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EDITORIAL

Deadwood Must Go

Living beyond one's means is a direct road to bankruptcy. The evil day can often be put off by borrowing or by subsidy but eventually goods and services have to be paid for by other goods and services. This principle of economics is easily overlooked when money is used as a medium of exchange. Exchanges would, of course, be much more difficult were money not available, because commodities would then have to be exchanged directly for each other. Money is a marvelous invention for it enables us to generalize our purchasing power. The generalizing of purchasing power, however, can easily conceal the fact that some people may receive incomes without producing or contributing anything useful, and that some may in fact be counterproductive.

In the recent past when the supply of money was expanded, the proportion of people receiving incomes from unproductive or counterproductive activity rose. The subsequent increase in total purchasing power without a concomitant increase in the supply of useful goods and services resulted in rising prices. Prices rose because more money was available to purchase the same quantity of goods and services.

The solution to this maladjustment seems obvious; a shift of people from unproductive and counterproductive occupations to productive ones. But how is it done? Not easily, because once a position has been created and filled, a vested interest develops and, naturally, the incumbent is usually reluctant to leave voluntarily.

At present, universities and governments find themselves victims of overexpansion followed by a decline in income. In universities—and dental schools are good examples—the expansion has resulted in a disproportionately large increase in administrators compared with the increase in the teaching faculty. Associate deans, assistant deans, and other managers, few of whom teach, usually receive large incomes and generate copious quantities of directives, regulations, and red tape that often hinder rather than help the teaching program. In addition, experimental educational programs peripheral to the main discipline have proliferated and, in dental schools, have expanded mainly at the expense of operative dentistry. Not all of these programs have been successful and, regrettably, the losers have been the students.

Universities must balance their budgets, and when incomes decline so must expenditures. Since the goal is to make the best use of available resources, where should universities make the reductions? Saving on the maintenance of buildings and equipment is unsound and short-sighted because repairs and replacements later will be more costly. Nor is a general reduction of salaries a good solution because that discourages the teaching faculty, leads to a decline in the number of competent teachers, and to a lowered standard of education. No, it is the pruning of the deadwood that insures the survival and productivity of the vine. The unproductive and counterproductive elements of the administration and the unsuccessful peripheral programs are the logical places to make the first cuts. Unfortunately, they are likely to be the last.

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OPERATIVE DENTISTRY, 1982, 7, 42–47.

O R I G I N A L   A R T I C L E

Mercury Emission from Capsules during Trituration

Reusable and disposable capsules lost weight during trituration. Part of the loss of weight is attributed to wear of capsule and the remainder to mercury. New reusable capsules with screw caps lose less weight than most disposable capsules.

J MALCOLM CARTER • ROBERT P MARIER

Summary

Seven brands of disposable capsule (Indiloy, Tytin, Sybraloy, Valiant, Dispersalloy, Unitek, Phase-A-Caps) and three brands of reusable capsule (S S White, Kerr, Johnson & Johnson) were tested for change in weight during trituration. All lost weight but an analysis of variance and ranking showed the differences among the disposable capsules were not statistically significant except for Phase-A-Caps, which lost the most weight. There was no statistical difference between the three reusable capsules. There was a trend for the reusable capsules to lose less weight than the disposable ones. Capsules always weigh less after trituration because of external wear; therefore, actual mercury loss, if any, is smaller.

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In recent years, following the general concern for environmental contamination and pollution, the dental profession has become increasingly aware of the toxicity of mercury vapor. A collection of papers in the *Journal of the American Dental Association* for June 1976 discussed the hazards of mercury vapor and recommended ways to reduce exposure to it. Since then, broader studies have been reported. Sinclair, Turner & Johns (1980) found significant levels of mercury present in samples of head hair and fingernails of dental students in their final year, presumably due to both increased workload and accompanying carelessness in using mercury. Harris & others (1978) in an extensive study of 115 offices analyzed the urine of 88 dental personnel in 40 offices and measured the levels of mercury vapor. Among the variables considered were age of dentist, number of amalgams placed per year, total weight of mercury used, whether a squeeze cloth was used, type of flooring and method and frequency of cleaning, and the form in which the mercury was used (bulk or capsules).

The only significant correlation was with the form in which the mercury was used, and this study concluded that premeasured disposable capsules produce the lowest levels of mercury in urine and in the environment.

Factors contributing to environmental contamination of the dental office include spillage while proportioning, leakage from the capsule during trituration (Capdeboscq & von der Lehr, 1979; von der Lehr & Capdeboscq, 1979; Blitzer & Pollack, 1981), droppings of triturated amalgam, removal of old amalgams (Mantyla, 1973), and condensation (Eames & Palmertree, 1979).

The rapid oscillating motion of the capsule during trituration is highly effective in subdividing leaking mercury into fine droplets, some of which will remain in the air as a fine mist or aerosol, like water, under high pressure from a nozzle. A droplet of mercury 1 mm in diameter (less than a pinhead) weighs about 7 mg. A room 9 x 24 x 8 ft (50 m^3) would need only 2.5 mg of vaporized mercury to reach the threshold limit value (TLV) of 0.05 $mg \cdot m^{-3}$ (see appendix).

Although mercury does not vaporize completely at ambient temperatures, cumulative effects make it essential that capsules do not leak. The draft of the new specification for dental amalgam by the International Standards Organization, ISO 1559, puts the maximum loss in mean weight of 5 capsules at 0.5 mg (Stanford, 1982). As a draft, it is subject to review.

The purpose of this work was to evaluate leakage of mercury from several well-known brands of disposable and reusable capsules by measuring weight lost during trituration.

MATERIALS

The seven brands of disposable capsule and three brands of reusable capsule that were tested are listed in Table 1 and shown in Figures 1 and 2.

A pellet of six grains (360 mg) of Caulk Fine Cut alloy (L D Caulk Co, Milford, DE 19963, USA) was used with each reusable capsule.

Table 1. Capsule Brands, Types, and Trituration Details

Capsule	Type	Trituration Setting
Disposable		
Indiloy (Shofu Dental Corp, Menlo Park, CA 94025, USA)	Friction	M-2:10 s
Tytin (S S White, Philadelphia, PA 19102, USA)	Friction	H-2:4 s
Sybraloy (Kerr Mfg Co, Romulus, MI 48174, USA)	Friction	M-3:10 s
Valiant (L D Caulk Co, Milford, DE 19963, USA)	Welded	H-2:6 s
Dispersalloy (Johnson & Johnson Dental Products Co, East Windsor, NJ 08520, USA)	Friction	H-2:3 s
Unitek (Unitek Corp, Monrovia, CA 91016, USA)	Friction	M-2:10 s
Phase-A-Caps (Phasealloy Inc, El Cajon, CA 92021, USA)	Screw	M-2:10 s
Reusable		
S S White	Screw, cylindrical pestle	L-2:8 s
Kerr	Screw, spherical pestle	L-2:8 s
Johnson & Johnson	Friction, cylindrical pestle	L-2:8 s

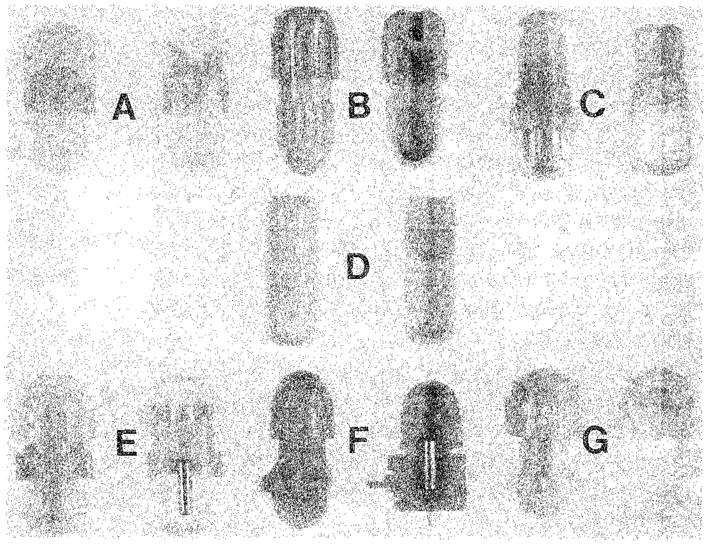

FIG 1. *Disposable capsules. A - Indiloy; B - Tytin; C - Sybraloy; D - Valiant; E - Dispersalloy; F - Unitek; G - Phase-A-Caps.*

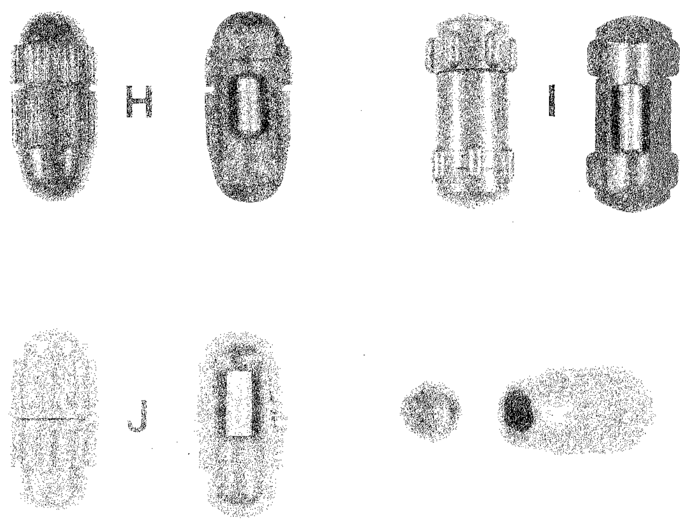

FIG 2. *Reusable capsules. H - Kerr, I - Johnson & Johnson, J - S S White; Lower right - failed capsule with broken end.*

METHODS

Disposable Capsules

After placing identification marks on the six capsules of each brand, they were blown clean with filtered compressed air and wiped. They were then placed with tweezers into a desiccator overnight until weighing. A Mettler model H10 balance (Mettler Instrument Corp, Princeton, NJ 08540, USA), which has 0.05 mg as the smallest division, was used to measure to the nearest 0.1 mg. The mercury and alloy were triturated with a Caulk Vari-Mix II (L D Caulk Co) for the maximum time and highest speed recommended by the manufacturer of each alloy. After trituration the capsules were blown clean with compressed air and stored in the desiccator overnight before weighing.

The loss of weight was calculated as a percentage of combined weight of capsule and contents. Loss expressed as a proportion is more meaningful than the actual loss since the weights of different brands of capsule and the amounts of premeasured alloy and mercury vary. For example, the Valiant capsule weighs about 2.5 g whereas that of Dispersalloy weighs around 4.7 g. Capsules were sectioned so that their internal details could be studied. A low-speed diamond saw (Isomet, Buehler Ltd, Evanston, IL 60204) lubricated with water was used. Figures 1 and 2 show capsules after trituration with the amalgam removed.

Reusable Capsules

Six new capsules and pestles of each brand were cleaned ultrasonically in detergent for 5 minutes, dried with tissue, and stored in the desiccator overnight. Alloy and mercury were triturated at the L-2 setting for 8 seconds, after which the capsules were blown clean, wiped, desiccated, and reweighed. Capsules were handled with tweezers at all times.

To measure weight lost by the capsule itself after repeated trituration, a Kerr capsule containing a pestle only was triturated and carefully weighed between runs. Two types of pestle, spherical and cylindrical, were used.

RESULTS

Table 2 shows results for disposable and reusable capsules, which are ranked from the least to the greatest percentage of weight lost. One-way analysis of variance showed the brand of capsule to affect percentage loss of weight ($P < 0.05$); however, ranking by Duncan's Multiple Range test showed that only Phase-A-Caps differed statistically from the others at the 95% level of significance. The Kerr reusable capsule, when tested without a charge of alloy and mercury but with a spherical pestle, showed a loss of weight of 0.002%. Each cycle of trituration produced a loss of nearly 0.1 mg, presumably by external wear. When a heavier cylindrical pestle was exchanged for the spherical one, the percentage of weight lost increased. How-

Table 2. Loss of Weight from Disposable (D) and Reusable (R) Capsules

Capsule	Type	Capsule Weight g Mean	Weight Lost mg Mean	Weight Lost % Mean	Weight Lost % SD
S S White	R	5.5338	0.17	0.0029 ┐	0.0039
Indiloy	D	4.1469	0.18	0.0044 │	0.0023
Kerr	R	4.1759	0.20	0.0047 │	0.0025
Johnson & Johnson	R	5.0500	0.35	0.0068 │	0.0044
Tytin	D	3.2866	0.28	0.0086 │	0.0059
Sybraloy	D	3.1546	0.33	0.0105 │	0.0052
Valiant	D	2.4969	0.35	0.0140 │	0.0072
Dispersalloy	D	4.6741	0.67	0.0142 │	0.0165
Unitek	D	4.6380	0.93	0.0199 ┘	0.0345
Phase-A-Caps	D	3.1122	2.75	0.0885	0.1036
*No Hg & alloy:**					
Kerr (spherical pestle)	R	3.2834	0.07	0.0020	0.0015
Kerr (cylindrical pestle)	R	4.9287	0.17	0.0033	0.0011

*A one-tailed *t* test showed the heavier cylindrical pestle tends to cause more wear at the 89% level.

The difference between any two means joined by the same vertical line is not significant at the 95% level.

ever, since a one-tailed t test showed low statistical significance ($P < 0.11$) for this change, it must be treated as a trend.

DISCUSSION

In spite of careful cleaning, handling, and weighing, the results show much variability. However, when the coefficients of variation and losses of weight are compared with those calculated from the published results of other workers (Capdeboscq & von der Lehr, 1979; Blitzer & Pollack, 1981), they lie within the same ranges. Our results showed only the Phase-A-Caps to be different even when disposable and reusable capsules were treated together. This is surprising since they were the only disposable capsules with screw tops that were tested; the remainder have tops that fit by friction, except for Valiant, which is welded shut. It is possible that variations in the force used to retighten the tops of Phase-A-Caps after the release of the mercury could have produced the larger variations in weight lost. With the Sybraloy capsules, alloy wetted by mercury was visible between the tightly fitted compartment for mercury and the outer case. This material could not be dislodged after opening the capsule and represents a small loss of material for the dentist. Surprisingly, the sealed Valiant capsules did not show the smallest loss of weight. Since loss of mercury is impossible because of the welded construction, the results represent wear of the capsule. An attempt to follow wear by retriturating Valiant capsules failed, since they disintegrated. The Unitek capsules did not fit the arms of the triturator as securely as did the other disposable capsules; and until the arms were rebent, a few capsules came apart, releasing partly mixed amalgam. This capsule tends to shorten when squeezed along its longitudinal axis since its short sleeve does not readily seat on the internal collar (Fig 1). Forces produced during insertion of the capsule into the arms of the triturator often made a poor fit. These samples were not included in the results.

In Figure 2, a failed reusable capsule is shown. This had been in clinical service for an unknown time, and failure of one end is probably due to fatigue in the plastic. Perhaps manufacturers could incorporate some kind of wear indicator into the ends of reusable capsules so that users could be warned of impending failure.

A friction-fitted capsule was observed with a stroboscope during trituration. It showed small changes in length resulting from the pestle, alloy, and mercury being hurled against the ends of the capsule. This produces a pumping action at the joint due to the movement of the two parts of the capsule. Therefore, the location and fit of this junction affects any loss of contents. If it could be occluded by an internal sleeve or the path of potential leakage made more tortuous by a stepped sleeve, less leakage should occur, especially if the parts of the capsule fit tightly.

The Indiloy and Tytin capsules had tightly fitting parts with two-step and internal sleeves, respectively (Fig 1). They lost the least weight of the disposable capsules tested in this study as well as in two others (Capdeboscq & von der Lehr, 1979; Blitzer & Pollack, 1981). The Sybraloy capsule had a one-step sleeve and Dispersalloy a long sleeve, which seated internally at the end of the capsule.

The Unitek capsule was similar to that of Dispersalloy but with a shorter sleeve and a rotating reservoir for mercury. This feature produces another potential path of leakage. The Phase-A-Caps capsule had a screw top containing a flexible plastic shield, which released mercury after the top was loosened and tapped. There is a possibility of mercury entering the threads if the top is loosened too much.

The amounts of mercury released from damaged or poorly designed capsules, especially during the first moments of trituration when the mercury is unreacted with the alloy, could far surpass losses during normal trituration. This suggests that a cover inclosing the triturator is necessary to contain spills. Reshaping the arms of the triturator is not advisable because their life may be shortened.

Because of the large variances associated with the method of evaluation used in this study, means and standard deviations by themselves are not sufficient to make conclusions about loss of weight of triturated capsules, or, much less, emissions of mercury since these are not measured directly. For example, the data of Blitzer & Pollack (1981) when subjected to analysis of variance and multiple ranking show no difference between capsules of Lee, Sybraloy, Phase-A-Caps, Indiloy, and Tytin with identical length of trituration (their Dispersalloy capsules showed a loss 50 times greater than the others and have been excluded since there was obviously something wrong with that batch). However, a *t* test of their data for capsules of Tytin and Phase-A-Caps triturated for different times shows that Tytin capsules lost less weight than did those of Phase-A-Caps ($P < 0.05$). This was also shown in our study. The data of Capdeboscq & von der Lehr (1979), when subjected to the same statistical analysis, showed capsules of Tytin lost the least weight, Caulk the greatest, with Indiloy, Sybraloy, and Aristaloy intermediate with no ranking differences. Their data on reusable capsules showed those of Caulk, Shofu, Crescent, Baker, and Kerr losing the least weight with no significant ranking and those of S S White (old style, push-fit) and Johnson & Johnson to be similar and losing the greatest weight.

In our study, also, Johnson & Johnson reusable capsules lost the most weight but S S White (new style, screw-top) capsules lost the least, in agreement with a later paper of von der Lehr & Capdeboscq. Any advantage of using reusable capsules that have a low loss of mercury will of course be negated if mercury is carelessly dispensed. The intriguing question raised by our results is how much loss in weight is due to wear and how much is due to mercury. The Valiant capsules, which could not leak, obviously, through wear lost weight of the same magnitude as most of the capsules tested. All the capsules except Dispersalloy, Unitek, and Phase-A-Caps would pass draft ISO 1559. Combined with the observation of progressive loss of weight on repeated trituration of the uncharged Kerr reusable capsule and the effects of pestle weight, wear of the capsule must be considered in any study attempting to measure loss of mercury indirectly. More work by direct measurement of the emission of mercury vapor is necessary to resolve this problem.

Appendix

The TLV is the maximum time-weighted average concentration of an atmospheric contaminant to which the majority of normal individuals may be exposed for prolonged periods during the course of their work (8 hours per day, 5 days per week) without adverse effects.

Acknowledgment

We thank Robert R Johnson, technical specialist in the Department of Dental Materials, for his help in collecting some of the data.

(Accepted 23 November 1981)

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 OPERATIVE DENTISTRY, 1982, 7, 48–49.

DENTAL PRACTICE

Is there Life after Death for Your Disposable Capsules?

Disposable capsules for amalgam make useful containers for mixing zinc oxide and eugenol cement in an amalgamator.

EDWARD J IRELAND

Summary

Spent disposable capsules for amalgam can be useful for mechanically mixing reinforced zinc oxide and eugenol cement. Depending upon the amalgamator used, an excellent consistency of base can be produced in as short a time as 7 seconds with no messy clean-up afterward.

Introduction

Many dentists now use disposable capsules for amalgam, so it may be time to resurrect an old idea. We have long known that reinforced zinc oxide and eugenol (ZOE) cement can be mixed in an amalgam capsule, but in the past capsules were reusable and too expensive to be used for mixing cement. Furthermore, the time needed to clean out the cement thoroughly after mixing made it easier just to mix the material with a spatula on a pad. The popularity of disposable capsules is increasing; and reusing them to mix reinforced ZOE cement is quick, efficient, and may be an idea whose time has come.

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Method

Virtually any type of reclosable capsule will work. Discard the pestle, if any, and inspect the inside of the capsule to make sure there are no remaining pieces of amalgam, though usually there are none.

To mix a cement base, follow exactly the ratio of powder to liquid recommended by the manufacturer. In this study, IRM (L D Caulk Co, Milford, DE 19963, USA) was the material used. One level scoop of powder was placed in the capsule, followed by one drop of liquid. A mixing time of 7 seconds on a Caulk Vari-Mix II amalgamator at an M2 setting produced an excellent mix suitable for a cement base. If a larger amount of material is needed, two scoops of powder to two drops of liquid mixed for 14 seconds will also produce a base of excellent consistency.

If a much thinner mix is desired for use as a temporary cement, mix two scoops of powder to three drops of liquid for 14 seconds. If a larger amount of temporary cement is desired, three scoops of powder to five drops of liquid also mixed for 14 seconds produce excellent results.

Testing

Samples of IRM mixed in a capsule to the consistency for a base were tested for crushing strength by placing them under strain in an Instron Universal Testing Machine (Instron Corp, Canton, MA 02021, USA) at a crosshead speed of 0.5 mm per minute (0.5 mm $\cdot$ min^{-1}). An average crushing strength of 10 003 lbf $\cdot$ in^{-2} (69 MPa) was obtained. This exceeds the standard of 9860 lbf $\cdot$ in^{-2} (68 MPa) set for IRM by the Council on Dental Materials, Instruments and Equipment of the American Dental Dental Association, a value obtained at a crosshead speed of 0.1 in $\cdot$ min^{-1}.

Recommendations

Trituration times may vary depending upon the type of machine used; consequently mixing time may vary slightly.

Begin with a fresh bottle of powder and liquid. An old bottle that may have accumulated moisture may produce a mix that is too stiff for a base. If the climate is humid accumulation of moisture can be avoided by placing a packet of silica gel in the bottle of powder. Such packets are available in many bottles of vitamin capsules or from a pharmacist.

Dispense the liquid accurately by allowing a full drop to accumulate on the tip of the dropper before discharging the liquid into the capsule on top of the powder. After mixing, use a narrow cement spatula to retrieve the material from the inside of the capsule. Discard the capsule after one use. One final reminder: reset the amalgamator to the correct timing before mixing amalgam.

Discussion

Triturating reinforced ZOE cement in a disposable capsule allows the material to be mixed in seconds with no messy cleanup afterward. Even more time can be saved if the assistant places powder into several capsules ahead of time. In this case, the assistant need only open the capsule, insert the liquid, and mix.

(Accepted 7 December 1981)

OPERATIVE DENTISTRY, 1982, 7, 50-54.

Class 2 Inlay Cavity Procedures

A technique for preparing class 2 cavities for inlays that has been shown to give excellent results

RICHARD V TUCKER

There are many technics and procedures that accomplish a good inlay cavity. The following is one that I have used to prepare thousands of cavities and find efficient and clinically satisfactory.

An inlay cavity that is properly prepared meets the requirements set long ago by G V Black, for example, proper outline form, resistance form, and retention form. It also is cut with reasonable precision to present smooth internal surfaces and sharp line angles and point angles as emphasized for many years by George A Ellsperman. Only from a cavity prepared with smooth walls, good marginal definition, and smooth flowing outlines can a dentist or technician wax and cast a precision gold inlay (Charbeneau, 1958).

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An essential first procedure in the preparation of a cavity is the proper placement of a rubber dam. With the rubber dam, access, visual definition, and tissue retraction can be accomplished. For ease, efficiency, and perfection the rubber dam must not be overlooked.

Old amalgam or extensive caries should be removed with a rotary instrument of choice. Since a large round bur does not always remove the final caries, its removal should be completed with a sharp spoon excavator, which leaves the cavity surface with a sheen.

Little time is needed to rout the cavity as just described. If the hole in the tooth is beyond ideal depth, either pulpally or axially, the deep areas are painted with a calcium hydroxide paste and a fine grain composite is pushed into the cavity with or without a matrix. Adjacent teeth serve as adequate matrix for this material, which serves as a temporary base. This procedure is particularly helpful in teaching as it allows a rather ideal cavity to be prepared and allows the cavity to be reprepared by replacing the composite if there is a flaw in the preparation. There are other advantages to the use of the composite build-up, particularly to facilitate a more conservative preparation. For example, if the axial wall is built up and the gingival wall is narrowed, margins need not be extended as far buccally and lingually to present a proper angle of enamel at the cavosurface. If the pulpal wall is made shallow by the build-up, with the necessary flare to the walls, it also allows a more restricted occlusal outline (Fig 1 a & b). Before placing the inlay the composite should be flaked out and zinc phosphate cement flowed into the cavity during the cementation procedure (Brännström & Nyborg, 1972).

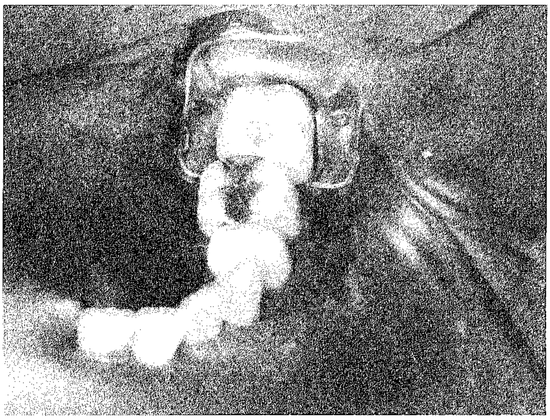

FIG 1a. *Extensive alloy to be replaced with a gold inlay due to recurrence of caries*

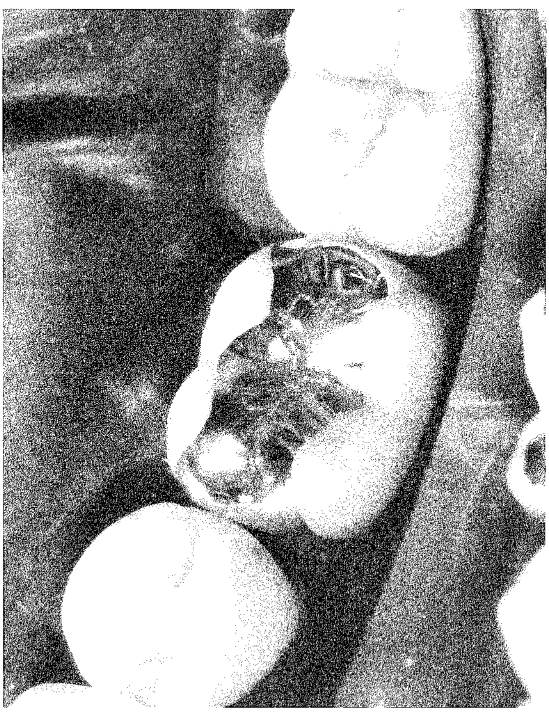

FIG 1b. *Conservative treatment in the preparation on the same tooth demonstrates minimum destruction of the tooth*

A #57 bur for molars or #56 bur for premolar teeth (Boyde, 1976) is used across the occlusal surface to establish a flat pulpal wall at an optimum depth. With many light planing motions across the pulpal wall, leaning the bur slightly toward buccal and lingual, a taper of approximately 10 degrees is established on the vertical walls while the pulpal wall is smoothed. The buccolingual dimension of the cavity should be kept as narrow as possible to avoid weakening the tooth and perhaps requiring cusp coverage (Larson, Douglas & Geistfeld, 1981).

The same bur is then used to extend the cavity gingivally on both mesial and distal to establish the gingival walls a few millimeters below the contact areas. Again by slowly planing with the end of the bur and by inclining the handpiece slightly, a smooth gingival wall is established and the proximal walls are simultaneously placed with a slight taper. If the gingival wall is kept short, when the walls are flared the cavity outline will not be unnecessarily extended.

At this point the cavity should be nearly finished. The gingival wall should be smooth and straight; the axial wall smooth and almost parallel to the opposing axial wall; and the pulpal wall smooth with well-defined buccopulpal and linguopulpal line angles. All walls should have a slight taper to allow easy withdrawal of the wax pattern (McGehee, 1936).

These factors further the aim of minimizing the use of hand instruments, because much time and effort can be wasted when the operator attempts to do with hand instruments that which can be done better with a bur. Nearly all hand instrumentation should be limited to slight smoothing of the walls, which should already be quite smooth, and placing and refining internal line and point angles.

Instrumentation of most cavities can be accomplished with four hand instruments: the #42S(15-10-16) and #43S(15-10-16) double ended off-angle hatchets designed by Jose E Medina and #232(10-95-10-16) and #233(10-80-10-16) margin trimmers. To be effective, the instruments must be sharpened after each time they are used.

The first step in the instrumentation is the cutting of the buccoaxial line angle on the distal aspect of the tooth with the #42S hatchet. The blade is placed on the distobuccal wall with the edge of the hatchet forming the buccoaxial line angle. Simultaneously the blade smooths and straightens the axial half of the buccal wall. (The rest of the buccal wall is straightened with a disc as the last step of the cavity preparation.) This can best be accomplished by placing the instrument in the proper position at the pulpal wall and sliding it gingivally with only one or two strokes at the proper angle.

The distolingual wall and the linguoaxial angle is then established in a similar manner with the opposite end of the same instrument. Having established the line angles on the distal aspect of the tooth, the same hatchet is used to plane down the axial wall with three or four strokes to smooth it and sharpen the line angle, removing the effect of gouging when the instrument was previously used on the adjacent wall.

The same procedure is followed for the internal form of the mesial aspect of the tooth, using the #43S off-angle hatchet. Limiting the number of strokes with these chisels should be emphasized, because one or two well-guided strokes will not cause irregularities, scars, and scratches but should leave one well-defined line angle and a sharp point angle where the vertical walls meet the gingival wall.

The gingival bevels are the next consideration. The distal margin is beveled with the #232 margin trimmer by planing a few strokes toward the buccal wall, then with the other end of the same instrument toward the lingual wall, followed by connecting the bevel in the middle aspect of the margin. This procedure avoids placing a swale in the bevel in the middle of the tooth where access is easy and thus is an aid to placing an even, smooth bevel. This bevel should be at an angle of approximately 45 degrees. The operator should take care not to use too much pressure on the instrument and so avoid placing too extensive a bevel. Rather, by using this sharp curved instrument with a scythelike stroke, cutting and not scraping the tooth, a narrow smooth bevel can be placed (Fig 2). Emphasis is on the sharpness and clarity of the bevel, not its width.

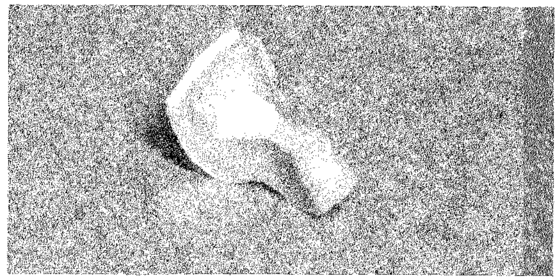

FIG 2. *Casting to indicate optimal angle and length of gingival bevel*

A bevel is placed on the mesial margin in the same manner, with the #233 margin trimmer. It is more difficult to create the proper 45-degree angle on the mesial aspect of the tooth because the rest of the dentition interferes with the angle of placement of the instrument. For this reason the angle of the mesial bevel is seldom adequate. Since the operator must depend entirely on the angle on the cutting edge of the margin trimmer, the angle should be increased when the instrument is sharpened (Fig 3). This is also the case

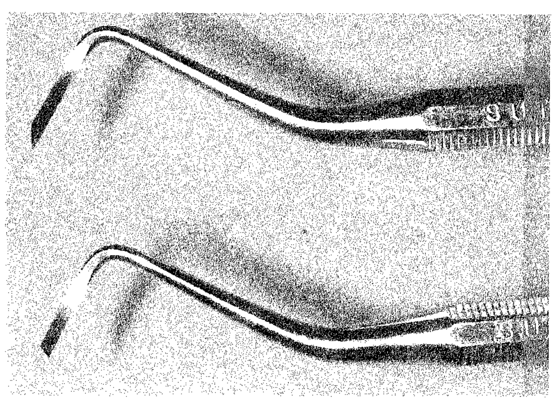

FIG 3. *Margin trimmers to indicate the modified angle placed on top instrument in sharpening*

for the distal margin trimmer but not quite to the same extent.

Following hand instrumentation a slight occlusal bevel of approximately 15 degrees should be placed on the occlusal outline with either a #56 or #57 bur (Frates, 1967; Bassett, Ingraham & Koser, 1964). Whereas the outline was established as the first step in the preparation, the outline as observed after the inlay is placed is the outside margin of the occlusal bevel. Considering this, be careful that the bevel is not so long that its plane blends with that of the incline of the cusp, making the outline obscure and indefinite (Fig 4a). Also, as the bevel is placed it gives the operator an opportunity to correct small flaws in the outline and create a smoothly flowing inlay margin (Fig 4b).

FIG 4a. *Castings show lack of definite outline due to elongated occlusal bevel on the preparation.*

FIG 4b. *Castings indicate well-defined outline when the occlusal bevel is minimized.*

If cusps are to be covered this would be the next step in the normal sequence of the operation. If not, the final step in the preparation is discing the proximal walls with a medium grit disc of narrow diameter. It should be placed parallel to the wall so another plane is not established. Discing straightens the wall, removing the reverse curve usually left by the bur on the occlusal outline; it removes the acute angle of enamel at the proximocavosurface and produces a smooth margin. Medium grit garnet is chosen rather than fine grit because it actually cuts the bulk of enamel to correct the outline rather than just polishing and rounding the surface. The discing should produce nearly a 90-degree angle with the cavosurface of the tooth (Kinzer & Morris, 1976).

If the cavity is too restricted to allow the disc to be placed on the proximal wall without bending the disc, which rounds the margin, the entire proximal wall should be straightened and planed with the off-angle hatchet at the time the internal line angles are placed.

The advantages of following a step-by-step procedure for cavity preparation are important not only for efficiency but also for allowing crisper and smoother preparation by avoiding overinstrumenting. For example, if at some stage in the cavity preparation the operator chooses to go back to a previous step, such as lowering the gingival wall, it usually requires completely repreparing the cavity. This emphasizes the importance of assessing each step and ensuring that it has been done with perfection before continuing with the next step of the cavity preparation (Stibbs, 1972).

Summary

STEPS IN CAVITY PREPARATION

1. Rubber dam placed
2. Removal of caries and previous restorations
3. Calcium hydroxide film in deep areas
4. Composite build-up

5. Occlusal outline and pulpal wall placed with straight fissure bur
6. Gingival wall established simultaneously with proximal walls and axial wall, same bur
7. Buccoaxial and linguoaxial line angles on distal aspect of tooth with #42S hatchet
8. Axial wall smoothed and line angles sharpened on distal with #42S hatchet
9. Buccoaxial and linguoaxial line angles on mesial aspect of tooth with #43S hatchet
10. Axial wall smoothed and line angles sharpened on mesial with #43S hatchet
11. Gingival bevel on distal with #232 altered margin trimmer
12. Gingival bevel on mesial with #233 altered margin trimmer
13. Occlusal bevel with straight fissure bur
14. Straighten proximal walls and cavo-surface margin with medium garnet disc

(Accepted 27 April 1982)

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CASE REPORT

Interstitial Emphysema: An Insidious Complication of Operative Dentistry

JAMES M CHILDERS • KIMBLE A TRAEGER

Summary

Interstitial emphysema can be an insidious complication of operative dentistry. Insidious because it is not common enough to be a familiar phenomenon to most practicing dentists, yet it is potentially serious enough to warrant recognition, understanding, and attention to prevent more serious consequences. The condition is due to air being forced into the submucosal tissues by the operator or the patient.

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Introduction

Interstitial emphysema can accompany restorative procedures, but is not exclusive to those procedures. Shovelton (1957) in his review of the American and British literature from 1900-1957, assigned the incidents of interstitial emphysema to one of three categories:

1) During or after extraction of teeth
2) During root canal therapy
3) After laceration of the soft tissue during dental operations

This article recounts a recent clinical incident. Duncan & Ferrillo (1967) have reported a similar case.

Report of Case

A 48-year-old Caucasian female was treated in the outpatient clinic of the dental school for a class 5 carious lesion in the mesial third of the facial surface of the mandibular right second molar. The lesion extended well below the gingival crest. An Ivory #12 rubber dam retainer (Columbus Dental, Ivory Division, San Fernando, CA 91340, USA) was used to retract the gingiva.

Before placement of the retainer, the gingival collar was stretched and loosened with a Premierlite 1-2 plastic instrument (Premier Dental Products Co, Norristown, PA 19401, USA) to prevent laceration when the gingiva was retracted. The tissue was not lacerated during the stretching, but the gingival attachment at the distal extent of the sulcus was apparently disturbed since the alveolar crest at the distofacial aspect could be detected.

The cavity was prepared with the rubber dam applied and the restoration placed in good fashion with very satisfactory isolation. After completing the restoration, the student was instructed to remove the rubber dam, to massage the soft tissue, and to inspect the site for debris.

During his examination, the student introduced compressed air (12-22 pounds per square inch; 83-152 kPa) with the air syringe into the gingival sulcus on the facial aspect. Swelling with crepitus developed immediately in the right cheek and below the eye. The enlargement was very rapid and the patient, while experiencing no pain, was quite conscious of the change in facial contour (see figure).

Facial swelling associated with interstitial emphysema

Interstitial emphysema was diagnosed and the patient informed of the circumstances and the prognosis. As the patient was allergic to penicillin, she was placed on a prophylactic regimen of Erythromycin, 250 mg, 4 times per day, and asked to return in two days.

At that time she reported no significant discomfort, and the swelling had subsided. The patient continued the antibiotic therapy for a total of five days from the date of incident. The emphysema resolved at the end of one week.

Discussion

Rapid swelling of the face in concert with dental procedures requires differential diagnosis. Interstitial emphysema must be differentiated from hematoma, which is much more commonly expected and experienced by the dentist. In the early stages of hematoma there is no superficial discoloration; the differentiating factor is the presence or absence of crepitus. While the tissue may be spongy after the formation of hematoma, crepitus will not be present.

Pain, though not a factor in this recounted incident, can accompany interstitial emphysema. Pain can be sharp as the swelling appears, but the duration is usually short (Shovelton, 1957).

Only two possibilities, either a positive or negative pressure, can be responsible for the introduction of air into the submucosal tissues. Modern dental instruments using compressed air supply positive pressure and should be used judiciously. A negative (sucking) action may be created by reflection of the periosteum from bone in the region of the third molar (Rhymes, 1964).

Usually the swelling associated with interstitial emphysema is bounded by the cervical fascia, but may reach the top of the head and as far down the thorax as the sixth rib (Shovelton, 1957).

Although there has been no report of death of a human from emboli of air associated with dental procedures, Rickles & Joshi (1963) produced death in four of seven dogs after prolonged introduction of compressed air into root canals of anterior teeth. Later, when their investigation was extended to dogs in the sitting position and with tighter seals between cannula and tooth, death occurred in seconds instead of minutes. One dog died from the effects of air introduced for three seconds at a pressure of 35 lbf · in^{-2} (241 kPa).

Conservative treatment of interstitial emphysema is usually adequate, and patients usually recover in two to four days. Analgesics should be prescribed if pain is present, and antibiotics reduce the possibility of infection from oral organisms, which can become pathogenic when transferred to remote tissues. Because some patients may be allergic to penicillin, Rhymes (1964) suggests the use of a broad-spectrum antibiotic in a dose comparable to 250 mg of penicillin taken orally four times a day.

Conclusion

Interstitial emphysema is not common in dentistry, nevertheless judicious intraoral use of instruments using compressed air would seem prudent. Treatment can be conservative and the prognosis is usually good. Infection, mediastinal emphysema, and air embolism are possible complications.

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D E N T A L   E D U C A T I O N

Communication between Educators: Philosophy and Scope of CODE

The regional meetings of the Conference of Operative Dentistry Educators facilitate communication among teachers.

FRANK J MIRANDA

Summary

The Conference of Operative Dentistry Educators (CODE), formed in 1973, is divided into seven geographic regions. Regional meetings are held annually to discuss a common agenda. In 1980 CODE became affiliated formally with the Section on Operative Dentistry of the American Association of Dental Schools.

Introduction

The continuing evolution of dentistry, with increasing refinement and sophistication of materials and methods, depends heavily on the ability and willingness of its members to communicate effectively. This is not to imply that the profession does not encourage interaction among its constituents. On the contrary, such national organizations as the American Association of Dental Schools and the American Dental Association alleviate the communication gap to some degree. However, due to inherent complexities in the structure, organization, directives, and goals of such large groups, much of this communication is general rather than the nuts and bolts specifics desired by the average practitioner or dental educator. National and local professional journals provide a second forum for communication but allow little interaction of author and reader. The greatest interaction and benefit come from face-to-face communication on topics of relevant and specific interest between dental educators on a national level. This is the main rationale behind the creation of CODE.

Origin of CODE

CODE is an acronym for *C*onference of *O*perative *D*entistry *E*ducators, a name suggested by William N von der Lehr of Louisiana State University. CODE was formed in the winter of 1973 as a direct outgrowth

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of Project ACORDE, a federally sponsored program charged with the development of instructional units for dental procedures that reflected a consensus of dental educational institutions nationwide. One of the greatest benefits from the ACORDE project was the numerous meetings of dental educators from around the country. These meetings provided an excellent forum for amassing and disseminating a great deal of knowledge and information that could be taken back to individual schools and used to augment or modify existing teaching programs. As the immediate goals of ACORDE were being realized, it became apparent that the traditional provincialism inherent in dental education was being gradually reduced. When the development of ACORDE was completed, a few of its participants met informally to discuss ways of continuing the communication process initiated through ACORDE. From this meeting the concept and initial structure of CODE was created.

The Early Years (1974-1977)

As with any new organization, CODE experienced a number of initial difficulties. It had no official organizational structure, no parent sponsor, no operating funds, and no functional system to direct its general purpose—communication on a national level to exchange ideas and discuss topics of interest in the field of operative dentistry. As founding father of the concept, Robert B Wolcott of the University of California at Los Angeles assumed the role of national coordinator and appointed Frank J Miranda of the University of Oklahoma as national secretary. Dr Wolcott had the awesome task of communicating with each dental school in the United States to gauge support for the idea and to develop an initial agenda. Since an unofficial organization would most likely command low priority in the travel budgets of various schools and travel expenses would thereby preclude one national meeting, the nation's dental schools were arbitrarily divided into six regions (see table) wherein a series of regional meetings would be conducted. These practical economic considerations could have defeated the attempt to reduce provincialism, but the common agenda provided to all regions helped offset this potential problem. The initial reaction of responding schools was overwhelmingly positive and plans were finalized to conduct the first regional meetings in the winter of 1974. The activities of CODE in its early days can be summarized as follows: Each participating school would send a representative to its regional meeting at which a chairperson and recording secretary would be selected; the provided agenda would be discussed; and minutes of proceedings would be recorded. Minutes of all regional meetings would be forwarded to the national secretary for compilation into one national report, which would then be printed and distributed to all participating schools thus completing the communication process. To cover operating expenses, each school was asked to submit nominal dues of $10.00. It is a tribute to the early participants that dues and, in some cases, travel expenses came from their own personal funds.

CODE operated rather smoothly for the first three years. Each region devised a system of rotation such that a different school hosted the regional meeting each year, providing a greater degree of motivation and bringing schools even closer together in a spirit of fellowship and unity. Each region submitted suggestions for future agendas, thereby insuring a continued discussion of interesting and relevant topics. Also in 1974 Canadian dental schools were extended an invitation to join CODE, an invitation they accepted enthusiastically, sending their first representatives to the 1975 regional meetings. A collection of tests (test bank) was started in early 1976 and consisted of submitted written examination questions on specified topics that were compiled and redistributed to all schools.

Although CODE still had no official sponsor and only minimal organization, the enthusiasm and dedication of the participants resulted in a high level of gathering and sharing of information. Some idea of the interesting, informative, and sometimes controversial nature of the regional meetings

CODE Regions and Member Schools

REGION I — PACIFIC COAST (9)

*Alberta
*British Columbia
California - Los Angeles
California - San Francisco
Loma Linda
Oregon
Pacific
Southern California
Washington

REGION II — MIDWEST (10)

Colorado
Creighton
Iowa
*Manitoba
Minnesota
Missouri - Kansas City
Nebraska
*Saskatchewan
Southern Illinois
Washington - St Louis

REGION III — SOUTH MIDWEST (9)

Baylor
Louisiana State
Mississippi
Oklahoma
Oral Roberts
Tennessee
Texas - Houston
Texas - San Antonio
Wells Meharry

REGION IV — GREAT LAKES (14)

Case Western
Detroit
Illinois
Indiana
Kentucky
Louisville

(Region IV, Great Lakes, contd)

Loyola - Chicago
Marquette
Michigan
Northwestern
Ohio State
Pittsburgh
SUNY - Buffalo
*Western Ontario

REGION V — NORTHEAST (19)

Boston
Columbia
Connecticut
*Dalhousie
Fairleigh Dickinson
Georgetown
Harvard
Howard
*Laval
Maryland
*McGill
*Montreal
New Jersey
New York
Pennsylvania
SUNY - Stony Brook
Temple
*Toronto
Tufts

REGION VI — SOUTH (9)

Alabama
Emory
Florida
Georgia
North Carolina
Puerto Rico
South Carolina
Virginia
West Virginia

*Canadian dental schools

can be grasped from the agendas of the first two years:

- Clinical Evaluation Methods
- Clinical Requirements vs Total Patient Care
- Burnishing of Amalgam Restorations
- Techniques for Finishing Composite Restorations
- Direct Gold in the Curriculum
- Indirect vs Direct Pulp Capping
- Cavity Preparations for Amalgam Restorations
- Problems with Rubber Dam Clamps

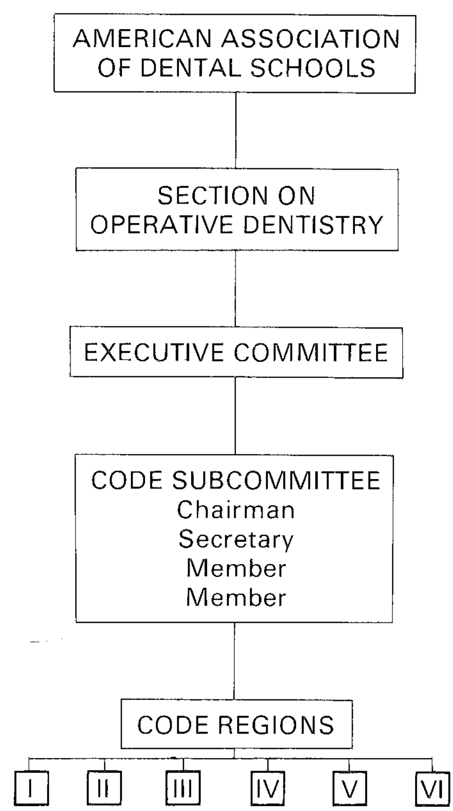
Other topics included programs of faculty enrichment, opportunities for intramural and extramural practice for educators, faculty salaries and travel budgets, and recruitment and retention of new faculty. The national compilation of these discussions provided each participating school with a national consensus of the topics treated.

The Transition Years (1977-1980)

The first indication that the future of CODE was in jeopardy came in 1977, the first year that a national report could not be compiled and distributed. A few regions failed either to conduct meetings or submit reports for compilation. An analysis of the problem revealed that CODE's unofficial status did not allow priority treatment of travel requests submitted by participants. As a result of this, coupled with increasing travel costs, fewer schools were represented at the regional meetings. In addition, costs of printing and mailing continued to rise as dues received began to fall. Regional meetings, originally scheduled for October or November of a given year, began to be spread over a six-month span due to scheduling conflicts of the participants. This made it nearly impossible to compile a national report before the next year's meetings were scheduled to begin. Lastly, regions began to devote more meeting time to topics of particular regional interest and less time to the national agenda, compounding the difficulty of compilation. CODE continued its operations but it was becoming clear that its future depended on some drastic revisions of policies and procedures.

In 1979, Dr Wolcott submitted a report on the status of CODE for the consideration of the executive committee of the Section on Operative Dentistry of the American Association of Dental Schools. As a result of this committee's interest and efforts in perpetuating the original concept, CODE was in effect reborn. As of 1980, CODE has achieved official recognition with the Section on Operative Dentistry of the American Association of Dental Schools as the official parent organization. Its leadership has been transformed from the structure of a national coordinator and secretary to a standing subcommittee under the auspices and direction of the executive committee (see chart). This subcommittee

CODE — Current Organizational Structure



will meet annually to plan the future direction of CODE and thus insure its perpetuation. All schools have been repolled for an indication of willingness to continue participation in CODE; the responses have been uniformly positive. Times of regional meetings have been slightly expanded to allow for discussion of topics of regional interest without jeopardizing the national agenda. Meeting dates have been coordinated to be held within specified periods, deadlines for submission of regional reports to the subcommittee have been established, and reporting forms have been standardized to facilitate transcription and submission of reports.

The Future of CODE

The official sponsorship of the Section on Operative Dentistry of the American Association of Dental Schools and the revised administrative structure of CODE are both designed to insure its continuance as a viable group. More important, however, the original concepts, ideas, and hopes for CODE remain unchanged and undiminished. Its philosophy continues to be based on the concept of dental educators speaking to one another, sharing secrets, encouraging and advising each other, and generally socializing in ways that foster communication. Therein lies the value of CODE. There is every reason to believe that organizations such as this—developed in other fields of dentistry—will continue to crumble the barriers of provincialism and provide the profession with a brotherhood that is truly national in scope.

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REVIEW

Low-gold Alloys for Use in Operative Dentistry

DAVID C SARRETT • JAMES S RICHESON

Of available low-gold alloys those containing 40-49% gold are suitable as less expensive substitutes for Types II and III gold alloys.

INTRODUCTION

Fluctuating prices of gold have led to increased interest in the use of low-gold alloys in dentistry. This review compares conventional alloys with those that are presently marketed (see Table 1) as substitutes for Types II and III gold alloys.

In 1934 the United States government established the Gold Reserve Act, which fixed the priced of gold at $35 per ounce. Since 1968 the price of gold has been allowed to fluctuate. In early 1980 the price of gold approached $900 per ounce, but has fallen since. Based on a cost of $400 per ounce for pure gold a Type III alloy (containing about 75% gold) will cost approximately $20 per dwt and a low-gold alloy (containing about 45% gold) will cost approximately $14 per dwt. Records at the University of Florida College of Dentistry reveal the average weight of castings for onlays and full crowns to be 1.53 dwts.

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In the circumstances, the present difference in cost between conventional and low-gold alloys is negligible when patients spend $250-$400 for these restorations. The history of rises and falls in the price of gold, however, shows each peak to be higher than the last. If the price of gold should ever escalate above $1000 per ounce, the difference in cost between conventional alloys and low-gold alloys might be substantial.

CONVENTIONAL TYPES II AND III ALLOYS

Gold alloys for dental castings are composed of varying amounts of gold, platinum, palladium, silver, copper, and zinc, with gold the primary constituent. Some traces of iridium or rhodium may be found and occasionally indium is substituted for zinc.

Gold

Gold imparts the resistance to tarnish and corrosion found in conventional dental alloys, contributes to ductility, and provides the gold color.

Platinum

Platinum increases the hardness of the alloy and also resists tarnish and corrosion,

Table 1. Alloys Included in Report

Alloy	Manufacturer
Low-gold alloys:	
Ag 340 Ag 440	Nobilium American Gold Co Chicago, IL 60609, USA
Alborium	J F Jelenko and Co New Rochelle, NY 10801, USA
Apollo	APM-Sterngold Stamford, CT 06907, USA
Baker 340	Engelhard/Baker Carteret, NJ 07008, USA
Codesco Bridge Gold 50	Codesco, Inc Philadelphia, PA 19123, USA
Dent Cast 44	Dentalloy, Inc Stanton, CA 90680, USA
Economy	Leff Dental Golds, Inc Woodside, NY 11377, USA
Forticast Midas	J F Jelenko and Co
Midigold 50 Minigold	Williams Gold Refining Co, Inc Buffalo, NY 14214, USA
Miracast	J M Ney Co Bloomfield, CT 06002, USA
Mowery KL Mowery No 46 Mowery No 120	W E Mowery Co St Paul, MN 55104, USA
Ney Cast III Ney Oro B-20 Ney Oro CB Ney Oro No 5 Paliney CB	J M Ney Co
Progold*	Progold Pryor, OK 74361, USA
Rx 41 Rx MHW Rx Midacast Rx Ny Sp Rx ORY	Rx Jeneric Gold Co Wallingford, CT 06492, USA
Stabilor G Stabilor NF-III	Degussa-J Aderer, Inc Long Island City, NY 11101, USA
Sterngold 40	APM-Sterngold
Super CB-3	Nobilium American Gold Co
T-IV Trend	Howmedica, Inc Chicago, IL 60632, USA
Tawny Cast	Heraeus Dental Gold Corporation (formerly A Szabo Co) Queens Village, NY 11429, USA
Thriftcast	Degussa-J Aderer, Inc
Tiffany	APM-Sterngold
Conventional gold alloys:	
Firmilay	J F Jelenko and Co
Harmony Line Hard	Williams Gold Refining Co
Jelenko No 7 Modulay	J F Jelenko and Co
Ney Oro A-A Ney Oro A-1 Ney Oro B-2 Ney Oro G-3	J M Ney Co
Silver/palladium alloys:	
Ney 76	J M Ney Co
Paladin 3 Sterngold 66	APM-Sterngold
WLW	Williams Gold Refining Co
Chromium/cobalt alloy:	
Lite Cast	Williams Gold Refining Co

* % of gold unavailable.

but only small quantities of platinum are included in Types II and III alloys. Platinum is expensive. Its melting point is over 1000 °F (538 °C) higher than that of gold, and small amounts raise the melting range of an alloy making it difficult to cast into gypsum-bonded investments and with a gas-air torch.

Palladium

Palladium is often substituted for platinum since palladium is much less expensive but has similar effects. Palladium is nearly half as dense as platinum and therefore much lower proportions by weight affect the properties of the alloys. Like platinum, palladium raises the melting range, increases the resistance to tarnish and corrosion, and increases the hardness of gold alloys. Alloys with little or no gold, containing predominantly silver and palladium, are available. They are extremely hard and have casting temperatures around 2000 °F (1094 °C) requiring a phosphate-bonded investment and a gas-oxygen torch for casting.

Silver

Silver is present in all conventional Types II and III alloys in the range of 5% to 15% by weight. Unlike gold, platinum, and palladium, silver tarnishes and corrodes in the mouth and is particularly susceptible to attack by sulfide. Silver is added because it can be substituted for gold with little change in mechanical properties of the alloy. Due to the lower cost of silver, addition of larger amounts than is usually found in Types II and III alloys is generally the basis for most of the low-gold alloys on the market today.

Copper

Copper is also present in Types II and III alloys primarily to increase the hardness and strength. Eight to 12% by weight of copper is required to make the alloy susceptible to hardening by heat treatment or aging. Most Type II alloys are not readily hardened by heat treatment and therefore the manner in which the alloy is cooled after casting is generally not important to the dentist. Type III alloys, on the contrary, contain sufficient copper to allow hardening by heat treatment. Water quenching of an alloy at 1300 °F (704 °C) will produce the softened condition. Hardening is best carried out by heat soaking the alloy at a temperature specified by the manufacturer for a specified time before quenching. The addition of copper to gold alloys also reduces the melting range and decreases the resistance to tarnish and corrosion.

Zinc and Indium

Zinc, and sometimes indium, is usually present in small amounts to act as a scavenger of oxides to make melting and casting of the alloys easier. In the amounts present, they have little effect on the other properties already discussed.

Table 2 shows the proportional compositions of the four types of dental casting alloy (Council on Dental Materials, Instruments, & Equipment, 1981). Type II alloys contain 73-83% gold and Type III alloys 71-79.8% gold. Type III alloys usually have higher percentages of platinum or palladium or both to increase hardness and strength. Silver is present in similar amounts in both Types II and III alloys.

CLASSIFICATION OF LOW-GOLD ALLOYS

The alloys available today for all metal restorations fall into four categories:

1) Gold alloys certified by the American Dental Association: Types I, II, III, IV
2) Low-gold alloys

Table 2. Range of Percentage Composition of Dental Casting

Type of Alloy	Gold	Silver	Copper	Palladium	Platinum	Zinc
I	80.2-95.8	2.4-12.0	1.6- 6.2	0.0- 3.6	0.0-1.0	0.0-1.2
II	73.0-83.0	6.9-14.5	5.8-10.5	0.0- 5.6	0.0-4.2	0.0-1.4
III	71.0-79.8	5.2-13.4	7.1-12.6	0.0- 6.5	0.0-7.5	0.0-2.0
IV	62.4-71.9	8.0-17.4	8.6-15.4	0.0-10.1	0.2-8.2	0.0-2.7

Source: Council on Dental Materials, Instruments, & Equipment (1981)

3) Silver/palladium alloys
4) Base metal alloys: nickel, cobalt, chromium

Of 146 low-gold alloys reported by Gettleman (1980), 64 contain 60-70% gold, and 35 contain 50-59% gold (Table 3). Unless these alloys have superior properties to Types II and III alloys, there is little reason to use them because the saving in cost would be negligible even if gold cost $1000 per ounce. Available data on tarnish and corrosion indicate that alloys with less than 40% gold are likely to tarnish in the mouth. Therefore, only the 18 low-gold alloys in the range of 40-49% gold (see Table 4) represent the choices for less expensive substitutes for a Type II or III gold alloy. Except for Ney Cast III, platinum has been excluded from the alloys in Table 4. Low-gold alloys characteristically contain greater amounts of silver than the 5-15% in Types II and III alloys. Tawny Cast has the highest percentage of silver (47.3%) and Codesco Bridge Gold 50 the lowest (3.5%). Ney Cast III and Codesco Bridge Gold 50 are the only alloys with a content of silver similar to that of a Type II or III alloy. The palladium content of these low-gold alloys is generally slightly higher than that of Types II or III alloys in an attempt to compensate for decreased resistance to tarnish and corrosion due to the increased

Table 3. Gold Content of Available Low-gold Alloys

Gold Range %	Number of Alloys
> 70	5
60-69	64
50-59	35
40-49	18
30-39	12
20-29	8
10-19	4

Source: Gettleman (1980)

Table 4. Low-gold Alloys with 40-49% Gold

Alloy	Au %	Pt %	Pd %	Ag %
Codesco Bridge Gold 50	49.5	0	3.5	3.5
Midigold 50	49.5	0	3.5	35.0
Rx Midacast	47.0	0	6.0	39.0
Midas	46.0	0	6.0	39.5
Thriftcast	44.0	0	6.0	26.0
Ag 440	42.0	0	5.0	18.0
Forticast	42.0	0	9.0	26.0
Mowery No 46	42.0	0	8.0	35.0
Ney Cast III	42.0	2.0	8.0	9.0
Sterngold 40	42.0	0	9.0	26.0
Super CB-3	42.0	0	5.0	17.5
Rx 41	41.7	0	5.0	29.0
Economy	41.5	0	5.0	28.7
T-IV Trend	41.0	0	4.5	46.0
Ag 340	40.0	0	5.0	45.0
Baker 340	40.0	0	4.0	43.0
Minigold	40.0	0	4.0	47.0
Tawny Cast	40.0	0	4.0	47.3

Source: Gettleman (1980)

content of silver. An additional increase in palladium would increase the resistance to tarnish and corrosion but the increase in hardness and melting range would be unacceptable.

Most manufacturers have one or two low-gold alloys that fall into this group of 40-49% gold. The properties of low-gold alloys vary tremendously, and gold content alone should not be used as the criterion for comparing various alloys. Two alloys with identical quantities of gold can have vastly different mechanical properties and resistance to tarnish.

MANIPULATION OF LOW-GOLD ALLOYS

Melting Range

The melting range of all the alloys containing 40-49% gold is similar to that of Types II and III alloys. It is difficult to distinguish a low-gold alloy from a conventional alloy by melting characteristics. The alloys become spheroid and produce a mirror surface when ready to cast. The major substitute for gold in these alloys is silver, which whitens the color and tends to lower the melting range slightly as compared to Types II and III alloys. Lofstrom, Myers & Asgar (1976) and the 1980 Conference of Operative Dentistry Educators both reported the use of gas-air torches for melting low-gold alloys. Leinfelder, Price & Gurley (1981) have reported that all alloys with gold content ranging from 27.6% to 59.5% can be melted to casting temperature with a gas-air torch. They recommend selecting an alloy with a casting temperature not exceeding 1850 °F (1010 °C); otherwise, a phosphate-bonded investment and possibly a gas-oxygen torch may be required.

Higher casting temperature may affect the fit of a casting. Alloys shrink on cooling, the shrinkage of Types II and III alloys being approximately 1.25-1.5%. Shrinkage is compensated for by the hygroscopic and thermal expansion of the investment. As the casting temperature of an alloy increases, the shrinkage of the casting generally increases and expansion of investment will not compensate for the additional shrinkage.

Castability

The castability and fit of low-gold alloys has been well documented. Table 5 lists

Table 5. Castability of Alloys

Alloy	Length Cast mm	Gold %
Tiffany	19.8	50.0
Midigold 50	18.7	49.5
Ney Cast III	18.5	42.0
Stabilor NF-III	16.9	55.0
Firmilay	14.9	74.5
Midas	14.4	46.0

Increased cylinder length indicates increased castability. Lines join means which are not significantly different at $P<0.05$.

Evaluated by Howard, Newman & Nunez (1980)

alloys evaluated for castability by Howard, Newman & Nunez (1980). The test pattern consisted of a wheel with four spokes and six nylon fishing lines, 20 mm long, spaced evenly around the wheel. The diameters of the six nylon lines were: 0.126, 0.151, 0.169, 0.214, 0.318, and 0.400 mm. The low-gold alloys were melted with a gas-air torch and cast in a gypsum-bonded investment. A broken-arm centrifugal casting machine was used and wax patterns were burned out at 900 °F (482 °C) for 1½ hours. The castings were evaluated by measuring the length of the lines cast. All alloys filled the 0.318 and 0.400 mm lines completely; no alloy was capable of filling all the lines completely. Tiffany filled all samples completely except the 0.126 mm line. Midas was the least castable low-gold alloy in this study, capable of filling completely only the 0.318 and 0.400 mm lines. Table 5 shows the mean length of all the lines combined for each alloy. Tiffany, Midigold 50, and Ney Cast III were significantly better (P = 0.05) than Midas, and Tiffany alone was significantly better (P = 0.05) than Firmilay. There was no difference at this confidence level between Tiffany, Midigold 50, Ney Cast II, and Stabilor NF-III.

Accuracy of Casting

Nitkin & Asgar (1976) evaluated Forticast (42% gold), Paliney CB (15% gold), and Alborium (15% gold), Ney Oro B-2, a Type III alloy, being used as a control. Forticast and Ney Oro B-2 were melted with a gas-air torch and cast into a gypsum-bonded investment using the hygroscopic technique, whereas Paliney CB and Alborium were melted by induction and cast into a phosphate-bonded investment. The as-cast fit of full crowns and 3/4 crowns showed no difference (P = 0.001) between Ney Oro B-2 and Forticast, and both were better than the other two alloys. Paliney CB was ranked second and Alborium third. Accurate castings with Paliney CB and Alborium are more difficult to obtain because their casting temperatures are higher due to the high content of palladium.

Landesman, de Gennaro & Martinoff (1981) evaluated Minigold (40% gold), WLW (silver/palladium alloy), and Lite Cast (chromium/cobalt alloy), Harmony Line Hard, a Type III alloy (74% gold) being used as a control. A total of 24 castings was fabricated consisting of inlays, onlays, and crowns. Nineteen of the 24 castings were rated acceptable for fit. All Harmony Line Hard and Minigold castings were acceptable. These were cast using a gas-air torch and a gypsum-bonded investment.

Leinfelder (1980) evaluated seven commercial alloys with gold content ranging from 40% to 59.5% and eight experimental alloys ranging from 27.7% to 49.92% gold, Modulay, a Type II alloy with 77% gold, being used as a control. He reported no differences among the alloys as to the fit of the castings on their respective dies. It was concluded that if the casting temperature of the alloy does not exceed 1850 °F (1010 °C), conventional techniques of investing, burning out, and casting will yield acceptable fits.

Dale & Moser (1977) evaluated Alborium (15% gold), Forticast (42% gold), Paladin 3 (silver/palladium), Sterngold 66 (silver/palladium), and WLW (silver/palladium) for castability and fit of inlays. All alloys were cast into a gypsum-bonded investment, except WLW, which was cast into a phosphate-bonded investment. All castings were accurate except those made with WLW, which showed signs of shrinkage.

Soldering

Because the melting range of low-gold alloys is similar to that of conventional alloys, soldering can be done with the gold solders presently available. The manufacturer of the alloy should be able to recommend the correct solder for each particular low-gold alloy. A solder with a melting range 150 °F (66 °C) below that of the alloy being soldered should suffice.

Summary

All of the available low-gold alloys in the 40-49% gold range can be manipulated similarly to Types II and III alloys. Gypsum-bonded investments can be used and alloys can be melted with gas-air torches. No changes in water: powder ratio or burnout procedures are necessary to obtain castings that fit as well as those of conventional alloys.

TARNISH AND CORROSION RESISTANCE OF LOW-GOLD ALLOYS

Reducing the content of gold below 50% definitely raises a question about the resistance of the alloy to chemical attack in the mouth. Types II and III gold alloys are, with few exceptions, extremely resistant to corrosion in the mouth. Porous or poorly polished areas are more likely to corrode than are smoother surfaces. Even an alloy with 75% gold will tarnish. Burse & others (1972) evaluated an 18-carat gold alloy composed of 75% gold, 12.5% copper, and 12.5% silver. It was found to be much more susceptible to sulfide attack than were Jelenko No 7, a Type IV alloy, and an experimental low-gold alloy (39-46.9% gold) evaluated in the same study. The reason for this appears to be the effect of palladium on the resistance of gold alloys to corrosion. Palladium by itself is highly resistant to tarnish and corrosion, and the addition of 4-6% palladium to a gold alloy allows the gold content to be reduced below 75% without increasing susceptibility of the alloy to tarnish and corrosion. It also appears that when the gold content is lowered, the silver:copper ratio becomes important to resistance to corrosion (Leinfelder & others, 1981). However, the optimal silver:copper ratio has not yet been determined. The absolute content of gold should not be used as a judge of resistance to corrosion because segregation of corrosive phases within an alloy can occur. Thus, two alloys with the same gold content can differ significantly in their resistance to tarnish and corrosion if one of the alloys tends to segregate, creating silver-rich or copper-rich phases.

Recently dental gold alloys have been marketed in the form of gold coins (South African Krugerrands or Canadian Mapleleaf) plus ingots of silver and copper. The dentist melts the coin and the ingots together to make an alloy for dental castings. Since these alloys contain no platinum or palladium, they may tarnish if their content of gold falls below 75%. Before using any alloy sold in this form, the dentist should be sure it contains sufficient gold to resist the oral environment. A low-gold alloy composed of only gold, silver, and copper will likely tarnish severely.

Two popular laboratory methods for assessing resistance of alloys to corrosion are sulfide immersion and potentiodynamic polarization. Tuccillo & Nielsen (1971) introduced an apparatus for subjecting alloy specimens to a sulfide solution. The specimens were attached to a wheel that rotated through a sulfide solution at one revolution per minute. As the specimen left the solution it was wiped with a cloth after each revolution. This intermittent contact with the sulfide solution and the wiping are thought to simulate oral conditions better than simply immersing specimens in a solution. This technique was used by Burse & others (1972) in the study mentioned above. Potentiodynamic polarization involves subjecting an alloy to a varying applied potential and measuring the current density across the specimen. As the current density increases, it implies increased corrosion. Wright, German & Gallant (1981) applied a potential difference between the test alloys and a reference electrode immersed in a 1% NaC1 solution. The applied potential was started at −600 mV, varied to +400 mV, then returned to −600 mV. After the evaluation of experimental gold, silver, and copper alloys, and several commercial crown and bridge alloys, two observations were made. First, a current density peak at 0 mV in the reverse scan was associated with corrosion of silver and secondly, a current density peak at −125 mV in the forward scan was associated with corrosion of copper. The magnitude of the peaks gave a relative indication of the amount of corrodible silver and copper present in the alloy. Table 6 shows the alloys evaluated in this study, their composition in atomic percent, and their relative peaks of copper and silver corrosion. Results indicate that the silver in Miracast is 500 times more corrodible than the silver in Ney Cast III even though their gold content is nearly identical. It was found that Miracast had a silver-rich phase that segregated out of the alloy and was highly susceptible to corrosion. This technique for assessing the corrodibility of dental casting alloys has not been correlated with clinical studies so the data must be used with caution when predicting how much clinical corrosion will occur. However, after testing in the Tuccillo-Nielsen apparatus, Ney Cast III was the only low-gold alloy with tarnish resistance equivalent to Firmilay, a Type III alloy (Lubovich, Kovarik & Kinser, 1979). More potentiodynamic studies are needed, possibly in different solutions, to evaluate the low-gold alloys in the 40-50% gold range.

Lubovich & others (1979) evaluated the tarnish resistance of 11 alloys, including Firmilay, to sulfide solution in the Tuccillo-Nielsen tarnish tester. Table 7 shows the alloys evaluated and their gold content. The amount of tarnish was determined by the amount of light reflected from the surface. Ney Cast III remained relatively un-

Table 6. Corrosion of Copper and Silver in Gold Alloys

Alloy	Atomic Percent			Current Density Peaks*	
	Au	Ag	Cu	Cu	Ag
Ney Oro A-A	67.0	18.0	8.0	1.0	1
Ney Oro A-1	60.0	18.0	18.0	1.0	2
Ney Oro B-2	55.0	16.0	22.0	1.0	2
Ney Oro G-3	49.0	16.0	24.0	0.4	4
Ney Oro No 5	43.0	24.0	25.0	1.0	2
Ney Oro B-20	43.0	33.0	17.0	1.0	1
Ney Oro CB	39.0	27.0	28.0	0.7	1
Ney Cast III	21.0	8.0	60.0	1.0	2
Miracast	20.0	8.0	58.0	1.0	1000
Paliney CB	8.0	42.0	26.0	2.0	90
Ney 76	-0-	53.0	21.0	3.0	6000

*Increased current density indicates increased corrosion probability.

Source: Wright, German & Gallant (1981)

Table 7. Sulfide Tarnish of Alloys

Alloy	Gold %	Reflectance* 6400 Rev	Reflectance* Control
Firmilay	74.5	43	47
Rx ORY	63.0	36	43
Stabilor G	58.0	36	48
Tiffany	50.0	38	42
Rx Midacast	47.0	10	40
Midas	46.0	35	49
Mowery No 46	42.0	34	45
Ney Cast III	42.0	40	45
Minigold	40.0	2	45
Dent Cast 44	56.0	0	39
Progold	**	20	49

*Decreased reflectance of 6400 revolutions (24 months simulated in a Tuccillo-Nielsen tarnish tester) compared to control gives indication of amount of tarnish that occurred.

**Gold content not available.

Evaluated by Lubovich, Kovarik & Kinser (1979)

tarnished, but Minigold tarnished heavily. Ney Cast III and Minigold differ by only 2% in gold content, but the silver content of Minigold is much greater than that of Ney Cast III and the tarnish is most likely silver sulfide. The palladium content of Minigold is 4% whereas that of Ney Cast III is 8%. The higher content of palladium of Ney Cast III also accounts for its excellent resistance to tarnish. The authors concluded:

1) Ney Cast III was superior to the other low-gold alloys and approximately equivalent to Firmilay, a Type III alloy with 74.5% gold.
2) Rx Midacast, Stabilor G, Mowery No 46, Tiffany, and Midas were intermediate and similar to Rx ORY, which contains 63% gold.
3) Dent Cast 44, Minigold, and Progold tarnished unacceptably.

When is tarnish of a crown and bridge alloy not acceptable? Should any alloy that tarnishes more than a Type II or III alloy be discarded? Surface discoloration due to tarnish is not believed to be a significant concern as long as the metal retains a metallic appearance. Blackening of the surface as well as pitting of the surface is not acceptable. Possible problems with surface discoloration are a metallic taste and toxic products of corrosion. The latter requires further research.

Leinfelder & others (1981) have reported that some restorations of Minigold (40% gold) began to tarnish after one year of clinical service. Most of the tarnish was on localized areas, but the entire surface of one casting discolored. This confirms to some extent the poor performance of Minigold reported by Lubovich & others (1979). Leinfelder & others (1981) found no tarnish clinically for periods of up to three years in any alloy containing at least 42% gold and 4% palladium. The University of Florida College of Dentistry has been using Midigold 50 (49.5% gold) for about two years in its clinics and recently some tarnish has been seen. The areas of tarnish were usually associated with either plaque or surface porosity. If one chooses to use a low-gold alloy, one must expect some tarnish, but if the alloy has at least 42% gold and 4% palladium the amount of tarnish will probably be tolerable.

BURNISHABILITY OF LOW-GOLD ALLOYS

Burnish, by definition, is to make glossy or shiny by rubbing. As dentists we misuse the word extensively. If a dentist is asked to compare the burnishability of two alloys, most likely he or she will use some method that tests how well the alloy can be adapted or fitted to the margin of a tooth preparation. The vagueness of the word burnishability results from methods by which we treat margins of castings clinically. Some dentists use an instrument called a burnisher, rubbing the alloy near the margin while applying considerable pressure. Others employ rotary instruments such a stones, discs, rubber wheels, or points. These methods, though more like grinding than rubbing, still are thought to adapt or fit the alloy to the margin of the tooth. Before turning our attention to the burnishability of low-gold alloys, a discussion of the mechanical properties involved in burnishing may be helpful. By definition, dental burnishing involves either bending the metal or stretching it toward the tooth margin or both. The yield strength and percent elongation, or ductility, are probably the most important properties determining the burnishability in an alloy.

To burnish or adapt an alloy to a cavosurface margin, the forces applied must create stress in the alloy above the elastic limit. Therefore the elastic limit of an alloy is a very important factor in its burnishability. A true elastic limit is sometimes difficult to measure but a value approximating the elastic limit, the offset yield strength, is readily measured. These are the data that alloy manufacturers usually supply. It is important when comparing the yield strength of two alloys that the specified offset is the same for both alloys; it will usually be 0.1% or 0.2%. Once the elastic limit, or offset yield strength, has been surpassed the alloy begins to deform permanently and burnishing can occur. A reasonable question is how far can an alloy be burnished before it breaks. The ultimate tensile strength is the highest stress the alloy can endure without breaking. The amount of strain between the offset yield strength and ultimate tensile strength is the percent elongation, or ductility, of the alloy. For burnishing, this value should be high. Considering these two mechanical properties, two or more alloys can be compared for burnishability. Most manufacturers of alloys will also supply values of either Vickers or Brinell hardness. Some researchers feel the hardness of alloy is also an indicator of burnishability.

Moon & Modjeski (1976) have suggested the use of a burnishability number equal to the Brinell hardness divided by the percent elongation. The larger the burnishability number the more difficult the alloy is to burnish. A comparison (Table 8) of the burnishability numbers of a Type III alloy, Harmony Line Hard, and two low-gold alloys, Minigold (40% gold) and Forticast (42% gold), revealed that in the softened state Minigold is approximately equal to Harmony Line Hard, but upon hardening with heat became more than three times as difficult to burnish. On the contrary,

Table 8. Burnishability Numbers of Gold Alloys

Alloy	Gold %	Burnishability Number* Soft	Hard
Harmony Line Hard	74.0	2.6	4.4
Minigold	40.0	2.7	14.0
Forticast	42.0	10.0	88.0
Type I	80.2-95.8***		3.9**
Type II	73.0-83.0***		8.4**
Type III	71.0-79.8***		10.9**

*Burnishability number = Brinell hardness/percent elongation.

**Maximum burnishability number using maximum Brinell hardness and minimum percent elongation from ADA Specification No 5 for gold alloys.

***From Table 2.

Source: Moon & Modjeski (1976)

Table 9. Burnishability Numbers of Low-gold Alloys in Softened Condition

Alloy	Au + Ag %	Burnishability Number
Mowery KL	89.3	2.5
Minigold	87.0	2.7
Apollo	84.5	3.8
Midas	85.5	4.2
Rx Midacast	86.0	4.4
Midigold 50	84.5	4.7
Mowery No 120	78.0	5.2
Mowery No 46	77.0	7.0
Tiffany	75.0	9.7
Forticast	68.0	9.7
Rx MHW	78.0	11.8
Rx Ny Sp	76.0	12.5
Rx 41	71.0	40.5

Forticast, even in a softened state, would be much more difficult to burnish than Harmony Line Hard. Moon & Modjeski (1976) also calculated what the maximum burnishability number should be for Types I, II, and III alloys using ADA Specification No 5 (Table 8). These values were derived by using the maximum Brinell hardness and minimum percent elongation listed for each alloy in Specification No 5. With this criterion, burnishing an alloy with a burnishability number greater than 10.9 would be difficult. Table 9 lists 13 low-gold alloys and their burnishability numbers. These numbers were calculated with the alloys in the softened, or quenched, state. Silver can be substituted for gold in an alloy with little change in mechanical properties. The order of burnishability numbers is almost identical to the gold plus silver content of the alloys. As the gold plus silver content decreases, the alloys become harder to burnish. Most important, it must be realized that the gold content alone is not the determining factor. Minigold has 40% gold but is second on the list, whereas Rx Ny Sp has 52% gold and is second from the bottom of the list. Higher content of gold does not necessarily mean the alloy will be easier to burnish.

Leinfelder (1980) has suggested that the ratio of gold and silver to copper is important in determining burnishability. He reports the most burnishable alloys are those containing no more than 10% copper and suggests that the gold and silver content should be 84-85%. This is supported by the order of burnishability numbers in Table 9. The alloys with lower numbers contain more than 84% gold and silver and less than 10% copper. Another factor to consider is the palladium content, which increases the hardness and yield strength. Alloy Rx MHW has a gold plus silver content of 78% but has a higher burnishability number than other alloys with lower contents of gold plus silver. Rx MHW has 14% palladium while most other alloys contain 4-8% palladium.

Price, Leinfelder & Taylor (1981) evaluated several low-gold alloys for burnishability using a wedge-shaped sample and a weighted mechanical burnisher. Their conclusions were: 1) there is a strong correlation between data for theoretical and experimental burnishing, 2) low-gold alloys were generally less burnishable than traditional alloys, and 3) a burnishability index equal to ductility (% elongation/yield strength) was suggested for predicting the relative burnishability of these alloys. If we compare the scale by Moon & Modjeski (1976) (burnishability number = Brinell hardness/% elongation) with the index suggested by Leinfelder and his associates (burnishability index = % elongation/yield strength), both generally predict the same order of burnishability (Table 10). More clinical data are needed to confirm the use of either of these predictors to be certain of their accuracy.

Table 10. Comparison of Burnishability Numbers and Burnishability Index of Low-gold Alloys

Alloy	Burnishability Number*	Burnishability Index**
Mowery KL	2.5	.0010
Minigold	2.7	.0014
Apollo	3.8	.0006
Midas	4.2	.0009
Rx Midacast	4.4	.0008
Midigold 50	4.7	.0006
Mowery No 120	5.2	.0006
Mowery No 46	7.0	.0004
Tiffany	9.7	.0003
Forticast	9.7	.0003
Rx MHW	11.8	.0003
Rx 41	40.5	.0001

*Burnishability number = Brinell hardness/ percent elongation (Moon & Modjeski, 1976).

**Burnishability index = percent elongation/ yield strength (Price, Leinfelder & Taylor, 1981).

However, when selecting a low-gold alloy for clinical use, this type of data is useful to compare the relative burnishability of alloys. If a low-gold alloy under consideration has a higher burnishability number or lower burnishability index than the alloy currently used by a practitioner, he can expect it to be more difficult to burnish. Values should be compared in the softened, or quenched, state and the dentist should be certain the castings received from the laboratory are in the softened, or quenched, state. For example, Modulay, a Type II alloy, has a burnishability number of 2.4 and is not affected by heat treatment; therefore no matter how the alloy is cooled in the laboratory, the mechanical properties will be the same. In comparison, a low-gold alloy, Midas (46% gold), has a burnishability number of 4.2 in the softened state and 16.1 in the hardened state, a factor of approximately four between the two states. In a softened state Midas is comparable to Modulay in burnishability, but in a hardened state there is no comparison. If a dentist decides to use Midas instead of Modulay he must be sure the Midas is in the softened, or quenched, state; otherwise he will be disappointed with the burnishability.

Huget, Vermilyea & Vilca (1982) evaluated the hardness and tensile properties of three low-gold alloys (Midas, Ney Cast III, and Minigold) that range in gold content from 40% to 46.5%, silver content from 9.1% to 46.8%, and copper content from 7.7% to 38.7%. Their results show that all three alloys reach maximum softening when heated at 1200 °F (649 °C) for 10 minutes, then water quenched, and reach maximum hardness following heat treatment at 800 °F (427 °C) for 10 minutes. Their findings indicate that "mechanical properties of low-gold alloys remain constant over a broad range of compositions" and that treatments with heat for softening and hardening are comparable to those of conventional gold alloys. In general then, all the low-gold alloys available are amenable to heat treatment, while most Type II alloys are not affected.

Sarrett, Richeson & Smith (1982) reported on the effect of four finishing techniques, including hand burnishing, on the interface of casting and tooth of both conventional and low-gold alloys. Their results indicate that Modulay (77% gold) was the easiest of the metals to modify by clinically treating the margins, with Midas (46% gold) being a close second. Midigold 50 (49.56% gold) and Firmilay (74.5% gold) were the most difficult alloys on which to improve the relationship of tooth to casting. The hand burnisher was the least effective of the four techniques observed for improving the marginal fit of the four types of alloy used in the study.

CONCLUSION

Alloys other than conventional gold alloys are available for all metal cast restorations. Alloys with gold content ranging from 0% to 70% are marketed as substitutes for the conventional alloys.

Since alloys containing more than 50% gold do not provide significant savings in the cost of the restoration and alloys below 40% gold are likely to tarnish in the mouth, the dentist should focus his attention for the present time on alloys in the range of 40-49% gold. These alloys can be melted, cast, and fit to the die using the techniques existing for conventional gold alloys. Most of these alloys will be difficult to burnish, especially if they are not placed in a softened condition. Attention to detail in margins of the wax pattern is essential for an acceptable fit of the margin of the casting to the tooth. Some tarnish should be expected from the alloys containing 40-49% gold but it should be tolerable.

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POINT OF VIEW

As Our World Turns
(the Current Saga of Changing Visionary Thinking)

MARVIN A JOHNSON

Rarely a month passes where there is not an article published by an employee of HEW, a dean of a dental school, or some other visionary, about what is wrong with our dental health delivery system and what changes will be made in the future. These precisely written fantasies are even more amazing when one stops to realize how these men have accumulated all of this expertise in dental care delivery. It is rare to find one of them who has delivered any kind of care beyond a dental school clinic. Having arrived at their lofty policy-making positions without the "laying on of hands" necessary for most dental treatment, they tend to demean this part of dentistry as beneath their dignity and suitable only for auxiliaries.

The whole picture that these fantasies create is strikingly similar to that of James Fenimore Cooper's Indians and with about the same relationship to reality.[1] It may be enlightening to compare two articles by the same author written less than five years apart.

The first example of visionary thinking is about the size of a small catalog and is entitled "A Curriculum for the Primary Care Dentist" by S Rovin.[2] An extremely well-written article with a fine title, it has undoubtedly influenced a great number of people. There are only some slight distortions and literary license. By the end of the article, sometime in the future, dentists are not dentists anymore, but physicians, and all dental health care as we know it is delivered by auxiliaries. We find the primary care dentist, MD, DDS, is completely qualified in an estimated six or seven years to talk about, to render diagnosis, and to supervise treatment of the whole patient, but not to do it. One could visualize a patient in a primary care facility, in a specially designed chair, having operative dentistry, an appendectomy, and a hemorrhoidectomy all at the same time, performed by three auxiliary teams and supervised by Superman. Ridiculous? Not so! Just think of the money that could be saved on the hospital alone. The limit to where these fantasies could take you as a dentist will come to a complete halt when physicians are involved. There they have hospital surgical committees, and even though most

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of their surgical procedures do not require nearly the precision for success as does the surgery of the teeth that dentists perform regularly, they still require a three-year surgical residency and a current surgical rating. Even though Mother Nature is working on the team with the physician, and many of his patients heal in spite of his surgery rather than because of it, hospital committees are constantly checking pathology reports and hospital records to remind him of his responsibilities. Surgery, even the minor variety, is not delegated to any technician. Why then is there always this desire by dental health planners to have much of clinical dentistry performed by technicians? Could it be that some dental school admission committees have mistakenly accepted rejects from medical schools or others with subverted desires to be physicians? Many of these people dislike and reject clinical dentistry after graduation and gravitate toward nonclinical positions with government or education, where they have time to become experts on clinical dentistry by reading each other's publications.

The second example, "Traditional and Emerging Forms of Dental Practice, Cost, Accessibility, and Quality Factors," written by the same author less than five years later, reveals some changes in his outlook.[3] This article describes all the various methods of dental care delivery available in the United States and quotes many practice management experts, business magazine editors, and department store managers who together deplore the cost and quality of fee-for-service dentistry as it is practiced today. Dr Rovin suggests that the department store dental facility may be the emerging system of the future that could contain costs and control quality at the same time. This he says could be done by hiring dentists at $15.00 an hour, who would almost automatically institute quality control to maintain the good name and reputation of the department store that is employing them.

One should probably question the intelligence of an individual who would spend eight years after high school and a very large sum of money to acquire a dental degree only to find himself able to earn less than the man who collects the garbage at his back door.[4]

Perhaps it should be noted that when Dr Rovin was in Seattle he was dean of a dental school. Therefore, he communicated with other deans and those anointed individuals of the federal government who dispense grant funds. He observed from a lofty position and used a highly polished crystal ball available to all deans to aid him in his predictions. Now he is chairman of a newly created Department of Dental Care Systems at another university and is obviously listening to another set of drums.

Will Rogers once stated that he thought the nation was comparatively safe as long as Congress was not in session. I'm sure he might modify his statement somewhat if he were around today to read some of the planning reports about medical care in general, and dentistry in particular, published by the federal bureaucracy and those whom they support.

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4. Contract between garbage collectors and contractors in Seattle signed 1979— $15.00 per hour plus fringe benefits, due to be raised this year.

DEPARTMENTS

Book Review

TEXTBOOK OF OPERATIVE DENTISTRY

By Lloyd Baum, Ralph W Phillips, and Melvin R Lund

Published by W B Saunders Co, Philadelphia, 1981. 580 pages, 845 illustrations. $32.00

This *Textbook of Operative Dentistry* blends the knowledge and expertise of three authors distinguished in dentistry within the areas of clinical treatment, dental education, and biomaterials research. The book effectively carries the reader from the study of scientific principles to practical ends. It is well designed for today's approach to dental education. A core of essential material is presented that every undergraduate dental student and practicing dentist should know about operative dentistry. New concepts of treatment based upon recent advances in biomaterials are presented along with the older but still valid techniques.

Such chapters as "Prevention of Dental Disease," "Tooth-colored Restoratives," "Retentive Pins in Operative Dentistry," and "Reinforcement of the Endodontically Treated Tooth" detail the current state of knowledge; the chapters covering the amalgam restoration, the cast gold restoration, and direct-filling gold restorations present an updated approach to clinical treatment with the materials and instruments currently available.

A cohesiveness of purpose and rhetoric between the three authors makes the book interesting, informative, and above all readable. Repetition and redundancy are held to a minimum, resulting in a book that is well organized, integrated, and refreshing to read.

The page makeup is uncrowded and airy. The illustrations are of high quality with explanatory captions that quickly guide the reader to the important features. The line drawings are superior. Teeth look like teeth, and instruments look like instruments. This aspect should be most helpful to the dental student attempting to understand a particular concept described in the text. The practicing dentist will also appreciate time-saving conceptualization resulting from realistic illustrations.

Seldom does one find a textbook filled with innovative tidbits of information based upon the clinical experience of the authors. Useful procedures are described that range from the maintenance of a twist drill by sharpening so that it won't break in a pin channel to the correct direction a gingival retraction cord should be packed around a tooth for ease of placement. Both the neophyte student and the sophisticated practitioner will benefit from the practical suggestions found in this book. The text is a wealth of material for lecturers on the continuing education circuit, who are always looking for some unique technique that their audiences can take back to their offices for immediate use.

The class 3 preparation for tooth-colored materials is covered in detail with a minimum of illustrations. This is not the case for the class 3 amalgam (distal of canines) and the class 3 direct-filling gold preparations. These latter two preparations are simply discussed but not in the same detail and graphics that so effectively describe the other cavity preparations.

Presented in 20 chapters, the text covers the subject material in an orderly progression for clarity and understanding. The major areas of amalgam, tooth-colored restoratives, direct-filling gold, and cast gold restorations are presented in proportion and balance with the demands of present-day dentistry. The operative dentist wherever he or she exists within the continuum of professional education will find the *Textbook of Operative Dentistry* filled with help and guidance. This is an excellent textbook and reference, even without the inclusion of bibliographic references.

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Wit and Wisdom

GOLD FOIL: WHAT DOES IT MEAN TO ME AFTER A HALF CENTURY IN DENTISTRY?

Gold foil continues to be one of the finest available means of restoring carious teeth, and the gauge by which other materials are compared.

It has provided great pleasure in my attempting to master it and to use it properly.

It has been highly demanding in the care and technical precision it requires.

It has been intriguing, as one traces its history in dentistry, and its peerless service. It is a never-ending object for study and means of self-improvement.

It has been one of the finest instruments for teaching students—undergraduate and graduate—an appreciation for excellence in dental restorative service through basic instruction and through study clubs. It has brought me into contact with students of the highest competence and motivation.

Being allied with gold foil has enabled an otherwise improbable affiliation with some of the giants of operative dentistry.

It has been one of the most effective means of keeping me humble in dentistry, because one never seems to have it completely under control.

Finally, in gold foil, there is an aura of romanticism and excellence that is not present in any other phase of dental practice or dental education.

G D STIBBS, DMD
May 1982

Press Digest

The effect of 0.2 per cent (48 mM) NaF rinses daily on human plaque acidogenicity *in situ* (Stephan curve) and fluoride content. Geddes, D A M & McNee, S G (1982) *Archives of Oral Biology*, 27, 765-769.

During a period of 1-2 months of daily rinsing with 48 mM NaF the fluoride concentration of plaque increased 12-fold and the pH increased slightly. The increase in the pH of the plaque may reinforce the cariostatic action of the fluoride.

Relationship between restorations and the level of the periodontal attachment. Than, A, Duguid, R & McKendrick, A J W (1982) *Journal of Clinical Periodontology*, 9, 193-302.

When 240 extracted teeth with a restoration on one proximal surface and none on the other were stained and examined for the quality and position of the restoration and the position of the periodontal attachment, only 27% of the restorations were good, 60% had overhangs, and 13%

deficiencies. The average loss of periodontal attachment was determined to be 0.18 mm and there was no evidence that the quality of the restoration affected the loss of periodontal attachment.

The effect of tooth cleaning procedures on fluoride uptake in enamel. Steele, R C, Waltner, A W & Bawden, J W (1982) *Pediatric Dentistry*, 4, 223-228.

Analysis of enamel by proton activation showed that the enamel of premolars cleaned with a toothbrush and dental floss contained a higher concentration of fluorine a week after an application of a topical fluoride (Luride) than did the enamel of teeth cleaned with a rubber cup and either a fluoridated or nonfluoridated prophylaxis paste.

Micromorphology of the fitting surface of failed sealants. Gwinnett, A J, Caputo, L & Ripa, L W (1982) *Pediatric Dentistry*, 4, 237-239.

Examination of failing sealants disclosed that much of the surface against the enamel was smooth and thus not securely attached. The smoothness may result from contamination of the etched enamel before the sealant is placed. The importance of proper methods of isolating the teeth and of careful technique is emphasized.

The value of self-applied fluorides at home. Holloway, P J & Levine, R S (1981) *International Dental Journal*, 31, 232-239.

The mechanism of the effect of fluoride in preventing dental caries is threefold: (1) fluoride, by being incorporated into the crystals of enamel, makes it more resistant to caries; (2) fluoride ions in the plaque limit the fall in pH by inhibiting glycolysis after the introduction of sugar and thus retard demineralization; and (3) fluoride ions in the plaque facilitate the remineralization of the enamel when the pH returns to neutrality. This process requires fluoride ions to be available continually, not just during the formation of enamel.

These conditions obtain when the concentration of fluoride in the water supply is adequate. Failing this, it is still possible to obtain protection by ingesting daily, from birth until about 13 years of age, an adequate dose of fluoride in the form of drops or tablets and by the daily use, either singly or combined, of dentifrices, mouth rinses, and gels containing fluoride. Combined treatments should probably be reserved for those at high risk to dental caries.

Surface roughness and porosity of dental amalgam. Leitão, J (1982) *Acta Odontologica Scandinavica*, 40, 9-16.

Seven dental amalgams were evaluated for roughness and porosity after polishing for metallography with a final grit of 3 μm. The roughness, measured in micrometers, was as follows: Sybralloy (0.23); Indiloy (0.25); Hi-Atomic (0.25); Amalcap Non Gamma 2 (0.28); Dispersalloy (0.30); New True Dentalloy (0.34); and Dialloy (0.42). Roughness and porosity were found to be correlated, but there was no correlation between roughness and size of particle of the alloy.

Announcements

NOTICE OF MEETINGS

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

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

Cartoon by Kurt Labberton

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.

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