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

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EDITORIAL

At Least, Do No Harm

The interrelation of the various parts of an economy is not always easy to perceive nor is the magnitude of the influence of one part on another easy to assess. Nevertheless, just as the parts of a human body are interrelated so too are those of an economy. As a consequence, the effects of a change made in one part of an economy are likely to be felt throughout the economy though the magnitude of these effects may vary among the parts and among the members constituting the society.

Economies, like people, are subject to ailments, and when it comes to treating a sick economy the remedy may also have unintended and unwanted side effects that create further problems. Prescribing a minimum wage, for example, has the varied consequences of raising wages for some, forcing unemployment on others, and raising prices for everyone. Many of the changes that are forced on an economy by politicians are for the benefit of special interests, but the costs are borne by all.

The complexity of an economy is such that, even for economists, predicting the outcome of a change in one part of the economy is replete with uncertainty. In his Nobel Memorial Lecture in 1974 the economist F A Hayek commented that "... economists are at this moment called upon to say how to extricate the free world from the serious threat of accelerating inflation which, it must be admitted, has been brought about by policies which the majority of economists recommended and even urged governments to pursue. We have indeed at the moment little cause for pride: as a profession we have made a mess of things."

In the circumstances, the results of attempts by politicians and economists to regulate the economy being what they are (results that in dentistry would be labeled 'iatrogenic') there is much to be said for letting the economy adjust automatically to changing conditions. Automatic controls have an excellent record of performance exemplified so well in the human body where many of the vital functions, such as the reflex arc of nerves and the peristaltic activity of the intestines, to name only two, are regulated involuntarily.

The treatment of malfunction, when it occurs, should be based on sound principles of economics rather than on expedience or pressure from special interests. Perhaps at this stage in the development of the discipline of economics it would be well for economists and politicians to heed the advice given to physicians by a character in Fielding's *Tom Jones* who said, "Nature should be left to do her own work, while the physician stands by, as it were, to clap her on the back and encourage her when she doth well."

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ORIGINAL ARTICLES

Use of Rubber Dam among General Dentists in the United States Air Force Dental Service

Dentists in the United States Air Force Dental Service use the rubber dam more frequently than dentists in private practice

MARK S HAGGE • WAYNE P PIERSON
ROBERT B MAYHEW • ROBERT D COWAN
E STEVEN DUKE

Summary

A sample of 276 US Air Force general dentists was surveyed on the use of rubber dam for various dental procedures. From the sample, 233 dentists (84%) replied. An average of 52.4% of these respondents reported using the rubber dam 81–100% of the time for operative procedures, and an average of 97.7% reported using the rubber dam at the same level for endodontic procedures. Lower levels of use were noted with pit and fissure sealants, polishing and finishing of amalgam restorations, and single-unit castings, in that order. The findings suggest that the use of rubber dam among USAF general dentists for operative procedures in particular, and other procedures in general, is greater than levels of use reported in previous studies of dentists in private practice.

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INTRODUCTION

Since Barnum's introduction of the rubber dam in 1864, numerous articles have appeared related to its advantages, practicality, and methods of application. Advantages such as protection of the patient (Christen, 1967), maintenance of a dry working field (Stebner, 1954), visibility for the operator (Ireland, 1962), quality of work (Medina, 1967), and less chair time (Heise, 1971) have all led to the use of rubber dam being accepted as a standard of care. In addition, the use of the rubber dam is taught and required in most dental schools today (Smith & Richeson, 1981).

Yet, in spite of this acceptance, the use of the rubber dam has been frequently ignored by practicing dentists. LaPorte (1956) estimated routine use of the rubber dam was confined to only 2–4% of practicing dentists. A 10% level of use by general dentists was reported by Murray (1960). Going and Sawinski (1967) surveyed 1251 practicing dentists and found only 18% used the rubber dam more than 5% of the time for operative procedures, whereas 63% of those surveyed used the rubber dam more than 5% of the time for endodontic procedures. In a 1964 survey of 3659 recent graduates of dental schools, 23% reported using the rubber dam 30% or more of the time (Wolcott & Goodman, 1964). Janet Siwinski found in 1980 (unpublished survey) that only 5% of general practitioners were regular users of rubber dam.

All of these studies have demonstrated a minimal use of rubber dam within the profession. Excluded from the literature are reports of the use of rubber dam by practicing dentists in the US Armed Services. Therefore, the purpose of this study was to investigate use of the rubber dam within the United States Air Force Dental Service.

MATERIALS AND METHODS

A stratified systematic sample of 276 general dentists, representing 25% of the general dentists currently on active duty in the USAF Dental Service, was selected to receive the questionnaire shown in Figure 1. Responses to each dental procedure were tabulated and comparisons made on the basis of percentage use of the rubber dam. A χ^2 analysis was used to compare the use of rubber dam with the number of years since graduation from dental school. A second χ^2 analysis was used to evaluate use of the rubber dam between those that had and those that had not completed a formal postgraduate residency.

RESULTS

The number of questionnaires returned was 233 (84%). The extent of the overall use of the rubber dam for each surveyed procedure is shown in Figure 2. For clarity in discussion, level I corresponds to a 0–20% use of rubber dam for a given procedure, and so on, with level V representing an 81–100% use.

Silver Amalgam Restorations

The highest level of use for amalgam restorations was 72.5% in level V for class 2 restorations in the mandibular arch. Similar use in the maxillary arch was reported at 66.5%. A slightly lower level of use was reported for class 1 restorations and a considerably lower level of use, 13.2% in level V, was reported for class 5 restorations on maxillary second molars.

Polishing and Finishing

Use of the rubber dam for polishing and finishing was relatively low with only 3.3% of the dentists reporting use at level V.

Resin Restorations

The pattern of use of rubber dam with resin restorations was comparable to that observed with amalgam restorations. For class 3 and 4 restorations on both arches, 65% of the dentists reported use in level V. Use of the rubber dam for class 5 restorations was less, with 49% of the dentists reporting use in level V in both arches.

Endodontics

The highest use of rubber dam reported in this study was with endodontic procedures. Equivalent use was reported with anterior, premolar, and molar teeth. The least use observed was 93.2% in level V for an emergency opening of an anterior tooth and the greatest use was 100% in level V for the endodontic filling of an anterior tooth.

Other Procedures

Infrequent use of the rubber dam was reported for procedures for single-unit castings. Only 17.5% of the dentists reported

USE OF THE RUBBER DAM IN GENERAL PRACTICE

INSTRUCTIONS:

BELOW IS A LIST OF DENTAL PROCEDURES. TO THE RIGHT ARE COLUMNS REFLECTING PERCENTAGE USE OF THE RUBBER DAM FOR THAT PARTICULAR PROCEDURE. IF A LISTED PROCEDURE IS PART OF YOUR PRACTICE, PLEASE CIRCLE THE NUMBER BELOW THE APPROPRIATE PERCENTAGE RANGE. IF A LISTED PROCEDURE IS NOT PART OF YOUR PRACTICE, PLEASE LEAVE THAT ITEM BLANK.

	PERCENTAGE USE OF RUBBER DAM				
SILVER AMALGAM RESTORATIONS	0-20%	21-40%	41-60%	61-80%	81-100%
MAXILLARY					
Class 1	1	2	3	4	5
Class 2	1	2	3	4	5
Class 5	1	2	3	4	5
Class 5 on maxillary second molar	1	2	3	4	5
MANDIBULAR					
Class 1	1	2	3	4	5
Class 2	1	2	3	4	5
Class 5	1	2	3	4	5
POLISHING/FINISHING	1	2	3	4	5
RESIN RESTORATIONS					
MAXILLARY					
Class 3, 4	1	2	3	4	5
Class 5	1	2	3	4	5
MANDIBULAR					
Class 3, 4	1	2	3	4	5
Class 5	1	2	3	4	5

	PERCENTAGE USE OF RUBBER DAM				
ENDODONTICS	0-20%	21-40%	41-60%	61-80%	81-100%
ANTERIOR					
Emergency opening	1	2	3	4	5
Pulpotomy/pulpectomy	1	2	3	4	5
Interim treatment	1	2	3	4	5
Fill	1	2	3	4	5
PREMOLAR					
Emergency opening	1	2	3	4	5
Pulpotomy/pulpectomy	1	2	3	4	5
Interim treatment	1	2	3	4	5
Fill	1	2	3	4	5
MOLAR					
Emergency opening	1	2	3	4	5
Pulpotomy/pulpectomy	1	2	3	4	5
Interim treatment	1	2	3	4	5
Fill	1	2	3	4	5
OTHER PROCEDURES					
SINGLE UNIT CASTINGS					
Preparation	1	2	3	4	5
Impression	1	2	3	4	5
Cementation	1	2	3	4	5
PLACING PIT & FISSURE SEALANTS	1	2	3	4	5

What year did you graduate from dental school? 19__

Have you completed a postgraduate residency (GPR, GDR)? YES NO

Comments:

FIG 1. *Survey form used to collect data on the use of rubber dam from 276 general dentists*

PROCEDURE	PERCENTAGE USE OF RUBBER DAM				
	0-20%	21-40%	41-60%	61-80%	81-100%
SILVER AMALGAM RESTORATIONS					
MAXILLARY					
Class 1	18.1	4.1	8.6	9.5	59.7
Class 2	12.7	4.5	8.1	8.1	66.5
Class 5	27.6	8.1	11.8	16.7	35.7
Class 5 on maxillary second molar	53.0	11.0	9.6	13.2	13.2
MANDIBULAR					
Class 1	13.1	5.0	6.3	11.7	64.0
Class 2	8.1	4.1	6.8	8.6	72.5
Class 5	23.9	10.6	13.3	17.4	34.9
POLISHING/FINISHING	76.5	6.6	8.9	4.7	3.3
RESIN RESTORATIONS					
MAXILLARY					
Class 3, 4	13.1	5.4	6.8	9.5	65.3
Class 5	21.7	6.8	9.0	12.7	49.8
MANDIBULAR					
Class 3, 4	12.6	6.8	6.8	9.5	65.8
Class 5	21.5	6.8	9.1	13.2	49.3

PROCEDURE	PERCENTAGE USE OF RUBBER DAM				
	0-20%	21-40%	41-60%	61-80%	81-100%
ENDODONTICS					
ANTERIOR					
EMERGENCY OPENING	1.8	0.9	0.9	3.2	93.2
PULPOTOMY/PULPECTOMY	0.5	0.0	0.5	0.0	99.1
INTERIM TREATMENT	0.5	0.0	0.0	1.4	98.2
FILL	0.0	0.0	0.0	0.0	100.0
PREMOLAR					
EMERGENCY OPENING	1.8	0.5	0.9	2.7	94.1
PULPOTOMY/PULPECTOMY	0.5	0.0	0.5	0.5	98.6
INTERIM TREATMENT	0.5	0.0	0.0	1.4	98.2
FILL	0.0	0.0	0.5	0.5	99.1
MOLAR					
EMERGENCY OPENING	2.3	0.5	0.5	2.3	94.6
PULPOTOMY/PULPECTOMY	0.0	0.0	0.9	0.0	99.1
INTERIM TREATMENT	0.5	0.0	0.0	0.9	98.6
FILL	0.0	0.0	0.5	0.0	99.5
OTHER PROCEDURES					
SINGLE UNIT CASTINGS					
PREPARATION	82.6	3.0	5.5	6.0	3.0
IMPRESSION	95.9	2.0	1.0	1.0	0.0
CEMENTATION	95.4	2.6	1.0	1.0	0.0
PLACING PIT AND FISSURE SEALANTS	32.4	6.9	13.7	12.7	34.3

FIG 2. *Percentage of dentists that placed a rubber dam for various procedures over five levels of use*

using the dam in levels II through V for preparing teeth for castings. Even lower levels of use were reported for the impression and cementation procedures.

The use for pit and fissure sealants was bimodal, with one-third of the dentists reporting in level I and one-third in level V.

Effect of Year of Graduation and Residency Training

When years since graduation were compared, a χ^2 analysis revealed a statistically significant difference ($P < 0.05$) in use between years for the following dental procedures:

Amalgam restorations
(a) Class 1 and 5 in both arches
(b) Class 5 in maxillary second molars
Resin restorations
(a) Class 3 and 4 in both arches
(b) Maxillary class 5

Table 1 provides two examples.

In all of the above restorative procedures the greatest use of rubber dam was reported by those graduating before 1970 and the least by those graduating since 1980. Generally there was a consistent increase in reported use with years since graduation.

The second χ^2 analysis, which assessed the effect of residency training, indicated that class 5 resin restorations were the only procedures in which there was a statistically sig-

Table 1. Levels of Use of Rubber Dam by Dentists by Year since Graduation

Year of Graduation	Use of Rubber Dam				
	Maxillary Class 1 Silver Amalgam*				
	0–20%	21–40%	41–60%	61–80%	81–100%
Pre-1970	7.1	0.0	7.1	0.0	85.7
1970-1974	6.9	3.4	6.9	10.3	72.4
1975-1979	15.8	6.1	10.5	11.4	56.1
1980 +	36.0	2.0	6.0	10.0	46.0
	Maxillary Class 3 and 4 Resin**				
Pre-1970	10.3	0.0	3.4	0.0	86.2
1970-1974	6.9	3.4	6.9	3.4	79.3
1975-1979	11.4	7.9	7.9	15.8	57.0
1980 +	22.0	4.0	6.0	4.0	64.0

*$\chi^2 = 25.9$, $P < 0.05$
**$\chi^2 = 22.5$, $P < 0.05$

nificant difference ($P < 0.05$) in the use of rubber dam. The greater use was reported by the residency-trained dentists (Table 2).

DISCUSSION

Comparing the use of rubber dam by USAF general dentists with results reported in previous studies is complicated by the various designs of survey and terminology used. The survey of USAF dentists was designed with numerous categories to provide more exact patterns of rubber dam use. However, some comparisons are possible.

Several authors have reported their findings under a heading of regular or routine use of rubber dam. In this category LaPorte (1956) reported a use of 2–4%, Murray (1960), 10%, and Siwinski (unpublished, 1980), 5%. Wolcott and Goodman (1964) reported that 23% of those surveyed used the dam 30% or more of the time, and Going and Sawinski (1967) reported that for operative procedures 15% of the dentists they surveyed used the rubber dam at least half the time. In the study reported here, 52.4% of the USAF dentists reported using the rubber dam 81–100% of the time (level V) for all categories of amalgam and resin restorations. In fact, for all categories of dental procedures surveyed, no comparisons could be made that suggested lower use of rubber dam by USAF dentists.

As the data suggest, however, there were variations in the extent of use among the operative procedures. For example, the lower levels of use with class 5 restorations of silver amalgam and resin could be attributed to the difficulty in isolating these lesions, especially on maxillary second molars. Techniques that have been suggested to improve isolation of these areas have included offsetting the hole for the involved tooth, modifying a cervical clamp (retractor), and using compound to stabilize the clamp (Brass, 1965). Procedures designed for increased retraction of

Table 2. Levels of Use of Rubber Dam for a Class 5 Resin by Dentists with and without Residency Training

Residency Training	Use of Rubber Dam				
	Maxillary Class 5 Resin*				
	0–20%	21–40%	41–60%	61–80%	81–100%
Yes	12.9	8.6	2.9	12.9	62.9
No	25.6	7.1	10.9	13.5	42.9
	Mandibular Class 5 Resin**				
Yes	11.6	7.2	2.9	15.9	62.3
No	25.8	7.7	11.6	12.3	42.6

*$\chi^2 = 11.4$, $P < 0.05$
**$\chi^2 = 12.8$, $P < 0.05$

gingiva have also been described (Barkmeier & Williams, 1978).

Although the rubber dam was not reported to be commonly used for polishing and finishing amalgams, the need for good vision while removing the excess over the margins has been noted as a specific indication for application of rubber dam, particularly when quadrants of restorations are involved (Gilmore & others, 1982).

The greater use of the rubber dam for endodontics, compared to operative procedures, was similar to the findings of Going and Sawinski (1967). Confinement of root canal instruments and irrigant, and simplified application of the dam to a single tooth are probable factors resulting in the higher use observed for endodontic therapy. In addition, Weine (1982) reported that placement of the rubber dam has been a standard of care practiced by endodontists and that general dentists must employ the same precautions as dental specialists or be considered legally negligent.

In contrast to endodontics and operative dentistry, the low use of the rubber dam for single-unit castings suggests that the rubber dam is not a part of the standard armamentarium for these procedures. Wolcott and Goodman (1964) reported that only 5% of dental students were required to use the dam for crown and bridge procedures. Other factors that may account for such low use include: common placement of subgingival margins, interference by rubber dam clamps, adherence of various impression materials to the dam, and the inability to visualize opposing teeth. A technique has been described by Elderton (1971) whereby occlusal reductions are accomplished before placement of the dam, followed by final preparation and impression with a nonadherent impression material after placement of the rubber dam.

The equivalent use of rubber dam seen in levels I and V for placement of pit and fissure sealants reflects, to some extent, the disparity found in the literature concerning the use of the dam for this procedure. Use of the rubber dam has been reported as the only method of guaranteeing that saliva will not contaminate the etched enamel (DePaola & Cheney, 1979). On the other hand, Simonsen (1981) has developed specialized techniques for isolation with cotton rolls, and has reported retention of sealant at 36 months at greater than 94%.

Although residency-trained dentists reported a greater use of the dam for class 5 resin restorations, there were no consistent differences in the use of rubber dam for other similar dental procedures. This casts some doubt on the strength of this difference in rubber dam use and suggests that there may be little real difference between those with and without residency training.

The data revealed a higher use of rubber dam among the USAF senior groups in comparison with recent graduates. This increased use over time may be related to the concept of group practice present in Air Force dental clinics where there is repeated exposure to the use of rubber dam and the opportunity to share techniques. Casey (1980) and Wolcott and Goodman (1964) have suggested that there is a high, positive correlation between the amount of clinical instruction in the technique of using rubber dam and the extent of use by the practitioner.

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Sensitivity of Teeth with and without Cement Bases under Amalgam Restorations: A Clinical Study

Teeth with zinc phosphate cement bases under amalgam restorations were less sensitive to a cold thermal stimulus than were the same teeth without cement bases

BROCK C MILLER • GERALD T CHARBENEAU

Summary

The effectiveness of zinc phosphate cement bases under amalgam restorations in reducing postoperative sensitivity to cold was evaluated clinically. Patients had removable and interchangeable amalgam inlays placed one week after initial preparation of the teeth. Each tooth had virgin caries that was sufficiently deep when excavated to receive a cement base. One inlay had a base of ideal thickness and one was without any base. Each patient was his own control. Thermal tests were performed both preoperatively and one week postoperatively. The tests demonstrated that the teeth with bases were significantly less sensitive than the teeth without bases. Postoperative sensitivity to cold was greater than that observed preoperatively.

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INTRODUCTION

Postoperative thermal sensitivity under amalgam restorations can be bothersome for a dental patient. Many different approaches have been used in an attempt to prevent or to treat this problem. None has been found to be completely satisfactory.

The traditional procedure used in operative dentistry has been to place a cement base underneath an amalgam restoration to provide thermal insulation when the prepared cavity is deep. Dentists generally have supported this concept even though it has not been experimentally verified in a clinical setting under controlled conditions. Recently Piperno and others (1982) surveyed patients about their postoperative discomfort after placement of amalgam restorations and concluded that cement bases were unnecessary for thermal protection. However, in every case surveyed a thermally insulating liner of calcium hydroxide was used beneath the amalgam restoration.

The purpose of this study was to compare in human subjects the sensitivity of teeth to cold water when amalgam restorations with ideal bases of zinc phosphate cement and amalgam restorations having no bases are used in a controlled clinical setting.

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MATERIALS AND METHODS

Patients were selected who had virgin occlusal caries in a mandibular tooth that would result in a prepared cavity deeper than ideal for the restorative material, but without pulpal exposure. A prepared cavity of ideal depth was defined as one that extends into dentin only to the minimal depth required by mechanical and biological factors. These teeth had no history of spontaneous pain nor evidence of periodontal disease. A total of 14 teeth from 14 male and female patients constituted the population of the study. The ages of the subjects ranged from 14 to 36 years.

The experimental procedure consisted of (1) thermal tests prior to anesthesia and tooth preparation to establish the preoperative baseline sensitivity for each tooth, (2) preparation of a cavity for an inlay in each tooth, (3) fabricating an amalgam inlay with a base and an amalgam inlay without a base on stone dies in the laboratory, and (4) at a subsequent appointment, measuring the patient's sensory response time to a stimulus of cold water applied when each amalgam inlay was in place. Each patient thus served as his own control. The sensory reponse times of the three categories—preoperative, with a base, and without a base—were compared.

Thermal tests were carried out in the following manner. The test tooth was isolated with a rubber base impression (Permlastic, Sybron/Kerr, Romulus, MI 48174, USA) in a tray of the quadrant involved. That portion of the impression and tray above the occlusal surface of the test tooth was removed. When replaced into the mouth, the impression effectively isolated that area of the test tooth from the remaining teeth in the quadrant. A rim of utility wax was sealed around the external opening in the tray to create a reservoir. The occlusal surface area was flooded with water at 10 °C to thermally stimulate the tooth. The cold water was introduced through a 10 ml disposable plastic syringe with a curved tip, which provided good access (Monojet 412, Sherwood Medical Industries Inc, Deland, FL 32720, USA).

A suction tip with a narrow orifice and connected to the saliva ejector was used just prior to the introduction of the water stimulus to remove any saliva and debris from the occlusal surface of the test tooth, and to remove excess water during the thermal test. In each case, the suction was placed in the distal part of the test site while the water was introduced at the mesial.

The patient used a hand-held stopwatch to measure the sensory response time. The sensory response time was defined as the time from the introduction of the cold water into the reservoir of the impression until a sensation of discomfort was perceived by the patient. The patient was instructed to begin timing when the introduction of the cold water began, and to stop the watch at the first sign of discomfort. Three thermal tests were made for each of the categories, namely, preoperative, with a base, and without a base. The three tests were used to establish a mean time for sensory response for each category for each patient. The impression was placed in a water bath at 37 °C prior to and between all tests. A period of two minutes was allowed between each test to permit the tooth to recover its normal temperature.

First Appointment

Two appointments were required for each patient. At the first appointment, the preoperative tests were performed as described. The patient was then anesthetized and an inlay type of cavity was prepared. The dentinal tubules were sealed with two layers of cavity varnish (Copalite, Cooley and Cooley Ltd, Houston, TX 77001, USA). If the walls of the prepared cavity were undercut from caries removal, these were filled with zinc phosphate cement (Tenacin, L D Caulk Company, Milford, DE 19963, USA). An impression of the prepared cavity was made with an addition reaction silicone (President, Coltene Inc, Altstaelter, Switzerland). A zinc oxide and eugenol temporary restoration (Ward's TemPak, Westward Dental Products Co, San Francisco, CA 94109, USA) was placed and the patient dismissed.

Laboratory Procedures

Amalgam inlays were fabricated in multiple stone dies formed from the impression of the preparation, one for the inlay with a base and

one for the inlay without a base. Additional dies were used for checking the fit of the inlays.

To aid the removal of the inlays from the tooth intraorally, and to affix the zinc phosphate cement to the amalgam of the inlays with bases, a 5-0 nylon suture was embedded in the inlays. The materials were packed around the suture material so that a loop was formed through the sides of the inlay and out through the occlusal surface (see figure).

The cement base (Tenacin) and amalgam restoration (Tytin, S S White Dental Products International, Philadelphia, PA 19102, USA) were placed into the dies by conventional techniques. For the inlay with a base the cement was placed to restore the pulpal floor to a depth just beneath the dentinoenamel junction. Once the base had set, the amalgam was condensed and carved to the contour of the occlusal surface. For the inlay without a base the amalgam was introduced directly against the pulpal floor of the die and carved in the same manner as the inlay with a base.

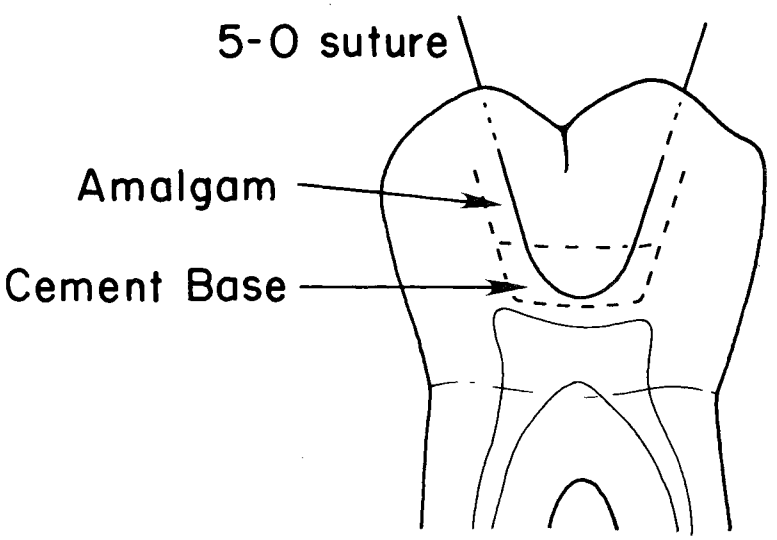
The dies were deeply scored and broken away from the inlay surfaces. Walls of the inlays were adjusted as necessary to achieve seating into the prepared cavities. However, in no case was the pulpal surface of any inlay adjusted.

Second Appointment

The second appointment followed one week after the first except for one patient for whom the second appointment followed the first by two days. Without anesthesia, the temporary restoration was removed with a small spoon excavator. Both inlays were tried into the tooth and adjusted as necessary to ensure complete seating. One-half of the patients randomly selected had the inlay without a base placed first for testing, the other half had the inlay with a base tested first.

To ensure that no insulating layer of air would remain between the inlay and tooth tissue, a small amount of water at 37 °C was placed into the prepared cavity. After seating the inlay, the excess water on the occlusal surface was removed with cotton pellets and the amalgam-enamel interface sealed with a quick-setting zinc oxide and eugenol cavity liner (Cavitec, Sybron/Kerr, Romulus, MI 48174, USA). The sealing was done to eliminate microleakage. The thermal tests were performed as described previously in the procedures for the first appointment.

After the first tests were completed, the inlay was removed by the suture loop. The preparation was cleansed with water at 37 °C and the other inlay was tested.



Suture loop through inlay

After the thermal tests were completed the patient was anesthetized and the tooth prepared to receive a conventional amalgam restoration.

RESULTS

The mean times of sensory response for each category for each patient are shown in Table 1 and the results of statistical analysis of the data by paired *t*-tests are shown in Table 2.

The individual times of sensory response did not show great variation. Of the 14 teeth tested, 12 (86%) had sensory response times that were shorter for the inlays without a base than for those with a base, the difference being statistically significant ($P = 0.0071$). Comparison of the preoperative response times with those of the inlays with bases likewise showed 12 of the 14 latter response times shorter, but the differences were not statistically significant at the 5% level ($P = 0.0940$). All of the sensory response times of teeth without bases were shorter than the preoperative sensory response times and the differences were statistically highly significant ($P = 0.0010$).

Table 1. Mean Times of Sensory Response in Seconds by Category

Patient	Preoperative	With Base	Without Base
	s	s	s
1	3.26	3.03	1.26
2	2.96	2.86	2.32
3	5.13	5.25	2.40
4	5.40	1.67	1.06
5	2.40	1.20	0.80
6	1.70	0.77	0.80
7	2.00	4.40	1.13
8	1.83	1.63	1.47
9	5.40	3.40	1.20
10	1.13	0.93	1.00
11	1.30	0.86	0.40
12	1.27	1.07	0.73
13	1.00	0.77	0.47
14	4.60	1.30	0.93

Table 2. Analysis of Data by Paired t-Test

Category	Mean	Difference between Means	SD	*t*-Statistic	Probability
	s				
Preoperative	2.8129	0.73143	1.5146	1.8069	0.0940
With base	2.0814				
Preoperative	2.8129	1.67210	1.4759	4.2391	0.0010
Without base	1.1407				
With base	2.0814	0.94071	1.1027	3.1919	0.0071
Without base	1.1407				

Although the patients were unaware of which inlay was in place, eight patients volunteered the observation that the tests of inlays without bases resulted in more severe discomfort and a longer lasting sensation than tests of inlays with bases. After the tests were completed and the results disclosed to the patient, many expressed the desire that bases be placed in their teeth in the final amalgam restoration.

DISCUSSION

Experiments involving sensation must rely upon subjectivity. This study attempted to minimize the associated problems by having the patients respond to their first perception of sensation in the tooth being tested. All comparisons between the based and unbased conditions were made on the same teeth and under the same testing conditions for each patient. The interchangeable inlays eliminated the problems of comparing different teeth on the same patient or between patients, and of comparing the teeth on different days. The thermal testing regimen allowed consistent thermal stimulation for all tests.

The mean times of thermal response at one week postoperatively show that bases are a significant factor in the reduction of postoperative sensitivity. Although patients were not told which restoration, with a base or without a base, was being thermally stimulated, most had no difficulty in judging which allowed the greater sensitivity.

These results contrast with the stated conclusions in another recent study involving bases and thermal sensitivity (Piperno & others, 1982). That study, while concluding that bases were unnecessary, did, in fact, use a calcium hydroxide liner in each tooth. Such a liner may provide similar thermal characteristics of a base. The semantic differences between base and liner should be put aside as they relate to their ability to provide thermal insulation beneath amalgam restorations. When this is done, the Piperno (1982) conclusion could state that a layer of calcium hydroxide may provide adequate thermal protection.

For those teeth in the Piperno (1982) study for which patients did experience hypersensitivity, the authors hypothesized that those patients probably had insufficient reparative dentin to "insulate them from thermal shock." However, it has been shown that significant formation of reparative dentin does not occur until after the first postoperative month (Stanley, White & McCray, 1966). Therefore, the placement of a base could be helpful to prevent thermal sensitivity, at least during this time. Also, the formation of reparative dentin is not consistent. It varies in permeability, thickness, and arrangement (Seltzer & Bender, 1975). Since the quality and quantity of reparative dentin is not predictable in individuals, it cannot be relied upon to provide short-term or long-term postoperative protection against thermal sensitivity. Cement bases should be considered as potentially helpful in preventing postoperative sensitivity when the prepared cavity is deeper than ideal for the mechanical and physiological requirements of the restoration.

The results also showed that even with the prepared cavity based to the ideal depth, the teeth were still more sensitive at one week than they were preoperatively with frank carious lesions. This increase in sensitivity may reflect (1) a decreased pain threshold due to the operative procedures, (2) the water under the inlays causing an increased hydrodynamic effect (Brännström, 1963), (3) the difference in thermal conductivity between the amalgam with a base in the restored tooth and the enamel and carious dentin of the unrestored tooth, or (4) some combination of these.

CONCLUSIONS

Patients report significantly less sensitivity to cold at one week postoperatively in teeth having amalgam restorations with thermally insulating bases of zinc phosphate cement than in the same teeth having amalgam restorations without bases.

At one week postoperatively, teeth are generally more sensitive than they were with the untreated caries prior to restoration, regardless of whether or not a cement base is present.

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Acknowledgment

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DENTAL PRACTICE

Restorative Treatment for the Cracked Tooth

Pin-retained amalgams provide conservative restorations for incompletely fractured teeth or may serve as foundations for more extensive cast restorations

LAWRENCE L CLARK • W F CAUGHMAN

Summary

Conventional treatment of incomplete fracture of a tooth usually involves a provisional crown followed by root canal therapy and later a complete cast crown. Following this course of treatment involves five procedures that have the potential to propagate the crack. To avoid an excessive number of insults to an already compromised tooth, we recommend the initial use of a pin-retained amalgam restoration to bind together the two segments of the tooth and to provide internal stabilization. Unless the prognosis is hopeless, we contend that the pin-retained amalgam should precede all other treatment. This approach should prevent further advancement of the fracture and decrease the number and severity of insults to the pulp.

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INTRODUCTION

The etiology and diagnosis of the cracked tooth, or incompletely fractured tooth, has appeared in the literature since the 1950s (Gibbs, 1954). Cameron (1964) and Stanley (1968) addressed this problem in detail and their articles are frequently quoted as classic works. The primary symptoms are pain on chewing and discomfort from thermal changes, particularly cold. Most cracks occur in a mesiodistal direction in previously restored molars and premolars, but cracks occur also in noncarious and nonrestored teeth. The highest incidence of incomplete fracture occurs in mandibular second molars (Cameron, 1976). Hiatt (1973) reported that 74% of the cracked teeth in a study had either no restoration or a

minimal occlusal restoration that should not have weakened the tooth. He postulated that the marginal and transverse ridges of maxillary molars make them stronger and less likely to fracture than mandibular molars. Abou-Rass (1983) has reviewed the theories on the probable causes of incomplete fractures of teeth and the appropriate tests for diagnosis of the fracture.

These and other contemporary studies have focused on the problems of recognizing the symptoms and deriving a proper diagnosis. Consideration of the various methods of treatment and their effect on the prognosis of teeth with incomplete fractures has been minimal. Traditional treatment for the problem has been to restore the tooth with either an onlay, a three-quarter crown, or a complete crown (Cameron, 1976; Snyder, 1976; Silvestri & Singh, 1978). Silvestri & Singh (1978), suggesting an interesting variation to this basic approach, reported that it may be possible, and in some cases preferable, to use an amalgam restoration placed across the line of fracture to bind the two fractured segments together mechanically before reducing the tooth for a cast restoration. They also suggested that intracoronal boxes or grooves not be placed in the line of the fracture and indicated that pins can be used, but as a compromise. Abou-Rass (1983) agrees with Silvestri and Singh (1978) but recommends that pins be avoided to prevent further injury to the tooth.

The use of pin-retained restorations has seldom been advocated for the treatment of teeth with incomplete fractures. The following discussion is presented to suggest that pin-retained restorations should be considered for a more conservative approach to treatment compared with the traditional treatment with cast restorations.

TYPES OF FRACTURE

The cracks in incompletely fractured teeth can occur in either a horizontal direction, as beneath a cusp, or vertically. Horizontal cracks normally result in restorative problems only, that is to say, cracks occurring in a horizontal direction, if left untreated, frequently result in the cusp fracturing away and the need for its restoration, while vertical cracks can lead to a much more serious problem such as loss of the tooth.

Incomplete fractures of teeth are vertical and almost always occur in a mesiodistal direction; seldom do they occur in a facio-lingual direction. In any case the treatment and prognosis would be the same.

For ease of discussion the types of fracture are categorized according to prognosis—from excellent to hopeless.

Excellent: (a) Cuspal fracture confined within dentin that angles from the faciopulpal or linguopulpal line angle of a cusp to the cementoenamel junction or slightly below (Figs 1 & 2)

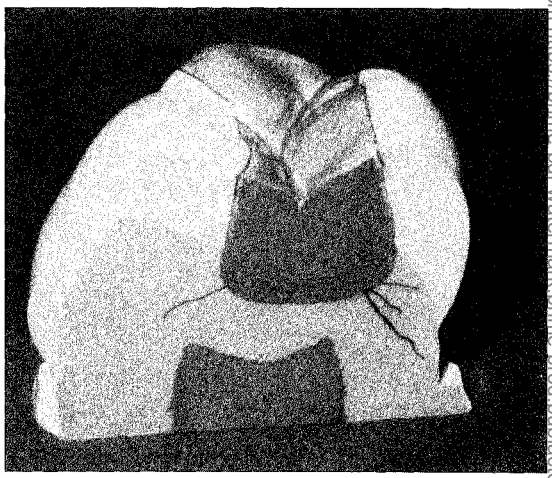

FIG 1. *Six-dimensional model of the angular fracture of a cusp*

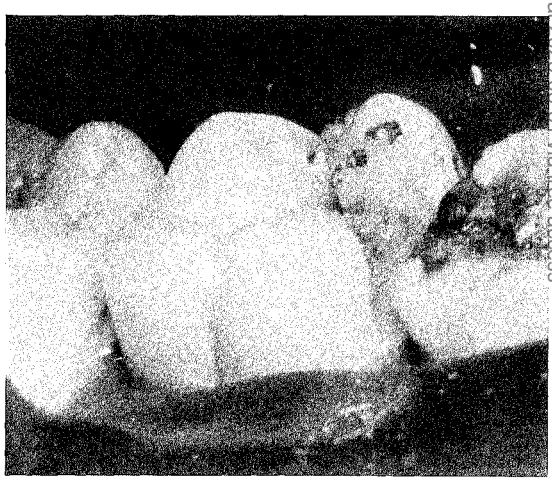

FIG 2. *Clinical view of an angular fracture of the mesiolingual cusp of a mandibular molar*

(b) Horizontal fracture of a cusp not involving the pulp (Fig 3)

FIG 3. *Clinical view of a horizontal fracture of a cusp*

Good: Vertical fracture mesiodistally into the dentin but not into the pulp (Fig 4)

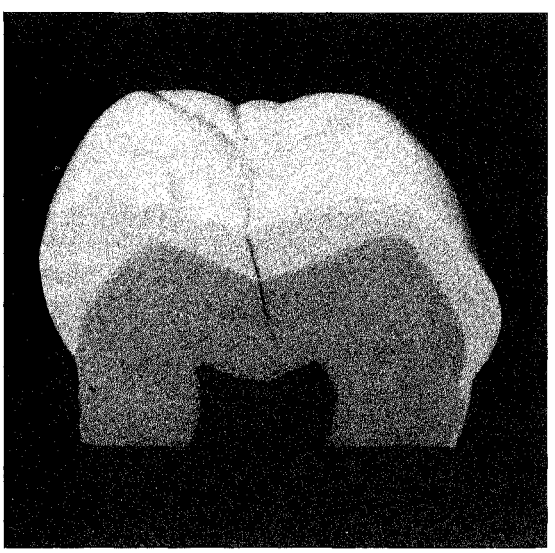

FIG 4. *A six-dimensional model demonstrating a vertical fracture that extends into the dentin but not into the pulp*

Poor: Vertical fracture mesiodistally into the pulp but confined to the crown (Fig 5)

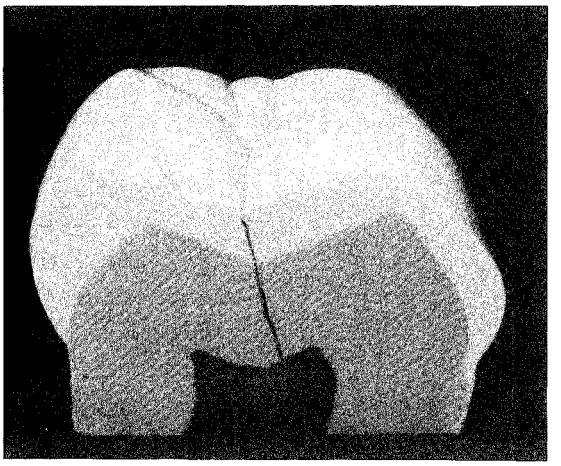

FIG 5. *A six-dimensional model demonstrating a vertical fracture that extends to the pulp, but not into the root*

Hopeless: Vertical fracture mesiodistally through the pulp and extending into the root (Figs 6 & 7)

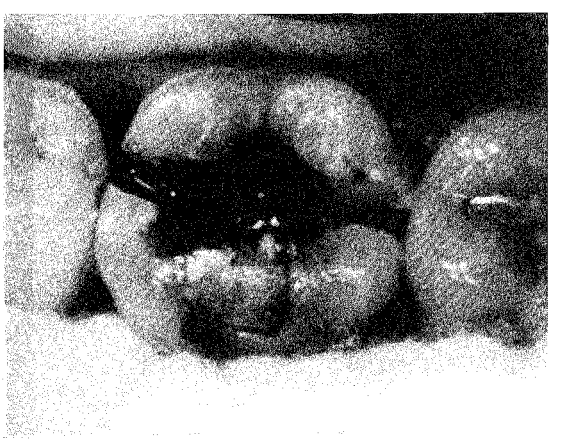

FIG 6. *Clinical photograph of a vertical fracture of a mandibular first molar, extending mesiodistally into the root*

TREATMENT

Only a few reports of cases and clinical studies give other than traditional methods of restoring cracked teeth, that is, with cast

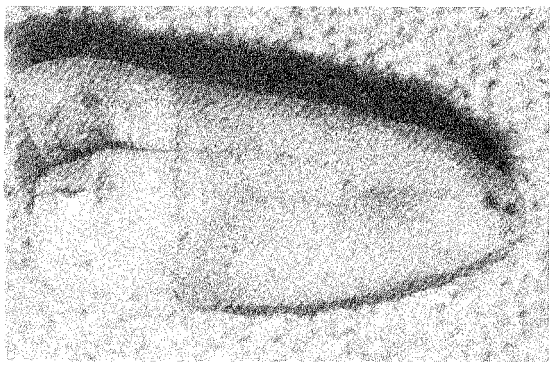

FIG 7. *Extracted mandibular molar, showing a vertical fracture into the root. This tooth had no previous restoration.*

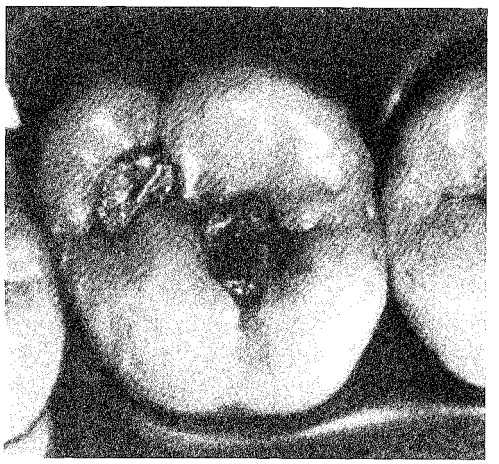

FIG 8A. *Maxillary first molar with fractured facial cusp*

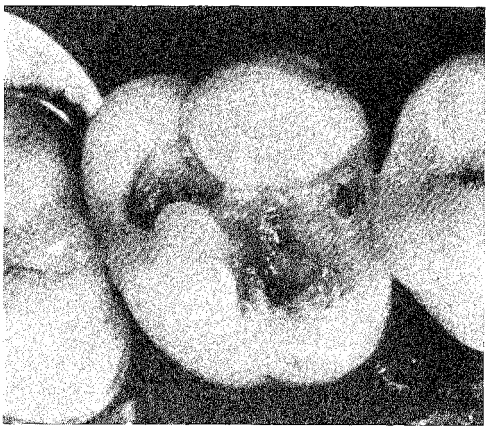

FIG 8B. *Preparation with pins in place*

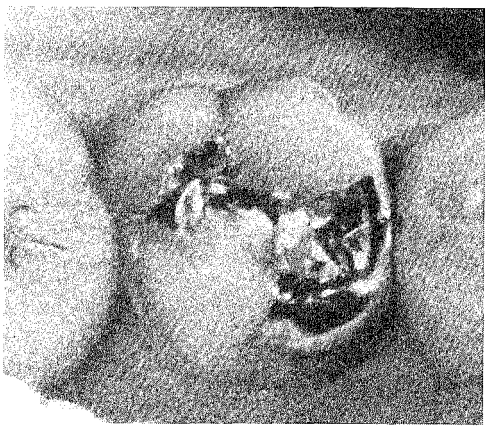

FIG 8C. *Restoration completed*

restorations. Distinct advantages, however, may be realized by placing pin-retained amalgams. This restoration should be considered as the initial method of treatment in many cases. The restoration must be skillfully and judiciously placed. The dentist should study the morphology of the tooth in question and examine a good radiograph before placing the pin into the proper position in the dentin. The net result is a satisfactory restoration. Several authors have reported effects of crazing on tooth structure when using pins (Dilts & others, 1970; Khera, Chan & Rittman, 1978); nonetheless, most failures associated with pin-retained amalgams are caused by operator error. We intend to demonstrate that the pin-retained amalgam is frequently the treatment of choice when restoring incompletely fractured teeth.

Treatment for each category of fracture previously presented is examined below.

Excellent Prognosis

The two types of crack listed in this category are probably the most common. As long as they are diagnosed before they advance, the treatment is basic and conservative.

The loss of one or more cusps can be adequately restored with a pin-retained amalgam (Figs 8 & 9). Birtcil and Venton (1976) prefer

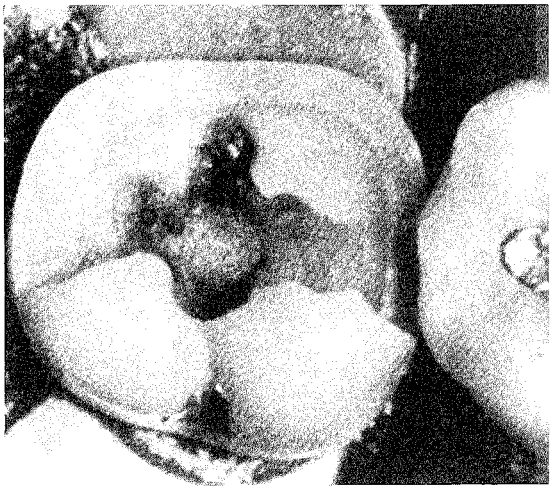

FIG 9A. *Mandibular molar; fractured mesiodistally through lingual cusps*

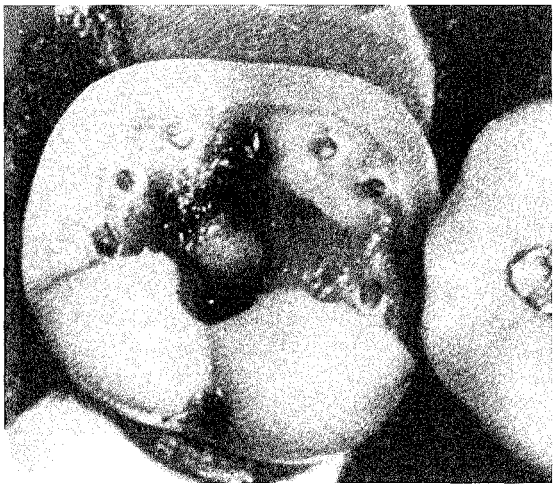

FIG 9B. *Six pins in place to retain restoration and prevent further vertical fracture*

slots or grooves, but these alone may not provide sufficient retention and resistance form, especially during the early set of the amalgam. However, there is no objection to a combination of slots and grooves along with pins to restore these teeth, as long as the pins are placed in the proper locations.

The complete cast crown is not necessarily the restoration of choice. Because a foundation of some kind is necessary to restore these teeth, even if a crown is being considered, a pin-retained amalgam should be placed first. When teeth are restored with pin-retained amalgams it is rare that the next problem with the tooth is the restoration; most often another part of the tooth will fail, leaving intact the pin-retained amalgam and remaining tooth structure to serve as the core for a complete crown.

Good Prognosis

The treatment for this category is a pin-retained amalgam or a complete crown; the net result is the same. A complete crown provides external stabilization of the segments; the pins provide internal binding for the segments. Therefore, the deciding factor is the operator's preferred sequence of treatment.

It is equally important to stabilize the crack as soon as possible to prevent it from extending to the pulp. Also, as David J Bales has pointed out, the operator should recognize the possibility of forcing cement into the crack when a casting is seated on a tooth that is not already tied together by some splinting restoration.

Protection of the pulp before placing pins is of prime importance at this time. Once the old restoration has been removed and the vertical fracture located, the area of the fracture should be covered with a layer of improved calcium hydroxide such as Life (Kerr Manufacturing Co/Sybron, Romulus, MI 48174, USA). This will allow finishing the preparation of the tooth under a spray of air and water while the pulp is protected.

Poor Prognosis

The treatment for teeth in this category should be the same as for the previous one, except that endodontic treatment is needed.

We prefer the pin-retained amalgam to splint the tooth immediately and prevent further advancement of the crack. Then the endodontic procedure can be safely undertaken and the opening restored with a small amalgam. The tooth should be stable. This recommended treatment provides an alterna-

tive that is less traumatic for the patient and more conservative economically in those cases with a guarded prognosis. Another advantage is that splinting the tooth as soon as possible prevents further propagation of the existing fracture. Strategic placement of pins on both sides of the crack allows the amalgam to stabilize the tooth immediately.

The second choice, which others prefer, is to prepare the tooth for complete coverage, place a temporary crown, and then perform the endodontic procedure through the temporary crown. When the endodontics has been completed, the permanent crown is fabricated (Abou-Rass, 1983). In our opinion this method of treatment is hazardous, because the tooth is repeatedly insulted by procedures that can potentially advance the fracture. For example, if the temporary restoration is fabricated by the indirect method an alginate impression must be made after the preparation of the crown has been completed. The temporary crown itself will be filled with cement and forced to place. After the endodontics has been completed, which further weakens the tooth, the temporary is removed, a final impression made, and the temporary recemented. Later the definitive crown is cemented on the tooth. Although each of these procedures may be assumed to be nontraumatic, each cementation or impression has the potential for propagating the crack. In a study of cracked teeth, Despain, Lloyd and Brown (1974), using scanning electron microscopy, found that impression material of silicone rubber can penetrate the cracks. The penetration of material into a crack, coupled with hydrostatic force of cementation or making an impression, could have a deleterious effect on a cracked tooth that has not previously been stabilized with a pin-retained amalgam. Certainly, if rubber impression material can penetrate the cracks, one must assume that less viscous substances such as saliva, a spray of air and water, and cements will also penetrate the crack, resulting in its spread or contamination of the pulp. Within this premise there are five insults to an already cracked tooth, all of which produce a certain amount of hydraulic pressure that could cause the prognosis to change from poor to hopeless. Also, one should remember that the last three insults occur after the endodontic therapy, which leaves the tooth weaker than it was at the start—more reason for splinting the tooth before endodontic treatment.

Another factor to consider when deciding the sequence of treatment is the foundation to be used under the final casting. If step-back endodontics has been performed, very little dentin will remain in which to place an adequate pin-retained amalgam (Gilmore & others, 1982). The recommended foundation then becomes a post and core, which has been demonstrated to be significantly weaker than a pin-retained amalgam (Lovdahl & Nicholls, 1977). This is an additional reason for using the pin-retained amalgam initially. Once the amalgam has been placed the endodontic treatment can be performed, followed by the casting, without any concern of further cracking of the tooth. A tooth that has been properly restored with a pin-retained amalgam provides an ideal foundation for a crown, and the best restoration of all if endodontic treatment is to be the next procedure.

Hopeless Prognosis

Because the crack will have progressed into the root, the only successful treatment would be extraction or endodontic treatment followed by hemisection of the tooth or resection of the involved root.

DISCUSSION

The time has come to recognize the value of the pin-retained amalgam, rather than considering it to be the culprit in pulpal death. Many articles have been written on the success of pin-retained amalgams (Markley, 1966, 1967; Dilts, Welk & Stovall, 1968; Going, 1966), however, many clinicians are reluctant to use the restoration. Perhaps they think that pins kill teeth, though it may be more accurate to say that poorly trained clinicians, not pins, kill teeth. Proper handling and placement of pins will continue to save teeth and should be the first step in the treatment of the difficult problem of incomplete fractures of teeth.

It is hoped that many clinicians will follow

the recommendations of this article and carefully document their procedures with radiographs and clinical notes. In this way our clinical knowledge will advance.

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POINT OF VIEW

Contributions always welcomed

The Case for the Clinical Study Club

MELVIN H CARLSON

Among the innovative and creative contributions bequeathed to generations of dentists by the giants of clinical dentistry the recognition of the necessity for constant honing and broadening of clinical skills predominates. The desire to share techniques, skills, and philosophical attitudes is a common denominator of outstanding clinicians and teachers. As a result, study groups with clinical emphasis on the strengths of the mentors and the desires of the membership have sprung up in various areas of the country. As the knowledge and appreciation of diverse aspects of dentistry have evolved, the basis of emphasis has broadened to include all aspects of clinical practice. The necessity for clinical expertise has expanded as clinical expectations have enlarged, and mentors have been challenged to meet the thirst for greater knowledge.

The profession having recognized that dentistry is a cottage industry, the necessity to keep abreast of developments becomes the obligation of the individual. In a private practice the lack of opportunity to compare results with those of one's peers and the lack of active competition in achieving excellence hamper growth. The comparison of one's achievements in clinical practice with oneself precludes the development of a role model or a clinical goal. Only when one competes with or demonstrates his clinical talents to his peers and is critiqued in a clinical environment does he realize where he stands on the ladder of achievable excellence.

Study is a lifelong process in the profession, and learning through observation of techniques and the personal performance of operations in a setting where neither time nor money is a factor, but the demonstration of one's concept of excellence is, profits a clinical practitioner far more than attempting to limit one's study to reading or attending nonparticipation courses.

Dental operations are best taught by observation of the ideal demonstrated by talented operators, and by the self-performance of operations that attempts to achieve the exquisite restoration, followed by a critique by observers and mentor to indicate the degree of success attained. It is an amazing discovery to find that what a cloistered practitioner produces in his office and considers excellence, in the critical atmosphere of peer review becomes merely adequate. The essence of clinical restorative practice is the producing of restorations within the capabilities of the operator while pursuing the goal of excellence. Restorative dentistry is delicate surgery of the teeth and requires vigilant attention to minute detail —a competitive aspect that is honed by critical observation by peers in a reciprocal setting. The fine edge of superb accomplishment in

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restorative dentistry is imperceptibly dulled by lack of competitive stimulation.

Various modes of operation of the club evolve in response to the desires and objectives of the members. Many supply houses, dental societies, or schools of dental hygiene, with a concentration of chairs and a lecture facility adequate for critique and lecture, provide suitable clinical facilities for study clubs. Private offices in proximity also afford clinical facilities with the mentor and observers moving from chair to chair for instruction and observation. The variety of options is limited only by the imagination of the participants.

The benefits of the study club do not end with the increased appreciation of excellence or the gain in knowledge and skills, but include also fellowship and the development of mutual respect.

It doesn't take long for the members, in a restorative club particularly, to determine their relative positions on the ladder of restorative skill. This leads to an appreciation of one's own goals, provides a basis of possible consultants, and leads inevitably to the conclusion that when a dentist desires restorative treatment for himself he has first-hand criteria to help him make a selection of practitioners.

A cross section of personalities in a closely knit organization provides support and encouragement to the entire membership. This extends to the sharing of expertise involving diagnosis and treatment of cases that are presented to the group, on either a formal or informal basis. It also expands the referral base of one's practice and defines the strengths of a practitioner, assuring the service that the patient desires. Many times the study club serves as the clearing house for cases of a particular nature that have been discussed or diagnosed as a club project, with suggestions for treatment.

Philosophical discussions in an arena of respect undiluted by laymen's attitudes are important to professionals. Freedom to discuss the directions of dentistry, the attitudes of the dental political hierarchy, prepaid programs, advertising, the responsibilities of the dentist to his community, relationships between dentists and auxiliary personnel, ethics, and myriad social and politically germane issues are best cleared in a small group with active individual participation. The parochial atmosphere of dentistry denies the opportunity to have open discussions except in a limited arena. The large world outside of our own needs to be explored and a respectful gathering of varying professional attitudes and experiences aids in this discovery and in enlarging the individual's perspective.

It is a mystery to mentors and members of study clubs alike that a very small percentage of practicing dentists takes advantage of the study club opportunity. Mentors have expressed the view that dentists are reluctant to operate in full view of their peers for fear their shortcomings will be exposed. If this be true, the dentist should not be fearful, as the motives of the clubs are to be supportive and instructive in a positive fashion. Study clubs have elevated many a practitioner from being a mediocre operator to an excellent operator by providing the opportunity to hone his own talents by supportive instruction and constructive criticism. The individuals who participate actively in clinical study clubs are invariably leaders in excellence in their communities and are recognized by dental specialists that treat patients subsequent to restorative treatment. The recognition of one's efforts is especially gratifying when it comes from an orthodontist or another specialist who may be a source of referrals for special patients in the future.

Dentists practicing in states that require continuing education for renewal of a license are especially fortunate that study clubs exist. Usually, clinical clubs set aside one full day a month with operations performed in the morning, and the afternoon devoted to critique, lectures, study, and fellowship. A nine-month schedule satisfies the requirements of points for continuing dental education inexpensively and conveniently. The expenses are considered deductible by the Internal Revenue Service because they maintain professional skills.

The ultimate beneficiary of concentrated training, of the acquired appreciation of excellence, and of the development of a critical eye for restorative quality is the patient. Our egos are stroked by peer praise and our confidence is elevated, but in all this the clinical study club's principal usefulness accrues to those to whom we owe the greatest obligation—our patients.

DEPARTMENTS

Letters

Gingival Response to Retraction by Ferric Sulfate (Astringedent)

Upon studying the report by Shaw, Krejci, Kalkwarf and Wentz in the Autumn issue of *Operative Dentistry* (1983, Volume 8, pp 142–147), it became apparent to me that several severe mistakes and fundamental problems occurred within the study.

First: Teeth received simulated preparations by removing "Small amounts of enamel within the sulcus..." as described by Shaw, Krejci and Cohen (1980). This was done with a thin diamond bur. "The gingiva was retracted by gently placing 1 inch of either a plain cord or a cord saturated with a drug solution..." One can understand the rationale for "simulating" a crown preparation: eliminating the need for temporaries (another variable to the healing process). As can be noted from Figure 3 of Shaw's study, however, most all of the sulcular epithelium is intact. Sulcular epithelium is only a few cells thick. The removal of a slight amount of enamel and very little if any sulcular epithelium followed by "gentle" placement of a small cord (#9 Pascal) is nearly equal to no preparation at all. A regular crown preparation with proper reduction allows for the dimensions necessary to accommodate the device recommended for placement of Astringedent (ferric sulfate 13.3%), *viz* the Dento-Infusor. If it does not, then there most likely is not adequate horizontal space at the margin to maintain sufficient bulk of impression material for good margin integrity in the impression anyway.

It is interesting to note the rippling of the gingival crest of Figure 5 of Shaw's study. If one realizes that there is an immovable unprepared tooth to the left, one can realize that the tissue was most likely pushed and bunched back as the Dento-Infusor was forced into an unprepared space. With a normal preparation, this does not occur either histologically or clinically (evidence available on request). It is also interesting to note that healing occurred within two weeks. This is consistent with what one expects with gingival curettage.

Second: Cords saturated in water and alum were "gently" placed into the sulcus, left for 10 minutes, removed, and the area flushed with water. "The 13.3% ferric sulfate was applied and left in place for 3 minutes.... After removal of the cord, the ferric sulfate solution was burnished into the sulcus until all bleeding stopped. Burnishing was accomplished using the medicament applicator, Dento-Infusor, supplied by the manufacturer." A qualitative study demands that the same conditions and procedures be done to the study as are done to the control, with the exception of one variable. The Astringedent group was "burnished" with the Dento-Infusor (a second variable). The control (water and alum group) was not! While manufacturer's directions were followed, the manufacturer in no way suggested burnishing a device the size of the Dento-Infusor (19-gauge needle with brush end) into an **unprepared** (simulated) sulcus. More importantly, the addition of a second variable to this qualitative study complicates the interpretation of the result.

Third: It is evident that Shaw mistakenly described an "amorphous mass" seen histologically as being dissolved connective tissue fibers. Tissue samples which are immersed for 6 hours in ferric sulfate 13.3% show no evidence of such (slides available upon request). There are probably two explanations for this error:

1. Shaw chose to use H&E stain. By simply placing ferric sulfate (Astringedent) on a small area of filter paper and allowing it to flow into contact with a few drops of H&E stain and then allowing it to set a few minutes for oxidation, one readily discovers that H&E stains black in the presence of ferric sulfate! Connective tissues will have some darkening due to the presence of nucleic acids from the ruptured nuclei following mechanical trauma. The presence of ferric sulfate within the tissue also

causes dark staining. Another stain should have been used. There are specific histological stains which will stain any tissue a bright blue if, and **only if,** it has taken on ferric ions (such as ferric sulfate, Astringedent). Every portion of the tissue biopsy which has not had ferric ions seep into it will stain a contrasting pink-tan. If one stains biopsy samples with such a stain (such as Mallory's stain), one can readily identify not only connective tissue fibers treated with ferric sulfate, but one can also note how far the ferric ion has traveled into the tissues. In duplicating Shaw's technique of a **simulated** preparation followed by the Astringedent and Dento-Infusor, it is obvious to note mechanical rippling extending beyond chemical penetration. Such is not the case with a normal preparation and adequate burnishing.

2. It is most probable that, had the investigators who evaluated the histological specimens been more tuned in to what occurred clinically, *viz* that Astringedent (ferric sulfate) and blood instantly form coagulum when mixed, they most probably wouldn't have described the amorphous material as dissolved connective tissue, but rather simply blood coagulum. This can be readily proven histologically with tissue stained with Mallory's (evidence available upon request).

Fourth: Shaw's main claim is that a **cord** soaked in Astringedent and applied to the sulcus resulted in **severe** connective tissue changes. **There was no test run by Shaw with cord and Astringedent alone to support said claim!** By the use of Mallory's stain, one will readily note that Astringedent (ferric ions) will not penetrate epithelium (hence not even reaching connective tissue) even after six hours of total immersion!

My final bewilderment is triggered by the last sentence of Shaw's "Discussion," which states: "Whether this damage to connective tissue is induced primarily by ferric sulfate or by the procedure of applying it is yet to be determined." This completely contradicts the first sentence of the "Conclusion," immediately following, which states: "A commercial solution of ferric sulfate, Astringedent, produced severe changes in connective tissue within 30 minutes of application."

Many clinicians have found the Astringedent and Dento-Infusor technique to be sound. Not all techniques worked equally well for every clinician. We don't claim this technique to be the last or only answer. We know it to be one answer.

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SHAW, D H, KREJCI, R F & COHEN, D M (1980) Retraction cords with aluminum chloride: effect on the gingiva. *Operative Dentistry,* **5,** 138–141.

After reading the article "Gingival Response to Ferric Sulfate" and reviewing the slides of Dr Fischer (manufacturer of Astringedent) showing the response of gingival tissue to the product Astringedent, I feel that the published article has a serious flaw that should be noted. Only Astringedent was applied with the Dento-Infusor and this to a simulated crown preparation where there was probably not sufficient room in the gingival sulcus to fit an instrument of that size. This would lead to mechanical trauma, which is consistent with the findings of the article and Dr Fischer's research.

In short, I believe that the article stated some unfounded and incorrect conclusions based on a poorly designed study and I feel that it should have a published rebuttal.

We have been using Astringedent in our clinic and in our private practice for several years, and my clinical impression of the material is that there are no more postoperative problems with it than with either aluminum chloride or epinephrine products. As a matter of fact I have never seen the problems that I have had with epinephrine products.

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I was disturbed by a recent article in the Autumn 1983 *Operative Dentistry.* As I use Astringedent myself and have advocated its use to others, I was concerned enough to make a trip to Salt Lake City in April to discuss this

article and its implications with Dr Dan Fischer, the developer and manufacturer of this product. Dr Fischer and I spent many hours evaluating the publication and reviewing histologic sections he had prepared. Before I left, I was convinced by histologic and scientific evidence that the article in Volume 8 was not only misleading, but exhibited several obvious weaknesses.

1. In a qualitative study such as this, the same steps or treatments should be applied to all experimental tissues. Such was not the case in this study. The Dento-Infusor was used only on Astringedent-treated tissues.

2. The summary itself states that when Astringedent was used to retract the gingiva of miniature swine, severe connective tissue changes were observed. This summary statement is misleading because the reader could assume that simple retraction with cord and Astringedent caused such changes. That was not the case; Astringedent and cord without the Dento-Infusor was not tested.

3. Dr Fischer does not advocate the use of the Dento-Infusor on tissues around unprepared teeth. The simulated preparations in these and in a previous study (Shaw, Krejci & Cohen, 1980) may not provide sufficient working space for the Dento-Infusor tip.

4. From the photographs (page 146), it appears that much of the severe damage was caused by mechanical trauma from the Dento-Infusor tip. Histologic specimens prepared by Dr Fischer appear to confirm this.

In summary, intended or not, this article appears to be a disservice to a very industrious, conscientious, and well-motivated member of our profession.

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Although a considerable amount of time has elapsed since you published a product report of the "Gingival Response to Retraction by Ferric Sulfate (Astringedent)," authored by Shaw and others, I feel constrained to respond.

The article is very cleverly written, especially because of what it **doesn't** say. The title leads the reader to think that its content pertains to direct clinical relevance, yet the article itself states: "The purpose of this study was to determine histologically the effects of commercial preparation of ferric sulfate . . . on the sulcular connective tissue subjacent to sulcular epithelium." Correlation between the data and clinical usage is inferred, yet it is misleading because readers inexperienced with the material are frightened away from experimenting with it clinically because of the data reported.

Severe changes in connective tissue caused by ferric sulfate were reported in the article. Clinically I cannot equate this with my subjective observation from using it routinely for over five years. It is very effective in controlling hemorrhage and it causes no sloughing of tissue. Healing is complete and uneventful and, from my observations, more rapid following the use of ferric sulfate than potassium alum. It has shown itself to be completely safe in the hands of dental students and is a real help in teaching gingival retraction and impression techniques.

But I am puzzled about one thing in the project these authors conducted. As stated on page 144: "The cords saturated with water and those saturated with potassium alum were allowed to remain for 10 minutes and the sulcus was flushed with water. *The 13.3% ferric sulfate was applied and left in place for three minutes as recommended by the manufacturer. After removal of the cord, the ferric sulfate solution was burnished into the sulcus until all bleeding stopped. Burnishing was accomplished using the medicament applicator, Dento-Infusor, supplied by the manufacturer.*" (italics mine)

My bewilderment stems from the above description. Why, in a comparative study of chemicals, was one chemical in place for 10 minutes yet another one for only three? Why were only cord and chemical placed in one sulcus, yet cord, chemical, plus a 1.5 mm diameter infusor tip placed (burnished) into the other? Was this a comparative study of chemicals or was it a study of techniques as proposed by the manufacturer?

Pictures of the microscopic sections do little to clarify the dilemma because the caption for Figure 5, for example, infers that the macer-

ated tissue was caused by chemical action alone. I find no place in the article where part of the study embodied the use of ferric sulfate without also using the infusor tip. Yet the caption below Figure 5 implies that the microscopic section was prepared from a sulcus area where only the cord and chemical were used.

Is the caption correct as stated or was the infusor also used—along with the cord and chemicals?

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AUTHORS' REPLY

Our study was designed to evaluate what, if any, sulcular tissue changes took place following the use of common tissue retractants. Potassium alum and water sham cords were left in the sulcus for 10 minutes because it has been our experience that this is in the potential time range of clinical usage. Ferric sulfate (Astringedent) was allowed to remain in place for only three minutes because that is precisely what the manufacturer recommends. Dr Baum is correct in pointing out that our study did not address the comparative histotoxicity of the two chemicals, but rather the tissue response to the different techniques. Drs Fischer, Roberts, and Sutherland expressed concern as to why the infusor was used only with the ferric sulfate. The answer is obvious. In comparing techniques, the infusor was used only with the product for which it is recommended by the manufacturer. Dr Sutherland is correct in observing that ferric sulfate and cord without the infusor was not tested. Again, the manufacturer's directions for Astringedent call for the use of the infusor to control hemorrhage. Not to have used the infusor would have disregarded these recommendations. In the hands of our clinician, with over 30 years of experience in restorative procedures, the use of ferric sulfate as recommended resulted in the reported severe damage to the connective tissue. We agree with Drs Roberts and Sutherland that this damage may be due to mechanical trauma. In fact, we stated this in the paper. Unfortunately, our study did not permit us to distinguish between chemical and mechanical trauma. We are currently working to clarify this issue.

Drs Roberts and Sutherland suggest that there was not sufficient working space for the proper use of the Astringedent technique. The working space was very similar to what is encountered in clinical practice. We do not believe this was an influencing factor.

The caption under Figure 5 and the first sentence in the conclusion of our article were indeed incomplete as pointed out by Drs Baum and Fischer. The infusor was used. However, this fact was clearly stated in the article.

Dr Fischer's concern with our histological technique is totally without merit. It is true that iron is often used as a mordant with hematoxylin to enhance the staining of tissue. The mordant serves to indirectly attach the dye to the tissue components with which the mordant reacts. However, the amount of iron available in our samples following tissue preparation was negligible since we could not detect any difference in the staining intensity between sham and ferric sulfate exposed tissue. Nuclear streaming mentioned by Dr Fischer is easy to detect and was not a complicating factor. The blinded design of our analysis and the high percentage of investigator agreement add validity to the study. Artifactual remnants from tissue processing did not contaminate our samples.

We did not intend to condemn the use of a commercial product but rather to warn the dental community that the product, when used as recommended, may produce harmful effects on the sulcular tissue. The use of Astringedent without the infusor may prove to produce a different tissue response.

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But It Isn't Used in Practice

The spring issue of *Operative Dentistry* has just been received and as usual your editorial receives reading priority. Of course you struck a favorable note in promoting direct gold as an important part of an operative curriculum. I have seen so many students dramatically improve their restorative skill by learning to do direct golds well. 'Tis a great teaching discipline.

Of course the most disturbing factor to me is that practitioners could, with a little practice, learn to produce a better fee-per-hour return doing direct gold than any other restorative procedure (except maybe a full crown). All they can remember are the long tedious hours spent **in learning** while in dental school.

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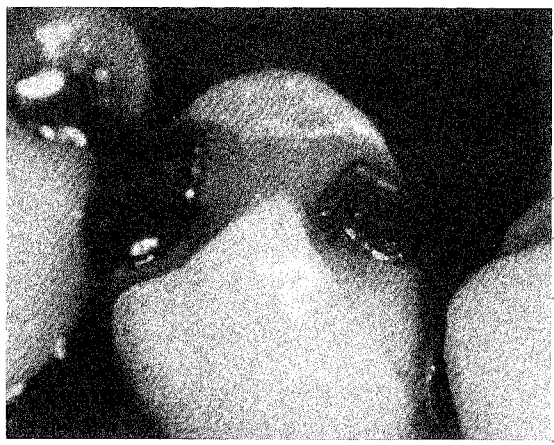
Wit and Wisdom

Manufacturers of composite have gone too far! In the beginning it was simple. There were only two or three brands and they were all about the same. Now one must have a degree in chemistry to understand what is going on. We have been macrofilled, minifilled, microfilled, UVed, photocured, and silane bonded. We have been acid-etched, BIS-GMAed, crossed-linked, and benzoyl peroxided. And now they are starting to come out with dentin bonding agents too! Tint kits and opaquers abound everywhere. Esthetics and polishability have exceeded what anyone would have dreamed possible 15 years ago. It's no wonder that the average practitioner is about to break under the strain.

In at least one case, documented herein, the poor operator must have become so befuddled that he was unable to differentiate between tooth structure and an MOD composite. In the confusion, a "snake eye" amalgam restoration was apparently placed into the composite. And



judging from the appearance of the amalgam, it was done several years ago even before things got as complicated as they are now. I cannot believe that with the ever-worsening confusion such oversights will be isolated instances. I think that manufacturers of composite should take the lead of the U S Bureau of Engraving and impregnate composite with the same small red and blue fibers that are found in dollar bills. This not only would enable any confused operator to recognize the genuine composite from tooth structure but would be patriotic as well.

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Announcements

AWARD WINNERS

W J Gies Award: Gerald D Stibbs

Gerald D Stibbs, BS, DMD, of Seattle, Washington, has received the prestigious William John Gies Award of the American College of Dentists for 1984, an award reserved for outstanding service in dentistry. Gerry Stibbs, a graduate of North Pacific College (Portland, Oregon) in 1931 and one of the most accomplished practitioners of all time, has compiled an enviable record of service not only to the patients he has treated but also to dental education and to the profession he has served so well.

Gerry is a superb teacher, who, during his tenure at the University of Washington, contributed largely to establishing the excellent reputation the dental school enjoyed for the competence of its graduates. His skill as an operator and his leadership, his critical eye and his dedication to excellence were soon recognized by his colleagues and consequently he has been much in demand as a clinician and a leader of study clubs. Currently he is the mentor of the George Ellsperman Gold Foil Seminar, the Walter K Sproule Study Club, and the Vancouver Ferrier Study Club.

Gerry has published 43 articles, a manual on the preparation of cavities, and has contributed to six textbooks, as well as presenting 80 essays and 58 clinics. One of his motion picture films, *Class 5 Gold Foil Restorations,* has won several prizes including the grand prize of the Second International Film Festival (Dental), Paris, 1962.

His many honors include the Distinguished Member Award of the American Academy of Gold Foil Operators and membership in Omicron Kappa Upsilon and Sigma Xi. His memberships include the American Academy of Gold Foil Operators (past-secretary, -treasurer, and -president), Academy of Operative Dentistry (charter member), American Academy of Restorative Dentistry, and CAIC Seminar. Gerald D Stibbs is indeed a worthy recipient of the W J Gies Award.

AGD Humanitarian Award: William S Frank

William S Frank, BA, DDS, of Los Angeles, California, has received the Humanitarian Award of the Academy of General Dentistry for his continuing efforts to heighten the image of general dentistry, for his exceptional humanitarianism in private practice, and for his leadership in local, national, and international organizations.

Bill Frank, a graduate of the University of Southern California, has practiced in Los Angeles since his graduation in 1950 as well as being a clinical associate professor of restorative dentistry at his alma mater.

Bill has given generously of himself and his resources to an astonishingly large number of humanitarian causes including the City of Hope, the March of Dimes, and Little League Baseball. He has participated energetically in the affairs of Rotary International and is a past-president of the Dental Alumni Association of the University of Southern California.

Among his honors Bill has received the Order of Merit of the Boy Scouts of America and the Torch of Learning award from the Hebrew University in Jerusalem as well as membership in Omicron Kappa Upsilon, being a past-president of the supreme chapter.

His memberships include the American Academy of Gold Foil Operators, Academy of Operative Dentistry, Academy of General Dentistry (membership and fellowship), American College of Dentists, International College of Dentists, and Academy of Dentistry International of which he is currently president.

Bill Frank has worked tirelessly to provide help wherever it is needed, both at home and abroad.

Callahan Memorial Award: Nelson W Rupp

Nelson W Rupp, DDS, MS, of Chevy Chase, Maryland, has received the Callahan Memorial Award for 1984, an international award given to dentists that make outstanding contributions to the dental profession. The award was presented on 15 September 1984 at the annual meeting of the Ohio Dental Association. Dr Rupp is a research assistant for the American Dental Association Health Foundation at the National Bureau of Standards. He also serves as National Civilian Consultant to the Air Force Surgeon General, is a professional lecturer at Georgetown University College of Dentistry, and is a consultant to the Naval Dental Center in Bethesda, Maryland.

"Woody" Rupp, a graduate of Ohio State College of Dentistry in 1943, went on to earn a master of science degree in dental materials from the National Bureau of Standards and Georgetown University. After two years in general practice, Woody spent 26 years in the US Navy where he taught prosthodontics at the Dental Technician School, conducted research in dental materials at the Navy Electronics Laboratory, and was head of the Research and Sciences Division and research coordinator at the Naval Dental School. He was head of the Officer Education Department when he retired from the Navy in 1969.

Through his research Woody has contributed substantially to the application of dental materials to clinical practice and has published over 30 articles on dental materials.

His memberships include the American Academy of Gold Foil Operators, Academy of Operative Dentistry (past-president), and the International Association for Dental Research.

Press Digest

The alkaline and antibacterial effect of seven $Ca(OH)_2$ liners in vitro. Forsten, L & Söderling, E (1984) *Acta Odontologica Scandinavica*, 42, 93-98.

A laboratory study of the strength of the alkaline reaction and the effect on the growth of *Streptococcus mutans* of the $Ca(OH)_2$ liners: Dycal (Caulk), Life (Kerr), MPC (Kerr), Procal (3M), Renew (S S White), Reocap-E (Vivadent), and Reolite (Vivadent), showed that the alkaline and bacterial effect was strong for Dycal, moderate for Life, Procal, Renew, and Reocap-E, and weak for MPC and Reolite.

An earlier study showed that the resistance to solubility by acid decreased in the following order: MPC, Dycal, Renew, Reocap-E, Life, Reolite, and Procal. Thus it is possible to choose a material with a good alkaline effect and good resistance to solubility by acid.

Burning mouth: an analysis of 57 patients. Zegarelli, D J (1984) *Oral Surgery, Oral Medicine, and Oral Pathology*, 58, 34-38.

The most frequent cause of burning mouth in 57 patients was psychogenesis (36.8%) followed by geographic tongue (26.3%) and moniliasis (21.1%). In seven patients (12.3%) there were multiple causes. The purely psychogenic group was composed mainly of postmenopausal women. The tongue and palate were the sites most frequently affected.

Drug stomatitis due to gold therapy. Glenert, U (1984) *Oral Surgery, Oral Medicine, and Oral Pathology*, 58, 52-56.

Eighteen patients developed oral eruptions while undergoing weekly injections of gold salts for the treatment of rheumatoid arthritis. The most frequent changes in the mucosa were nonspecific ulcerations, lichenoid eruptions, atrophy of lingual filiform papillae, and diffuse erythema. All the eruptions disappeared either spontaneously or after completion of treatment.

Lou-Ann Loew Leaves *Operative Dentistry*

Lou-Ann Loew, who has performed so well as the editorial assistant for *Operative Dentistry* for the past two years, has resigned to pursue full time her studies for a higher degree in social work at the University of Washington. Lou-Ann has been a model of efficiency and has contributed greatly to the continuing success of *Operative Dentistry.* We thank her for her efforts during the time she has spent with us and wish her every success in her career.

NOTICE OF MEETINGS

Academy of Operative Dentistry

Annual Meeting: 18 and 19 February 1985
Westin Hotel
Chicago, Illinois

American Academy of Gold Foil Operators

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

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

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

Exclusive Publication

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

Manuscripts

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

Tables

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

Illustrations

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

References

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

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