OPERATIVE DENTISTRY

AMERICAN ACADEMY OF GOLD FOIL OPERATORS

ACADEMY OF OPERATIVE DENTISTRY

winter 1981 • volume 6 • number 1 • 1-40

(ISSN 0361-7734)

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WINTER 1981 • VOLUME 6 • NUMBER 1 • 1-40

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Operative Dentistry publishes articles that advance the practice of operative dentistry. The scope of the journal includes conservation and restoration of teeth; the scientific foundation of operative dental therapy; dental materials; dental education; and the social, political, and economic aspects of dental practice. Review papers and letters also are published.

Publisher

Operative Dentistry is published five times a year: Winter, Spring-2, Summer, and Autumn, by:

Operative Dentistry, Inc
University of Washington
School of Dentistry SM-57
Seattle, WA 98195 USA

POSTMASTER: Send address changes to this address. *Operative Dentistry* is the official journal of the American Academy of Gold Foil Operators and the Academy of Operative Dentistry.

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Yearly subscription in USA and Canada, $20.00; other countries, $30.00 (sent air mail); dental students, $13.00 in USA and Canada; other countries, $20.00; single copy in USA and Canada, $7.00; other countries, $10.00. Make remittances payable (in US dollars only) to *Operative Dentistry* and send to the above address.

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EDITORIAL

Economic Malpractice?

The state of the economy is frequently described in terms similar to those used in describing the physical and mental condition of human beings. We may say that the economy is healthy or that it is ailing, growing or declining, robust or weak, brisk or sluggish, and so on. How far can the analogy be carried?

Economics is a social science. Unfortunately, the social sciences do not have the precise and rigorous methods of analysis that are available to the natural sciences. Consequently predictions of the effects of a specific treatment on an ailing economy are not always free of error. Economists are almost always divided in their opinions about the appropriateness of particular remedies. Presently, for example, some economists are prescribing cuts in taxes as the proper therapy for inflation while others are advocating increased taxes. That is like treating pulpitis with either irritants or sedatives.

Some people have been unkind enough to suggest that economists mostly exacerbate rather than cure the ailments of an economy. For example, it can be seen in retrospect that in most instances when the Federal Reserve Board intervened to correct a disequilibrium in the economy, the wrong action was taken, and an economy that had just begun to recover was plunged into a relapse. That is comparable to extracting the tooth after the inflamed pulp is on the road to recovery or selectively eliminating all the functional occlusal contacts when adjusting an occlusion.

In dentistry this type of treatment would be referred to euphemistically as 'iatrogenic', a term derived from the Greek *iatros* — physician + -genic — produced by. Why not coin an analogous term 'econogenic', from *oikos* — house + *nomos* — manage, to signify the problems caused by economists? If they could be found culpable for econogenic activity perhaps they could be charged with malpractice. That might startle the Federal Trade Commission! In their treatment of dentistry as it relates to the economy, economists would be well advised to heed an admonition of one of their celebrated practitioners, namely, "If economists could manage to get themselves thought of as humble, competent people on a level with dentists, that would be splendid!" (Keynes, 1932)

KEYNES, J M (1932) *Essays in Persuasion.* P 373. New York: W W Norton Co, Inc.

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

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OPERATIVE DENTISTRY, 1981, 6, 2-5.

ORIGINAL ARTICLES

Effect of Prepared Cavities on the Strength of Teeth

Cavities prepared in occlusal and proximo-occlusal surfaces of teeth weaken them, but the proximal boxes do not contribute to the reduction in strength.

T D LARSON • W H DOUGLAS
R E GEISTFELD

Summary

The force required to fracture teeth with occlusal and MOD cavities was determined and compared with that required to fracture sound teeth. In all instances, teeth with cavity preparations were significantly weaker. The influential factor was the width of the occlusal portion of the cavity. This was of more influence in weakening the crown than were proximal boxes.

Introduction

The crown of a tooth is usually weakened by the preparation of an occlusal or a proximal cavity. Vale (1956, 1959), nevertheless, found that teeth with MOD cavities in which the width of the occlusal portion was only one-fourth the intercuspal distance were as strong as sound teeth without prepared cavities. However, when the width of the occlusal portion of the cavity was increased to one-third the intercuspal distance the teeth were weakened significantly. Vale limited his study to teeth with MOD cavities. The purpose of this study was to compare the effect of occlusal cavities as well as MOD cavities on the strength of teeth and in both instances to compare the effect of cavities that are narrow occlusally (one-fourth the intercuspal distance) and those that are wide (one-third the intercuspal distance).

University of Minnesota, School of Dentistry, Department of Operative Dentistry, Health Sciences Unit A, Minneapolis, MN 55455, USA

T D LARSON, DDS, MSD, assistant professor

W H DOUGLAS, BDS, MS, PhD, associate professor and director of the biomaterials program

R E GEISTFELD, DDS, associate professor and chairman

Materials and Methods

Sixty noncarious, maxillary premolar teeth were used in the study. They were stored at room temperature in deionized water until the cavities could be prepared and between preparing the cavities and testing. The faciolingual and mesiodistal dimensions of the teeth were measured as well as the distance between the cusps. The teeth were then divided into five groups, each group consisting of teeth selected to be of approximately the same size. Five variables were examined:

1. Unprepared teeth
2. MOD preparations with wide occlusal portions (1/3 intercuspal distance)
3. MOD preparations with narrow occlusal portions (1/4 intercuspal distance)
4. Occlusal preparations—wide (1/3 intercuspal distance)

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5. Occlusal preparations—narrow (1/4 intercuspal distance)

Each cavity was prepared with a new 56 FG bur (American Midwest, Des Plaines, IL 60018, USA). The cavities obliterated the central grooves of the teeth and were carried 0.5 mm into the dentin. The occlusal preparations were extended mesiodistally far enough to obliterate the central groove but without undermining the marginal ridges. The faciolingual width of each proximal box was one-third the width of the tooth and the box was located faciolingually to simulate a clinical situation. The depth of the boxes mesiodistally was such as to place the gingivoaxial line angle 0.5 mm axially to the dentinoenamel junction. All preparations were completed using a Midwest high-speed handpiece (American Midwest, Des Plaines, IL 60018, USA) with a water spray (Figure 1).

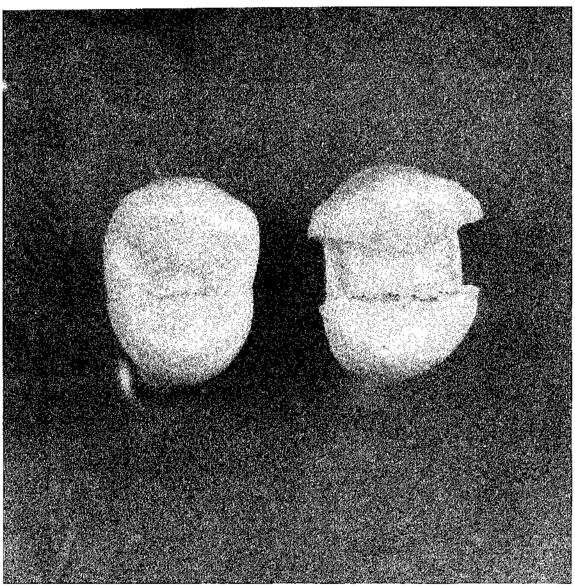

FIG 1. *Occlusal view of an occlusal preparation and an MOD preparation on maxillary premolars*

The teeth were mounted in dental stone in flat nylon rings (outside diameter 4.5 cm, inside diameter 1.7 cm, and thickness 1.2 cm). The mounted teeth were set on a platen of an M T S 812 Electrohydraulic Testing Machine (M T S Corp, Eden Prairies, MN 55425, USA). A force was applied axially and centrally to the occlusal surface with a steel sphere 3/16 in (4.76 mm) in diameter, so that both cusps of the crown were contacted (Figure 2). The size of the steel sphere was such

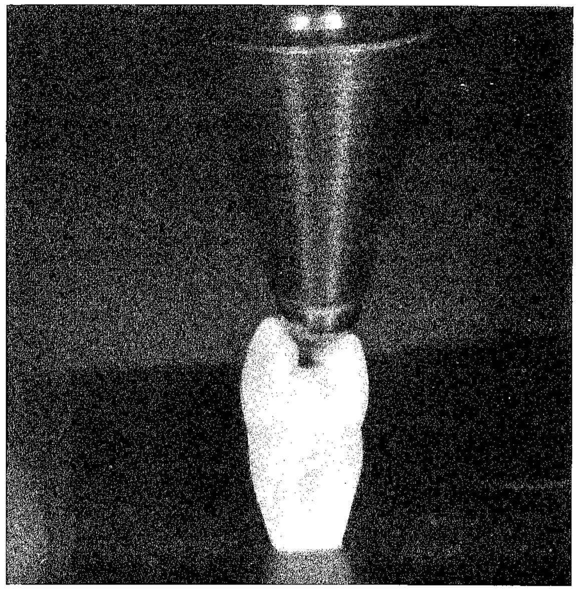

FIG 2. *Steel sphere in contact with maxillary premolar with an MOD preparation*

that the triangular ridges of the cusps were contacted but the margins of the prepared cavities were not. The testing machine was operated under closed loop conditions and a force of 20 pounds per second (20 $lbf \cdot s^{-1}$ or $88 N \cdot s^{-1}$) applied until the main fracture of the crown occurred. The load was applied at a controlled rate so that the instrument compensated automatically for any relaxation of stress within the tooth or its supporting structure. This method of loading closely approximates that of the isometric contraction of the main muscles of mastication when the teeth are in occlusion. The force is increased without shortening of the muscle fibers. Control of the rate at which the load is applied differs significantly from controlling the rate at which the movement is induced, the more usual method of testing.

For statistical purposes the data were subjected to analysis of variance.

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Results

The average dimensions of the teeth within each group are shown in Table 1. The agreement within groups and between groups is good, the standard deviations being 10% and 2% respectively.

Table 1. Dimensions of the Teeth in Each of the Five Groups

Group	Faciolingual Width mm Mean	SD	Mesiodistal Width mm Mean	SD	Intercuspal Distance (ICD) mm Mean	SD
No cavity	9.09	0.05	7.1	0.43	5.2	0.43
¼ ICD/MOD	9.57	0.63	7.45	0.8	5.36	0.38
¼ ICD/OCC	9.4	0.64	7.3	0.5	5.3	0.32
⅓ ICD/MOD	9.6	0.572	7.4	0.135	5.5	0.351
⅓ ICD/OCC	9.4	0.61	7.2	0.43	5.4	0.37
Standard deviation of the means	0.20		0.14		0.11	

The mean force needed to produce failure of the crowns of teeth is shown in Table 2. More force was required to fracture teeth without prepared cavities than teeth with prepared cavities, the difference being statistically significant ($P < 0.01$). Teeth with narrow occlusal preparations as well as teeth with narrow occlusal portions of MOD cavities required more force to fracture than did teeth with wide cavities, the difference being statistically significant ($P < 0.02$). There was no statistically significant difference, however, in the force required to fracture teeth with MOD preparations and those with occlusal preparations of the same occlusal width.

Sample curves of the tests are shown in Figure 3 and examples of the type of fracture sustained are illustrated in Figure 4.

Table 2. Load Required to Fracture Teeth

Group	Load lb *(kg)* Mean	SD
No cavity	530 *(238.5)*	119.3 *(53.7)*
1/4 ICD/MOD	334 *(150.3)*	115.6 *(52)*]
1/4 ICD/OCC	333 *(149.9)*	112.4 *(50.6)*]
1/3 ICD/MOD	216 *(97.2)*	62.8 *(28.3)*]
1/3 ICD/OCC	213 *(95.9)*	66 *(30)*]

] Joins pairs that are not significantly different

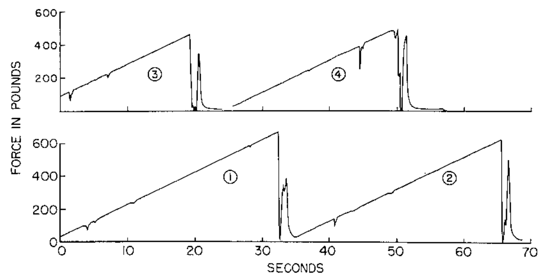

FIG 3. *Specimen curves showing the brittle failure of the crown of a tooth under load control (isometric)*

FIG 4. *Example of fractured teeth showing longitudinal fracture through the crown of the tooth*

Discussion

The greater resistance to fracture of teeth without prepared cavities indicates that even with the narrower occlusal cavities the

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crowns are weakened significantly. However, the most surprising result is the lack of any difference in the strength of teeth with MOD preparations and teeth with occlusal preparations of the same width. Thus a proximal box with minimum penetration of the dentin does not further weaken a tooth with an occlusal preparation. It might have been argued that the lingual and facial cusps and the mesial and distal marginal ridges form a circle of enamel that is important to the strength of the crown. Breaching the circle with mesial and distal boxes should weaken the crown seriously. This proved not to be so with minimum penetration of the dentin.

Vale (1959), using a force of compressed air that also gave him control of the rate of loading, found no difference in the strength of teeth without cavities and those with MOD preparations with the occlusal portion one-fourth the intercuspal distance. However, on increasing the width of the occlusal portion to one-third the intercuspal distance, he found a dramatic fall in the strength of the crown. The present study confirms the effect of the occlusal width of the cavity on the strength of the crown. However, it was also found that even with a narrow preparation there was a significant reduction in the strength of the crown of a tooth compared with a tooth without a cavity. It appears that the reduction of occlusal enamel is the first step toward the weakening of the crown of a tooth.

This study partly confirms the work of Mondelli and others (1980), in that the preparation of a cavity in a tooth weakens it significantly. However, Mondelli also found that teeth with class 2 preparations, of both two and three surfaces, fractured with less force than teeth with occlusal preparations of the same occlusal width. Several differences in experimental technique may account for this disagreement. Mondelli's preparations extended deeper pulpally than did ours, and the diameter of the sphere used by Mondelli was 4 mm whereas ours was 4.76 mm. This would mean the tangent on the cuspal triangular ridges occurred further facially and lingually in our testing and thus alters the site of application of the force.

The forces generated in the present study are greater than the typical forces generated in the mouth. According to Helkimo and Ingervall (1978), typical forces in the mouth are 40-180 pounds. The forces seen in this study would be approached only instantaneously by biting on a hard object.

The standard deviations in the present study were high, which is typical of mechanical testing on irregular anatomic shapes. This fact is accounted for in the statistical testing.

The present study supports the trend toward the conservative restoration (Gale & Osborne, 1980). As indicated, part of the rationale for this trend rests on the ability to achieve a favorable cavosurface angle. This study suggests that the conservative preparation would also better preserve the strength of the crown.

Conclusion

The width of the occlusal portion of a preparation affects the strength of the crown of a prepared tooth. The extension of a preparation to involve proximal boxes does not significantly reduce the strength of a tooth provided only a minimal amount of dentin is removed.

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OPERATIVE DENTISTRY, 1981, 6, 6–10.

The Influence of Condensing Pressure on the Strength of Three Dental Amalgams

Compressive strength of amalgam tends to vary directly with the pressure of condensation but tensile strength is not affected.

ARTHUR E CLARK • JOHN W FARAH
T DWYGHT CLARK • CRAIG ETTS
HAMDI MOHAMMED

Summary

Measurement of compressive strength of amalgams of Velvalloy, Dispersalloy, and Tytin, after being condensed by static loads varying from 5 to 40 lb (2.25-18 kg), showed that compressive strength increases with increasing loads. When condensed by hand, however, the compressive strength of amalgams of Velvalloy and Dispersalloy was lower than that achieved with static loads whereas the strength of amalgams of Tytin remained about the same. Scanning electron micrographs show that increased condensing pressures reduce the porosity of amalgams of Velvalloy and Dispersalloy whereas that of Tytin is unaffected. Maximum loads are required when condensing amalgams of Velvalloy and Dispersalloy but not when condensing Tytin.

University of Florida, College of Dentistry, Department of Dental Biomaterials, J Hillis Miller Health Center, Gainesville, FL 32610, USA

ARTHUR E CLARK, PhD, assistant professor

JOHN W FARAH, DDS, PhD, associate professor of dental materials, presently at the University of Michigan School of Dentistry

T DWYGHT CLARK, DDS, assistant professor of operative dentistry

CRAIG ETTS, student research assistant

HAMDI MOHAMMED, DDS, PhD, professor and chairman

Reprint requests to Dr T Dwyght Clark, at the University of Florida, Department of Operative Dentistry Box J-415

Introduction

An accepted concept in the condensation of dental amalgam is the application of maximum loads by the operator. Jørgensen and Nielsen (1964) have studied conventional amalgams and have demonstrated increased crushing strength with increased condensing loads. To achieve optimal strength, excess mercury is forced to the surface where it is removed. This practice minimizes porosity and γ-1 and γ-2 phases, resulting in a set product with optimal physical and mechanical properties. Strength and resistance to corrosion are improved and creep is reduced.

With the introduction of copper-rich alloys, the application of maximum loads has led to difficulty in manipulating the amalgam (Marker & Marshall, 1979). Some amalgam alloys are excessively plastic, which makes condensation of the amalgam difficult. These alloys are so fluid they offer little resistance to the condenser and flow around the con-

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denser tip rather than pack beneath it. Manipulation of these alloys would be facilitated if the operator were not concerned with maximizing the condensing load.

The purpose of this investigation was to examine the influence of various condensing loads on the compressive and tensile strengths of three commercially available alloys and, where possible, to correlate changes in strength with microstructure. These alloys represent a conventional lathe-cut alloy, a dispersed phase copper-rich alloy, and a single phase copper-rich alloy.

Materials and Methods

Velvalloy (S S White, Philadelphia, PA 19102, USA), Dispersalloy (Johnson & Johnson, East Windsor, NJ 08520, USA), and Tytin (S S White, Philadelphia, PA 19102, USA) were the alloys studied. All alloys were supplied in predispensed capsules containing two spills. Trituration times recommended by the respective manufacturers were used.

A stainless steel mold that conforms to the dimensional tolerances listed in the revised Specification No 1 of the American Dental Association was used for the condensation of all specimens. Static loads of 40, 20, 15, 10, and 5 lb (18, 9, 6.75, 4.5, and 2.25 kg) were used to condense one series of samples. Specification No 1 calls for a load of 40 lb (18 kg).

In a second method, two clinicians were instructed to condense by hand two sets of specimens for each alloy into the mold described above. In one instance the clinician applied the maximum condensing load that he felt could be applied clinically; in the other, he applied the minimum condensing load that he deemed clinically acceptable.

All samples were stored for 24 hours at 37 °C. The compressive and diametral tensile strengths were measured on a universal testing machine (Instron Model 1125, Instron Corp, Canton, MA 02021, USA) using a loading rate of 0.2 millimeters per minute ($mm \cdot min^{-1}$) and 0.5 $mm \cdot min^{-1}$, respectively. A minimum of five samples was tested for each variable.

Specimens fractured by tensile stress were mounted in cold-cure resin and ground on a series of abrasive papers of silicon carbide from 180 to 600 grit, and then polished with particles of alumina of sizes 6, 0.3, and 0.05 μm. An optical microscope was used to examine and photograph the specimens at several magnifications.

Results

Compressive strengths at 24 hours for the three amalgams as a function of condensing load are shown in Figure 1. For Velvalloy, reducing the condensing load from 40 to 20 lb (18 to 9 kg) produced no detrimental effect on strength, but further reductions to 10 and 5 lb (4.5 and 2.25 kg) resulted in further decreases in strength. The dispersed phase copper-rich amalgam, Dispersalloy, exhibited a continuing decrease in strength as the condensing load was reduced from 40 to 5 lb (18 to 2.25 kg). The single phase copper-rich amalgam, Tytin, exhibited similar strength at condensing loads of 40, 20, and 10 lb (18, 9, and 4.5 kg). Only when the condensing load was reduced to 5 lb (2.25 kg) did strength decrease notably. However, the strength of Tytin condensed at a load of 5 lb (2.25 kg) was greater than the strengths of Velvalloy and Dispersalloy condensed at a load of 10 lb (4.5 kg). These results do not reveal a clear-cut trend in the effect of condensing

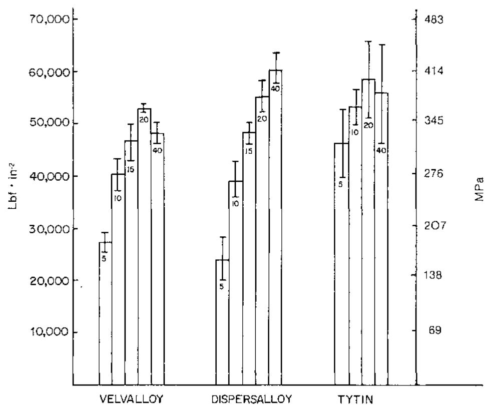

FIG 1. *Compressive strength of amalgam at 24 h when condensed by static loads*

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load on compressive strength. The strength of the lathe-cut amalgam and the dispersed phase amalgam decreased with reduced condensing loads, whereas the strength of the single phase copper-rich amalgam seemed unaffected by the condensing load except at the lowest value of 5 lb (2.25 kg).

The compressive strengths at 24 hours of the three amalgams when condensed by hand by two clinicians are shown in Figure 2. For

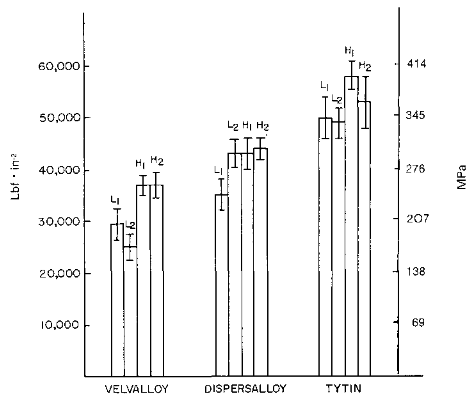

FIG 2. *Compressive strength of amalgam at 24 h when condensed by hand. L = light pressure, H = heavy pressure, 1 & 2 = operators.*

Velvalloy the maximum strength achieved when condensed by hand was less than 40,000 lb · in-2 (276 MPa) compared with 50,000 lb · in-2 (345 MPa) when condensed with a load of 20 lb (9 kg). For Dispersalloy the maximum strength achieved when condensed by hand was less than 45,000 lb · in-2 (310.5 MPa) compared with 55,000 lb · in-2 (379.5 MPa) at a condensing load of 20 lb (9 kg). The compressive strength of Tytin when condensed by hand varied from 55,000 to 57,000 lb · in-2 (393.3 MPa) compared with 57,000 lb · in-2 (393.3 MPa) at a condensing load of 20 lb (9 kg). Thus only when the specimens of Tytin were condensed by hand did the strength match that achieved with a controlled static condensing load of 20 lb (9 kg).

The tensile strengths for the three amalgams when condensed by hand are shown in Figure 3. There is no noticeable difference

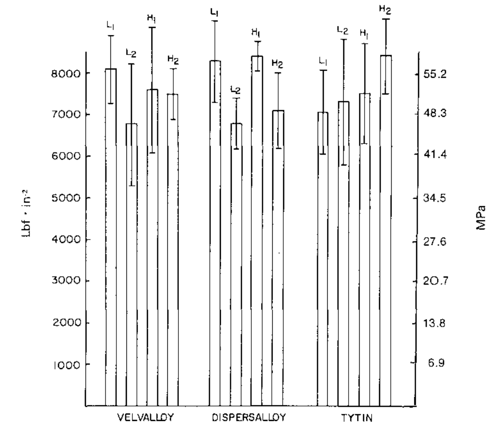

FIG 3. *Tensile strength of amalgam at 24 h when condensed by hand. L = light pressure, H = heavy pressure, 1 & 2 = operators.*

in tensile strength among any of the amalgams under either light or heavy pressure.

Since porosity was suspected as a likely detrimental factor in the reduction in strength, the microstructure of selected samples was examined. The micrographs shown in Figures 4-9 are from polished but unetched specimens and are at a magnification of ×33.

Figure 4, of a specimen of Velvalloy condensed with a load of 5 lb (2.25 kg), contains large pores approximately 50-100 μm in size.

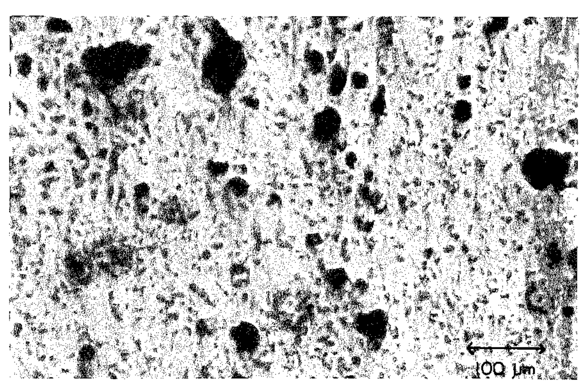

FIG 4. *Velvalloy amalgam condensed with a load of 5 lb (2.25 kg). X 33.*

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Figure 5 shows a sample of Velvalloy condensed at a load of 40 lb (18 kg). The reduction in the size of the pores is obvious.

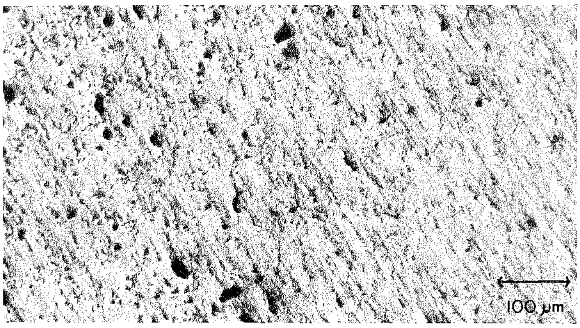

FIG 5. *Velvalloy amalgam condensed with a load of 40 lb (18 kg). X 33.*

Figures 6 and 7 show samples of Dispersalloy condensed at loads of 5 and 40 lb (2.25 and 18 kg), respectively. Large pores or voids are apparent throughout the structure when a condensing load of 5 lb (2.25 kg) was used. When the condensing load was increased to 40 lb (18 kg) a marked reduction in size of pore is observed.

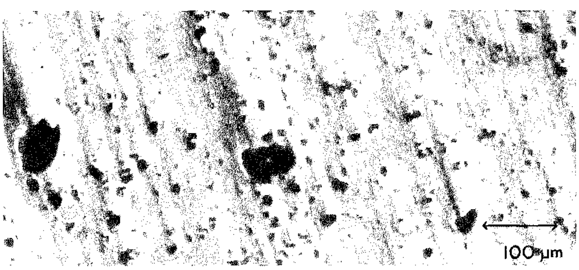

FIG 6. *Dispersalloy amalgam condensed with a load of 5 lb (2.25 kg). X 33.*

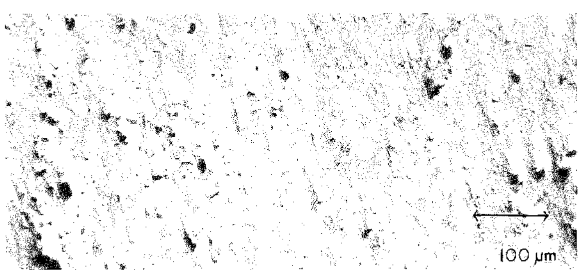

FIG 7. *Dispersalloy amalgam condensed with a load of 40 lb (18 kg). X 33.*

In contrast to these two amalgams, Tytin showed little effect of condensing load on porosity. Figures 8 and 9 show specimens of Tytin condensed at 5 and 40 lb (2.25 and 18 kg), respectively. Little difference is noted in the structure of the two. Thus it seems likely

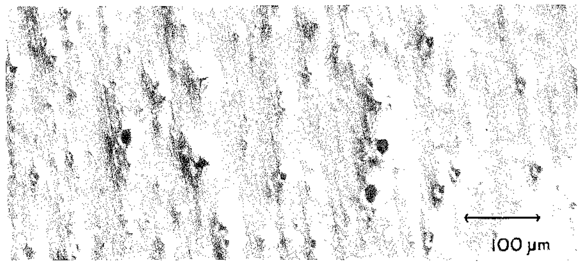

FIG 8. *Tytin amalgam condensed with a load of 5 lb (2.25 kg). X 33.*

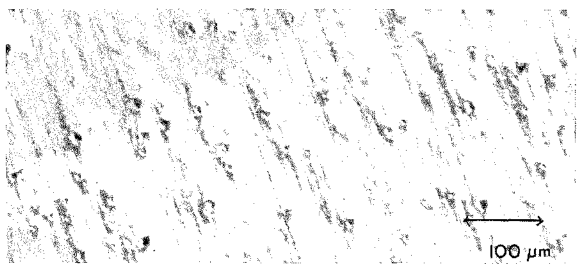

FIG 9. *Tytin amalgam condensed with a load of 40 lb (18 kg). X 33.*

that for Velvalloy and Dispersalloy porosity contributed to the observed reduction in strength with reduced condensing loads. However, other factors, such as size and shape of the particles and heat treatment of the alloy, are also likely to affect the mechanical properties.

Discussion

Since the diameter of the plunger of the mold specified by the American Dental Association is 4 mm and the diameter of the condenser used by the clinicians is 2 mm, to develop similar stresses the load on the condenser should be only one-fourth that of the load applied to the plunger. The stress produced by a load of 20 lb (9 kg) on the plunger is 1000 lbf · in^{-2} (6.9 MPa). To produce a similar stress with the condenser

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should require a load of only 5 lb (2.25 kg). Studies by Rakow, Eleczko and Light (1978) show that loads in excess of 10 lb (4.5 kg) are within the range developed by dental students and that loads of 5 lb (2.25 kg) are routinely achieved. Thus, in this study, the stresses produced when the samples were condensed by hand should be similar to the stresses produced by loads of 20 lb (9 kg). Hence the compressive strength should be similar. A comparison of the strengths achieved by controlled loading at 20 lb (9 kg) and hand condensation (Figs 1 & 2) shows this is not so for Velvalloy and Dispersalloy.

These results are not surprising considering the method by which the samples were made. The plunger is designed to fit snugly into the cylinder. Thus when the load is applied none of the amalgam can escape from around the plunger and a uniform stress is developed. However, the diameter of the condenser is only half the diameter of the cylinder. Thus when samples are condensed there is room for the amalgam to flow around the condenser tip. This will effectively reduce the stress produced within the amalgam. Accordingly, the lower strengths developed when Velvalloy and Dispersalloy were condensed by hand compared with controlled loading are expected.

The steel mold in which the samples were condensed represents at best an ideal clinical situation; that is, a prepared cavity where condensation is facilitated by having the amalgam totally supported and contained within a rigid structure. It would be even more difficult for a clinician to apply heavy loads in a less ideal situation such as in the oral environment. Yet, these results clearly show that to approach the strengths achieved with the technique specified by the American Dental Association for Velvalloy and Dispersalloy, one must make every effort to maximize the condensing load.

The same differences in preparation of samples exist for Tytin. In spite of this, the strength for both controlled loading and hand condensing are comparable. Thus in the development of an optimal compressive strength Tytin is much less sensitive to condensing loads.

Conclusions

The results show that under a controlled condensing load the compressive strengths of Velvalloy and Dispersalloy are related to the magnitude of the load. Tytin, on the other hand, exhibits strengths that are relatively independent of load. When hand condensation is substituted for controlled loading, however, maximum condensing loads do not produce strengths for Velvalloy and Dispersalloy even close to those achieved with controlled loads. Thus, for these two amalgams to produce restorations with the maximum possible compressive strength, maximum condensing loads should still be applied.

The compressive strength of Tytin when condensed by hand has values similar to those produced by controlled loading. Therefore, when using Tytin one can decrease the condensing load on the plastic mass and still achieve acceptable strength.

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(Accepted 17 June 1980)

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OPERATIVE DENTISTRY, 1981, 6, 11–14.

Effect of Abrasive Blasting on Castings of Gold Alloys

Margins need to be protected when inlays and crowns are subjected to abrasive blasting.

HARMON F ADAMS

Summary

Castings of gold alloys of Types II and III as well as of an alloy with low content of noble metals were subjected to sandblasting and to abrasive blasting. Metal was removed from unprotected margins and elevations were formed on the axial surfaces.

Introduction

We have known for many years that the retention of a cast restoration is substantially increased by roughening the surfaces that are to be cemented together (Jørgensen, 1955). Extreme roughness, however, prevents the casting from being seated completely (Charbeneau & Peyton, 1958). The internal surface of a casting can be roughened by grinding with stones or disks, by chemical etching (Ostlund, 1974), by electrochemical stripping (Cherberg & Nicholls, 1979), by the casting technique (Fusayama & Yamane, 1973), or by sandblasting (Beaudreau, 1975). Sandblasting has also been recommended as a method of removing excess metal from the internal surface of the casting before cementation (Farne & Nealey, 1976). The roughness produced by sandblasting or abrasive blasting is more uniform than that produced by grinding, which produces deep grooves and sharp edges.

University of Washington, School of Dentistry, Department of Restorative Dentistry SM-56, Seattle, WA 98195, USA

HARMON F ADAMS, DDS, assistant professor

Despite the frequent use of abrasive blasting, little is known about its effects, nor have measurements of the amount of change to the surface of a cast restoration as a result of abrasive blasting been reported. The purpose of this investigation was to examine the effects of abrasive blasting on the margins and internal surfaces of restorations cast in gold alloys.

Materials and Methods

Ten wax patterns were made by swaging wax (Kerr's Hard Blue Inlay Wax, Kerr Mfg Co, Romulus, MI 48174, USA) to a lubricated die (Velmix Die Stone, Kerr Mfg Co) of a tooth prepared for a class 2 inlay. A plastic sprue was attached to the pulpal floor of the wax pattern and oriented parallel to the axial wall to provide a fixed point of reference (Fig 1).

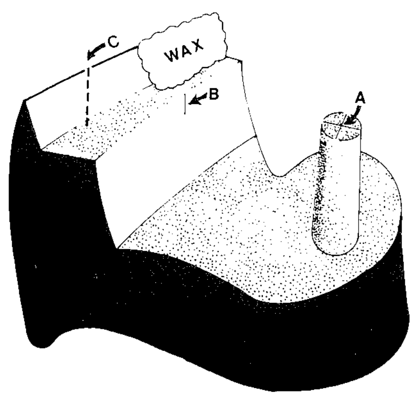

FIG 1. *Illustration of a standard casting with fixed points of reference on the sprue (A), the internal surface (B), and the cavosurface margin (C). Part of the margin was protected by wax.*

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The patterns were invested in a cristobalite investment (Lustercast, Kerr Mfg Co) according to manufacturer's specifications.

Two castings were made with a gold alloy meeting the specifications of the American Dental Association for Type II (Modulay, Jelenko/Pennwalt, New Rochelle, NY 10801, USA), four with a gold alloy of Type III (Firmilay, Jelenko/Pennwalt), and four with an alloy of a low content of noble metals (Midas, Jelenko/Pennwalt). The castings were quenched after loss of redness and cleaned of investment ultrasonically in hydrofluoric acid for 60 minutes. They were then inspected with a 25-power stereomicroscope for internal nodules, which were removed with a sharp spoon excavator. With the aid of a stereomicroscope a knifelike cavosurface margin with an angle of 30° was established at the gingival with cuttle disks. The end of the sprue was scored to provide a fixed point of reference for the measurements.

The castings were divided into two groups. Two each of the Type III alloy of gold and the alloy with a low content of noble metals were heat treated by soaking for 10 minutes in an electric furnace at 1300 °F (704 °C), then immediately quenched in water. They were placed in an oven at 600 °F (316 °C) for 15 minutes, removed, and allowed to cool in air.

The Type II alloy of gold, following the manufacturer's recommendation, was not treated with heat.

Five specimens were sandblasted with very fine sand (Quartz Abrasive, J F Jelenko/Pennwalt, New Rochelle, NY 10801, USA) in a sandblaster (Handy Sandy Sandblaster, Jelenko/Pennwalt) with air pressure at 35 pounds per square inch (lbf · in^{-2}) (241.5 kPa). The size of the particles of sand varied from 100 to 300 micrometers (μm). A second set of five specimens was tested in the same manner with an abrasive blaster (Micro Abrasive Blaster, Belle de St Claire, Van Nuys, CA 91406, USA) and aluminum oxide at a pressure of 75 lbf · in^{-2} (517.5 kPa). The size of the particles was 50 μm. Each specimen was measured and weighed before testing and again after 1, 5, and 10 seconds of abrasion. During abrasion, the point of reference was protected by a cap of polymethyl methacrylate. The weights were measured on a balance accurate to 0.1 mg. The amount of change to the margin and the internal surface was measured from the fixed point of reference to a fixed point on the cavosurface margin and also to a fixed point on the internal surface of the casting. Measurements were made on a two-way table with digital micrometers having an accuracy of 1.0 μm.

Results

The weight lost by the abraded alloys is given in Table 1. The table shows that loss of weight decreases with increasing hardness

Table 1. Loss of Weight from Abrasion

Specimen		Brinell Hardness Number	Loss of Weight: Abrasive Blast			Loss of Weight: Sand Blast		
Alloy	Treatment		1s mg	5s mg	10s mg	1s mg	5s mg	10s mg
II Gold	None	92	0.6	2.9	4.2	0.5	2.7	4.1
III Gold	Quenched	110	0.4	2.6	3.9	0.4	2.6	3.6
III Gold	Heat treated	165	0.4	2.4	3.8	0.3	2.0	3.3
Low noble	Quenched	125	0.4	2.7	4.5	0.4	2.6	4.1
Low noble	Heat treated	210	0.3	1.7	3.1	0.3	1.5	2.8

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of the alloy, except for the alloy of low content of noble metals in the quenched state.

The change in horizontal dimension from the point of reference to the cavosurface margin is shown in Table 2. Both rolling of the margin and loss of material are represented in this dimensional change. Again, the results show a smaller change with increasing hardness of alloy, except for the alloy of low content of noble metals in a quenched state. The changes for both types of abrasion are similar.

The change in elevation of the surface from abrasion is shown in Table 3. In all instances the surface of the casting was elevated. In this test the alloy with low content of noble metals in the quenched state follows the trend.

As an indication of the marginal discrepancy produced by this abrasion, Figures 2 and 3 show the final shape of the casting of gold alloy of Type II after 10 seconds of abrasive blasting.

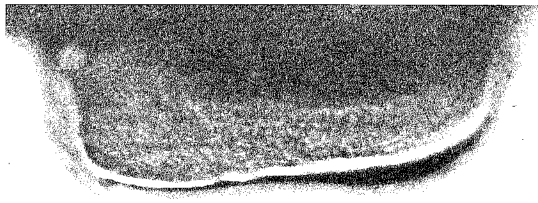

FIG 2. *Marginal opening after 10 seconds of abrasion. Type II gold alloy*

FIG 3. *Margin of casting after 10 seconds of abrasion. Type II gold alloy*

Table 2. Shortening of the Cavosurface Margin

Specimen: Alloy	Specimen: Treatment	Brinell Hardness Number	Shortening: Abrasive Blast 1s µm	5s µm	10s µm	Sand Blast 1s µm	5s µm	10s µm
II Gold	None	92	8	33	61	8	31	58
III Gold	Quenched	110	7	30	50	6	28	46
III Gold	Heat treated	165	6	26	45	4	19	40
Low noble	Quenched	125	4	23	53	4	22	51
Low noble	Heat treated	210	2	11	41	2	12	38

Table 3. Elevation of the Internal Surface of the Casting

Specimen: Alloy	Specimen: Treatment	Brinell Hardness Number	Elevation: Abrasive Blast 1s µm	5s µm	10s µm	Sand Blast 1s µm	5s µm	10s µm
II Gold	None	92	10	22	18	10	20	20
III Gold	Quenched	110	10	21	17	9	19	20
III Gold	Heat treated	165	7	12	13	6	12	14
Low noble	Quenched	125	7	15	14	7	13	13
Low noble	Heat treated	210	5	12	12	5	12	12

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Discussion

The results of abrasion by the sandblaster and the abrasive blaster were similar. This is so because even though the mass of the particles of the abrasive blaster is smaller their velocity is higher and thus they exert approximately the same force to the surface of the alloy. Both abrasives produced immediate changes to the cavosurface margin and internal surface of the casting. There was an initial rolling of the margins after 1 second followed by a loss of material during subsequent abrasion. One second of abrasion produced changes in the range of 2 to 8 μm depending on the type of alloy and whether it was heat treated. There is a direct relationship between the duration of abrasive action and the amount of change to the cavosurface margin. Continued abrasion produced an opening of the cavosurface margin (Fig 2) and loss of material as verified by the change in weight. The margin began to blunt at 5 seconds and after 10 seconds ranged in width from 38 to 61 μm.

The loss of weight of the alloy of low content of noble metals in the quenched state was higher than that predicted by Brinell hardness alone. This is because the amount of material removed depends also on its density.

The change to the internal surface of the casting was characterized by an elevation of the surface. This observation is contrary to the report of Farne & Nealey (1976), who suggested that gold is removed by sandblasting. The elevations resulted from the furrows and ridges formed by the impact of particles. The elevation was greatest after 5 seconds of abrasion. All alloys responded similarly with the changes in elevation being 5-10 μm at 1 second and 12-22 μm after 5 seconds of abrasion. Continued sandblasting beyond 5 seconds showed little or no change in the elevation of the surface except for abrasive blasting of the Type II and Type III quenched alloys. Here the elevation was decreased. The elevation of the internal surface of the casting reduces the space available for the luting cement and may prevent complete seating of the restoration.

Conclusions

Abrasive blasting of the internal surface of a cast restoration is desirable to increase the roughness of the surface and thus increase the retention of the casting. The margin must be protected from the abrasives to prevent its destruction. All fine-grain alloys tested responded with immediate change to an unprotected cavosurface margin. The following conclusions on the effects of abrasive blasting can be drawn:

- Metal is removed from margins.
- Internal surfaces are elevated.
- Sticky wax protects margins.

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(Accepted 3 July 1980)

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REVIEW

Elastomeric Impression Materials

A review of the properties of polysulfide, silicone, and polyether impression materials with suggestions for their use.

JOHN W FARAH • ARTHUR E CLARK
PARVIZ R AINPOUR

Introduction

In recent years impression materials have been developed from liquid polymers which, when mixed with a suitable catalyst, are converted to elastomers. These elastomers should be dimensionally accurate and stable. They should also set in a reasonably short time and have adequate shelf life. In addition, the elastomers should be easy to mix and well accepted by the patient. Presently three types of elastomeric material are available to the dental profession: the polysulfides, the polyethers, and the silicones (Table 1). This paper will review these elastomers and point out the advantages and disadvantages of each.

Polysulfides

The elastomeric impression materials with the longest history of clinical use are the polysulfides. These materials are supplied as a base and catalyst in the form of pastes in

University of Florida, College of Dentistry, Department of Biomaterials, Gainesville, FL 32610, USA

JOHN W FARAH, DDS, PhD, associate professor of dental materials, now at the University of Michigan School of Dentistry

ARTHUR E CLARK, PhD, assistant professor of dental materials

PARVIZ R AINPOUR, PhD, research chemist, Pfizer, Howmedica Div, Groton, CT 06340, USA

Reprint requests to Dr Farah at the University of Michigan, Ann Arbor, MI 48103, USA

Table 1. Some Commercially Available Elastomeric Materials

Polysulfides	
Coe Flex Coe Laboratories, Inc Chicago, IL 60658	*Mim* S S White Philadelphia, PA 19102
Neo-Plex Lactona Corp Philadelphia, PA 19114	*Omniflex* Coe Laboratories, Inc
Permlastic Kerr Mfg C/Sybron Romulus, MI 48174	*Proflex* Professional Products Co San Diego, CA 92112
Rubberjel L D Caulk Co Milford, DE 19963	*Super Rubber* Harry J Bosworth Co Skokie, IL 60076
Unilastic Kerr Mfg Co/Sybron	
Polyethers	
Impregum Premier Dental Products Co Norristown, PA 19401	*Polygel* L D Caulk Co
Silicones	
Conventional	Addition-Cured
Citricon Kerr Mfg Co/Sybron	*Permagum* Espe Seefeld, West Germany
Elasticon Kerr Mfg Co/Sybron	*President* Coltene, Inc Hudson, MA 01749
Jelcone L D Caulk Co	*Reflect* Kerr Mfg Co/Sybron
Optosil Unitek Corp Monrovia, CA 91016	*Reprosil* L D Caulk Co
Plastosil Harry J Bosworth Co	
Xantopren Unitek Corp	

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collapsible tubes and are dispensed in equal lengths on a mixing pad. They are mixed with a stiff spatula, and mixing should be completed within 45-60 seconds. The base consists of a polysulfide of low molecular weight with sulfhydryl groups located at the ends of the molecules as well as branching off near the center of the molecule. The base also contains titanium dioxide or other fillers in amounts varying from 10 to 50% to control the stiffness of the material. The catalyst contains lead dioxide, an accelerator, which imparts a brown color. Newer materials are activated by cupric hydroxide, resulting in a greenish color.

When terminal sulfhydryl groups are oxidized, the polymer lengthens, a process called chain lengthening. Associated with this process is increased viscosity. When pendant or branching sulfhydryl groups are oxidized, a continuous three-dimensional structure is produced. This is referred to as cross-linking and leads to the development of elasticity in the material. Lengthening of the chain occurs more rapidly than cross-linking. Accordingly, the manipulation and insertion of the material must be completed before the cross-linking occurs to any significant extent.

The initial thickening that is noted immediately after mixing is due to lengthening of the chain. Although the material is thickening it will still flow around the contours of the teeth. Once cross-linking occurs, however, elasticity begins to develop and the material should not be moved during this period. In general, the working time of polysulfide materials ranges from 2 to 4 minutes. Complete setting requires a total of 8-10 minutes. An additional 1-2 minutes is recommended to allow for sudden changes in local conditions.

Increased temperature while mixing or the presence of moisture decreases the working as well as the setting time of polysulfides (Bell & von Fraunhofer, 1975).

Polysulfides are available in three consistencies. Less viscous, light-bodied pastes with longer setting times are generally ejected with a syringe. More viscous, regular- and heavy-bodied pastes are used in impression trays. Regular consistencies can also be used with a syringe. Because these materials do not adhere to a custom tray, the tray must be coated with an adhesive. This adhesive must be allowed to dry for 10 minutes before the rubber base material is placed in the tray.

To obtain optimum properties and consistent behavior from polysulfides, the two pastes must be proportioned correctly and mixed uniformly. Both undermixing and overmixing can produce significant changes in the percentage of permanent deformation. Thus, the recommended mixing time of the manufacturer should be closely followed. A uniform thickness of impression material, 2-3 mm in a rigid custom tray, is most desirable to ensure accurate reproduction (Harcourt, 1977, 1978). Polymerization continues well after removal of the tray from the oral environment and results in some shrinkage. Furthermore, under conditions of medium or low relative humidity, water, a by-product, can evaporate, producing further shrinkage. Ideally, the impression should be allowed to stand about 15 minutes, after removal from the mouth, to permit elastic recovery before the cast is poured (Bell & von Fraunhofer, 1975). However, it is best not to wait more than 60 minutes before pouring the cast. Second-pour casts can be made as long as one recognizes that they are usually less accurate than the first cast. The wax pattern should always be made on the die obtained from the first pour.

The tear strength of elastomeric impression materials has been evaluated under simulated clinical conditions, and the polysulfides have been shown to resist tearing better than do silicones and polyethers (Herfort & others, 1978). Thus, when tight interproximal areas or deep subgingival preparations are involved, polysulfides are the materials of choice. Polysulfides generally have long working times, with light-bodied pastes having low viscosities and thus excellent flow. Polysulfides, being less rigid than silicones or polyethers, will exhibit higher permanent deformation under load. Thus, it is not advisable to ship polysulfide impressions to commercial laboratories. These impressions can inadvertently become loaded under their own weight during shipment and result in inaccurate end products. A safer method is to ship the stone cast.

Polyethers

Polyethers were introduced to the dental profession in 1970. They consist of two

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pastes, a base and catalyst. The base is a polyether with imine end-groups, while the catalyst contains an aromatic sulfonic acid. When they are mixed they polymerize to a rubber-like material. During the reaction the terminal imine rings open, thereby increasing molecular weight and branching. The reaction is rapid, so mixing and insertion should occur within 2 minutes. Setting generally occurs in 3-5 minutes. A thinner may be added to increase the working time and reduce the viscosity of the unset material. Addition of too much thinner can reduce resistance to tearing (American Dental Association, 1977).

Polyethers are thixotropic; that is, at low rates of shear, flow does not occur readily, but high rates of shear will cause the material to flow with greater ease. This behavior enables the clinician to load the impression tray without the material dripping. However, when a load is applied to the tray, as in taking an impression, the material flows around the preparation.

Polyethers have a higher modulus of elasticity than do polysulfides or silicones, and this often necessitates the use of substantial force to remove the set impression from the mouth. The rigidity of polyethers, combined with low resistance to tearing, makes it difficult to use the material in tight interproximal areas and deep subgingival preparations. For these reasons, manufacturers often recommend a greater bulk of material between the tray and the preparation.

In actual performance, the polyethers are dimensionally stable, have less permanent deformation than polysulfides upon removal from the mouth, good accuracy of reproduction, and the capacity for more than one accurate cast. The high degree of dimensional stability is attributed to the absence of any volatile by-products of the reaction.

When manipulating polyethers, one should minimize contamination with moisture by completely drying the prepared cavity before taking the impression because the water sorption of polyethers is relatively high (Hembree & Nunez, 1974). It is especially pronounced in thin sections such as in the interproximal area. If electroplating is desired, begin the procedure soon after the impression is taken to minimize contamination by moisture. Polyethers when stored under dry conditions are very stable over long periods of time.

Hypersensitivity to polyether impression material has been reported (Nally & Storrs, 1973). The component, alkyl benzene sulfonate, in the catalyst was implicated as the cause of irritation. Therefore, one should exercise care in handling the material to avoid contacting the skin with the unmixed catalyst. If contact does occur, the area should be rinsed with water. Discontinue use of the material in cases of allergic reaction. Furthermore, exercise care in the use of the tray adhesive since it consists of a rubber dissolved in ketones and chloroform. Since the solvents are volatile, they should be used with adequate ventilation. Avoid breathing the vapors and contact with skin.

Silicones

Silicones are synthetic polymers whose basic chemical structure includes alternating atoms of silicon and oxygen to give polysiloxanes. Different organic radicals can be added to the chain. As with other polymers, the length of the chain determines the molecular weight of the polymer. Short chains characterize liquid polymers whereas longer chains characterize the more viscous polymers. Suitable catalysts, such as tin octanoate with an organic orthosilicate, when mixed with the base initiate polymerization and cross-linking of the molecules.

Inert fillers added to the base allow adjustments of consistency and enhance the mechanical properties of the material. The setting times of these materials are generally shorter but less sensitive to temperature than are those of the polysulfides.

The setting reaction is a condensation polymerization creating an alcohol as a by-product. Long-term shrinkage does take place because of the slow loss of alcohol. This can be minimized by pouring the cast within 1 hour after taking the impression. The above dimensional change can also be reduced by using a putty-wash system. The putty has a high content of filler, producing less shrinkage from polymerization and from cooling on removal from the oral cavity, thus ensuring good reproduction of detail. The putty is placed in the impression tray and a preliminary impression taken. When the preparation

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of the final restoration is completed, the wash is applied with a syringe to both the preparation and the putty to obtain a final impression.

New silicones polymerized by an addition reaction, instead of the condensation reaction mentioned above, yield no by-products and thus have the lowest dimensional change upon setting of any of the rubber impression materials. In addition, they have excellent elasticity (McCabe & Wilson, 1978). These newer silicones have slightly longer working times (3-5 minutes) than the conventional silicones (1.5-3.5 minutes), which make them more convenient to use clinically. The setting times of silicones cured by the addition method are comparable to the conventional silicones (in the range of 5-8 minutes). Although the material might set in a shorter time, it is advisable to follow the setting times suggested by the manufacturer so the material can attain its optimum elasticity, thus minimizing the likelihood of any distortion. The resistance to tearing of regular- and heavy-bodied addition-cured silicone is higher than that of the conventional silicone, but the light-bodied consistency has lower resistance to tearing than have conventional silicones. Thus in deep subgingival preparations and in severely undercut areas, the regular-bodied addition-cured silicone is a better choice than the light-bodied because of higher resistance to tearing. Low resistance to tearing for the light-bodied consistency is especially apparent in cases in which second pours are made.

The main advantage of the addition-cured silicones is their superior dimensional stability. This improved dimensional stability is especially important when the stone cast cannot be poured shortly after the impression has been taken.

Recommendations for Selection and Manipulation of Elastomeric Impression Materials

The properties of elastomeric impression materials are compared in Table 2.

To achieve optimum properties and maximum accuracy, the following procedures are recommended.

Table 2. Qualities of Elastomeric Impression Materials

	Polysulfides	Polyethers	Silicones Condensation-cured	Silicones Addition-cured
Stability	Pour within one hour	Can wait several hours	Pour within one hour	Can wait several hours
Reproduction of detail	Excellent	Good	Good-Excellent	Good-Excellent
Resistance to tearing	Excellent	Poor	Good	Good
Ability to flow	Excellent	Fair	Good	Good
Rigidity	Low	High	Medium	High
Stability upon setting	Good	Excellent	Good	Excellent
Approximate cost per package	$13.00	$27.00	$19.00	$33.00

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• Mix all materials vigorously until a homogeneous mass free of streaks is obtained.

• Use custom trays rather than stock trays. The trays should be rigid and allow enough clearance for a uniform thickness of 2 mm of impression material. For polyethers, a thickness of up to 4 mm is preferred. Custom trays generally reduce the amount of impression material used, thus reducing the cost.

• Adhere to the setting time suggested by the manufacturer.

• Ideally, after removing the impression from the oral cavity, set it aside for 15 minutes to allow elastic recovery. The recovery is less critical for polyethers and addition-cured silicones.

• Second-pour stone casts are always less accurate than first pours. Thus, complete the waxing and finishing on the die obtained from the first pour.

• Since polyethers are most susceptible to high humidity, store under dry conditions for best results.

• Polyethers, if properly stored, and addition-cured silicones are best suited for shipping. However, it is best to pour the stone cast before shipping.

• For impressions of complete arches or preparations of several teeth the best material is polysulfide, light- or regular-bodied, followed by addition-cured silicones, then condensation-cured silicones, and finally polyethers. This order is based primarily on the ability of the material to flow and its resistance to tearing.

• Tray adhesives for polysulfides are not suitable for silicones or polyethers and thus they should not be interchanged.

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 OPERATIVE DENTISTRY, 1981, 6, 20-25.

PRODUCT REPORT

Mercury-Alloy Dispensing Systems

Variations in the amount of mercury dispensed by some dispensers or in the weight of the pellets of alloy may affect the amalgam by changing the ratio of alloy to mercury.

ROBERT C HAMM, JR • WOOD E CURRENS
J ANTHONY von FRAUNHOFER

Summary

Seven dispensers of mercury (Baker Universal, Baker Red Top, Caulk Saf-T-Cote, Johnson & Johnson, Phasealloy, S S White, and Sybron/Kerr) were tested for accuracy and consistency of operation. The Johnson & Johnson and S S White dispensers were the most variable, especially when the mercury in the reservoir was down to the level for refilling.

Tablets of eight alloys (Aristaloy, Aristaloy CR, Dispersalloy, Phasealloy FS, Phasealloy XFS, Sybraloy, Sybraloy FS, and Tytin) were weighed for consistency and the weights compared with those specified by the manufacturer. In general the weights were consistent but not always the same as those specified by the manufacturers.

Dispersalloy and Tytin in capsule form with mercury were found to be consistent and the proportions accurate. A restoration made of Tytin in capsule form costs about three cents more than one made of tablets.

University of Louisville, School of Dentistry, Health Sciences Center, Louisville, KY 40292, USA

ROBERT C HAMM, JR, BA, dental student in the class of 1982

WOOD E CURRENS, DMD, MEd, assistant dean for clinical affairs and associate professor, Department of Restorative Dentistry

J ANTHONY von FRAUNHOFER, PhD, MSc, director of biomaterial sciences and professor, Department of Restorative Dentistry

Reprint requests to Dr Currens

Introduction

Most dispensers for proportioning mercury and alloy have been found to be reasonably accurate when manufacturers' directions are followed (Ryge, Fairhurst & Oberbreckling, 1958; Eames, Mack & Auvenshine, 1970). Recently, however, there have been changes in the design of dispensers and the criteria for acceptable behavior of amalgams, as well as significant developments in amalgam alloys, such as the advent of alloys rich in copper and free of the γ-2 phase. By improving marginal integrity and decreasing creep and corrosion these alloys have improved the clinical performance of amalgam restorations. But despite the significant improvements in mechanical and electrochemical properties achieved with copper-rich alloys, the ratio of alloy to mercury is central to clinical success.

Accordingly, the accuracy of seven dispensers (five adjustable and two fixed) was investigated to assess their ability to deliver consistent amounts of mercury. The consistency of the weights of tablets of seven modern alloys and one conventional alloy was also studied because variations in the weight of alloy used with a given weight of mercury obviously affect the properties of the amalgam. In addition, two capsulated materials were assessed for the consistency of their ratios of mercury to alloy.

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Methods and Materials

The dispensers used in this study are specified in Table 1 and the amalgam alloys in Table 2.

Table 1. Mercury Dispensers

Name and Manufacturer	Type
Baker Universal (Black Top) Engelhard/Baker Dental Carteret, NJ 07008, USA	Adjustable
Baker Red Top Engelhard/Baker Dental Carteret, NJ 07008, USA	Fixed
Caulk Saf-T-Cote L D Caulk Company Milford, DE 19963, USA	Fixed
Johnson & Johnson East Windsor, NJ 08520, USA	Adjustable
Phasealloy, Inc El Cajon, CA 92021, USA	Adjustable
S S White/Pennwalt Philadelphia, PA 19102, USA	Adjustable
Sybron/Kerr Romulus, MI 48174, USA	Adjustable

Four of the adjustable dispensers (Johnson & Johnson, Phasealloy, Sybron/Kerr, and S S White) dispensed both alloy pellets and mercury, the reservoir for mercury being mounted vertically on the top plate. Johnson & Johnson and S S White dispensers have the same design and patent number. The Phasealloy and Sybron/Kerr dispensers appear similar to the other two, but are covered by different patents. Mercury is released from all four devices by a mechanism comprising a push button and a sliding arm. The wells in the sliding arm in the Johnson & Johnson, S S White, and Sybron/Kerr dispensers are filled only when the arm is moved under the reservoir. On release of the button, a spring returns the sliding arm to its position of rest over the delivery point and the mercury is released. In the Phasealloy dispenser, in contrast, the well of the sliding arm in its rest position is situated under the reservoir and is filled automatically. When the button is pushed, the well moves over the delivery point and the mercury is released.

The wells of the Baker Universal (adjustable), Baker Red Top (fixed), and Caulk dispensers are filled only when the devices are inverted and the buttons pushed. When this is done the well moves over the delivery point and the mercury is released.

Table 2. Dental Amalgam Alloy Tablets

Alloy	Type	Mean Weight mg ± SD	Nominal Weight gr	Nominal Weight mg
Aristaloy	Conventional	387.2 ± 2.7	6	389
Aristaloy CR	Copper-rich eutectic	312.4 ± 4.4	5	324
Dispersalloy	Conventional mixed with copper-rich spherical	393.3 ± 4.4	6	389
Phasealloy FS	Copper-rich spherical	388.0 ± 2.0	6	389
Phasealloy XFS		388.7 ± 1.1	6	389
Sybraloy	Copper-rich spherical	300.1 ± 1.8		300
Sybraloy FS		300.2 ± 4.1		300
Tytin	Copper-rich spherical	399.3 ± 3.5	6	389

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The amounts of mercury delivered by each dispenser were determined by weighing the droplets with a centimilligram (0.01 mg) balance (Sartorious 2434, Sartorious Gmbh, Göttingen, Federal Republic of Germany). For the adjustable dispensers, the amounts delivered at the three settings—minimum, midpoint, and maximum—were determined both when the reservoir was full and when it was at the level for refilling. The amounts of mercury delivered at the full and refill levels were determined also for the fixed volume dispensers of Baker and Caulk. A minimum of ten aliquots of ten droplets each was weighed for each dispenser at every setting. Means and standard deviations were calculated for each set of determinations.

The tablets of alloy were weighed to assess the consistency of their weights. A minimum of ten tablets of each type was taken from two or more containers. Means and standard deviations were calculated for each type of tablet. In addition, two capsulated materials, Dispersalloy and Tytin, were examined by opening the capsules and weighing the amounts of alloy powder and mercury. Ten capsules of each brand were tested.

Results

The mean weights of the tablets of the alloys are given in Table 2 along with the nominal weights given by the manufacturers. Weights of tablets of Aristaloy and Aristaloy CR were found to differ slightly from the nominal weights, the differences being statistically significant at $P < 0.05$ for Aristaloy and $P < 0.001$ for Aristaloy CR. The mean weight of the tablets of Dispersalloy is greater than the nominal weight ($P < 0.01$), as is the weight of tablets of Tytin ($P < 0.001$). In contrast, the difference in the mean and nominal weights of both types of Phasealloy and Sybraloy tablets is not statistically significant.

The average amounts of mercury dispensed at the various settings by each brand of adjustable dispenser when full and at the refill level are shown in Table 3.

The differences in the mean amounts of mercury delivered by the Johnson & Johnson dispenser for the three settings at both the full and refill levels were all found to be statistically significant, $P < 0.05$ and < 0.01 respectively. With the S S White dispensers, a statistically significant difference ($P < 0.05$) between the full and refill levels was found only at the maximum setting. For the Johnson & Johnson and S S White dispensers, the coefficients of variation at the three settings were always two to three times greater at the refill level than when the mercury reservoirs were full. These coefficients reflect the variations found in the individual dispensers that were tested. In contrast, no statistically significant differences in the weights of mercury dispensed at the full and refill levels for the three selected settings were found for the other adjustable dispensers (Baker Universal, Phasealloy, and Sybron/Kerr).

Table 3. Quantity of Mercury Dispensed by Each Brand of Adjustable Dispenser

Dispenser	n	Setting: Minimum, Full mg, mean ± SD	Minimum, Refill mg, mean ± SD	Midpoint, Full mg, mean ± SD	Midpoint, Refill mg, mean ± SD	Maximum, Full mg, mean ± SD	Maximum, Refill mg, mean ± SD
Baker Universal	7	291.3 ± 3.2	292.6 ± 2.8	347.2 ± 4.3	347.9 ± 6.8	400.8 ± 7.2	406.2 ± 9.4
Johnson & Johnson	7	388.3 ± 7.7	371.8 ± 15.0	409.7 ± 7.2	391.7 ± 14.8	428.7 ± 7.2	404.5 ± 23.2
Phasealloy	3	328.5 ± 7.2	328.9 ± 7.9	371.7 ± 5.6	372.1 ± 6.1	434.6 ± 3.6	434.6 ± 3.5
S S White	5	272.4 ± 7.7	252.7 ± 28.1	294.7 ± 8.3	274.2 ± 27.0	332.1 ± 9.2	301.4 ± 30.8
Sybron/Kerr	3	230.8 ± 2.0	230.4 ± 1.0	268.3 ± 1.7	268.1 ± 0.7	313.4 ± 1.9	313.0 ± 1.3

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Table 4. Mercury Content of Mixes

Dispenser	Setting						Recommended
	Minimum		Midpoint		Maximum		
	Full	Refill	Full	Refill	Full	Refill	
	%		%		%		%
Johnson & Johnson	49.7	48.6	51.0	49.9	52.2	50.7	50
Baker Universal	48.3	48.4	52.6	52.7	56.2	56.5	50
Phasealloy	45.8	45.9	48.9	49.0	52.8	52.8	50
Sybron/Kerr	43.5	43.4	47.2	47.2	51.1	51.1	43-51
S S White	40.6	38.8	42.5	40.7	45.4	43.0	44.5

The content of mercury in mixes prepared with the dispensers at the three settings for both the full and refill levels is given in Table 4. The proportions of mercury recommended by the manufacturers for each alloy are also given in this table. For the Johnson & Johnson and S S White dispensers, both of which exhibited differences in the weight of mercury dispensed at the full and refill levels, the differences in the content of mercury of the mixes ranged from 1.1 to 2.4%.

The mean weights of mercury delivered by the fixed dispensers at the full and refill levels are given in Table 5. No statistically significant differences were found between the weights of mercury at the full and refill levels for either of the dispensers ($P < 0.05$).

Table 5. Quantity of Mercury Dispensed by Each Brand of Dispenser

	n	Full mg Mean SD	Refill mg Mean SD
Baker Red Top	3	594.3 ± 6.2	597.8 ± 4.6
Caulk Saf-T-Cote			
C Sleeve	4	474.9 ± 2.0	475.6 ± 5.1
D Sleeve	3	416.0 ± 5.5	415.8 ± 3.0

The weights of alloy and mercury, together with their corresponding ratios, for the Dispersalloy and Tytin capsules are given in Table 6. The weights were consistent, that is, the coefficient of variation was less than 1% for both types.

Table 6. Weights of Alloy and Mercury in Capsules

	Alloy mg Mean SD	Mercury mg Mean SD	Ratio of Mercury %
Dispersalloy	593.8 ± 5.0	593.5 ± 3.8	50.0
Tytin	805.4 ± 3.2	594.3 ± 2.5	42.5

Discussion

Although there are statistically significant differences in the actual (measured) and nominal weights of some of the alloy tablets, overall the weights of the tablets themselves vary little. The coefficient of variation was less than 1.5% in all instances and was below 1.0% in five of the eight alloys tested. In contrast, there were greater inconsistencies with the mercury dispensers.

The Johnson & Johnson dispensers showed wide variations, number 6 (and number 7 to a lesser degree) always delivering less mercury than the others. The S S White dispensers showed similar trends. This could be anticipated since they are identical in design.

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These dispensers generally showed greater variability at the refill than at the full level. Furthermore, less mercury was dispensed at the refill level suggesting that the mercury reservoir in this design of dispenser should be maintained at the full level as far as possible to minimize variations in the mix.

The other adjustable dispensers showed little variability. Furthermore, the coefficients of variation were similar for all test conditions.

The effect of variability of dispenser on the final amalgam is shown clearly in Table 4. Differences in the content of mercury of the mixes were less than 0.5% for the accurate and reproducible Baker Universal, Phasealloy, and Sybron/Kerr dispensers. With the Johnson & Johnson and S S White dispensers, however, the content of mercury varied between 1.1 and 2.5% for the full and refill levels of the mercury reservoir. Differences of this magnitude are clinically significant and any factor that affects the dispensing of the mercury may magnify the variability. Typically, dirty mercury, or residues of mercury in the reservoir, or dirt or grease in the mechanism of the sliding arm will affect the accuracy of the dispenser and hence the resulting amalgam. It follows that the releasing mechanism of all dispensers should be kept clean and free of debris. It is also of interest that although the Baker Universal showed little variability, the manufacturer recommends that the dispenser be kept at least one quarter full.

The fixed dispensers showed little variability between the amounts dispensed at the full and refill levels. However, it was found that when dispensing two or more aliquots of mercury, the dispenser had to be fully inverted between each release of the button to ensure that the well was properly filled.

The weights of the capsulated materials were consistent and accurate. The ratio of mercury for capsulated Tytin, 42.5%, was lower than that for the alloy in tablet form because the tablet contains a cohesive agent to facilitate manufacture and this affects the ratio of mercury to alloy.

The difference in cost to produce a restoration from a capsule compared with a tablet is of importance to the practicing dentist. The Pennwalt Corporation conducted an informal survey (see appendix) to estimate the average amounts of alloy and mercury per restoration used by dentists, and calculated that a restoration made from capsules costs 3¢ more than one made from tablets. In view of the greater accuracy, consistency, convenience, and hygiene of the capsules, together with the elimination of the need for a somewhat expensive dispenser susceptible to accidents, the capsules might have many clinical advantages.

Conclusions

Many of the current dispensers of combined alloy and mercury that have adjustable levels of mercury are accurate, reproducible, and do not vary significantly in the amount of mercury delivered for variable levels of mercury in the reservoir. In contrast, two widely used devices, Johnson & Johnson and S S White, which are based on the same design, show variations. These variations can be as great as 2.5%, which may be clinically significant.

Behavior of dispensers of the same design can vary significantly. Practitioners who are using the Johnson & Johnson and S S White dispensers should calibrate their devices, keep them clean, and also as nearly as possible keep the reservoir full of mercury to minimize variations. Apart from the obvious need for cleanliness and good mercury hygiene, it appears that strict control of the level of mercury in the reservoir is not necessary for other designs of dispenser. The fixed mercury dispensers are accurate and consistent though they are now falling into disuse.

The weights of the capsulated materials were found to be very accurate and consistent. On considerations of economics as well as hygiene the use of capsules might be advisable in modern dental practice.

Tablets of alloy generally were found to be consistent though the measured weights of the tablets were usually found to be the same or greater than the weights specified by the manufacturers. This might affect the selected ratio of mercury in adjustable dispensers, particularly where the dispenser has a tendency to vary the amount of mercury delivered.

The authors wish to thank Richard Spiers for his technical assistance.

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Appendix

Costs of Tablets and Capsules Compared

Our survey indicates that dentists using tablets will typically use a mix of two spills 70% of the time and a mix of one spill 30% of the time. With current retail prices for Tytin tablets, the average cost per restoration for the alloy alone would be as follows:

$$\frac{(80¢ \times 3) + (\$1.60 \times 7)}{10} = \$1.36 \text{ per restoration with tablets}$$

Our survey also shows that dentists using capsules will use the 800 mg size 40% of the time, 600 mg 30% of the time, and 400 mg 30% of the time. With current retail prices for Tytin capsules, the average cost per restoration for alloy, mercury, capsules, and pestles would be as follows:

$$\frac{(98¢ \times 3) + (\$1.34 \times 3) + (\$1.74 \times 4)}{10} = \$1.39 \text{ per restoration with capsules}$$

As can be seen, the cost per restoration with capsules is 3¢ more than with tablets. However, this system already includes the mercury and capsule and eliminates the need for mercury dispensers and pestles. Additionally, S S White capsules are more convenient, result in more consistent mixes, and promote better mercury hygiene.

Data from S S White

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(Accepted 11 February 1980)

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POINT OF VIEW

Disciplined Operative Dentistry Requires Regeneration

ADALBERT L VLAZNY

INTRODUCTION

This is the time to re-establish the practice of sound clinical operative dentistry; the discipline that, for most patients and for most dentists, signifies dentistry. The decline in the quality of clinical performance has been due mainly to relaxation of the keen discipline that has been necessary and worthwhile in the past, but other factors have also contributed to the decline.

CHANGES IN EDUCATION

Subtle influences led instructors to assume that students wished to go second class and merely fulfill the minimum educational experience. Instructors who compromised discipline for clinical expedience became more popular than instructors who insisted on maintaining quality of performance. Evaluation of instructors by students usually suggested that students prefer monitoring that is less strict. The concerned instructor recognized the real potential of the modern student to meet prescribed requirements but many instructors, on the other hand, sought popularity with the students. Furthermore, organizations of students began to defend their rights but appeared to act against the few teachers who attempted to give an education of high quality. The dedication of these teachers was interpreted as rigid guidance, which made the modern student uncomfortable.

The result of these influences was that almost every student passed and graduated. The specter of legal challenge confronted the modern teacher, who faced exacting documentation, conformity with due process, and compliance with the Buckley Amendment. The use of the curve in establishing grades inflated them and lowered standards. Some dental schools modified grading even further by adopting only two alternatives, pass or fail. The effort and energy of both student and teacher have been diverted from the essentials of developing a disciplined professional.

Academic careers are not competitive in the market place. The present pool of instructors available for operative dentistry consists largely of newly graduated dentists, who teach temporarily until their practices become profitable, and of semiretired dentists disenchanted with the rigors of private practice. Neither lends much substance to discipline or quality in education. Then, too, many potential teachers of operative dentistry have been attracted to specialties.

If there are fewer capable operative dentists and even fewer competent teachers of operative dentistry, something evidently has changed. Perhaps too many expert and dedicated teachers of operative dentistry have left dental education. Those remaining may not be receiving support from the administration. Increasing the number of dental schools and rapidly expanding the size of classes spread

Loyola School of Dentistry, Department of Operative Dentistry, 2160 South First Avenue, Maywood, IL 60153, USA

ADALBERT L VLAZNY, DDS, MS, associate professor and chairman

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very thin the ranks of teachers who could maintain professional standards. The ranks were diluted even further by the commitment to teach operative dentistry to auxiliary personnel. Accepting financial aid from the government also contributed to declining standards.

Many dental schools have restorative departments with strong emphasis on fixed prosthetics and reconstruction, relegating the equally important procedures of operative dentistry to a minor position. Some dental schools do not teach cast restorations as part of operative dentistry; many have reduced or eliminated the requirements for gold foil; others have de-emphasized the usefulness of restorations of amalgam.

The progress of students is related to the teachers' management of the educational system. If the important aspects of operative dentistry have been modified, they have been modified with the direct or indirect consent of those who surrendered this responsibility.

FACING THE REAL WORLD

How have newly graduated dentists responded to their experiences? They criticize the educational process as being inadequate and not tough enough to prepare them for the rigors of practice. Those who apply for teaching positions are anxious to introduce stricter guidelines for students, though they were vehemently opposed to them when they were students. Associations of dentists in practice have soured recently because of the poor showing of the new associate in operative dentistry. At a 1980 board meeting of the Chicago Dental Society it was reported that 300 dental graduates of recent years were not employed as dentists. Some dental graduates work in several offices—not a sound way to build a core of dedicated and trusting patients. It is sad to note that these dentists must gain employment in union and welfare clinics.

Some recent graduates view with alarm the results of poor dentistry. They note the increase of complaints by patients to peer review boards. Legal redress is also on the increase in dental organizations. Anyone who has deviated from the prescribed norms is very vulnerable to legal chastisement. It cannot be overemphasized that the best defense against lawsuits as well as denturism is good operative dentistry.

CHANGES IN TECHNIQUES

Although the introduction of new instruments, materials, and techniques has generally been beneficial, some of these, however, have been mixed blessings.

High-speed Rotary Instruments

High-speed rotary instruments preclude the delicate dexterity required for fine sculpturing of tooth structure in the miniature surgery of operative dentistry and should not be the only instruments used in preparing cavities. High speed, if not used with care, may also damage odontoblasts and dentin and fracture enamel.

Rubber-base Impression Materials

Newer materials allowed impressions to be made of cavities with undercuts and invited technicians to correct defects by blocking out dies and overly reducing the internal aspects of the casting by abrasion. The student lost an important opportunity to evaluate the cast and the die because a technician was gaining this experience.

Preparation of Ultraconservative Cavities

A few years ago emphasis was placed on preparation of ultraconservative cavities. In some instances criticism from committees of accreditation was based on the criterion of minimal dimensions of preparations. Ultraconservative preparations sometimes had little relationship to the extent of caries, unsupported enamel often being retained in the name of conservatism.

De-emphasis of Proper Instrumentation

The use of hand instruments is the hallmark of the master operative dentist. He re-

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spects dentin and gives it gentle care. He realizes that the loose prisms of enamel, usually fragmented like bits of chipped glass, must be removed gingerly. Hand instruments give the quality necessary for an acceptably prepared cavity.

Overemphasis of Cosmetic Dentistry

Much healthy and useful tooth structure has been sacrificed on the altar of cosmetic dentistry. The convenience and speed in "coning" a tooth for a ceramic tombstone, as well as the chance for financial gain, have contributed to early loss of teeth and in some instances the dentition. Reasonable instruction coupled with skill in performing operative dentistry would, as it has in the past, prolong the life of a tooth and subsequently the dentition.

LICENSING BOARDS

A study of the records and critiques of licensing boards shows some interesting findings about operative dentistry. Failures are predicated on inadequate instruction and very little compliance with the fundamentals. The reasons for failing the examination in operative dentistry are similar nationwide:

- poor preparation of cavities
- overcarved preparations
- incomplete removal of caries
- rough cavities from overuse of high-speed rotary instruments
- poor protection of pulp
- covering an exposure
- improper use of rubber dam and rubber dam napkin
- improper use of instruments
- poor arrangement of instruments
- injury to adjacent tooth
- treating the wrong tooth
- poor diagnosis and selection of test case (some boards rate this as 50% of the examination)
- lack of professional approach

In some states repeated failure necessitates retraining. Others require qualifying for the clinical examination by passing a test on a dentoform. Demonstrated expertise in operative dentistry is still the important means for evaluating the qualifications of dentists for practice, because the principles of operative dentistry form the sound foundation for the practice of general dentistry and for the other disciplines as well.

INFLUENCES OF THIRD PARTIES

Procedures in operative dentistry are individual treatments. Presently, powerful third parties that are not oriented dentally—unions, insurance companies, service corporations, and the government—set the theme of the "right" to dental care rather than individual responsibility. Furthermore, companies specializing in the management of businesses have long ago redirected dentistry to productivity for high income but not necessarily for services of quality.

THE IMPORTANCE OF OPERATIVE DENTISTRY

Operative dentistry is the most difficult and most exacting of dental disciplines. Its responsibilities are profound and wide. The general dentist is dedicated to preserving the natural tooth through maintenance and prevention. The general dentist analyzes and diagnoses the original problem, prescribes and implements the treatment, or refers the patient to a specialist. Even after treatment is complete, the general dentist maintains constant care. Operative dentistry is the only aspect of dentistry that must be performed in general practice. The important phases of original diagnosis, preparation of the cavity, completion of the restoration, maintenance, and prevention cannot be referred elsewhere.

Operative dentistry ties the whole of dentistry together neatly and constructively. Complying with its disciplined guidelines gives the newly graduated dentist a skill that he can readily sell and one with which he will be comfortable. The skills of the specialist are built on the knowledge of basics taught in operative dentistry. They form the foundation of an individual dentist's philosophy and pattern of practice—truly his professional style.

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Skill in operative dentistry is not magic but is based on repetitious practice, hard work, and a desire for achievement. Educators must carefully explain these needs as well as the philosophy on which the principles are based.

A new practice cannot be built on sophisticated dental treatment only, such as implants, occlusal rehabilitation, and full-mouth cosmetic dentistry. There are a limited number of patients who would acquiesce to these programs.

THE CHALLENGE

Performances of quality must once again be rekindled by discipline. The one-to-one relationship of dentist and patient—the heart and soul of a sound practice—must be reestablished.

Virtuosity in operative dentistry produces professional satisfaction and achievement. Those who possess the knowledge and skill of operative dentistry should promote it by sharing and demonstrating their knowledge and skill. We must teach virtuosity in operative dentistry to produce professional achievement and satisfaction, culminating in benefits for the patient. This task falls heavily on the shoulders of those who have slipped away from virtuosity in the past but now must promote it pertinaciously.

Therefore, we must demonstrate our respect for the ambition, energy, and talent of future practitioners of operative dentistry by maintaining the disciplines that were worthwhile in the era of genuine professionalism.

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*OPERATIVE DENTISTRY, 1981, **6**, 30–31.*

Hollenback Prize

The Hollenback Memorial Research Prize for 1981 has been won by Rafael Lee Bowen. The prize is given annually by the Academy of Operative Dentistry to recognize excellence in research that has contributed substantially to the advancement of operative dentistry.

One of the most impressive ways of affecting the practice of dentistry is by developing a dental material. Dr Bowen has centered his research on composite materials and the techniques for their use in restoring teeth.

In 1956 he began searching for an esthetic restorative material that would be insoluble, stable in color, shrink little during curing, and have a coefficient of thermal expansion close to that of teeth. He developed silanated silica as a filler that has appropriate translucency, a strong bond to the resin matrix, and a matching coefficient of thermal expansion.

His most important development may be the resin molecule, bis-GMA, which has a high molecular weight and shrinks much less during polymerization than does the previously used methylmethacrylate. Bis-GMA resin is used in preventive dentistry to seal pits and fissures, in orthodontics for bonding brackets to teeth without bands, and as a replacement for the silicate and unfilled resins once used for esthetic class 3 and class 5 restorations. This same bis-GMA resin is also used in industry.

Dr Bowen has also developed flexible disks for final polishing and accelerator-catalyst systems that are stable in color, has incorporated into composites radiopaque materials and microporous glass fillers that increase resistance to wear, and has devised coupling agents to promote adhesion of resin to dentin and enamel for better adaptation to walls of cavities and better marginal sealing. He holds ten patents on synthetic dental materials. At present he is making great progress in treating the surfaces of enamel and dentin and is also evaluating materials for biocompatibility.

Dr Bowen's research is a milestone in restorative dentistry because it has upgraded the quality of resin restorations and thus helps provide superior service to the dental population throughout the world. Calculations based on the relative serviceability and cost of silicate cement and composite restorations, the number placed, and the number of practicing dentists show an annual savings of 284 billion dollars to dental patients.

Dr Bowen is a native of Takoma Park, Maryland, where he attended elementary and high schools. After service in the US Army Medical Corps from 1944 to 1946 he attended Washington Missionary College in Takoma Park and then La Sierra College in Arlington, California. He began his dental career in private practice in San Diego after graduating from the University of Southern California Dental School in 1953.

He began as a so-called kitchen researcher but was frustrated by lack of equipment and funds. When he almost blew up his porch and house while working with epoxy he began to dream of a more suitable environment

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Drawing of Rafael Bowen by Michael Wheeler

for research and, encouraged by Dr Ralph Phillips, began work at the National Bureau of Standards in 1956. He was appointed associate director of the American Dental Association Research Unit at the bureau in January 1970.

While at the bureau he has taken a variety of extracurricular courses in chemistry, mathematics, statistics, radioactive isotopes, logic, human relations, psychology, and patent law, which indicates the broad background a person may need to achieve success in the very competitive world of inventions. It is highly unusual to find an individual who combines those fields into a workable concept or therapy. This he did with accompanying patience and humility.

Dr Bowen began early in his career to publish his findings. In the past 25 years of diligent work he has found time to author or coauthor 80 scientific publications and to lecture throughout the world.

He is a member of the International Association for Dental Research (IADR), the Federation Dentaire Internationale, and Sigma XI and is a fellow of the American College of Dentists.

Honors include an award from the Academy of Plastics Research in Dentistry for his outstanding research with polymers, a certificate of appreciation from the US Department of Commerce "for exemplary pioneering research in the synthesis and development of dental composite, direct filling, restorative materials," the Wilmer Souder Award from the Dental Materials Group of the IADR "for outstanding and meritorious dental research," and the Callahan Memorial Award from the Ohio Dental Association.

Dr Bowen is a student of the time and the very school where Dr Hollenback taught and worked. He is exceptional for his accomplishments already achieved as well as for continuing research. Beyond that, in Dr Paffenbarger's words, he is a fine citizen and a humble gentleman.

From the presentation by Anna T Hampel, Chairman, Research Committee, Academy of Operative Dentistry, February 1981.

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OPERATIVE DENTISTRY, 1981, 6, 32–33.

Ralph Werner Honored by Academy of Operative Dentistry

Drawing of Dr Werner by Michael Wheeler

The membership has asked me to present this plaque to Ralph Werner as a small token of our gratitude for his years of dedicated service to this academy. Ever since its official organization in 1972, and even earlier in the formative period, he has worked long and hard for the academy and its individual members, and we are all grateful for his efforts.

Through the efforts of Roger Tibbetts the logo of the academy has been converted into a three-dimensional mold and cast in brass by a Navy second class petty officer. The inscription reads:

RALPH J WERNER
Secretary-treasurer 1971-198-
In recognition and appreciation
for dedicating your life to the organization
and maintenance of our academy. You have
been the force that has kept us going
and on course. The academy thanks you.

You will notice that the inclusive dates are 1971 to 198-, with the last year not completed. We can fill that in later and will be happy to change that 8 to a 9 if he is willing to serve that long.

Thank you again, Ralph, for all you have done for all of us.

JULIAN J THOMAS, JR
Rear Admiral, Dental Corps
United States Navy

Ralph Werner is the first, and has been the only, secretary-treasurer of the Academy of Operative Dentistry. He is an able officer, has served the academy with distinction, and is most deserving of this tribute accorded him. With a deft hand, a steady eye, and a flair for organization he has guided the academy to its present position of pre-eminence

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in the dental community. He has brought to the position of secretary-treasurer a wealth of experience exemplified by his being past president of the American Academy of Gold Foil Operators, the Minnesota Dental Alumni Association, the Minnesota Century Club, the North West District Dental Society of Wisconsin, and the Minnesota Prosthodontic Society. His acknowledged acumen in business affairs has kept the academy financially sound and the personal attention he gives to all the details assures the members that the activities of the academy are in good hands.

Among his other duties Ralph is currently chairman of the Section of Operative Dentistry of the American Dental Association. In his "spare time" he enjoys traveling and likes nothing better than finding unusual and meaningful gifts for his many friends. Warm and friendly, thoughtful and kind, Ralph is indeed a precious asset to the Academy of Operative Dentistry.

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OPERATIVE DENTISTRY, 1981, ***6****, 34–35.*

EDITORIAL OPINION

Who's Up Front?

ROBERT J NELSEN

Editorial (May 1980) ***News & Views*** **(newsletter of the American College of Dentists), (8) 1-2.**

Because flying involves routine procedures, one could assume that a person could be trained to follow selected recipes and thereby perform many duties of an aircraft pilot. Such an assumption could lead some firms providing public air transportation to consider use of Expanded Function Flight Attendants—EFFA. This could lessen the workload of the highly paid professional pilot and reduce cost of public air transportation.

With federal support, flight attendants could be given special training which would indicate that an attendant could learn to maneuver an aircraft as well and often better than the average pilot in practice. Similar programs would show that satisfactory performance can be attained with minimum training in navigation, instrument flight and takeoff or landing procedure. Soon, book publishers would induce pilots who are instructors in flying schools to author textbooks for the use of EFFAs who will be eligible as paraprofessional pilots by virtue of changes in the laws governing the rights of EFFAs to fly planes. It will be comforting to know that the law might require the presence of a licensed pilot, or at least that he be somewhere in the aircraft available in case of an emergency requiring his special knowledge, skill and judgment, as in a sudden loss of power.

With eyes open, providers of air transportation would certainly perceive public reaction and would immediately reject the use of EFFAs. Furthermore, can you imagine professional pilots or the Airline and Pilots Association endorsing such an innovation? Certainly not; they know better. When the passenger buckles his seat belt, he has confidence that the professional up front can handle every situation. The professional pilot is in complete accord that the flight attendant is there to make airline performance most efficient and, further, that each passenger will be recognized as a person and made as comfortable as possible. He endorses her role as instructor in buckle-up and other self-care procedures of flying but his attitude is, "Keep

American College of Dentists, 7315 Wisconsin Avenue, Suite 352 N, Bethesda, MD 20014, USA

ROBERT J NELSEN, DDS, executive director, American College of Dentists

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your hands off the controls; I am in charge. I am flying the plane. If you want to fly the plane, become a pilot, start at the beginning, survive the qualifying requirements, get enough experience to be judged competent."

Recently, there have been published three textbooks, purported to meet the need for expanded function dental auxiliaries. Each text has excerpted from the scientific and clinical literature of the dental profession knowledge which is the property and province of the dental profession, not of its ancillary helpers. That these books would be offered as literature of auxiliaries implies that an auxiliary is now or will be capable of treating dental disease. Such inference, found in the prefaces, introductions and tables of contents, will bring mischief and disorder to the delivery patterns of professional oral health care and eventually distress to patients. When a patient sits in the dental chair, he surrenders his personal well-being to the care of a professional in the same manner as does a passenger in an airliner. In like manner, he may ask, "Who is the doctor? Who is about to make value judgments for me? Who is in charge of my welfare?" If he sees a substitute, he will become alarmed about being a consumer rather than a patient.

If dentistry wishes to continue as a profession, there better be a dentist beside that chair with the courage to say, "I am in charge. I have the superior knowledge, skills and judgment which you need. I profess to place your interests before my own. I am fully responsible and accountable to you. I am here at your side on that basis."

That is what makes dentistry a profession.

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DEPARTMENTS

Letters

We Have Met the Enemy

Once again I think you hit the nail right on the head in your recent editorial in *Operative Dentistry* ("We Have Met the Enemy," Vol 5, No 3), and once again I hope that your article is widely read.

As a prosthodontist, I have long been annoyed with and jealous of the time I have had to spend on various committees trying to figure ways to hold back the denturists' movement and for that matter the movement of other illegal practitioners; for I too have felt that the "enemy is us."

If all dentists were doing their jobs, there would be no need for denturists or any other illegal practitioners and the movement would be quickly terminated. However, as long as dentists allow technicians to design their cases, do all the fabricating of their cases, send patients to laboratories for shades, and do many other things that the dentist should do, the movement will continue regardless of our efforts.

I think you put it beautifully in your editorial, and again, I hope it is widely read.

WILLIAM H PRUDEN II, DDS
Fairleigh Dickinson University
School of Dentistry
Department of Prosthodontics
Hackensack, NJ 07601

Product Reports

I am writing this letter to let you know that I enjoy very much your journal *Operative Dentistry* and also to state that I agree very much with the letter by Dr Benjamin Magier of Oak Park, MI in your Summer 1980 issue (Vol 5, No 3). He would prefer to have Product Reports published in *Operative Dentistry* alone rather than in both it and *General Dentistry.*

As a general dentist, amalgam restorations are our "bread and butter"; consequently I especially enjoyed the article on "Clinical Performance of Amalgams with High Content of Copper" by Dr K F Leinfelder, as well as similar articles in the past by Dr Eames. I would be very interested in seeing a similar article done on the high-copper amalgams that are produced by the various mail order catalogs (Darby, Schein, etc), especially since these mail-order, high-copper alloys usually have a more "attractive price"; but I really don't have the slightest idea if these so-called high-copper alloys are worth a plugged nickel (pardon the pun).

HUNTER V POPE, DMD
2220 Old Springville Road
Birmingham, AL 35215

Dear Woody

Question from Summer 1980 Issue

Frequently, when taking a hydrocolloid impression, I observe tears in the hydrocolloid at the margin of the cavity preparation and into the gingival crevice. What can I do, short of changing impression material, to prevent these tears?

Answers

In answer to the question regarding tears in hydrocolloid impressions, I can offer the following suggestions:

1. The tray material may not have been tempered long enough. The syringe material should be very fluid and the tray material **very** stiff. In a properly taken impression the syringe material is all but completely dis-

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placed leaving a much stronger material at the marginal area.

2. The prepared tooth (teeth) may be a great deal out of parallel with other teeth in the mouth, as for example in cases with facially inclined upper anterior teeth. In this situation the impression may not be withdrawn from the mouth parallel to the long axis of the prepared teeth, resulting in tears. The solution is to "force" the impression out of the mouth parallel to the long axis of the preparations and if tears occur, let them occur on the unprepared teeth.

3. There are many reasons to avoid long thin bevels and excessive entry into the sulcus. One of these is that the marginal area is impressed with syringe material and because of the lack of bulk it is all the weaker. The best preparations are those with a definite shoulder and a very short bevel of about 45-60 degrees and with minimal entry into the sulcus. Where excessive entry into the sulcus is necessary and there is no way to provide the bulk achieved with a shoulder, excision of this undesirable tissue should be considered.

ALVIN J FILLASTRE, DDS
3855 South Florida Avenue
Lakeland, FL 33803

With reference to hydrocolloid tearing at the margin and the gingival crevice, may I offer these clinical observations.

Provided one is using a good brand of hydrocolloid and provided the material is used properly, the tear seems to occur because the hydrocolloid adheres to soft tissue tabs. These tabs usually happen when the operator nicks the tissue during preparation or nicks it during retraction. Either or both of these undesirable conditions can occur occasionally to the most careful operators.

To prevent the hydrocolloid tear the operator can:

1. Use the wet impression technique: place warm water in the crevice just before taking the impression and after removing the retraction cord.

2. Moisten the crevice and margin with die lubricant (Kerr's Microfilm). This is best accomplished with a soft brush wetted with lubricant and passed around the crevice just before taking the impression and after removing the retraction cord. It is the surest method.

FRANCIS R ABADIE, DDS
940 Maison Blanche Building
New Orleans, LA 70112

I am writing this with the hope of offering information on the question of tears in impressions of hydrocolloid.

I have had considerable experience with reversible hydrocolloid and have published an article about it (Lampert, S H [1970] Combined electrosurgery and gingival retraction. *Journal of Prosthetic Dentistry,* **23,** 164-172). I use Van R Regular FlexSkins and Cartriloids and no lubricants. The teeth are dried prior to injecting the syringe material. The retraction is accomplished with Van R Gingibraid #3.

One of the causes for tearing of reversible hydrocolloid is carrying the preparation too deeply into the gingival sulcus. Assuming one has a normal sulcus, the finishing line is extended no more than one millimeter into the sulcus. On occasion because of caries it may extend deeper. If the excess tissue above the finishing line is eliminated by electrosurgery there is no free tissue to tear the hycrocolloid.

With the hope of not sounding immodest, I would like to say that my results have been excellent and while I do retake impressions on occasion my success rate has been quite high.

S HENRY LAMPERT, DDS
48 Main Street
Essex Junction, VT 05450

In my hands, the most common problems concerning tearing of hydrocolloid impression material seem to be related to three areas: desiccated tissues, inadequate space for impression material or a path of removal that exceeds the tensile strength of the material.

Desiccated tissues will adhere to set hydrocolloid material. Removal of dried retraction cotton without first wetting it wounds the

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sulcular epithelium. Both problems are solved by liberally wetting the tooth and retraction cotton with water or releasing spray prior to the impression.

Space for impression material and path of insertion are intimately related problems and are as important in tooth preparation as occlusal reduction. Once a margin is within the gingival sulcus, a decision needs to be made about the ideal tooth contours necessary for optimal health of the tooth. Many times creative preparation of margins allows prosthetic changes in tooth contour that enhance comfort, function, and resistance to disease. Aggressive beveling of margins creates more space for impression material as well as a less acute undercut just past the margin. If aggressive beveling of margins is not indicated, space must be created by displacing or removing gingiva. Firm, healthy tissue can be displaced by packing cotton in the traditional manner. Diseased, inflamed tissue (or even floppy normal tissue) can be removed by rotary, chemical, or electrosurgical curettage. This increases space for the impression material and lessens the risk of trapping a flabby gingival margin during cementation.

The keys here are:

1. Make the impression in a moist to wet field.
2. Prepare the tooth and sulcus to give adequate strength and a path for removal of the impression material.

STEVEN N GREEN, DDS
8740 North Kendall Drive
Miami, FL 33176

New Question

There have been several reports published concerning materials and techniques for repairing fractured porcelain on porcelain to metal crowns. Is there a truly effective repair material and technique?

Editor's note: Any reader with an answer to this question—or with another question—is asked to communicate as soon as possible with Dr Nelson W Rupp, National Bureau of Standards, Dental Research Section, Washington, DC 20234.

Book Reviews

OUTLINE OF TEMPOROMANDIBULAR JOINT DIAGNOSIS AND TREATMENT

by William B Farrar and William L McCarty, Jr

Published by the Normandie Study Group, Montgomery, Alabama, 1980. Spiralbound. 86 pages. Illustrated. $20.00

TEMPOROMANDIBULAR JOINT PROBLEMS

by William K Solberg and Glenn T Clark

Published by Quintessence Publishing Co, Chicago, 1980. 178 pages. Illustrated and indexed. $39.00

Two recent books about temporomandibular joint (TMJ) problems acquaint the clinician with current thinking on a topic of burgeoning interest. Farrar and McCarty's book is the sixth edition of a spiralbound workbook they have provided participants in their popular courses. It presents in somewhat cookbook fashion the authors' concepts of how TMJ problems occur and what methods they use in treating them. Dr Farrar, who wrote most of the text, began studying the TMJ more than twenty years ago and has gained considerable renown for his knowledge of internal derangements of the joint. In a field fraught with divergent views, Farrar's ideas are accepted in most quarters and that alone gives the book a certain legitimacy.

Dr McCarty has distinguished himself in the development of TMJ surgical and arthrographic techniques and he writes a "how-to" section in this book for would-be TMJ surgeons. The rest of the manual outlines types and causes of TMJ derangement and dysfunction, how to recognize and diagnose them, and several methods of treatment. Although the pages are typewritten and were not proofread thoroughly enough to filter a number of typographical and grammatical errors, the wealth of useful information justi-

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fies putting this book on the desk of any dentist seeking to treat or understand TMJ problems.

An international symposium on TMJ disorders held in 1979 provided the basis for the book by Solberg and Clark. The handsome hardbound volume is a verbatim account of the lectures and subsequent discussions presented at the symposium by eight authorities on TMJ anatomy and physiology. Photographs and illustrations used at the meeting are nicely reproduced. Treated are diagnosis and classification of disorders, TMJ function and dysfunction, TMJ radiology and arthrography, and occlusion and surgery of the TMJ. Other topics such as neuromuscular and kinesiological theories are not included.

Reading the book is much like being at the symposium itself. I had to shift the gears in my mind each time a new speaker brought his own particular style of lecturing to the podium. It is good fare, however, for the serious student of the temporomandibular joint seeking the up-to-date thinking of experts from around the world. A thorough index adds to the usefulness of this volume although the book is not a manual of technique in the sense of the Farrar-McCarty workbook. If future symposia are documented in the same manner, and if they treat other aspects of TMJ, the cumulative volumes could well become an encyclopedia of the temporomandibular joint.

KENNETH G JOHNSEN, DDS
Kent, Washington

Announcements

AWARDS

Eames Honored by Hinman

The 1981 Thomas P Hinman Distinguished Service Award was given to Dr Wilmer B Eames on 24 March 1981 at the annual Hinman meeting in Atlanta, Georgia. Dr Eames, who developed the standardized technique for mixing mercury and alloy in a proper ratio that is now used throughout the world, is the twelfth person to receive the coveted award in its 69-year history.

Roberta Merryman Wins Golden Pencil

Roberta Merryman, our editorial assistant, also assists the Pacific Coast Society of Orthodontists in publishing the *PCSO Bulletin* and has won for that publication a Golden Pencil Award, Division II, in the competition for journalism sponsored by the International College of Dentists. The award is for the creative and effective use of illustrations or other graphic arts. Roberta designed an eight-page report on the PCSO annual meeting that consisted of line art, photographs, and handwritten messages on notepaper.

Roberta Merryman

Faculty Advisor Award to Eames

Dr Wilmer B Eames, professor emeritus at Emory University School of Dentistry, has received the 1980 Faculty Advisor Award presented by the Alumni Association of Student

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Clinicians—American Dental Association (SCADA), comprised of former participants in national student table clinics in the US, Canada, and the United Kingdom. The award recognizes outstanding service by individuals responsible for spring table clinics at their dental schools. Dr Eames was cited for his long years of superior service to the table clinic program at Emory and his innovative and creative ideas, which made him a constant source of guidance and support for the students.

NOTICE OF AWARDS TO BE GIVEN

Nominations Invited for Hollenback Prize

Nominations of candidates for the Hollenback Memorial Prize are invited by the Academy of Operative Dentistry. The prize is given annually for research and accomplishments that have contributed substantially to the advancement of operative dentistry. The research may be either fundamental or applied and may deal with prevention of dental disease or its treatment. There are no geographic or occupational limits on eligibility for the prize.

Names of nominees and particulars of their research (including a curriculum vitae and support letters from two members of the academy) may be sent to Dr Anna T Hampel, Chairman of the Research Committee, Academy of Operative Dentistry, University of Minnesota, Minneapolis, MN 55455.

Nominations should be submitted by 15 July 1981.

Achievement Award for Students

The Academy of Operative Dentistry will recognize outstanding achievement among dental students through an award for a table clinic. The awardee is to be selected from the Student Table Clinic Program at the annual meeting of the American Dental Association. The award consists of a certificate, $200, and a place on the table clinic program at the annual meeting of the academy in Chicago. Travel and expenses for the Chicago meeting will be paid by the academy.

NEWS OF THE ACADEMIES

Academy of Operative Dentistry

The tenth annual meeting of the Academy of Operative Dentistry was held 12 and 13 February 1981 in Chicago at the Hyatt Regency Hotel. The program consisted of essays, table clinics, and limited attendance clinics.

At lunch on the first day the Hollenback Memorial Prize was presented to Rafael L Bowen. A special feature this year was the honoring of Ralph J Werner, the secretary-treasurer, for his prodigious service to the academy. Ralph was presented with a plaque of the logo of the academy cast in bronze.

Officers elected for 1981 are: president, Harold R Laswell; president-elect, Paul H Loflin; vice-president, Robert L Kinzer; secretary-treasurer, Ralph J Werner; assistant-secretary, Gregory E Smith; and councilors, Norman C Ferguson, William N Gagnon, Lawrence L Clark, Frank K Eggleston, R Craig Bridgeman, and William N von der Lehr.

Outgoing President Dick Tucker addresses the meeting.

NOTICE OF MEETINGS

American Academy of Gold Foil Operators
Annual Meeting: 21-23 October 1981
University of Oklahoma
Oklahoma City, Oklahoma

Academy of Operative Dentistry
Annual Meeting: 18 and 19 February 1982
Hyatt Regency Hotel
Chicago, Illinois

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INSTRUCTIONS TO CONTRIBUTORS

Correspondence

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

Exclusive Publication

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

Manuscripts

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

Tables

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

Illustrations

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

References

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

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