OPERATIVE DENTISTRY

january - february 1991 • volume 16 • number 1 • 1 - 40

(ISSN 0361-7734)

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JANUARY - FEBRUARY 1991 • VOLUME 16 • NUMBER 1 • 1 - 40

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.

Publisher
Operative Dentistry (ISSN 0361-7734) is published bimonthly in January, March, May, July, September, and November. *Operative Dentistry* is the official journal of the American Academy of Gold Foil Operators and the Academy of Operative Dentistry.

POSTMASTER: Send address changes to: Operative Dentistry, Inc, University of Washington, School of Dentistry, SM-57, Seattle, WA 98195, USA.

Subscriptions
Yearly subscription in USA and Canada, $55.00; other countries, $65.00 (sent air mail); dental students, $25.00 in USA and Canada; other countries, $34.00; single copy in USA and Canada, $15.00; other countries, $18.00. For back issue prices, write the journal office for quotations. Make remittances payable (in US dollars only) to *Operative Dentistry* and send to the above address.

Contributions
Contributors should study the instructions for their guidance printed inside the back cover and should follow them carefully.

Second class postage paid at Seattle, WA.

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

Subscription Manager
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EDITORIAL

Silver Amalgam under Attack

Dentistry in North America was dealt a severe blow on 16 December 1991. It came in the form of CBS-TV's news program *60 Minutes*. Approximately half of the program dealt with the potential hazards of silver amalgam. Biased and presenting the concepts long held by those who have been prejudiced against silver amalgam for many years, it did considerable harm to our image as health care providers and to the well-being of many patients who watched or heard about the program.

Many dentists felt the ADA's defense on *60 Minutes* was inadequate, but the response they wanted to hear would not be possible on such a biased and prejudicial program. I congratulate the ADA and Dr Simmons for their efforts on *60 Minutes*. Just two days ago I received my ADA journal, which included an insert dealing with the problems generated by that program. Such an immediate response from organized dentistry will be of assistance to us all. The Washington State Dental Association provided all members with a set of sample questions and answers to use in response to their patients' questions about amalgam. One would assume that other state organizations did the same. There was an excellent article entitled "When your patients ask about mercury in amalgam" (*JADA* 1990;120:395-398) which is excellent for patient education. If you have not read or used it with your patients, it would be worth having on hand.

Dentists across this continent were deluged with phone calls in the week following the initial airing of the show and also the following week when letters to the program were aired. Likewise, dental schools received huge numbers of calls from people who wanted to know where they could find a dentist who would remove all their silver amalgams. Patients are alarmed and frightened as a result of the type of journalism displayed on *60 Minutes*.

Silver amalgam has served us well for almost 150 years. It would be to the dentists' and the patients' benefit if we were to continue to use it until a direct restorative material was available which functioned as well as amalgam, and at such a reasonable cost to the patient. Amalgam remains the primary posterior restorative for most patients; no suitable replacement is available today. Any alternative to silver amalgam is more expensive to the patient and more technic-sensitive to the dentist. In the end, if we were forced to eliminate the use of silver amalgam it would be a serious problem for the majority of patients.

The effects of this program will be with us a long, long time. It is but a sign of the growing pressure by a very vocal group of "antiamalgamists" who will stop at nothing to prevent dentists from using silver amalgam in the treatment of their patients. This phenomenon is somewhat regional but growing each year. The number of antiamalgamists in the health care industry outside of the dental profession is increasing. Unfortunately, these misguided individuals frequently have great influence in the community. It is very, very difficult for dentists to defend the use of silver amalgam when there are physicians in the community actively counseling patients to have their amalgams removed. In general, patients tend to believe the MD before they believe the DDS or DMD.

Now that the controversy has received such national "news" coverage, we can assume that it will continue until we stop using silver amalgam. (Notice that I use the term "silver amalgam" and that everyone opposed to it, including the news commentators on *60 Minutes*, use the term "mercury amalgam.")

It is not hard to imagine that patients will have more faith in the news media than in the profession and that we will give up the right to use such a useful restorative rather than fight a society that does not want it. Patients in increasing numbers will refuse to accept dental amalgam as a restorative. We may eventually encounter legislation prohibiting the use of dental amalgam.

Let us keep up the good fight and maintain for the profession one of our oldest and most successful materials.

DAVID J BALES
Editor

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ORIGINAL ARTICLES

Shear Bond Strength of Composite Resin to Amalgam: an Experiment in Vitro Using Different Bonding Systems

F HADAVI • J H HEY • E R AMBROSE

Summary

The shear bond strength between amalgam and composite resin with and without the use of adhesive systems was evaluated. It was found that the application of Cover-Up II or Prisma Universal Bond prior to placement of composite resin enhanced the shear bond strength between amalgam and composite resin more than five times; and a shear strength of 4.34 and 4.30 MPa was measured respectively. Acid-etching of the roughened amalgam surface prior to application of Prisma Universal Bond decreased the bond strength by nearly 45%.

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Introduction

Dental amalgam is an excellent, widely used restorative material in dentistry. Some clinical situations, however, necessitate joining an amalgam restoration with composite resin because of extensive defects in tooth structure or to mask the unesthetic appearance of the amalgam restoration. Composite resin and dental amalgam are two dissimilar materials, therefore the question is whether any problems are likely to arise from such a combination.

Some bonding systems have been promoted to chemically bond composite resin to amalgam. Cooley, McCourt, and Train (1989) used a bonding system containing 4-methacryloxyethyl trimellitate anhydride (4-META) (Cover-Up II, Parkell Products, Inc, Farmingdale, NY 11735) to bond composite resin to amalgam and reported a bond strength between 7.47 and

4.40 MPa. They also tested a modified phosphate ester of BISGMA-containing bonding agent (Panavia, J Morita USA, Tustin, CA 92680) for which a bond strength between 3.84 and 3.19 MPa was measured. In a study conducted by Murrey and Bailey (1988), a 4-META-based bonding agent (Cover-Up, Parkell) showed a bond strength of 5.2 to 3 MPa to amalgam, depending on age and thermocycling of the test sample.

One commonly used adhesive system to bond composite resin to tooth structure is Prisma Universal Bond (L D Caulk Co, Milford, DE 19963).

The purpose of this study was to present a comprehensive evaluation in vitro of the shear bond strength of Prisma Universal Bond and Cover-Up II to amalgam.

Materials and Methods

Forty-eight round acrylic (Orthocryl, Stratford-Cookson Co, Newman, GA 30264) cylinders were fabricated with a diameter of 33 mm and a height of 20 mm to fit into the device used during shear bond strength testing. A round undercut cavity (diameter, 8 mm; depth, 2.5 mm) was prepared in the center of the acrylic surface and the cavity was restored using a non-gamma-2 spherical amalgam (Tytin, Sybron/Kerr, Romulus, MI 48174).

The amalgam alloy was triturated in a Varimix III amalgamator (L D Caulk Co), according to the manufacturer's recommendations for speed and time and condensed using a hand condenser following acceptable operative procedures (Charbeneau, 1988). The cavity was overfilled and with a sharp hand instrument the mercury-rich excess was removed.

After 15 minutes, the acrylic cylinders were placed in a water bath at room temperature for 10 days. Then the amalgam surface was roughened with a diamond bur #701-8p (Den-Tal-Ez, Lancaster, PA 17601).

The samples were assigned at random to four experimental groups, each consisting of 12 samples:

Group	Treatment
1	No further treatment
2	One layer of Prisma Universal Bond was applied on the amalgam, thinned with a stream of air, and light-cured for 20 seconds.
3	Tooth conditioner gel, containing 35% orthophosphoric acid (Coe Laboratories, Inc, Chicago, IL 60658) was brushed on the amalgam. After 60 seconds the surface was rinsed and dried thoroughly and Prisma Universal Bond was applied as in group #2.
4	Cover-Up II was applied in two steps according to the manufacturer's instructions and allowed to cure for three minutes.

The acrylic cylinders were immediately placed in a plastic holder with an inner diameter of 33.5 mm and a round split die with a 4 mm opening was placed on the top of it in the plastic holder (Fig 1). A composite resin (Occlusin, Coe Laboratories) was inserted in three increments

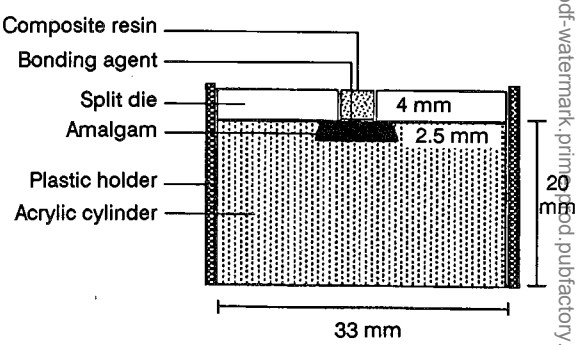

FIG 1. *Cross section of test sample*

with a teflon-coated hand instrument using a smearing technique to avoid air incorporation and porosity (Chadwick & others, 1989). Each increment was cured for 40 seconds using a Visilux 2 light-curing unit (3M Dental Products, St Paul, MN 55144). The acrylic cylinder and split die were released from the holder and the split die was carefully removed. This created a composite resin cylinder 4 mm in diameter and length, bonded to the underlying amalgam restoration at a 90° angle. All specimens were stored in distilled water at 37 °C for 24 hours.

The samples were mounted in a Universal Testing Machine (Lloyd Instruments, Southampton, S03 6HP, England) using an alignment jig and subjected to a shear strength force with a crosshead speed of 0.01 inch/min until debonding resulted. The data were analyzed with Student's *t*-tests and evaluated for significance.

Results

The mean shear bond strength and standard deviation in the test groups are shown in the table and Figure 2. There was no significant difference between group #2 and group #4 ($P = 0.902$). Etching of the amalgam surface before application of Prisma Universal Bond (group #3) affected the shear bond strength significantly in comparison to group #2 ($P < 0.01$). All samples in group #2, #3 and #4 broke at the junction of amalgam and bonding agent. The shear bond strength measured in group #1 was significantly lower than in all other test groups ($P < 0.001$), and the samples broke at the junction of amalgam and composite.

Group	1	2	3	4
Mean (MPa)	0.83	4.30	2.45	4.34
Stdev	0.21	0.78	0.53	0.60

Shear Bond Strength and Standard Deviation in Different Test Groups (MPa)

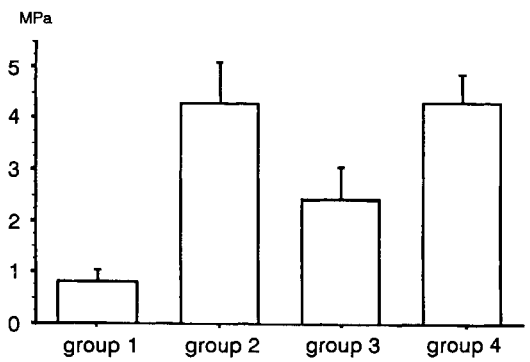

FIG 2. *Shear bond strength in the different test groups*

Discussion

This study showed comparable shear bond strengths for Prisma Universal Bond and Cover-Up II. Cooley and others (1989) reported that diamond-treated amalgam surfaces provided a higher bond strength of Cover-Up II than an air-polished surface. They did not report, however, what type of diamond stone was used to prepare the amalgam surfaces in their testing. In our study a coarse diamond bur was used, creating a rough surface, but our results did not reach the level of their findings. Cooley and others (1989) also utilized a different type of amalgam (Dispersalloy, Johnson & Johnson Dental Products Co, East Windsor, NJ 08520), and it is unclear if this has influenced the bond strength of Cover-Up II.

Murrey and Bailey (1988) studied the original Cover-Up and they found a bond strength to Tytin between 5.2 and 3 MPa. These bond strengths are similar to findings in the present study, although an improved formulation of the original Cover-Up was utilized.

Prisma Universal Bond is a one-component, visible-light-cured adhesive. This bonding agent has been advocated for its effectiveness in bonding to enamel and dentin. Hammesfahr, Huang and Shaffer (1987) reported a bond strength of Prisma Universal Bond to etched enamel between 3220 and 2970 psi (22.2 and 20.5 MPa) and to dentin between 1080 and 961 psi (7.5 and 6.6 MPa). 4-META has been reported to adhere with a bond strength of 14 MPa to etched enamel, over 17 MPa to dentin treated with a solution of 3% ferric chloride in 10% citric acid, 20 MPa to porcelain primed with a silane coupling agent and ferric chloride, over 21 MPa to sandblasted cobalt-chromium alloys, over 19 MPa to sandblasted gold alloy and more than 24 MPa to nickel-chromium alloy (Swift, 1989; Tanaka & others, 1981; Tanaka & others, 1988). In this study, neither Prisma Universal Bond nor Cover-Up II presented shear bond strengths to amalgam close to these ranges. The comparatively low strengths found in this study suggest that when amalgam and composite resin are joined, the use of an adhesive system by itself is inadequate. Added retentive features are essential to enhance mechanical retention and create a restoration that is more functional.

Tanaka and others (1981) reported that oxidation of alloy surfaces resulted in a significant improvement in durability of adhesion, indicating that 4-META resin bonds more strongly to the oxide film than to metal itself. The shear bond strength of Prisma Universal Bond achieved in this study suggests that some component(s) of this bonding agent possibly react with the oxide film formed on the amalgam. Hadavi, Hey, and Ambrose (1990) evaluated the microleakage between amalgam and composite resin and

concluded that significantly more microleakage was found when Prisma Universal Bond was applied to the roughened etched amalgam prior to placement of composite. Acid-etching probably removes the oxide layer from the amalgam surface and this might explain why bond strength was reduced by 45% and microleakage increased.

Conclusion

There was no significant difference between the shear bond strength of Prisma Universal Bond and Cover-Up II to amalgam. The bonding between amalgam and composite resin was almost five times higher when using either Prisma Universal Bond or Cover-Up II. The results indicate, however, that an adhesive system by itself does not join amalgam and composite resin with sufficient bond strength and that additional retentive features are essential. Further investigation is needed to explore composite/amalgam adhesive possibilities, especially regarding their long-term potential under conditions in vivo.

(Received 4 June 1990)

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Assessing Microleakage at the Junction between Amalgam and Composite Resin: A New Method in Vitro

F HADAVI • J H HEY • E R AMBROSE

Summary

A new dye-diffusion test method was utilized to evaluate the microleakage between amalgam and composite resin. An amalgam cylinder was made to which a base of composite was added. The effects of several factors upon the microleakage were investigated. The test results indicated less microleakage when bonding agent was applied directly to the roughened amalgam prior to placement of composite resin. The most microleakage was found when roughened amalgam surface was acid-etched before placement of bonding agent and composite resin.

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INTRODUCTION

Dental amalgam continues to be a good material for restoring posterior teeth. The poor esthetic results in the more visible areas of the mouth, e g, canine and premolar areas, however, limit the use of silver amalgam. In several publications (Anglis & Fine, 1982; Barkmeier & Cooley, 1979; Cardash & others, 1990; Durnan, 1971; Gordon, Laufer & Metzger, 1985; Gourley & Ambrose, 1982; Lambert, Scrabeck & Robinson, 1983; St Arnault & Coury, 1983; Zalkind & others, 1981) the application of composite resins has been advocated to mask the unesthetic appearance of amalgam in these areas. Some

other clinical situations also necessitate placement of the composite resin restoration adjacent to an existing or freshly placed amalgam restoration and vice versa. It is not determined, however, if such a combination serves as a provisional solution or has a more permanent character. Amalgam and composite are very different types of restorative material and a definitive technique for combining them has not been well documented.

A few studies (Fuks & Shey, 1983; Kossa, 1987; Maroney & others, 1988; Cardash & others, 1990) reported the microleakage at the junction of amalgam and composite resin. The presence and amount of microleakage between composite resin and amalgam are likely related to several factors: initial adaptation of composite resin to the amalgam surface, dimensional changes of composite resin due to shrinkage of polymerization, thermal contraction or absorption of water, and other operator-related factors coupled with the dimensional changes of amalgam.

The purposes of this study were to: (a) measure microleakage at the amalgam/composite interface utilizing a new test method and (b) evaluate the influence of different surface treatments for amalgam on this process.

MATERIALS AND METHODS

Two types of mold were designed for this study. One mold was used to make amalgam cylinders with an inside diameter of 5 mm, a length of 10 mm, and a cylinder wall thickness of 2 mm (Fig 1). High-copper spherical amalgam (Tytin, Sybron/Kerr, Romulus, MI 48174) was used to make the cylinders. The other mold consisted of a mounted stainless steel positioning rod 8 mm long; with a diameter 3% smaller than the inside radius of the amalgam cylinder (Fig 2).

The amalgam cylinders were placed on the positioning rod to add a 2 mm base of composite resin (Ful-fil posterior restorative, L D Caulk Co, Division of Dentsply International, Milford, DE 19963).

The amalgam alloy was triturated in a Varimix III (L D Caulk Co) amalgamator at the manufacturer's instructed speed and time. Small increments of amalgam were immediately placed in the first mold and condensed with pressure intervals of approximately one second on each superimposed area. A hand condenser with a

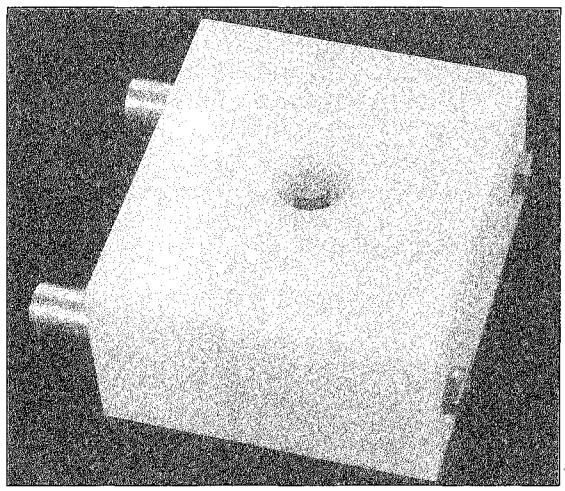

FIG 1. *Mold used to make the amalgam cylinder*

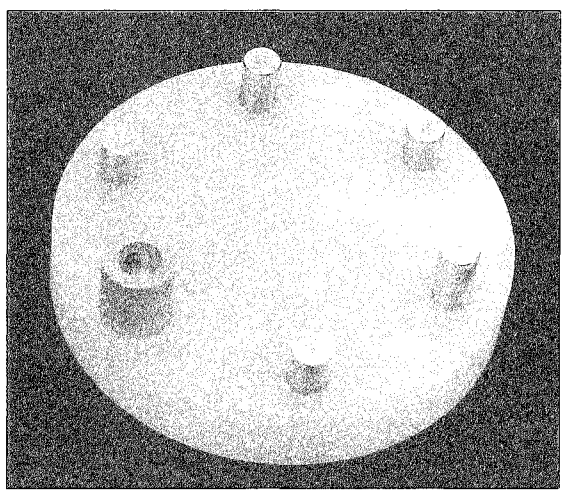

FIG 2. *Positioning rod*

smooth round surface and a diameter of 1.5 mm was used to apply a condensation pressure of 10-50 N per work surface. Each test sample was condensed for the same length of time by the same operator. The amalgam cylinders were left in the mold for one hour before being carefully removed and stored at room temperature. A total of 30 amalgam cylinders was made and divided, at random, into six test groups.

After 10 days, the lower 2 mm of the inner-face of the amalgam cylinders was roughened using a low-speed carbide bur #700 (Jet, Beavers Dental Products Ltd, Morrisburg, Ontario

K0C 1X0), and the amalgam cylinders were placed on the positioning rod. A 2 mm composite base was added to the amalgam cylinders after the treatments of the roughened innerface as shown in Table 1.

Table 1. Treatment Groups

Group	Treatment
1	No further treatment
2	Prisma Universal Bond (L D Caulk Co) was applied, thinned with a stream of air, and light-cured for 20 seconds.
3	Tooth conditioner gel (L D Caulk Co) was brushed on, and after 60 seconds the amalgam surface was rinsed and dried thoroughly.
4	After 60 seconds' etching with Tooth conditioner gel, the amalgam surface was rinsed, dried, and Prisma Universal Bond was applied as explained in group #2.
5	The amalgam surface was treated as explained in group #3, but Tooth conditioner liquid (L D Caulk Co) was used.
6	The amalgam surface was treated as explained in group #4, but Tooth conditioner liquid was used.

The composite resin was applied to the treated surface in two increments with a teflon-coated hand instrument using a smearing technique to avoid incorporation of air and porosity (Chadwick & others, 1989). Each increment was cured for 40 seconds with a Visilux 2 unit (3M Dental Products, St Paul, MN 55144). The samples were taken off the positioning rod and the junction of amalgam and composite polished with 600-grit sandpaper (Buehler Ltd, Evanston, IL 60204) to remove any composite flashes. The sample weight was measured on an electronic balance (Sartorius L 2205, Göttingen, West Germany) with an accuracy of 0.001 gram. The amalgam cylinders were filled with a solution of 0.05% fuchsin, and the weight of the samples was measured again. The weight difference presented the amount of solution. Wax was used to seal the amalgam cylinder top to prevent evaporation of liquid and the total weight of the sample was remeasured (Fig 3).

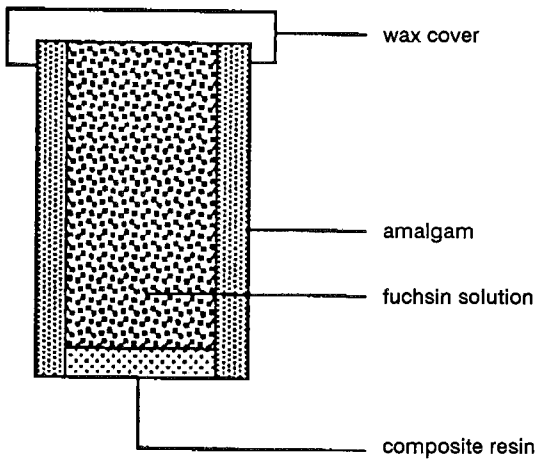

FIG 3. *Cross-section of the test sample*

The sample was placed on a filter paper with the composite base down,and the weight was measured after one, three, six, and 24 hours at room temperature. Any leakage through the junction between amalgam and composite would be evident by coloring the filter paper as well as by weight loss of the test samples. After each measurement the sample was placed on a new filter paper. The results were subjected to Student's *t*-test analysis and all data were evaluated for significance.

RESULTS

The results of the testing are summarized in Table 2. The most leakage measured was in test groups #1 and #3 - #6 after 24 hours. In groups #3 - #6, the leakage became obvious as soon as the amalgam cylinders were filled with the fuchsin solution; the dye solution penetrated all along the interface between amalgam and composite.

In group #1 the amount of leakage in the first hour was significantly less than in group #5 ($P < 0.05$), but after that no significant difference was found between group #1 and group #5 ($P > 0.05$).

In group #2 no leakage was found in the first hour. After three hours slight leakage was observed, which did not occur all along the interface, but at isolated spots. In later hours leakage

Table 2. Results of Microleakage Study

		BASELINE	AMOUNT OF LEAKAGE			
			1 hr*	3 hrs**	6 hrs**	24 hrs**
Group #1	Average (grams)	0.116	0.015	0.042	0.074	0.093
	St dev	0.011	0.016	0.050	0.049	0.042
	% leakage	0	12.9	40.2	63.8	80.2
Group #2	Average (grams)	0.112	0	0.0008	0.0018	0.025
	St dev	0.010	0	0.0008	0.0020	0.017
	% leakage	0	0	0.7	1.5	21.1
Group #3	Average (grams)	0.111	0.058	0.093	0.108	0.110
	St dev	0.005	0.041	0.02	0.006	0.005
	% leakage	0	51.9	83.6	97.7	99.1
Group #4	Average (grams)	0.107	0.070	0.087	0.106	0.107
	St dev	0.003	0.032	0.023	0.029	0.027
	% leakage	0	65.7	80.8	98.8	99.8
Group #5	Average (grams)	0.110	0.076	0.096	0.103	0.108
	St dev	0.002	0.024	0.009	0.005	0.006
	% leakage	0	69.2	87.1	93.7	97.6
Group #6	Average (grams)	0.115	0.062	0.084	0.105	0.112
	St dev	0.005	0.039	0.036	0.019	0.007
	% leakage	0	53.7	72.4	91.0	97.1

*Significant difference between group #2 and groups #4-6 ($P < 0.05$) and between group #1 and group #5 ($P < 0.05$)

**Highly significant difference between group #2 and groups #4-6 ($P < 0.01$) and significant difference between group #2 and group #1 ($P < 0.05$)

was noticed in larger areas. Figure 4 illustrates the microleakage patterns in the different test groups.

Figures 5 and 6 show graphic representation of the amount of microleakage.

DISCUSSION

With this new test method we were able to demonstrate and quantify the amount of microleakage in vitro. The significant difference in dye penetration in group #2 compared to groups #4 and #6 suggests a better adhesion of the bonding agent if the roughened amalgam surface was not acid-etched. This result is consistent with studies by Maroney and others (1988) and Cardash and others (1990), who reported microleakage at the etched-amalgam/composite resin interface. Etching of enamel is recommended to reduce the marginal leakage of

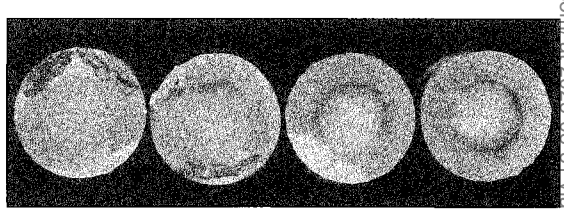

FIG 4. *Dye penetration at the junction of amalgam and composite resin base*

composite restoration because it increases the surface area for bonding, creates microporosities in the enamel, and encourages the wettability of the etched enamel surface (Asmussen, 1977; Retief, 1987). However, etching of the amalgam surface in this study showed an adverse effect on the leakage between amalgam and composite resin.

After evaluating the leakage in groups #3 and #4, in which etching gel was utilized, one of the

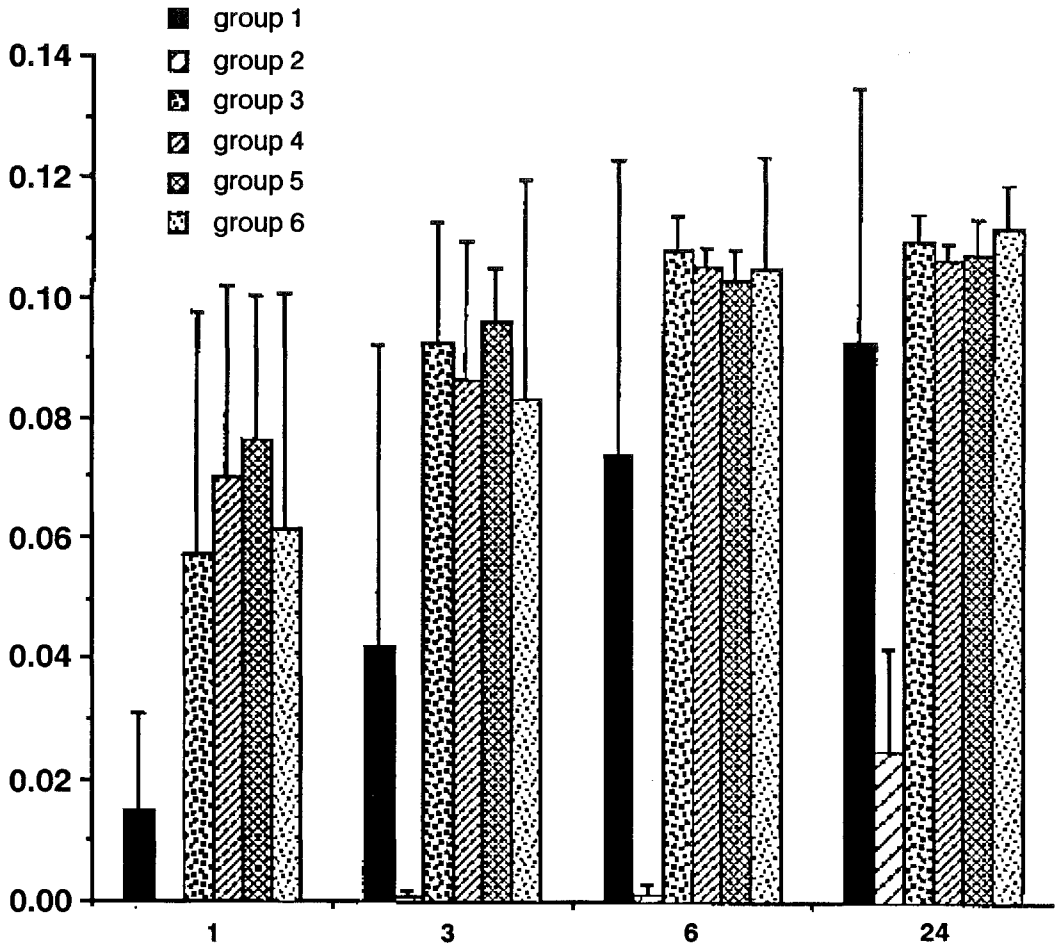

FIG 5. *Amount of dye penetration in test groups*

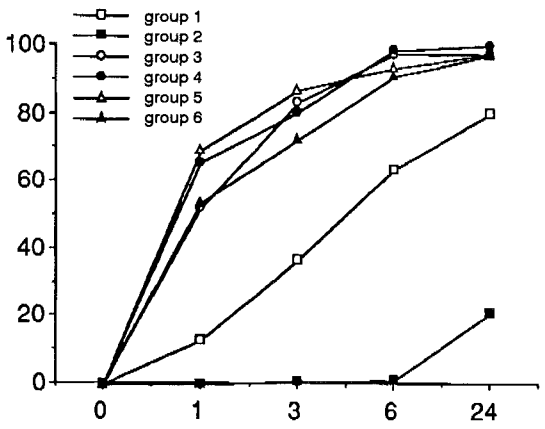

FIG 6. *Percentage of microleakage at different time intervals*

explanations for the increased amount of leakage was that it might not be possible to completely remove the gel from the roughened amalgam surface. However, when the amalgam surfaces were etched with liquid acid conditioner (groups #5 and #6) our results did not significantly differ from groups #3 and #4 ($P > 0.05$). These findings indicate that in regard to microleakage, it is advisable not to etch the roughened amalgam surface before applying bonding agent and composite resin. Some reaction between metal and bonding agent might be responsible for better adhesion, and acid-etching disrupts this process.

The magnitude of microleakage in test groups #1 and #3 - #6 is thought to be the result of polymerization shrinkage combined with lack of adhesion of the composite base to the amalgam

walls. The composite resin materials undergo contraction during setting (Hegdahl & Gjerdet, 1977). The contraction forces can cause cracks at the margin of the restorations or can create a gap between cavity wall and resin, allowing microleakage (Staninec & others, 1986). Walls, McCabe and Murray (1988) reported a polymerization contraction of Ful-fil of 2.48 and 2.77% after 30 and 60 seconds of light-curing.

In previous reported studies (Fuks & Shey, 1983; Kossa, 1987; Maroney & others, 1988) unfilled and filled self-curing resins were used. Kossa (1987) reported a study in which composite was added to amalgam or amalgam to composite using a conventional self-curing composite resin and no bonding agent or etchant. He concluded that microleakage through an amalgam-composite interface was decreased when placement of amalgam precedes the placement of composite. However, he reported marked leakage in both cases, which is consistent with our findings in group #1.

In a study reported by Fuks and Shey (1983) less microleakage was found between amalgam and sealants than between amalgam and tooth structure. They felt that the resilience and water resorption of the sealant contributes to a better adaptation. In our study less leakage was found in group #2 when bonding agent was directly applied to the roughened amalgam. This could be due to the bonding agent reacting with amalgam and/or smear layer produced during roughening of the amalgam surface and the mentioned qualities of the unfilled resin.

Several factors, such as corrosion, creep, thermal expansion, and bond strength were not evaluated in this study. Jodaikin (1981) reported that factors such as corrosion, amalgam creep, and deposition of metalloprotein complexes at the tooth/amalgam interface affect the marginal seal of amalgam restorations. We cannot predict what will happen at the amalgam/composite resin interface on a long-term basis; more study will be needed. It is also questionable whether the dye penetration pattern found in vitro can be applied to a situation in vivo. It has been reported that the penetration of dye was significantly less under conditions in vivo than in vitro (Loiselle & others, 1969).

CONCLUSION

This study addressed several factors that may affect microleakage at the amalgam/composite interface:

1. Direct application of bonding agent to the roughened amalgam surface prior to placement of composite decreased microleakage.
2. Etching of the roughened amalgam surface increased the amount of microleakage.
3. Direct application of composite to the roughened amalgam surface resulted in marked leakage.

Furthermore, our results indicate that when placing composite next to the enamel/amalgam junction, it is desirable to roughen amalgam after acid-etching, rinsing, and drying the enamel.

More investigation, however, is needed to test other physical properties of combined amalgam and composite resin restorations.

(Received 13 June 1990)

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Root Surface Marginal Microleakage of Composites: Comparison of Cavosurface Finishes

L J LITKOWSKI • M SWIERCZEWSKI

Summary

The effect on microleakage of a modification of the cavosurface finish was evaluated using extracted thermalcycled teeth. Composite resin was placed in cavity preparations on root surfaces of teeth and finished to leave either a flash of material on the margin or finished flush to the margin. The teeth were thermalcycled for 10 days at 5 and 55 °C. The teeth were evaluated for microleakage using the silver nitrate staining procedure. Results showed a significant decrease in the amount of microleakage on the margins finished leaving a flash of composite resin. Clinical trials placing these restorations on root surfaces will be necessary to evaluate the impact on the periodontal health.

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Introduction

There has been a dramatic shift in the types of restorative services rendered by dental providers toward the placement of restorations on root surfaces. This has necessitated the development of materials that will bond to root surfaces and provide a functional and esthetic result. A recent NIH study concluded that the incidence of root caries will be one of the most rapidly expanding areas of dental disease (National Institute of Dental Research, 1987). This is due to a number of factors, including demographics and increased utilization of dental services with the resultant increase in the numbers of teeth saved in the older population (Beck & others, 1985; Katz & others, 1982; Seichter, 1987). Composite resin materials currently available fulfill the esthetic and functional requirements on

enamel, but the bonding materials are inadequate for long-lasting restorations in dentin and cementum.

Current methods for bonding composite resins rely on the enamel to attain a bond which is strong enough to resist polymerization shrinkage (Davidson & de Gee, 1984) and decrease the amount of marginal leakage (Crim & Mattingly, 1980; LeClaire & others, 1988; Torstenson, Brännström & Mattsson, 1985; Zidan, Gómez-Marín & Tsuchiya, 1987). Porte and others (1984) discussed the modification of cavity designs to enhance retention and showed that several experimental designs gave improved results. These cavity preparations all made use of an increase in the enamel surface area to increase the bond strength with the resultant decrease in microleakage. Thus the possibility exists that modification of cavity design may aid in the retention and decrease the microleakage of composites placed entirely on cementum or dentin. However, the bond strength reported for dentin is inadequate to resist marginal gap formation due to polymerization shrinkage (Davidson & de Gee, 1984). If the restoration is placed in an area with a limited amount of enamel to bond, the clinical retention of the restoration will be diminished. LeClaire and others (1988) reported that using a two-stage application of the composite resin reduced the amount of marginal microleakage below the cementoenamel junction. A study by Zidan and others (1987) evaluated marginal gap formation and compared restorations placed on both enamel and cementum. They reported that marginal gaps were present on the enamel location only 6% of the time, whereas they were present 75% of the time on the dentin locations. Although several studies have examined the microleakage of composites when placed on root surfaces (Fuks, Hirschfeld & Grajower, 1985; Hembree, 1986; LeClaire & others, 1988; Phair & Fuller, 1985), no study has evaluated the role of cavity design for root surface composite resin restorations. A previous study (Litkowski, Swierczewski & Strassler, 1990a) attempted to decrease microleakage by a modification of the cavity preparation with a 45° bevel placed on root surfaces. That study showed no decrease in microleakage with this modification. However, in the course of the study, it was noted that samples which were discarded due to a flash left after composite finishing showed no penetration of the silver nitrate dye. A study reported at the most recent IADR meeting (Chohayeb, Eichmiller & Rupp, 1990) also noted that the presence of gingival flash decreased the microleakage scores. The question of the role of gingival flash led to the design of the present study.

The purpose of this study (Litkowski, Swierczewski & Strassler, 1990b) is to evaluate microleakage in composite resin restorations placed entirely in root dentin with two cavosurface finishes. The finishing of each specimen was modified so that one margin contained a well-contoured, 0.5 mm flash of material over the cementum, while the opposite margin was finished to the dentin/cementum cavosurface margin with no flash remaining. The difference in microleakage between the two surfaces was compared. The present study compared the amount of microleakage between the two different cavosurface finishes.

Materials and Methods

Seventy-five root samples stored in saline at 4 °C were prepared to a butt joint on all margins using a pear-shaped #330 bur. The resulting cavity was completely surrounded by cementum with external dimensions of 2.0 mm x 2.0 mm and a pulpal depth of 1.5 mm (Fig 1). The specimens were randomly divided into three separate groups. Three dentin bonding agents, Gluma (Miles Dental, St Louis, MO), Scotchbond 2 (3M Dental Products, St Paul, MN 55144) and Tenure (Den-Mat Corp, Santa Maria, CA 93456) were placed following manufacturers' instructions. Herculite Hybrid Composite (Kerr/Sybron, Romulus, MI 48174) resin material was placed in

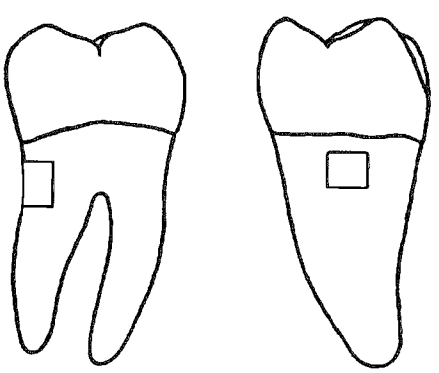

FIG 1. *Placement and design of cavity preparation*

the cavity preparations in three increments (Fig 2). Each increment was cured for 20 seconds with a Den-Mat CeriLight Visible Light Curing unit. One side of the cavosurface was finished flush to the margin leaving no flash of material. The opposite side was finished leaving approximately 0.5 mm flash of composite resin at the margin (Fig 2). These finishes were alternated between the apical and coronal portion of the preparation. The samples were trimmed and polished using 3M Sof-Lex fine-grit disks. The restored root surfaces were thermalcycled between two water baths for 10 days at approximately 500 cycles per day for a total of 5000 cycles. The water baths were maintained at 5 and 55 °C.

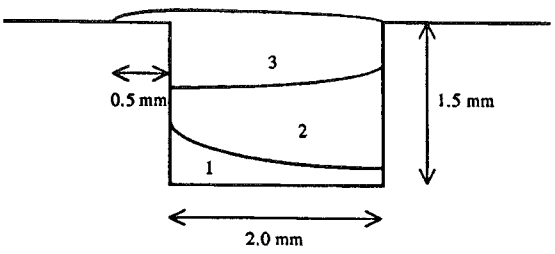

FIG 2. *Cavity preparation showing overall dimensions, width of flash, and incremental placement of composite resin on tooth-root surface*

Upon completion of the cycling, the samples were evaluated through the use of the silver nitrate staining techniques (Wu & Cobb, 1981) with modifications (Dumsha & Biron, 1984a; Dumsha & Biron, 1984b). Samples were first sealed to the margins with varnish, to inhibit alternate portals of entry for the stain. All teeth were placed in a 50% (by weight) silver nitrate solution at room temperature for two hours. The teeth were rinsed for 60 seconds and placed in rapid developing solution (IFP Developer, M & D International, Carpinteria, CA 93013) for two hours.

Using an Isomet Low Speed Diamond Saw (Buehler Ltd, Lake Bluff, IL 60204), the teeth were sectioned longitudinally through the midline of the restored cavity preparation. The sectioned teeth were examined under a stereo microscope at X15 power with a millimeter rule in the ocular.

Microleakage was expressed in categories determined by the extent of silver nitrate penetration as follows: category 0 = no leakage; category 1 = penetration of the silver nitrate up to 50% of cavity depth; category 2 = penetration of silver nitrate from 51 to 99% of cavity depth; category 3 = penetration to the pulpal wall and beyond. Statistical comparison between categories of microleakage of the no-flash versus flash groups was made using a chi-square analysis.

Results

The results of the microleakage measurements of the sectioned teeth are reported in the table. The distribution of categories is expressed as the number of teeth evaluated followed by the percentage in each category. A chi-square analysis was performed on each group and there was a significant difference ($P < .05$) between the no-flash versus the flash finish for all of the bonding systems.

Discussion

The purpose of this study was to attempt to decrease the amount of microleakage by a modification of the conventional cavosurface margin finish line. Statistically, there was a significant difference between the two methods with all of the bonding systems (table). This concurs with the study of Chohayeb and

Results of Silver Staining Measurements

Cavity Design	Microleakage Categories			
Gluma	**0**	**1**	**2**	**3**
No Flash	2/9%	18/78%	1/4%	2/8%
Flash*	10/43%	13/57%	0/0%	0/0%
Scotchbond				
No Flash	2/8%	19/76%	4/16%	0/0%
Flash*	11/44%	14/56%	0/0%	0/0%
Tenure				
No Flash	6/24%	16/64%	1/4%	2/8%
Flash*	15/60%	10/40%	0/0%	0/0%

*significantly different from the no-flash group

others (1990), who reported a decrease in the microleakage scores on cementum margins when a gingival flash of composite resin was left. These results raise several interesting issues. Although there is a significant decrease in the microleakage of the samples tested, the long-term effects of this modification on the periodontium must be evaluated to determine if there is an adverse tissue response due to gingival flash of composite resin. The concern about the periodontal response is somewhat heightened because the composite resins are brittle, and when placed in thin layers the possibility exists for chipping or cracking in these areas. This change in the polish and contour of the restoration could also lead to an increase in gingival irritation and the failure of the restoration.

Conclusion

Based on the dye penetration of silver nitrate solution, the flash cavity preparation has a significant decrease in the amount of microleakage on thermalcycled root surfaces. Clinically, this has significance to possibly decrease the leakage, increase the retention rate, and improve esthetics by a decrease on the marginal staining of class 5 cavity preparations on root surfaces. However, the periodontal health and the strength of the thin flash of composite must be evaluated in a clinical study before the standard method of placement for composite resins is modified.

(Received 20 June 1990)

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Longevity of Cusp-covered Amalgams: Survivals after 15 Years

ROGER J SMALES

Summary

The longevity of 124 cusp-covered class 2 amalgam restorations and 644 restorations placed without cusp coverage was assessed over periods of up to 15 years. The survivals of both groups of restorations were approximately 72% after 15 years. The longevity of the cusp-covered restorations was not affected significantly by the use of pins for retention, or by patient age. The survivals were much better than the estimates of longevity generally ascribed by dentists to cusp-covered or complex amalgam restorations.

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INTRODUCTION

The longevity of amalgam alloys used for the restoration of large cavity preparations in posterior teeth is generally considered to be inferior to that of cast alloys (Christensen, 1971, 1978; Marynuik & Kaplan, 1986), although there have been no long-term controlled trials which confirm such opinions.

A recent retrospective clinical study of the longevity of complex amalgam restorations found a 50% survival at 11.5 years (Summitt & Robbins, 1987), compared with longevity reports for various cast restorations which ranged from 42% survival at 10 years (Crabb, 1981) and 50% at 13 years (Mjör, Jokstad & Qvist, 1990), to over 90% at 10 years (Bentley & Drake, 1986; Leempoel & others, 1985).

In one study in vitro which used repetitive heavy angular forces, amalgam overlays showed more cracks and heavier wear facets, but less microleakage wear than did cast gold onlays (Liberman & others, 1987), while another study demonstrated that placing pinned amalgam

restorations with cusp coverage significantly increased the fracture resistance of wide class 2 preparations to values close to those of unprepared teeth (Reagan, Schwandt & Duncanson, 1989).

In the present long-term/ongoing clinical study, the survival of amalgam restorations used to restore class 2 preparations with or without cusp coverage or pin retention was assessed.

MATERIALS AND METHODS

A fine lathe-cut low-copper amalgam alloy, New True Dentalloy (S S White Co, Harrow, UK), and three high-copper amalgam alloys, Indiloy (Shofu Dental Co, Kyoto, Japan), Dispersalloy (Johnson & Johnson Dental Products Co, East Windsor, NJ 08520) and Tytin (S S White Co, Holmdel, NJ 07733), were placed in 768 class 2 cavity preparations. The 470 low-copper and 298 high-copper alloy restorations were inserted by a large number of operators in 332 premolar and 436 molar teeth in eligible patients treated at the Adelaide Dental Hospital, and assessed over varying periods of up to 15 years.

The majority of the amalgam restorations placed did not require cusp coverage. Cusp coverage was usually indicated when the occlusal width of the preparations had left severely weakened cusps, or when cusps had been lost. The affected cusps were generally covered with 2-4 mm of amalgam alloy. When used, one Thread-Mate-System Regular or Minim pin (Whaledent International, New York, NY 10001) was generally inserted for each cusp replaced. Rarely were pins used in the absence of cusp coverage.

The longevity of the restorations was determined by actuarial life table analysis using the BMBP Statistical Software program 1L (Dixon, 1988). Failures included repairs and replacements of the restorations. The failures were evaluated according to cusp coverage, pin retention, tooth type, and patient age.

RESULTS

The distributions of the amalgam restorations for cusp coverage by tooth type and by pin retention are shown in Tables 1 and 2. Some 16% of the restorations required cusp coverage, of which 38% were pinned. There were very few premolar teeth with cusp coverage, or pins placed in the absence of cusp coverage. New True Dentalloy had relatively fewer pinned restorations than did the high-copper alloys ($P < 0.001$).

Table 1. Distribution of Class 2 Amalgams for Cusp Coverage, by Tooth Type

	Cusp Coverage		No Coverage	
Material	Premolar	Molar	Premolar	Molar
New True Dentalloy	16	55	185	214
High-copper Alloys	9	44	122	123
	$x^2 = 0.29$, df = 1 $P > 0.10$		$x^2 = 0.59$, df = 1 $P > 0.10$	

Table 2. Distribution of Class 2 Amalgams for Cusp Coverage, by Pin Retention

	Cusp Coverage		No Coverage	
Material	Pinned	No Pin	Pinned	No Pin
New True Dentalloy	18	54	1	398
High-copper Alloys	29	23	5	240
	$x^2 = 18.87$, df = 1 $P < 0.001$*		$x^2 = 3.51$, df = 1 $P > 0.05$	

*Significant difference at the 0.1% probability level

The actuarial life table cumulative survivals of all restorations by their cusp-coverage status are shown in Figure 1. After 15 years the cumulative survival (and standard error) for cusp-covered amalgams was 72.6 ± 8.0%, and for amalgams with no cusp coverage it was 72.8 ± 5.9%.

Life table survivals of cusp-covered restorations by pin status are shown in Figure 2. The survival after 15 years for pinned amalgams was 60.3 ± 13.6%, and for amalgams without pins it was 78.7 ± 10.0%.

The survivals of cusp-covered restorations by patient age are given in Figure 3. After 15 years the survival for amalgams in patients younger than 41 years was 77.3 ± 9.3%, and for amalgams in patients 41 years and older it was 63.0 ± 16.1%. There were no significant differences found for any of the three factors

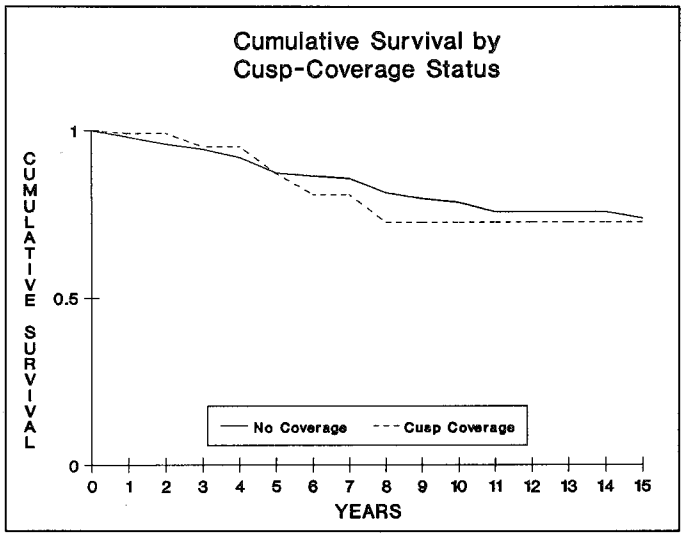

FIG 1. *Life table cumulative survivals of class 2 amalgams, by cusp coverage*

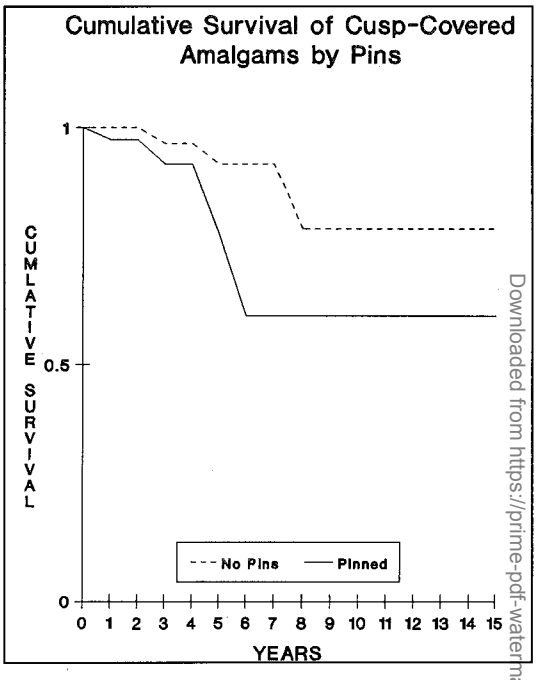

FIG 2. *Life table cumulative survivals of class 2 cusp-covered amalgams by pins*

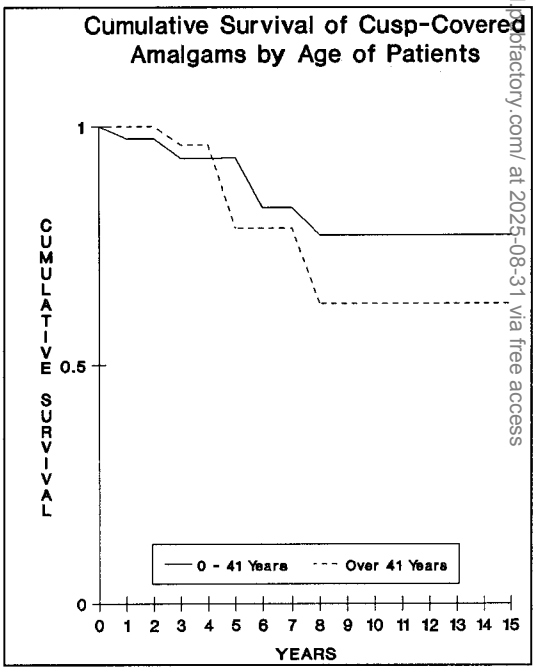

FIG 3. *Life table cumulative survivals of class 2 cusp-covered amalgams by patient age*

assessed, ($P > 0.10$).

There were 10 (8%) failed cusp-covered amalgam restorations; six were pinned, nine were in molar teeth, and seven were high-copper alloys. Two restorations were replaced because of fracture and one because of recurrent caries, three restorations were repaired, and the reasons for the replacement of the four others were not known. No failures were associated with patient bruxing, and all replacements and repairs were with amalgam.

DISCUSSION

Most of the publications on complex amalgam restorations have been concerned with investigations in vitro of the problems and effectiveness of different methods used for retention and resistance of the restorations. The resistance of the remaining tooth structure may also be enhanced by appropriate preparations, and a comprehensive review of these aspects of complex amalgams has been published recently (Robbins, Burgess & Summitt, 1989).

Clinicians generally believe that cast restorations offer superior occlusal form, longevity, and costeffectiveness, although complex amalgam restorations are much cheaper than cast onlays, and demonstrate adequate occlusal contact stability (Peerlings & others, 1988). A survey of many dentists found that the expected mean longevity of complex amalgams was 6.1 years and that of cast crowns was 13.0 years (Marynuik & Kaplan,

1986). However, very little reliable information is available on the long-term performance of complex amalgams, and cast restorations may not be cost-effective if placed as the initial restoration (Marynuik, Schweitzer & Braun, 1988).

In the present ongoing study, the cumulative survival of cusp-covered amalgams was 72.6 ± 8.0% after 15 years, as compared to the 50% survival reported at 11.5 years in another, retrospective study (Summitt & Robins, 1987). These results do not support the pessimistic estimates of longevity generally ascribed by dentists to cusp-coverage amalgam restorations, and the findings also have significant implications for the provision of cost-effective large posterior restorations in an aging dentate population (Marynuik & others, 1988).

The cumulative survivals of all the amalgam restorations in the present study were similar, irrespective of their cusp-coverage status (Fig 1). Because few failures occurred with the cusp-covered restorations during the course of the study, and because there were relatively few such restorations followed for more than six to 10 years, the survival findings for the pin status of these restorations, and for the patient age groups, should be viewed cautiously (Figs 2 & 3).

CONCLUSIONS

Regardless of the presence or absence of cusp coverage, the cumulative survivals of the class 2 amalgam restorations placed in the present study were approximately 72% after 15 years. Cusp-covered restoration survivals were not affected significantly by the use of pins or by patient age, and compared favorably with the survivals reported elsewhere for various cast restorations.

Acknowledgments

I would like to thank the Director, Dental Services, Adelaide Dental Hospital, for permission to examine the patients seen in this survey. The data processing assistance received from Mr D A Webster, Research Officer, Department of Dentistry, is also acknowledged.

(Received 28 June 1990)

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CLINICAL PRACTICE

Treating Dental Caries as an Infectious Disease

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INTRODUCTION

Dental caries has been part of the human circumstance since humans evolved as a species (Keene, 1981). One hundred years ago, W D Miller (1890) demonstrated that dental caries was a disease of bacterial origin. A short while later, Dr G V Black wrote extensively on the pathology of caries. He stated in 1908, "The complete divorcement of dental practice from studies of the pathology of dental caries, that existed in the past, is an anomaly in science that should not continue. It has the apparent tendency plainly to make dentists mechanics only." We now have the materials and methods available to diagnose and control dental caries as Black dreamed. This article presents arguments for the diagnosis and treatment of dental caries as an infectious disease.

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HISTORY

Conventional Model

Dental caries has been viewed as a bacterially mediated disease since 1890, when medical microbiology was a developing science and Miller (1890) presented the chemoparasitic theory of tooth decay. The basic tenet of his work was that oral bacteria, which populated the saliva, were responsible for dental caries. Miller did much of the original taxonomy for the organisms of the oral cavity. Until his investigations, few researchers had examined the flora of the oral cavity. Important models for cause-and-effect relationships for bacterial diseases were evolving in

Robert Koch's laboratories, where Dr Miller performed part of his work. Koch formulated his postulates which delineate the steps required to show a cause-and-effect relationship between a suspected pathogen and a disease. Miller applied these state-of-the-art techniques to his research. However, because he did not have our current techology, Miller erred in some important observations that today we take for granted. Principally he did not know that the oral cavity harbors many different microbial ecosystems. He could not know that the bacteria which populate the pits and fissures were ecologically different than those in the plaque on the buccal and lingual surfaces, that they were different still from those that prosper within the gingival sulcus or periodontal pocket. Therefore he assumed all oral bacteria were odontopathic. The derivatives of that assumption shaped our conventional treatment model in dentistry.

The assumptions (Loesche, 1982) which follow if all plaque and hence all oral bacteria are odontopathic are:

1. No diagnosis is required, since everybody has plaque and all plaque is odontopathic.
2. The entire population must be treated, since everyone forms plaque.
3. Treatment is directed toward plaque removal and must be continuous, since plaque forms continuously. (We implement this by encouraging our patients to brush and floss more often.)
4. Failure is the patient's fault, since the occurrence of a carious lesion is prima facie evidence that the patient did not keep the plaque off the tooth.

The result of this treatment philosophy is our surgical model of dentistry. In this model, restorative dentists are relegated to the role of artisan/technicians, as Dr G V Black had hoped would not happen. Dentists repair the damage caused by the disease process to the best of their ability, but are helpless to prevent the continuation of the disease process.

Specific Plaque Hypothesis

During the part 25 years, a second and competing philosophy has emerged called the Specific Plaque Hypothesis (Loesche, 1976). This hypothesis states that only a limited number of the organisms in dental plaque cause the disease process. The remainder are not odontopathic. The consequences of this assumption give an entirely different, in fact dichotomous, set of assumptions. They are:

1. Diagnosis is essential.
2. Only those patients at risk for the clinical manifestations of infection are treated.
3. Treatment is directed at reduction or elimination of only the odontopathogens and ceases at that therapeutic endpoint.
4. Failure is the dentist's fault, since it is a failure to diagnose the infection.

This is a medical, rather than a surgical mode of dental care. The dentist is concerned with the timely restoration of diseased areas and the elimination of the infection that caused the carious lesions.

Bacteria Associated with Dental Caries

Since diagnosis of the infection is essential in this model, we need to know which of the 200-plus oral organisms cause this disease.

A number of reported association studies revealed that two of the primary organisms involved in human caries are *Streptococcus mutans* and *Lactobacilli* species (de Stoppelaar, van Houte & Backer Dirks, 1969; Loesche, 1976; Loesche & Straffon, 1979; Carlsson, Grahnen & Jonsson, 1975; Keene & Shklair, 1974). Clark (1924) first identified *S mutans* in the caries of his London patients. Some 36 years later, Fitzgerald and Keyes (1960) demonstrated that this organism was an infectious odontopathogen capable of causing caries in hamsters. During this experiment, they verified that *S mutans* fulfills Koch's postulates as a caries-causing agent in hamsters. Later the US Navy examined its recruit population for their levels of *S mutans* and the presence or absence of caries (Shklair, Keene & Cullen, 1974). They found that, generally, those recruits with low or non-existent *S mutans* levels had no caries. Those with high *S mutans* titers in their saliva had high caries rates. Longitudinal data show that *S mutans* populations increase before caries detection (Loesche & Straffon, 1979).

Several researchers demonstrated that *S mutans* was not found in predentulous infants (Carlsson & others, 1970; Catalanotto & others, 1974; Berkowitz, Jordon & White, 1975). Yet by age five, *S mutans* was found in about half the population (Carlsson & others, 1975). Berkowitz and Jordan (1975), through serotyping, showed

that children who became infected had the same organism as their mothers. Van Houte and Green (1974) found that a critical level of *S mutans* was necessary to establish an intraoral infection. Köhler and Bratthall (1978) then showed that it was possible to transmit this critical level of *S mutans* via a spoon from mother to offspring. Additionally they found that caries-free children generally had <10 000 colony-forming units CFU/ml saliva. (CFU/ml are the number of bacterial colonies which grow in or on an appropriate nutrient media per unit volume.)

Analysis of these and numerous other laboratory studies and studies in vivo has led to the universally accepted conclusion that, in humans, caries is a bacterial infection, mediated primarily by *S mutans*, and can be transmitted within families by salivary exchange.

Lactobacilli have also been associated with dental caries (Enright, Friesell & Threscher, 1932; Jay & others, 1936). It may be found in patients with caries. Early attempts to base treatment on the identification of this organism in the saliva were not generally successful because *Lactobacilli* appeared to be a secondary caries organism. They do not have the tenacious attachment mechanisms of *S mutans* to effectively initiate the carious process. However, once the carious process is established, the environment becomes acidic and conducive to growth for *Lactobacilli*. Tests for *Lactobacilli* may show that there is caries activity present, but generally do not predict the carious process (Loesche, 1982).

Detection of *S Mutans* Infections

Logically then, there is a need to know when an *S mutans* infection has occurred and the magnitude of infection (if infection levels make a difference in our treatment).

Fortunately the advancement of the carious process from infection to cavitation takes time. It takes from six months to more than three years for pit and fissure caries to progress from infection to cavitation (Featherstone, 1990). Cavitation of smooth surfaces takes longer and may average five to six years (Berkey & others, 1989). Thus there is time to determine the presence or recurrence of the infection.

The level of infection is important. An infection of 3000 CFU/ml of saliva *S mutans* is necessary to colonize pits and fissures given a suitable morphology (Svanberg & Loesche, 1977). A level of 45 000 CFU/ml can establish a smooth surface infection (van Houte & Green, 1974). While these numbers are not absolutes, they provide guidance for therapeutic treatment of an *S mutans* infection. It is important to recognize that 10 000 CFU/ml is highly significant in the patient having only three remaining teeth. It is not significant with sealants in place and a full complement of 28 or 32 teeth.

In-office tests are available that detect and quantify the presence of an *S mutans* infection and its magnitude. In the United States, CarieScreen SM (J O Butler, Chicago, IL 60630) provides this selective media culture test. It discriminates at seven levels of *S mutans* in the saliva between 0, 10 000, 50 000, 100 000, 250 000, 500 000, and 1 000 000 CFU/ml. This test has rather low sensitivity (true positive) but relatively high specificity (true negative). Thus the test is poor for predicting who will get carious lesions based on the presence of *S mutans* alone. However, it is good for predicting low caries levels given low *S mutans* counts. Therefore to use this test to best advantage, only those patients with a demonstrated caries susceptibility should be tested. That susceptibility may be their previous history, or, in the case of children, their family's history. Diagnosis should also be performed by standard clinical examination. Patients with active caries have an infection. It makes little sense to test them bacteriologically while those lesions are unrestored unless looking for baseline data for record-keeping or performing research.

TREATMENT

Once a caries-susceptible patient has been identified as having an odontopathic level of *S mutans*, the patient should be treated for the infection. A rationale for treatment would encompass those elements required to treat any bacterial infection. Most bacterial infections are treated on a short-term basis, intensively, and to a therapeutic endpoint (Loesche, 1982). An example is a bacterial pneumonia. The infection is treated intensively with appropriately high doses of antibiotics to disrupt the pathogen and allow the body's defenses to take over. The infection is treated to a therapeutic endpoint. When the causative organism has been defeated, the treatment is discontinued. The treatment regimen for

S mutans should encompass the same model. In the case of caries, we should not use antibiotics which might be needed to treat a life-threatening infection in the future. However, we can use antimicrobials and sound bacteriologic principles to control and defeat the *S mutans* infection.

Restoration

THE FIRST STEP in the treatment of the infection is to restore the existing carious lesions which have penetrated dentin. This must be the first step. Failure to remove the nidi of infection could lead to an actual superinfection with *S mutans* (Loesche, 1982). The rationale for this argument is that treatment with antimicrobials before restoration would disrupt only the normal surface flora. Then the bacterial residents of protected areas, such as carious lesions or infected pits and fissures, would face no competition for the tooth surface. The organisms within the protected environment would be free to grow out of the cavity and populate the tooth. Organisms within superficial lesions are susceptible to the therapeutic regimen which follows. The type of restoration placed is important. Caries-control temporary restorations should be placed in rampant caries cases with many carious lesions until *S mutans* has been reduced to non-cariogenic levels (Krasse, 1988). This prevents population of the margins of new restorations with *S mutans* and subsequent recurrent caries. When only a small number of lesions are present, final restoration is appropriate. Final restorations should take advantage of intracoronal fluoride application, or appropriate anticariogenic restoratives. This will reduce the chance of cariogenic organisms surviving the restorative process.

Sealants

THE SECOND STEP, administered simultaneously with the restorative process in step one, is the application of pit and fissure sealants. In the permanent dentition, these should be applied to the molar teeth, since bicuspids do not routinely experience pit and fissure caries (Arthur & Swango, 1987). However, each patient is unique, and the morphologic presentation and caries history of the bicuspids must be considered in determining if they should be sealed. In the primary and mixed dentition, the deciduous molars should be sealed, if warranted, under the same morphologic criterion. Sealants may be effectively applied to questionable and early carious pit and fissure sites (Handelman, 1982; Elderton, 1985; Council on Dental Health and Health Planning, Council on Dental Materials, Instruments, and Equipment, 1987; Council on Dental Research, 1985). Odontopathic organisms trapped below a sealant will decrease in number and remain quiescent for the duration of their entombment (Handelman, Washburn & Wopperer, 1976).

Application of the pit and fissure sealants completes the removal of *S mutans'* protected ecologic niches. Notice that a pit and fissure sealant application also eliminates consideration of the 3 000 CFU/ml *S mutans* diagnosis point from a treatment scheme, because the pits and fissures are not available for infection. Now we can deal with the smooth surfaces where the organism is more vulnerable. Treatment can now be directed toward only those patients who have demonstrated a lack of resistance to this organism (previous caries) and who have equal to or greater than 50 000 CFU/ml S mutans. (50 000 CFU/ml is the closest diagnostic point on the CarieScreen SM test to the 43 000 CFU/ml needed to establish a smooth surface infection.

Chlorhexidine

THE THIRD STEP in treatment is the initial attack of the *S mutans* infection. This begins with the short-term use of the antimicrobial, chlorhexidine. Chlorhexidine is highly effective against *S mutans* infections (von der Fehr, Löe & Theilade, 1970; Zickert, Emilson & Krasse, 1982). Maintaining the concept of an intensive, short-term treatment to a therapeutic endpoint, one 16-ounce bottle of chlorhexidine rinse should be prescribed for the patient. The drug is administered at 1/2 ounce, for a 30-second rinse, morning and evening. If a patient objects to the taste of the drug in the morning, a 16-day regimen of 1/2 ounce at bedtime should be prescribed. Salivary flow diminishes to nearly zero overnight, and the concentration of the drug remains high until morning.

The reason for chlorhexidine's effectiveness is its chemical charge. Chlorhexidine is a biguanide and strongly cationic. Since almost all surfaces in the oral cavity are negatively charged, the positive charge of this drug causes it to

adhere to almost all intraoral surfaces (Gjermo, Bonesvoll & Rolla, 1976; Rolla, 1974). This adherence gives the drug substantivity (Bonesvoll, Lokken & Rolla, 1974). Substantivity is the ability to keep an agent in contact with an organism long enough to kill or disable the organism. The drug maintains cidal activity for approximately six waking hours and for the duration of sleep. A 16-day regimen will suppress the *S mutans* infection below the 10 000 CFU/ml lower sensitivity limit of the CarieScreen test (Cote & Anderson, 1990). The proposed mechanism of kill for this drug is its effect on the cell membrane (Hennessey, 1977). In cidal concentration it appears to precipitate the protein in the cell membrane. The cell is thus unable to maintain its electrolyte balance and expires. If this is the only treatment rendered, *S mutans* suppression will last between 12 and 26 weeks (Emilson, Lindquist & Wennerholm, 1987).

These caries and *S mutans* data are derived from European studies where this drug is currently approved for wider use than in the United States. In the United States, chlorhexidine is approved for the treatment of gingivitis. For the past 30 years in Europe, chlorhexidine has established an excellent efficacy and safety record. The teratogenic and carcinogenic safety has been adequately demonstrated in animals and human populations (Rushton, 1977). Because chlorhexidine is poorly absorbed from the intestinal tract, the lethal dose for 50% of the population (LD50) for this drug is estimated at 2000 mg/kg body weight (Case, 1977). That means that a 50-kg child must drink 10 16-ounce bottles over a short period of time to stand a 50/50 chance of expiring. At 11% ethyl alcohol, or 22-proof, this is a highly unlikely event. At the conclusion of the 16-day regimen, the clinician should institute the next two steps in treatment of the *S mutans* infection.

Xylitol Gum

THE FOURTH STEP consists of prescribing xylitol gum for patients who are willing to chew gum as a means of controlling caries. This gum not only demonstrates noncariogenic properties, but actually appears to be anticariogenic (Scheinin & others, 1975). Xylitol is a five-carbon sugar that is not a fermentable substrate for *S mutans* (Makinen & others, 1985). It is a normal sugar found in the pentose shunt in the Krebs cycle in humans. Xylitol is as pleasant-tasting as sucrose and is appealing to children. Its anticariogenic properties have been clearly demonstrated in the Turku sugar studies I-XXI (Scheinin & others, 1975). These longitudinal trials from Finland show not only decay reductions, but also actual reversal of minimal lesions (Scheinin & others, 1975). A negative effect on *S mutans* has been demonstrated in vivo (Loesche & others, 1984). The actual cause of the reduction in the *S mutans* population is speculative. The essence of all the arguments is that *S mutans* loses its competitive advantage in the ecology when exposed to adequate quantities of xylitol. It is affected even with concurrent sucrose intake (Scheinin & others, 1975). Total substitution and wholesale diet alteration are not required or even desirable. Additionally xylitol gum encourages remineralization of minimal carious lesions. The gum causes increased salivary flow, and saliva is a wonderful remineralizing solution. Xylifresh gum, distributed in the United States by Leaf, Inc (Bannockburn, IL 60015), is the same gum used in the Turku studies. The gum's protocol is to chew two of the gum pieces three times a day, for five minutes per chewing experience. Less exposure will significantly reduce the gum's efficacy (Isokangas & others, 1988). If patients like the gum, they can continue chewing as long as they wish.

Fluoride Rinses

THE FIFTH STEP is administration of over-the-counter fluoride rinses and the use of an ADA-accepted fluoride dentifrice. Fluoride rinses are given at the end of the 16-day chlorhexidine regimen at the same time as the xylitol gum. Fluoride has three basic mechanisms of action in caries: it facilitates remineralization by prejudicing the remineralization/demineralization rate equation toward remineralization, it forms acid-resistant carbonate crystals during the remineralization process (Featherstone, 1989), and it is a powerful bactericidal agent for *S mutans* and other acid-producing organisms. Patients should be instructed to use the over-the-counter rinse, in addition to their fluoridated toothpaste, at least twice a day, at times separated from their brushing. The presence of the fluoride ion, with the saturated solution of calcium and phosphate from the saliva stimulated by the xylitol gum, will remineralize early carious lesions (Rekola, 1986).

Bacteriologic Testing

THE SIXTH STEP in treatment is the first recall appointment after antimicrobial therapy. The appointment should be scheduled for three months after the end of therapy. Bacteriologic testing should be performed and the integrity of the pit and fissure sealants checked. If the patients have no detectable *S mutans* in their saliva, it is time to perform the final restorations. If not, then retreat to effect a therapeutic cure.

Final Restoration

THE SEVENTH AND FINAL STEP, for only the rampant caries cases, is definitive restoration of the temporarily restored carious lesions. Thought should be given to the final restoration material. Fluoride-leaching materials and cements and intracoronal fluoride applications are particularly effective in the prevention of recurrent (residual) caries. Certain amalgam formulations actually inhibit the growth of *S mutans*.

Recall

This completes the treatment regimen. Patients who continue to chew xylitol gum will have a low recurrence of caries. Similarly, those who choose to continue to rinse twice daily with the over-the-counter fluoride rinse will continue to suppress *S mutans* while remineralizing the previous demineralized areas (Featherstone, 1989).

The first recall should occur six months after the completion of antimicrobial treatment. Recall consists of:

1. an *S mutans* level determination,
2. a clinical examination and repair of any deficient pit and fissure sealants, and
3. an office fluoride treatment.

Recall is important, since if any of the pit and fissure sealants are to fail, they usually fail within the first six months. Subsequent recalls should occur at six-month intervals and consist of the same protocols as the three-month recall. If the infection recurs, the clinician once again gains control with the chlorhexidine, xylitol, and fluoride regimen.

CONCLUSIONS

Incorporating the precepts of a medical model of infection control into the routine practice of dentistry is simple, practical, and tremendously beneficial to our patients. We have the technology to diagnose and control dental caries in our patients. We can identify patients at risk and control their infections. We can become the healers G V Black envisioned, as well as superior artisans and technicians. If you find these ideas stimulating, you need only begin to imagine the application of a medical model to your periodontal patients.

(Received 28 June 1990)

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Restoration of Severely Fractured Teeth Using a Flexible Facial Matrix

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Introduction

It is a challenge to restore teeth that have fractured, leaving little tooth structure upon which to place a restoration (Fig 1). Large carious lesions that undermine significant portions of a tooth or large amalgam restorations are often the etiology of such fractures.

When endodontic therapy is indicated for the restoration of fractured teeth, a post-and-core restoration may be utilized to replace part of the tooth structure. A problem arises, however, during the preparation of a severely fractured tooth for a metal-ceramic restoration. After preparing the tooth for the proper facial and incisal reduction, one is often left with little remaining tooth structure. It is very difficult to fabricate a post and core of proper dimensions when all tooth landmarks have been removed.

It is the purpose of this article to describe a method for the fabrication of a post and core that is properly contoured when all anatomic landmarks are lost during the preparation of a severely fractured tooth.

FIG 1. *Existing fractured maxillary first premolar*

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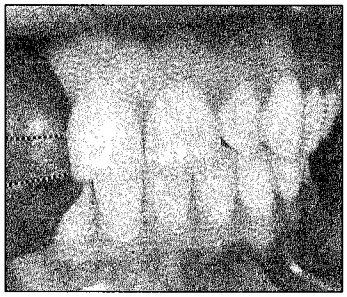


FIG 2. *Potential lines for horizontal sectioning of polyvinylsiloxane matrix*

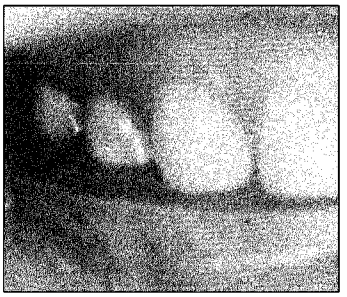


FIG 3. *Matrix in place, midcoronal section*

FIG 4. *Occlusal view of same*

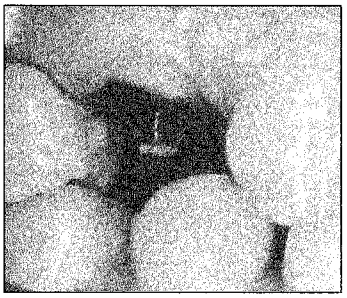


FIG 5. *Preparation completed, direct post pattern inserted*

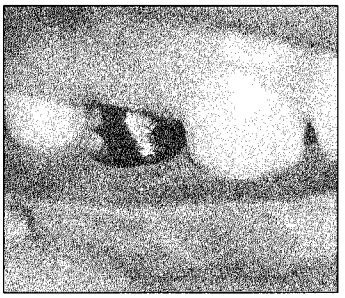


FIG 6. *Facial reduction verified with matrix*

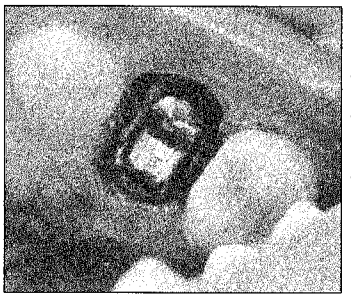


FIG 7. *Occlusal reduction verified with matrix*

Technique

1. The patient is asked to occlude into a polyvinylsiloxane putty material until it is completely set.
2. The putty index is removed from the mouth and sectioned parallel to the occlusal plane (Fig 2), at the incisal level of the tooth to be restored.
3. The matrix is again sectioned, parallel to the first cut but at a level that is in the middle half of the occlusal-gingival height of the clinical crown (Figs 2-4).
4. The tooth may then be prepared to receive a direct post and core.
5. The matrix can be placed back in the mouth if desired and used to verify proper facial and occlusal reduction while fabricating the post and core (Figs 5-7).

Using a flexible facial matrix allows the dentist to ensure that proper facial reduction is accomplished while restoring a severely fractured tooth. The direct post and core may then be cast and delivered to the mouth with proper previously established contours, so that intraoral preparation of the metal post and core is minimized.

Conclusions

Use of the flexible matrix offers several advantages over a vacuum-formed matrix:

1. The polyvinylsiloxane matrix has more bulk of material to it. This offers greater ease of handling intraorally, thus making correct positioning of the matrix easier.
2. The polyvinylsiloxane matrix may be sectioned and easily reapproximated at any height in relation to the clinical crown being restored (Fig 2). The clinician, therefore, may evaluate facial reduction at any desired level on the clinical crown.
3. The polyvinylsiloxane matrix offers color contrast that a vacuum-formed matrix does not. This feature aids the clinician when evaluating tooth reduction.
4. The polyvinylsiloxane matrix may be stored between appointments, if necessary, with maximum dimensional stability of the material being assured.

(Received 27 April 1990)

Clinician of the Year Award

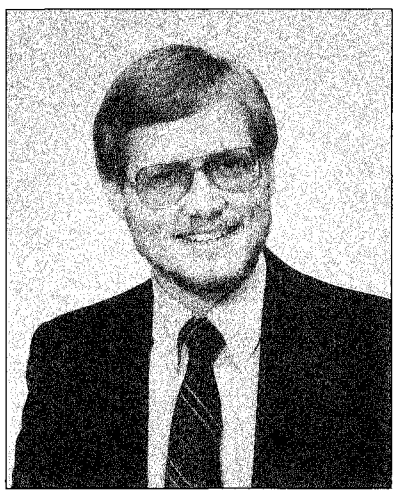
Once again, I have the privilege of being able to present our newest award to the Young Dentist/ Outstanding Clinician of the Year. As you may remember, the idea of such an award came from Vic Williams a few years ago, and the plaque is donated by Ivoclar/Williams Co. We decided to try something different this year with the award--keeping it a secret until the presentation.

There were a number of names taken into consideration, each individual with solid credentials. Actually, no names were suggested from the membership so the committee of Craig Bridgeman, Julian Thomas and myself each suggested several names. If one name appeared consistently higher on the list, it was agreed to select that person.

This year's recipient has played an active role as a clinician, educator, and presenter of dental trivia at local, state, national, and international levels. Although he may not be particularly big in stature, I often find myself looking up to him.

When he graduated from dental school a few years ago, it was almost embarrassing for him as he received most of the awards available to the entire class. It was only natural to offer him a job in education after he completed a two-year stint doing mission dentistry in Haiti. If invited, he will be more than happy to chat in Creole with anyone interested. He'll probably do it even if no one is interested.

He has been an active member of this Academy for over seven years, has operated at several annual sessions, and served on various committees. He belongs to all the usual and unusual organizations, has published a number of worthwhile papers, as well as some that I couldn't understand, and presented numerous table clinics and lectures.



Tim Carlson

He is an outstanding family man, is most active in work with his church, does a lot of extra work with young people, is convincingly knowledgeable about computers, an excellent teacher, handyman, punster and funster. Not only that--he could do dentistry on me or my family anytime. He's not only an outstanding clinician but also a good friend.

It really gives me a great deal of pleasure to be able to make this award to someone I see in action daily--Tim Carlson.

RONALD K HARRIS, DDS, MSD

DEPARTMENTS

Press Digest

Estimation by a 24-hour study of the daily dose of intra-oral mercury vapor inhaled after release from dental amalgam. Berglund, A (1990) *Journal of Dental Research* 69 1646-1651.

(Department of Dental Materials and Technology, University of Umeå, Sweden)

This clinical research report estimates the total exposure to mercury from dental amalgam in inspired air during a 24-hour period. Inspired air levels are a significant concern since absorption of elemental mercury via the respiratory organs is about 80%. The data are derived by standardizing patient activities and intraoral samplings every 30-45 minutes during the 24-hour period using atomic absorption spectrophotometry. Patients in the test group had an average of 13 occlusal surfaces (range, 9-19) and an average of 27 surfaces restored with dental amalgam (range, 13-48). The daily dose of mercury vapor was **not** significantly related to either the occlusal or the total number or area of the amalgam surfaces. The mean value for inhaled mercury vapor was 1.7 μg/24 hr with a range of 0.4-4.4 μg. When compared to the WHO threshold limit value of 50 $\mu g/m^3$, the derived values represent about 1% of the threshold values. The rate of release of inorganic mercury into saliva showed a significant positive correlation with both the number of occlusal surfaces and the total surface area of amalgam, but showed no correlation with the rate of release of mercury vapor into intra-oral air measured directly before and after the saliva sampling. Creatinine-adjusted urinary mercury concentrations showed no correlation with either the daily dose or the occlusal and total amalgam surface area. This article reviews previous works where higher estimates were made for inspired mercury and concludes that a single sample or a short series of samples of mercury vapor for prediction of the inhaled daily dose may be an inadequate sampling technique.

A new way to make provisional restorations for laminate veneer preparations.*Elledge, D A, Cowan, R D & Bannister, M (1990) *Esthetic Dentistry Update* 1 84-88.

(*University of Missouri-Kansas City, School of Dentistry, 650 E 25th St,Kansas City, MO 64108-2795)

The majority of veneer cases do not require temporization; however, there is an occasional case which may require esthetic temporization. This technique article describes a quick, efficient way to perform this service with materials found in most dental offices. The technique uses an alginate impression of the diagnostic wax-up or the original models of the teeth which has autocuring resin applied to the sites of the prepared teeth. The impression is seated over the lubricated prepared teeth and allowed to set. It is then trimmed and luted with pit and fissure sealant to a small etched area of enamel on the incisal edge within the preparation boundary. The article is accompanied by a series of highly descriptive color photographs.

A 24-month clinical study of the incidence and progression of dental caries in relation to consumption of chewing gum containing xylitol in school preventive programs. *Kandelman, D & Gagnon, G (1990) *Journal of Dental Research* 69 1771-1775.

(*Department of Oral Health, Faculty of Dentistry, University of Montreal, CP 6128, Succursale "A", Montreal, Quebec, Canada H3C 3J7)

This clinical research report covers a 24-month, school-delivered, chewing-gum trial where 274 eight- and nine-year-old children of low socioeconomic status with high caries rates. The test group was given either a 15% or a 65% xylitol-based chewing gum. The control group received no gum. All three groups received the same basic preventive program. Children receiving either concentration of the xylitol gum had a significantly lower caries progression rate over the 24-month period than the control group

for all tooth types and tooth surfaces although the buccal and lingual surfaces benefitted the most. The mean number of new DMFS was 2.24 for the xylitol group and 6.06 new surfaces for the control group. There were a significant number of radiographic caries reversals associated with the xylitol groups where radiographically apparent lesions resolved over time. This suggests that regular use of xylitol or a mixture of xylitol and sorbitol gums may be associated with remineralization. Xylitol has many effects on the caries-causing bacteria. *Streptococcus mutans* cannot ferment this sugar and seems to lose its competitive advantage in the oral ecosystem when regularly exposed to xylitol. This report confirms previous studies conducted in Scandinavia.

The utility of the BANA test for monitoring anaerobic infections due to spirochetes (*Treponema denticola*) in periodontal disease. *Loesche, W J, Giordano, J & Hujoel, P P (1990) *Journal of Dental Research* 69 1696-1702.

(*The University of Michigan School of Dentistry, Ann Arbor, MI 48109-1078)

A number of new periodontal diagnostic tests for use in general practice are being investigated or have been investigated and are awaiting approval before the FDA. This article reports on the clinical use of the so-called BANA (benzoyl-DL-arginine-naphthylamide) test for periodontal disease activity. This is a clinical report in which patients were tested for BANA-positive flora and then treated with either a placebo plus scaling and root planing or systemic metronidazole (250 mg tid for seven days) and scaling and root planing. The results showed that sites which had persistent BANA-positive plaques had a high proportion of spirochetes and lost significantly more periodontal attachment in the year following active treatment than did those with a BANA-negative test result. The ability of the BANA test to possibly predict future attachment loss indicates that this test may be helpful in the management of the periodontally diseased patient in a general practice and could portend a significant change in the diagnosis and treatment schemes for periodontal disease.

Regenerating bone in clinical periodontics. *Mellonig, J T & Bowers, G M (1990) *Journal of the American Dental Association* 121 497-502.

(*University of Texas, Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78284-7894)

This review article focused on the regeneration of the functional attachment apparatus in the periodontally diseased dentition. This is a major area of interest for the restorative dentist since restoration of the supporting structures can significantly alter treatment plans for the restoration of a damaged dentition. The article reviews the clinical results of grafting with allografts of freeze-dried bone (FDBA) and decalcified freeze-dried bone (DFDBA) with and without the addition of autogenous bone. Potentials for disease transmission, root resorption, and ankylosis are reviewed. The authors review what is currently known about the nature of the attachment with and without guided tissue regeneration. The article concludes that new attachment over pathologically exposed roots in the future will rely on placement of an osteogenic material to enhance formation of bone, cementum, and periodontal ligament and some mechanism to exclude tissues competing for the space to be occupied by the regenerated tissues.

Effect of Pd on the clinical performance of amalgam. *Mahler, D B, Engle, J H & Adey, J D (1990) *Journal of Dental Research* 69 1759-1761.

(*Oregon Health Sciences University, 611 SW Campus Drive, Portland, OR 97201)

This clinical research report investigated the effect of the addition of 0.5% Palladium (Pd) to the commercial spherical alloy, Valiant. Marginal fracture, surface texture, and surface luster of 193 restorations were evaluated at one year, 182 at two years, and 144 at three years. Additionally, corrosion tests in vitro of anodic polarization and constant potential coulometry were conducted. Marginal fracture indices based on the Mahler-Marantz photographic scale showed significant differences at polish, one, and two

years, but could not discriminate a difference at three years. This is interesting since it conflicts with the data of Osborne, which showed that one-year data correlated well with 14-year data for a group of alloys. This indicates that while one-year data may be predictive for most alloys, some do not follow the group pattern, and hence prediction of performance based on one-year data may be risky. Surface texture and surface luster were evaluated clinically using an ordinal system with modified ridit means. The Pd system showed no difference in surface texture at any reported period but consistently showed higher luster than the non-Pd alloy. This high surface luster relates directly to the reduced electrochemical activity shown by the Pd-containing alloy.

A 5-year study comparing a posterior composite resin and an amalgam. *Norman, R D, Wright, J S, Rydberg, R J & Feikner, L L (1990) *Journal of Prosthetic Dentistry* 64 523-529.

(*School of Dental Medicine, Southern Illinois University, Alton, IL 62002)

This clinical research report compares the composite Occlusin with the amalgam Dispersalloy over a five-year period. Occlusin is a moderately filled (70% by volume) hybrid with a urethane-dimethacrylate resin base. Sixty-two original patients received a total of 107 resin and 53 amalgam restorations. Restoration sizes were evaluated as small, moderate, or large according to specific criteria. Restorations were required to have at least one approximal and occlusal contact. A conventional amalgam-type preparation was used for both materials. In resin restorations, the enamel was etched for one minute, dried, and an unfilled resin applied and polymerized prior to the filled resin placement and curing. Evaluations employed the criteria of Cvar and Ryge with additional data derived from models. Wear measurements were determined by the Leinfelder method and by laser interferometer. Color stability was evaluated photographically. The data showed only two areas of significant differences between products. Occlusin wore at a rate twice that of amalgam but within the ADA guidelines for the time period, while the marginal integrity of the Occlusin was superior to that of Dispersalloy. Ninety-one percent of the Occlusin restorations showed color stability for the five-year period. The authors feel the data demonstrate that, for a five-year period, Occlusin is as effective as Dispersalloy.

Polymeric adhesion to dentin: Contrasting substrates. *Duke, E S & Lindemuth, J (1990) *American Journal of Dentistry* 3 264-270.

(*Clinical Research Facility, Dental School, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Dr, San Antonio, TX 78284)

This study investigates the relationship between the various morphotypes of dentin and adhesive bond strengths. The original tenet of the research is that in some systems there is a significant amount of bond strength derived from penetration of the dentinal tubules by bonding resins. Hence, patent tubules would provide a more adhesive substrate than sclerotic dentin. The study uses both a laboratory and clinical SEM model to determine the relationship between tubule patency and adhesive bond strength. Through a series of SEM prints the authors show the differences before and after treatment with a Maleic Acid/HEMA adhesive primer and BIS-GMA/HEMA resin adhesive system (Scotchbond 2). There are obvious visual differences in the patency of tubules between the recently extracted third molar control teeth and the cervical erosion/abrasion teeth in the test group. These differences are also apparent when the maleic acid/HEMA solution is applied. The teeth with tubules occluded only by a smear layer show penetration of the resin while teeth demonstrating sclerotic dentin showed little if any penetration of the resin system. The clinical trial used unetched lesions entirely in dentin and lesions with etched enamel on the coronal margin. No statistically significant differences were seen between the etched and unetched groups. The clinical lesions were grouped by morphotype at the start of the clinical study, but no statistical report of the two-year clinical results on the basis of type was reported.

Book Reviews

BENCH TOP ORTHODONTICS

Harvey W Lawson, AAA, CDT and Joan L Blazucki, RG, BS

Published by Quintessence Publishing Co, Inc, Chicago, 1990. 140 pages, 325 illustrations. $38.00.

The intent of this publication is "to assist dental students, technicians, and auxiliaries in the construction of the most commonly prescribed fixed and removable orthodontic appliances." The authors have accomplished this extremely well with high-quality, sequential photographs of actual appliance fabrication. The accompanying text is concise and clear.

The first chapters describe the fundamentals of wire bending, clasp formation, soldering, and welding. The authors then describe the fabrication of many orthodontic appliances, including space maintainers, palatal expansion devices, transpalatal arches, and removable Hawley appliances for various types of tooth movement. A brief list of indications for each appliance precedes the steps for construction. Also the authors include chapters on fabrication of study models and diagnostic set-ups. For each procedure they show an example of a properly filled-out lab prescription.

This book would be an excellent resource for the laboratory aspects of orthodontic practice. It would not be a substitute, however, for a major orthodontic text which deals with diagnosis, treatment planning, and treatment techniques.

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DENTAL IMPLANTS: ARE THEY FOR ME?

Thomas D Taylor, DDS, MSD, in consultation with William R Laney, DDS, MS

Published by Quintessence Publishing Co, Inc, Chicago, 1990. 66 pages, 44 color illustrations. $24.00, soft cover.

This patient guide includes a tear-out handout for patients at the back of the book that reviews home care oral hygiene procedures for implant prostheses. The purpose of the publication is to address the following questions for patients considering implant therapy: What are dental implants? Are they for me? How are they placed and used to support dental replacements? How are they to be maintained once treatment is completed? The publication contains 44 color illustrations that are clearly labeled in the body of the pamphlet as well as clinical photos in the handout that concerns itself with hygiene procedures. A distinct attempt was made to simplify the text to make it understandable for the lay public. In light of the complexity of implant therapy, this text enables potential patients interested in implant therapy to develop a generic understanding of the comprehensive process associated with this type of treatment from initial consultation to postinsertion care.

While treatment approaches may vary from those described in this text, the booklet offers potential patients an excellent overview of the scope of implant therapy. This publication can serve as a very useful tool for introducing patients to this modality of treatment. The tear-out handout, which is included in this text or can be ordered separately for distribution to patients at the time treatment has been completed, offers a worthwhile guide for maintenance and home care procedures.

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CREATIVE CERAMIC COLOR: A PRACTICAL SYSTEM

Ernest A Hegenbarth

Published by Quintessence Publishing Co, Inc, Chicago, 1989. 112 pages, 198 color illustrations. $58.00.

This text describes a new system in which the technician and the dentist may arrive at better results. It requires purchase of a new shade guide and porcelain kit. Although the results demonstrated are quite spectacular, the text fails to adequately show its readers how to obtain these results. This book is definitely not for the neophyte.

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DENTAL ANATOMY: ITS RELEVANCE TO DENTISTRY Fourth Edition

Julian B Woelfel, DDS

Published by Lea & Febiger, Philadelphia, 1990. 438 pages, 342 figures. $42.50, paperback.

This book provides a broader view of dentistry than do most books on dental anatomy. The author's purpose, as stated in the preface, is "to guide dental students, dental hygiene students, dental assistants, and dental laboratory technicians in the study of tooth morphology and to help them understand the relationship of teeth to one another and to the bones, muscles, and nerves closesly associated with the dentition."

A major strength of the book is that it works to relate the anatomy of teeth and other oral structures to the practice of dentistry and of dental hygiene. Fourteen of the 22 chapters cover topics usually found in books on dental anatomy, such as terminology, anatomy of individual teeth, occlusion, the masticatory system, and the evolution of the dentition. But the book also offers eight chapters (141 pages) on less usual subjects such as operative dentistry, forensic dentistry, and head anatomy.

The text contains the information necessary for a student to learn the morphology of permanent and primary teeth. Another strength is that, in addition to tooth dimensions given to guide the student in drawing and carving teeth, it gives mean dimensions for each tooth and dimension ranges derived from the measurement of a large number of teeth. The tables on distinguishing individual teeth one from another are also beneficial to the dental anatomy student. Its comprehensive treatment of tooth anomalies is informative, although it would have been advantageous for students if the problems the anomalies pose in the practice of dentistry had been emphasized. The chapter on forensic dentistry helps the student to understand one of the important aspects of a good knowledge of dental anatomy. The chapters are well written. All but three of the chapters are supported by references, and much recent research is quoted. Many of the references given in support of the information in the chapters on tooth anatomy and head anatomy are from other textbooks on those subjects. The study guides, notes, and study questions at the ends of some of the chapters would be helpful in studying the subjects.

The drawings and photographs are good, but the porous quality of the paper makes some of the details in some photographs very difficult to discern. There is only one color plate in the book.

It appears that this book was designed primarily for the curricula of one or two schools. The author stated in the preface that the book "is for those who may not have had a formal course in head anatomy." Certainly the four chapters which concern head anatomy, with the possible exception of the chapter on the craniomandibular joint, are of little value to those who have had a course in head anatomy and who have an anatomy textbook. The chapter on operative dentistry presents an overview of operative dentistry as taught at Ohio State University, including Black's principles of cavity preparation. In a dental anatomy text, the pages could have been better spent relating dental anatomy and morphology to operative dentistry. Another chapter does a fine job of relating periodontal considerations and root anatomy. The chapter on occlusion would benefit from figures illustrating the usual positions of centric occlusion contacts and paths

of cuspal movement.

The chapter "Directions for Drawing and Carving Teeth" is separated from the chapters on individual tooth anatomy. This seems to be tailored for an individual school and may not be desirable in the curricula of other dental schools.

Overall the book was a nice attempt to interrelate some basic sciences and various disciplines of dentistry to dental anatomy. It would be a useful reference on dental anatomy, but its usefulness as a reference on the other subjects covered in the book would be overshadowed by more complete texts in head anatomy, operative dentistry, and periodontics. As a dental school or dental hygiene textbook for dental anatomy, it should certainly be evaluated by each school considering a textbook change because it presents a variation from more traditional textbooks in dental anatomy.

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ARTHROSCOPIC ATLAS OF THE TEMPOROMANDIBULAR JOINT

D I Blaustein, DDS, PhD, and L B Heffez, DMD, MS, FRCD(c)

Published by Lea & Febiger, Philadelphia, 1990. 117 pages, 214 illustrations. $65.00.

Intended as a reference volume for those who perform arthroscopic procedures on the TMJ, this atlas would also serve as an excellent text on TMJ anatomy and pathology for those clinicians who provide nonsurgical treatment of temporomandibular disorders. The authors, oral surgeons at the University of Illinois at Chicago Temporomandibular Joint and Facial Pain Clinic, have compiled their extensive research and experience working with cadavers, primates and humans to provide detailed protocols for the arthroscopic examination of the TMJ.

The early chapters examine the gross and microscopic morphology and pathology of the joint. This section provides an extensive review of the TMJ histology and histopathology replete with large format photomicrographs that are extensively detailed and easy to interpret. Sections on arthroscopic technique and instrumentation are followed by chapters on arthroscopic anatomy and pathology. These chapters are illustrated with color plates of the arthroscopic views of the joint accompanied by a descriptive drawing of each plate.

The final section on troubleshooting deals with problems of interpretation, complications, and instrument failure. The book contains two appendices that include a glossary of arthroscopic terms and a chronologic history of endoscopy and arthroscopy.

Although the authors state in the preface that "Imaging data (arthrotomograms and/or magnetic resonance images) are provided to document the accuracy of our arthroscopic interpretations," there are, unfortunately, no imaging data at all to support their interpretations. Despite this shortcoming, considering the consistently high-quality illustrations, including the 55 color plates taken inside the TMJ, this book is an excellent reference text.

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IMPRESSIONS: A Text for Selection of Materials and Techniques

Harry F Albers, DDS

Published by Alto Books, Santa Rosa, CA,1990. 101 pages, indexed, softbound. $29.00. (Special price for dental schools: $7.50 each in 56-per-case lots)

Perhaps the term monograph rather than text is more appropriate for this publication since it deals principally with impression materials, although working casts and management of soft tissues were also included. The monograph is clearly written and recommendations are often referenced. Several extensive tables containing product information have been included to aid the reader in selecting and procuring materials.

The monograph is complete in scope but is occasionally lacking in detail. For example, the

subject of soft-tissue management does not include a discussion of the use of antisialagogues and field-isolation techniques. Also overlooked were the use of chemical retarders to extend the working time of addition silicones, the use of thermoplastic custom impression trays, and hand articulation of casts as an alternative to interocclusal records. A recommendation was made to place addition silicone impressions in a bell jar under vacuum to remove hydrogen gas. There was no reference to document this suggestion, nor discussion of the effects of a vacuum on the accuracy of the impression.

These omissions do not detract measurably from the value of this monograph. The information and suggestions contained in this publication can translate into greater clinical success with impressions and castings for all clinicians.

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WAX-UP FOR FUNCTIONAL OCCLUSION

M P Lang, DDS, A Gipp, CDT, and A Gredelmeier, DDS

Published by Quintessence Publishing Co, Inc, Chicago, 1989. 27 pages, 28 illustrations, $18.00.

This is a short text split into three sections. The first section, entitled "Principles of Occlusion," is an oversimplified explanation of a complex discipline, which was probably included to justify their position on using long-centric occlusion. The second section, "Wax-up in Long Centric," simply and effectively describes the procedure. The third section is a "Glossary of Specialized Terminology," which vaguely fits into the mission of the book.

A text of limited usage, it is best suited for those who want to wax long-centric occlusion.

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QUINTESSENCE OF DENTAL TECHNOLOGY 1990/1991

Edited by Robert P Renner, DDS

Published by Quintessence Publishing Co, Inc, Chicago, 1990. 224 pages. $52.00.

This year's *QDT* informs the dental technician of the past year's innovations and ideas regarding ceramic restorations, fixed and removable partial dentures, complete dentures, orthodontics, and implant prosthodontics. There are also review articles regarding provisional restorations and orthodontic appliances that will help the dental technician attain a better understanding of their fabrication and clinical usage. The journal is peer-reviewed by an editorial review board of distinguished clinicians and technicians to assure high standards of information and research.

Each of the aforementioned sections contains two or more papers written by independent researchers whose interests are in dental technology. The format and quality of research varies from paper to paper because of the diversity of authors. For example, the study comparing different denture bases used a feeler gauge to measure distortion gaps between the polymerized resin and the stone cast. The precision and accuracy of this method is not described. These are some of the important aspects which should be addressed in any research. The feature article this year is a round table discussion among three of Japan's premier ceramists. It is an excellent review on crown contours through the different "seasons" of life and discusses the particulars of what it is they see in a tooth form that is important to replicate in ceramics to make a natural-appearing prosthesis. A very helpful part of the discussion is the step-by-step contouring technique they use daily to attain the beautiful results that are depicted in the demonstration figures throughout the text.

References are given at the end of most papers to support statements made. Some of the technique papers do not reference other papers even though they make statements that would warrant this. An important typographical error to note is within the title of the paper "Fabrication of ceramic inlays in the dental laboratory: experience with Dura-Lay." Dura-Lay should read "Ducera-Lay," which is the refractory material

made by the Ducera Corporation.

Overall the journal is useful as a means to become acquainted with new technology as well as a supplement to broader texts on dental technology.

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PROBLEM AND PROCEDURES IN DENTOFACIAL ORTHOPEDICS

Frans PGM van der Linden, DDS, PhD

Published by Quintessence Publishing Co, Inc, Chicago, 1990. 382 pages, 609 illustrations. $68.00.

Written primarily for dental students and general dentists, this book is an excellent source for this audience in unraveling the mysteries of the development of the dentition.

The book discusses eruption patterns and clinical problems from birth to adulthood in a clear, categorical manner. Growth phases are described separately for the maxilla and mandible with regard to the transition of the incisors, posterior teeth, and changes that occur in the anterior region after eruption of the posterior teeth.

Also reviewed are problems often seen clinically, such as premature loss of deciduous teeth, agenisis, trauma, and abnormal lip position. These sections are described beautifully with schematic drawings, photographs of models, and some interesting photos of human skulls at the mixed dentition stage with unerupted teeth. The organization and illustrations teach the dentist to unscramble a puzzling orthodontic case and understand it without detailed cephalometrics and orthodontic discussion.

This book builds upon three works published earlier: *Development of the Dentition*, *Facial Growth and Facial Orthopedics*, and *Diagnosis and Treatment Planning in Dentofacial Orthopedics*. It is very useful alone, however, and it is not imperative that one read the preceding works. It does not teach procedural orthodontics but rather aids dentists in understanding the mixed dentition, thereby enabling them to discuss cases with parents and to give informed referrals to orthodontists.

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COLOR ATLAS OF CLINICAL ORAL PATHOLOGY

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Published by Lea & Febiger, Philadelphia, 1991. 381 pages, 500 illustrations. $89.50.

This atlas is a pleasure to read; it is well organized, has excellent radiographs and clinical pictures, and a wealth of information. Its strongest feature is its precise, up-to-date, and logical presentation of the material. The contributors are very successful in demonstrating their excellent credentials and experience in the field of clinical oral pathology. This is apparent in their informative and concise discussions of each disease. They have deftly handled different points of view when applicable, as when discussing controversial lesions.

The text covers a broad range of oral diseases, which can be described as falling into two major categories. The first group consists of lesions occurring in the oral region. These include developmental, reactive, neoplastic, and infectious processes of both the hard and soft tissues. The second group addresses the oral manifestations of systemic diseases including infections, metabolic disorders, genetic abnormalities, and neoplasms. Excellent classic and recent references are provided for each disease. The clinician is provided with the information necessary for proper management and early detection of systemic disease. This is particularly relevant in diseases such as leukemia, diabetes, and infectious processes where early detection may lead to a favorable prognosis. Management and histopathology are also addressed briefly in some other instances.

With the recent changes and advances in various fields of dentistry, as well as the description of "new" diseases and lesions, this book will be of invaluable assistance to seasoned practitioners and recent dental school graduates, professors, and dental students alike. Its value lies in being not only an excellent textbook but also a quick reference book in a clinical setting. This atlas will assist clinicians in formulating a meaningful differential diagnosis and possibly even a final diagnosis. Dental practitioners of various specialties and some medical practitioners (dermatologists and otolaryngologists) will find it to be a valuable and essential part of their personal libraries.

I strongly recommend this atlas as a reference text for practicing dentists of different specialties.

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Letters

I read your editorial in the July/August issue of *Operative Dentistry* and was motivated to view the videotape entitled "The Changing Faces of Dentistry," which was the subject covered. This was funded by the National Institute of Dental Research and the American Fund for Dental Health (AFDH). In your editorial you suggest that the American Dental Association (ADA) was in some way behind the development of this videotape. This indeed is not the case, and there are no credits or acknowledgments in the video which elude (*sic*) to the American Dental Association. I take exception to your statement that "... the American Dental Association is supporting a portrayal which makes dentists look foolish and sadistic." I draw your attention to the videos that have been developed by SELECT for the recruitment of dental students and dental auxiliaries and also the countless other publications of the American Dental Association that have been produced in support of our profession.

You ask "Why does our professional leadership take such pride in putting down anyone who does 'dentistry'?" I don't believe that you have any evidence to substantiate that question as it relates to the ADA. You also ask "Why are our governmental agencies and the American Dental Association trying so hard to eliminate dentistry as it now exists, when it will always be needed...?" Obviously dentistry is undergoing evolutionary changes, and changes which are good not only for the profession, but for the public which it serves. We should all be proud of the fact that we are growing as our knowledge base expands and that we are not complacent or satisfied with the status quo.

I feel it is important for you to inform your readers that the videotape "The Changing Faces of Dentistry" was not produced by the Association or any of its agencies. I think it is extremely unfortunate that you should use your Offices of Editor as a format for suggesting that the American Dental Association is not supportive of the dental profession or its membership.

R MALCOLM OVERBEY, DDS
President, American Dental Association

RESPONSE

I can appreciate your position; however, it may be that you are overly defensive. Is not the American Fund for Dental Health (AFDH) an arm of the American Dental Association? If not, I apologize. If it is a sponsored program of the American Dental Association, then I feel that the comments made in the editorial are indeed valid.

I am also pleased to see us expand our horizons and that includes reviewing what we teach in dental schools. Perhaps you missed my point. There has been and continues to be great pressure in academics to decrease the amount of time spent on mechanical skills and instead to devote the time to the teaching of more medicine and other related fields as indicated in the video tape. We find no support in organized dentistry to ensure that we have adequate time to teach clinical skills required of a general dentist of today or in the future. Why has the ADA not taken a positive position in this most important academic issue?

DAVID J BALES
Editor

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

Send manuscripts and correspondence about manuscripts to the Editor, David J Bales, at the editorial office: Operative Dentistry, University of Washington, School of Dentistry SM-57, Seattle, WA 98195, USA.

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Submit the original manuscript and one copy; authors should keep another copy for reference. Type double spaced, including references, and leave margins of at least 3 cm (one inch). Supply a short title for running headlines. Spelling should conform to Webster's *Third New International Dictionary*, unabridged edition, 1971. Nomenclature used in descriptive human anatomy should conform to *Nomina Anatomica*, 5th ed, 1983; the terms 'canine', 'premolar', and 'facial' are preferred but 'cuspid', 'bicuspid', and 'labial' and 'buccal' are acceptable. SI (Système International) units are preferred for scientific measurement but traditional units are acceptable. Proprietary names of equipment, instruments, and materials should be followed in parentheses by the name and address of the source or manufacturer. The editor reserves the right to make literary corrections.

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References

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OPERATIVE DENTISTRY

JANUARY-FEBRUARY 1991 • VOLUME 16 • NUMBER 1 • 1-40

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