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EDITORIAL

Deficit Bashing

Deficits are always problems but the national deficit of the United States has become a problem whose resolution has been accorded the highest priority. In fact the national deficit has now replaced inflation (also a consequence of a mismanaged economy) as the foremost danger to the economic health of the nation.

One does not have to be a genius to realize that if expenditures exceed receipts bankruptcy is likely to ensue and, therefore, given the mental capacity of those that govern our affairs, it is astonishing that we should be in any financial difficulty. As it stands, however, if we are to become solvent the government must either increase its revenue or decrease its disbursements, or both.

The government obtains its revenue mainly by taxation, but raising taxes affects the economy adversely by reducing incentives to work, by reducing investment, and, concomitantly, by reducing the establishment of new businesses and thus the opportunity for more jobs. One way for the government to augment its revenue would be to close the loopholes that allow some to circumvent the payment of taxes by engaging in activities that lead to distortions in the allocation of resources. The government often uses its power of taxation to effect economic policy by encouraging some activities while discouraging others, sometimes the result being the opposite of that intended. This is understandable given the ramifications of the economy and the interrelatedness of its parts.

Reducing expenditures would seem to be sensible but this approach is snarled with roadblocks because much of the government's expenditure is for subsidies to special interests. As we have seen, almost every attempt to eliminate or reduce a subsidy has been challenged by the special interest it serves. Special interests, forming numerically smaller constituencies than the population of consumers, are more easily organized and thus more effective in serving their own ends (Olson, 1982). Subsidies allow their recipients to get a relatively larger share of the economic pie than otherwise would be possible, but only at the cost of the production of a smaller pie.

Contributions toward health insurance can be deducted by the employer as a cost, and, as income to the employee, are not taxable. By exempting this part of income from taxation the federal government has subsidized health insurance by 16-42%, depending on the income of the consumer, and has thus contributed to the inflated costs of medical and dental treatment (Frech, 1984). With the urgent need to reduce the deficit, would it not be better, at this point, to recognize subsidies for the impediments they are to economic progress, renounce them, and reward the special interests with relatively smaller shares of what would be a much larger and more delicious economic pie?

A further step in improving the health of the economy would be to eliminate fringe benefits, such as health insurance, by paying employees the equivalent in cash. Third parties, beware!

A IAN HAMILTON
University of Washington
School of Dentistry SM-56
Seattle, WA 98195, USA

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ORIGINAL ARTICLES

Speed Variation in New and Used Amalgamators

The speed at which amalgamators operate may vary with line voltage, age, and weight of capsule. Some amalgamators may require warming up to attain their specified speed.

WILLIAM W BRACKETT

Summary

The following amalgamators [Wig-L-Bug (LP-60, DS-80, and S-2000), Vari-Mix (II, IIM, and III), Silamat, and Capmaster] were tested for variations in speed: 1) during warm-up, 2) with age, 3) with changes in line voltage, and 4) with changes in weight of capsule. Variable-speed amalgamators of older design (Wig-L-Bug LP-60 and DS-80 and Vari-Mix II) are the most susceptible to variations in speed from changes in line voltage, during warming up, and with age.

INTRODUCTION

Mechanical amalgamation has been widely accepted since the 1940s (Sweeney, 1940; Phillips, 1944). While several studies (Osborne & others, 1977; Espevik, 1977; Asgar & Arfaei, 1975) have shown that variation in trituration can adversely affect the physical properties of conventional amalgams, none has shown any significant effect on those of high-copper amalgams (Osborne & others, 1977; Rehberg & Gramberg, 1979; Duke, 1981). Unfortunately, relatively few high-copper alloys have been evaluated in these studies.

Since physical properties of amalgam correlate poorly with its handling characteristics during condensation and carving (Jørgensen, 1983), it is not known whether the handling of high-copper amalgams is altered by variation in mixing, though one study (Eames & others, 1981) implies that it is.

Even in the absence of definite information about the significance of mixing speed, an amalgamator that maintains its speed under varied conditions and with age must be a better choice than one of similar price that does not. Consistent speed may be the best criterion for selecting an amalgamator, since operating speed cannot be easily assessed by the operator.

The purpose of this study was to determine whether several models of amalgamator do indeed maintain consistent speed with variation in line voltage or weight of capsule and with long-term use.

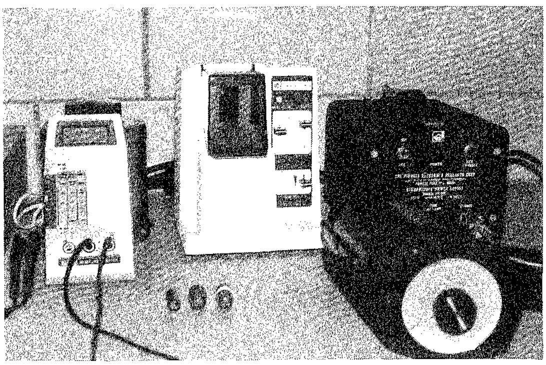
Indiana University School of Dentistry, Department of Operative Dentistry, 1121 West Michigan Street, Indianapolis, IN 46202, USA

WILLIAM W BRACKETT, DDS, assistant professor

MATERIALS AND METHODS

All determinations of the speed of the amalgamators were made, during the latter half of a 10-second run, with a stroboscope (Model PS 30K, Pioneer Electric and Research Corporation, Forest Park, IL 60130, USA) accurate to ±25 cycles per minute (c min^{-1}) or 0.4 Hz. Amalgamators with multiple speeds were tested at the speed setting used for most alloys.

Line voltage was controlled with a variable transformer and measured with a voltmeter. The weight of the capsule was determined on an analytical balance. The test apparatus is shown in the figure.



Test apparatus: transformer, volt meter (left), stroboscope (right)

The following new amalgamators were tested: Wig-L-Bug DS-80 and S-2000 (Crescent Dental Manufacturing, Inc, Lyons, IL 60534, USA), Vari-Mix III (L D Caulk Co, Milford, DE 19963, USA), Capmaster (S S White Dental Products, Philadelphia, PA 19102, USA), and Silamat (H D Justi Manufacturing Co, Oxnard, CA 93030, USA). One of each type was available for testing.

The following used amalgamators, generally at least five years old, were tested: Wig-L-Bug LP-60 (Crescent Dental Manufacturing), Vari-Mix II and IIM (L D Caulk Co), and Silamat (H D Justi Manufacturing Co). Two Vari-Mix IIM, 10 Vari-Mix II, 33 Silamat, and 53 LP-60 amalgamators were located for testing.

Warm-up

Pilot studies indicated variation in speed over the first few runs for some machines. However, the operating speed was stable by the third or fourth run for these machines. Based on this information, all available machines were tested on two occasions for four consecutive runs with line voltage and weight of capsule constant at 120 V and 4.62 g, respectively. For this and all subsequent tests, runs were separated by a delay of 30 seconds, and all amalgamators had been unused for at least 24 hours before each testing. So that speeds would be stable, amalgamators were warmed up for 30 seconds before all subsequent tests.

Age

Average speeds for the fourth run in the tests for variation during warm-up were used to determine variation with age in used machines. This was done for all but the Vari-Mix IIM machines, which were too few in number for a statistical comparison.

Line Voltage

Preliminary investigations showed that line voltage varied from 108 V to 127 V. Based on this information, each type of machine was tested at each increment of 5 V over the range of 105-125 V. For each machine, two test runs were made at each voltage on two separate occasions. Used machines that showed variation with age were excluded from this test so that the effects of changing line voltage could be observed independent of age. Eight LP-60, nine Silamat, seven Vari-Mix II, and two Vari-Mix IIM amalgamators were included. Weight of capsule was 4.62 g.

Weight of Capsule

One of each type of amalgamator was tested for variation in speed due to a change in weight of capsule. (A machine performing at specification was selected for each type of used amalgamator.) Weights selected for the capsules were 2.60 g (typical weight for a precapsulated system with no pestle), 6.38 g (typical for a double mix of a dispensed system with a pestle), and 4.62 g (an intermediate weight). On two separate occasions, two test runs were made for each machine with each weight of capsule. Line voltage was 120 V.

Statistical Analysis

No statistical analysis was undertaken for results in any test of new amalgamators since only one of each type was available. This was also the case for the used Vari-Mix IIM amalgamators, since only two were located for testing. The effects of varied weight of capsule were determined using only one of each type of machine and no statistical comparisons were made.

At least seven of each of the remaining models of used amalgamator were included in the sections on warm-up, age, and line voltage, and these results were analyzed using a *t*-test with a significance level of $P < 0.05$.

RESULTS

Warm-up

Each new machine ran at the same speed for all runs. Average speeds for the first and fourth runs of used machines are reported in Table 1. The Wig-L-Bug LP-60 and the Vari-Mix II amalgamators showed a significant increase in speed over the four runs.

Age

Average speeds for the fourth runs shown in Table 1 were compared to the manufacturer's specified speed to determine the change in speed due to age for used machines. All of the used machines available in sufficient numbers showed significant variation in speed with age. The LP-60 and Silamat amalgamators ran slower than the specified speed, whereas the Vari-Mix II amalgamators ran faster. The increased speed of Vari-Mix II amalgamators with age is in agreement with an earlier study (DuBois, Haisch & Rinne, 1982). The two Vari-Mix IIM amalgamators tested showed no change in speed with age.

Line Voltage

Variations in speed with changing line voltage are reported for all amalgamators in Table 2. Of the new amalgamators, only the Wig-L-Bug DS-80 showed much variation, with operating speed increasing as line voltage was increased. The LP-60, Silamat, and Vari-Mix II amalgamators were included in sufficient

Table 1. Amalgamator Speed on Consecutive Runs

Amalgamator	Number Tested	Setting	Specified Speed	Speed c min^{-1} (Hz) Run 1 mean	Run 1 SD	Run 4 mean	Run 4 SD
LP-60*	53	medium	3600 (60)	2923 (42)	334 (6)	3223** (54)	350 (6)
Silamat	33	—	4500 (75)	4380 (73)	146 (2)	4379** (73)	146 (2)
Vari-Mix II*	10	M2	3600 (60)	3890 (65)	522 (9)	3995 (67)	540 (9)
Vari-Mix IIM	2	M2	3600 (60)	3600 (60)	—	3600 (60)	—

*Statistically significant, Run 1 vs Run 4, $P < 0.05$ (*t*-test)
**Statistically significant, Run 4 vs specification, $P < 0.05$ (*t*-test)

Table 2. Amalgamator Speed at Various Line Voltages (weight of capsule = 4.62 g)

Amalgamator	Number Tested	Setting	Specified Speed	Speed c min^{-1} (Hz) 105 V		110 V		115 V		120 V		125 V	
				mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
LP-60	8	medium	3600 (60)	2856* (48)	148 (3)	3188* (52)	138 (2)	3344* (57)	105 (2)	3563 (59)	106 (2)	3788* (63)	128 (2)
Silamat	9		4500 (75)	4378* (73)	97 (2)	4405* (73)	110 (2)	4428* (74)	123 (2)	4433 (74)	109 (2)	4455* (74)	92 (2)
Vari-Mix II	7	M2	3600 (60)	3028* (51)	236 (4)	3264* (54)	125 (2)	3442* (57)	79 (1)	3600 (60)	58 (0)	3707* (62)	89 (2)
Vari-Mix IIM	2	M2	3600 (60)	3600 (60)		3600 (60)		3600 (60)		3600 (60)		3600 (60)	
Vari-Mix III	1	medium	3600 (60)	3650 (61)		3700 (62)		3700 (62)		3700 (62)		3700 (62)	
Capmaster	1		3200 (53)	3050 (51)		3100 (52)		3150 (53)		3200 (53)		3200 (53)	
DS-80	1	low	3200 (53)	3400 (57)		3500 (58)		3650 (61)		3800 (63)		3950 (66)	
S-2000	1	2 of 4	3900 (65)	3900 (65)		3900 (65)		3900 (65)		3900 (65)		3900 (65)	

*Statistically significant vs 120 V, $P < 0.05$ (*t*-test) number for comparison. For all three models, average speeds for each of the other voltages were significantly different than the average speeds for 120 V. All showed increased speed with increased voltage. There were no changes in speed noted for the two Vari-Mix IIM machines tested.

Weight of Capsule

The effect of increased weight of capsule on each type of amalgamator is noted in Table 3. Only the Vari-Mix IIM and III were unaffected by change in weight of capsule. The other multiple-speed amalgamators (Wig-L-Bug LP-60, DS-80, and S-2000) seem to be more affected by varied weights of capsule than the single-speed Silamat and Capmaster machines.

DISCUSSION

The data suggest that variable-speed amalgamators of older design (Wig-L-Bug LP-60 and DS-80, and Vari-Mix II) are the most susceptible to variation from changing line voltage and age and are the most likely to run at a reduced speed until they warm up. The variable-resistor control for speed has been implicated as the source of much of this variation (S S White Technical Data, 1982).

Manufacturers' claims that variable-speed models of newer design (Wig-L-Bug S-2000,

Table 3. Amalgamator Speed with Various Weights of Capsule (line voltage = 120 V)

Amalgamator	Setting	Specified Speed	Speed c min^{-1} (Hz) 2.60 g	4.62 g	6.38 g
LP-60	medium	3600 (60)	3700 (62)	3600 (60)	3450 (58)
Silamat		4500 (75)	4500 (75)	4500 (75)	4350 (73)
Vari-Mix II	M2	3600 (60)	4200 (70)	3600 (60)	3600 (60)
Vari-Mix IIM	M2	3600 (60)	3600 (60)	3600 (60)	3600 (60)
Vari-Mix III	medium	3600 (60)	3700 (62)	3700 (62)	3650 (61)
Capmaster		3200 (53)	3200 (53)	3200 (53)	3100 (52)
DS-80	low	3200 (53)	3800 (63)	3800 (63)	3600 (60)
S-2000	2 of 4	3900 (65)	4000 (67)	3900 (65)	3750 (63)

Vari-Mix IIM and III) electronically compensate for variation in line voltage seem to be accurate, though the Vari-Mix IIM and III are the only machines tested that also compensate for variation in weight of capsule. How these more sophisticated machines will perform with age is not yet known.

The single-speed amalgamators (Capmaster; Silamat) appear to maintain their calibration relatively well with age, and to show less variation with changing line voltage or weight of capsule than the older designs of variable machines.

Though many of the observed differences in this study are statistically significant, their clinical importance is not fully understood. The properties of some brands of amalgam that have not been evaluated may be adversely affected by trituration at an inappropriate speed. It is also possible that variation in the operation of the amalgamator could cause some of the inconsistencies in the setting rate of amalgam that are observed in clinical practice.

CONCLUSIONS

All of the variables studied cause changes in speed in some types of amalgamator. Most of the variation observed can be minimized by avoidance of mixes of amalgam heavier than two spills, and by use of either a single-speed amalgamator or a variable-speed amalgamator of newer design.

Older machines should probably be warmed up each day before use, and their operating speed checked periodically with a stroboscope.

(Accepted 17 April 1984)

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Frequency of Secondary Caries at Various Anatomical Locations

Caries recurs more frequently at cervical and approximal margins than at incisal or occlusal margins

IVAR A MJÖR

Summary

Of 1570 restorations (1238 amalgam and 332 composite), placed by 28 clinicians during a period of two weeks, most of them replaced failing restorations (637 amalgam and 235 composite), and of these the reason for replacement of 453 (72%) amalgams and 102 (43%) composites was secondary caries. Examination of 261 class 2 amalgams and 102 composites, replaced because of the clinical diagnosis of secondary caries, disclosed that caries recurred mainly at cervical and approximal margins (93% for amalgam and 62% for composite) compared with incisal and occlusal margins (7% for amalgam and 38% for composite).

NIOM, Scandinavian Institute of Dental Materials, Forskningsveien 1, 0371 Oslo 3, Norway

IVAR A MJÖR, BDS, MSD, MS, Dr odont, director

Introduction

Secondary, or recurrent, caries is by definition found at the interface of tooth and restoration. The processes involved are considered to be similar to those causing primary caries. Therefore, the importance of oral hygiene and retention of food must be considered when evaluating the distribution and frequency of secondary caries.

Secondary caries represents the main reason for replacement of amalgam restorations, and it is one of three major reasons for replacement of composite restorations (Mjör, 1981; Mjör & Leinfelder, 1985). However, few details are available on clinical evaluation of secondary caries. In a recent review paper it has been claimed that marginal breakdown of amalgam restorations may predispose to secondary caries (O'Brien, Mahler & Greener, 1985). Jørgensen & Wakumoto (1968) studied selected areas on teeth with class 1 restorations of amalgam that did not exhibit any gross defects. They demonstrated a correlation between the magnitude of marginal defects and secondary caries, diagnosed microscopically, in certain areas but not in others. A correlation between marginal quality and secondary caries was also shown by Goldberg and others (1981), but no significant correlation existed on the occlusal surface. A 10-year clinical study did not show a significant relationship between marginal breakdown and clinical failure (Hamilton & others, 1983), which agrees with observations by Mjör (1981), who recorded poor marginal adaptation as the reason for replacement of amalgam restorations in only 8% of all teeth.

The aim of the present study was to clinically evaluate the frequency of secondary caries at various anatomical positions.

Materials and Methods

Twenty-eight clinicians treating both children and adults agreed to record all the restorations placed in a two-week period and to differentiate between those placed due to primary caries and those that were replacements of defective restorations. Secondary caries as the reason for replacement of restorations was singled out, and the clinicians were instructed to make a diagram of the defective fillings on a chart that was supplied and to indicate in red where the secondary caries was localized. The clinicians were also asked to report, whenever possible, the age of the restorations replaced due to secondary caries, that is, when the restoration had been placed in the same practice. Restorations of amalgam and composite in permanent teeth and restorations of amalgam in deciduous teeth were recorded on separate charts.

Results

A total of 1570 restorations were inserted and their distribution is shown in Table 1. Replacement of restorations constituted more than half of all the amalgam restorations inserted in permanent teeth and about a third of those placed in deciduous teeth. More than 70% of all composite restorations were replacements. Secondary caries was by far the most frequent reason for replacement of amalgam restorations, especially in permanent teeth (Table 1). It was generally located cervically and approximally and only rarely on the occlusal surface. The localization of secondary caries on 261 class 2 restorations in permanent teeth clearly showed that the cervical and approximal areas were much more susceptible than

Table 1. Distribution of Restorations

Material		Primary Caries		Replacements		Replacements due to Secondary Caries	
	n	*n*	*(%)*	*n*	*(%)*	*n*	*(%)*
Amalgam (permanent teeth)	1095	598	(46)	587	(54)	425	(72)
Amalgam (deciduous teeth)	143	93	(65)	50	(35)	28	(56)
Composite	332	97	(29)	235	(71)	102	(43)

Table 2. Anatomical Location of Secondary Caries in Permanent Teeth

Material		Cervically and Approximally		Occlusally or Incisally	
	n	*n*	*(%)*	*n*	*(%)*
Amalgam Class 2 restorations	261	242	(93)	19	(7)
Composite	102	63	(62)	39	(38)

the occlusal surface (Table 2). The composite restorations recorded were all class 3 and class 5 types. They also exhibited secondary caries more frequently at the cervical and approximal areas than at the incisal and occlusal aspects.

The ages of the restorations replaced due to secondary caries were recorded for 330 amalgam restorations (including 28 in deciduous teeth) and 110 tooth-colored restorations. A detailed subdivision of these relatively small groups can reflect only trends. The same intervals of time, in years, as used in a previous survey, were employed (Mjör, 1981). The distribution of the ages of the amalgam (Fig 1) and composite restorations (Fig 2) indicates that for most permanent teeth recurrent caries develops within 10 years for amalgam restorations and within 7 years for composite restorations.

Discussion

Because the population of the present study included children as well as adults, the percentages of the amalgam restorations inserted in permanent teeth due to primary caries and those inserted as replacements for failed restorations differ from those in a previous study comprising only adults (Mjör, 1981). Almost half of the restorations placed in the present study were due to primary caries, whereas only

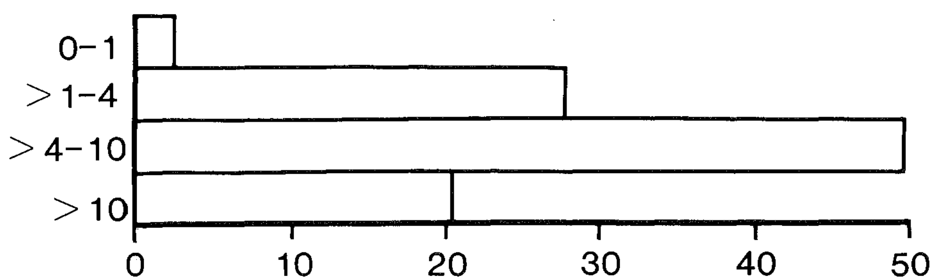

FIG 1. *Distribution of amalgam restorations by age in permanent teeth that required replacement due to secondary caries (*n = *320)*

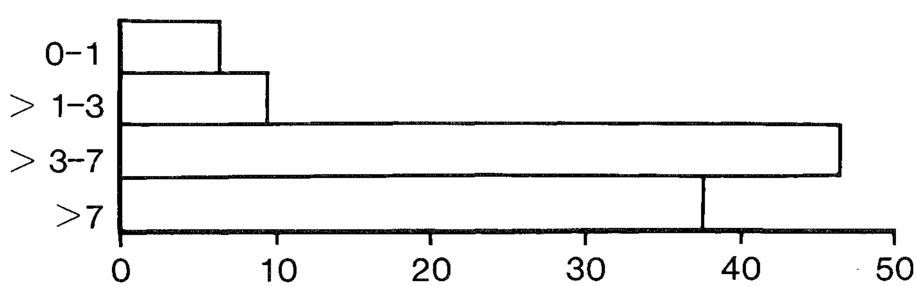

FIG 2. *Distribution of composite restorations by age in permanent teeth that required replacement due to secondary caries (*n = *110)*

29% were recorded in the previous study. Charbeneau and Klausner (1984) have reported that almost 60% of all restorations placed were due to primary caries. Such deviations may be explained by differences in the ages of the populations of patients studied, because the rate of replacement of restorations depends on age (Birkeland, 1980). The differences in rates of replacement in deciduous and permanent teeth may be explained by the somewhat limited life span of deciduous teeth and also because the reasons for replacement of restorations in deciduous teeth differ from those in permanent teeth (Dunston & others, 1978).

The rate of replacement of 71% for tooth-colored restorations was only slightly lower than that reported previously (Mjör, 1981). The effect of age on the rate of replacement is therefore less noticeable for composite than for amalgam restorations. This is to be expected because composite restorations are placed later in life and less frequently than amalgam restorations.

A higher incidence of secondary caries as the reported reason for replacement of restorations was found in the present study compared to previous data (see review by Mjör & Leinfelder, 1985). It amounted to 72% compared to an average value of about 55% for permanent teeth in previous reports. No apparent features can explain this difference, except that the present investigation focused attention on secondary caries. Such emphasis on one clinical parameter may have alerted the clinicians' attention to this problem and thus increased the number of diagnosed lesions.

The information on the anatomical position of the secondary carious lesions in permanent teeth clearly indicated that the cervical and approximal areas were much more vulnerable than the occlusal or incisal aspects, especially for amalgam restorations, as indicated by Eide and Birkeland (1982). For class 2 restorations only 7% of all secondary carious lesions were found occlusally. Analyses of the degree of marginal degradation of the amalgam restorations replaced were not performed, primarily because the previous surveys had shown that marginal breakdown was a minor clinical problem (Mjör, 1981). A similar conclusion may be made regarding occlusal secondary caries. The information related to the position of secondary caries for composite restorations (Table 2) indicates that more than a third were located along the incisal or occlusal part of the restoration, that is, quite different from that of amalgam restorations. A greater accumulation of plaque on composite materials than on amalgam (Skjørland, 1973) may explain this difference.

Marginal degradation of amalgam restorations, a feature typical of the occlusal surface, is usually recorded by indirect techniques such as photography and impressions/replicas. Several reports have shown statistically significant differences in marginal degradation between different brands of amalgam (Mahler & others, 1970; Letzel & others, 1978). Clinically significant results may also be found under extreme conditions using a conventional amalgam with a high value of creep (Mjör & Espevik, 1980). However, marginal degradation has limited value as a parameter for the general clinical quality of amalgam restorations in terms of effects on the rate of replacement. Furthermore, the present data emphasize the importance of secondary caries as a reason for replacement of restorations. The fact that most of the lesions are located cervically and approximally supports the observations of Goldberg and others (1981), who did not find any correlation between secondary caries and a score of marginal quality beyond 3, on a scale of 1-11. The present observations also support the conclusion reached by Hamilton and others (1983), who found no significant relationship between marginal breakdown and clinical failure.

'Secondary caries', or 'recurrent caries', are ill-defined terms in the clinical context. Broadly speaking, any condition where the probe tends to stick or catch might be recorded as recurrent caries. Undoubtedly, a number of the lesions clinically recorded as secondary caries may be due to voids or crevices caused by inadequate condensation of the amalgam during insertion (Mjör & Smith, 1984) or to faulty preparation of cavities. Such voids are particularly frequent at the cervical and approximal parts of amalgam restorations (Ekstrand & Mjör, unpublished).

The possibility that the caries recorded adjacent to a restoration in fact is not secondary, but residual, must also be considered. Furthermore, lesions may develop in the enamel and extend to a restoration and thus be misdiagnosed as secondary caries. No attempt was made to define the term 'secondary caries' to the clinicians in the present study; it represents merely the clinical diagnosis of secondary caries.

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Castability of Alloys of Base Metal and Semiprecious Metal for Dental Castings

Alloys of base metal and semiprecious metal generally form good castings

J S COVINGTON • M A McBRIDE
W F SLAGLE • A L DISNEY

Summary

The castability of 32 alloys of base or semiprecious metals for dental castings was assessed by determining the proportion of a mold formed by a polyester sieve that was completely filled by the castings. The castability of the alloys ranged from 45.9 to 100%, with eight of the alloys having a mean of 100%.

University of Tennessee, Center for the Health Sciences, College of Dentistry, Department of Biologic and Diagnostic Sciences, Memphis, TN 38163, USA

J S COVINGTON, BS, MS, DDS, assistant professor

M A McBRIDE, BS, DDS, instructor of operative dentistry

W F SLAGLE, BA, MEd, DDS, professor and dean

A L DISNEY, CDT, assistant professor and director of the Dental Production Laboratory

Introduction

Although few would contest the superiority of the formulations of the American Dental Association's types II and III alloys for dental castings, the increased cost of gold has led to the development of many new alloys that have a lower content of gold than the traditional alloys for dental castings. The manufacturers of these new alloys provide information about some of the properties of the alloys but none is available on castability. The ability of a molten alloy to fill a mold has been assessed by various methods: casting of sieves, thin plates, spirals, wedges, spoked wheels, saucers, razor blades, and copings; measurement of marginal discrepancy; and matching of cast frameworks. These methods have been used by researchers to lend numerical equivalents to otherwise nebulous criteria. There has been little concurrence on methods.

The purpose of our study was to assess the castability of many of the new alloys that have a low content of gold compared with the traditional alloys. Since no absolute unit for measuring castability is available, we decided to use a

Table 1. Alloys, Manufacturers, and Composition

Manufacturer	Alloy	Composition by Weight (%)								
		Ni	Cr	Mo	Be	Ag	Co	Pd	In	Other
Alba Dent, Concord, CA	Verabond	P	P	-	2	-	-	-	-	
Aderer, Long Island City, NY	Bond-On	-	-	-	-	-	T	80	T	
	Cer-On	-	-	-	-	40	-	50	T	
	Pors-On	-	-	-	-	31	-	58	T	
Astro, Morton Grove, IL	Astro-3	66	22	-	-	-	-	-	-	
	Mighty Bond	77	20	-	-	-	-	-	-	
	Astro Superior	66	22	-	-	-	-	-	-	Sn
Ceramco, East Windsor, NJ	Bake-ON NP	77	13	5	2	-	-	-	-	
	Bake-ON SP	-	-	-	-	30	-	58	-	
	Ceramalloy	72	19	4	-	-	-	-	-	4Si, B
	Ceramalloy II	72	19	4	-	-	-	-	-	4Si, B
Dentsply, York, PA	Biobond C&B	76	12	3	-	-	-	-	-	Sn, Si, Nb, B
Heraeus, Queens Village, NY	Albabond-O	-	-	-	-	37	-	53	T	
	Albabond-60	-	-	-	-	28	-	61	T	
	Dent-O-Bond	-	28	-	-	-	64	-	-	
	Omni	78	12	5	T	-	-	-	-	Si, Al
Howmedica, Chicago, IL	A-35	-	-	-	-	30	-	60	-	
Jelenko, Armonk, NY	Genesis	-	27	-	-	-	53	-	-	
	Jelstar	-	-	-	-	28	-	60	6	6Sn
	Odyssey	78	12	5	2	-	-	-	-	3Al, Si, C
Jeneric, Wallingford, CT	Rexillium III	76	13	5	2	-	-	-	-	Al, Co, Ti, Zr
Leff, Woodside, NY	Fidelity 1000	P	P		P	-	-	-	-	
	Opal	-	-	-	-	-	-	60	-	
Neoloy, Posen, IL	Neobond-II	-	P	-	-	-	P	-	-	
	Neobond-II Special	-	P	-	-	-	P	-	-	
Ney, Bloomfield, CT	Neydium	77	12	T	-	-	-	-	-	Si, Al, Nb
Pacific, Santa Ana, CA	Formula 5-B	70	17	6	2	-	-	-	-	2Si, 3Al, 0.25 Fe
Pentron, Wallingford, CT	Excel	-	30	-	-	-	60	-	-	
	Pentex - 90	-	-	-	-	-	-	60	-	
	Pentillium	76	13	5	2	-	-	-	-	Al, Co, Ti, Zr
Williams, Buffalo, NY	Litecast-B	77	13	4	2	-	-	-	-	Si, Al, Fe
	Will Ceram W-1	-	-	-	-	38	-	53	-	

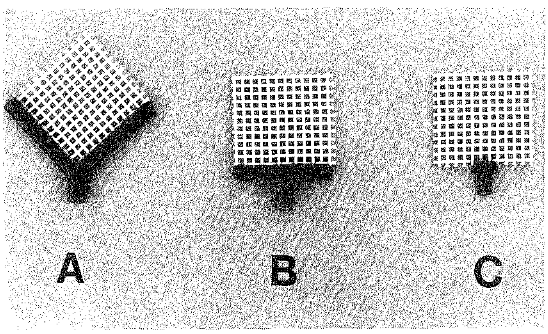
P = Element present but percentage not divulged by manufacturer
\- = None indicated by manufacturer
T = Trace

test employing a mold of standard dimensions that is sufficiently complex to enable a ranking of castability that is statistically valid.

Materials and Methods

Thirty-two alloys were investigated in this study. Grouped by type of base, seven were nickel-chromium, eight nickel-beryllium, eight silver-palladium, two palladium, and six chromium-cobalt. The names, composition, and respective manufacturers of the alloys are given in Table 1.

The casting form used, a modification of the one suggested by Whitlock and others (1981), is shown in the figure. The form consists of a sieve of polyester cloth (Nalgene Division, Sybron Corporation, Rochester, NY 14602, USA) of standard dimensions as specified by the American Society of Technical Manufacturers, Specification No E11-70. The cloth has square openings (1.0 x 1.0 mm) and provides a standard form that is easily duplicated. The pattern measured 10 x 10 squares. The short stubs remaining after the pattern was cut were used to lute the pattern to the two sprues that ran along two sides of the square, which was oriented in the form of a diamond. The number of completed squares in the casting, expressed as a percentage, was the basis for assigning a value of castability. Nine castings were made for each alloy.



The three patterns used in this study. Pattern A *is that suggested by Whitlock. For the 20 alloys with values of castability of 99% or greater, a more difficult test was devised in Pattern* B. *It also failed to differentiate enough so Pattern* C *was devised.*

After analyzing the results of the nine castings for each alloy, those with standard deviations greater than 10 had the size of the sample increased to 12. For alloys that had values of castability of 99% or greater, the experiment was repeated with a more difficult pattern, B in the figure, to try to distinguish differences. This still resulted in uniformly high values of castability, so an even more difficult pattern, C in the figure, was finally used.

The patterns were cleaned and invested in Complete (J F Jelenko & Co, Armonk, NY 10504, USA), a phosphate-bonded investment that was spatulated in a vacuum. The mold was placed horizontally in a Ticomatic Electronic Induction Casting Machine, Model 3000-D1 (Ticonium Company, Albany, NY 12207, USA). Induction heating was used to melt the alloy because preliminary experiments had demonstrated that the use of a hand torch, with visual assessment of readiness to cast, induced errors. Each alloy was cast under the conditions recommended by the manufacturer and all of the castings for each alloy were made without reuse of any alloy.

Results and Discussion

The results of the test for castability are given in Table 2. Twenty of the alloys had values of castability of 99% or greater with pattern A. When these alloys were retested by means of the more difficult pattern C, eight retained their value of 100%. The fact that most of the alloys had a high value for castability (an average of 91% for 31 alloys) is not surprising. No manufacturer is going to market a grossly uncastable alloy, because a dental technician will quickly equate a series of miscasts with a property of the alloy and not with lack of technical skill.

When the results were analyzed according to the type of base or constituent element of the alloys, it was noted that the inclusion of beryllium seems to enhance castability, with all castings reaching a value of nearly 100%. Although the maximum amount of beryllium in any of the alloys is 2%, its small size (element No 4 on the periodic chart) probably contributes a property not unlike a lubricant while the metal is in the molten state. The radius of the beryllium atom is 35 picometers (pm) while that of nickel is 69 pm and chromium 89 pm. Although the inclu-

Table 2. Results of Test for Castability

Alloy		Completeness of Casting (%)					
		Pattern A			Pattern C ($n = 9$)		
	n	mean	SD	range	mean	SD	range
Verabond	9	99.6	0.71	98-100	97.3	0.35	92-100
Bond-On	9	67.1	9.3	58- 78			
Cer-On	12	79.0	11.2	65- 98			
Pors-On	9	94.8	5.2	87-100			
Astro-3	9	99.3	1.2	97-100	93.2	3.2	89- 98
Mighty Bond	12	58.4	25.6	29-100			
Astro Superior	9	99.6	0.71	98-100	90.7	3.8	81- 93
Bake-ON NP	9	100	0	100-100	99.0	2.0	96-100
Bake-ON SP	9	100	0	100-100	85.0	15.1	58-100
Ceramalloy	9	100	0	100-100	95.0	7.2	78-100
Ceramalloy II	9	98.9	1.4	96-100	99.0	3.6	97-100
Biobond C&B	9	99.5	1.3	96-100	96.2	4.6	89- 99
Albabond-O	9	100	0	100-100	100	0	100-100
Albabond-60	9	97.9	4.0	88-100			
Dent-O-Bond	12	47.8	32.5	13- 96			
Omni	9	100	0	100-100	99.9	0.4	99-100
A-35	9	94.7	7.7	76-100			
Genesis	12	79.2	17.0	58-100			
Jelstar	9	93.3	3.8	90-100			
Odyssey	9	99.5	0.88	98-100	97.2	2.4	94-100
Rexillium III	9	100	0	100-100	100	0	100-100
Fidelity 1000	9	100	0	100-100	100	0	100-100
Opal	9	99.6	1.0	97-100	96.1	3.9	92-100
Neobond-II	12	80.3	17.7	56-100			
Neobond-II Special	12	65.9	33.0	6- 93			
Neydium	9	100	0	100-100	95.0	2.6	90-100
Formula 5-B	9	100	0	100-100	96.0	3.8	88-100
Excel	9	100	0	100-100	100	0	100-100
Pentex - 90	9	91.4	8.9	76-100	100	0	100-100
Pentillium	9	100	0	100-100	100	0	100-100
Litecast-B	9	100	0	100-100	100	0	100-100
Will Ceram W-1	9	100	0	100-100	100	0	100-100

sion of beryllium presents a problem of toxicity (Kuschner, 1981; Radding & Furst, 1980), beryllium seems to have a good effect on castability. It is important to note that castability is not synonymous with the accuracy of the fit of the casting. Accuracy of fit is related mainly to the setting and burnout of the investment. Whereas an alloy will contract on cooling, the contraction is small, and in a test of the fit of a casting, the performance of the investment, not the alloy, is the crucial issue (Barreto & others, 1980).

No other base seemed to contribute any particular property to the castability of the alloys. One of the chromium-cobalt alloys (Dent-O-Bond) had the lowest single value (45.9%), but two other chromium-cobalt alloys (Astro Superior and Excel) had values exceeding 99%. The ranges of the values of castability and the means for the alloys grouped according to base are given in Table 3.

Table 3. Castability of Alloys Grouped by Type of Base

Group	Completeness of Casting (%) range	mean
Ni-Cr	49.6-100.0	81.3
Ni-Be	96.0-100.0	99.5
Ag-Pd	81.1-100.0	92.3
Pd	67.1- 99.6	83.6
Cr-Co	45.9-100.0	74.4

Induction heating may be the single most important element in uniformly producing high values of castability. The tendency to overheat alloys of base metal while waiting for the alloy to slump or spin invariably burns off the minor constituents that are responsible for many of the properties of these alloys.

If castability were the only property to be considered in choosing an alloy, then one of the nickel-beryllium group would be the best. However, if one takes into consideration the difficulty of grinding and polishing these alloys, as well as the risk of toxicity, we feel that an alloy of palladium or of the silver-palladium group should be the alloy of choice. The additional cost is negligible when these other factors are considered.

Acknowledgment

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DENTAL PRACTICE

Repair of Defective Restorations of Direct Gold

RALPH L LAMBERT • MARVIN H GOLDFOGEL

A properly condensed and finished restoration of direct gold will not deteriorate in the oral environment and will provide a longer service than any other dental restoration. On occasion, however, a restoration may require replacement or repair due to the loss of a small portion of the gold. This flaking or cohesive failure is most probably related to inadequate condensation or contamination during the insertion of the gold. The decision of whether to replace the restoration or to repair the defect depends upon the size of the discrepancy and the condition of the remaining gold.

A defective area on an existing restoration of direct gold (Fig 1) may be repaired by the addition of gold after the surface has been thoroughly decontaminated and prepared. Following proper isolation, the defect and the immediately surrounding area are cleansed by removal of the surface with a round or inverted cone bur at slow speed (Fig 2).

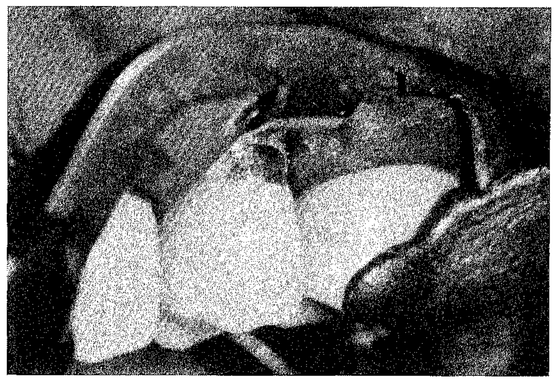

FIG 1. *Class 5 direct gold restoration with small defect at mesio-occlusal*

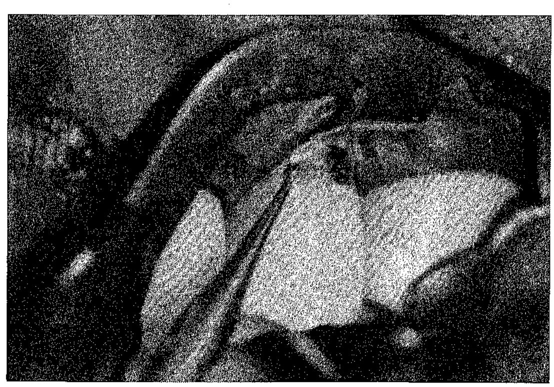

FIG 2. *Removal of contaminated surface layer of defect with inverted cone bur*

University of Colorado, School of Dentistry, Department of Restorative Dentistry, Health Sciences Center, 4200 East Ninth Avenue, Denver, CO 80262, USA

RALPH L LAMBERT, DMD, MS, associate professor and chairman, Division of Operative Dentistry

MARVIN H GOLDFOGEL, DDS, associate professor and chairman, Division of Fixed Prosthodontics

The surface of the remaining gold is tested for proper compaction by applying heavy force to a small hand condenser (0.5 mm diameter). Any significant penetration of the surface by the condenser would indicate inadequate condensation and porosity in the remaining gold. A restoration exhibiting poor condensation would not be an indication for repair and should be totally replaced as it most likely is not well adapted to the cavity walls. Such a restoration is subject to gross leakage and early failure.

The surface of the gold that is being repaired should be thoroughly condensed with a small condenser point with sharp serrations as suggested by Howard (1973). The serrations on the nib of the condenser point will create a serrated surface, which will provide a larger area for the cohesion of the new gold.

A pellet of gold foil is degassed (annealed) and then lightly pressed against the prepared surface of the restoration with a hand condenser. Clean gold will readily adhere to clean gold with minimal pressure (Charbeneau & others, 1981). Failure of the pellet to stick to the prepared surface indicates contamination of the gold. To eliminate the possibility of contamination of the pellets, the operator should test the cohesive qualities of two degassed pellets (Fig 3). If the purity of the pellets is proven but cohesion with the gold remaining in the restoration is not achievable, further preparation of the defective area or replacement of the entire restoration is indicated.

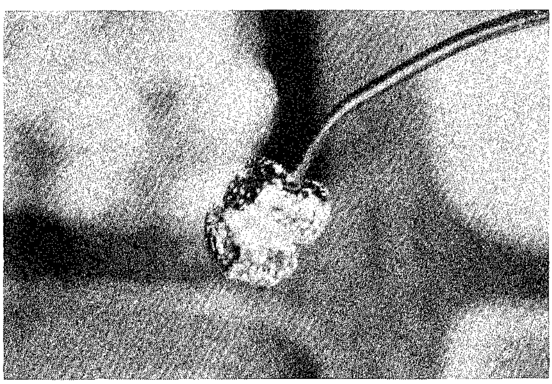

FIG 3. *Two pellets of gold foil exhibiting cohesion with minimal pressure evident with clean degassed pure gold*

When cohesion of the pellet of gold foil to the prepared surface is apparent, the initial pellet is carefully condensed with malleting forces and its cohesion to the restoration is tested again by forceful attempts to remove it. Additional pellets are added until the defect is restored. The normal procedures of burnishing and finishing complete the restoration (Fig 4).

FIG 4. *Completed repair of defective class 5 direct gold restoration*

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D E N T A L   R E V I E W

Approximal Retentive Grooves in Cavities Prepared for Amalgam: A Historical and Current Assessment

The need for retentive grooves in the approximal box of class 2 cavities prepared for amalgam depends mainly on whether the strength of the amalgam at the isthmus will be adequate to withstand the forces to which the restoration will be subjected

JAMES M CHILDERS

Introduction

One of the more difficult tasks for dental students to accomplish is the accurate and adequate instrumentation of the approximal retentive grooves in cavities prepared for amalgam. Since the retentive grooves are generally among the last features imparted to the cavity, it is not uncommon to see an otherwise well-prepared cavity blemished, if not mutilated, by poor instrumentation of the retentive grooves. If such poor results are experienced by students working under close supervision, is it not possible that many teeth treated in private practice also suffer rotary abuse, the increased experience of the practitioner notwithstanding?

In an attempt to determine whether the theoretical and empirical advantages attributed to approximal grooves for retention of class 2 restorations of amalgam outweigh the potential for abuse to dentin, enamel, and pulp, a review of the literature on opinions and investigations regarding retentive grooves was undertaken. There is ample material, the opinions and results are mixed, there tends to be no middle ground, and one finds his personal attitude shifting as he progresses from one article to the next. It becomes easy to understand the controversy associated with this feature of a cavity.

University of Texas Health Science Center at San Antonio, Dental School, Department of Restorative Dentistry, 7703 Floyd Curl Drive, San Antonio, TX 78284, USA

JAMES M CHILDERS, DMD, professor. Dr Childers is a fellow of the American College of Dentists and a founding member of the American Board of Operative Dentistry.

Review of the Literature

One must go back to G V Black (1900) to find the application of scientific principles to the preparation of cavities. Even at that early date in the profession, Black makes the point that "the improvements in knowledge that have stood the test of time have been those that have been made by laboratory methods." This statement is significant and would seem to conflict with the opinions of later investigators.

As one searches the literature for some early mention or recommendation of retentive grooves, the earliest encounter is with Prime (1928). Although referring to restoration with gold foil, Prime recommended "acute angles cut in the buccal and lingual walls" of the approximal box. It is easy to relate the progression of this recommendation to the cavity for amalgam by clinicians concerned with the provision of additional retention form.

Black (1900) had stated that retention form must be related to principles of physics. Recognizing this to be true, Bronner (1930) used principles of engineering to analyze the class 2 cavity for amalgam. In his remarks directed at increased retention, he advised convergence occlusally of facial and lingual approximal walls to resist movement in an occlusal direction. Also he suggested that the cervical floor be inclined toward the axial wall to form an acute axiocervical angle to counteract "slip" (flow) of the approximal mass of amalgam. It is of interest that he made no mention or suggestion of retentive grooves. This may reflect his concern for the pulp since he directs attention to the fact that the mesial cornua are very persistent even in a receding pulp, which makes the pulp horns susceptible to irritation, if not exposure.

Progressing to the more modern opinions and studies, we encounter a statement by Phillips and others (1945) that expands on the earlier statement of Black (1900) regarding laboratory methods. Phillips and his coworkers stated that "conclusions regarding the behavior of amalgam in the mouth that are based upon laboratory findings are acceptable only after being verified by clinical evidence." Acceptance or nonacceptance of this statement will be crucial as the question of retentive grooves is continued.

At this juncture it would be well to clarify the roles that grooves for approximal retention supposedly play in the cavity for amalgam. The roles are twofold, pertaining to flow, and to the possibility of fracture that separates the approximal mass of amalgam from the occlusal mass.

Flow is a physical property of dental amalgam that is responsible for a certain degree of plastic deformation when amalgam is subjected to a static load in the laboratory, and the dynamic forces of mastication clinically. That some clinicians have attached a serious significance and consequence to this physical property is evidenced by Ingraham (1950) who states that "insufficient retention in the proximal portion of the cavity results in gradual flow of the amalgam beyond the margins, leading to an early failure of the restoration." Early on, Sweeney (1940) found "no clinical evidence of flow from biting stresses was observed in the mouth even though alloys of high flow were used." Later, the clinical studies conducted by Terkla, Mahler and Van Eysden (1973) seemed to agree with those of Sweeney, and led them to conclude that the degree of flow observed depended on the value of the flow of the amalgam employed, and that "interproximal retention grooves did not influence the extent of proximal extrusion, regardless of tooth type or restoration width." These conclusions should relieve our concerns regarding flow, assuming that we use amalgam that is within the specifications for flow of the American Dental Association.

The second consideration is fracture separating the approximal mass from the occlusal mass. Again, the concern of clinicians can be represented by the statement of Markley (1951) when he said "occlusal steps, either narrow or broad, are insufficient to support the proximal portion of a restoration." The conclusions of the studies later conducted by Terkla and Mahler (1967) disagreed with the statement by Markley. These investigators stated that "these results indicate that the retentive cavity design, although it provides greater resistance to bulk fracture than the base cavity design in laboratory tests, is not required to prevent bulk fracture of silver amalgam restorations in service." They qualified this statement by saying "as long as the pulpal and axial wall depths of cavity preparations are terminated in dentin just beyond the dentino-enamel junction." Whereas Terkla and Mahler (1967) tested resistance to fracture, Bouschor and Martin (1976) used tensile stress to remove amalgam restorations by pulling them in an occlusal direction. They concluded that "in a properly prepared Class II Black cavity preparation, no additional retention is needed to securely hold or lock the amalgam restoration in the tooth." They also made the disquieting statement that "if a fracture occurs at the isthmus, the proximal portion of the amalgam will fall out, thus calling the patient's attention to the problem before more pathoses can develop." Undoubtedly this is true in some instances, but experienced clinicians can recall many instances of fracture through the isthmus in which the approximal fragment is loose but retained. Generally, patients seem to be unaware of the situation until symptoms occur. The rapidity with which caries develops under such a retained fragment is comparable to that under a loose retainer of a fixed partial denture, and excavation often results in carious exposure of the pulp.

The work of Mondelli and others (1974), and of Crockett and others (1975), is helpful in making decisions about retentive grooves. The Mondelli study found that fractures at the isthmus in cavities prepared without retentive grooves resulted in a clean separation, in a vertical plane, of the approximal mass from the occlusal mass at the axiopulpal angle. In contrast, in cavities prepared with retentive grooves, the fracture occurred at an angle of 45 degrees, with part of the approximal portion remaining locked in position. The study by the Crockett group confirmed the Mondelli result by finding that when a horizontal force was applied to the axial surface of restorations retained by both an occlusal dovetail and approximal retentive grooves, fracture occurred in the areas of the occlusal isthmus and the retentive grooves, leaving amalgam in both the occlusal dovetail and the retentive grooves.

Discussion

The controversy over approximal retentive grooves in class 2 cavities prepared for amalgam continues, but seems to be narrowing. Based on a survey recently reported by O'Hara and Clark (1984) on current philosophy in teaching operative dentistry, there can be little doubt that the modern, or conservative, cavity for amalgam is experiencing great popularity, and rightfully so. Regarding the teaching of approximal retentive grooves in class 2 cavities for amalgam, a survey of North American dental schools showed that 51 schools advocate the use of grooves, while nine do not; four schools did not respond. The concern about flow can be put to rest. Regarding fracture, the reader will have to make a choice. If you subscribe to the tenet of Terkla and Mahler (1967) that amalgams of sufficient bulk (depth) will not fracture in service, you can, with a clear conscience, eliminate retentive grooves from your cavities for amalgam. Contrarily, if you feel that fracture through the isthmus is a possibility even in amalgam restorations of sufficient bulk, you would be wise to include the retentive grooves in your cavities for amalgam. The anchorage of the approximal component after fracture would seem to lend protection against the severe onset of caries that is to be found under loose but retained approximal fragments.

Conclusion

Since this article began with reference to Black (1900), it would seem appropriate to conclude it with an observation from the same article by Black.

> It is quite possible that two distinct methods of doing a mechanical operation may both be good methods; it is hardly possible that two distinct methods will be equally as good; one will inevitably be better than the other. It is the best method that we wish to attain, and if we should happily obtain the best method of any mechanical procedure, it would be best that all learn that method.

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Action of Mercury in Dental Exposures to Mercury

JANET G BAUER

Summary

The cases cited in the literature indicate that the potential for toxicity or poisoning with mercury exists as an occupational hazard to the dentist and dental personnel. The cause is the elemental form of mercury resulting from vaporization due to an accidental spill of mercury. Undetected or unreported spills produced chronic and low level exposures.

When exposure to mercury affected the dental patient, it was during the placement of the amalgam restoration that an allergic reaction was precipitated. When allowed, the reaction was self-limiting, resolving by its own processes. For patients who are particularly allergic to mercury and not amenable to antihistamine therapy, removal of the newly placed amalgam restoration is recommended.

University of California, Los Angeles, Center for the Health Sciences, School of Dentistry, Division of Operative Dentistry, Los Angeles, CA 90024, USA

JANET G BAUER, DDS, MS, assistant professor. Dr Bauer is a member of the American Academy of Gold Foil Operators and the Academy of Operative Dentistry.

INTRODUCTION

Existing information from environmental, occupational, and clinical exposures to mercury has formed the basis for the toxicological assessment of the dangers of mercury in the general population and is pertinent to dentistry. A review of this material is used to assess the source of contamination in the cases that have been reported in the literature as instances of mercurial toxicity and hypersensitivity from dental exposures.

CHEMICAL FORMS OF MERCURY

The action of mercury on dental personnel or dental patients, when they are exposed to it, depends on its chemical form. Mercury may be introduced into the body as elemental mercury, inorganic mercury, or organic mercury. Although mercury generally has high affinity for the kidney, the toxic actions of the various forms can differ greatly in the type and degree of response.[1] Some of these toxic effects have been demonstrated in man and some only in animals.[2] Data from experimental animals are unsatisfactory because the experimental design may not correspond to the usual situation of human exposure or the animal selected may not behave like man. A ranking of toxicity in laboratory animals is useful, but only as a first step toward its assessment in humans.[3]

Elemental Mercury

Elemental mercury, that is, free, or metallic, mercury exists in the un-ionized form and has a high vapor pressure.[4] Elemental mercury is classified as an industrial and occupational contaminant rather than a hazardous environmental contaminant.

The most important route of absorption of elemental mercury is through the respiratory tract.[2,4-16] The proportion of the vapor of elemental mercury that is deposited and retained is high, about 80%, because it is monoatomic and soluble in lipid. After inhalation and subsequent diffusion, elemental mercury appears in the blood, partly unchanged and partly oxidized within the erythrocytes to the divalent, or mercuric, form.[2,17] Elemental mercury is poorly absorbed from the gastrointestinal tract, less than 0.01%, because the mercury occurs as large globular particles.[2]

Contamination by elemental mercury and its oxidized form, inorganic mercury, is indicated by an increase in excretion of mercury in the urine. The correlation between the degree of exposure and severity of symptoms, however, is not always good.[4-5,8,18-20] In exposure to elemental mercury the critical organ for disease is the central nervous system because mercury is soluble in lipid, and the transfer from the blood to the brain is sufficiently rapid to give it a differential distribution that is toxicologically significant. Because the critical effects are neurologic, the relationship between dose and effect is not measurable. Levels of mercury in urine and blood are useful as indicators because they are roughly proportional to the level of exposure to mercury in the air. The best correlation with response is the actual concentration of mercury breathed by the subject, as contrasted with the concentrations of mercury in the urine or blood of exposed subjects.[2,5]

In man, with exposures to concentrations of mercury in air below 0.1 mg m^{-3}, Goldwater[4] states elimination is complete; with greater concentrations, some mercury is retained temporarily combined with tissue until concentrations are reached that manifest damage to the tissue. This is why the Occupational Safety and Health Administration has set the toxic limit value (TLV) low, 0.05 mg m^{-3}, more as a preventive measure than for the onset of disease which is set at around 0.1 mg m^{-3}.

The kidneys have a great tolerance for, or a definite capacity to eliminate, mercury so that accumulation takes place only when the rate of absorption exceeds this capacity. Thus man is able to absorb and excrete substantial amounts of mercury without developing any untoward manifestations.[1,4]

Inorganic Mercury

Inorganic mercury is the oxidized or ionized form of elemental mercury and readily forms salts and complexes, notably with sulfhydryl groups.[1] There are two ionized forms, of which the divalent, or mercuric, form is highly soluble and thus more relevant to a discussion on toxicity, whereas the monovalent, or mercurous, form is highly insoluble.[2,21-22] As with elemental mercury, inorganic mercury is considered an industrial and occupational contaminant rather than a hazardous environmental contaminant and is only minimally absorbed by plants and animals.[23]

Inorganic mercury, as aerosols of mercuric salts, is absorbed mainly through inhalation, the extent to which has not been well established. In the gastrointestinal tract, inorganic mercury is absorbed to the extent of about 7%. In chronic exposures, nephrotoxicity is characterized by proteinuria, specifically the loss of albumin and proteins of low molecular weight.[24] In severe cases, the loss of plasma protein is great enough to cause hypoproteinemia with edema of dependent parts. Exposure to inorganic mercury can also cause severe inflammation of the mouth, esophagus, stomach, and small intestine.[2,22] In the erythrocytes, the divalent form of inorganic mercury binds to hemoglobin, in the blood, to plasma proteins. Inorganic mercury is distributed preferentially to the kidney; secondarily, it accumulates in the liver.

Inorganic mercury is excreted mainly through the urine, the mechanism by which is complex and not well understood except for highly toxic doses. Under toxic doses, excretion occurs by exfoliation of renal cells.[2] It may be possible to quantify the elevated excretion of protein in the urine and thus define the relationship between the dose of inorganic mercury and its effect, the toxic manifestations being renal. This effect, however, has not been studied adequately.

Based on limited data, the clearance, or biologic half-life, of inorganic mercury is 40 days.[2] The relationship between dose and response can only be estimated.

Organic Mercury

Organic mercury, in contrast to elemental mercury and inorganic mercury, is an environmental contaminant and pollutant. Although its use has been curtailed in therapeutics, the alkoxyalkyl mercury diuretics are still used.[24] The chemical structure of the organic compounds of mercury is diverse and they vary in the stability of the carbon-mercury bonds. They include all compounds in which mercury forms a bond with one atom of carbon. As a group, they include methyl, ethyl, phenyl, and the family of alkoxyalkyl compounds of mercury.

Of most concern is methyl mercury because of its potential to enter the food chain, becoming concentrated as it moves up the chain and thus becoming a considerable toxic pollutant.[2] Evidence for this is the serious poisoning of humans in Minimata and Niigata, Japan, as a result of eating contaminated fish, in New Mexico from contaminated pork, and in Iraq from contaminated cereal grains.[2,21-22,25-26]

Organic mercury is efficiently absorbed in the gastrointestinal tract to the extent of 95% or greater and, after diffusion, is very stable and circulates unchanged in the blood. Unlike inorganic mercury, organic mercury is excreted mainly in the feces by two separate processes. These are biliary excretion and exfoliation of intestinal epithelial cells.

Toxic manifestations specific to contamination by organic mercury have the central nervous system as their target organ. As with elemental mercury, organic mercury concentrates to a high degree in the brain; its action, however, is distinctly different. Whereas the effects of elemental mercury are neuropsychiatric, those of organic mercury are sensorimotor.[3] Tremor occurs, but motor effects such as incoordination, paralysis, and abnormal reflexes are more consistent and probably result from defects in the sensory input. In exposure to organic mercury, the earliest signs are paraesthesia and constriction of the visual field. At somewhat higher levels, other sensory effects such as loss of hearing, of vestibular function, and of the senses of smell and taste occur, followed by stupor, coma, and death.[22] Most of these effects are not known to occur in exposure to elemental mercury. Some neuropsychiatric effects occur but not consistently. Shyness and irritability are not observed but spontaneous fits of laughing and crying and intellectual deterioration are specific to this type of exposure.[2]

The mechanism of action of organic mercury has been studied but there is no one hypothesis that adequately accounts for all the neurologic phenomena that have been observed clinically and experimentally.[2]

The biological conversion of ingested inorganic mercury to organic mercury, specifically methyl mercury, has been demonstrated in fish, bacteria in sediment and, under laboratory conditions, in strains of bacteria from animals and humans.[2,21,26-31] This conversion, or methylation, is a detoxication response that occurs under strict environmental and chemical conditions within a narrow range of pH.[1] Further, in bacteria in sediment, the best conversion rate under ideal conditions is less than 1.5% per month.[21,27] If poisoning is to occur, the sources are more likely to be contaminated food and direct ingestion of methyl mercury rather than methylation of inorganic mercury in situ.[21] Thus the implications of inorganic mercury being released from amalgam restorations, followed by conversion to methyl mercury, assuming ideal conditions, and then absorbed in the human intestinal tract to later produce a toxic exposure are conjectural and not supported by any human clinical data.

MODES OF ENTRY TO THE BODY

In general, mercury can enter the body as a vapor, an aerosol, or a mixture of both, and as a free metal or compounds of metal. The most toxic forms are methyl and ethyl mercury, followed by elemental mercury, inorganic mercury, and phenyl and methoxyethyl salts of mercury.[2] In dentistry, the possible avenues of contamination may be from the dental environment and the amalgam restoration.

In the dental environment, the exposure to mercury occurs mainly from the storage, preparation, and handling of dental amalgam and its component of mercury, which exists in the elemental form. Exposure to organic mercury occurs from use of ointments, germicides, and sterilizing solutions.[32] Safe substitutes for these toxic substances, however, have been recommended and are currently used, thus removing exposure to organic compounds of mercury as a potential hazard in dentistry.[14,32-34]

If exposure from amalgam restorations were to occur, the likely routes would be from the placement, removal, and wear of the restoration, freeing mercury and resulting in the ingestion of the inorganic form of mercury.

CASES REPORTED AS MERCURIAL TOXICITY

Of the 50 cases out of 21 incidents cited as mercurial toxicity during the period from 1920 to 1980 (Table 1), the validity of the 13 cases reported between the years 1926 to 1934 has been challenged and rejected.[32,38-43] The remaining documented cases reported during the period 1963 to 1978 occurred as a result of spills of mercury that went undetected or were not reported to the dentist. These irresponsible acts as well as the improper handling of mercury that led to the spills allowed the vaporization of elemental mercury to produce a chronic and toxic exposure.

The outcomes of the cited exposures varied with the onset of symptoms, averaging 62.5 days (Table 2). Two cases[36-37,44] resulted in death — both involved dental assistants who succumbed from toxic effects similar to those of ingestion of a mercury salt rather than to those resulting cumulatively from high levels of elemental mercury found in occupational exposures. The death reported by Cook and Yates[44] was speculated but could not be verified as an occupational exposure.[37,44] Additionally, a case resulting from contamination of an office in which the affected personnel were monitored by urine analysis but were without symptoms or diagnosis of disease was reported by Pagnotto and Comproni.[45] The duration of the disease in the other cases reported averaged about eight days.

The increase in excretion of mercury in the

Table 1. Occurrences of Mercurial Toxicity, 1920-1980

No of cases: 50	No of incidents: 21	
Age: range 20–61	mean - 43.3	median - 44
Gender: M - 8 cases	F - 6 cases	

Table 2. Onset and Duration of Disease in Mercurial Toxicity as a Result of Dental Exposures

	Range	Mean	Median
1926-1934			
Onset of symptoms	None reported	None reported	None reported
Duration of disease	Few weeks to 20-25 years	15 weeks	2 weeks
1963-1968			
Onset of symptoms	4 days to 6 months	62.5 days	—
Duration of disease	20 months to 14 days	7.9 days	8.5 days

urine was the main systemic feature in the cases reported (Table 3). The most prevalent

Table 3. Systemic Features as a Result of Mercurial Toxicity from Dental Exposures

	Cases Reporting
Fever	1
Urinary system:	
Fatal nephretic syndrome — uremia	1
Level of Hg in urine:	
2X maximum	1
2X normal	1
4X normal	1
15X normal	1

biologic effect or clinical feature reported was erethism (Table 4), with this effect being reported in 34% of the cases. The features included weakness, fatigue, malaise, depression, loss of memory, feeling of hopelessness, and irritability. Erethism is a consistent, pronounced effect and an early sign of chronic exposure at low levels. Additionally, it is characterized by excessive shyness, insomnia, and emotional instability, and is accompanied by stomatitis, gingivitis, and sometimes excessive salivation and a metallic taste,[2-5,7,13-16,33,37,46-52] features also reported in the cited cases.

Symptoms involving the nervous system constituted the second highest effect reported in 26% of the cases. The features included headaches, tremor, decreased reflexes, and loss of fine motor control. Tremor, a result of exposure to elemental mercury, begins in the hands and then spreads to other parts of the body with increasing duration of exposure. The reported loss in fine motor activity and the increase in salivation may indicate micromercurialism, described as one of the earliest signs of toxicity, preceding even erethism and occurring at chronic exposure to low levels of mercury. Micromercurialism is also characterized by increased excitability of the central and autonomic nervous systems, fine tremor, and salivation, but not lesions of the central ner-

Table 4. Clinical Features as a Result of Mercurial Toxicity from Dental Exposures

	% of Cases Reporting 1926-1934	1963-1978
Erethism	10	34
Weakness, fatigue, malaise	4	14
Depression	4	8
Loss of memory	2	2
Feeling of hopelessness	—	8
Irritability	—	2
Symptoms in nervous system	2	26
Headaches	2	8
Tremor	—	8
Decreased reflexes, loss of fine motor control	—	10
Visual disturbances	—	22
Pigmentation of lens and retina	—	2
Metal droplets on eyes	—	8
Digestive disturbances	4	16
Diarrhea	—	2
Poor appetite	2	—
Nausea	—	6
Stomatitis	10	10
Metallic taste	—	10
Burning tongue	2	—
Sore mouth	2	—
Increased secretions	4	8
Nasal	2	—
Saliva	2	8
Red palms	—	8
Symptoms in extremities	6	4
Eczema	4	—

vous system.[5,33,52-53] In 22% of the cases, visual disturbances that included pigmentation of the lens and retina and metal droplets on the eyes were recorded in chronic exposure to low levels of mercury. Digestive disturbances accompanied by diarrhea, poor appetite, and nausea were reported in 16% of the cases. Thus the evidence indicates that the toxic exposures that occurred in the dental environment resulted from the accidental contamination with elemental mercury, which was at chronic low levels not producing changes severe enough to cause permanent injury or death.

Toxic exposures to mercury in the dental environment that affected the dental patient as distinct from the personnel of the dental office were not reported. When effects of exposures were manifested in the dental patient, these were reported as mercurial hypersensitivity.

MERCURIAL HYPERSENSITIVITY

Sixty-six cases, as well as incidents of an allergic reaction to mercury from dental procedures, were cited in the literature during the period from 1928 to 1980 (Table 5).[35,46] Almost

Table 5. Occurrences of Mercurial Hypersensitivity 1928-1980

No of cases: 65 No of incidents: 65

Age: range 4–73 years mean - 22.48 median - 26 years

Gender: M - 5 cases F - 24 cases

all the cases reported a previous sensitization to mercury from either an occupational or medicinal exposure (Table 6). Thus most of the cases gave a history of allergy. The amount of mercury present during the placement of an amalgam restoration can expose the dental patient to either a sensitizing dose or the first occurrence of an allergic response.[42,53-56] The dose can be sensitizing in particularly sensitive individuals because the allergic reaction is of the delayed type and can remain latent but active with occurrences at intervals of from 6 months to 10 years.[43,54-55,57] Of the 29 cases reported by Djerassi and Berova,[57] the

Table 6. History of Allergy to Mercury

Previous Exposure	% of Cases Reporting
None	2
Amalgam restorations	9
Amalgam restorations with previous allergy to mercury	20
Previous allergy to other mercurial-based compounds	8
Other allergies	2 or 46*

*Cases reported by Djerassi & Berova[57] cited chronic eczema but were nonspecific about relationship to current exposure.

origin of previous sensitization was not identified except for the presence of amalgam restorations. However, no significant relationship between contact allergy to amalgam and contact allergy to mercury could be found.[57] When documented, the onset of symptoms occurred in a range of from 3 to 17 hours after the placement of the amalgam restoration (Table 7). The duration of the illness was about 12 days. In 20 cases, the patch test was performed as the confirmatory test for the allergic response to mercury. In four cases, pyrexia in the range 101° to 104 °F (38.3-40 °C) was the main systemic feature.

The most prevalent clinical feature reported was dermatitis in the upper extremities and around the eyes and lips, edema being the second most prevalent (Table 8). Other features reported included stomatitis, redness of the upper extremities, rash, polyps, and malaise. Oral lesions involved edema and burning of the lips, cheeks, tongue, and mucosa.

The allergic episodes were treated by removing the amalgam restorations or by letting the

Table 7. Onset and Duration of Disease in Mercurial Hypersensitivity as a Result of Dental Exposures

	Range	Mean	Median
Onset of symptoms: 6 cases reporting with onset groupings			
earlier	1 hour to 2 days	13.6 hours	3 hours
later	1 hour to 7 months	23.6 days	16.8 hours
Duration of disease	7 hours to 5 months	25 days	12 days

disease run its course (Table 9). While removing the amalgam restorations was the earliest treatment reported, later reportings[58-61] suggested antihistamine therapy as a prophylactic and for relief of symptoms while leaving the amalgam restorations intact.

In most cases cited, the allergic reaction was related more to the placement of the amalgam restoration than to the existing restoration present in the mouth, and the skin was the most common site affected. When left to resolve itself, the allergic reaction was self-limiting and tended to cease after a definite period of time as a result of its own processes. At no time did symptoms produce severe complications such as damage to the central nervous system or death. In one case,[46] however, sensitization from occupational exposures effectively shortened the career of the affected dentist.

The same precautions used in occupational exposure — prevention and aherence to proper procedures — can significantly reduce discomfort in the sensitive individual. Sensitive individuals can be identified through an adequate medical history that would reveal previous allergic episodes. Proper procedures, such as use of the rubber dam, water spray with high-speed evacuation, cavity liners and bases, good hygiene, and properly condensed, carved, and polished amalgam restorations, as well as cleansing of any contaminated areas with soap and water, can reduce and minimize the duration of the exposure.[54,59,62-64] Antihistamine therapy used topically and orally may be useful as a palliative treatment and amalgam restorations should be removed only when resolution is not otherwise obtainable.

Table 8. Clinical Features as a Result of Mercurial Hypersensitivity from Dental Exposures

Clinical Features	% of Cases Reporting
Allergic reaction, rash	5
Dermatitis	42
upper extremities	6
eyes	2
gingiva	2
lips	9
Redness of upper extremities	6
Edema	18
Stomatitis	8
Polyps	5
Malaise	2

Table 9. Treatment Regimens in Mercurial Hypersensitivity

Treatment	% of Cases Reporting
Removal of restorations	17
Antihistamine therapy both orally and topically	6
Corticosteroid therapy with removal of restorations	2
None	2

PREVENTIVE MEASURES

The occupational hazard from exposure to elemental mercury in the dental environment has been well discussed by the dental profession, pointing out the potential causes of contamination by mercury in the dental environment. These include improper hygiene, breakable and leaking containers of elemental mercury, poorly ventilated working areas, heating the amalgam or mercury, spills of mercury that occur over cabinets with cracked and seamed tops, over floors with cracks, and over carpets. Thus prevention and adherence to proper procedures can reduce significantly the occupational hazard of mercury and have done so, with studies showing that most offices practice good hygiene and prescribe to accepted practices.[10,14,33,48–49,65–68] Preproportioned, sealed capsules of amalgam, water spray with high-speed evacuation, adequately ventilated working areas, and proper collection of globular particles of mercury and amalgam scrap in a tightly sealed, polythene container with water, slurry of sulfur and calcium oxide, or commercial suppressant have been suggested as good preventive measures along with devices to monitor, contain, and remove contamination and spills of mercury.[37,45,69–72] It has also been suggested to avoid storage of mercury around sources of heat, the use of the ultrasonic condensers for amalgam, and the use of counter tops that are cracked and seamed, floors with cracks, and carpets in the dental operatory and supportive areas.[4,10,14–16,33,47,49–51,73–75]

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WIT AND WISDOM

A Psychological Study of Journal Editors

S A RUDIN

The clinical psychologist Anne Roe studied the manner in which a scientist is seduced by his field of study, and she reported her findings in her book, *The Making of a Scientist* (Roe, 1955). She obtained interviews and test results from the 20 most eminent physical scientists, the 20 most eminent biological scientists, and the 20 most eminent social scientists in the USA. She concluded that the biological scientists tended to be preoccupied with death, that the physical scientists had difficulty locating themselves in the physical world, and that the social scientists disliked and could not get along with people.

This study extends her methods to the study of editors of scientific journals. The editors chosen for study were in charge of all major scientific journals in the USA, making a total of 318,991 subjects. Each subject was studied exhaustively by a combination of depth interview, case history, and numerous psychological tests of intelligence, aptitude, interests and personality.

RESULTS

First impression and general appearance. Subjects ranged from tall* to short, fat to thin, and warped to degenerate in general appearance. Despite this heterogeneity, each was marked by certain tell-tale characteristics: the eyes were narrowed; the mouth was pursed into a snarl; and the writing hand was cramped and taut from stamping REJECTED thousands of times. Upon first perceiving the experimenter, each subject exclaimed, "NO!" before noticing that no manuscript was being tendered.

Childhood background. That childhood experiences strongly influence the developing personality is well known. Again, great diversity of backgrounds was noted: they came from every conceivable environment, from palatial mansions in Hollywood to wretched hovels on some university campuses, but all had in common a peculiar set of family relationships. In every case, the father turned out to have been an alcoholic, drug addict, professional . . .**, or the

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editor of a scientific journal. The mother was found to spend but little time with her children, devoting herself to such pursuits as managing a house...**, selling drugs to adolescents, smuggling diamonds past customs officials, or editing a scientific journal. But of greatest interest for the purposes of this study was the discovery that in every case, the child had been beaten often and severely *with a book.* Naturally, such traumatic stimulation eventually led to a deep-seated hatred of anything associated with reading, writing, learning, knowledge, and scholarship. Some showed this tendency as early as the second year by tearing pages out of the Encyclopaedia Britannica, setting them afire in the middle of the living room floor, and executing an exultant war dance around them in the fashion of certain American Indian tribes.

Intelligence and aptitudes. These were measured by a variety of instruments including the Wechsler Adult Intelligence Scale (WAIS), the Draw-A-Person Test and various special aptitude tests. Considerable difficulty was encountered since none of the subjecs could read. The use of oral and nonverbal tests, however, finally yielded usable data. It was found that the subjects were uniformly below IQ 71. This highest IQ was attained by the editor of a widely read psychology journal who was himself the author of one of the intelligence tests used. The pattern of abilities measured by the specialized aptitude tests showed the subjects to be well below the standardization group (which was made up of college sophomores, white rats, and some persons from mental hospitals) on verbal reasoning, numerical reasoning, perceptual speed, spatial reasoning, verbal recall, clerical ability, map-reading ability, needle-threading ability, and the capacity to pronounce words of more than three syllables. Indeed, the only tests on which the subjects performed well were ones requiring the use of a spade to pick up and transfer material from one pile to another and the ability to ignore noxious odors.

Interest tests. On the Strong Vocational Interest Blank and the Kuder Preference Record-Vocational, subjects tended to score lower than average on activities and occupations associated with originality, critical thinking, creativity, scientific research, and literary production and appreciation. They scored relatively high, however, on scales measuring interest in mild manual labor and evading work altogether.

Personality tests. All subjects were found to register insane on Rohrschach Ink-Blot Test, Thematic Apperception Test, Minnesota Multi-Phasic Personality Inventory and the House-Three-Person Test. Exceptions were two subjects, both neurotic, ulcer-ridden, and compulsive shoe-lace cleptomaniacs. All subjects perceived themselves as God, except for one who claimed that he had created God. Another signed his name omitting all vowels.*** Yet another claimed that the ink-blots were actually reprints of old copies of his Journal, and sued the experimenter for plagiarism.

CONCLUSIONS

The reasons for the success of these subjects in editing journals is clear. First, by preventing new ideas from appearing in print, they make it easier to keep up with the literature. Second, by requiring the experimenter to repeat his study dozens of times and rewrite his paper hundreds of times, they enforce the consumption of materials and labor, thus stimulating the national economy. Third, if *they* can understand a paper, *anyone* can.

*e.g. J. Bacteriol. (the rest of description does not apply).
**censored
***He was from Israel.

DEPARTMENTS

Book Review

PERIODONTAL LIGAMENT ANAESTHESIA: Clinical Experience and Review of Recent Research

M Brännström, D H Pashley, and R Garberoglio

Published by Grafica Editoriale, Asti, Italy, 1984. 30 pages, illustrated. $7.95

This concise booklet reviews periodontal ligament anaesthesia (PDLA) in 30 well-printed pages. The material is supported by 39 up-to-date references. The three authors have used the technique extensively and have undertaken original investigative work. After reviewing the techniques for administering PDLA, they quote several clinical studies which support the efficacy of this method and others which illustrate adverse effects. Research — both histological and physiological — on animals is presented to explain clinical observations. In conclusion, the authors give recommendations about anaesthetic solutions, modes of administration, avoidance of infection and needle trauma, and list three contraindications to using PDLA. The authors reach their stated goal of presenting an unbiased, up-to-date review of clinical experience and research in periodontal ligament anaesthesia.

ROBERT W T MYALL, BDS, FRCD(C), MD
Department of Oral and Maxillofacial Surgery
School of Dentistry
University of Washington
Seattle, WA 98195, USA

Announcements

Membership in the Academies

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

American Academy of Gold Foil Operators
Dr Ralph A Boelsche
2514 Watts Road
Houston, TX 77030
(713) 664-3537

Academy of Operative Dentistry
Dr Ralph J Werner
Box 177
Menomonie, WI 54751
(715) 235-7566

NOTICE OF MEETINGS

American Academy of Gold Foil Operators

Annual Meeting: 31 October and 1 November 1985
University of California
San Francisco, California

Academy of Operative Dentistry

Annual Meeting: 13 and 14 February 1986
Westin Hotel
Chicago, Illinois

RECIPIENTS OF 1985 STUDENT ACHIEVEMENT AWARDS

American Academy of Gold Foil Operators

Baltimore College of Dental Surgery	John Richard Droter
Boston University	Joseph Benjamin Silberman
University of California, Los Angeles	William Robert Dapper
University of Detroit	Mark E Wolowiec
Fairleigh Dickinson University	Drew William Fairweather
Howard University	Sastri E Harnarayan
University of Illinois	Dean Dorian Sana
Indiana University	Robert H Cinatl
Loma Linda University	S Brian Noguchi
Louisiana State University	Timothy Robert Thomas
Loyola University of Chicago	Randy T Vaughn
University of Michigan	Steven J Niergarth
University of Minnesota	John H Broker
University of Missouri, Kansas City	Russell L Coad
University of Nebraska	Thomas G Hipsher
New Jersey Dental School	Joseph DiBenedetto
State University of New York, Buffalo	Frank B Giorgianni
State University of New York, Stony Brook	Thomas J Wilkens
Northwestern University	Gordon D Wee
Oral Roberts University	Leon Arthur Cerniway
University of the Pacific	William P O'Gara
University of Pennsylvania	Jeffrey S Leon
Medical University of South Carolina	Scott M Jensen
University of Southern California	Greg Brooks
Southern Illinois University	Geri P Unhold
Temple University	Joseph F Capalong
University of Texas, San Antonio	Lan T Tran-Lauderback
Tufts University	Roberto Antonio del Castillo
University of Washington	Bruce Y Todoki
Washington University, St Louis	Russell J Smith
West Virginia University	Arthur L Mams

Academy of Operative Dentistry

University of Alabama	Phillip Roland Cox
University of Alberta	Jennifer Cote
Baltimore College of Dental Surgery	Seth C Kleinrock
Baylor College of Dentistry	Richard Joseph Tosie
Boston University	James Michael Stein
University of British Columbia	Gerald Mitchel Kersten
University of California, Los Angeles	Lewis Arthur Enstedt
University of California, San Francisco	Jimmy Saiku
Case Western Reserve University	Daniel S German

University of Colorado	Alexander Van Acker
University of Connecticut	Michael Babinski
Creighton University	Keven R Mills
University of Detroit	Perry E Cellini
Emory University	Mary S Jurkovic
Fairleigh Dickinson University	Gary G Vandervliet
University of Florida	David M Arteaga
Georgetown University	Douglas C Stoker
Medical College of Georgia	Gary L Pool
University of Illinois	Scott Michael Kazalla
Indiana University	Herbert P Pleiman, Jr
University of Iowa	Christopher W Carpenter
University of Kentucky	Joe L Mason, Jr
Loma Linda University	Craig A Kinzer
Louisiana State University	Edward Antonio Vela
University of Louisville	Janet M McIntyre
Loyola University of Chicago	Kathleen A Gorman
Marquette University	Fred A Lacourt
Meharry Medical College	Daren Agard King
University of Michigan	Patrick K Mack
University of Minnesota	Thomas C Dewitt
University of Mississippi	Wade Herman Ditcharo
University of Missouri, Kansas City	Randal L Hillis
Université de Montréal	Anne Elazhary
University of Nebraska	Sandra Sue Hubner Larson
New Jersey Dental School	Kathleen E Lolla
New York University	Sergio Garcia-Rivera
State University of New York, Buffalo	Paris P Perry
State University of New York, Stony Brook	Robert R Strunk
University of Nijmegen	R L Martina
University of Nijmegen	Roland C H Scholle
University of North Carolina, Chapel Hill	David Gerald Feeney
Northwestern University	James R Chapko
Ohio State University	Roberta Lynn Diehl
University of Oklahoma	Scott Holmgren
Oral Roberts University	Leon Arthur Cerniway
Oregon Health Sciences University	Robert E Andreotti
University of the Pacific	Ryan Bernell Davis
University of Pennsylvania	Michael Thomas Dachowski
University of Pittsburgh	Annette Kadar Weyant
University of Saskatchewan	Kelvin Kudryk
Medical University of South Carolina	Frank Loudermilk
Southern Illinois University	Eric M Langenwalter
Temple University	P Joseph Perrotti
University of Tennessee	Benson L Parris
University of Texas, San Antonio	Gordon Dwight Mueller
University of Texas, Houston	Travis Vance Crocker
Tufts University	Clifford Jay Yanover
Medical College of Virginia	Robert D King
University of Washington	Ronald O Maxfield
Washington University	Charles R Lyon
University of Western Ontario	Craig I Allison
West Virginia University	P Laray Rector

OBITUARIES

John T Ryan

Dr John T Ryan passed away on 16 January 1985 in Seattle, Washington, at the age of 97. He had practiced dentistry for more than 65 years. The final operation he performed, before he retired at 90, was a gold foil.

To those of you who did not have the privilege of knowing John Ryan as well as we did in the Pacific Northwest, it might be of interest to recount his background.

He was born in Havre, Montana, and helped build the family home out of hand-hewn logs. He was creative with his hands and made tools and other useful equipment for the ranch. This led to his entering the dental profession, following words of encouragement from the family dentist.

He enrolled in North Pacific College of Dentistry (now the Oregon Health Sciences University) and graduated with the class of 1913.

John later returned to his alma mater to head the Department of Operative Dentistry. He was instrumental in bringing Dr W I Ferrier to the dental school as an adviser.

John returned to Seattle eventually to open a private practice in the Medical Dental Building.

In later years, John moved his office to his lovely home on the shores of Lake Washington, where he had a clinic set up; there he practiced until his retirement.

He was a fellow of the International College of Dentists and the American College of Dentists and a member of the International College of Nutrition, the American Academy of Gold Foil Operators, Omicron Kappa Upsilon fraternity, the Academy of Operative Dentistry, the G V Black Study Club, and the Associated Ferrier Gold Foil Study Clubs.

Dr Ryan was noted in the Northwest not only for his fine operative ability, but also his research on amalgam. He constructed gauges to measure the expansion and contraction that took place in the setting of amalgam, as well as to measure the pressure necessary to properly condense amalgam. He demonstrated this at many national meetings. Dentists would stop by his table clinics at meetings and measure their finger pressure on his device, and he would tell most in no uncertain terms that the pressure exerted was not enough to properly condense amalgam; for he had remarkably strong and steady hands even well into his nineties.

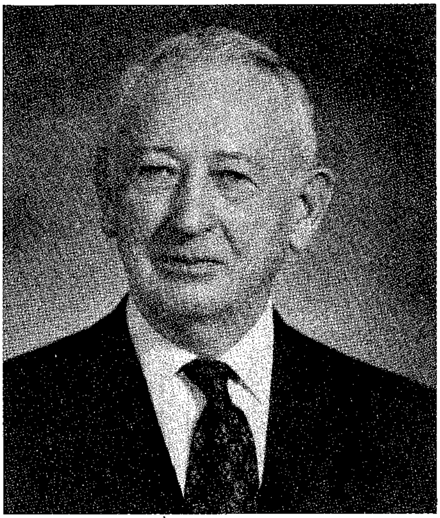
Photography was another of his many interests. He built his own darkroom where he did his own printing and enlarging. He took thousands of feet of movies as well as thousands of still photographs, not only of his research but of various clinical operations as well as of his far-flung travels.

Another of John's avocations was working in metal and wood. He had a well-equipped metal and woodshop at his home, where he would use his lathes and drills to make a variety of dental instruments from his own design or modify others. These could be used in a more effective manner in the dental practice.

The quality of his life was an inspiration — he was involved in two dental study clubs (one crown-and-bridge club that he joined at the age of 91) but he was also an early follower of programs in nutritional research. On several occasions he went with People to People programs studying nutrition in other countries.

John's first wife, Edna, was a dentist, who also taught at dental school when he did. After her passing he married Reza Fleetwood, also a practicing dentist.

Survivors include three stepdaughters: Kathryn Anderson, Bellevue; Shirley Patterson, Redmond; and Maryanne Addington, Cordova, Alaska.



Ralph Edgerton Plummer

Dr Ralph Plummer passed away on Saturday, 11 May 1985, in Seattle, Washington. In every respect, Ralph Plummer was a true and fine representative of our profession. His conduct and daily life commanded admiration. He was of high moral character and dependability. His wise and careful counsel was often sought by his fellow professionals. With his passing, at age 94, dentistry and humanity have lost a master.

He was born in Puyallup, Washington, in 1891, a child of early pioneer parents who settled in the Puyallup valley.

Ralph worked his way through North Pacific Dental School (now Oregon Health Sciences University) and graduated with the class of 1914.

Ralph practiced until 1983, as his patients, who so highly valued his careful and excellent treatment, would not let him retire until his early 90s. He practiced almost 70 years.

At one time he taught dental materials at the University of Washington School of Dentistry, taking a vital interest in his work and the students he came in contact with.

He established a room for gold foil study clubs in Seattle on the 18th floor of the Medical Dental Building, and was mentor of the G V Black Gold Foil Study Club that met there regularly since 1930.

Ralph was a fellow of the American College of Dentists; one of the founders and a past president of the American Academy of Gold Foil Operators; a past president and life member of the Seattle District Dental Society; and life member of the Washington State Dental Society and the American Dental Association. He was also three times president of the Associated Ferrier Gold Foil Study Club, and the last remaining member of the original Seattle Gold Foil Study Club that was founded in 1922.

He was a meticulous operator, not only with gold foil, but in all restorative treatments.

An avid gardener, fisherman, and hiker, he had a great love of the outdoors and the beauty of the Pacific Northwest.

His warm sense of humor and firm handshake are going to be greatly missed.

He is survived by a daughter, Patricia, and a son Ralph Jr., three grandchildren, and one great grandchild.

It can be said that Drs John Ryan and Ralph Plummer had achieved the highest reward of mankind, that of having lived so the world is a better place for them having lived in it.

They made a deep and lasting impression upon all of us who were fortunate enough to have known them.

"In the life of such a man, death can only be an incident, and for those friends whom he earned with his kindness and service, he still lives and abounds."

HAROLD L SONDHEIM

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

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

Exclusive Publication

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

Manuscripts

Submit the original manuscript and one copy; authors should keep another copy for reference. Type double spaced, including references, and leave margins of at least 3 cm (one inch). Supply a short title for running headlines. Spelling should conform to *Webster's Third New International Dictionary,* unabridged edition, 1971. Nomenclature used in descriptive human anatomy should conform to *Nomina Anatomica,* 5th ed, 1983; 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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University of Washington
School of Dentistry SM-57
Seattle, WA 98195 USA