult to assess in clinical studies related to the longevity of the amalgam restorations. Thus, studies are needed that deal with the effect of cavity preparation on the occurrence of local defects as well as on the effect of the overall quality of the preparation. A major difficulty exists with respect to the classification of cavity preparations.

A classification system based on Charbeneau's quality evaluation criteria for prepared amalgam cavities (Charbeneau, 1981) is presently being developed at our institute. The rating is based on the USPHS principles, but modified with three ratings "satisfactory" and two ratings "not acceptable."

Preliminary data indicate that even though a majority of the cavity preparations in a longitudinal study are in the "not acceptable" category, only about 7% of all restorations have failed, and the great majority have been in service for five to six years to date (unpublished observations). Such findings suggest that our criteria for "satisfactory" and "not acceptable" cavity preparations are too restrictive or too tight.

Chipping of cavity margins has been described in detail (Tronstad & Leidal, 1974). Chipping is much more frequent on the so-called exit side than on the entry side of cavities. "Exit" and "entry" refer to the rotation of the bur, that is, whether it rotates into or out of the cavity during preparation. Clinical procedures to eliminate or reduce these defects have been de-

scribed (Leidal & Tronstad, 1975), but the long-term effect of remaining defects has not been established.

Elderton and coworkers (Elderton, 1976; Merrett & Elderton, 1984) have devoted much time to quality assessment of replaced restorations over the past 10 years, including the need to extend a cavity preparation beyond the margin of the old restoration during replacement of restorations. Obviously, all the secondary caries should be removed, but often the cavity walls are "freshened up." The result is a loss of considerable amounts of tooth tissue. Studies to assess the necessity for this procedure are needed.

Clinical Diagnosis

Marked variations in diagnosis of primary caries by clinicians have been observed (Markén, 1962). Merrett and Elderton (1984) studied such variations in diagnosis, and found that the need for replacement diagnosed by the clinicians showed extreme variations. Nine clinicians were asked to assess the same 228 restorations on extracted teeth. One clinician felt that 28 of the restorations needed replacement; another indicated that 119 of the 228 required replacement.

The breakdown of the figures for secondary caries in Merrett and Elderton's study showed a similar tendency in the diagnoses of secondary caries. One clinician diagnosed 11 as having secondary caries, while another was of the opinion that 57 of the same restorations had secondary caries. Of all the 228 teeth, a total of 105 restorations received a diagnosis of secondary caries by one or more of the nine clinicians.

These data are disturbing. The need for research, information, and possibly most of all, calibration, is clearly demonstrated.

Changes in diagnostic pattern should also be monitored closely, illustrated by the differences in diagnostic level collected on two different occasions, 12 years apart (Boyd & Richardson, 1985). We find a dramatic change in the frequency of ditching as a reason for replacement of restorations. In 1972, 5% quoted marginal breakdown as the reason for replacement. In 1984, an increase in frequency to 21% was reported. The authors of this report suggest that the explanation for this change in diagnostic level may include an increased supply of dentists, a reduction in caries, and a drop in the dentists' economy. The focusing on marginal breakdown in many clinical studies may also have some effect on the diagnostic significance of this parameter.

A discussion of clinical assessment of amalgam restorations would not be complete without mentioning side effects. No scientific evidence has been presented to demonstrate a general toxic reaction of corrosion products from amalgam restorations. However, allergic reactions to these products do occur. White lesions in the oral mucosa, so-called oral lichen planus, may also develop next to amalgam restorations. Some of these are undoubtedly related to the restorations (Bánóczy & others, 1979; Lyberg & Lind, 1984). The mechanism involved in the development and resolution of such lesions, following removal of the restoration, is not understood. Oral lichen planus as a side effect is not only associated with amalgam restorations, although it most frequently occurs in connection with such restorations, especially those subjected to severe corrosion.

Concluding Remarks

A good amalgam restoration is an excellent treatment for an established carious lesion and for the replacement of failed restorations. It is usually the treatment of choice in routine operative treatment of premolars and molars. If properly placed, such restoration will last for many years. However, it must be emphasized that no one really wants restorations; they are accepted only because of failure to prevent caries in the first place. Once placed, the need for replacement will inevitably come, an everlasting process that gradually destroys the tooth. Some of the data on the longevity of amalgam restorations indicates that about half of all restorations last more than 10 years (Robinson, 1971; Allan, 1977), while other studies indicate a somewhat shorter lifespan (Lavelle, 1976; Allan, 1977; Mjör, 1985). Much attention must be focused on increasing the longevity of amalgam restorations. Provided that attention is directed toward the major etiological

factors, the possibilities for improvement are considered good.

Prevention of caries should be the guideline for every dental practice. In many instances it involves a marked change in the practice of dentistry, a change that represents a challenge to the profession. Hopefully, dentistry may reach a stage where the patients do not pay for the restorations made, but for the restorations that are *not* made.

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PRODUCT REPORTS

Frequency Variations in Calibrated versus Uncalibrated Amalgamators

C J SCHULTZ • M J MODJEAN
A T HAMPEL

Summary

The consistency of the frequency of oscillation of amalgamators calibrated weekly, Vari-Mix II, Model VMB (L D Caulk Co, Milford, DE 19963, USA), compared with uncalibrated amalgamators differed only in the amount of variation. Not one of the tested amalgamators in either group (n = 20) has a consistency within the expected 3600 ± 200 c min^{-1} (60 ± 3.3 Hz). The range in the recalibrated group of 2580-4200 c min^{-1} (43-70 Hz) equals a variation of 46%, that in the uncalibrated group of 1800-4200 c min^{-1} (30-70 Hz) equals a variation of 58%. Both groups of amalgamators had been in use for eight years without recalibration prior to this study.

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Introduction

An observation in the clinics at the University of Minnesota that the same manipulative procedures with the same type of alloy did not produce consistency in the plasticity of mixes of amalgam prompted an investigation of the accuracy of the frequency of oscillation of the amalgamators used in the process of trituration. These amalgamators had been installed new in the clinic in 1974 and at the time of testing were eight years old. Inasmuch as these instruments had never been recalibrated, and the manufacturer's recommendation to warm up the instrument before daily use had not been adhered to, it was suspected that this might be the cause of the difference in the plasticity of the mixes.

Mixes that are undertriturated, as when the amalgamator is running too slowly, will be grainy and have low strength and poor resistance to corrosion. When the mix is overtriturated, as occurs when the amalgamator is running too fast, heat is generated and the setting time and plasticity are affected (Phillips, 1982).

The purpose of this study was to measure the variation in the frequency of oscillation of 10 calibrated amalgamators and 10 uncalibrated amalgamators, all of which had been in use for eight years without recalibration prior to this study. The variation between the two groups of amalgamators was then compared. The effect of a change in line voltage was also investigated.

Materials and Methods

Twenty amalgamators, Vari-Mix II, Model VMB (L D Caulk Co, Milford, DE 19963, USA) were tested for consistency of speed. The 20 amalgamators were tested weekly on the same day prior to the clinical session by the same part-time member of the faculty of operative dentistry.

For the warm-up of the machine, a two-pellet mix of Dispersalloy (Johnson & Johnson Dental Products Co, East Windsor, NJ 08520, USA) in a prepackaged capsule was placed in the amalgamator and triturated for 30 seconds at the M-2 setting. A stroboscope (Strobatax, Gen RA, G R 1531-AB) was then used to calibrate each machine to 3600 cycles per minute (60 hertz) by running it with the same capsule in place.

The machines were tested weekly for the next seven weeks. Ten amalgamators were warmed up as described and the speed then determined with the stroboscope. The amalgamator was then reset to 3600 c min^{-1} (60 Hz).

The resetting was accomplished by removing the knob, calibrating the machine and replacing the knob with the arrow pointed at M-2. The knob can be removed by loosening a set screw on the underside of the knob.

The other 10 units were warmed up as described and the speed was checked at the end of the warm-up. These machines were not reset to 3600 c min^{-1} (60 Hz). Since we were not checking the effect of a change in line voltage on a weekly basis, it was investigated by the placement of a voltage rheostat between the line current and the amalgamator.

Results

The mean, range, and variation of the frequency of oscillation of each of the recalibrated amalgamators are shown in Table 1 and of the uncalibrated amalgamators in Table 2. The graph (Fig 1) illustrates a comparison of the

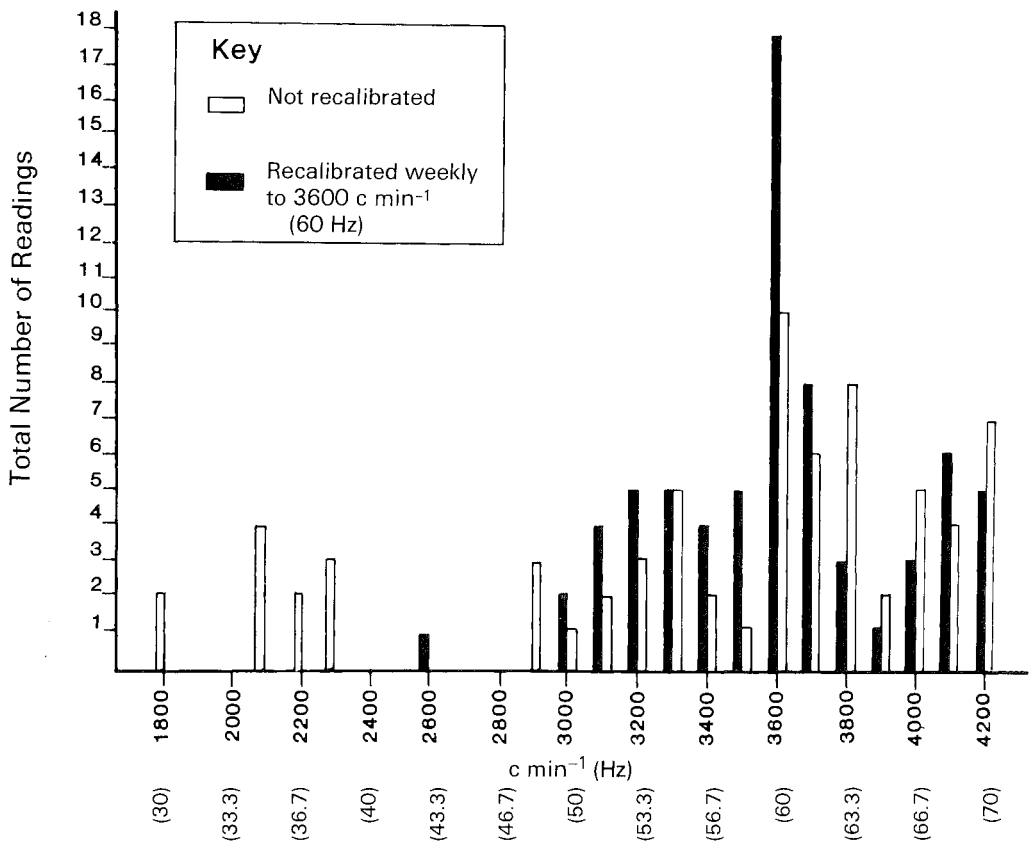

FIG 1. *Number of readings for each frequency of oscillation for the nonrecalibrated and the recalibrated instruments*

Table 1. Frequency of Oscillation of Recalibrated Amalgamators

Amalgamator	Frequency of Oscillation c min^{-1} (Hz)			
	Range	Variation	Mean	SD
1	2580-4200 (43-70)	1620 (27)	3384 (56.4)	577 (9.6)
2	3500-4100 (58.3-68.3)	600 (10)	3660 (61)	245 (4.1)
3	3120-4200 (52-70)	1080 (18)	3740 (62.3)	430 (7.2)
4	3390-3980 (56.5-66.3)	590 (9.8)	3650 (60.8)	202 (3.4)
5	3000-4200 (50-70)	1200 (20)	3536 (58.9)	416 (6.9)
6	3180-4100 (53-68.3)	920 (15.3)	3549 (59.2)	316 (5.3)
7	2640-4200 (44-70)	1560 (26)	3633 (60.6)	412 (6.9)
8	2400-3980 (40-66.3)	1580 (26.3)	3589 (59.8)	261 (4.4)
9	3200-4100 (53.3-68.3)	900 (15)	3617 (60.3)	266 (4.4)
10	3180-4200 (53-70)	1020 (17)	3643 (60.7)	299 (5)

values in Tables 1 and 2.

The day-to-day variations of each amalgamator did not show any consistent trend to either an increase or a decrease in frequency of oscillation, sometimes being above the specified frequency and sometimes below.

The analysis of variance shows statistically significant day-to-day differences among mean frequencies for both recalibrated and uncalibrated instruments.

- Recalibrated: $F(6,54) = 2.881$, $P = .0165$
- Uncalibrated: $F(6,54) = 6.123$, $P < .001$

The residual variations among readings for uncalibrated instruments weekly is significantly greater than those for machines recalibrated weekly.

$$F(54,54) = 2.777,\ P < .001$$

The readings at the start of the study varied considerably. Only nine of the 20 instruments

Table 2. Frequency of Oscillation of Uncalibrated Amalgamators

Amalgamator	Frequency of Oscillation c min^{-1} (Hz) Range	Variation	Mean	SD
1	2880-4200 (48-70)	1320 (22)	3694 (61.6)	542 (9)
2	2900-4200 (483-70)	1300 (21.7)	3639 (60.7)	539 (9)
3	2060-3820 (343-63.7)	1760 (29.3)	3196 (53.3)	557 (9.3)
4	2200-4200 (36.7-70)	2000 (33.3)	3329 (55.5)	798 (13.3)
5	1820-4100 (30.3-68.3)	2280 (38)	3286 (54.8)	869 (14.5)
6	2080-4150 (34.7-69.2)	2070 (34.5)	3239 (54)	811 (13.5)
7	1840-4160 (30.7-69.3)	2320 (38.7)	3111 (51.9)	830 (13.8)
8	2260-4200 (37.7-70)	1940 (32.3)	3689 (61.5)	644 (10.7)
9	2340-4100 (39-68.3)	1760 (29.3)	3620 (60.3)	580 (9.7)
10	2400-4200 (40-70)	1800 (30)	3487 (58.1)	418 (7)

were within the manufacturer's stated range.

The large differences among readings for the instruments listed as both unused and uncalibrated throughout the course of the study is not understood.

Varying the line voltage between 110 and 119.5 volts gave a fluctuation in frequency of oscillation that was within $\pm$ 200 c min^{-1} (3.3 Hz) of the 3600 C min^{-1} (60 Hz). Figure 2 illustrates this finding.

Discussion

The findings of our study do not substantiate the manufacturer's assumption of avoiding variations in mixes through warming up of the instrument.

The suggestions that the line voltage has an influence on the accuracy of the speed of the instrument was found to be correct but only within certain limits.

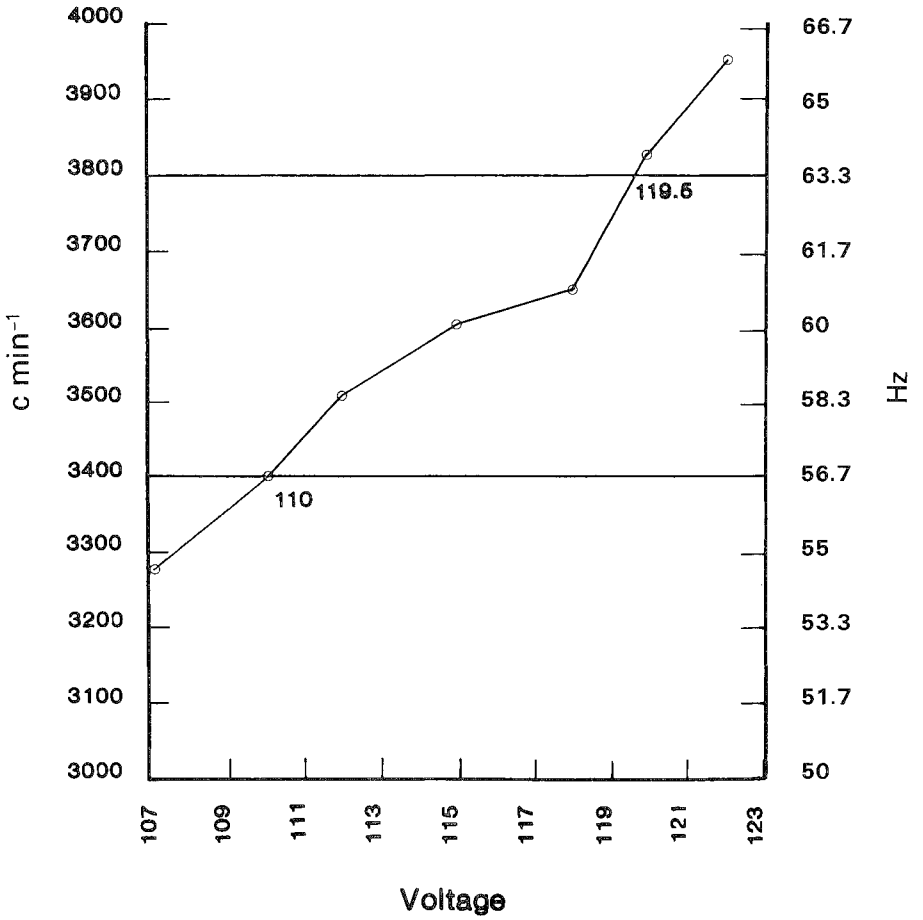

FIG 2. *Effect of line voltage on the speed of an amalgamator*

The wide range of our measurements of frequency of oscillation cannot be fully explained on the basis of not compensating for variations in voltage. The statement in the study by DuBois, Haisch, and Rinne (1982) that the frequency increases over time was not borne out by our results.

According to Brackett (1985), the older amalgamators, such as the Vari-Mix II, are the most susceptible to variations in speed. To help solve the problems we were having with our machines, three were sent back to the factory. All three had the motors, large wire clip, rubber feet, and rubber washers replaced. When checked two years later, they were within the range of acceptability (3600 [60 Hz] ± 200 [3.3 Hz] C min^{-1}).

Conclusion

Consistency and physical properties of amalgam are influenced by the work produced during trituration. The time and speed of mixing relates directly to the work produced. Work = Force × Speed × Time. The results of our investigation showed that eight-year-old amalgamators, Vari-Mix II, Model I VMB —

- Fluctuated widely in frequency of oscillation between units and within the same unit tested over seven weeks.
- Recalibrating weekly did not dependably eliminate the variations; it did, however, decrease the range of variation.

- There was no predictable trend in change of frequency of oscillation upward or downward with or without recalibration.
- The range of frequency was far greater than could be explained by variation in line voltage.
- The speed settings of eight-year-old amalgamators cannot be relied upon as being accurate within manufacturer's specifications.
- Amalgamators that produce erratic plasticity of mixes of amalgam should be checked and possibly examined by the manufacturer.

The practicing dentist can overcome much of this problem by triturating to plasticity. The speed of the amalgamator can be compensated by changing the setting up or down from M-2 or by changing the time of trituration.

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Simultaneous versus Independent Polymerization of a Bonding Agent and Composite Resin

A S MOWERY • R J KLOCKOWSKI
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Summary

When Prisma-Fil bonding agent and composite were cured with visible light, this study demonstrated that no significant difference existed between the shear bond strength achieved by simultaneous or independent polymerization, in contrast to the manufacturer's recommendation which stated that the bonding agent and resin should be cured simultaneously. The testing procedures developed for this study indicate that the use of two prepared testing sites on the same tooth does produce consistent, reliable data.

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Introduction

Bonding agents are used routinely in conjunction with most composite resin restorations. With the advent of the light-cured resins, new techniques evolved permitting the dentist to polymerize the bonding agent and composite at the same time or separately. Many practitioners, faculty members, and lecturers regard the two-step curing process as advantageous because the manipulation of the composite filling material is easier in the presence of a polymerized bonding agent. This technique is not consistent with at least one manufacturer's instructions (L D Caulk, Inc, Milford, DE 19963, USA) which recommend that the bonding agent and composite resin be polymerized simultaneously. The primary purpose of this investigation was to examine the effect of simultaneous versus independent polymerization of this one brand of bonding agent and composite resin on enamel-composite shear bond strength.

One of the major problems in enamel bond studies has been the lack of uniformity in techniques (Schneider, Masser & Douglas, 1981). Most studies have employed different methods of tooth preparation and shear bond

strength measurement. Variations in research methodology render interpretation of results across studies tentative at best. A secondary purpose of this study was to develop a standardized, replicable methodology for enamel bond research.

Materials and Methods

Human molars which had been initially placed for a short period of time in 10% neutral buffered formalin (Buonocore, Matsui & Gwinnett, 1968; Mitchem & Turner, 1974) immediately following extraction were collected for this study. Teeth which were minimally restored and presented relatively large areas of noncarious enamel were mechanically cleaned of soft tissue and placed in isotonic saline for storage (Coury & others, 1982) until needed for this study.

Jørgensen (1975) stated: "(1) that different non-contralateral teeth may show significant differences in the pattern of the etched surfaces, (2) that this pattern may frequently vary within the same tooth surface, and (3) that symmetric areas on pairs of contralateral teeth have almost identical etch patterns." The use of symmetric surfaces of contralateral teeth from the same patient would therefore appear to be ideal. In reality this test design is very difficult to achieve due to the relative unavailability of sound, contralateral human teeth. Thus, the use of enamel areas from the same tooth as control and test sites was adapted for this study as the best tenable research design, since it is thought that these areas would produce nearly identical etch patterns, especially after grinding procedures.

Past research suggests that the most favorable altered surface, in terms of surface debris, roughness (Eick & others, 1970), and retentive strength (Aker, Aker & Sorensen, 1979), is one prepared by cutting wet with a diamond bur. Using an SEM comparison, the 260-grit diamond facetor's lap (Crystalite Corp, Marina del Rey, CA 90291, USA) selected for this study was determined to produce a surface very similar to a medium-grit diamond bur. Use of a faceting machine (B&I Manufacturing Co, Fresno, CA 93728, USA) was found to lend a high degree of precision to tooth preparation in vitro.

Thus, to prepare uniform enamel sites having surface characteristics similar to those obtained with a medium diamond bur in clinical situations, the following techniques were developed. First, a molar was mounted on the faceting arm (B&I Manufacturing Co) with the two larger areas of enamel as nearly parallel to the long axis of the arm as possible. This was achieved by using facetor's wax (Rio Grande Albuquerque, Albuquerque, NM 87109, USA) on the occlusal surface of each molar and attaching this to a faceting dop (Montgomery, 1982).

With the arm held in a horizontal position, the tooth preparation was initiated using the 260-grit diamond lap (Crystalite Corp) with copious water flow (Fig 1). Care was taken not to penetrate into dentin during this procedure. The lap allows preparation of enamel sites that are consistent in surface characteristics, parallel to each other, and uniform in depth. These conditions are difficult to obtain with a diamond bur secured in a high-speed handpiece, even if a jig is used. The result was two faceted areas of enamel approximately 5 mm by 7 mm on each tooth. This area was chosen so that the enamel sites would be slightly larger than the 5 mm diameter of the composite resin specimens.

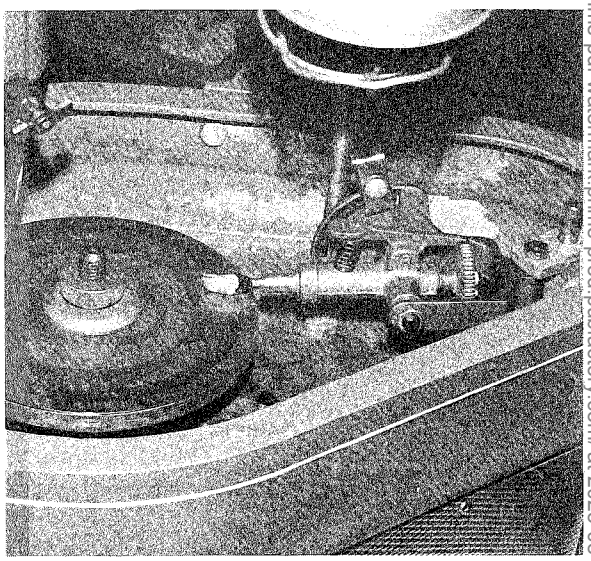

FIG 1. *Facetor arm in horizontal position with tooth being faceted on 260-grit lap*

Notches were then placed in the roots of the prepared tooth, prior to mounting, to aid in retention within the stone base. Following this procedure, a plastic former, approximately half filled with a fresh mix of Vel-Mix (Kerr Manufacturing Co, Romulus, MI 48174, USA), was placed on a flat steel lap and the tooth was positioned vertically and lowered until the cementoenamel junction approached the level of the stone mix (Fig 2). After the stone

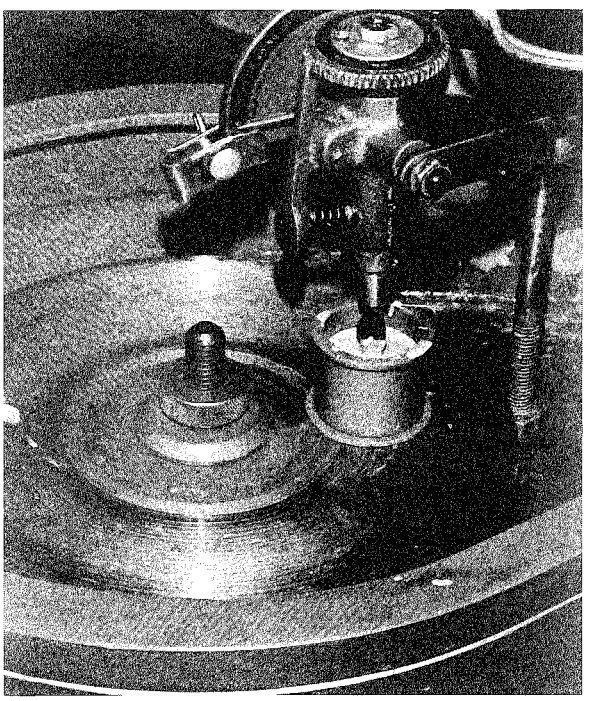

FIG 2. *Facetor arm in vertical position with faceted tooth being mounted in Vel-Mix base*

hardened, the mounted tooth was removed from the faceting machine and the plastic former was removed from the base. This produced a tooth possessing two flat areas of enamel, which were also perpendicular to the flat bottom of the stone base. The mounted tooth was then stored in water until such time composite specimens could be attached. A total of 30 teeth were prepared.

Specimens were prepared using the following techniques. After the tooth was air dried, the control enamel site was etched by applying the etchant (L D Caulk) for 60 seconds, then rinsed with copious amounts of water for 20 seconds. Prisma-Bond (L D Caulk) was applied to the bond site and thinned with a light stream of air. A No 4 gelatin capsule (approximately 5 mm in diameter), which had been overfilled with Prisma-Fil (L D Caulk), was immediately adapted to this site. With the aid of a facetor's jig (B&I Manufacturing Co), the capsule was firmly held perpendicular to the prepared site (Fig 3). Excess material was carefully and

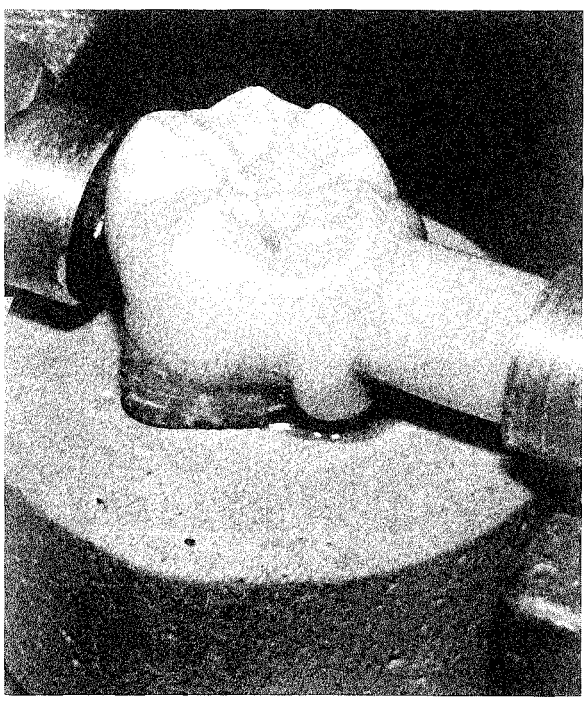

FIG 3. *Mounted tooth in facetor's jig with overfilled capsule securely held in place*

quickly removed from the edges of the site and the specimen was light-cured for 40 seconds. This process was repeated at the other test site on the same tooth, with the exception that the bonding agent was light-cured for 10 seconds prior to the application of the composite filling material. Each tooth with a completed pair of specimens was immediately placed in 37 °C water and stored for 24 hours prior to testing (Retief, 1974). The gelatin capsules became softened in the water and were removed prior to testing, thus eliminating their possible interference at the point loading.

A wedge-shaped bar that had been fabricated for this investigation was attached to the Instron Testing Machine (Instron Engineering Co, Canton, MA 02021, USA) crosshead arm. To prevent slippage, each mounted tooth was placed on a piece of damp blotter paper which was approximately centered on a 100 kg load cell. The mounted tooth was repositioned slightly until the bar could be carefully centered to rest on one of the composite specimens precisely 1 mm from the bond site (Fig 4). A

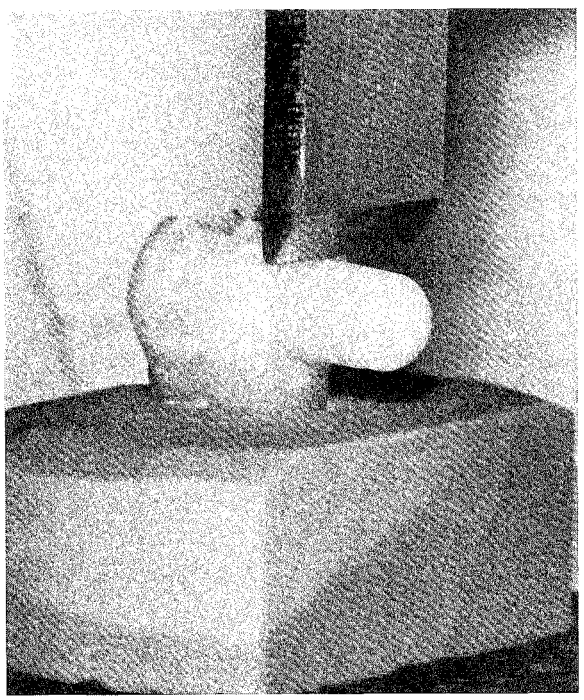

FIG 4. *Loading bar of the Instron in position for testing*

dynamic force was applied at a crosshead speed of 0.01 cm/min until the specimen fractured at the bond site. This loading was plotted and the force in kg at the time of failure was recorded. In addition, the fracture site of each specimen was observed and the characteristics of failure noted.

Results

The variable measured was the force in kg required to cause the specimen to fracture at the bond site. Two control specimens were lost and therefore were eliminated from the study. Thus, data for 30 test and 28 control sites were reported. The mean force in kg required to cause fracture was 36.42 $\pm$ 5.68 for the simultaneous polymerization (control) group and 35.17 $\pm$ 5.94 for the independent polymerization (test) group.

Based on a study by Jørgensen (1975), the assumption was made that the enamel composition of test and control sites within a given tooth may be different. Thus, the data were analyzed using a two-tailed unpaired *t*-test. No significant difference was found between the shear bond strengths of the two polymerization techniques ($t^{56} = 0.81$, $P > 0.05$).

The composite specimens were measured and found to have a mean diameter of 5.07 mm $\pm$ 0.035 SD at the bonding site. Using a conversion factor of kg/cm^2 X 0.09807 = MPa (Schneider & others, 1981), the mean shear bond strength for each group was equivalent to control group, 13.90 MPa; and test group, 13.42 MPa.

Discussion

Schneider, Masser and Douglas (1981) have indicated that one major problem with bonding studies is the lack of standardized methods among investigators. The method described herein, creating parallel test sites on the same tooth and using a facetor's jig for greater accuracy in specimen attachment, provides a practical, reliable technique which can be easily replicated. This also insures that all specimens are tested in the same alignment. The use of a diamond lap, which has a large surface area, repeatedly yields enamel sites having consistent surface characteristics.

The mean difference in the force in kg required to cause the specimens to fracture at the bond site was not statistically significant between simultaneous and independent polymerization groups. This suggests that the two methods of polymerization do not produce different bonding results. The implication could be made that either technique might yield similar clinical results when using Prisma-Bond and Prisma-Fil.

Further observation revealed enamel "tears" in 27% of the specimens. In each case these tears represented an area of 50% or more of the bond site. The occurrence of tears was evenly distributed between the control and test groups, and extended into dentin, suggesting that, in these cases, the composite-enamel bond was stronger than the dentinoenamel bond. This phenomenon was unexpected, but has been reported elsewhere in the literature (Retief, 1974; Williams & Svare, 1985). Future research focusing on the enamel tears is planned to further characterize this phenomenon.

Conclusion

The results of this study indicate there is no statistical difference in the shear bond strength achieved with either independent or simultaneous polymerization of the bonding agent and composite when using Prisma-Bond and Prisma-Fil.

The data also shows that a standardized testing procedure to evaluate shear strength of resin to tooth structure can be accomplished using two test sites on the same tooth when such surfaces are prepared in a standardized manner. Such standardization should allow for comparison of data between different study groups.

Acknowledgments

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Hollenback Prize for 1986

The Hollenback Memorial prize for 1986 has been awarded to Nelson W Rupp, currently associate director of the Paffenbarger Research Center at the National Bureau of Standards in Gaithersburg, Maryland. This award is given annually by the Academy of Operative Dentistry to recognize excellence in research and dedication to the advancement of operative dentistry.

Dr George Hollenback, in whose memory this award was established, had an appreciation for the materials being used in his day to restore lost tooth structure. His research was strongly related to the clinical application of materials and was directed toward improving the quality of restorative dentistry. Dr Rupp, likewise, has engaged in two distinct careers, each of which involved practicing, investigating, and teaching the concepts of materials management.

Dr Rupp earned his BA degree from Denison University in Ohio, majoring in mathematics. He continued on to dental school at Ohio State University and received his DDS degree in 1943. He spent the following 26 years in the US Navy, including two tours at sea practicing general dentistry on the USS Shenandoah and the USS Los Angeles. From 1951 to 1955, he was assigned to the Bureau of Standards near Washington, DC, and obtained an MS degree in Dental Materials in a joint program with Georgetown University. During his illustrious career in the Navy, he was an instructor in the Dental Technician School at Great Lakes; engaged in research at the Navy Electronics Laboratory at San Diego; and was head of the Standards and Training Division for the Bureau of Medicine and Surgery. In 1965, he was sent to the Navy Dental School in Bethesda, Maryland, as head of the Research and Sciences Division. He later became research coordinator for the school (1965-67) and retired as head of the Officer Education Department in 1969. His teaching responsibilities while at the School were in dental materials, research methodology, the pathology of dental caries, and scientific communication.

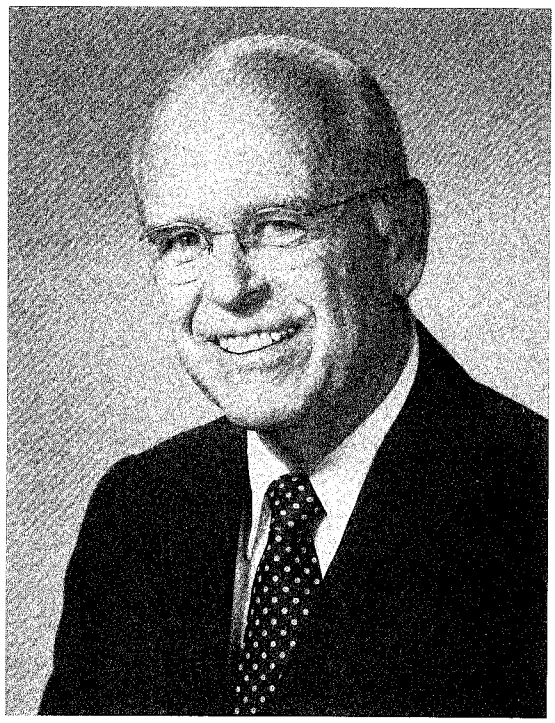
In 1969, Dr Rupp returned to the National Bureau of Standards as a research associate of the American Dental Association Health Foundation. He began a second career with a new employer, but his goals and objectives were very much the same. In his position as Chief Scientist for Clinical Research, he has become an effective liaison between the basic science groups at NBS and the application of their developments for the dental practitioner. He also has a teaching appointment as a professorial lecturer in the graduate programs at Georgetown University, College of Dentistry. He has served as a consultant to the Naval Dental Center, to the Surgeon General for the US Air

Force, and to the Commission on Dental Products for Fédération Dentaire Internationale.

During the past few years, Dr Rupp has been very active, both nationally and internationally, in the development of specifications for the certification of dental materials. For the American National Standards Institute (ANSI/ADA), he serves on the MD156 Committee on Dental Materials, Instruments and Equipment as chairman of Group I on Restorative Materials, including responsibility for amalgam, dental cements, composite resins, and pit and fissure sealants. Internationally, he is active in the International Standards Organization (ISO), Committee TC106 for Dentistry, and is chairman of Working Groups 1 and 6 for Dental Amalgam and Mechanical Amalgamators. This distinguished record of voluntary service represents a lifelong commitment to improve the standard of materials manufacturing and marketing and the quality of dental care in the United States.

Dr Rupp is an avid supporter of organized dentistry and has held offices in many organizations. He is an active member of the American Dental Association and the International Association for Dental Research. He has been awarded membership in Omicron Kappa Upsilon, the honor fraternity for dentistry, Sigma Xi, the honor fraternity for science, and the Fédération Dentaire Internationale. He has held office as treasurer of the Washington Academy of Sciences (1972), president of the American Academy of Gold Foil Operators (1986), and president of the Dental Materials Group, IADR (1976), and the Washington Section, AADR (1976). He has participated on many committees for this Academy and is responsible for development of the Glossary of Terms which has been a great benefit to all of us. Dr Rupp served as president of the Academy of Operative Dentistry in 1978-79.

As a service to the profession and as a testimony to his teaching ability, Dr Rupp has published more than 30 scientific articles in the dental literature. His research projects and publications have involved denture construction, dental amalgam, mercury hygiene, and composite resins. For both amalgam and composite resins, he has intensively studied the marginal interface of restorations and related performance to material composition. He is currently involved in the clinical testing of titanium casting alloys, mercury toxicity, and a new dentin bonding agent. As a communicator, he has readily passed on this information in the many lectures and seminars he has given at both national and state meetings, including the recent Callahan Memorial Award Lecture at the Ohio State Dental Meeting. He has been on our Academy program as both an essayist and a clinician, presenting material that is always stimulating, current, and clinically relevant.



Nelson W Rupp

The Academy of Operative Dentistry honors Dr Nelson Rupp today for his dedication to scientific investigation, his desire to communicate knowledge to the profession, and his determination to uphold quality in restorative dentistry. His accomplishments have left an imprint on this Academy and have touched a great many of its members individually. It is a special privilege to give this award to one of our own colleagues, who has so exemplified the highest of professional ideals, yet to all of us here, he is truly our friend — "Woody."

JOSEPH B DENNISON

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Award of Excellence

The Academy of Operative Dentistry Award of Excellence, the first such award to be presented, was given for 1986 to Dr Gerald D Stibbs, Seattle, Wash, at the annual meeting in February of the Academy in Chicago.

This premier award will be presented annually in recognition of service to the Academy, the teaching of operative dentistry, the promotion of good dentistry on both the national and international level, and, most important, of excellence in dentistry.

Awards are given in dentistry for many reasons and various accomplishments, but probably no other has been designated for "most excellent dentist." This is a most appropriate award from an academy in which all of its members are constantly striving for excellence.

The search committee wisely disregards political and popularity considerations, reserving its honors for that person who, among his colleagues, is demonstrably outstanding for his knowledge and creativity in performing the fine art of clinical dentistry in a multiplicity of aspects.

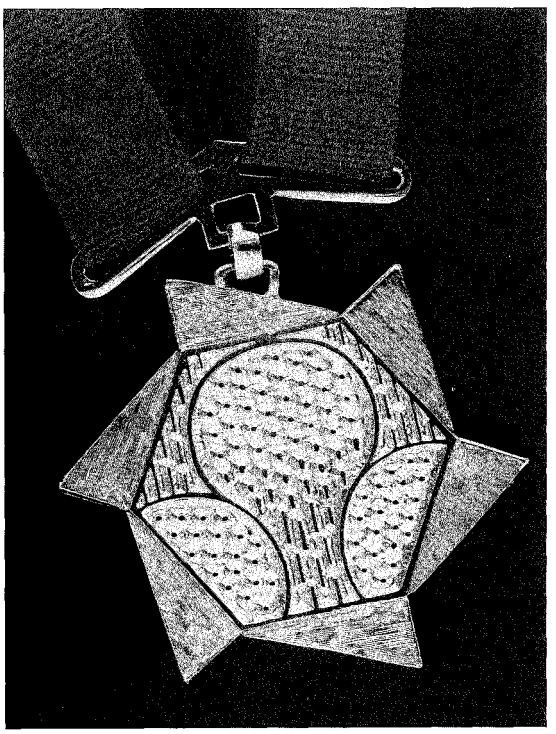
The Award of Excellence may be considered by dentistry as comparable to the Tchaikovsky Award in music. All of us cannot be a Van Cliburn, but all of us believe in recognition for great achievement. Such achievement is the result of many ingredients — high motivation, strong personal drive, hard work, self-discipline, and a special inherent ability. This inherent ability allows the accomplishment of fine art form with finite detail, and dental restorations then indeed become an art that is recognized by those who understand it.

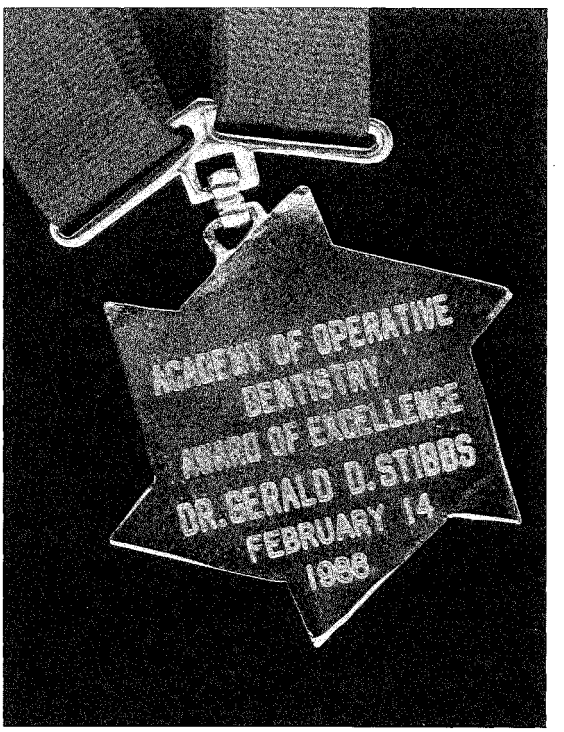
Dr Stibbs, after more than 60 years in dentistry, still maintains a part-time practice and teaches three gold foil study clubs where members meet monthly to perform clinical dentistry on patients.

Gerald D Stibbs

A native of Ontario, Canada, Dr Stibbs graduated from North Pacific College of Dentistry, now a school within the University of Oregon. For 17 years he practiced his profession in British Columbia. His continual involvement with study clubs has been an important part of his professional life. He served as president of the British Columbia Dental Association and became a member of the prestigious Vancouver Ferrier Study Club. Through this association,

The medallion, hung on a black background; back view on left





he became known to Dr Ernest Jones, dean of the newly established School of Dentistry at the University of Washington in Seattle. He joined the faculty in 1948 as professor of Operative Dentistry. A disciple of Dr George Ellsperman, his study club instructor during the early years of practice, Dr Stibbs keyed his teaching to discipline and excellence in clinical dentistry, the quality of which is attested to by many of his students. Dr Stibbs has presented many papers and clinics; he has published widely and received many honors.

He and his wife, Gloria, and their three children, all live in the state of Washington.

The noted British philosopher, John Ruskin, provides a most appropriate quote that describes Dr Stibbs' practice of dentistry:

> It is not what you know
> It is not what you think
> It is not what you believe
> It is what you do that is important.

RICHARD V TUCKER, DDS

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EDITORIAL OPINION

What Can We Do about the Mercurophobes?

An editorial critique of the March 1986 *Consumer Reports* article on US dentists promoting the removal of dental amalgam due to the dangers of mercury is presented.

LAWRENCE GETTLEMAN

The recent *Consumer Reports* article on the anti-amalgamists accurately presents the view that nearly all dentists have had for many years: although mercury can be harmful to dental professionals if handled unhygienically, it poses no toxic threat to the general public (Rupp & Paffenbarger, 1971). The *CR* report presented the view of nondental investigators as well as dental experts that "if a dentist wants to remove your fillings because they contain mercury, watch your wallet." They then go on to cite many positive facts that support the good properties of dental amalgam as the most widely used restorative material.

Perhaps due to the limitations of space, the authors of the *CR* article failed to point out the self-sealing properties of dental amalgam from the accumulation of corrosion products at the tooth/amalgam interface (Andrews & Hembree, 1980; Domagala, Van Thyne & Lenke, 1968; Glassman & Miller, 1984; Jørgensen, 1965). They also reported that dental amalgams usually last 5 to 10 years. Now if this were true, we would be far busier than we are now, replacing most amalgam restorations every few years. The published reports, however, describe the life of amalgam restorations which **fail**, and usually do not take into account those which continue to survive. This is understandable because of the difficulty of following large populations for two, three, or more decades (Crabb, 1981). In retrospective studies carried out for such long periods, the clinic records are usually lost and the memory of who, what, when, and where the restorations were placed is very imprecise. Most patients only know that the time span was 15, 20, or 30 years or more, and usually do not return to clinics unless a problem develops. So the literature does not reveal the high degree of success that we can achieve. A recent article in the *Journal of the American Dental Association* (Maryniuk & Kaplan, 1986) reported on dentists' perceptions regarding the life span of dental restorations. Here, the size of the amalgam filling and longev-

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LAWRENCE GETTLEMAN, BA, DMD, MSD, senior staff associate

ity were inversely related; small restorations were perceived to last the longest.

Another area of incomplete reporting in the *Consumer Reports* article was the apparent confusion between mercury vapor from dental amalgam restorations and mercury salts, amalgam alloy particles, or organic compounds. Using a worst-case model, a mouth with 20 new amalgam restorations would not even double the human intake of mercury received from food and drink (20 μg/day) (Brune & Evje, 1985). The preponderance of evidence indicates that it is the tin and copper in the amalgam that corrodes (Holland & Asgar, 1974), releasing metallic mercury back into the restoration and not into the tooth, saliva, or air (Domagala, Van Thyne & Lenke, 1968).

The renewed interest in mercury toxicity is mostly a function of the availability now of very sensitive instruments which can detect parts-per-billion of mercury in the air. Although the increases in mercury vapor in the oral cavity have been shown to be statistically significant, disease or pathology has not been demonstrated as a result of mercury toxicity. Dentistry has been using mercury in fillings for more than 150 years. One would have expected some observations to have been made of serious ill effects by now. We have always been aware of the potential danger of mercury when used in our patients, but there is still no substantial evidence that it poses a public health menace in all but a few individuals who may be hypersensitive to mercury (Rupp & Paffenbarger, 1971).

The *CR* article goes on to describe the use of composite resins for posterior teeth as replacements for dental amalgam. Esthetics is the driving force behind the search for a resin-based material. Secondary to this is the similarity of composite resins to natural teeth in composition and structure; teeth are composites of calcium- and phosphorus-based crystals in a polymer of collagen, while composite resins are of ceramics based upon silica, bismuth, barium, and others in a matrix of acrylic derivatives. But the posterior composite resins are not proven as yet and should only be used in selected cases. They have captured the imagination of the public, but dentists must charge more for them than dental amalgams due to the increased time required to place them properly. They fail by the methods described in the *CR* article, but of greater importance is their rapid loss in some patients by excessive wear and abrasion (Gettleman, 1980, 1981). This results in irreversible supereruption of teeth and crowding of teeth brought about by the loss of the composite resin on the occlusal surface and interproximally, respectively. Without frequent inspection for wear, the teeth may move and present occlusal and periodontal problems for patients in the future.

The writings and the media promotion of those who advocate the removal of dental amalgam restorations are, I believe, done mostly for financial reasons. I can see very little evidence for the wholesale removal of long-serving amalgam restorations, but will not deny the possibility of true allergies to mercury, silver, tin, copper, or zinc in a very small proportion of the population. But they are very few. One can find definite allergies to gold and palladium as well (Shepard & others, 1983; Van Ketel & Niebber, 1981). These rare examples should not put limits on otherwise safe material. **It is unfortunate that some dentists are intent on convincing susceptible or gullible patients to replace their well-serving amalgam restorations; they prey upon most patients' distaste for dentistry.** It is not hard to imagine the response of a patient when told that all of their problems result from the material which dentists have been placing in their teeth for so long. Something is wrong here. **Have we been so blind not to see the damage done by dental amalgam, or is it in the imaginations of those who would undo the virtues of this restorative material for their own benefit?**

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POINT OF VIEW

Contributions always welcome

Reflections on Board Certification

ROBERT C KEENE

Some folks might ask, "Why would someone who has been in the practice of dentistry for 20 years undertake a two- to three-year examination process which includes a day-long written test and three days of oral and clinical performance testing, just to get a sheet of paper declaring that he had passed a board certification?" He must be crazy to upset his office routine, spend the money, and undergo the trauma of such an undertaking! Right?

If asked to explain why I did these "crazy" things, it would not be easy to do. It has more to do with how one views challenges — how you look at those hurdles which give you a sense of accomplishment. It is more like the mountain climber who climbs because "it is there." It gives satisfaction when you have endured, conquered, or achieved a goal.

Part of the force impelling me to seek board certification was the professional attraction of people I had met in dentistry — those who impressed me as dentist's dentists: Miles Markley, Carl Monacelli, Jack Freese, José Medina, Jim Vernetti, Charlie Stebner, Gerry Stibbs, and others. Another impetus comes from that faint voice which asks: "Are you really as good at what you do as you think you are?"

Taking the boards is in many ways a stretching exercise. Your mind and dexterity skills are stretched and you gain insights in treating your patients as a result of your experience. It seems tragic that, if we are in the health profession, we only consider our physical health. Our mental health must also be considered and included in our stretching exercise.

The experience was at times painful, but like any conditioning, the enduring of pain produces growth. I would encourage anyone who is willing to grow to consider the American Operative Boards as a challenge worth taking. The experience was indeed a true "mountaintop event" for me as well as those of my staff who aided in the process.

31 South Park Street, Hanover, NH 03755

ROBERT C KEENE, DMD, is in private practice.

Editor's note:

Dr Keene was recently certified by the American Board of Operative Dentistry, having successfully challenged all three components of the Certification Examination. Our congratulations to Dr Keene.

DEPARTMENTS

Book Reviews

TEMPOROMANDIBULAR JOINT DISORDERS, DIAGNOSIS AND TREATMENT

Mark H Friedman, DDS
Joseph Weisberg, PT, PhD

Published by Quintessence Publishing Co, Inc, Chicago, 1985. 170 pp; indexed. $48.00

In an era with too many nonbooks (anthologies) about the TMJ it is nice to have a new book that does hang together from cover to cover. The book is a unique combination of therapies by a dentist and those by a physical therapist. The two authors work well together and think like one. The strong points are its clarity, brevity, and practicality, a nice blend of clinical wisdom and techniques that serves well as a practitioners' guide. Frequently the reader discovers in its pages sound principles of biology and diagnosis but these could be better organized into a specific section of the book.

Three key statements in the book provide some clues about the authors' perspectives:

"A faulty occlusion is probably the most common cause of TMJ disorders." (p 33)

"Failure to diagnose cervical problems is a major fault in 'state of the art' TMJ therapy." (p 35)

"Although psychological factors can induce symptoms or worsen TMJ disorders, psychologic treatment is often recommended unselectively." (p 37)

The book describes and cites references for numerous diagnostic procedures and treatment techniques aimed at disorders in the synovial joints and associated muscles of the head and neck. Each reader will find that some of these concepts and techniques are new to him but the authors do not provide sufficient data for us to evaluate critically the clinical usefulness of these diagnostic and management options.

A few of the less common procedures listed in the index include distraction and compression tests for the cervical spine, and treatments for joint hyper- and hypomobility, respectively, by means of manipulation and mobilization to reduce subluxated articular facets versus releasing adhesions and increasing the range of motion.

For muscles of the head and neck there are guidelines on transcutaneous electrical neural stimulation (TENS) and electrogalvanic stimulation (EGS) that are specifically designed for each patient. Other modalities include repositioning appliances, anti-inflammatory drugs, biofeedback, exercise, neuromuscular re-education, traction, ultrasonic and trigger point therapies.

Controversial topics are discussed from opposing viewpoints and with little bias. After explaining their diagnostic perspectives and treatment techniques the authors conclude the book with 12 case reports, anecdotes that are mostly numerators without denominators. Thus the reader is not told by means of a statistical analysis of patients' responses to treatment how valid the diagnostic premises are as a basis for deciding what should be treated and how it should be done. Furthermore, the reader is led to believe without supporting data that the treatment outcomes of neck and TMJ disorders are highly correlated and that the success rates will be consistently high for all disorders.

Reading their book will be an interesting learning experience and applying their concepts may provide another somewhat different kind of learning. Hopefully, the authors will provide statistical denominators in the next edition of their book. Without generating their own

data base many readers may adopt the authors' premises routinely as an assembly line for all TMJ patients and thus use the book as a substitute for a diagnostic analysis. I do not believe that this is the authors' intention.

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Correction

On page 19 of the Winter 1986 issue of *Operative Dentistry* (Interfacial space, marginal leakage, and enamel cracks around composite resins, by Michal Staninec & others), please note that the two photos in Figure 3 should be reversed: the photo at **top** shows the **microfilled composite;** the photo at the **bottom** is the **conventional composite.**

DIRECT BONDED RETAINERS: THE ADVANCED ALTERNATIVE

Gerald McLaughlin, DDS

Published by J B Lippincott Co, Philadelphia, 1986. 320 pages, 235 illustrations; indexed; hardcover. $47.50

The stated purpose of this book is "to provide a definitive guide to the direct bonded retainer technique for the dental practitioner and laboratory technician" as an alternative to more conventional crown and bridge techniques.

The initial five chapters provide basic background and research information on etching and bonding to enamel and alloys, and a review of various materials used. A significant portion of this book deals with clinical considerations and metal framework design. Two chapters, contributed by dental technicians, are devoted to the laboratory techniques critical to the clinical success of the treatment. Dr Alain Rochette, a pioneer in the field of direct bonded retainers, provides two chapters devoted to the "perforated retainer" and the "glass bead" retention technique for periodontal splinting. J M Sossamon outlines the use of direct resin bonding for precision attachments in more complex removable prosthodontic treatment. The textbook concludes with two brief chapters devoted to direct bonded porcelain veneers and "noncast" techniques for splinting of teeth.

This textbook is generally organized in logical fashion with basic information first, clinical and laboratory procedures second, and concluding with more complex techniques. The 235 illustrations are black and white, of average quality, and in most instances meet their intent. The majority of the chapters are modestly referenced.

Although this textbook cannot be construed as an easily readable clinical and laboratory technique reference, it does provide the dentist and technician with the important principles and procedures necessary for the clinical success of direct resin bonded retainers.

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Wit and Wisdom

The Burden of Scientific Literature

I mentioned the intolerable burden of the literature. I am one of the editors of a journal —a thankless, and to oneself at least, a profitless task. I know how difficult and unpleasant it is to attempt to put a brake on publication. Something, however, must be done, or science will perish under its own weight. The days are already too short to read all that appears in print, however diligent one may be; and the financial strain is so great that even the Royal

Society of London now does not take a number of important periodicals.

The trouble is that science and publication have become a business: the practice of advertisement has crept in; professional advancement depends — as I said at Boston three years ago — upon the number of kilogrammes of paper published. Various devices are employed to this end: (1) the same research is described, usually in slightly different form, in different journals; (2) a paper is split up into many separate parts: n papers are a better advertisement than one, although the total information conveyed is the same; (3) the names of authors are arranged in every possible order, to the great confusion of indexes and catalogues: if there be r authors the paper must be split into r parts to allow each author's name to come first; (4) papers are written at unnecessary length, with unnecessary duplication of data in tables and figures: historical references, many of them never verified, are given ad nauseam: pages, sometimes sheets, of undigested results are exposed, where an average and a standard deviation would be sufficient; (5) personal animosities and grievances are ventilated — which add the interest and dignity of a dog-fight to scientific discussion.

Authors, however, are not the only sinners: editors and publishers, with certain honorable exceptions, are to blame. The first condition of proper control is that scientific journals should be owned by scientific societies, not by commercial firms, so that it is in nobody's interest to publish too much. The second condition is that the editors should be firmly supported by the societies for whom they work. In some countries, it is urged, physiologists have so little confidence in their colleagues that they would not submit to an editorship undertaken seriously. I hope and believe that in no country is the general feeling so bad. Everywhere there are unreasonable and truculent people, but the editors appointed by a powerful national society, in dealing firmly with these, are assured of the support and gratitude of the great majority of their colleagues.

I feel, therefore, that this Congress would act wisely in appointing an international committee to consider the publication and cataloguing of physiological and biochemical papers. Apart from scientific discussions and the making and renewing of personal friendships, this is the most important way in which it could aid in advancing our subject.

Not only in our journals, however, but at our meetings, not only in the written but in the spoken word, most of us miss our opportunities. The art of making a communication to a scientific assembly is one which very few know. Too often a blackboard, or a set of lantern slides, is packed with indigestible data and the matter is expounded in detail, and at increasing speed, until the chairman's bell rings. There is no excuse for telling busy people in 15 minutes what they could perfectly well read in 5. The advantage of the spoken over the written word is this: that by emphasizing the essential ideas and difficulties, stressing the dramatic element in discovery, it can add a humane flavor to scientific discussion.

Our colleagues do us great honor by coming to sit at our table: let us make sure at least that the meal we provide is not cold.

A V HILL

Reprinted by permission of Nuova Casa Editrice, Bologna, Italy; originally published in *Archivio di Scienze Biologiche* (January 1933) **18** 3–14.

Announcements

NEWS OF THE ACADEMIES

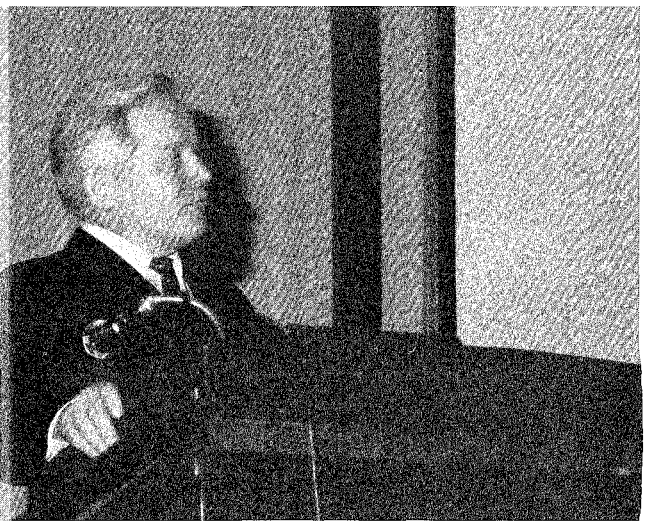
Academy of Operative Dentistry

The fifteenth annual meeting of the Academy of Operative Dentistry was held 13 and 14 February in Chicago at the Westin Hotel. An excellent program comprised of essays, table clinics, and limited attendance clinics was presented. The fifth M G Buonocore Memorial Lecture was delivered by Ivar Mjör.

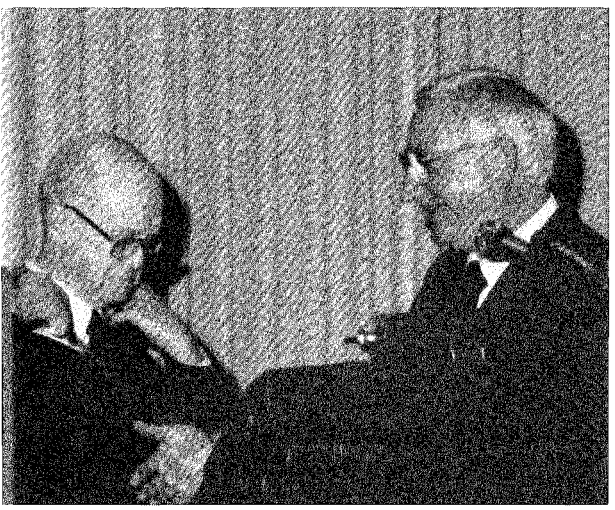
At lunch on the first day the Hollenback Memorial Prize was presented to Nelson W Rupp and the Student Achievement Award to John W Martin III of Georgetown University. Gerald D Stibbs was presented the first Award

of Excellence at the luncheon on the second day. A brief presentation on topics of current concern was made by ADA trustee and past president of this academy, H William Gilmore.

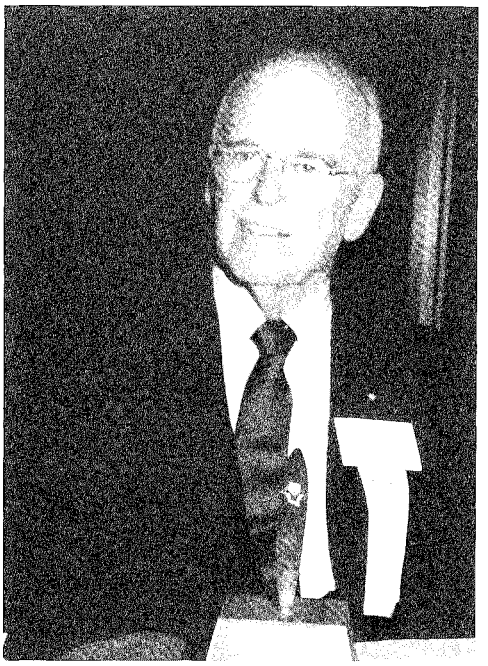
Officers elected for 1986 are: president, Frank K Eggleston; immediate past-president, Lawrence L Clark; president-elect, William N von der Lehr; vice-president, J Martin Anderson; secretary-treasurer, Ralph J Werner; assistant secretary, Gregory E Smith; and councillors, Glenn H Birkitt, Eugene S Merchant, Baxter B Sapp, Judson Klooster, Robert D Cowan, and Ralph M Phelan.



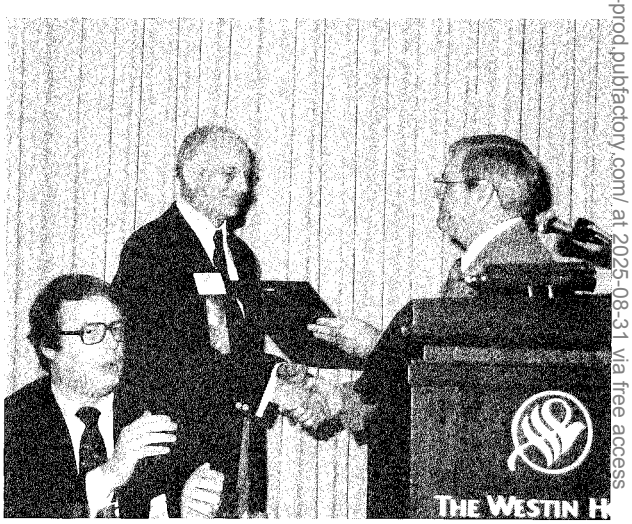
Ivar Mjör delivering the Buonocore Memorial Lecture



Gerald Stibbs adjusting the Academy's Award for Excellence medallion just presented by Richard Tucker



Nelson W Rupp receiving the Hollenback Prize for 1986



Ian Hamilton receiving recognition for his service as editor of the Journal for the past 10 years from Academy president Lawrence Clark; on left, Frank Eggleston.

Student Achievement Award

The Outstanding Student Achievement Award of the Academy of Operative Dentistry was presented this year to John W Martin III, a junior dental student at Georgetown University. A research fellow at Eastman Dental Center during the summers of '83 and '84, his primary area of research was in the field of cariology. John has been selected to participate in an international dental exchange program at Trinity College, University of Dublin, Dublin, Ireland, during the summer of 1986. His award-winning clinic, "Antibacterial Effect of Foods," was a result of his research.

John W Martin III accepting the Outstanding Student Achievement Award from Joseph B Dennison

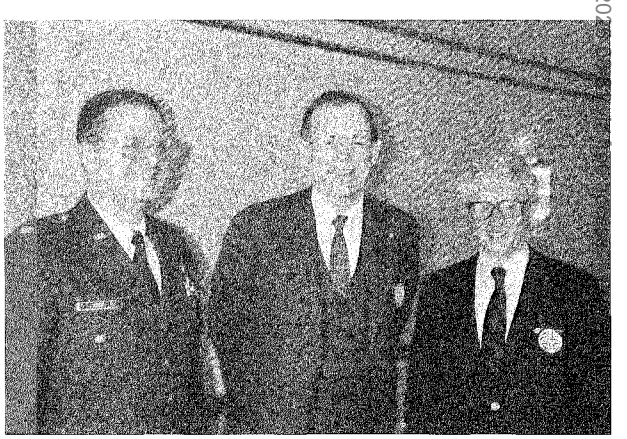
Certification in Operative Dentistry

On 12 February 1986 in Chicago at the annual meeting of the American Board of Operative Dentistry, held in conjunction with the Academy of Operative Dentistry, three newly certified members were received into membership. They are: Dr (Lt Colonel, USAF) Patrick J Haney (Albuquerque, NM), Dr Robert C Keene (Hanover, NH), and Dr Maurice E Logan (Hanover, NH). They were presented a Certificate of Proficiency in Operative Dentistry at a luncheon hosted by the Board. This distinction was earned by the recipients after an examination extending over a period of two or more years and involving three phases: a written examination, an oral examination based upon the submission of cases for which restorative services were provided, and a clinical examination that required the performance of clinical procedures during a concentrated three-day session.

This certification program, which designates the successful candidates as board certified in operative dentistry, is sponsored by the Academy of Operative Dentistry, an organization devoted to the promotion of excellence in the practice, education, and research in operative dentistry. With the addition of these three newly certified members, there are now a total of eight who have achieved this distinction and recognition.

The next clinical and oral examinations are scheduled for 11-13 August at the University of Michigan, Ann Arbor, Michigan. Cases and fees should be sent to Dr John Reinhardt, Operative Dentistry Department, University of Iowa, Iowa City, IA 52242.

The next written examination will be given at multiple sites around the country in September and again in February in conjunction with the Chicago meeting. For more information and applications, please contact: Dr James Gourley, Secretary-treasurer, 12238 Olympic View Rd NW, Silverdale, WA 98383.



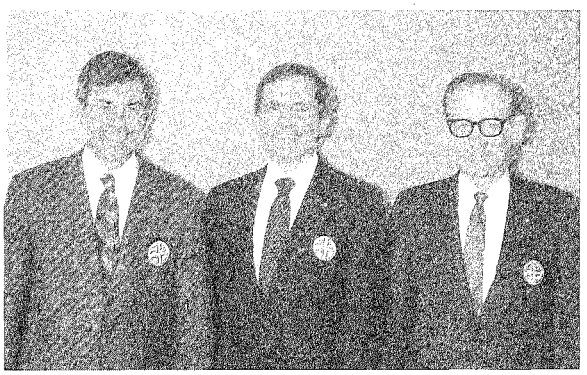
New members of the American Board of Operative Dentistry are, left to right: Patrick J Haney, Robert C Keene, and Maurice E Logan.

The American Board of Operative Dentistry Installs New Officers

New officers of the American Board of Operative Dentistry were installed February 12, 1986, in Chicago. They are: William T Pike, New London, NH, president; John W Reinhardt, Iowa City, Iowa, vice-president; and James V Gourley, Silverdale, Wash, secretary-treasurer. The new officers will serve the Board until 1988.

These newly installed officers are from the first group to be awarded the certificate of proficiency designating them as Board Certified in Operative Dentistry. They received that recognition in February of 1985, after having successfully challenged all three phases of the certifying examination.

The American Board of Operative Dentistry now enters a new era as these Board Certified Operative Dentists assume the leadership of the Board and the founding fathers relinquish the reins of leadership.



New officers of the American Board of Operative Dentistry are, left to right: William T Pike, president; John W Reinhardt, vice-president; and James V Gourley, secretary-treasurer.

NOTICE OF MEETINGS

American Academy of Gold Foil Operators

Annual Meeting: 15-17 October 1986
University of Puerto Rico
San Juan, Puerto Rico

Academy of Operative Dentistry

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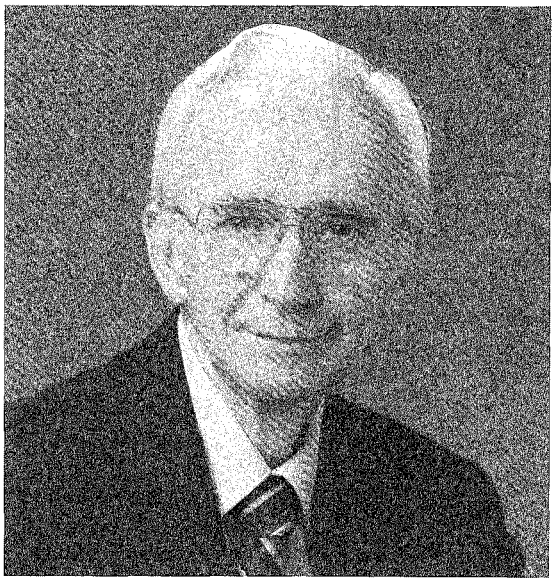
Eames Receives University of Colorado Distinguished Service Award



Wilmer B Eames, DDS, a dental practitioner and academician, received the University of Colorado Distinguished Service Award during commencement exercises May 24, 1986, at the CU Health Sciences Center. Dr Eames is an outstanding practitioner and academician who has devoted nearly half a century to the art and science of dentistry.

Dr Eames received his dental degree from Kansas City-Western Dental College in 1939. After more than 20 years of clinical practice in Colorado, particularly in Glenwood Springs, including four years of duty with the US Army Air Corps at Lowry Air Force Base during World War II, he began his academic career at Northwestern University in 1961 where he served as professor of operative dentistry and associate dean, and continued to expand his research activities started earlier in Colorado.

In 1967, he joined the faculty at Emory University in Atlanta as professor of operative dentistry and director of the applied dental research program. Not only did he continue his own research efforts there, but he also established a program that stimulated interest among undergraduate students in dental research through their own active participation.

He currently is a visiting clinical professor at the CU School of Dentistry.

Including both laboratory and clinical stu-

dies, Dr Eames' research has had a significant influence on the practice of clinical dentistry. An example of his notable efforts is his work with the mercury-alloy ratio for dental restorations. What has now become standard practice throughout the dental profession began as an idea of Dr Eames who devoted years of research and teaching to establish what came to be known as the Eames Technique. Among other major research studies conducted by Dr Eames are those on dental cements, composite resins, and high-speed instrumentation.

He is a member of numerous societies, both dental and scientific. He has authored more than 100 significant dental publications and presented more than 400 major lectures during his distinguished career. Additionally, more than 50 scientific abstracts of his work have been published by the International Association for Dental Research.

Dr Eames has been the recipient of many well-deserved professional honors and awards. These include the George M Hollenback Award from the Academy of Operative Dentistry; the Man of the Year Award from the Colorado Chapter of the American College of Dentists; the Albert L Borish Award from the Academy of General Dentistry; and the William Souder Award from the International Association for Dental Research.

Although Dr Eames has officially retired from teaching, he certainly has not retired from active dental research or lessened his enthusiasm in serving the dental profession and his fellow man. He continues to act as a consultant in the field of dental materials and as an adviser to numerous research groups, both in this country and abroad. Dr Eames also serves the profession as a manuscript reviewer for several prominent scientific publications, and is a constant source of inspiration and advice for practicing dentists and scholars from around the world.

Press Digest

The compressive strength of nonprecious versus precious ceramometal restorations with various frame designs. Marker, J D, Goodkind, R J & Gerberich (1986) *Journal of Prosthetic Dentistry* 55 560-567.

In this evaluation of porcelain fused to metal crowns, one precious metal and two nonprecious metals were cast using three framework designs: (1) porcelain coverage of the facial cusp, (2) coverage of facial cusp to the central sulcus, and (3) full occlusal coverage. Cemented crowns were subjected to loading of the occlusal surface on the buccal cusp tip. It was demonstrated that covering of the facial cusps with porcelain was the design which exhibited the greatest fracture resistance.

Film thickness of dental luting cements. Øilo, G & Evje, D M (1986) *Dental Materials* 2 85-89.

The film thickness, as a function of time, was evaluated by two methods for one zinc phosphate, two polycarboxylate, and three glass ionomer cements. The two methods were the standard minimal film thickness obtained by compressing the cement between two glass plates and a second method using cementation of a crown tooth model. The data indicates that a method simulating clinical conditions might be more appropriate for a test of working time, as compared to the more frequently used testing procedure using two glass plates.

INSTRUCTIONS TO CONTRIBUTORS

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References

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