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Aim and Scope

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

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Editorial Office

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EDITORIAL

A Plea for Comprehensiveness in Dental Research

Dental practitioners are helped greatly by published reports of scientific research. This is true especially of the testing of materials and the evaluation of techniques. Although a practicing dentist may be able, in a relatively short time, to determine for himself whether or not a particular material or technique is performing satisfactorily, often several years may elapse before deficiencies become evident. Then begins the painful process of replacing restorations—a costly procedure for both dentist and patient.

The introduction of new materials and techniques provides a welcome challenge for researchers. Frequently several laboratories begin simultaneously, though perhaps with different methods, to investigate the same problem. Not unnaturally there is a desire to be the first to report results. Sometimes haste overshadows thoroughness and results are reported that later are contradicted by more careful studies. This does little to help the clinician, who is now confused by the conflicting results.

In other instances a number of materials designed for the same purpose, silver alloys for example, may be compared for a single property, which may be only one of several that are significant for the success of the material. This information of itself is not of much use to the practitioner, who must wait until the evaluations of the other properties have been completed and published. Unfortunately the information is now fragmented and requires the reader to search back through the literature—if he can find all the articles—to obtain the information he needs to decide which material or technique to use. Conversely, all the appropriate tests of all the significant properties of a material may be undertaken but only two out of ten brands analyzed. In this instance, though it may be possible to determine which material is better, one is left with the nagging thought that one of the materials not tested may be the best.

This a plea for more comprehensiveness and greater thoroughness in dental research and publication. Undoubtedly this would require more time and effort for each project but reliable information—the only useful kind—still comes slowly.

A IAN HAMILTON

OPERATIVE DENTISTRY, 1977, 2, 130-142.

ORIGINAL ARTICLE

A New Method of Bonding Dental Cements and Porcelain to Metal Surfaces

Failure of restorations occurs at the cement bond. Attachment to tooth surfaces has received increasing attention but the metal or porcelain interface has been comparatively neglected. Both interfaces are equally vital if microleakage is to be overcome.

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Summary

A new method has been evolved for bonding polyacrylic acid-based cements to gold alloys or pure platinum by coating the metal surfaces with 0.2–2 μm of tin. Tin oxide coatings will also facilitate the bonding of dental porcelain to precious metals allowing the use of thin platinum foils in place of cast metal copings for the metal-ceramic crown. The physicochemical bonding of cements to these restorations can result in improved resistance to microleakage at the margins.

THE BONDING OF DENTAL CEMENTS TO METAL AND TOOTH SUBSTRATES

The permanence of the marginal seal of cast metal restorations or porcelain crowns depends upon the integrity of the cement margin. Clearly the better the fit of the restoration, the greater the chance of success. However, even the best restorations cannot be made to fit within an accuracy of much less than 20 μm (McLean & Fraunhofer, 1971).

In recent years great attention has been paid to achieving a true physicochemical bond between cements and tooth structure but very little work has been done to improve the bond between the cement and the restoration.

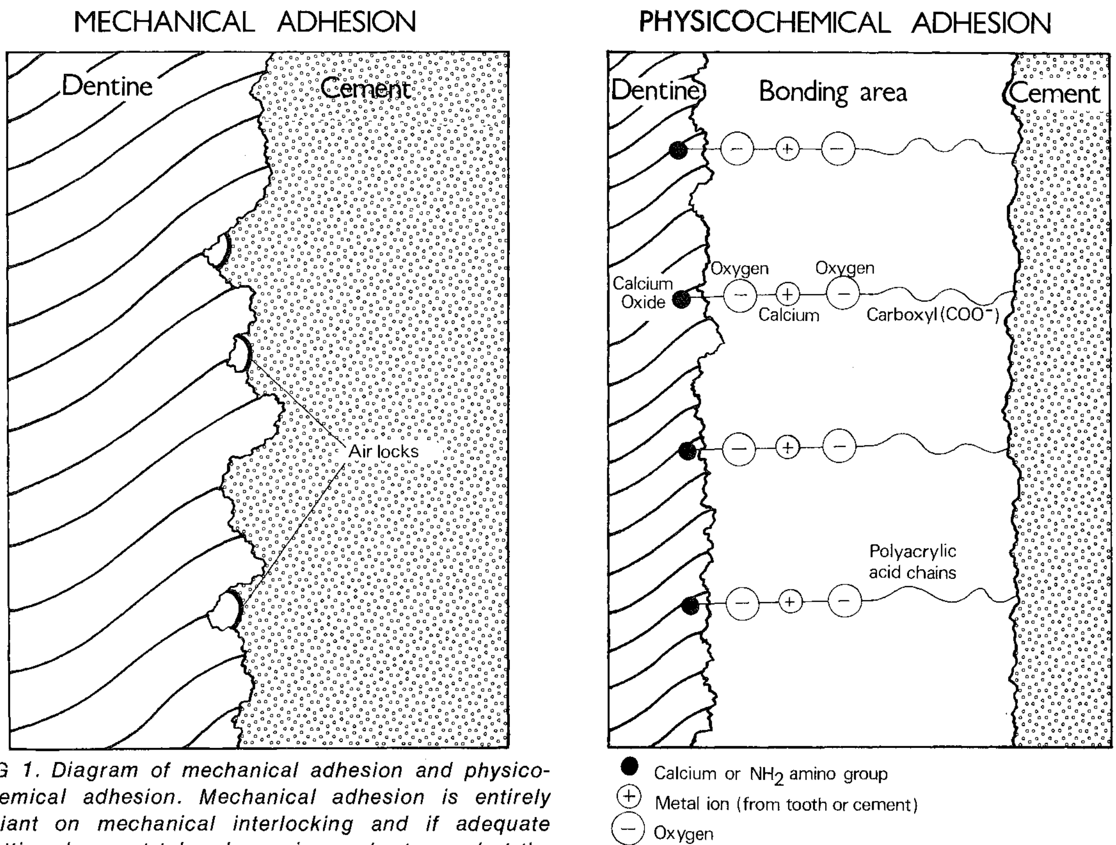

FIG 1. Diagram of mechanical adhesion and physicochemical adhesion. Mechanical adhesion is entirely reliant on mechanical interlocking and if adequate wetting does not take place, air may be trapped at the interface and reduce the area for attachment. Good wetting is also necessary to obtain physicochemical adhesion.

Failure at the metal or porcelain interface can be just as disastrous as failure at the tooth interface so that to achieve durable results both interfaces must offer sites for attachment of dental cement.

Phosphate-bonded cements rely on mechanical interlocking for their retention. However, the introduction of polycarboxylate cements by Smith (1968) has brought a major advance towards securing true adhesive attachment by molecular bonding to tooth surfaces. More recently, Wilson and Kent (1971) have developed the glass-ionomer cements with similar adhesive properties. Initially, when these cements are in a fluid condition, there are many free pendant COOH groups available in the polyacid for the formation of hydrogen bonds, which improve the wettability on active surfaces. Good wetting is a prerequisite for adhesive attachment. As the reaction of the cement proceeds, the hydrogen bridges are progressively replaced by metal bridges, the metal ions coming from the cement or the tooth surface or both, thus providing a more rigid and permanent attachment. The difference between mechanical adhesion and true physicochemical adhesion is shown in Fig. 1 where in the latter the essential bond is the ionic one between oxygen anions and metal cations. At the interface of cement and dentine, oxygen anions at the surface of the dentine and those contained in the polyacid cement are ionically linked by, most probably, Ca^{2+} ions. In restorations of cast gold alloy, the availability of oxygen anions is very limited. However, as will be shown, by tin-plating the gold a surface of tin oxide becomes available, providing oxygen anions which are ionically linked to those contained in the cement matrix by Sn^{2+} ions available from the tin plate.

Table 1

Mechanical Properties of Luting Cements

	Glass-Ionomer Aspa IV A	Silicophosphate	Zinc Carboxylate	Zinc Phosphate	ZOE	EBA
Compressive Strength (N/mm^2, 1 day)	128	153	79	83	39.4	91
Tensile Strength (N/mm^2, 1 day)	8.2	9.3	12.5	4.9	4.0	7.6
Creep Resistance 1 day	1.50	—	5.02	—	—	—
Change of stress (N/mm^2) per unit change of log time 25 days	0.06		2.92			

Adapted from Wilson & *others* (1977), and Paddon & Wilson, *Journal of Dentistry* (1976), **4**, 183–189.

Selection of Cements

Before describing the method of tin-plating precious metals to obtain bonding to cements and porcelain, it is essential to evaluate the cements suitable for this technique. The mechanical properties of all types of luting cement are given in Table 1.

Although zinc phosphate and silicophosphate cements possess many ideal properties for luting purposes, they do not provide polar surfaces for physicochemical bonding to tooth or metal surfaces. Likewise, ZOE and EBA cements form no chemical bonds to tooth structure. All these cements rely on so-called mechanical adhesion for their retention. Despite this lack of true adhesion, zinc phosphate cements are still very widely used and where the retention form of the casting is minimal, they often remain the material of choice. However, to obtain physicochemical bonding to tooth and metal substrates, it is essential to use cements that make polar groups available for molecular interaction. At the present time, only the carboxylate and glass-ionomer cements fall into this category and the latter, only just becoming available commercially, still require further clinical evaluation.

However, certain features in the experimental glass-ionomer cement Aspa IV A reported by Wilson and others (1977) make it attractive for future development. The useful properties of this cement may be summarized as follows:

1. Low film thickness with a consistency comparable to zinc phosphate
2. High compression and tensile strength
3. Greater resistance to creep than the carboxylate cements
4. Biological compatibility similar to the carboxylate cements
5. Fluoride leach provides the means for some cariostatic action
6. Better resistance to acid attack than phosphate-bonded cements
7. Translucency for cementation of porcelain work or for lining visible cusp areas
8. When set, the calcium polyacrylate matrix forms a stiff gel which allows the cement to be easily removed from the margins by light probing or with floss silk
9. Final set is rock-hard like a silicate due to the formation of the aluminum polyacrylate matrix
10. The cement makes polar groups readily available for physicochemical bonding

Until further work has been completed on the glass-ionomer luting cements, the dentist is advised to use a modern carboxylate cement for bonding to tin-plated surfaces. The zinc carboxylate cements have been considerably improved in strength in recent years by the addition of up to 10% stannous fluoride to the zinc oxide powder so that they are now more suitable for cementation of bridgework.

Bonding to Metal

Any precious metal may be prepared for bonding to carboxylate or glass-ionomer cements by tin-plating the fit surface. Onlays, post crowns and gold cores, full veneer crowns, precious metal-ceramic crowns, and aluminous porcelain crowns bonded to platinum are all suitable for this technique.

METHOD

For purposes of illustration, the preparation of an MOD onlay will be shown.

The onlay is waxed, cast, and fitted to the die by standard technique. Final polishing is carried out and the onlay checked for fit on the die (Fig. 2).

The non-fit surface is covered with wax, but care is taken to avoid the edges (Fig. 3). The wax will prevent any tin from being deposited in the fissures where it is difficult to remove.

Cleaning the Casting

An electroplating machine, the Ceramiplater (Vita Zahnfabrik, Säckingen, West Germany), has been designed for degreasing and plating metal surfaces for the attachment of porcelain and cement (McLean, Kedge & Hubbard, 1976). The unit, when set on auto, consists of timed circuits for cleaning and plating precious metals. The power supply is stabilized to be independent of mains fluctuations thus minimizing ripple current, and the supply output has been protected against short circuits, thus ensuring that the optimum thickness of tin plate is delivered. Research has shown that the optimum thickness of tin plate for porcelain bonding should lie within the range 0.2–2 μm (McLean & Sced, 1976) and that this thickness is also suitable for cement bonding (McLean & *others*, 1976; Hotz & *others*, 1977).

Cleaning is carried out by attaching the onlay to a special holding clip (Fig. 4) and then immersing it in a stainless steel beaker con-

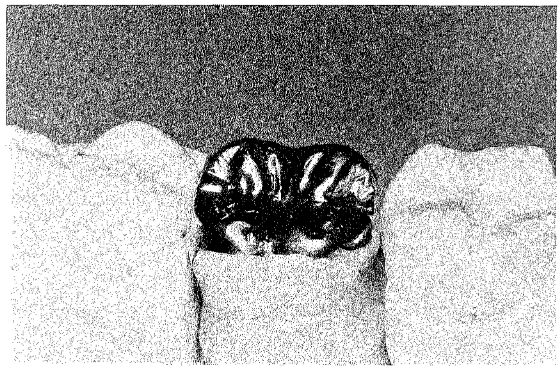

FIG. 2. Onlay fitted on die prior to tin-plating

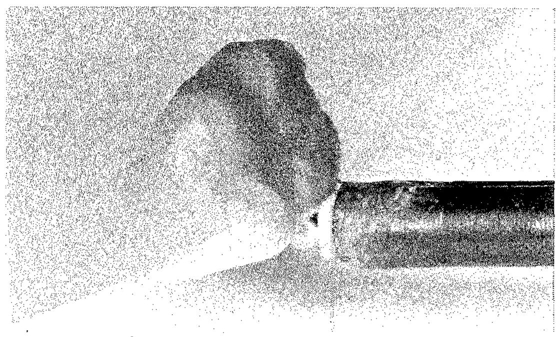

FIG. 3. Occlusal and proximal surfaces of onlay waxed out to prevent tin plate encroaching on areas difficult to polish

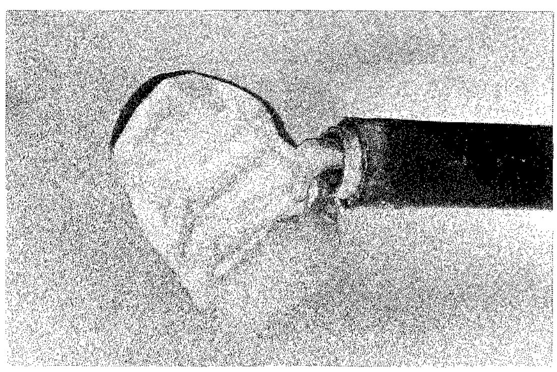

FIG. 4. Onlay attached to holding clip prior to cleaning and plating

taining caustic soda. Once the start button of the timer has been pressed on the machine, a current setting of 500 mA is used to degrease the onlay. This will be seen by the effervescence from the bombardment of hydrogen ions. At one minute, the machine automatically switches off. The onlay should then be washed in water and placed in a solution of citric acid for a few seconds to neutralize the soda and again washed in water.

Tin-plating the Onlay

A solution of acid sulphate is supplied with the Ceramiplater for tin-plating. Plating is done by attaching the plating wire (red) to the tin anode contained in the beaker of electrolyte (stannous sulphate). The onlay is attached to the holder clip and lowered into the beaker. Tin-plating is carried out for one minute at a current setting of 50 mA, the onlay being agitated as it effervesces. The machine will automatically switch off at the end of plating and the onlay may then be washed in water.

Once plating has ceased, do not contaminate the fit surface. A perfect bond will be achieved only if the tin remains undisturbed. The wax on the non-fit surface may be removed with boiling water or an ultrasonic cleaner (Fig. 5).

Bonding to Type III Cast Gold Alloys

Originally, when this work began, the tin plate was alloyed and oxidized on the gold at 800 °C. However, subsequent work has shown this procedure to be unnecessary because the pure tin surface will oxidize sufficiently to give a good bond to the glass-ionomer cement. This has been confirmed by analysis of the surface coating, which indicates a cohesive failure within the cement at the interface of tin oxide and platinum. The scanning electron micrograph (Fig. 6) illustrates the bonding of Aspa IV A to a surface of Type III gold casting alloy that has been sandblasted (30 μm Al_2O_3) but not

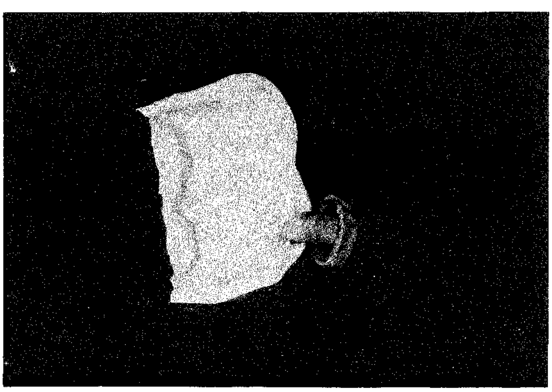

FIG. 5. Tin-plated fit surface of onlay after removal of wax and prior to cementation

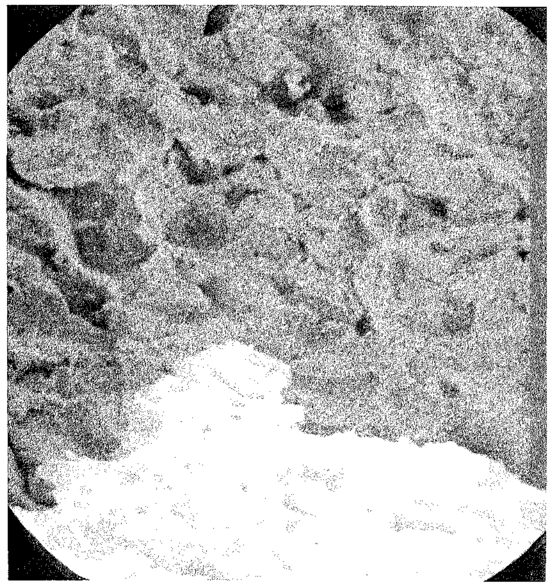

FIG. 6. Broken surface of Aspa IV A cemented to Type III cast gold alloy. Only one large piece of Aspa is held by mechanical retention. Original magnification X 1600.

FIG. 7. Broken surface of Aspa IV A cemented to a tin-plated Type III cast gold alloy. Entire surface above the large piece of Aspa is covered with a thin film of Aspa which is ionically bonded to the tin oxide surface. Original magnification X 1600.

Table 2

Bond Strengths of Tin-oxide Coated Metals against Polyacid Cements and Dental Porcelain

Adherand	Substrate	Treatment	Bond Strength N/mm²	Standard Deviation
Aspa IV A	Dentine	50% citric acid cleaner	2.92	0.90
Aspa IV A	Pure platinum	Sandblasted	0.07	0.11
Aspa IV A	Tinned platinum	Electroplated tin	2.43	2.72
Aspa IV A	Gold alloy	Sandblasted	0.05	0.10
Aspa IV A	Tinned gold alloy	Electroplated tin	4.32	0.29
Durelon	Tinned gold alloy	Electroplated tin	5.53	1.31
Aluminous Porcelain Vita-Pt	Pure platinum	Sandblasted	15.8	—
Aluminous Porcelain Vita-Pt	Tinned platinum	Electroplated tin	53.0	

Adapted from Hotz & *others* (1977) and McLean & Sced (1976).

plated. This shows only very limited attachment of cement to a nonplated surface of gold alloy. By comparison the attachment to a tin-plated surface is of a very high order (Fig. 7). The bond strength of these cements is given in Table 2.

Bonding to Precious Metal Ceramic Alloys

Preliminary work has also shown that tin-plating of a precious metal ceramic crown can also improve bonding of the polyacrylic acid cements. The bonding of the polycarboxylate cement Durelon (Premier Dental Products Co., Morristown, PA 19401, USA) to a gold/platinum based ceramic alloy is illustrated in Figures 8 and 9 where it may be seen that a cohesive fracture has occurred in the polycarboxylate cement which has remained firmly bonded to the tin oxide surface. Plating of the metal/ceramic restoration must be done after the porcelain has been baked and after any exposed non-fit metal surface has been polished.

Preparation of Tooth

The preparation of the onlay for polar bonding to cements based on polyacrylic acid is a simple procedure and can be done under completely controlled conditions. The preparation of the tooth substrate, however, is a very different proposition.

Prepared surfaces of teeth are always covered with a layer of grinding debris probably composed of particles whose size ranges from less than 1 μm to more than 15 μm (Eick & *others*, 1970). This debris can consist of both organic and inorganic material. In addition, the surface can be contaminated with saliva, blood, or even remnants of the temporary filling. Grinding debris will invariably contain micro-organisms, which may remain during cementation (Brännström & Nyborg, 1974).

The cleaning of tooth surfaces does present a considerable problem. There is little doubt that if they are etched with acid, all grinding debris can be removed, but such a procedure free of contamination by saliva or serumal seepage. Rubber dam should be used whenever any doubt exists on salivary control.

Preparation of Glass-ionomer or Carboxylate Cements

1. All mixing should be done on a refrigerated glass slab to prolong working time. *N.B.* Polyacrylic acid liquids must not be stored in a refrigerator since reduced temperatures increase the risk of the liquid turning to gel.

2. The liquid should be dispensed in a syringe, when available; alternatively, special laboratory syringes can be purchased for this purpose. A measuring scoop should be used for the powder.

3. The ideal powder/liquid ratio for the glass-ionomer cement Aspa IV A when used on a refrigerated slab is 1.67 g/ml but this must be reduced to 1.5 g/ml if a room temperature mix is used. The powder/liquid ratios of the carboxylate cements generally range around 1.5 g/ml. Exposure of the dispensed liquid for longer than 60 s can result in loss of water by evaporation and concentration of the liquid will produce a more viscous material.

4. Tooth surfaces should not be dehydrated prior to applying cement. Excessive drying can concentrate any protein debris and prevent efficient wetting of the tooth.

5. The mixed cement should be applied evenly to the surfaces of both restoration and tooth. In the case of the full crown, air bubbles must not be left trapped in the incisal region. After the restoration has been seated, it is vital to protect the margins for at least five minutes from salivary contamination as the cements based on polyacrylic acid are hydrophilic and can easily be diluted and weakened by water.

6. On completion of set, which may vary between 6 and 8 min from start of mix, the onlay margins may be lightly finished with sintered diamond stones, or tungsten stones, or finishing burs. Final polishing with rubber cups or brushes, using prophylactic paste followed by a fine slurry of zinc oxide will complete the finish. After burnishing of the edges it is recommended that they be sealed with two coats of a copal-ether varnish to protect the cement during its final stages of set. The finished onlay is shown in Fig. 12.

Providing all the above steps have been followed, a good adhesive bond between the gold

FIG. 12. Onlay cemented into tooth with Aspa IV A glass-ionomer cement

onlay and the tooth will be achieved. As shown in Table 2, for Aspa IV A and Durelon carboxylate cement, bond strengths to gold of 4.32 N/mm^2 and 5.53 N/mm^2 respectively have been achieved (Hotz & *others*, 1977).

THE BONDING OF DENTAL PORCELAIN TO PLATINUM WITH TIN OXIDE COATINGS

Dental porcelain has a high resistance to compressive stresses but its tensile strength is low (McLean, 1974). Porcelain jacket crowns fracture because of the deepening of microcracks on the fit surface (McLean & Sced, 1976) produced by tensile stresses developing in the cervical third of the crown (McLean, 1976). The most unfavorable site for high stress in this region is in the proximal areas (Derand, 1974) and if planes of weakness are present in the facial and lingual proximal areas, early fracture of the crown may occur (Fig. 13). The

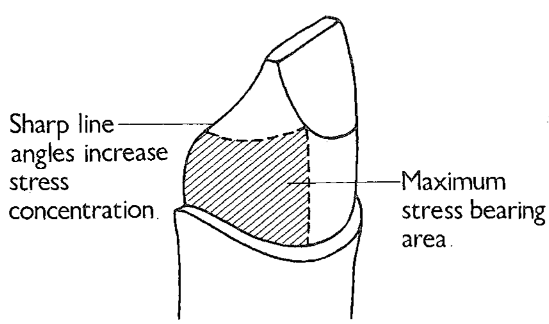

FIG. 13. Diagram of maximum stress-bearing areas in a porcelain jacket crown preparation.

optimum types of preparation to resist fracture have been described (McLean, 1976). The preparation must have adequate width and length to support the crown. Shoulders should be at right angles to the axial walls and not less than 1.0 mm wide on the labial and lingual. The lingual surface should be concave and all internal line and point angles slightly rounded to reduce stress.

Unfortunately, despite all the above precautions, porcelain jackets can still fracture in service. In particular this occurs where thin sections of less than 1.0 mm have to be used in adolescent teeth. Recent work has shown that by tin-plating platinum foil with approximately 2 μm of tin and then alloying and oxidizing it at 1000 °C to the platinum surface, aluminous porcelain can be bonded chemically to this surface (McLean & Sced, 1976). This platinum lined surface largely eliminates any microcracks and can increase the strength of jacket crowns of aluminous porcelain by up to 80% (Sced, McLean & Hotz, 1977).

A detailed technique for constructing a bonded alumina crown has been described (McLean & *others,* 1976; 1977) and only recent advances in technology will be discussed here.

Here the outer bonded foil (0.025 mm) is first sandblasted with 30 μm aluminum oxide grit, then cleaned, and tin-plated as described earlier in this paper. The crown is constructed using an inner foil (unplated) covered by the outer bonded foil (Fig. 14). After the aluminous porcelain crown has been baked the inner unplated foil is stripped out and the tin-plated foil left attached to the inner surface of the crown. It is this foil that acts as an inner skin, sealing off any potential microcracks that might develop and preventing delayed fracture of the crown due to occlusal stresses in service.

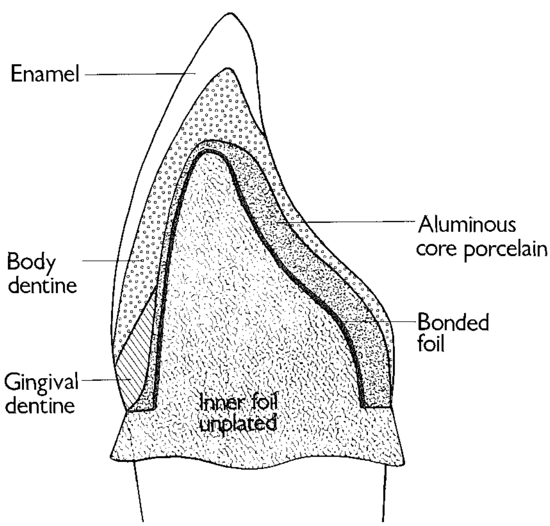

FIG. 14. Diagram of the platinum-bonded alumina crown showing optimum position for the bonded foil, leaving a butt fit of the porcelain at the shoulder.

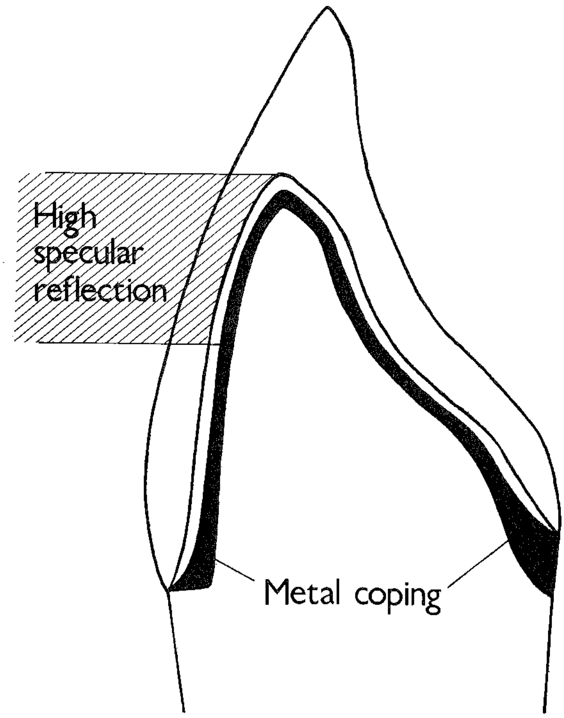

FIG. 15. Diagram illustrating the area of maximum specular reflection of light in a metal-ceramic crown when a thin facial surface is involved.

The major problem with metal-lined crowns is that opaque porcelains designed to mask out the metal also increase light reflectivity and brightness (Fig. 15). In adolescent teeth or adult teeth that are a light shade or very translucent, the chances of accurately duplicating their appearance in metal-ceramics is almost impossible. However, as previously explained, the porcelain jacket when inserted in these cases is very prone to fracture. The use of a modified crown of alumina bonded to platinum in these special cases has proved of great value.

It has been shown that the commonest site for fracture is in the cervical third and this is often the zone where aesthetics is easiest to obtain. If we analyze the stresses that can occur in the preparation of a difficult tooth for an adolescent, we see they must occur at the proximal shoulder area. Because the shoulder often has to be almost V-shaped, a fracture can originate here and spread in either direction to cleave the lingual plate or facial wall of the crown (Fig. 16). Clearly if these areas can be lined with a bonded platinum foil, delayed fracture of the crown might be arrested. However, if the platinum foil is extended too far incisally the situation in Fig. 15 occurs, where a highly reflective opaque porcelain will dominate incisal aesthetics. Because the bonded alumina crown uses a twin foil technique for construction, it is possible to remove the bonded foil from the incisal region. The question is, how much foil should be removed? The most important rule is to retain the foil at least 3 mm above the crest of the proximal shoulder and this foil must completely encircle the tooth at this level. In addition, the foil must cover the cingulum and lower third of the lingual concavity of the preparation if the axiolingual wall

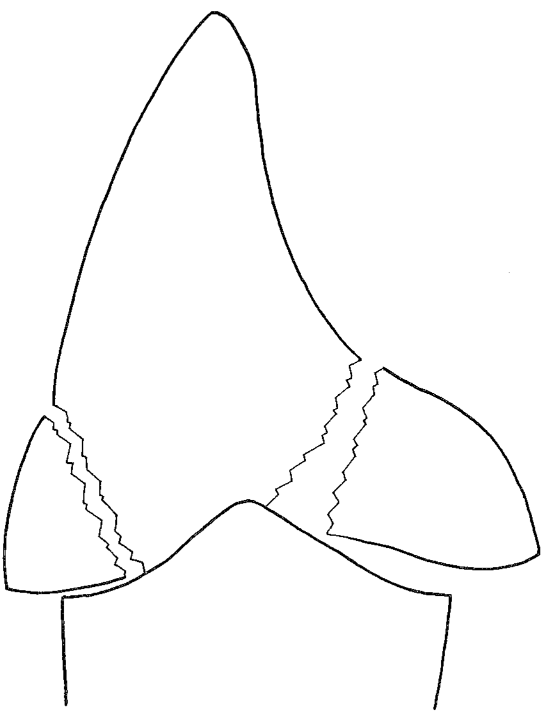

FIG. 16. Sites of potential fracture in a porcelain jacket crown fitted to an adolescent tooth where the preparation follows a high gingival crest.

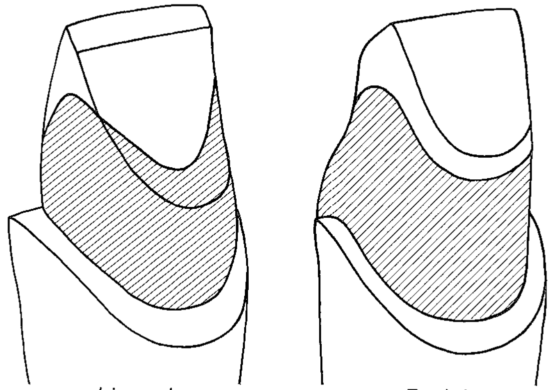

FIG. 17. Recommended design for a bonded alumina crown in an adolescent or very thin tooth where maximum transmission of light is required in the incisal one-third of the preparation.

of the crown is to be strengthened. Where it is vital to allow maximum transmission of light through the incisal third to preserve enamel translucence, the design shown in Fig. 17 is recommended. The foil is extended in the proximal area to approximately two-thirds the level of the preparation and then trimmed to slope cervically both in a facial and lingual direction. However, on the lingual surface, all the cingulum area must be covered. When building the crown it is useful to dilute or even eliminate the aluminous core porcelain at the incisal. If core porcelain is used then a mixture of one-third core to two-thirds enamel will act as a color toner over the dentine stump. Alternatively, the stump may be covered with a layer of dentine porcelain. This must be thick enough to avoid a blend line between the cervical platinum and the incisal enamel. Providing the layers of porcelain are carefully blended, high transmission of light can be achieved through the incisal area (Fig. 18). The partial lining of aluminous porcelain crowns with a bonded platinum foil is also of great benefit when restoring the lower incisors.

The platinum bonded alumina crown should be cemented with a glass-ionomer or carboxylate cement since the inner surface, because of its tin oxide coating, is also receptive to polar bonding to the carboxyl groups in polyacid cements. A schematic drawing of the mechanism of bonding porcelain to platinum and the platinum surface to polyacid cements is shown in Fig. 19.

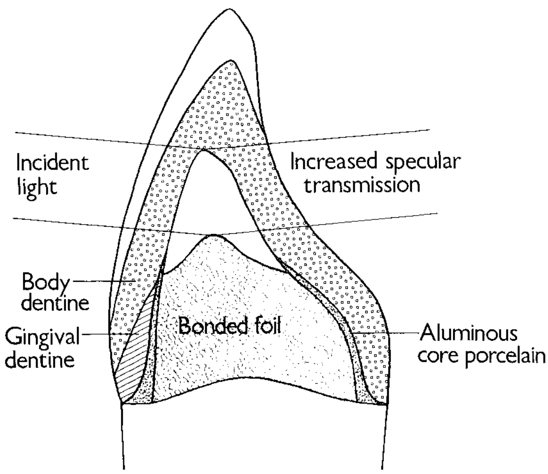

FIG. 18. The bonded foil is removed from at least one-third of the incisal area of the preparation but must remain above the critical stress-bearing areas as illustrated in Fig. 16.

The strength of the bond between aluminous porcelain and platinum coated with tin oxide is given in Table 2 and bond strengths for the polyacid cements, gold alloy, tinned platinum and dentine surfaces have been included for comparison. It should be noted that without tin-plating the bond between porcelain and platinum is only a mechanical one, and when polyacid cements are used an almost zero bond strength is recorded in the absence of an active tin-plated surface.

DISCUSSION

The introduction of more sophisticated techniques such as scanning electron microscopy and electron probe microanalysis has led to a better understanding of the problems of adhesion to tooth structure. Indeed it might be said that at last the dental research worker can now climb the molecular interface of the tooth. It is possible to achieve much improved bonding between the tooth and the restoration.

Preparation of the tooth should involve microabrasive rather than macroabrasive techniques to provide smooth surfaces for physicochemical bonding. Enamel and dentine should be cleaned and sterilized to provide the optimum site for attachment of cements. In addition, more thought should be given to treating the tooth surface during operative procedures with calcifying fluids, cements, or gels, so that the dentine is sealed from further assault by oral fluids or restorative materials. This process should be a continuing one when extensive crown and bridgework is being done and each visit should be the occasion for further application of calcifying or sealing agents so that when the final restoration is cemented the tooth has already had an opportunity of effecting some repair.

It is of equal importance to obtain strong chemical bonding of cements to the restoration. Tin-plating of precious metal surfaces is

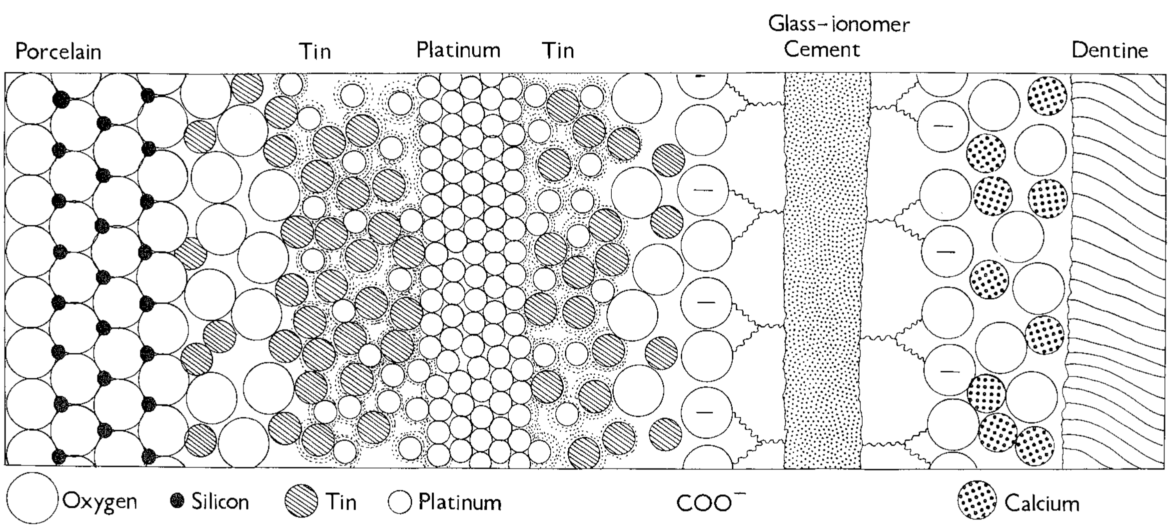

FIG. 19. Diagram of the bonding of porcelain and glass-ionomer cement to tin-plated platinum. Atoms are drawn to scale in relation to their atomic radii.

one way of doing this quickly and if this technique is used with polyacid cements of higher strength and creep resistance, it may assist in strengthening the cement bond in cases of extensive fixed bridgework or splinting.

CONCLUSIONS

Criticism that polycarboxylate cements will bond only to tooth structure but fail at the interface of metal and restoration has now been overcome.

The surfaces of precious metals can be made receptive to polar bonding of polycarboxylate and glass-ionomer cements by tin-plating the fit surface of the restoration. The thickness of the layer of tin-plating should not exceed 2 μm. Plating can be done in three minutes and is therefore a quick and inexpensive way of ensuring strong chemical bonding between all types of precious metals and alloys and the cements based on polyacrylic acid.

The same principle may be applied to the bonding of dental porcelain to precious metals. Platinum foils can be bonded chemically to aluminous porcelain surfaces with tin-oxide coatings.

It is recommended that all cast gold onlays, full veneer crowns, metal-ceramic crowns, and gold posts and cores be tin-plated when cements based on polyacrylic acid are being used.

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SPECIAL ARTICLES

Can Our Academy Cope with the Community Hope?

HARRY ROSEN

INTRODUCTION

The major aim of the Academy of Operative Dentistry is to promote the highest possible standards of prevention and treatment of dental disease. The members attracted to this academy are prepared to make personal sacrifices to maintain these standards and also to elevate them where possible. High standards in a professional body are not created merely with the drafting of a constitution; they evolve through years of dedication and perseverance.

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Presented at the Academy of Operative Dentistry, February 18, 1977, Chicago.

High standards are passed on by the senior to the junior, by the more gifted to the less gifted, by the more motivated to the less motivated. The process is much like a religion or philosophy that is passed on from father to son, guru to disciple, from the more enlightened to the less enlightened.

The Academy of Operative Dentistry, though relatively young, is fortunate in having as a parent body the American Academy of Gold Foil Operators. Here, tried and tested mechanisms for promoting the highest possible professional ideals, clinical standards, and research standards have existed for years.

Time and expense, strain on patient and dentist, output of work and efficiency, though recognized as important, are rarely emphasized. We concern ourselves primarily with our objectives of excellence, precision, and permanence. However, are these aims broad enough? How consistent are they with the needs of the community?

ACADEMY INTEREST IN COMMUNITY DENTISTRY

The Academy of Operative Dentistry has shown considerable interest in community dentistry. At the annual meeting in 1976, our officers featured Clifton O Dummett who spoke on "Community Dentistry's Contributions to Quality Health Care." For the meeting this year our officers directed me to review current literature to determine how community dentistry's aims in general, and Dr Dummett's recommendations in particular, apply to the membership of the Academy of Operative Dentistry.

Community dentistry is vitally concerned with those health services that the dental profession may render to all elements of the population. It is therefore concerned with:

- Prevention
- Cost of health services
- Minimum standards of quality and consumer protection
- Availability of dental services for all citizens

Prevention

Our Academy always has been, and always will be, interested in every aspect of prevention, which obviously goes beyond control of plaque, application of fluoride, and education of patients in the private dental office. Nelson (1976) has stated that: "Certainly, the costly time of the dentist and the expensive environment of the dental office is no place for training in tooth and mouth cleaning which is essentially a part of the bath."

Dummett has "been most impressed with the creation of the new National Center for Health Education, which has been heralded as being able to serve as a focal point for promoting, researching, coordinating and upgrading programs to educate citizens on maintaining their own health and the health of their families, including the proper use of health facilities."

What public health dentists and community dentists generally overlook is the important contribution the dentist makes to preventive dentistry by adhering to the basic principles of operative dentistry, pedodontics, periodontics, orthodontics, and occlusion (Rosen & Gitnick, 1961; Rosen, 1964). An absolute *must* on this subject is an article entitled "Prevention in Perspective" by Johnson (1976) in which he states, "To call flossing, brushing, and fleecing preventive dentistry is one of the greatest overstatements in the history of our profession—like renaming Bunker Hill Mt Everest. To build this limited concept of prevention into a specialty is unthinkable." And further: "Prevention of iatrogenic dental disease should be the prime consideration of every member of the dental profession."

I will list just a few of the many preventive procedures possible in the ethical practice of general dentistry:

(1) Extension of preparations to areas that can be maintained by the patient.

(2) Restoration of contour, contact, and occlusion to prevent food impaction and to protect and stimulate the gingivae.

(3) Completion of restorations with smooth, highly polished surfaces and impeccable margins to reduce retention of plaque, recurrence of caries, and irritation of soft tissue.

(4) Correction or restoration of occlusal defects to eliminate trauma and to enable the load to be distributed.

(5) Splinting of mobile teeth.

(6) Control of destructive habits through patient education and bite plane therapy.

(7) Orthodontic or combined surgical and orthodontic procedures to avoid crowding and establish integrity of the arch (Williams, 1976).

(8) Hemisection of teeth to eliminate vulnerable root furcations (Rosen & Gitnick, 1969).

(9) Mucogingival surgery to eliminate harmful frena and muscle insertions and to provide a broader zone of attached gingiva.

(10) Replacement of missing teeth to provide occlusal stability and distribution of the load.

Virtually every facet of dentistry is accompanied by a preventive component.

To quote Terkla (1976): "The public is not responding noticeably to a philosophy of a primary preventive dentistry and teeth continue to be damaged at an alarming rate. General practitioners of dentistry must meet the public demand for secondary and tertiary preventive care which consists mainly of restorative dentistry."

Cost of Health Services

Community dentists in general have been questioning the high costs of dental care and Dummett, in particular, has recommended that "a realistic reappraisal of dental fees would certainly be in order." By way of rebuttal, let us examine some statistics (Worthington, 1975).

In 1974 Americans spent $104.2 billion on medical care (that is all health care excluding teaching and research) or $485.00 per capita (US government estimate). In that same year, Americans spent $6.2 billion on dental care, or $29.00 per capita. What does this mean? It means that expenditures for dental care account for only 5.95% of total expenditures for medical care. This proportion is considerably smaller than that spent on dental care in 1930. In other words, dental care has received a progressively smaller portion of the health care pie. And further, at 5.95% dentistry in America receives a smaller proportion of the health care dollar than does dentistry in a number of European nations. Community dentists should not be arguing about spending less money for dental care, but rather how dentistry can obtain its rightful share to provide best the services asked of the profession.

Countries like the United Kingdom where the fee-for-service system has been ostensibly eliminated do not enjoy higher standards of dentistry. On the contrary, patients requiring more sophisticated restorative treatment seek dentists in private practice, who usually operate on a part-time basis outside the denticare scheme.

The Denticare program in the province of Quebec, Canada, which provides free dental services for children up to the age of ten, can hardly be looked upon as a low-cost system. Dentists place Rocky Mountain crowns on deciduous teeth that need MOD amalgams because crowns fetch a higher fee.

The high cost of medical services in America has been attributed to a great extent to the inefficiencies of operating hospitals. The dental office in which most dental services (especially restorative services) are dispensed is generally considered an efficient operating unit. The dentist works more hours than the average professional and spends a greater proportion of his working hours in productive activity.

The use of auxiliary personnel can affect the cost of dental treatment. Some dentists can be more productive with the proper use of auxiliaries. Studies with expanded duty dental assistants (EDDA) in solo private practice indicate that the employment of EDDAs can have positive results provided the dentist is committed to the concept of team dentistry and is willing to learn and apply the managerial principles of delegation (Douglas & *others,* 1976). However, there is real concern by some that the proponents of the programs for expanded function auxiliaries have never really taken into consideration the nonmonetary costs of mental stress and strain that these added auxiliaries would place on the practicing dentist (Igel, 1976).

Most dental schools teach the behavioral sciences under the umbrella of Community Dentistry. Mandatory requisites for the proper treatment of patients of all ages are:

- To listen to the patient
- To educate the patient
- To provide the patient with supportive therapy
- To be human as well as knowledgeable and competent

Budgets of nationalized health schemes do not permit either the dentist or the patient such luxuries. Nor do they prevent the erosion of the 'profession' to a 'craft' (Nelson, 1976). Community dentists by virtue of their background training and exposure reflect the aspirations of the lay population better than any other dental body. However, community dentists are by no means unanimous in recommending "a realistic reappraisal of dental fees."

Minimum Acceptable Standards and Consumer Protection

The concept of minimum standards has no place in relation to treatment services. Though the term is used by some community dentists, it cannot be construed as a position advocated by all of them. Dental schools and dental academies traditionally have advocated the highest possible standards. In spite of the fact that most dentists are imbued with the concept of the ideal as their objective, allowing for human error and disparities between the skills of different dentists, most patients receive only an acceptable or adequate service. Recent studies conducted on the fit of castings confirm that discriminating dentists working with an explorer and loupe will accept margins that are far from perfect when examined microscopically (Christensen, 1966; McLean & Fraunhofer, 1971; Pullinger, 1976). Literature on the poor seal of many of our restorative materials, when tested in the laboratory under ideal conditions, is plentiful. Clinical use of these materials introduces numerous variables that are beyond the practitioner's control. It logically follows that one must strive for the ideal to arrive at a result that might be nothing more than adequate.

What could be useful for dental students and new graduates is to have a better concept of adequacy. Just as students have difficulty formulating a notion of the normal (e.g. normal occlusal wear for a sixty-year-old might be a sign of bruxism for the twenty-two-year-old), students and new graduates have difficulty in formulating a feeling for what is adequate for a given situation. This is a far cry from devising minimal standards. Dentists who strive for the highest ideals may be guilty of overtreatment in their pursuit of excellence. That is unforgivable. One can get carried away when performing procedures at study club meetings or when practicing dentistry for the camera. Under these circumstances it is possible to overmanipulate to achieve an ideal result, and thereby introduce iatrogenic factors, which can be detrimental to the patient, to say nothing of the loss of productive time and the incurring of additional expense.

There is no conflict between our Academy and community dentistry on the dangers of "art for art's sake." However, I suspect that most members of this Academy are uncomfortable with the concept of minimum standards, as recommended by some. (Can a contact be left open just a little bit, or occlusion left high just a little bit—it's like marrying a maiden that's just a little bit pregnant.) I would suspect too, that most members of this Academy would be uncomfortable with the term 'consumer', yet are in full agreement that licensing bodies should exercise their fullest powers to discipline those charlatans that our code of ethics tends to protect.

Availability of Dental Services

A number of factors have combined to increase the availability of dental services. The ratio of dentists to population has been steadily improving—it is now one dentist to every 1,800 persons in the United States. More dental schools are graduating more dentists than ever before in North American history. Insurance schemes, though costly, make dentistry more available to more people. The tendency for dentists to practice in groups, either with medical specialists and family practitioners, or with dental specialists, frequently in areas of greatest accessibility such as shopping centers, is another factor in making dental services available to greater numbers of the population. Another is the recognition of the dental needs of geriatric patients. They are coming in increasing numbers for dental treatment and more and more have teeth and prostheses retained by attachment apparatus rather than by alveolar ridges. The birth of the Academy of Geriatric Dentistry and the inclusion of geriatric dentistry in dental curricula and dental programs affirm the profession's recognition of the need for dental service for this segment of the population.

CONCLUSIONS

The present-day system of delivery of dental health is providing North Americans with a higher standard of service than is available anywhere else in the world.

The Academy is generally sympathetic to the aspirations of community dentistry:

- To improve preventive programs inside and outside of the dental office
- To reduce costs through efficiency
- To protect the public
- To improve the availability of dental services

However, the Academy of Operative Dentistry has a commitment to strive constantly for the highest standards rather than debate the merits of minimal standards. The Academy also has a commitment as a scientific body to question the rationale of change for the sake of change and resist forces that drive the profession from the known to the unknown.

The answer to the question: "Can our Academy cope with the community hope?" is: "Yes."

I thank John Stamm for providing the statistics on dentistry in the United States.

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Skinner Memorial Lecture

The Disciples of Eugene W Skinner: Philander B Taylor and George M Hollenback

GEORGE C PAFFENBARGER

Annually we congregate to celebrate the memory of a man who left us a little over a decade ago. But he actually did not leave us any more than many former distinguished faculty of Northwestern University Dental School have left us when they died. A whole list of such distinguished persons can be compiled, with Dr Greene Vardiman Black the most renowned. His eminent son, Dr Arthur Davenport Black, brought Dr Skinner to Northwestern University in 1934. Dr Arthur Black did not make any mistake in selecting Dr Skinner for his faculty nor did Dr Skinner make any mistake in accepting the position here at Northwestern University. One of the first things Dr Arthur Black said to Dr Skinner was that he wanted him to write a textbook on dental materials. Dr Arthur Black noted that there was no authoritative text in this field and that he wanted the faculty of Northwestern University Dental School to be pre-eminent. Dr Arthur Black believed that one mark of pre-eminence is authorship of a worthwhile textbook. Dr Skinner said that he was ever grateful to Dr Arthur Black for prodding him into writing the book and in the preface to the first edition gave full credit to Dr Black. This book, *The Science of Dental Materials,* is no ordinary dental textbook; during the sixth edition (1967) the 100,000th copy was sold.

Dr Skinner not only knew how to write a superb text and reference book but he also had the erudition to have it extended and improved through several editions during his lifetime, and by taking on a coauthor he had the wisdom to have it perpetuated after his death. With uncanny insight he selected Dr Ralph W Phillips—a wise and appropriate selection.

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This third lecture, dedicated to the memory of Dr E W Skinner, was delivered on April 20, 1977, at Northwestern University Dental School, Chicago.

Disciples of Eugene W Skinner

PHILANDER B TAYLOR, AB, AM

In P B Taylor we encounter the first disciple of Dr Eugene Skinner. In the preface to the first edition of *The Science of Dental Materials,* Dr Skinner wrote: ". . . and thanks to P B Taylor of Western Reserve University who not only read and reread the manuscript several times, but also contributed Chapters 36 to 38 inclusive, and furnished data and photographs from his

PHILANDER B TAYLOR

original researches." P B Taylor continued to rewrite those chapters in the 1940 and 1946 editions of *The Science of Dental Materials*. He furnished some hitherto unpublished data concerning the theory and manipulation of denture resins for the 1954 edition.

Now who was this man, P B Taylor, and how did he become a disciple of Dr Skinner and thus choose a life career in dental materials research? Their acquaintance began before even Dr Skinner had any idea or intention of making a career in dental materials. Dr Skinner graduated from the State University of Iowa in 1930 with a PhD degree in physics. During his years of graduate study he was professor of physics and mathematics at Olivet College, Olivet, Michigan. Among his pupils was Philander Taylor from Detroit, where Taylor's father, a physician, was the coroner. His father died while Taylor was in college and he found in Dr Skinner both a teacher and a friend. There developed out of this relationship a father-son association. When Dr Skinner left Olivet College and transferred to Western Reserve University as assistant professor of basic dental technology in the School of Dentistry, he wanted Taylor to transfer there also. Taylor was persuaded to come to Western Reserve after his graduation from Olivet in 1930 with an AB degree with a major in physics and a minor in mathematics. Dr Skinner was able to arrange a master's degree fellowship, and Taylor was granted a master's degree in physics in 1932. Interestingly enough the subject chosen for Taylor's thesis was "A Study of the Silver-tin-mercury System." Taylor built and calibrated a differential interferometer, an instrument employing a monochromatic light source for measuring with great precision small linear changes in dimension. Its primary use in dental materials is the precision measurement of the linear dimensional change of amalgam during hardening.

When Dr Skinner transferred from Western Reserve University to Northwestern University, Taylor stayed at Western Reserve on the dental faculty until he joined the Army in 1940, when he became the laboratory officer in charge of physical testing for procurement of the Army's medical supplies. He was stationed in New York City from 1940–1945.

During the years of World War II a most productive collaboration developed between Taylor and myself as a result of my being stationed from January 1942 to May 1946, at the Naval Medical Supply Depot at Sands and Pearl Streets in nearby Brooklyn. We used each other's equipment, worked in each other's laboratories, and exchanged test data, especially on products that failed to comply with the specifications. We caught some manufacturers switching rejected material from one service to another and we diverted shipments of common contractors in each category when the Army or the Navy needed material quickly. We certainly enjoyed such a close working arrangement between the Army and the Navy. Of course, it was all unofficial; such cooperation would have been impossible if we had tried officially, so it was all done by word of mouth.

We became staunch professional friends and our families had a delightful time together. He was my best friend, and he was Skinner's best friend, and eventually best man at Skinner's wedding with Rosamond Liddell.

In the 1930s Dr Taylor experimented with fluxes and solders for fabricating dental appliances of 18-8 stainless steel and thought that a flux of the following formula did well:

Potassium fluoride	75%
Boric acid	25%

Dilute hydrochloric acid sufficient to moisten.

The ingredients are mixed to a pasty consistency. Water is added occasionally to maintain the consistency.

He plotted the frequency of tensile failure at various ranges of strength showing that when a 10-carat gold solder was used about 40% of the soldered joints had strengths ranging from 70,000 to 80,000 lbf/in^2. When Wipla, a commercial stainless steel solder made by Krupp of Germany, was used, about 40% of the soldered joints had strengths ranging from 80,000 to 90,000 lbf/in^2. Then he used an experimental solder of silver, 42%; copper, 31%; zinc, 20%; and cadmium, 7%; and found that about 40% of the soldered joints had strengths ranging from 100,000 to 110,000 lbf/in^2.

In the late 1930s Taylor's measurements of MOD wax patterns indicated mechanical distortion of the pattern due to the setting expansion of the investment.

Vulcanite or hard rubber was the organic denture base used almost universally when Taylor began his work. Porosity was frequently encountered in dentures and was thought to be caused by the outside hardening first so that developing gases were entrapped in the center of the thick portion of the denture. He demonstrated that a control of the time-temperature relation in the vulcanizing of denture rubber was the critical factor. By controlling time-temperature relation he produced specimens sound throughout or specimens with an uncured outside but with a porous hard center. Here we have a good example of speculation by dentists and dental educators being dissected by a physicist in a research laboratory with controlled and well monitored experiments on dental materials.

When the acrylic resins appeared as a denture base in the late 1930s Taylor was doing some unique experiments: measuring the shrinkage of the resin under pressure as a function of temperature; measuring the pressure exerted by an acrylic resin during processing; developing stress-strain curves for a rapid curing dental stone of different ages; and plotting flow curves for the stone under pressures produced by the confined acrylic resins within the flask. From these data he showed how the undesirable movement of the flasked teeth in the investing plaster could be prevented or minimized. He suggested a technique of denture flasking and curing cycles that had a solid basis of experimental design and prevented porosity and the fracturing of the porcelain teeth, yet at the same time produced minimal strain in the denture.

Dr Taylor's range of knowledge was wide. When the centenary of dental education was celebrated in Baltimore in 1939, Taylor gave one of the principal addresses, on inlay casting procedure—its evaluation and the effect of manipulating variables.

His last paper was published in 1950, on low temperature polymerization of acrylic resins. This research dealt with color stability, mechanical properties, degree of polymerization, and those properties generally referred to as accuracy and dimensional stability.

He reported that the amine-peroxide initiation, propagation, and termination of the polymerization of the so-called self-curing resins was the cause of the discoloration in service. He showed that less discoloration occurred when aliphatic rather than aromatic amines were used and that when P-toluenesulfinic acid was dissolved in methyl methacrylate monomer enough suitable sulfur was liberated to initiate polymerization with less discoloration than when the amines were used. He also pointed out that sulfur had been so used to initiate vulcanization in rubber. The problem was to devise a system which would liberate sulfur at ambient temperatures. This use of such sulfur compounds was not of course the discovery of Taylor but came out of the laboratories of the manufacturers of the direct filling resin sold under the trade name of Sevriton.

He showed that specimens of the self-curing resins had greater deflection and less strength in transverse bending than the heat cured resins but that if the specimens of self-curing resin were boiled there was no difference. He showed too that the residual or free monomer in the self-curing specimens was roughly 2.5%. This amount was reduced to about 0.5% after boiling. He showed that the number average molecular weight may or may not increase on boiling depending upon the materials.

He prophesied 25 years ago that self-curing acrylic resins would find many excellent uses in dentistry but the use should be approached with some reservation. We have lived to see many of his predictions materialize.

In 1945 and until his death in 1961 at age 54, he was Director of Research for Julius Aderer, Inc.

In all of his research P B Taylor worked closely with the clinical faculty and assisted both the faculty and his students in transferring his research findings to practice. He liked teaching and was attempting to return to an academic position at the time of his untimely death almost a quarter of a century ago.

GEORGE M HOLLENBACK, DDS, MSD, DSc(Hon)

When George Hollenback was a guest at the Paffenbarger's farm in Maryland several years ago he said he was born on a Kansas farm in 1886 and raised there. He said that farm life had taught him to be self-reliant, but he had no yearning ever to live on a farm again, or to be connected with one in any manner. However, that farm experience provided a background from which his innate ingenuity surfaced in later years to produce many inventions and research investigations on dental materials that have increased substantially the effectiveness of dental health service.

This "educated" gentleman had an elementary education of 36 months in a country school. When he was 17 he walked five miles to see his physician about a toothache. The physician gave him some pain reliever and suggested he visit an itinerant dentist whenever he came to the area. It was this experience that caused Dr Hollenback to think about dentistry as a career. Even though he did not have a high school diploma he was able to pass the entrance requirements of Kansas City Dental College, now the University of Missouri at Kansas City, Missouri, where he matriculated in 1905 and graduated in 1912. In 1907 he was licensed to practice in Kansas but moved to Montana in 1909 because he had contracted tuberculosis. Here he resided for 10 years, before moving to Los Angeles. There he practiced until 1955. In Los Angeles he had an elite clientele including many Hollywood personalities such as Katherine Hepburn, Clark Gable, Olivia de Haviland, William Powell, and Richard Dix. Many of these celebrities, especially Katherine Hepburn and Olivia de Haviland, not only found in Dr George M Hollenback a dentist's dentist, but also developed close personal friendships that continued until his death. Miss Hepburn attended his funeral.

The father of Howard Hughes brought him as a patient to Dr Hollenback when Howard was 12 to 13 years old. Over the 36 years when Dr Hollenback practiced in Los Angeles there developed a close personal friendship between the two. Dr Hollenback showed Howard Hughes some of the precise dental gold castings he had made and explained many of the not easily controlled variables involved. When he asked Hughes how to make certain precision measurements, he suggested that Dr Hollenback consult some of the engineers at the Hughes Aircraft firm. All were so impressed with the effort that Dr Hollenback had made that Mr Hughes supported him financially in establishing a research laboratory. This relationship continued until Dr Hollenback became so enfeebled that he could no longer continue his investigative work. Thus was founded in 1957 the research facility associated with Dr Hollenback and Mr Hughes. When I visited Dr

Hollenback several years ago the laboratory was located next to his residence. The area of the laboratory covered about 1280 square feet. Later the laboratory was moved from the grounds of Dr Hollenback's residence to a building partially occupied by the Hughes interests.

In 1967 there was a plan to transfer the laboratory to the School of Dentistry, College of Physicians and Surgeons, University of the Pacific. Dr Hollenback did not go to San Francisco; he donated all of the equipment of the laboratory including the instrument shop to the University of the Pacific where it is now housed, but he never saw it installed.

Dr Hollenback was a dedicated dentist who was particularly generous to the University of the Pacific, giving this institution contributions valued at about $400,000. In addition he made substantial contributions to the building fund. He purchased for $85,000 the remarkable skull collection of Dr Spencer Atkinson for the school. This skull collection had over 1400 specimens and also a complete library of applied anatomy.

He gave substantial sums to other dental schools. So one realizes that Dr Hollenback, the superb dentist, was not only an excellent dental researcher but also was successful financially. He used his worldly goods generously not only for institutions of dental education but also for his friends.

Dr Hollenback's chief interest unrelated to dentistry was automobiles. When his patient, Clark Gable, bought a new Jaguar so did George Hollenback.

Dr Hollenback felt that he needed some formal training in research and suggested to Dr Skinner that he would like to come to Northwestern University and work for a master's degree. He and Dr Skinner had been friends for years but, more important, they had a great deal of respect for each other. Dr Hollenback left his practice and came to Northwestern University to work under the monitorship of Eugene W Skinner. In 1945 Northwestern University gave George M Hollenback a Master of Science degree in Dentistry. An abstract of the thesis on "Shrinkage During Casting of Gold and Gold Alloys" shows that, as in many other of his research reports, Dr Hollenback, the superb instrument maker, here designs an apparatus for measuring casting shrinkage of gold alloys used in dentistry. He and Dr Skinner showed that the linear casting shrinkage, under the test conditions, was $1.67 \pm 0.02\%$ for pure gold and for dark 22-carat gold 1.50 ± 0.01. In this report they showed that casting shrinkage was a function of the composition of the gold alloy. However, their recommendation that the manufacturers publish the values for the casting shrinkage of each alloy never materialized. Even now it is not feasible to state precisely what the casting shrinkage is for any precious or base metal alloy unless exact details of the size and shape of the test specimen and precise details of the casting technique and the materials and methods used in the determination are given.

George M Hollenback was an industrious researcher as manifested by his bibliography of some 100 items dealing with almost all of the materials and techniques used in operative dentistry. One finds reports on the physical properties of gold, gold alloys and gold foil. He also published reports on amalgams, cavity liners and composites, and on elastic, alginate, and agar impression materials, pattern waxes, investments, gypsums, and duplicating compounds.

His expertness as an instrument maker saw fruition in the development of many dental instruments and appliances such as the Hollenback carver, a pneumatic mallet, and casting accessories.

Many of his papers were on the accuracy of the techniques used in laboratory and clinical research as well as by the practicing dentist. He usually identified the materials he was testing by trade brand names. When one scans these reports, published prior to his training under Dr Skinner, one is amazed how George M Hollenback, with almost no research experience, trained himself to conduct such investigations.

He had an innate ability that few persons have. He was respected and admired by his patients and by his fellow dentists throughout the world.

His memory and his works will not soon be forgotten. As I sit in the library of the Dental and Medical Materials Section at the National Bureau of Standards in Washington, I see a bronze plaque of Dr Wilmer Souder, the founder of dental research at the National Bureau of Standards. I see on this plaque this inscription, "Presented to the Dental Research Section of the National Bureau of Standards by George M Hollenback, DDS, MSD, DSc, March 10, 1960." I also see on the library's wall a photograph of George M Hollenback who was the 1963 winner of the Wilmer Souder Award, which is presented annually by the Dental Materials Group of the International Association for Dental Research as the "Highest Honor in the Field of Dental Materials Research."

It is to the everlasting credit of the Academy of Operative Dentistry that it established the Hollenback Memorial Prize in 1975 as a token of esteem and affection for George M Hollenback, an extraordinarily gifted and devoted dental researcher and philanthropist.

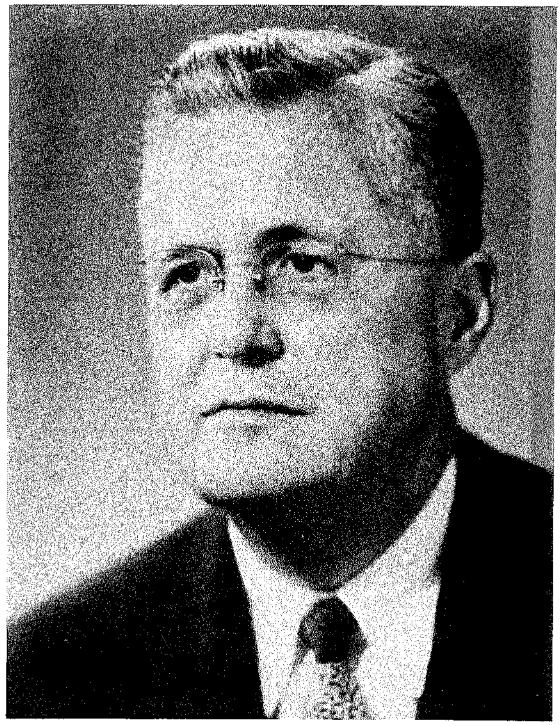
* * * *

Thus we see how the personality and the teachings of Eugene William Skinner rubbed off on Philander B Taylor and George McDonald Hollenback. Many other examples could be cited.

Northwestern University is fortunate in having Dr Evan H Greener as Dr Skinner's successor, for under Dr Greener's leadership research in dental materials is prospering at Northwestern.

The author wishes to acknowledge the assistance of: Martha Allis, Secretary to the Dean; Ann Marie Corey, Librarian, School of Dentistry, University of Missouri at Kansas City; Dorothy Altschul, Secretary to George M Hollenback for 13 years; Alita Bell, Secretary, Board of Dental Examiners, State of Kansas; Lisa Casman, Administrative Secretary, Board of Dentists, State of Montana; George W Ferguson, Director, Division of Restorative Dentistry, School of Dentistry, State University of New York at Buffalo; Minnie Orfanos, Librarian, Northwestern University Dental School; Ralph W Phillips, Associate Dean for Research and Research Professor of Dental Materials, Indiana University School of Dentistry; Gunnar Ryge, Assistant Dean for Research, School of Dentistry, University of the Pacific; Rosamond L Skinner, Administrative Secretary, Office of the Dean, Northwestern University Dental School; Ruth H Taylor, widow of P B Taylor; and Donald Washburn, Director, Bureau of Library Services, American Dental Association.

Complete bibliographies of the publications of Philander B Taylor and George M Hollenback may be obtained from the author by writing to him.



EUGENE W SKINNER

OPERATIVE DENTISTRY, 1977, 2, 154–155.

POINT OF VIEW

Product Dependability?

BRUCE B SMITH

Do you occasionally become upset with the manufacturers of dental products? Have you found that a product upon which you have depended for some years has suddenly acquired a new set of properties, apparently without cause? Have you experienced casting failures when you know your technique remained unchanged? Have your castings looked as good as usual—maybe better than usual—but upon trying them in the mouth, where they must go to be of any value, the fit was not quite correct? Such an experience is of course followed by a period of self-examination, worry, frustration, annoyance, and extra work as you try to create a proper fit. And you have the nagging fear that some other casting that was not quite exact might have slipped by.

Such an untenable situation may be the result of the manufacturer changing his procedure or substituting another product without changing the original label. Possibly he has acquired another company, or merged, and has substituted its product. Is this fraud or is it criminal negligence? In any case, the practitioner is the goat. The damage has been done. To solve the problem the dentist must now work out an entirely new technique. If he is lucky just a change in casting temperature will suffice. The usual course, however, is hours of experimentation with a change to a new product. In rare instances the patient may be the one that suffers most by accidentally receiving inferior dentistry.

Some Case Histories

One West Coast manufacturer of casting investment sold his excellent product and name to a large, supposedly reputable, national dental manufacturing firm. This firm proceeded to place its own investment in the con-

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BRUCE B SMITH, BSc, DDS, conducts a private practice full time. He is president-elect of the American Academy of Restorative Dentistry and a past president of the American Academy of Gold Foil Operators and of the Academy of Operative Dentistry. He is director of the John Kuratli Crown and Bridge Seminar in Oregon and director of the Bruce B Smith Crown and Bridge Seminar in Seattle.

OPERATIVE DENTISTRY, 1977, 2, 156-164.

PRODUCT REPORT

Cutting Efficiency of Diamond Stones: Effect of Technique Variables

No one diamond far excelled in these tests but diamonds did as a whole cut two to three times faster in teeth and eighteen to forty times faster in glass than did carbide burs.

WILMER B EAMES • BARRY S REDER • GLEN A SMITH

Summary

Straight cylindrical diamond stones ranging from 1.1 to 1.2 mm in diameter, all of medium grit, were tested for efficiency and durability.

The volume of water spray used to cool and clean the field while cutting teeth was shown to have a profound effect upon the cutting efficiency of diamond stones. Higher rates of water flow are necessary to prevent clogging when increased leads are applied to the stone.

Diamond stones cut teeth two to three times faster than do carbide burs.

Durability was evaluated by cutting glass plates for one hour. Though there were individual differences, the group showed a rather uniform geometric fall-off in cutting rate over the hour.

Some stones were capable of cutting 40 times farther in glass, without failure due to dulling, than carbide burs. Many diamond stones failed to complete the 150 g (5.25 oz) glass-cutting tests due to breakage at the neck of the shank, but most withstood the more nearly clinical 50 g (1.78 oz) load when cutting glass or teeth.

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BARRY S REDER, BA, is a student in the class of 1978.

GLEN A SMITH, BA, is a student in the class of 1979.

INTRODUCTION

Past comparisons between carbide burs and diamond cutting stones have given rise to questions about the value of diamonds at ultra-high cutting speeds. While burs have definitive requirements (American Dental Association Specification No. 23, 1973), diamond stones are not required to pass tests which would determine their relative ability to cut safely and effectively at speeds of 350,000 to 400,000 rev/min. This report describes an attempt to compare diamond stones of various manufacturers.

Schuchard and Watkins (1967) found that

tainers of the original company, even in sealed, weighed envelopes. No notice was sent to dentists of the change of material. No new instructions were mailed with the packages. Study clubs and private offices, schools and other institutions, routinely using the familiar product, were suddenly faced with problems not previously encountered. Only after several months of exasperating experiences did the truth finally emerge when a salesman was prodded enough to admit what had happened. He explained only on the condition that he remain anonymous.

In another case, a silicone impression material known for its accuracy changed manufacturers three times, always retaining the same name so that the good will of the product and the market for it would be protected. The difficulties each manufacturer had in trying to produce the original material had a gross effect on its properties and shelf-life. Eventually a large company with an interest in accuracy struggled through the processes and now the product is once again usable and dependable —still under the original brand name. A composite was also designed and sold in this manner.

The Medicine-Show Advertising Problem

Closely related to the maintenance of quality control is the current style of introducing new products. New alloys are designed and placed on the market, with great claims, before tests have been completed by the profession. Filled resins are also advertised and marketed with medicine show attributes. Full reports on these products by the Council on Dental Materials and Devices may not be available until six months or a year later.

What To Do?

We are all aware that there is an organization of dental manufacturers. It is supposed to maintain control over its members, handle problems such as those described here, and strive for ethical conduct. Yet clandestine agreements, trade secrets, and suspect procedures continue today much as they did in the past. No reliable system of control governs the quality of new products on the market, or provides a check upon the contents of brand name products that have been accepted. Even with the fine work done by the Council on Dental Materials and Devices of the American Dental Association we, as a profession, continue to "shut the windows after someone has stolen all the silverware."

If the companies were required to submit samples for testing to the American Dental Association whenever a change in ownership took effect, before products were again allowed on the market, the public and the profession would have a measure of protection.

I do not believe that the profession and the public should assume the role of guinea pigs. It is a mystery that these things can occur and are occurring in today's enlightened society. We must draw attention to practices of this type and work to gain proper solutions and security.

carbide burs were superior to diamond stones in cutting milled segments of dentin. In their experiment the S S White 557 carbide bur cut four times more rapidly than the 557 Starlite diamond. The comparison was made without a water spray, using a 6-ounce (170.5 g) load. They concluded: "While there may be indications for the use of diamonds at ultrahigh speeds, the dentist should consider their inefficient cutting action in contrast to burs, the increased functional heat developed, and the rough cavity wall produced in the cutting action."

Eames and Nale (1973) published a comparative study of the efficiency of carbide burs using both human teeth and glass plates as substrates. The instruments were tested by cutting for 0.5-second intervals, using 150 g (5.25 oz) load, while a fine stream of water (3.5 ml/min) cooled and cleaned the field. The results showed that all burs failed to cut after having cut glass a maximum of 20 mm. A significant drop-off in cutting efficiency occurred after one minute of glass cutting and after 7 to 9 minutes of cutting teeth.

The efficiency and durability of diamond stones, as presented here, are markedly improved over the performance of carbide burs.

Diamond stones were compared first at 150 g lateral load to evaluate the cutting efficiency of the diamond stones versus the cutting efficiency of carbide burs as previously reported. The amount of breakage found at the 150 g load was much higher than that experienced by clinicians. A cursory survey suggested that clinicians may prepare teeth using a load of 10 g to 50 g. Consequently, a second group of tests was run at 50 g (1.78 oz). Stones of other manufacturers were included in the latter test.

MATERIALS

Cylindrical diamond stones of medium grit and varying from 1.1 to 1.2 mm in diameter were tested. They are listed in the table. Three specimens of each manufacturer's stones were tested at a load of 150 g (5.25 oz). The sample size was increased to five for the more nearly clinical load of 50 g (1.78 oz).

Manufacturers of Cylindrical Diamond Stones Tested

Rugby 557	Darby Drug Company, Inc. Rockville Centre, NY 11570	557-5	Ransom and Randolph Toledo, OH 43601
515.7M	Den-Tal-Ez Manufacturing Company Columbus, OH 43219	836-3	Henry Schein Inc. Flushing, NY 11358
Blessing 14E	Dental Film Company Brooklyn, NY 11215	PN0602	Shofu Dental Corporation Menlo Park, CA 94025
C1-3	Lasco Diamond Products Chatsworth, CA 91311	557-5M	Star Dental Manufacturing Company, Inc. Conshohocken, PA 19428
383454	Midwest American Melrose Park, IL 60160	Blu-White 7F	Teledyne Dental, Densco Div. Denver, CO 80207
Vantage 836-12	Miltex Instrument Company New York, NY 10010	314S	Union Broach Company, Inc. Long Island City, NY 11101
Horico K3/2	Pfingst and Company, Inc. New York, NY 10003	832-026	Unitek Corporation Monrovia, CA 91016

Conversion Information

Handpiece Loads

150 grams load = 5.3 ounces, an abusive test for diamonds because of breakage. Burs usually withstand this load.

50 grams load = 1.78 ounces, more nearly clinical for diamonds—a light touch more commonly used by the average dentist.

ml/min of water:

The amount of water spray emitted while running the dental handpiece at full speed. This can be measured using a glass beaker.

METHODS

A freely moving cart (Johnson & Johnson Dental Products Co., East Windsor, NJ 08520, USA) on rails, holding the substrate to be cut, was pulled against a diamond stone rotating at a speed of 350,000 to 400,000 rev/min with a 150 or 50 g load for 0.5-second intervals (Fig. 1). Both glass and teeth were cut at a depth of 2 mm (Fig. 2). Midwest Quiet-air handpieces (Midwest American, Melrose Park, IL 60160, USA) were employed throughout the test.

▪ *Tooth Cutting*

Caries-free human molars were placed in a linear arrangement, invested in gypsum stone, and flattened by removing the cusps to prevent the effect of erratic cutting through fissures, and to assure the equalized cutting of both enamel and dentin. Each block of teeth contained eight molars. Cuts, 2 mm deep, were made on each side of the central sulcus. The distance that each diamond cut, over 10-minute intervals, was measured and recorded on an audio tape recorder, and the data transcribed and tabulated at the end of each session.

▪ *Glass Cutting*

Quarter-inch plate glass of 520 Knoop hardness was cut using an identical technique over one-hour intervals. Scanning electron micrographs were taken of several stones before and after the one-hour interval.

It was discovered during the experiment that different handpieces sometimes yielded up to seven times the cutting rate normally measured, even though the handpieces were identical models from the same manufacturer. This brief burst of speed was probably caused by the eccentricity of the chuck and is indicative of turbine wear. Therefore, when handpieces exhibited wear, new handpieces were used that had been calibrated by using diamond stones of brands previously tested to determine their capacity to give similar data.

A pilot study suggested that, unlike burs, the efficiency of abrasive cutting stones is affected by the volume of water used to clean and cool the field. Initial tests of stones of two manufacturers, using 150 g force, showed a sigmoidal increase in cutting efficiency as the volume of water was increased (Fig. 3).

Cutting with the lighter 50 g load was similarly affected by water flow though the curve shifted to the left (Fig. 4).

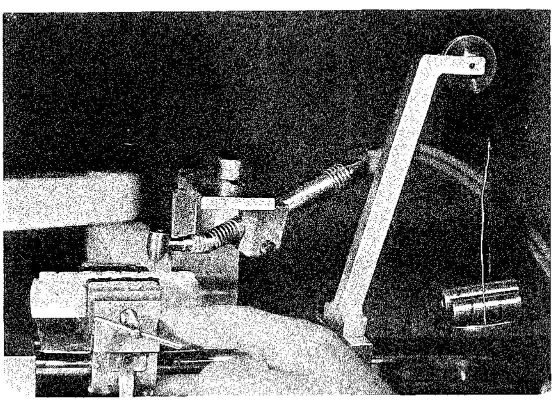


FIG. 1. Instrument constructed to test the durability and cutting rate of diamond stones under a constant load against glass and human teeth. (Instrument constructed courtesy of Johnson & Johnson Dental Products Company.)

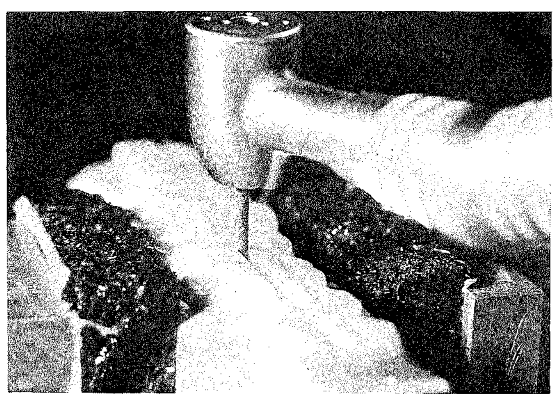


FIG. 2. Both glass and teeth were cut at a depth of 2 mm. Midwest Quiet-air handpieces were employed throughout the test.

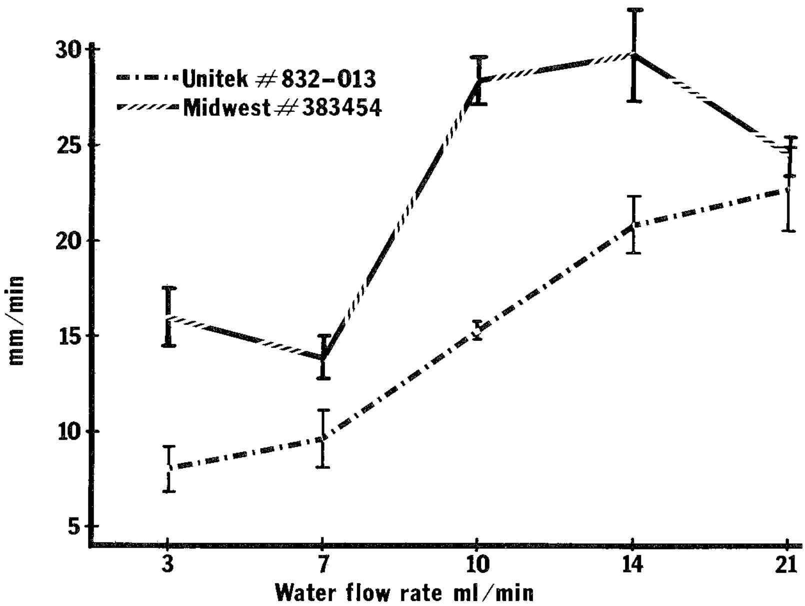


FIG. 3. Tests with two manufacturers' stones using a 5.25-ounce load (150 g) illustrates the increase in cutting efficiency as the volume of the water spray is increased.

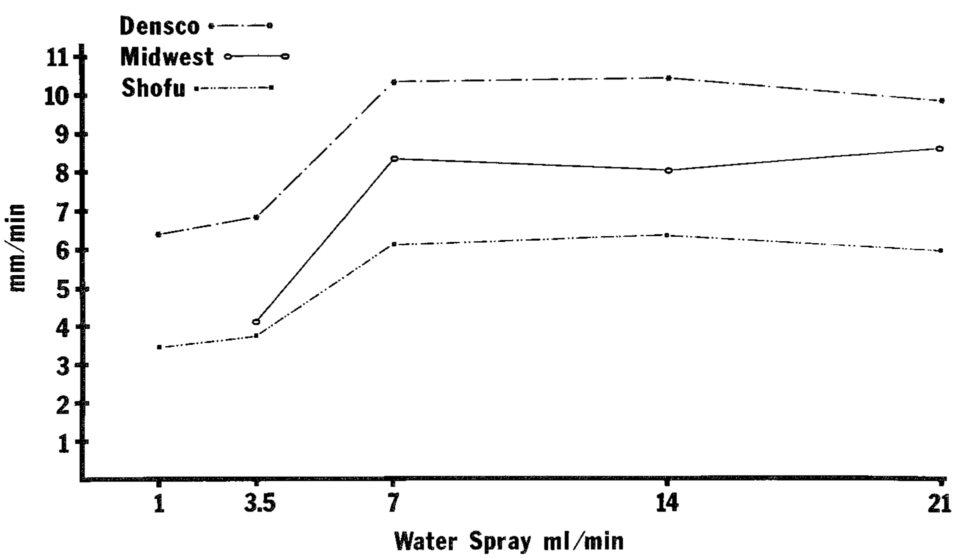


FIG. 4. When cutting with a lighter load of 1.8 ounces (50 g) it is shown that less water was sufficient for efficient cutting.

The cutting rates of the diamond stones of 10 manufacturers, tested at 150 g, were evaluated at water flow of 7 and 21 ml/min. Diamond stones of 14 manufacturers were evaluated using 7 ml/min at a 50 g load.

Two 557 burs each from four manufacturers (Kerr Mfg Co., Romulus, MI 48174, USA; Midwest American, Melrose Park, IL 60160; Pascal Company, Inc., Bellevue, WA 98004; Ransom and Randolph, Toledo, OH 43604) were also tested for cutting rates in teeth at the 50 g load, since our publication reported them at the 150 g load. The conditions were identical to those used in obtaining data for diamond stones.

RESULTS

Cutting Rate in Teeth

The relationship between cutting efficiency as affected by the load and water flow rate is demonstrated in Figures 3 and 4. Based upon our observations, a flow rate of 7 ml/min seemed to be manageable for two-handed dentistry while 21 ml/min was an acceptable flow in four-handed dentistry using a high speed evacuator.

The average cutting rate of teeth of the eight trials using 557 burs of four manufacturers at 50 g was 2.9 ± 0.7 mm/min.

■ *Using the 5.25-Ounce Load (150 g)*

Figure 5 illustrates the varied effects of an increase in water flow rate on the diamond stones of the 10 manufacturers that were tested on teeth at the abusive load of 150 g. With water at the rate of 7 ml/min, the Den-Tal-Ez and Unitek stones cut the most rapidly, followed closely by Densco and Lasco, and finally by Midwest, Pfingst, Shofu, and Star. All Union Broach and Ransom and Randolph stones suffered torsional fatigue and broke at the neck of the shank before completing the 10-minute test. When the water flow was increased to 21 ml/min, the Pfingst and Shofu stones exhibited the greatest improvement and the two highest cutting rates. Den-Tal-Ez and Midwest stones also demonstrated an improved rate. Star diamonds showed no change in rate while the Densco, Lasco, Ransom and Randolph, Union Broach, and Unitek failed before completion of the test. The breakage reported here and above was not anticipated since carbide burs of the same dimensions had not failed under identical test conditions while cutting teeth.

■ *Using the 1.8-Ounce Load (50 g)*

A water flow of 7 ml/min was sufficient for maximum efficiency in cutting teeth at the lighter 50 g load as seen in Figure 6. Reducing

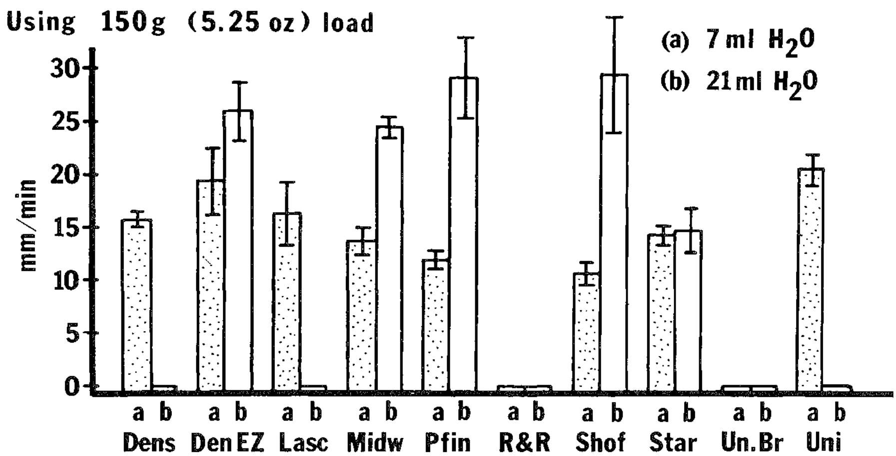


FIG. 5. The cutting rate effectiveness of using more water with a heavier load in cutting teeth. Five of the ten stones fractured at the necks under torsional stress.

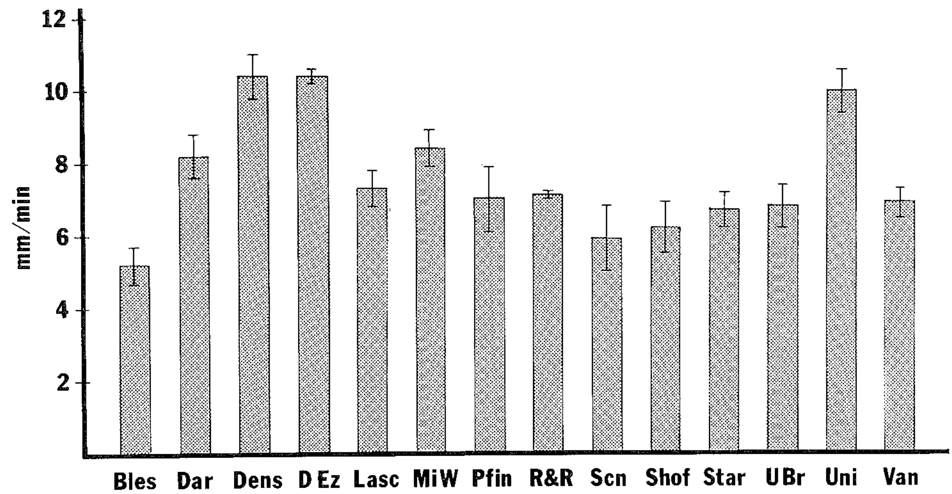


FIG. 6. The reduced rate of tooth-cutting as affected by using a lighter handpiece load of 1.8 oz (50 g). Less water was required to prevent clogging.

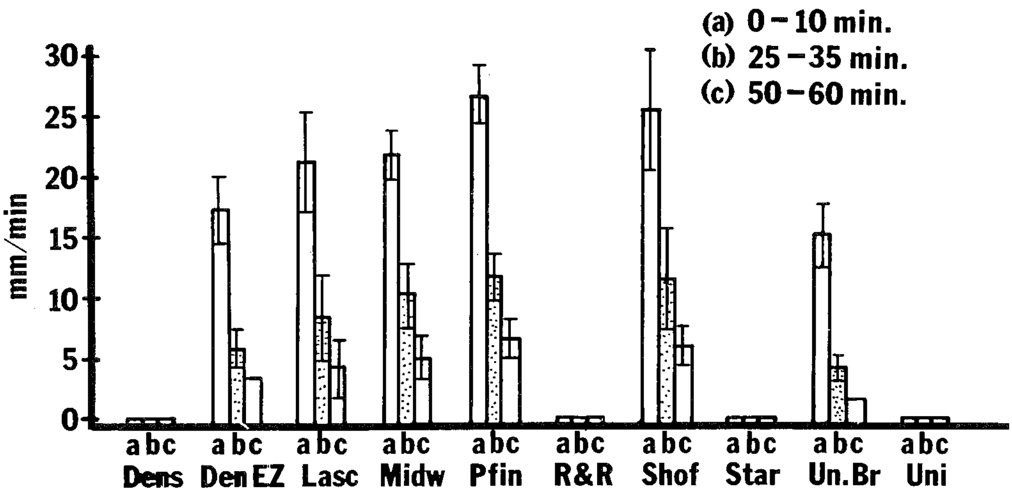


FIG. 7. Using the heavier load of 5.25 ounces (150 g) resulted in a higher cutting rate on glass and varying degrees of loss of cutting speed.

the water flow to 3.5 or 1 ml/min (Fig. 4) caused a marked reduction in cutting rate, but increasing the flow to 14 or 21 ml/min had no significant effect on cutting efficiency.

The three stones tested for the effect of varying the water volume were representative of one of the fastest cutting stones (Densco), a slightly above-average stone (Midwest), and a below-average stone (Shofu). Unlike the tooth-cutting test at 150 g, the water flow had a uniform effect on stones of the various manufacturers, that is, the stones which cut most efficiently at 7 ml/min also were more efficient at either higher or lower flow rates. Densco, Den-Tal-Ez, and Unitek cut teeth the most rapidly at the 50 g load. Of the Ransom and Randolph stones, 16 of 18 failed to withstand the 10-minute tooth-cutting test. Fracturing at the shank neck has been previously assessed as torsional fatigue.

Durability in Glass

The durability of the various stones (Figs. 7 & 8) was evaluated by comparing the declining average cutting rates at the initial, middle, and

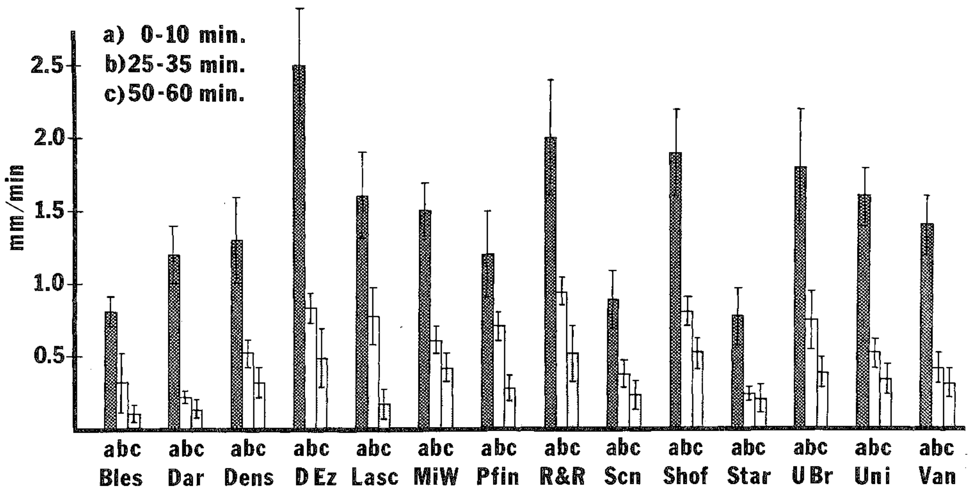
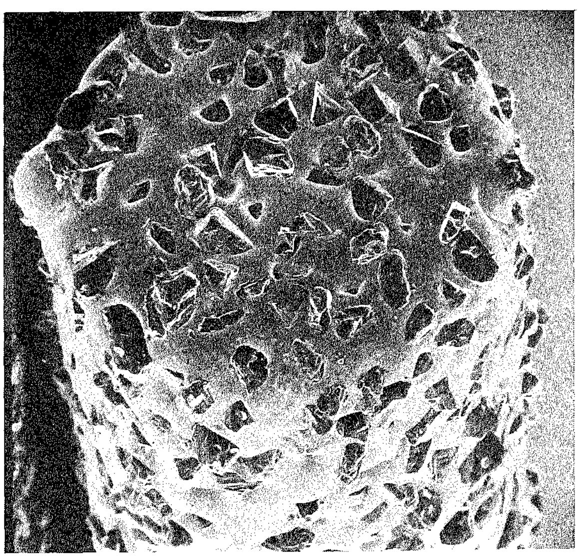


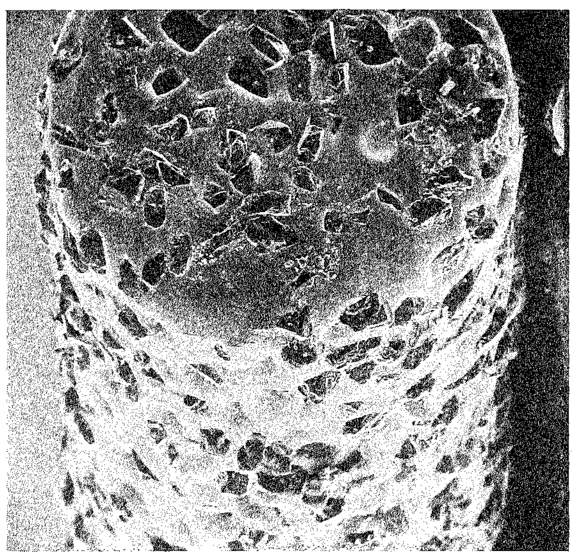
FIG. 8. When a lighter load of 1.8 ounces (50 g) is used on glass, a rather uniform fall-off in performance results, accompanied by a much slower cutting rate. Most stones did not break under the lighter load.

final 10-minute segments of the one-hour glass-cutting test. Though there are a few distinct differences in glass-cutting rates, stones showed a rather uniform geometric fall-off in performance during both the 150 g and 50 g hour-long test. Densco, Ransom and Randolph, Star, and Unitek stones failed before completing the 150 g test, but withstood the 50 g load. Sixty-three percent of the Ransom and Randolph stones withstood the 50 g test.

The scanning electron micrographs (Fig. 9) were intended to show the various amounts of attrition suffered by the respective stones. The before and after view of the Union Broach stone at 57x magnification does show considerable wear. In our view neither the before nor after SEMs were predictive of a diamond's performance in either glass or teeth. When



SHOFU — NEW

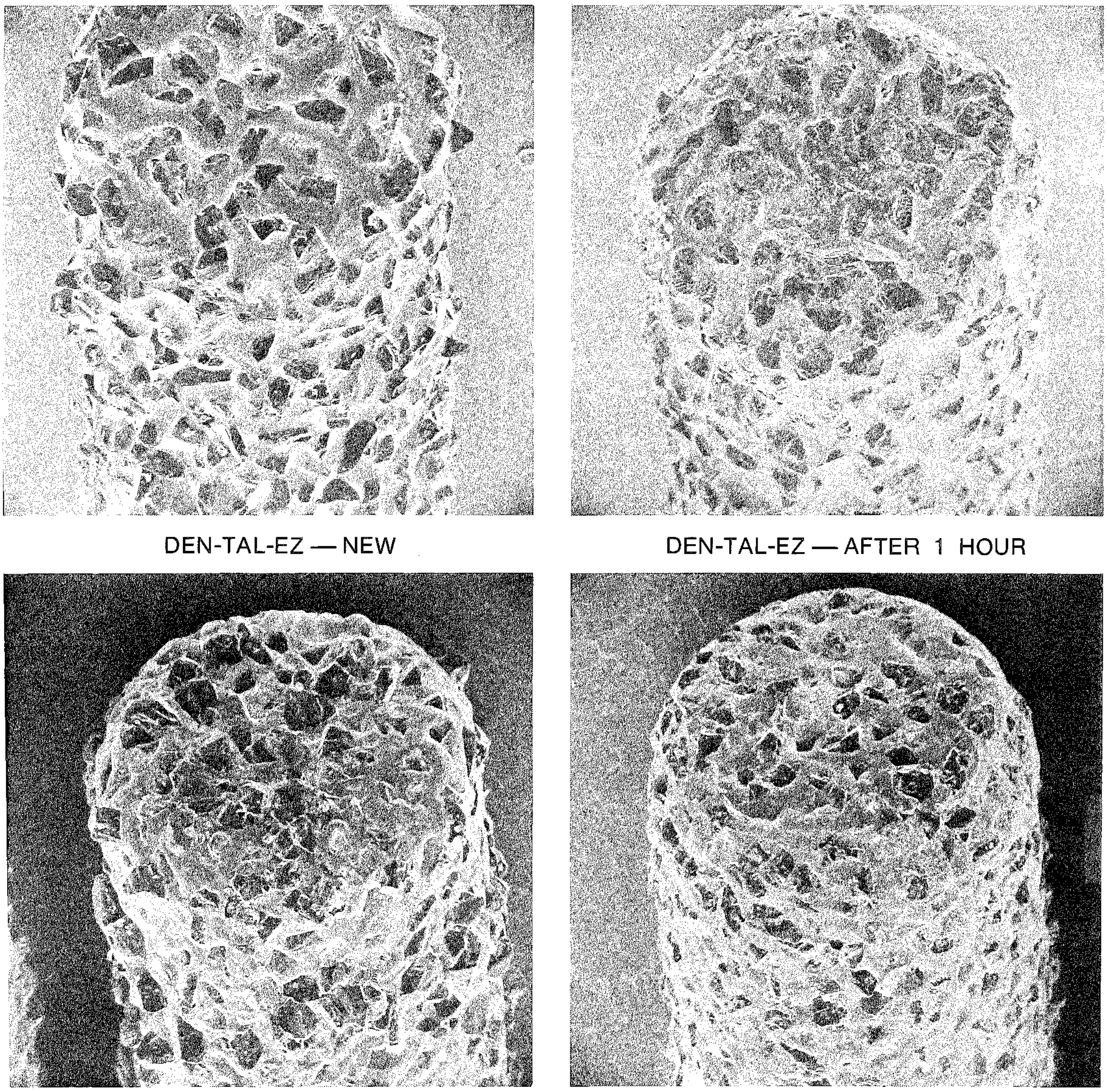


SHOFU — AFTER 1 HOUR

new, and after having cut glass for one hour, the Den-Tal-Ez stone appears to exhibit a more abrasive surface than the Shofu stone. However, Shofu stones cut slightly more rapidly in teeth with 21 ml/min of water than the Den-Tal-Ez stones. Only in teeth at 7 ml/min of water flow did the more abrasive appearing Den-Tal-Ez stone cut more rapidly than the Shofu stone.

DISCUSSION

An earlier study of ours (Eames & Nale, 1973) reported that carbide burs cut a maximum of 20 mm in glass before dulling to the point where they could no longer perform. Under nearly identical conditions, diamonds which completed the one-hour glass test cut a



DEN-TAL-EZ — NEW

DEN-TAL-EZ — AFTER 1 HOUR

UNION BROACH — NEW

UNION BROACH — AFTER 1 HOUR

FIG. 9. Diamond stones shown under scanning electron micrograph magnification (originally 57X), new and after one hour of glass cutting. The use of SEMs were not predictive of diamond stone performance.

minimum of 360 mm to a maximum of 800 mm in that period of time. Carbide burs also showed a considerable drop-off in efficiency after having cut teeth for 7 to 9 minutes. After 10 minutes, the cutting rate of the carbide bur was approximately 8 mm/min. Diamond stones, however, showed no fall-off in cutting rate after 10 minutes. Furthermore the cutting rate of the diamond stones could be increased at the 150 g load from an average of 15 to 26 mm/min by increasing the rate of water flow used to cool and clean the field.

Using the lighter 50 g load with only 7 ml/min water flow, the average stone cut at a rate of 7.6 mm/min in teeth. This was 2.5 times faster than the average carbide steel bur tested, using the same load and water flow.

Lack of torsional strength of the shank was often experienced during the testing. Breakage unexpectedly proved to be the most troublesome point in the entire study. Stones that broke before completion of a test were not included in the data.

We do feel that our tests, while admittedly severe, may be reflective of the diamond stone's long-term usefulness and safety. Carbide burs withstood equally strenuous tests without shank breakage.

This study underscores the effect of water flow on the cutting rates of diamond stones. At low water flow rates, stones clog and their maximum potential is not realized.

Although not intended as a part of this particular study, a side result of the experiments was the discovery that if diamond stones clog, under the conditions described, and if high levels of water spray are not acceptable, they may be cleaned effectively by frequently using the small Chairside Ultrasonic Cleaner (Yates & Bird, Chicago, IL 60610, USA) or by using cleaning stones manufactured for this purpose such as Clean-Diamond (Den-Tal-Ez Manufacturing Co., Columbus OH 43219, USA) or the 172 Densco Cleaning Stone (Teledyne Dental, Densco Division, Denver, CO 80207, USA).

The Analysis

Because the equivalents of 557 size diamonds varied somewhat in diameter with the manufacturer, we determined early in our testing to limit their variance to only 0.1 mm, that is, between 1.1 and 1.2 mm. It was felt that this was a fairly stringent requirement and in fact did eliminate some diamond products from the study. At the conclusion of the tests, while conducting an analysis of our data it became apparent that the 0.1 mm difference was significant.

Using the 50 g tooth-cutting data, the *t* test was applied to the mean scores of both 1.1 and 1.2 mm diameter stones. The mean cutting rate of the 1.1 mm stones (8.51 mm/min) was significantly greater ($p < .05$) than that of the larger 1.2 mm stones (6.43 mm/min).

Although a size variance of 0.1 mm is virtually impossible to discern, the effect of this miniscule differential upon the stone's cutting efficiency perhaps should be considered in designs of future tests.

Due to lack of correlation between the glass and tooth-cutting test methods, no single manufacturer's stone has shown a statistically significant overall superiority. *While no one diamond far excelled in our tests, they did as a whole cut two to three times faster in teeth, and 18 to 40 times farther in glass than carbide burs.*

This study was supported in part by the National Institutes of Health, National Institute of Dental Research, Research Grant No. 5 RO 1 DE 03504-08 and by the Fifth District Dental Society of Atlanta.

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DEPARTMENTS

Press Digest

On the use of fissure sealants in caries prevention. Alvesalo, L., Brummer, R. & LeBell, Y. (1977) *Acta Odontologica Scandinavica* (35) 155-159.

First permanent upper and lower molars as well as first and second deciduous molars for 163 children, 6–7 years old, were sealed with Nuva-Seal. At the end of 2 years, 73 children were available for examination. At the end of 1 year the estimated rate of caries reduction was 84%, and at the end of 2 years, 53%. The author suggests that if a long-term reduction in caries is to be achieved the patients should be examined every 6 months and the fissures resealed where necessary. The advantage of the sealant is that restorative procedures can be postponed.

Marginal adaptation of restorative resins in acid etched cavities. Asmussen, E. (1977) *Acta Odontologica Scandinavica* (35) 125-133.

Marginal adaptation of 12 restorative resins was investigated in extracted human teeth. The effects of absorption of water and changes in temperature on the formation of marginal gaps were studied. The enamel walls of the cavity and 1.5–2 mm of adjacent surface enamel were etched with 35% H_3PO_4. When polished and examined immediately after setting, Sevriton Simplified, Opotow, Adaptic, Concise, Compact, and Smile showed no marginal gaps. On the other hand, gaps were found in some of the samples of Cosmic, HL72, Concise cap-c-rynge, Estic pasta, Compocap, and Prestige. Gaps appeared around the margins of some of the samples of the first group after storage in water at 37 °C for 1 day. Gaps were also formed after the specimens were cooled from 37 to 23 °C. Storage for 1 day in water at 37 °C before polishing reduced the tendency of gaps to form.

Critical discussion of previous experience and new approaches in the development of composite filling materials. C-H Fischer (1977), *International Dental Journal* (27), 130-138.

The final word on the value of a material for dental restorations can be given only after the performance of the material in the oral cavity has been assessed. Observation over a period of a year gives some information; after two years, important differences will be recognized, and over more than four years the results become more significant. Monitoring a sufficiently large number of patients or fillings over a long period is difficult. New materials are constantly being placed on the market without evidence that they have undergone sufficiently long periods of clinical trials.

Chemical bonding of plastics to tooth tissue has been under investigation but the problem is a difficult one and so far success has been elusive.

An adhesive effect may be obtained by mechanical anchorage but so far the adhesion to enamel has been of limited duration. Etching the enamel with acid improves the adhesion of the restorative material. The natural surface of the tooth is destroyed by the demineralization but no damage is expected because even if there is no covering with plastic rapid remineralization seems to occur.

The relatively high coefficient of thermal expansion of resins compared with tooth structure can be reduced by adding an inorganic filler with a very low coefficient of thermal expansion. Even so stain occurs around the filling, but the margins can subsequently be corrected without renewing the whole filling.

Attempts are continually being made to improve resistance to wear. No objective clinical studies have been carried out over a sufficiently long period of time and in a sufficient number of cases to show that contours are maintained when Class II cavities of premolars and molars are filled with composite filling materials, though there are some showing that this does not happen.

Plastics that are polymerized by ultraviolet light permit application in layers and stepwise polymerization which can be beneficial.

The extent to which plastics are tolerated by the pulp is still debated. The amount of pulp damage is determined by the dose of toxic substance in the material and varies from pulp to pulp. Damage does not always lead to pulp necrosis.

The smoothest surface is that obtained with a matrix band. Metal particles from the use of burs in finishing can cause discoloration. Linen strips and fine paper discs are preferred for smoothing. Rubber discs give the best polish.

There is now strong opposition to the view that in certain circumstances lining with a base is unnecessary.

Absorption of water with subsequent swelling can compensate to some extent for the shrinkage of polymerization but the practical effect of closing the marginal gap has not been shown.

Radiopacity is desirable to permit the diagnosis of secondary caries by X-ray examination. Glass fillers provide adequate radiopacity.

Status report: high copper amalgams. CDA Council for Dental Materials and Devices (1977), *Journal of the Canadian Dental Association* (43), 437-439.

High-copper alloys have better physical properties for dental purposes than have conventional alloys. Dispersalloy has been on the market for several years and has proven itself worthy of being classified as a superior amalgam alloy. The clinical performance of the other high-copper alloys is not yet fully known because they have appeared on the market only recently. Most of them have values for creep approximating that of Dispersalloy and thus should have the resistance to marginal fracture demonstrated clinically by Dispersalloy. Only Micro II and Optaloy II have higher values of creep but even so they are in this respect superior to conventional alloys.

High-copper alloys should resist corrosion and this has been proven under oral conditions by Dispersalloy. Indiloy (containing indium) may be a breakthrough if it provides an inert restoration as claimed by the manufacturer, but only time will tell.

High-copper alloys also develop higher early strength and should be more resistant to bulk fracture.

When selecting an alloy, factors other than these should also be considered, such as speed of the operator, size, shape and location of the cavity, ability of the operator to handle the various shapes of particles, and the carvability and feel of the material.

In addition, a successful restoration requires proper manipulation of the materials, correct cavity preparation, a dry field, proper occlusion, and final polish.

Book Review

A MANUAL OF OPERATIVE DENTISTRY

By H M Pickard, FDSRCS(Eng.), MRCS(Eng.), LRCP(London)

Published by Oxford University Press, 1976. Fourth edition. 189 pages. Illustrated and indexed. £3.50 net in UK; $8.25 in USA.

This paperback handbook is intended to serve second and third year students with a rationale for understanding principles of operative dentistry. The manual does not intend to supplant standard textbooks, to some of which references have been made, but rather it should be used as a supplement to existing literature. The fourth edition has been rewritten and all chapters have been revised; equivocally updated.

While the author has perhaps wisely eschewed emphasizing discussion of clinical theory and research data with its extensive speculation, he has included the more basic concepts of common operative procedures. The author, perceiving that the novice has not yet developed consistent strategies of any interest, presents clinical information in a manner conducive to introspective evaluation. For instance, in chapter one the ergonomic design of equipment and facility layout is such that the operator is both comfortable and efficient. It is easy for the student to visualize for himself the benefits and efficacy of such designs.

A special and most interesting feature of this manual is the inclusion of two chapters on direct gold inlay techniques. Though the direct inlay has not been in fashion for some time, the direct techniques show the essentials of all inlay techniques and are in themselves suitable for small and uncomplicated cavities. Valuable information is provided for both the single surface restoration and the compound cavities.

The manual could do without the section on the bonded amalgam restoration. This is an antiquated technique rich in hope but poor in theory. The placement of phosphate cement in a cavity preparation just prior to insertion of amalgam can lead only to disaster.

It is surprising, at least to this reviewer, to find two chapters dealing with root canal therapy and instrumentation in this manual. The inclusion of information on vital pulp therapy and the prevention of pulpal pathosis seems appropriate enough; however, the manual would be better served if these chapters were printed elsewhere.

Equally astonishing and inexplicable is the omission of information on the use of gold foil. The author laments his omission of this proven filling material, but offers no reasonable explanation for denying students access to information on direct gold theory and technique. There are clear value choices to be made in dental education, and the choices have distinct consequences for students' achievement and clinical behavior. Learning the gold foil technique unquestionably strengthens the clinician's competence.

These shortcomings notwithstanding, the manual provides interesting information and gives the student a rational understanding of the technical problems of operative dentistry.

J Martin Anderson

Letters

Dear Sir:

Your editorial in *Operative Dentistry*, Spring, 1977, Vol. 2, No. 2, couldn't be more apropos in your evaluation of the State Board Examinations.

If my memory serves me faithfully, it seems that state board examinations were instituted for the express purpose of controlling the nefarious, or fly-by-night, dental schools that were part of the scene at that time. Now, by some magic, the term 'accreditation' supposedly takes care of all of the necessary requirements for optimum professional training.

A case in point is the local public school system, wherein teaching has been "innovated" to a point where some of the high school graduates cannot pass a third grade reading test. Now, I understand there is a movement afoot by those concerned to institute a state board examination for high school graduates in an attempt to bring the teaching of basic skills back into proper perspective.

Sincerely,
Earl C Maston
5126 25th Avenue N.E.
Seattle, WA 98105

Announcements

NOTICE OF MEETINGS

Academy of Operative Dentistry

Annual Meeting: February 2 and 3, 1978
Hyatt Regency Hotel
Chicago, Illinois

American Academy of Gold Foil Operators

Annual Meeting: October 19 and 20, 1978
Pearl Harbor
Hawaii

NEWS OF STUDY CLUBS

Course in Gold Foil Procedures
Seattle, Washington

The Associated Ferrier Study Clubs are planning to offer a 2-week course, September 18-29, 1978, in Seattle. This is the class participation, clinical course that is provided by the Association for its Associate members. A limited number of non-members of the Study Clubs can usually be accepted into the class, depending on available facilities.

Anyone who is seriously interested in such a course is invited to indicate his or her interest, as soon as possible, to the Association Secretary,

Dr. Bernard Lodge
624-6th St
New Westminster BC
Canada V3L 3C4

OPERATIVE DENTISTRY

volume 2
1977

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AMERICAN ACADEMY OF GOLD FOIL OPERATORS
ACADEMY OF OPERATIVE DENTISTRY

OPERATIVE DENTISTRY

Aim and Scope

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

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