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EDITORIAL

Spare Time?

Much of the world seems to be sliding into insolvency—the consequence of following bad economic policies, most of which were recommended by economists. It is astonishing, however, how long it often takes for the results of these policies to become apparent. By contrast, neglect to place incisal retention in a class 3 cavity for direct gold and the failure is almost immediate; drive a car without changing the oil and the effects take a little longer to appear; but bad economic policies can often be pursued for decades before the imminence of collapse is perceived. It is like restoring teeth by a technique that appears to be satisfactory initially but subsequently, 20 to 50 years later, produces the unwanted by-product of abscessed teeth.

Dentists feel the effect of an economic depression relatively early because much of dental treatment can be postponed—at least temporarily. And it is true that dentists today face a reduced demand for their services. What can be done? In attempting to maintain productivity dentists are likely to refer patients to specialists less frequently and may reduce dependence on hygienists. Two other avenues are worth exploring.

One leads to the laboratory where spare time can be used advantageously in making inlays, crowns, and bridges. Besides saving money, laboratory work provides good discipline for the dentist and may alert him to problems that he may have been passing on to the laboratory technician.

The other avenue leads to the education of patients. Spare time can profitably be directed to devising visual aids to assist patients in understanding the best solutions to their dental problems, and to developing and perfecting ways of convincing patients or potential patients that dental health is worth more to them than many of the commodities on which they spend their incomes. This task may be difficult since unfortunately many patients have been misled into believing that dentistry is a right—which it is not—and that someone else should pay.

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OPERATIVE DENTISTRY, 1982, 7, 82-85.

ORIGINAL ARTICLES

Porosity in Composite Resin Restorations

Composite resins activated by visible light are less porous than other composite resins.

JOHN W REINHARDT • GERALD E DENEHY
RICHARD D JORDAN • BARRY R J RITTMAN

Summary

The surface of composite resins activated by visible light (Prisma-Fil and Silux) contained fewer voids than the surfaces of restorations of chemically activated composite resins and, with one exception—Miradapt—contained fewer voids 50 μm or more in diameter.

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Introduction

The roughness of the surfaces of restorations of composite resin concerns restorative dentists. Rough surfaces retain plaque, which can discolor the restoration and cause gingival inflammation, especially around class 5 restorations (Weitman & Eames, 1975). Roughness of the surface may result from the composition of the material, the technique of finishing, voids in the material, or a combination of all three.

Because composite resins are heterogeneous—composed of hard particles within a softer matrix of resin—achieving a high polish is difficult, and studies to determine the best method for polishing composite resin have given conflicting results (McCabe & Caddick, 1978; Staley & Kopel, 1979; Wilson & Smith, 1981). The introduction of composite resin with particles of filler less than a micrometer in size (microfilled) has led to great improvements in the texture of the surfaces of restorations because the smaller particles of filler allow for better polishing.

Voids, caused by entrapment of air during manufacturing or mixing, are common with restorations of composite resin (Eliasson & others, 1976). These voids may appear as pits on the surface during polishing or may be exposed later as the restoration becomes abraded. Voids increase the roughness of the surface and may trap materials that stain the surface.

The purpose of this study was to compare the number and size of voids in several composite resins, including conventional and microfilled composite resins in which polymerization is activated by chemicals as well as those in which it is activated by visible light.

Methods and Materials

The seven composite resins examined in this study are listed in Table 1. The samples included two conventional composite resins (average particle size greater than 1.0 μm), three microfilled resins, and two resins combining particles of regular and submicrometer sizes.

Ten samples of each composite resin were prepared, each chemically activated material being mixed according to the manufacturer's instructions and placed into cylindrical cavities 2 mm wide and 3 mm deep in Plexiglas blocks. The chemically activated resins were each covered with a Mylar strip and a weight of 0.5 kg for 5 minutes. The resins activated by light were each extruded from its dispenser onto a mixing pad and then wiped into the cavities in one increment using a Teflon instrument. Those samples were then covered with a Mylar strip and a glass mixing slab 18 mm thick and weighing 0.5 kg, and polymerized with a Prisma-Lite (L D Caulk Co) directed through the glass slab for 75 seconds. After the glass slab was removed each sample was exposed to the Prisma-Lite for an additional 60 seconds. All samples were stored in 100% relative humidity at 37 °C for 1 week.

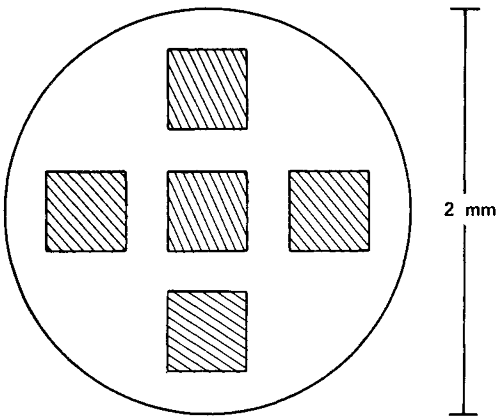
The samples were sectioned horizontally at a depth of 0.75-1.0 mm beneath the surface to produce a disc approximately

Table 1. Composite Resins

Material	Manufacturer	Filler	Activation
Concise	3M Co Dental Products Div St Paul, MN 55144	conventional	chemical
Silar	3M Co	microfilled	chemical
Silux	3M Co	microfilled	light
Finesse	The L D Caulk Co Milford, DE 19963	conventional and microfilled	chemical
Prisma-Fil Compules	The L D Caulk Co	conventional	light
Miradapt	Johnson & Johnson Dental Products Co East Windsor, NJ 08520	conventional and microfilled	chemical
Isopast	Vivadent (USA) Inc Tonawanda, NY 14150	microfilled	chemical

0.1 mm thick. The discs were examined by transmitted light with a Zeiss Photomicroscope and an automatic image analyzer (Quantimet 720). Magnification of the projected image on the analyzer screen was 576x.

On each sample, data were collected at five specific locations representing approximately 22% of the surface (see figure). The



Surface view of sample of composite resin. Shaded portions indicate areas of sampling.

number and sizes of individual voids within these sampling areas were recorded. The number of voids is expressed as a proportion (%) of the area of the surface examined.

Table 2. Percentage of Surface Area Consisting of Voids

Material	Activation	Surface Voids (%) Mean	SD
Prisma-Fil	light	1.7	3.5
Silux	light	2.9	3.6
Silar	chemical	10.4	2.8
Miradapt	chemical	16.2	5.8
Finesse	chemical	17.2	6.7
Concise	chemical	18.4	9.0
Isopast	chemical	26.9	12.0

Table 3. Total Number of Voids Equal to or Greater than 50 μm in Diameter

Material	Activation	Voids ≥ 50 μm Diameter
Silux	light	5
Miradapt	chemical	8
Prisma-Fil	light	8
Concise	chemical	16
Finesse	chemical	20
Silar	chemical	22
Isopast	chemical	38

Results

The results are summarized in Tables 2 & 3. Table 2 shows that Prisma-Fil and Silux, the composites activated by light, had the fewest voids, and Isopast, a chemically activated composite, the most. Table 3 shows Silux, a light activated composite, had the fewest voids 50 μm or more in diameter, that Prisma-Fil (light activated) and Miradapt (chemically activated) were next, and that Isopast had the most.

Discussion

The authors' clinical experience seemed to indicate a greater number of voids on the surfaces of restorations of chemically activated microfilled resins than on the surfaces of restorations of conventional composite resin. The results presented for Isopast in Table 2 tend to confirm this impression but those for Silar do not. Further examination of the samples revealed that the clinical problem was not necessarily the number of voids but rather their large size. As seen in Table 3, Isopast had the greatest number of large voids, whereas Silar was similar to the other chemically activated materials.

Miradapt, containing a blend of particles of conventional and submicrometer sizes, shows a relatively low number of voids equal to or greater than 50 μm, half as many as the next chemically activated material. This could be related to the high percentage of filler particles in Miradapt (82%, by weight).

Composite resins activated by light, both conventional (Prisma-Fil) and microfilled (Silux), contained relatively few voids or large voids. This indicates that mixing composite resins contributes to the occurrence of voids.

Conclusions

The results of this study show that voids are present in all the composite resins studied. Chemically activated composites contained the greatest number of voids, and one of them, Isopast, contained the most voids 50 μm or greater in diameter. The resins activated by light were lowest in percentage of voids and generally low in the number of large voids. The main conclusion of this study is that dentists may minimize the clinical problem of voids in restorations of composite resin by using conventional or microfilled materials that are activated by visible light.

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Effect of Diameters of Self-threading Pins and Channel Locations on Enamel Crazing

The size of a pin and its location are important to avoid crazing of the enamel.

JERRY S DURKOWSKI • GEORGE B PELLEU
RONALD K HARRIS • RICHARD H HARPER

Summary

When TMS pins were evaluated for their effect on crazing in enamel after being inserted at distances of 0, 1, 2, and 3 times the diameter of the drill from the dentinoenamel junction, Regular pins produced more crazing than did Minim, Minikin, and Minuta pins when they were inserted at distances 0, 1, and 2 times the diameter of the drill from the dentinoenamel junction. Regular pins also penetrated the pulp at positions 2 and 3 more frequently than did the other pins.

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Reprint requests to Dr Pelleu

Introduction

An area of concern for the restorative dentist is the crazing of enamel that may result from the placement of self-threading pins. A routine method of determining the optimal location for pin channels without compromising remaining tooth structure is needed. When placing pins, the clinician should also consider other factors, such as penetration of the pulp or encroachment on the periodontium or areas of furcation. Generally accepted methods for positioning pins do not always apply in situations involving deep carious lesions, unusual morphology of the pulp, or teeth of exceptional size. Crazing may originate from physical stresses induced by twist drills and techniques for inserting the pins, as well as being related to the distance between the pins and to dentinal support for the pins (Standlee, Collard & Caputo, 1970; Chan, Denehy & Ivey, 1974; Khera, Chan & Rittman, 1978; Pameijer & Stallard, 1972).

Several methods of determining the optimal location for channels for self-threading pins have been proposed. Markley (1966) has suggested using radiographs to locate the pinhole midway between the root surface and the pulp. However, radiographs can be misleading because only a two-dimensional picture is presented, and the apparent location of the pulp may not be a reliable guide. Another technique involves an evaluation of the bulk of dentin available. Dilts & Mullaney (1968) studying single cross sections at the cementoenamel junction of incisors, premolars, and first and second molars found that the ideal position for the pinhole is midway between the pulp chamber and the external surface of the tooth. Gourley (1980) studied six cross sections of first and second molars, one at the cementoenamel junction, two sections coronal to the cementoenamel junction, and three apical to the cementoenamel junction. He recommended that the thickness of the dentin where a pinhole is placed be at least three times the diameter of the pinhole, with the measurement made from the external surface of the tooth, and found that the line angles (corners) of molars are favorable locations for placing the pinholes.

In an evaluation of the effect of the placement of pins on crazing of tooth structure, Dilts & others (1970) placed pins 0.0 mm, 0.5 mm, and 1.0 mm from the dentinoenamel junction in molars. They reported fewer craze lines with pins placed in dentin at least 0.5 mm from the dentinoenamel junction than with the pins placed at 0.0 mm. They also found that self-threading Regular TMS pins produce more crazing than other pins. According to Collard, Caputo & Standlee (1970), the best location to minimize crazing, for all types of pins, is midway between the pulp and the dentinoenamel junction.

If the effect of the diameter of the pin drill and the distance of the pin channel from the dentinoenamel junction on enamel crazing could be established, it might be possible to avoid crazing. This laboratory study was undertaken to investigate that relationship to establish convenient clinical guidelines for the location of pins.

Materials and Methods

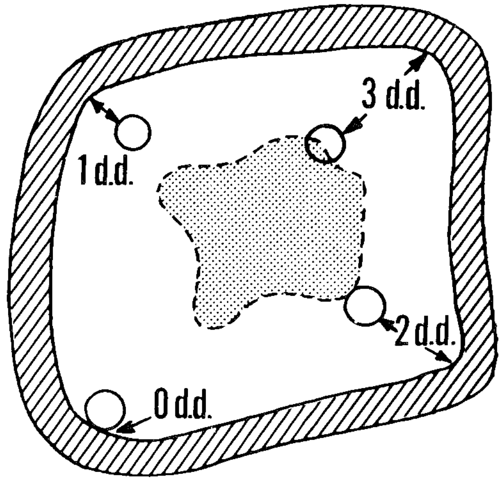
A total of 104 human molars with no large restorations or gross caries was used. The teeth were immersed in tap water immediately after extraction and stored at 37 °C.

The staining technique described by Wu & Cobb (1981), which uses a silver nitrate solution ($AgNO_3$), was employed to detect cracks or crazing that might be present in tooth enamel before the crowns were sectioned (baseline reference). These cracks will appear as black lines when sectioned and viewed under a microscope at a magnification of 70X. This technique requires less equipment, is relatively rapid, clean, and simple, and produces a more permanent stain than other techniques for detecting cracks. The teeth were covered with wax from the cementoenamel junction to the apex, and a layer of clear fingernail polish was applied over the wax as a secondary seal. The teeth were immersed in 50% aqueous $AgNO_3$ and stored in darkness for 2 hours. They were then rinsed in running distilled water for 1 minute to remove the silver ions from the surface. After they were rinsed, the teeth were immersed in a photo-developing solution and exposed to fluorescent light for 6 hours, then rinsed again in distilled water to remove residual developer.

Next, the teeth were individually embedded in blocks of tray acrylic resin to a level approximately 1 mm apical to the cementoenamel junction. The crowns were removed at a level approximately 1.5 mm coronal to the cementoenamel junction. This was done with a diamond disk (Bronwill, TSM 77, VWR Scientific, San Francisco, CA 94119, USA) lubricated with water flowing at a constant rate. The sectioned surfaces were then finished with a 400-grit emery paper and water. Twentyfour of the 104 teeth received no additional preparation and served as controls.

A mark was placed with a 1/1000 micrometer caliper (L S Starrett Co, Athol, MA 01331, USA) and a bow compass (Charvoz Carsen Corp, Fairfield, NJ 07006, USA) at the four line angles of each of the 80 experimental teeth at distances equal to 0, 1, 2, or 3 times the diameter of the drill from the dentinoenamel junction toward the center (see figure). The diameter of the drill varies according to the type of twist drill used.

The four types of pin used in this study were Regular, Minim, Minikin, and Minuta (TMS pin, Whaledent, Inc, New York, NY 10001, USA). The 80 experimental samples were divided into four groups of 20 teeth for each type of pin. There were four pin channels of the same diameter for each tooth, so that there were 320 pin channels in all. The armamentarium for TMS pins was used. The manufacturer's specifications and the actual measurements for the TMS pins and drills are shown in Table 1.



Cross-sectional diagram of a molar illustrating the amount of remaining dentin between the pin channel and the dentinoenamel junction when the diameter of the twist drill is used as a gauge for the placement of pin channels at the indicated line angles.

Table 1. Diameters of TMS Pins and Drills and Pin Oversize

	Diameter of Drill inches (mm)			Diameter of Pin inches (mm)			Actual Oversize of Pin inches (mm)
	Specified	Measured		Specified	Measured		
		Mean	SD		Mean	SD	
Regular (Nonshearing)	0.027 (0.686)	0.026 (0.660	0.000 0.000)	0.031 (0.787)	0.030 (0.762	0.0002 0.005)	0.004 (0.102)
Minim (Nonshearing)	0.021 (0.533)	0.020 (0.508	0.000 0.000)	0.024 (0.610)	0.023 (0.584	0.0000 0.000)	0.003 (0.076)
Minikin (Self-shearing)	0.017 (0.432)	0.016 (0.406	0.0003 0.008)	0.019 (0.483)	0.019 (0.483	0.0004 0.010)	0.003 (0.076)
Minuta (Self-shearing)	0.0135 (0.343)	0.012 (0.305	0.000 0.000)	0.015 (0.381)	0.013 (0.330	0.0002 0.005)	0.001 (0.025)

Means and standard deviations for 10 samples per category

The difference obtained by subtracting the diameter of the drill from that of the pin, termed 'pin oversize', is typical of threaded pins. Conversely, the difference obtained by subtracting the diameter of the pin from that of the drill, termed 'drill oversize', is typical of cemented pins. The measurements of the diameter of the pin and the corresponding drill were verified with the micrometer caliper at two locations 90 degrees apart on each of 10 samples of each of the four types of TMS pin used.

The size of the marks made on the dentin by the metal point of the bow compass was increased with another metal point so that the tip of the drill would have an accurate start. Channels for the pins were drilled by hand with a low-speed handpiece. Drills were discarded after making 10 pinholes. Minimal speed and pressure were applied when the pin channels were drilled, so that the holes could be bored efficiently.

The occlusal portion of each tooth was flooded for 1 minute with a 10% aqueous solution of methylene blue dye containing 0.1% Triton X100 (Fischer Scientific Co, Chemical Manufacturing Division, Fair Lawn, NJ 07410, USA) as a wetting agent. After the tooth was rinsed under running tap water to remove excess dye, the surface was dried with compressed air so that any crazing produced after drilling would be visible as a blue line when observed at a magnification of 70X under the stereomicroscope (Stereo Zoom 7 dissecting microscope; Bausch & Lomb, Inc, Rochester, NY 14604, USA).

The corresponding pin for the channel was then placed with a hand wrench. Insertion of the pin was considered complete when the self-shearing pin sheared or when further insertion of the nonshearing pin met with resistance. After all four pins were placed, the occlusal portion of the tooth was flooded for 1 minute with a 10% aqueous solution of phenol red dye containing 0.1% Triton X100. The tooth was rinsed under running tap water to remove excess dye, and the surface dried with compressed air. Any crazing produced after insertion of the pin would be visible as a red line when observed microscopically. Crazing for each of the sites of insertion was determined by the presence of one or more cracks as demonstrated by the dye stain. Crazing was checked immediately after pin insertion and again after 2 weeks.

Results

The effect of the diameter of the drill and the location of the channel on crazing of enamel for the four types of pin, immediately after placement of the pins and 2 weeks afterwards, is shown in Table 2.

None of the 320 pin channels showed crazing immediately after drilling. Only 3 of the 24 processed control teeth not prepared for channels showed crazing after 2 weeks.

Comparisons between the total number of sites of enamel demonstrating crazing after placement of pins (combined immediate and 2-week results) and those of the control teeth showed statistically significant increases in the number of sites with crazing ($P \leq 0.05$) at the 0, 1, and 2 positions for the Regular and Minikin pins and at the 0 and 1 positions for the Minim pin. No statistically significant increases were noted for the Minuta pins ($P \geq 0.05$).

Regular pins produced more crazing than did all others ($P \leq 0.01$) and Minuta pins produced less crazing than did all others ($P \leq 0.01$). No statistically significant difference was noted between crazing of Minim and Minikin pins ($P \geq 0.05$).

In most cases an increase in the number of sites of crazing was noted 2 weeks after placement of the pins. Additional crazing was seen after 2 weeks in 19% of the sites with the Regular pins, 16% of sites with Minim pins, 28% of sites with Minikin pins, and 22% of sites with Minuta pins. Most cracks seen in the enamel could not be seen on the surfaces of the dentin between the dentinoenamel junction and the pin. Pulpal penetration occurred only with the Regular and the Minim pins.

Discussion

The results indicate that the most appropriate positions for the Minim and Minikin pins are 2 or 3 times the diameter of the drill from the dentinoenamel junction to the

Table 2. The Effect of Drill Diameter and Channel Location on Enamel Crazing

Type of Pin	Position of Pin*	Number of Sites of Crazing after Pin Placement: Immediate	2-week		Total	Significant Difference from Control in Crazing**	Number of Pulpal Penetrations
Regular	0	20	0		20	yes	0
	1	17	3		20	yes	0
	2	9	6		15	yes	4
	3	1	6		7	no	15
		47	15	combined	62+		
Minim	0	12	2		14	yes	0
	1	9	2		11	yes	0
	2	3	4		7	no	0
	3	1	5		6	no	7
		25	13	combined	38		
Minikin	0	9	3		12	yes	0
	1	4	7		11	yes	0
	2	1	9		10	yes	0
	3	2	3		5	no	0
		16	22	combined	37		
Minuta	0	1	6		7	no	0
	1	1	7		8	no@	0
	2	2	5		7	no	0
	3	0	0		0	no	0
		4	18	combined	22++		

*Each position represents the amount of remaining dentin measured in the number of diameters of the drill from the dentinoenamel junction.

**Statistical comparisons (χ^2 analysis) between the total number of enamel sites showing crazing at the respective positions of the pins with the results of crazing of the 24 control teeth (without pin channels). Three of the 24 control teeth showed crazing 2 weeks after placement. YES = significant ($P \leq 0.05$), NO = not significant ($P \geq 0.05$, @ $P = 0.02$).

+,++Statistical comparisons (χ^2 analysis) of crazing between each type of pin for all sites.
+Significantly more crazing than all other types of pin ($P \leq 0.01$)
++Significantly less crazing than all other types of pin ($P \leq 0.01$)
No significant difference between the Minim and Minikin pins

circumference of the pin channel. Although the Minim pin placed at 3 times the diameter of the drill produces fewer cracks than at the other positions, the chance of pulpal penetration also increases. A variable introduced with the Minikin and Minuta pins is the self-shearing property. Additional force may be required to shear the pin. The use of this additional force may explain why the Minikin pin produced more cracks at the position of 2 times the drill than did the Minim pin.

Regular pins may exceed the modulus of elasticity of dentin. When a pin is screwed into a pin channel, stress is induced in the surrounding dentin. If the stress exceeds the modulus of elasticity of dentin, a crack may be generated internally to the pulp or externally to the enamel, or possibly both ways (Trabert & others, 1973). The 0.004-inch (0.100 mm) oversize of the pin may explain the large number of craze lines produced in enamel when this pin was used.

The data on Regular pins show that enamel crazing decreases as the distance from the dentinoenamel junction increases but that the likelihood of pulpal penetration increases if the Regular pin is used at a distance of 2 or 3 times the diameter of the drill from the dentinoenamel junction. To reduce the possibility of enamel crazing or pulpal penetration it is suggested that regular pins not be used.

The Minuta pin demonstrated no significant cracking at any position. However, before placing this pin the prudent operator should consider factors other than cracking, such as retention of various restorative materials when subjected to complex masticating forces (Eames & Solly, 1980; Hembree, 1981; Lambert, Scrabeck & Robinson, 1982).

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Thermal Discomfort of Teeth Related to Presence or Absence of Cement Bases under Amalgam Restorations

Absence of cement bases under amalgam restorations does not increase thermal sensitivity of teeth except for those not previously restored and then for only the first 24 hours.

SHELDON PIPERNO • EMANUEL BAROUCH
STUART M HIRSCH • JAMES M KAIM

Summary

Patients were asked to evaluate the sensitivity of teeth to heat and cold at 24 hours, 1 week, 1 month, and 6 months after the placement of amalgam restorations with and without cement bases. The responses were generally negative for all teeth except primary lesions, and for these sensitivity was limited to the first 24 hours.

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Introduction

Restoring teeth with amalgam can result in iatrogenic problems. Efforts to minimize adverse pulpal responses have led to the use of cavity varnish, liners, and bases. Cavity varnish is placed as a barrier to initial microleakage and to chemical components of the amalgam. Liners are thinly placed materials that can either intentionally irritate or sedate the pulp. Bases are thick materials placed as thermal insulation for the pulp. A recent study indicates that the increase in thermal insulation of a base decreases markedly at thicknesses greater than 0.62 mm (Peters & Augsberger, 1981).

When deep restorations of amalgam are removed because of secondary decay, fracture, and the like, often no bases are present. Even though the teeth may be asymptomatic and vital, it is impossible to determine if these teeth were thermally sensitive when the restorations were placed. The tooth may not have required a base or, in response to the trauma of placement and subsequent irritations, may have formed reparative dentin, which now acts as a base. On the other hand, one would expect that a tooth without a previous restoration, subjected to similar trauma in the placement of amalgam, would be thermally sensitive if the tooth required a base and none were placed, since minimal or no secondary dentin would be present. This study compared thermal discomfort experienced by patients with and without bases placed under class 1 and class 2 restorations of amalgam in teeth with primary or recurrent decay.

Methods and Materials

The subjects of this study were 59 patients, both male and female, between 18 and 65 years of age with primary or secondary carious lesions needing class 1 or class 2 preparations at least 1 mm into dentin and not requiring pins for additional retention. All teeth used in the study had been radiographed during the last 6 months and were evaluated as asymptomatic and vital, as demonstrated by a reading of 6 or less on an electric pulp tester having a scale of 1 to 10 (Demetron Research Corp, Danbury, CT 06810, USA). Each tooth had a normal periodontium.

After the caries had been excavated, the teeth were isolated with rubber dam and the preparations categorized into three groups according to the depth into dentin on the deepest part of either the axial wall or the pulpal floor (see Fig 1).

Shallow	1.0 - 1.5 mm into dentin
Medium	1.6 - 2.5 mm into dentin
Deep	deeper than 2.5 mm into dentin

The depth of the prepared cavity was measured with a periodontal probe (No KM0816, American Dental Mfg Co, Missoula, MT 59806, USA). All teeth were then lined with calcium hydroxide (HYPO-CAL, Ellman Instrument Mfg Co, Hewlett, NY 11557, USA) and two layers of varnish (Copalite, Cooley & Cooley Ltd, Houston, TX 77001, USA) by one of two investigators. The decision of whether or not to place a base of zinc phosphate was randomized. The bases of zinc phosphate cement (Fleck's Zinc Cement, Mizzy, Inc, Clifton Forge, VA 24422, USA) were at least 0.5 mm thick and subsequently were covered by another layer of cavity varnish. All procedures were accomplished during one appointment.

After the insertion of the amalgam (Optaloy II, L D Caulk Co, Milford, DE 19963, USA) the patient was given two identical

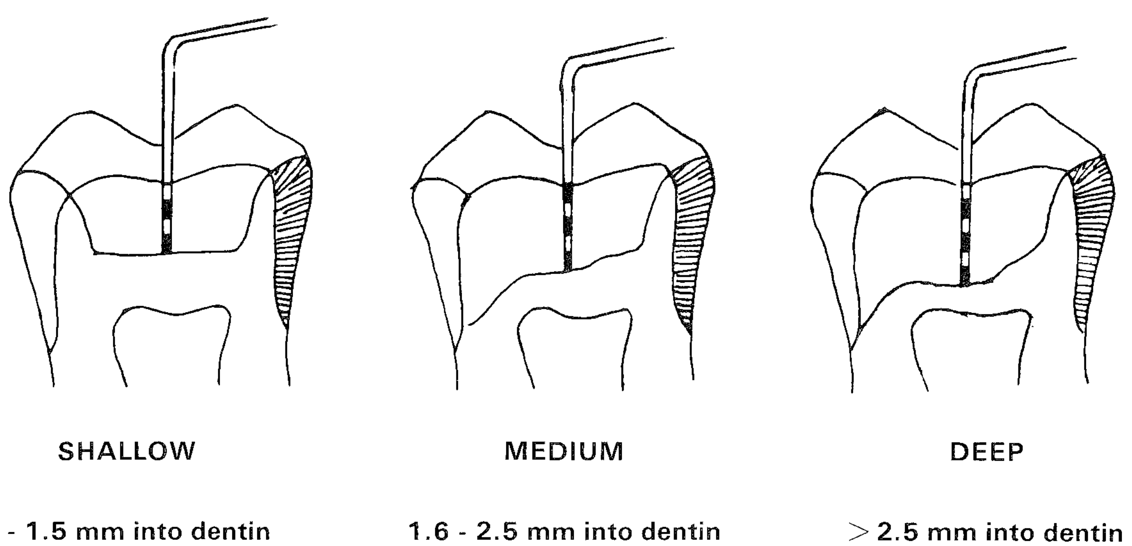

FIG 1. *Classification of cavities according to depth*

questionnaires on post cards and asked to mail one card the following day, and the second card a week later (see Fig 2). The

Date postcard should be mailed ____________

Patient's name __________ chart number ______

	Yes	No
1. Have you experienced any discomfort from the tooth just worked on?	___	___
2. Have you any discomfort around the tooth such as the gum tissue?	___	___
3. Do you have any discomfort when biting?	___	___
4. Do you have any sensation when eating hot foods?	___	___
Cold foods?	___	___
Sweets?	___	___
5. Did the sensitivity last for more than 5 minutes?	___	___
6. Are you trapping any food around the new filling?	___	___

Comments: ______________________________

FIG 2. *Questionnaire given to patients*

patient was also scheduled for another appointment a month later for a follow-up clinical examination and pulp testing by one of two investigators. Finally, at 6 months, the patient was interviewed by telephone and asked the same questions as were on the post card questionnaire.

Results

Of the 59 patients treated, 27 of those receiving a base and 25 of those not receiving a base returned post cards indicating sensitivity or lack of sensitivity to hot or cold at intervals of 24 hours and 1 week. At 1 month, nine clinical examinations were given to patients with bases and seven to patients without bases. At 6 months, six patients with bases and six without bases were interviewed by telephone (see the table).

At 24 hours no statistically significant difference in sensitivity between the groups with and without bases was reported. This was true for each depth and for all depths grouped together, as illustrated by the Fisher exact test (Siegel, 1956). In the deep group, more of the teeth with primary lesions in which a base was not placed were sensitive to cold than were teeth with primary lesions in which a base was placed. However, this difference is not statistically significant at the 0.05 level. In the shallow and deep groups, combining the base and the no-base groups indicates that more of the teeth with primary lesions were sensitive to cold than were teeth with secondary lesions ($P < 0.05$). In the medium group, only one tooth was thermally sensitive at 24 hours. This finding indicates that teeth with primary lesions are more likely to be sensitive to cold at 24 hours than are teeth with recurrent decay, regardless of the placement of a base.

At 1 week the number of subjects reporting thermal sensitivity was very low and all differences between teeth treated with or without a base disappeared. Additionally, the differences in teeth with primary lesions and those with secondary lesions were nonexistent. Almost no sensitivity was reported at 1 month and no sensitivity was reported at 6 months.

Discussion

The results indicate that bases under amalgam restorations do not affect thermal sensitivity in patients, except possibly in teeth with primary carious lesions that are very deep, and only for 24 hours after the restoration is placed. Cavity varnish alone has been shown to be effective in reducing thermal sensitivity under newly placed amalgam restorations (Dachi & Stigers, 1967). Varnish prevents microleakage around amalgam restorations, and the subsequent passage of salivary ions into the freshly cut dentin and subsequently into the pulp (Barber & Massler, 1964). Microleakage, rather than poor insulation, may be the cause of discomfort to thermal stimulation of teeth with amalgam restorations. Laboratory studies have shown that amalgam is a good thermal conductor and that placing a base could significantly reduce thermal conduction to the pulp (Peters & Augs-

Thermal Sensitivity of Teeth with and without Cement Bases under Amalgam Restorations

Depth and Type of Lesion	Thermal Sensitivity							
	24 hours		1 week		1 month		6 months	
	yes	no	yes	no	yes	no	yes	no
Shallow								
Primary lesion								
base	5	3	2	6	1	3	0	2
no base	2	5	0	7	0	2	0	0
Secondary lesion								
base	0	3	1	2	0	2	0	1
no base	1	4	1	4	0	1	0	1
Medium								
Primary lesion								
base	0	4	0	4	0	1	0	0
no base	0	0	0	0	0	0	0	0
Secondary lesion								
base	0	3	0	3	0	0	0	1
no base	1	4	1	4	0	2	0	2
Deep								
Primary lesion								
base	1	2	0	3	0	1	0	0
no base	4	0	3	1	0	0	0	1
Secondary lesion								
base	4	2	3	3	0	1	0	2
no base	2	2	1	3	0	2	0	2
Total:								
Primary lesion								
base	6	9	1	14	1	5	0	2
no base	6	5	3	8	0	2	0	1
Secondary lesion								
base	4	8	4	8	0	3	0	4
no base	4	10	3	11	0	5	0	5

berger, 1981). This clinical study indicates that the thermal conductivity of amalgam may not be related to the thermal sensitivity of patients, except for the immediate postoperative thermal sensitivity of teeth with deep primary carious lesions. The teeth of the deep group that had primary lesions probably did not have sufficient reparative dentin to insulate them from thermal shock. Preparing the cavities and placing the amalgam is traumatic to the pulp. The deeper the preparation the greater is the trauma, thus increasing pulpal inflammation and possibly increasing thermal sensitivity. After 1 week, even these teeth were able to adapt to the irritation and were no longer any more sensitive than teeth previously restored.

Conclusions

Teeth that have never been restored are more sensitive after they are restored with amalgam than are teeth that have been restored.

Bases under amalgam restorations do not affect thermal sensitivity of teeth in patients.

Acknowledgment

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Disparity in Expert Opinions on Size of Acceptable Margin Openings

H W DEDMON

Summary

When experienced dental faculty used an explorer to evaluate nonvisible margins on a device made to simulate gradations in two types of open margins frequently found when fitting dental castings, there was significant inconsistency within and among members of the faculty as to the maximum opening acceptable. The range for horizontally open margins was 32 - 230 μm and that for vertically open margins was 43 - 196 μm.

INTRODUCTION

Before cementing castings dentists evaluate the margins intraorally with a dental explorer. These margins are often not visible; therefore, the dentist must rely upon his tactile sense. Christensen (1966) has reported that experienced restorative dentists using an explorer to evaluate the nonvisible margins of inlays cemented in extracted teeth could not rate the margins consistently.

The purpose of the present study was to evaluate the agreement within and between experienced dentists when using an explorer to identify the maximum size of acceptable openings of nonvisible margins.

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METHOD

A stainless steel instrument was designed and machined to provide a continuous 60° beveled margin 75 mm long down two sides of a rectangular block. By placing spacers between parts of the device, dimensions of the opening of the margins were made to change continuously along inclined planes. One side was adjusted to create a horizontally open, overhanging margin simulating an oversized casting; the other side simulated a casting that is not completely seated, creating a vertically open margin (Fig 1).

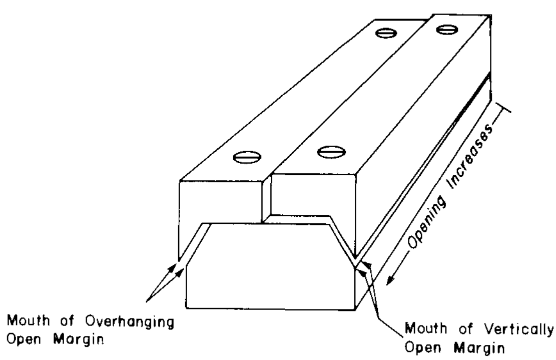

FIG 1. *End view of instrument for simulating discrepancies of margins*

The rate of change along each margin was determined by measuring the maximum and minimum opening microscopically, taking the difference and dividing by the length of the margin (75 mm). The minima were too small to measure and assumed to be zero. The vertically open side increased 3.36 micrometers per millimeter ($\mu m \cdot mm^{-1}$) of length; the horizontally open side increased 3.6 $\mu m \cdot mm^{-1}$ of length. The dimension of the mouth of the opening at any point along the margin could be calculated by multiplying the distance from the zero end by the rate of change. For example, at 30 mm from the zero end on the vertically open side the dimension of the mouth of the margin would be 30 x 3.36 = 100.80 or 101 μm.

Six subjects were chosen. Two were heads or former heads of departments of fixed prosthodontics. Two were eligible for the board in fixed prosthodontics and had experience teaching clinical fixed prosthodontics. Two had five or more years experience practicing and teaching clinical fixed prosthodontics.

With eyes closed, each subject evaluated the margin by feeling it with an explorer. The opening of the margin was gradually increased by moving the metal block from the zero end. When the subject said the maximum opening acceptable had been reached, the position of the explorer tip on the margin was recorded. A millimeter scale was attached parallel to each margin so the position of the explorer tip could be accurately located (Fig 2). (The ruler is inverted in order to place the millimeter scale nearer the margin.) The subject was then asked whether the margin was open, overhanging, or both.

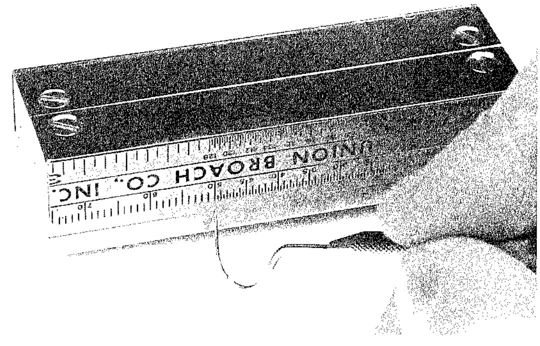

FIG 2. *Illustrating use of instrument for simulating discrepancies of margins*

Ten trials were recorded for each subject, five for each type of margin. Alternation of the type of margin was randomized. All subjects used the same explorer, which was chosen from a random sample of those used in the dental clinics of the University of Iowa.

The recorded data were analyzed statistically using Duncan's multiple range test to determine how the order of the trials affected the results. This test also was used to determine the significance of the differences between subjects for both types of margin and between types of margin. Analysis of the components of the variances was used as a test of reliability within subjects.

RESULTS

Figure 3 shows the individual ranges and means for each type of margin, the combined range and mean for each subject, the overall mean for each type of margin, and the combined mean for all subjects and types.

With a range of 94 - 230 μm and a mean of 165 μm, subject number 3 was the least consistent when evaluating overhanging open margins. Subject number 4 was the most consistent on overhangs and the least consistent on vertically open margins with a range of 84 - 151 μm and a mean of 107 μm. Subject number 6 was the most consistent on vertically open margins. Subject number 2 was the least consistent overall with a combined range of acceptance varying from 50 to 195 μm and a mean of 138 μm.

The mean for the group for vertically open margins was 114 μm compared with 93 μm for overhanging open margins. The combined mean for both types of margin was 104 μm.

Statistical analysis of the results using Duncan's multiple range test revealed that the order in which the trials occurred did

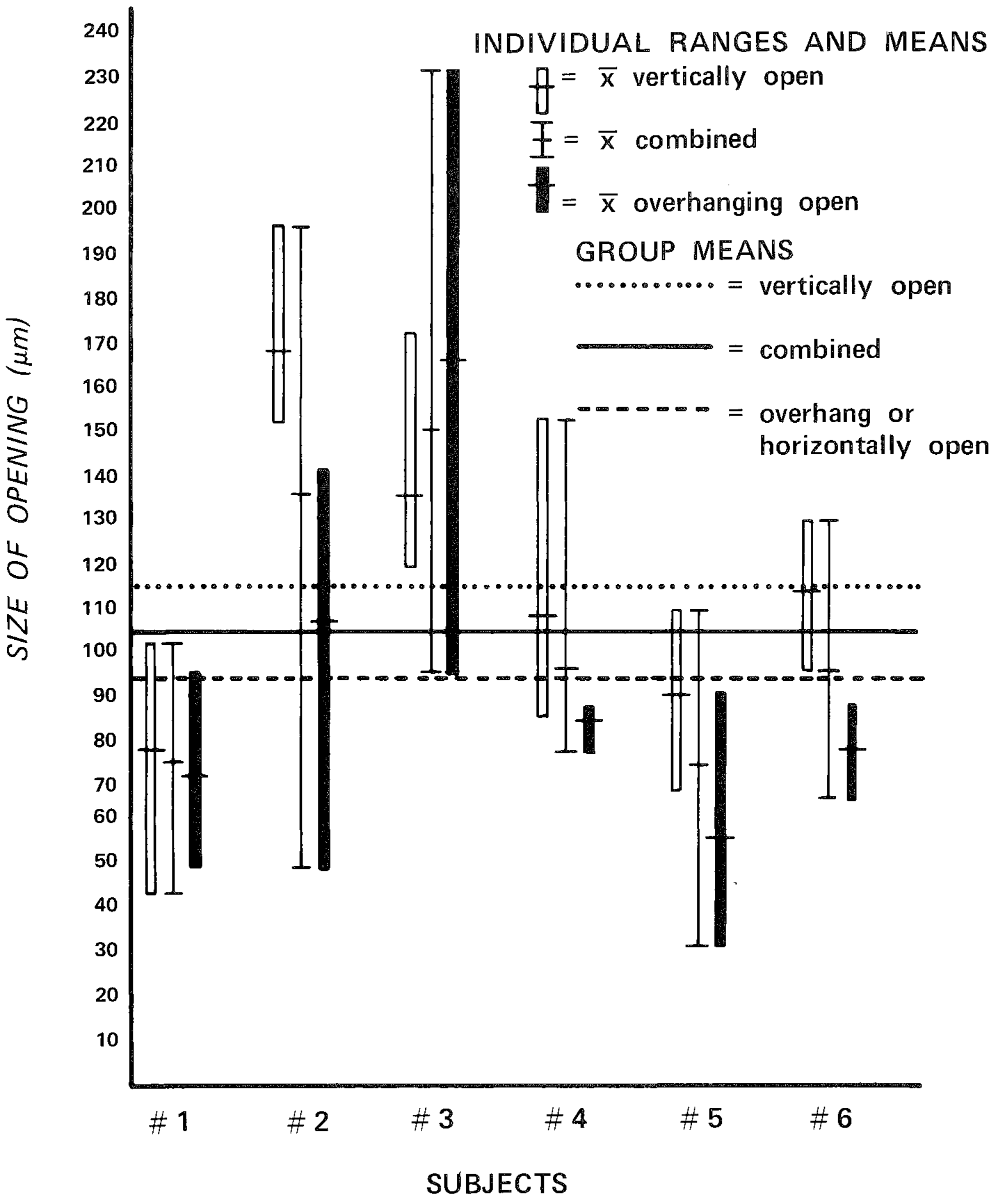

FIG 3. *Results of testing for discrepancies of margins*

not affect the results for either type of margin ($P < 0.05$). The same test revealed significant differences between subjects for both types of margin and between types of margin ($P < 0.05$).

Analysis of the components of the variance, as a test of reliability within subjects, was 0.60 for vertically open margins. This means that 60% of the variation was due to the differences among individuals while 40% was due to the differences within individuals. The reliability within individuals for overhanging margins was 0.71, meaning 71% of the variation was due to differences between subjects and 29% was due to differences within subjects.

The table shows numbers, types, and percentages of errors recorded when subjects described the type of margin being felt on each trial.

DISCUSSION

The relationship between rate of failure and size of opening of margins for dental castings has not been established by definitive, longitudinal, clinical studies. A laboratory study (Mesu, 1982) has shown that thickness of the layer of cement may, among other factors, affect the speed of disintegration of cement. However, there is general agreement that it is desirable to have margins closed as much as possible to reduce the width of the line of cement.

Christensen (1966) reported that when visible margins were evaluated with an explorer the barely acceptable range was 2 - 51 μm with a mean of 21 μm. Most interproximal margins, however, are not visible and many facial and lingual margins are not visible because they are placed beneath the gingiva.

The results of the present study indicate that the most commonly used method for evaluating the fit of nonvisible margins of castings may be even less reliable than previously reported. The range of barely acceptable nonvisible margins reported by Christensen (1966) was 34 - 119 μm with a mean of 74 μm, as compared with a range of 32 - 230 μm and a mean of 104 μm in this study.

There was a definite tendency in this study to accept larger openings on vertically open margins. The overall mean for vertically open margins was 114 μm versus 93 μm for overhanging margins. This difference was statistically significant ($P < 0.05$). Therefore, incomplete seating of castings may be less detectable than overhanging margins and oversized castings when margins are not visible.

When questioned during the study all subjects reported they could not actually feel an opening with the explorer. They said they felt ledges, ridges, and overhangs. These opinions were confirmed by the errors made when describing the type of margin being felt (see table). The most common error on the vertically open margin was to describe it as a ledge or overhang (33.3%) whereas the overhang was most often correctly described without recognizing that the margin was also open (76.7%).

Christensen (1966) did not differentiate between types of margin and it might be

Errors in Describing Margins

	Correct No	Correct %	Partly Correct	No	%	Incorrect	No	%
Vertically open N = 30			Ledge + open	3	10.0	Ledge	8	26.7
			Overhang + open	1	3.3	Overhang	2	6.7
Total:	16	53.3		4	13.3		10	33.3
Overhang + open N = 30			Overhang	23	76.7			
			Open	6	20.0			
Total:	1	3.3		29	96.7		0	0.0

argued that the instrument used in this study does not simulate cemented castings well enough to compare absolute dimensions of openings of margins. However, the existence of significant variation within and between highly skilled practitioners was confirmed by both studies.

CONCLUSIONS

1. When identifying acceptable openings of nonvisible margins with an explorer, experienced dentists differ within and between them.
2. When nonvisible margins are evaluated with an explorer, acceptance is more likely to be based on the size and character of overhangs and ledges than on the actual size of opening of the margin.
3. More reliable methods are needed for evaluating nonvisible margins of castings before cementation.

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The Facial Slot Preparation: A Nonocclusal Option for Class 2 Carious Lesions

An approximal cavity that does not involve the occlusal surface.

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Summary

Preparation of a class 2 cavity by gaining access to the lesion from the facial embrasure rather than from the occlusal surface thus preserving the occlusal surface and marginal ridge allows, in selected cases, the placement of restorations that: (1) are more esthetic, (2) require less time for placement, (3) are not subject to functional breakdown, (4) preserve the strength of the teeth, (5) cause fewer postoperative problems, and (6) are more acceptable to patients.

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Introduction

Preparations for class 2 cavities often require the removal of some sound tooth structure during the formation of the proximal box and removal of occlusal grooves. Uninvolved occlusal surfaces and marginal ridges may be needlessly sacrificed in some cases (Almquist, 1973; Baum, 1981).

This article describes a cavity preparation that improves on the esthetics of conventional designs for class 2 cavities and conserves tooth structure by opening into the approximal caries through the facial embrasure instead of through the occlusal surface.

Limiting Criteria

Conservative preparations are limited to selected cases in which the carious process is not in an advanced stage. The facial slot preparation may be the method of choice for teeth having approximal lesions at least 2 mm cervical to the marginal ridge (Fig 1). Healthy gingivae are essential for

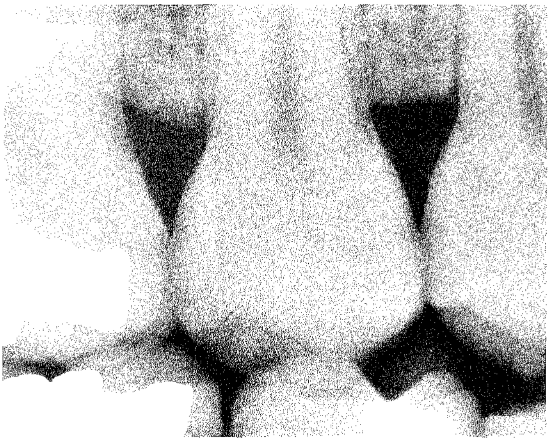

FIG 1. *Radiograph showing approximal lesions suitable for the facial slot preparation; #4 distal shows ideal form.*

proper preparation and restoration. Although greater care is required with this preparation, the benefits include satisfactory esthetics, avoidance of unnecessary occlusal involvement, greater postoperative strength of the tooth, and restorative margins that are not subject to functional breakdown.

Instrumentation and Materials

The following are recommended for this procedure:

1. Transilluminating light of fiber optics (Photon Transilluminator, Kinetic Instruments, Inc, Bethel, CT 06801, USA)
2. Size 0 or 00 amalgam condenser
3. #329 pear-shaped and #¼ round burs
4. Stainless steel band for matrices
5. Contoured wooden wedges
6. Small, sharp chisel (such as a 10-4-10 binangle)
7. Interproximal carver
8. Waxed dental floss

Initially, the tooth is examined for calculus and the health of the surrounding gingivae. A rubber dam is placed to improve access and protect the gingivae. Bitewing radiographs are reviewed to locate the point of entry.

Entry is made with a high-speed #329 bur, starting in the facial embrasure at a point nearest the caries (Fig 2). Damage to

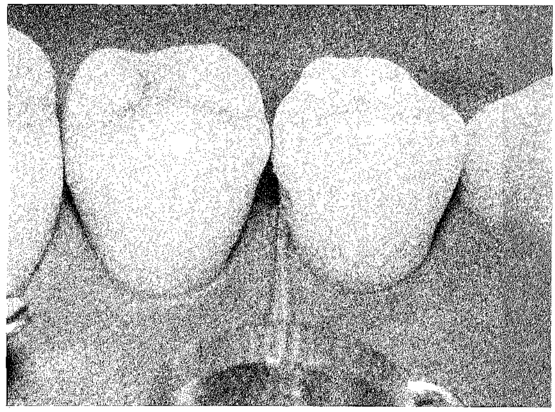

FIG 2. *The #329 bur used to cut the preparation*

the adjacent tooth should be avoided by temporary interproximal placement of a piece of matrix metal. To avoid overcutting the preparation, the outline form is established first. Excavation is carried through just to the lingual embrasure, creating a wall there for adequate condensation of amalgam.

The same bur at slow speed is used to shape the internal form. A bright transilluminating light (Fig 3) is necessary for

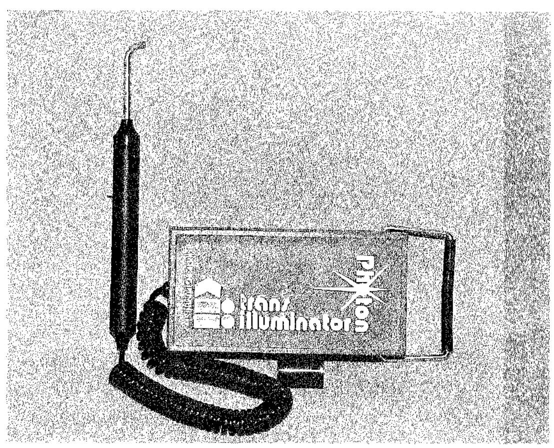

FIG 3. *The Photon Transilluminator used in this study*

detecting any residual decay or hypocalcification (Fig 4). At this point, the adequacy of

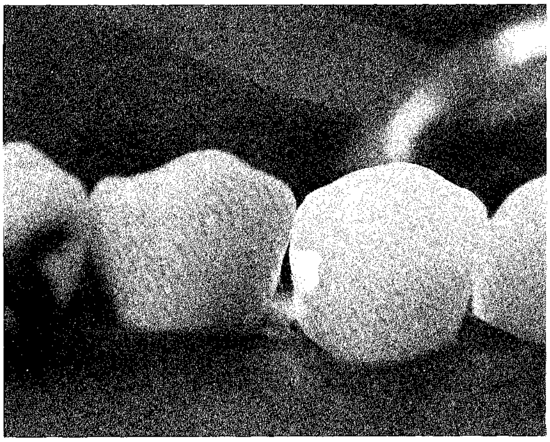

FIG 4. *Transillumination is necessary to see carious or hypocalcified tooth structure.*

the structure of the remaining marginal ridge should be evaluated and a decision made to continue or to shift to a more traditional preparation (Fig 5).

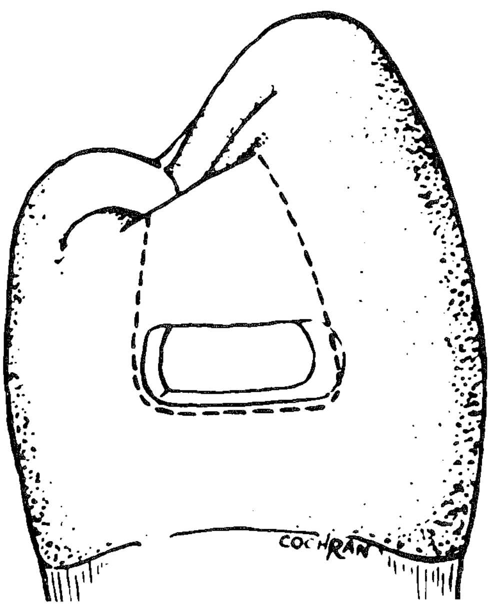

FIG 5. *The facial margin ideally extends only about 1 mm beyond that of conventional class 2 preparations.*

Cavosurface margins are instrumented to approximately a 90-degree angle using a narrow-bladed monangle or binangle chisel (Fig 6). The outline for access to the prepa-

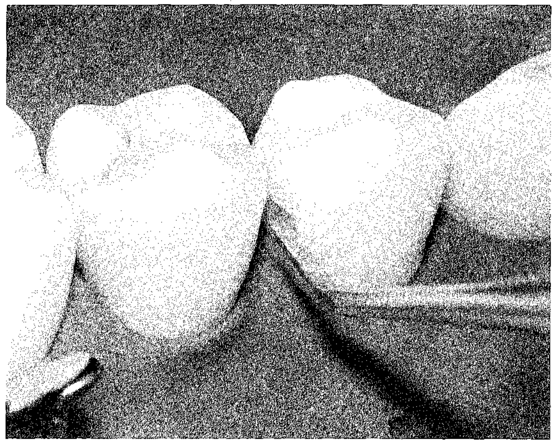

FIG 6. *A small chisel used to produce clean, straight 90-degree cavosurface margins*

ration is only slightly greater in diameter than a #329 bur and is as long occlusocervically as required by the extent of caries. Squaring the corners in the outline provides distinct margins to which to carve and finish. Extra care is necessary when instrumenting the cavosurface margin inside the area of the interdental contact. Retentive grooves are placed cervically and occlusally in dentin with the ¼ round bur.

When the preparation is complete (Fig 7),

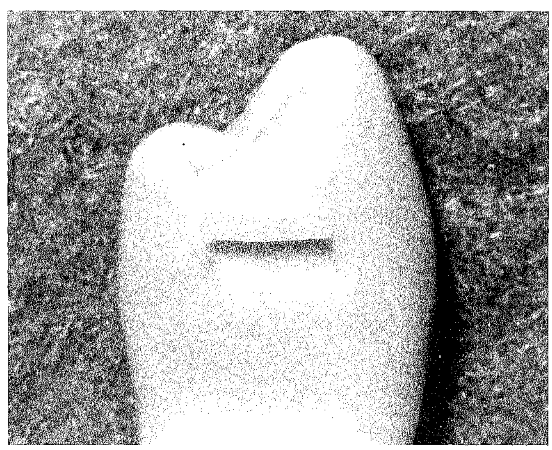

FIG 7. *View of preparation showing conservative outline form*

two coats of cavity varnish are applied and a custom matrix is prepared. This S-shaped band is formed from a strip of stainless steel matrix material ½ in long. The ends are rounded, and the strip is drawn over an instrument with a narrow diameter to produce an S-shaped curl. The matrix is then placed interproximally and wedged tightly from the lingual embrasure. The wedge should be trimmed so that it is at or slightly apical to the cervical margin (Fig 8).

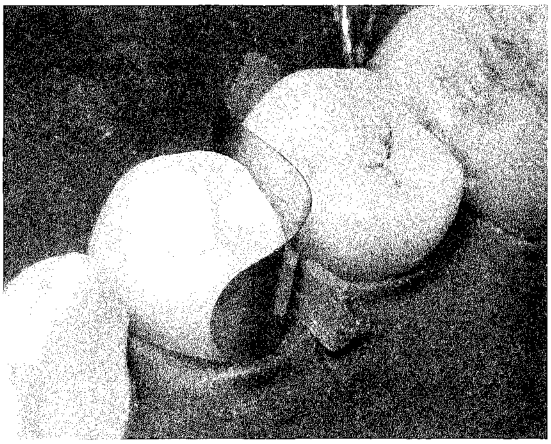

FIG 8. *The S-band placed securely with a customized wooden wedge.*

Because of the miniature proportions of the preparation, a very small amalgam condenser is usually necessary (Fig 9). Amalgam is condensed into the cervical and occlusal retentive grooves with a side-to-side action of the condenser tip. The surface of the amalgam should be carved back to the original contour of the tooth with an interproximal carver (Fig 10). This is important to prevent either retention of plaque by a concave surface or difficulty in flossing occasioned by an overcontoured restoration. The side of an explorer tip can be used to carve and burnish the margins and to smooth the surface. Some operators may choose to pass waxed dental floss through the contact to ensure final interproximal clearance. Floss should be introduced into the facial embrasure at a 45-degree angle and passed through in a linguocervical direction (Fig 11). If this cannot be accomplished,

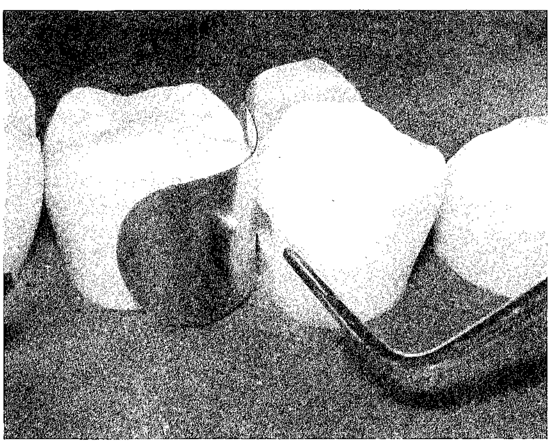

FIG 9. *The number 0 condenser tip (approximately 0.6 mm in diameter) shown relative to the preparation*

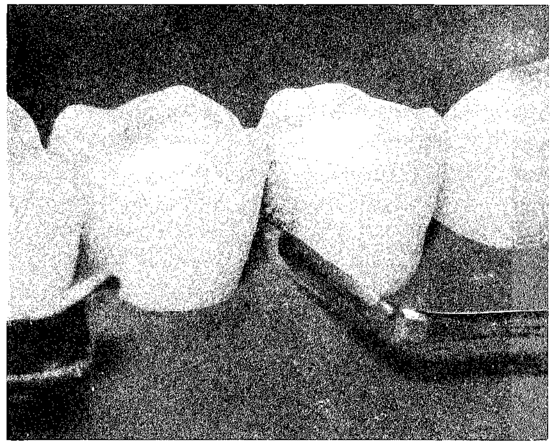

FIG 10. *The interproximal carver contours the restoration and removes flash.*

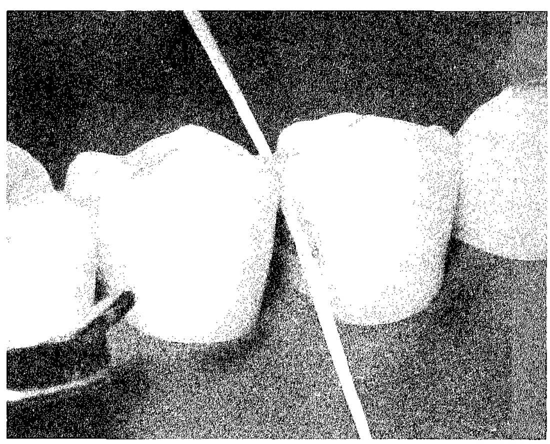

FIG 11. *Waxed dental floss is brought into the facial embrasure at a 45-degree angle.*

the floss must be fed through the embrasure below the restoration and pulled in an occlusolingual direction. (Bringing the floss facially can dislodge unset amalgam from the surface of the embrasure.)

Discussion

Today's high-speed instrumentation, widespread community fluoridation, earlier diagnosis and treatment of caries, and recent studies on the strength of teeth related to cavity preparation (Mondelli & others, 1980; Larson & others, 1981) suggest that some prudent modification of the design of the original cavity may be in order. G V Black himself (1904) suggested that each tooth should be restored according to its own special needs.

Approximal caries generally starts just cervically to the proximal contact, and several modifications of the conventional design of the class 2 preparation have been made to preserve integrity of the marginal ridge. Among these are the facial approach for class 3 restorations of deciduous canines as used in pedodontics (McDonald & Avery, 1978), the slot preparation proposed by Battock & others (1979) for treatment of interproximal caries of roots in patients with gingival recession, and the common practice of restoring "wrap-around" cervical caries entirely from the facial approach.

The technique of the facial slot, once mastered, accomplishes approximal restoration of molars and premolars in approximately one-third less time than by conventional means. The margins are limited to nonfunctional surfaces, eliminating restorative failure from heavy occlusion, and postoperative sensitivity to temperature is reduced due to the conservative size and depth of the restoration. The preparation also lends itself to direct gold or the radiopaque type of resin filling materials. In some cases, for greater esthetics, the cavity may be prepared from the lingual, though this approach is usually more difficult.

Gaining access for treatment via the facial or lingual embrasure can be a valuable option for treatment of posterior teeth where location of the approximal lesion permits conservatism. The extra care in preparation is rewarded by greater satisfaction in providing serviceable, more esthetic restorations (Fig 12).

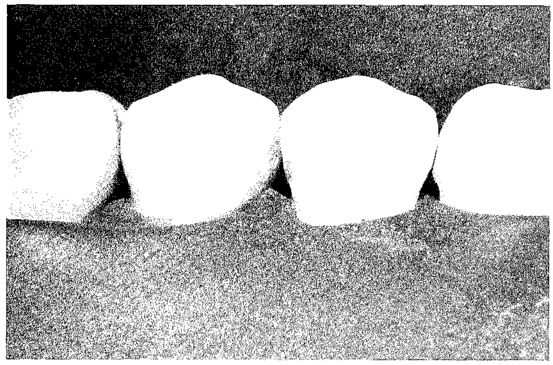

FIG 12. *The completed class 2 facial slot restoration viewed facially*

Acknowledgment

Gratitude is extended to Dr Miles Markley for prepublication review of this paper.

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DENTAL EDUCATION

Gold Foil as a Teaching Material

JULIAN J THOMAS

Gold foil is really not a teaching material. It is a material with unique properties that when used advantageously make it possible for a dentist to most effectively restore a tooth to function. It has been called a standard because of its durability and its biological acceptance. It has been around since before dentistry became a profession and at one time was the only material available to restore a tooth. Its effectiveness as a restorative material has stood the test of time and has been scrutinized over many, many years by exacting and very critical clinical observers. Its biological effects and metallurgical properties have been thoroughly studied, all of which have shown it to be a very effective restoration indeed.

Over the years other restorative methods have been added to our armamentarium so that now we can also utilize cast gold, amalgam, composite materials, and—yes—even silicates and unfilled resins. Yet with all these additions the direct gold restoration continues to be one of our most effective means of restoring teeth that have been damaged by dental caries and trauma. The development of different forms of pure gold as a restorative material has been rather dramatic over the years so that today we are fortunate to have many forms of pure gold to use in restoring teeth. Most of these developments have aided us in that they have made it easier and more efficient to restore teeth with direct filling gold.

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Presented at the annual meeting of the American Academy of Gold Foil Operators 5 November 1982 in Los Angeles.

It is a sad commentary on our profession that with all these improvements in the handling characteristics of pure gold its use in practice as well as in the various dental schools has declined. There are several reasons for this. Some of the newer materials, even though they deteriorate rapidly, are easier to use, tolerate much less precision on the part of the operator, and are very forgiving of sloppy technique. On the other hand, restoring a tooth with direct filling gold requires precision, discipline, and a systematic procedure. It is an unforgiving material in that if the clinician is not precise, disciplined, or systematic the restoration will show the defects immediately. Yet if done properly the restoration is by far the most durable of any available today.

At one time the use of this material was taught in virtually every dental school in this country and was a requirement of all state boards for licensure. Today we find that numerous dental schools either do not teach it at all or consider it an optional restorative measure (Lambert, 1980). In any case, the message is clear to the students; their faculty feels that this restoration is no longer a viable alternative in operative dentistry.

The dental schools that fail to emphasize this alternative offer two reasons for their policies. One is that there is pressure from the curriculum committees of their schools to reduce the number of hours devoted to operative dentistry, the other is that they do not have instructors capable of teaching the use of this material. Both reasons may be valid, but both are correctable. There is sufficient documentation to demonstrate to the curriculum committees that the direct gold restoration is a valuable method of treatment in operative dentistry. Instructors in operative dentistry faculties can certainly be trained to place this restoration effectively and to teach it. The American Academy of Gold Foil Operators has offered to teach direct gold restorations to the faculties and is even funding that effort. Unfortunately, the response to this very generous and timely offer has been less than enthusiastic.

There are some who advocate even further reduction in the emphasis on operative dentistry in the curriculum. A group that met recently under the sponsorship of the Procter and Gamble Corporation asserted that the decrease in the incidence of dental caries would allow a drastic reduction in the amount of time allocated to operative dentistry in the curricula of dental schools. I completely disagree because the decrease is primarily in larger lesions of smooth surfaces necessitating full or partial cast gold restorations. The decrease in the number of large lesions enables operative dentists to concentrate their efforts on the more conservative lesions. These are the lesions requiring a greater variety of restorative methods as well as more precision and clinical ability. Of course, the department of operative dentistry would continue to be responsible for teaching **all** methods of restorative treatment regardless of their frequency of use in practice. Even **if** dental caries were **completely** abolished, operative dentistry would continue to be needed for decades to come.

The lack of emphasis on direct gold restorations in schools and state boards is reflected in the performance of recent graduates over the last 10 years. Numerous articles have appeared in the literature including a survey by Smith, Bomberg & Bauer (1980) in which they questioned board examiners on the proficiency of the candidates for the last few years. The majority (67%) felt that proficiency in operative dentistry has decreased. Lambert (1980) stated that he felt that the decline of the performance of those recent graduates on board examinations correlated directly with the trend in dental schools toward less and less teaching of direct gold restorations. Hamilton (1976) stated that practicing dentists, operative dentistry faculty, and board examiners observed that recent graduates are not as well trained as formerly.

With all of the evidence at hand today, why then do many schools not teach this restoration as part of their curriculum? The answers lies very likely in several areas:

1. The unfortunate attitude of many in our profession who feel that when new materials are developed they must replace one that is already present and proven. More logically, we should think of these as additions that enhance our ability to restore the teeth of our patients.

2. Perhaps many of the operative dentistry faculty have an aversion to the gold foil restoration because of the way it was taught when they were in dental school. Many times in the past this was considered almost as a punitive exercise and the unlucky student had to try to place this highly precise restoration with very little, if any, direction and, of course, no chairside assistance at all. In such circumstances building these restorations was extremely inefficient and frustrating.

3. Despite documentation to the contrary, old wives tales have circulated for years to the effect that gold foil restorations cause severe pulpal response. This is simply not true. These restorations have been studied scientifically and shown to be very acceptable as to effect on the pulp (Thomas, Stanley & Gilmore, 1969). Years and years of clinical observation have amply demonstrated the gold foil restoration to be successful and highly accepted by the surrounding tissues. Actually we have no restorative material today that is inherently traumatic to the pulp when used properly. Pulpal trauma is caused by abusive techniques on the part of the clinician.

Although direct filling golds can and do stand on their own as a restorative method, they do have a great advantage in that they can teach the student the discipline necessary in operative dentistry. Because the material is so unforgiving it gives the student immediate feedback on whether he or she is performing the procedure properly or not. For the operator to successfully place a direct gold restoration the area to be restored must be properly isolated and meticulously clean. This can be done only by adequate isolation with rubber dam and proper retraction of tissue to be able to visualize and instrument the restoration. The cavity preparation must be cut with small rotary and sharp hand instruments to achieve the necessary precision so that the restoration can be built with the direct gold of choice. The line and point angles must be precise and the walls planed cleanly and with very sharp cavosurface margins. The gold must be condensed in a systematic manner to avoid porosity and to achieve a good cavity seal. The anatomy of the final restoration must be built into the restoration as it is being condensed, unlike other methods in which we overcondense and then carve the material back to the anatomical form. The restoration must be finished step by step so that not only the anatomical form is achieved but the marginal seal is virtually undetectable.

All of these steps develop a clinician who is more discerning and more demanding of his own efforts. The operator who has placed a number of gold foil restorations cannot help but become a better cast gold clinician, a better amalgam clinician, and more demanding of his own efforts in tooth-colored materials. The operator who has restored teeth with class 3 and 4 direct gold restorations is very well aware of the necessity of contouring the preparation so that the gold margins are invisible or so subtle that they are not seen. This has direct implications for anterior restorations including tooth-colored materials, but more specifically for partial veneer crowns in which esthetics is a primary consideration. The clinician who has restored teeth with class 5 gold foils will find it difficult to attempt a class 5 restoration in which he is not able to isolate the lesion to gain access as well as achieve complete visibility of the area. The clinician who has condensed a class 1 or 2 restoration in which he has developed the anatomy will carry his skill over into other metallic class 1 and 2 restorations, in which he must restore anatomy and occlusion for function as well as esthetics. A clinician who has placed any type of direct gold restoration whether operating by himself or with an assistant cannot help but gain a true appreciation for the value of a well-trained assistant. For the observant clinician, direct filling gold restorations simply teach the value of direct filling gold restorations over a period of years. Likewise, the patients who have direct filling gold restorations are fully aware of their value as a treatment method. I am convinced that if our patients knew as much as we know about all of the various restorative methods and alternatives to treatment, we would today see a very strong public demand for this restoration and undoubtedly would see direct gold routinely utilized in private practice and, as a result, much more emphasis would be placed on this particular method of treatment in our dental schools.

Schools that do not teach **all** of the various methods of treatment available in operative dentistry are abrogating their responsibility to prepare their students for graduation. Their graduates are handicapped because they cannot make a knowledgeable decision on the best treatment for their patients. When students graduate and go into practice, they should be prepared to make a conscious and deliberate decision about how well they will treat their patients and not be able to "cop out" by saying that they were not properly prepared while in dental school.

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OPERATIVE DENTISTRY, 1982, 7, 110-113.

PRODUCT REPORT

Accuracy of Mercury:Alloy Ratio in Preproportioned Capsules

Control of the mercury:alloy ratio of capsules of preproportioned amalgam has improved significantly.

M GOLDFOGEL • J AMBROSE

Summary

When 11 brands of capsules of preproportioned amalgam (Aristaloy CR Precapsulated, Optaloy-II Caps, Valiant-Sure Caps, Dispersalloy-Cap II, Sabra Blend Snap Caps, Indiloy Double Spill Caps, Permite C2N Caps, Sybraloy Precapsulated - zinc free, Contour, Phase-A-Cap, and Tytin White Cap) were tested for the consistency of the actual percentage of mercury compared with that claimed by the manufacturer, all variances were well within the limits specified by the American Dental Association. Manufacturers explained the discrepancies as representing differences in the optimum requirements for each batch of alloy.

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JULIKA AMBROSE, DMD, clinical associate professor

Introduction

The importance of consistent proportions of mercury and alloy for silver amalgam restorations has been recognized for over 20 years (Eames, 1959). The American Dental Association published a report on the status of amalgamators and proportioners as well as disposable capsules in 1972 (Eames, 1972). More recently, proportioning systems have been tested but researchers have been hard-pressed to keep pace with the development of products (Hamm, Currens & von Fraunhofer, 1981).

The clinicians and practitioners who used the early preproportioned capsules became suspicious that the ratio of mercury to alloy was not as accurate from capsule to capsule as clinical practice would demand. As a matter of fact, the sparse amount of data published on the preproportioned capsule systems showed that the fears of the practitioners using amalgam was justifiable. Eames & others tested six brands of preproportioned capsules and rejected three of them for gross discrepancy in proportion (Eames, Mack & Auvenshine, 1970).

The advent of new products, revisions and improvements in packaging, and the growing popularity of disposable capsules justify concern about the accuracy of available brands of preproportioned capsules. Loss of mercury and leakage of capsules have been tested for some of the preproportioned capsules (Blitzer & Pollack, 1981). Such leakage would certainly have considerable effect on ultimate proportion of mercury and might produce significant mercury pollution as well.

In this report, 11 commercially available preproportioned capsules are compared for consistency of the ratio of mercury to alloy. This constitutes an assessment of the effectiveness of the manufacturers' control of quality for the brands tested.

Materials and Methods

The preproportioned capsules tested are listed in the table. In each case, the capsules were carefully opened and the contents weighed on a Model 32754 Ainsworth beam balance, Type BCT (William Ainsworth & Sons, Incorporated, Denver, CO 80223).

The several types of capsules on the market are of various shapes, sizes, and colors. Basically, however, these are either of the diaphragm type or the pillow type. In the case of the diaphragm type (Fig 1), the action of trituration forces a break in the separator, or diaphragm, and allows the mercury and alloy to mix. In the pillow type (Fig 2), the mercury is placed in a small packet, or pillow, of foil, which releases mercury during trituration.

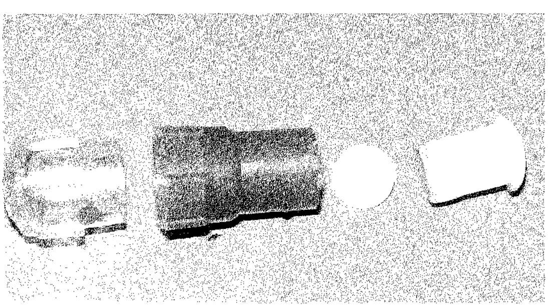

FIG 1. *Diaphragm type of capsule*

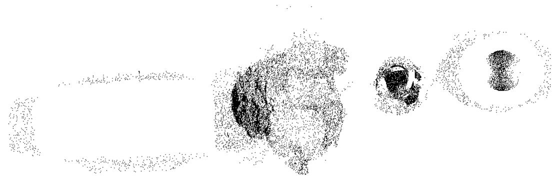

FIG 2. *Packet, or pillow, type of capsule*

For purposes of this study, capsules of the diaphragm type were opened and the alloy and mercury easily retrieved for individual measuring. In capsules where the mercury is contained in a pillow within the capsule, high-energy trituration was used to expel all of the mercury from the packet. For three brands (Dispersalloy, Contour, and Valiant), the particles of alloy tended to stick to the inside of the capsule, making retrieval difficult. In these cases, a subtractive, or "wash," method was used to obtain samples for weighing.

When the wash technic was necessary, the unopened capsule was first weighed and then the alloy removed by multiple washing and drying. The capsule was weighed again and the net weight of the alloy determined. Subsequently, the mercury was expressed from the packet, or pillow, by trituration with a pestle until no more free mercury could be detected and then each capsule was weighed a second time. The percentage of mercury by weight was then calculated for each capsule from the individual weights of the alloy and the mercury. At least 10 samples of each product were separated and weighed. Means and standard deviations expressed in percentages were calculated for each sample.

All but one of the brands tested supplied the alloy in the form of powder. Sabra Blend supplied the alloy in a loosely packed pellet within the capsule.

Results

The mean percentages of mercury for each brand of amalgam and the standard deviations are given in the table. Since there were often considerable differences between the actual mean percentages and

Mercury:Alloy Ratio of Preproportioned Capsules of Amalgam Compared with Manufacturers' Claims

Brand	Proportion of Mercury % — Manufacturer's Claim	Measured Mean	Measured SD	Measured Range
Aristaloy CR Precapsulated Engelhard Industries Carteret, NJ 07008	48.0	48.47	0.19	48.78-4804 = 0.74
Contour, Regular Set Sybron/Kerr Romulus, MI 48174	48.0	47.74	0.05	47.67-47.83 = 0.16
Dispersalloy, Cap II Johnson & Johnson East Windsor, NJ 08510	49.5 ± 0.5	49.36	0.13	49.18-49.55 = 0.37
Indiloy Double Spill, Discovery Pak Shofu Dental Corp Menlo Park, CA 94025	45.6	45.48	0.08	45.34-45.56 = 0.22
Optaloy II, Caps L D Caulk Co Milford, DE 19963	54.0	52.91	0.12	52.61-53.03 = 0.42
Permite C2N Caps Southern Dental Industries Tigard, OR 97223	52.0	52.98	0.09	52.84-53.09 = 0.25
Phasealloy Phase-A-Cap Phasealloy, Inc El Cajon, CA 92021	50.0	50.67	0.07	50.58-50.82 = 0.24
Sabra Blend Snap Caps Sabra Dental Products North Miami Beach, FL 33179	54.5	53.16	0.30	52.78-53.62 = 0.84
Sybraloy Precapsulated (zinc free) Sybron/Kerr Romulus, MI 48174	49.0 ± 0.5	49.14	0.07	49.04-49.27 = 0.23
Tytin White Cap-Double Spill S S White Philadelphia, PA 19102	42.4	42.30	0.07	42.21-42.42 = 0.21
Valiant, Sure Caps L D Caulk Co Milford, DE 19963	42.5	42.58	0.17	42.39-42.69 = 0.30

the nominal, or label, percentages, several manufacturers were contacted for clarification of the nominal figures. Correspondence with the technical directors for several of the manufacturers disclosed that the percentage of mercury used in a given batch of product is based upon the manufacturer's laboratory tests for optimal qualities of physical handling for that particular batch. In this respect, the percentage of some of the capsules measured varied from the stated nominal percentage but the percentage seemed to be fairly consistent from one capsule to another within a specific batch.

The percentages were then subjected to the Eames Range Test (Eames, 1972), which was published by the Council on Dental Materials as a standard for clinical tolerance. The table shows that all 11 of the brands tested were well within the range of ± 1.25% for percentage of mercury in the capsules. This shows a significant improvement in accuracy of packaging or control of quality for the preproportioned products tested. The poorest reliability was with Sabra Blend, the only capsule containing a loosely packed pellet instead of powdered alloy. However, the range was still well within the ± 1.25% set by Eames and the Council on Dental Materials in 1972.

When the percentages were subjected to the Bartlett Box F Test (Snedecor & Cochran, 1967) comparing variances within batches, it was determined that there are significant differences (less than $P = 0.001$) in the percentages. While being significantly different, all measurements fell within the guidelines accepted by the Council on Dental Materials of the American Dental Association as shown in the table.

Acknowledgments

The authors express appreciation for the support and consultation given by Wilmer B Eames. Dennis Zoglo in the Department of Biometrics at the University of Colorado Health Sciences Center was most helpful in planning and executing the statistics.

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Distinguished Member Award

The fourth annual Distinguished Member Award of the American Academy of Gold Foil Operators has been presented to James P Vernetti. The recipient of this award is selected for outstanding contributions to the Academy and the profession as a whole and no one can deny that Jim has devoted his time, talents, and energies to this end.

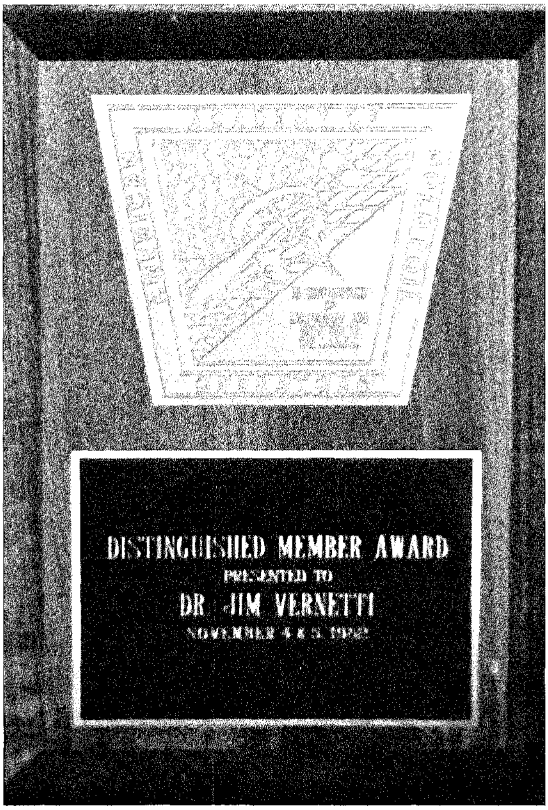
Having graduated from the University of Southern California in 1937, Jim spent 38 years in private practice in Coronado, California. As a tribute to his dedicated service the mayor of Coronado proclaimed 23 May 1975 Jim Vernetti Day and presented him with the key to the city.

During these years Dr Vernetti was not only involved in private practice but heavily committed to social and community activities. The Boy Scouts of America has been and continues to be one of Jim's favorite organizations and no one could better exemplify the spirit of the Scout oath: "On my honor I will do my best to do my duty to God and my country and to obey the Scout law, to help other people at all times, to keep myself physically strong, mentally awake, and morally straight."

In 1975 Jim left his beloved Coronado for the purpose of entering the academic arena as a full-time professor at the University of Texas Dental School at San Antonio. This was not his first commitment to teaching, however, since throughout his years in private practice Jim was also part time on the faculty at the University of California at Los Angeles, University of Southern California, and Loma Linda University as well as directing study clubs.

James P Vernetti

During his years at the University of Texas Dr Vernetti quickly demonstrated his teaching skills coupled with a compassion for and understanding of the dental student. Having earned the respect and admiration of his faculty colleagues and students he was selected as the commencement speaker in 1976, and received a plaque for the "Most Outstanding Professor" by the



Plaque presented to Dr Vernetti

student body in 1979. In addition, an annual James P Vernetti Award for Excellence in Operative Dentistry was created in 1978, and perhaps because of his continental charisma he was given the Women's Choice Award by the women of the Class of '79.

Civic affairs have always played a prominent role in Jim Vernetti's life. As a Rotarian Jim served as president of the Coronado Rotary Club and helped organize and served as the first president of the Oak Hill Rotary Club of San Antonio, Texas. Again, his manner and approach to people epitomize the Rotarian's four-way test of the things we think, say, or do:

1. Is it the truth?
2. Is it fair to all concerned?
3. Will it build good will and better friendship?
4. Will it be beneficial to all concerned?

In the field of organized dentistry Jim Vernetti has done it all. He is a charter member of the American Academy of Gold Foil Operators and a charter member of the Academy of Operative Dentistry, a member of the American Academy of Restorative Dentistry, a fellow of the American College of Dentists, the International College of Dentists, the Academy of General Dentistry, the Academy of Dentistry International, and a member of Omicron Kappa Upsilon.

G V Black said, "A professional man has no right to be other than a continuous student." Dr Vernetti has taken this one step further by not only being a continuous student but also a continuous teacher sharing his knowledge and talents with us all, and for this we are grateful.

As an ambassador of the American Academy of Gold Foil Operators Dr Vernetti visited Oral Roberts University this year to share his knowledge and skill with its faculty and student body. I would like to quote from the critiques of two students who participated in this learning experience:

"I feel truly honored to have been able to attend your lecture, not from the standpoint of your past accomplishments, but from your current humility and attitude toward inspired teaching and quality dentistry. Thank you so much for coming and sharing yourself with us—and most of all, for letting God speak to us through your life."

"I highly recommend Dr Vernetti's return next year. Before this last week, I had very little idea of what direct gold was; now I am sold on it and I am making it one of my goals to become excellent in gold restorations."

Our congratulations go to Jim Vernetti as the fourth recipient of the Distinguished Member Award. In addition to this plaque his name has also been added to those of the other distinguished recipients of this honor on a plaque, which hangs in perpetuity in a prominent place at the headquarters of the American Dental Association in Chicago.

From the address by Clifford H Miller, 12 November 1982.

DEPARTMENTS

Book Review

ORAL SURGERY AND DENTAL PRACTICE

By E Kruger and P Worthington

Published by Quintessence Publishing Company, Inc, Chicago, 1981. 392 pages. $68.00

This is an oral surgery textbook written by European and American authors for the dental student or the general dentist who wishes to retain some oral surgery in his practice. It is indexed and has suggestions for further reading at the end of each chapter.

As the foreword tells us, the purpose of this book "is to give not only a description of surgical techniques and a review of pain control measures, but also to describe problems of preoperative and postoperative management—including the prevention and treatment of potential complications. The selection of material is deliberately slanted toward the practicalities of general dental practice. And: "It should therefore be regarded as complementing, not replacing, works on general surgery and oral surgery."

There are chapters on surgical principles, extraction of teeth, apicoectomy, cysts, preprosthetic surgery, oral infections, and tooth trauma. Postoperative care and treatment of delayed bleeding are discussed.

Besides the two main authors, three contributing authors address dental implantology, periodontal surgery, and anesthesia. A periodontist has written the periodontal chapter. The four chapters on anesthesia give excellent coverage of techniques by a practicing oral surgeon for local, sedative, and general anesthesia. Treatment of emergencies is well covered. No detailed coverage of antibiotic prophylaxis for prevention of bacterial endocarditis was noted.

Advanced oral maxillofacial surgery comprising jaw fractures, temporomandibular joints, acquired or congenital defects, tumors, salivary glands, neurological problems, or hospital care was not included.

A chapter on sterilization is practical and detailed. This book sticks to its purpose and is an excellent book for the general dentist.

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Letters

As Our World Turns

I have just read "As Our World Turns" by Marvin A Johnson in the Spring 1982 issue of *Operative Dentistry* and I couldn't agree more. I spent 10 years on the Tennessee Board of Dentistry (dental examiners) and a large part of our time was spent in battling the bureaucrats of HEW and the liberal deans you so accurately describe. We are somewhat fortunate that there are some deans, not many but a few, who would agree with you. However, it isn't the deans who scare me the most—the ones who will ultimately cause our demise are the practitioners who want to give our profession away—the ones who support and promote such operations as the Delta Dental Plans, the Veterans Administration, etc., who set our fees and require that their fee schedule be accepted as payment in full. Our profession should not allow any third party, even though it is of our own doing, as is Delta Dental, and even if their fee schedule is twice our usual and customary fee, to set our fees as payment in full. This establishes a dangerous precedent that will deliver us into the hands of bureaucrats in Washington when they socialize the health care delivery programs. As it is now, many dentists who participate in these programs develop a system of auxiliary utilization that will produce a profit whatever the fee schedule.

Thank you, Dr Johnson, for saying it and saying it well. The rest of us should join you.

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Deadwood Must Go

I liked your editorial "Deadwood Must Go" (Spring 1982). I think the next effort toward eliminating deadwood in the profession should be directed at some of the dentists in practice. Note the enclosed overture from a dentist to me to become a salesman for honeybee juice. Also, I have been approached by practicing dentists to become a salesman for Amway products and spend my time selling toilet bowl cleaner and underarm foo foo. I think there are many deadwood professionals in the area of private practice who need to be chastised about using their professional position as a springboard to commercial enterprise. These interests cause professional values to rot and leave about the odor of commerce and materialism. Dentists who become entranced with commercial enterprise and fail to maintain professional competence because of business interests are deadwood as far as the real profession is concerned. Unfortunately this is also happening in medicine and the law. Society will become upset with educators who select people to become professionals, provide expensive schooling for them, and then have some of those so-called professionals spend time and talent selling bee juice or potty cleaner. This sounds ridiculous, but that's what is happening.

It is the editor and his journal (who seem always to be at the end of the line behind the researcher, the teacher, and the practitioner) who must keep the profession and the professional "in line" regarding conduct. The end of the line is a good position for it allows the editor to monitor these others and when the occasion demands, apply a gentle pat on the head, a poke in the ribs, or a rap on the knuckles. The last two take courage, even professional journalistic guts at times. This you have evidenced in your editorial, and that's why I like it. Besides, it is well written.

For similar reasons I also like Marvin A Johnson's "As Our World Turns," in that same issue.

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Scarcity of Materials

My sincere compliments on an excellent issue (Vol 7, No 1). Your editorial ("Conserving Scarce Materials") is also quite appropriate. We are prone to waste things in our disposable society simply because they are affordable.

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Rome, NY 13440

Wit and Wisdom

The brain is not an organ of thinking, but an organ of survival, like claws and fangs. It is made in such a way as to make us accept as truth that which is only advantage. It is an exceptional, almost pathological constitution one has, if one follows thoughts logically through, regardless of consequences. Such people make martyrs, apostles, or scientists, and mostly end on the stake, or in a chair, electric or academic.

—Albert Szent-Gyorgyi

Announcements

NOTICE OF MEETINGS

Academy of Operative Dentistry
Annual Meeting: 17 and 18 February 1983
Westin Hotel
Chicago, Illinois

American Academy of Gold Foil Operators
Annual Meeting: 29 and 30 September 1983
University of California at Los Angeles
Los Angeles, California

Bernie Lodge and Sandy Hartley condensing a class 5 foil.

NEWS OF THE ACADEMIES

American Academy of Gold Foil Operators

The 32nd annual meeting was held 4-5 November 1982 at the University of Southern California School of Dentistry and the University Hilton Hotel in Los Angeles. Clinical operations of direct gold restorations were demonstrated during the morning of 4 November. In the afternoon the members and their guests visited the Huntington Library, Gallery, and Gardens in Pasadena. The day concluded with the president's reception and banquet, the highlights of the banquet being the presentation of the Distinguished Member Award to James P Vernetti and an address on diet and nutrition by Nathan Pritikin. The next morning was given to reports and essays.

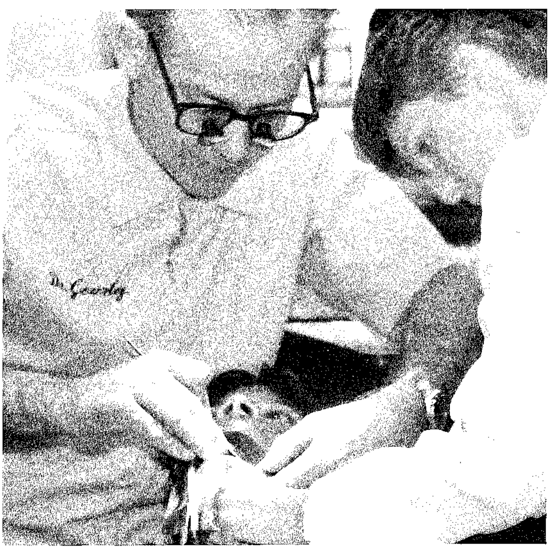
The officers of the academy for the forthcoming year are:

President: Norman C Ferguson
President-elect: William J Roberts
Vice-president: Ronald K Harris
Secretary-treasurer: Ralph A Boelsche
Councillors: Nelson W Rupp, Julian J Thomas, Jr, and Roy A Fetterman.

Norm Ferguson, delivering his presidential speech.

Harold Schnepper, the outgoing president, addressing the assembly.

Gerry Stibbs and Ludlow Beamish shadowing the operation for a better view.



Jim Gourley and Rene Kelly operate on the distal of the lower first premolar.

Jim and Joanne Harken condensing gold foil.

Scenes from the annual meeting of the American Academy of Gold Foil Operators

Press Digest

Pulpal effects of electrosurgery involving based and unbased cervical amalgam restorations. Spangberg, L S, Helldén, L, Robertson, P B & Levy, B M ***Oral Surgery, Oral Medicine and Oral Pathology,*** **54, 678-685.**

When the electrode of an electrosurgery unit operated under conditions of normal clinical use was applied to enamel, cementum, and class 5 restorations of amalgam with bases of calcium hydroxide and varnish and without bases in extracted human teeth the potential between the electrode and a reference probe in the pulp was slightly less for teeth without bases, and could not be detected through enamel and cementum.

When the probe was applied for one second to amalgam restorations with and without bases in the teeth of monkeys pulpal damage was found, including altered matrix of dentin, necrosis subjacent to the cavity, and a zone of transition between necrotic and vital pulp. By eight weeks after electrosurgery most of the specimens showed that the odontoblastic layer and the adjacent pulp tissue had been replaced by dense connective tissue with areas of irregular calcification. Application of the electrode to enamel had no discernible effect on the pulp.

Effects of electrosurgery on dog pulps under cervical metallic restorations. Krejci, R F, Reinhardt, R C, Wentz, F M, Hardt, A B & Shaw D H (1982) ***Oral Surgery, Oral Medicine and Oral Pathology*** **(54) 575-582.**

At levels of power normally used for removing redundant gingivae, passing the active electrode of an electrosurgical unit across a class 5 restoration of amalgam produced no histologic changes in the pulps of the teeth of dogs if the time of contact was 0.4 seconds or less. Longer periods of contact resulted in pulpal damage.

Effect of sucrose rinses on bacterial colonization on amalgam and composite. Skjørland, K Kr and Sønju, T (1982) ***Acta Odontologica Scandinavica,*** **40, 193-196.**

Small disks, 5 mm in diameter, made from amalgam (Royal Dental Alloy) and composite (Adaptic) were fastened to the facial surfaces of upper molar teeth for 2½ h. The experimental subjects rinsed with a 15% solution of sucrose every hour for 12 hours before the disks were inserted. At the end of 2½ h the disks were removed and cultured. The highest number of colonies of bacteria were found on the composite. Few were found on amalgam or enamel.

Analgesic efficacy in dental pain. Seymour, R A & Walton, J G (1982) ***British Dental Journal,*** **153, 291-298.**

A review of the studies of the efficacy of different analgesics on the treatment of postoperative dental pain suggests that aspirin, when prescribed in a single dose of 1000 mg or more, is the drug of choice followed, though not closely, by paracetamol for those patients for whom aspirin is contraindicated. The authors report that two new drugs, diflunisal and zomepirac, appear promising.

Periodontal tissue changes after intraligamentary anesthesia. Brännström, M, Nordenvall, K-J & Hëdstrom, K G (1982) ***Journal of Dentistry for Children,*** **49, 417-423.**

Injections into the periodontal ligament of monkeys with a Peripress syringe, a 30-gauge needle, and Citanest with Octapressin produced localized damage in the tissue, which showed signs of healing after two weeks. The authors advise not injecting on both sides of the alveolar crest because more extensive damage may result. They also caution against the use of anesthetics containing epinephrine and advocate that the gingival sulcus and the neck of the tooth be cleaned and disinfected to minimize the possibility of infecting the periodontium. The authors also warn of possible damage to developing permanent teeth if the technique were used for primary teeth.

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

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

Exclusive Publication

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Manuscripts

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

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References

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