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Aim and Scope

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

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EDITORIAL

Which is Best?

The use of the best materials and techniques for restorative dentistry is the aim of all dentists conscientiously trying to provide the best treatment for their patients. As new materials and techniques are developed and introduced, the dentist must decide whether to incorporate them into the practice and, in consequence, discard materials and techniques with which he has become proficient. Not too difficult a decision if the new materials and techniques differ little from the old and demonstrate a distinct advantage, but a more serious problem if expensive new equipment or radical modifications to technique are required, or if the advantage of the change is marginal.

How good are the new materials and techniques? Often it is difficult to tell because success in restorative dentistry depends mainly on the durability of restorations, a longevity that is measured in years, often many, and, ideally, approaching the life span of the tooth. Experiments in the laboratory may disclose useful information, but it may not always apply to clinical conditions. Sometimes the likely performance of a material can be deduced from its physical properties, such as resistance to wear, coefficient of thermal expansion, and ability to take a polish. Clini cal tests are required, but they present more difficulty in standardizing experimental conditions; and obtaining long-term results may require years of waiting. Should a material or technique be grossly inadequate, however, the results are usually manifest in a matter of months or, at most, a few years. The iniquitous circumstance is when, after five to ten years of initial success and the treatment has been administered to millions of patients, failure suddenly occurs. One does not like to be the last to lay aside the old when something better may be available; but neither does one want to be carried away by the example of the neophiliacs whose enthusiastic acceptance of the new may be based more on optimism than on science.

Some materials, such as direct gold, cast gold, porcelain, and amalgam, have been in use long enough for us to know their advantages and limitations and the best ways of manipulating them. Resins, on the other hand, are relatively new and, moreover, have undergone many changes since their introduction. Furthermore, they continue to change, so that research begun on a particular product today may not be of much use in a few years when the product may no longer be on the market.

Much of the information a dentist needs as a guide in selecting the best materials and techniques is available in the literature, but often the information is inconclusive, frequently incomplete, and sometimes contradictory. Furthermore, it may be spread among many publications. Practitioners would be helped immensely if more articles were available, such as critical reviews, that synthesize the existing information on a material or technique, put the information in the proper perspective, and evaluate the material or technique rigorously.

A Ian Hamilton
University of Washington
School of Dentistry SM-56
Seattle, WA 98195, USA

OPERATIVE DENTISTRY, 1983, 8, 122–129.

ORIGINAL ARTICLES

Gingival Response to Laminate Veneer Restorations

Laminated veneers of resin (Mastique) properly applied to facial surfaces of maxillary anterior teeth do not affect adversely the health of the gingivae if oral hygiene is maintained

TRAVIS P G BARHAM, JR • ROBERT B MAYHEW
ROBERT D COWAN • RICHARD M LUBOW
WAYNE P PIERSON • JAMES E VOSS

Summary

Laminate veneers of resin (Mastique) were placed on 43 maxillary anterior teeth and were observed over an interval of nine months for rate of flow of sulcular fluid, depth of sulcus, height of free gingival margin, plaque index, and gingival index. Patients were given oral prophylaxes and instructed in methods of oral hygiene. Compared with control teeth the veneered teeth did not affect adversely the health of the gingivae, the only statistically significant difference being an increase in plaque on interproximal surfaces for both control and veneer teeth.

Department of the Air Force, Wilford Hall USAF Medical Center (AFSC), Department of General Dentistry, Lackland Air Force Base, TX 78236, USA

TRAVIS P G BARHAM, JR, DDS, resident

ROBERT B MAYHEW, DMD, PhD, assistant chairman for junior resident training

ROBERT D COWAN, DDS, MS, chairman, Department of General Dentistry

RICHARD M LUBOW, DMD, MS, chief, Periodontics Section

WAYNE P PIERSON, PhD, chief, Research Consultation Services

JAMES E VOSS, DDS, MS, assistant base dental surgeon, Hahn AB, Federal Republic of Germany

INTRODUCTION

The classical management of malformed, discolored, or fractured maxillary permanent incisors, especially in young patients, presents an all too common and difficult restorative problem for the general dentist. A variety of solutions has been proposed, ranging from vital bleaching (Arens, Rich & Healey, 1972; Hayashi & others, 1980) to prosthetic cover

age (Goldberg, 1971). For younger patients in particular these modes of treatment may not be acceptable because of the potential for compromising the vitality of the involved teeth, the variability of the results, and the cost. With the advent of the technique of etching enamel with acid (Buonocore, 1955), however, new modes of interim treatment have been developed.

In 1976 Faunce and Myers introduced the use of a thin, heat-cured, laminate veneer of resin, which they bonded to the facial surface of the involved tooth with a composite resin. After their initial report, a variety of techniques for applying laminate veneers was reported (Mouradian, Graham & Fernald, 1976; Chalkley, 1980; Ronk, 1981; Rakow, Light & Condello, 1978). Several investigators have shown high rates of retention for laminate veneers (Faunce & Myers, 1976; Mouradian & others, 1976; Chalkley, 1980; Ronk, 1981; Rakow & others, 1978). Thus, the technique has shown promise in the treatment of discolored, malformed, and fractured teeth.

Although considerable attention has been focused on the esthetic improvement created by these veneers, little attention has been given to the response of the gingivae. Therefore, the purpose of this investigation was to examine the short-term response of the gingivae to laminate veneer restorations by measuring the flow of the fluid from the gingival sulcus, the height of the margin of the free gingiva, the indices for plaque and gingival health, and the changes in the depth of the gingival sulcus, on treated and control teeth.

MATERIALS AND METHODS

Nine patients, ranging in age from 11 to 60, received a total of 43 laminate veneer restorations in this study. The prefabricated laminate veneer, Mastique (L D Caulk Co, Milford, DE 19963, USA), was used and the manufacturer's instructions were followed for the placement of each veneer. Prismafil (L D Caulk Co) was used as the luting resin.

The treated teeth were all maxillary anterior teeth (Nos 6-11) and the number of veneers placed ranged from two to six per patient. On the basis of previous epidemiological studies (Ramfjord, 1959; Russell, 1956) tooth Nos 3, 12, 19, 25, and 28 were chosen as representing the total level of oral hygiene.

Gross adaptation of each veneer was accomplished on stone casts, with final contouring performed on the patient immediately before placement. The cervical margin of each veneer was placed at or incisal to the margin of the free gingiva, with none being placed into the gingival sulcus.

Seven appointments were programmed for this study. At the initial appointment, patients were advised of the protocol of the study, given an oral prophylaxis, and provided instructions on oral hygiene with emphasis on the techniques of sulcular and interproximal cleaning. At the second appointment, two weeks later, each patient's control of plaque was evaluated by the index of O'Leary, Drake, and Naylor (1972), those scoring 10% or less being selected as subjects. Baseline measurements were then taken as follows.

- Flow of fluid from the gingival sulcus: as measured by a Periotron (Harco Electronics, Winnipeg, Canada) (Garnick, Pearson & Harrell, 1979; Golub & Kleinberg, 1976; Tsuchida & Hara, 1981). See Figure 1.

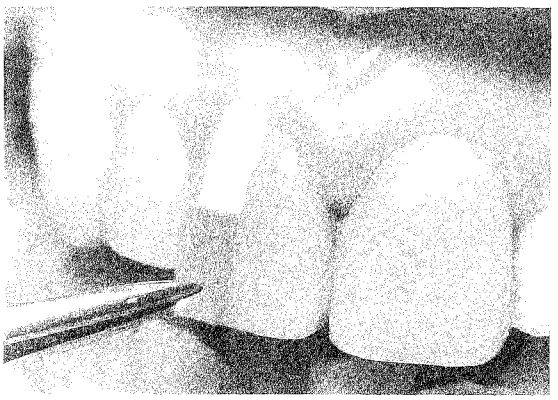

FIG 1. *Rates of flow of sulcular fluid were measured by carefully placing a Periotron strip into the facial sulcus of the tooth*

- Height of gingival margin: from incisal edge to margin of free gingiva, as measured with a Boley gauge at the midfacial region.

- Sulcus depth as measured by the technique of Ramfjord (1959).

- Gingival index, as measured by the technique of Löe and Silness (1963) (see table).
- Plaque index, as measured by the technique of Silness and Löe (1964) (see table).

At the third appointment, the laminate veneer of Mastique was placed, cotton rolls and plain retraction cord being used for isolation. Each treated tooth was etched for 60 seconds with 37% phosphoric acid, and the veneer was finished with 12-fluted finishing burs and finishing strips and disks of aluminum oxide. To eliminate operator variability one operator placed all veneers and recorded all the data.

Patients were seen after six weeks and then at intervals of three to four months for counseling and prophylaxis (Rosling, Nyman & Lindhe, 1976). Baseline measurements were repeated at six weeks and nine months.

The indices for gingivae and plaque were scored on an ordinal scale of four points (see table) and are reported as a frequency, expressed by a percentage, for each tooth surface: for example, the percentage of all mesial surfaces (M) that received a score of 0, 1, or 2.

An analysis of variance for repeated measures was used to evaluate changes in height of free gingiva, depth of sulcus, and rate of flow of sulcular fluid between groups over time. A ridit (relative to an identified distribution) analysis was also used to compare the frequency of 0 scores of the indices of plaque and gingivae from the facial and interproximal surfaces.

Criteria for the Plaque Index (Silness & Löe, 1964) and the Gingival Index (Löe & Silness, 1963)

Plaque Index	Gingival Index
0 = No plaque in the gingival area	0 = Normal gingivae
1 = A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be recognized only by running a probe across the tooth surface.	1 = Mild inflammation, slight change in color, slight edema; no bleeding on probing
2 = Moderate accumulation of soft deposits within the gingival pocket, on the gingival margin or adjacent surface of the tooth, that can be seen with the naked eye	2 = Moderate inflammation; redness, edema, and glazing; bleeding on probing
3 = Abundance of soft matter within the gingival pocket or on the gingival margin and adjacent surface of the tooth	3 = Severe inflammation, marked redness, and edema; ulcerations; tendency to spontaneous bleeding

RESULTS

Flow of Sulcular Fluid

The rates of flow of sulcular fluid are presented in Figure 2. There was a statistically

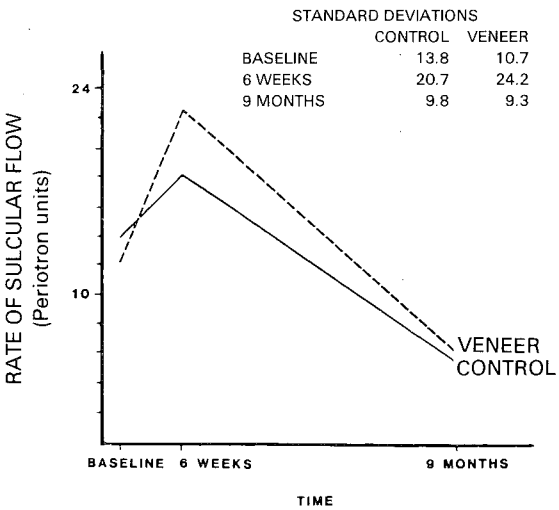

FIG 2. *Rates of sulcular flow for veneered and control groups compared over time*

significant decrease in the rate of flow from the baseline and six-week interval to the nine-month point in both the control and experimental groups ($P < 0.05$). However, there were no statistically significant differences in rates of sulcular flow between the treatment and control groups ($P < 0.05$).

Depth of Sulcus

In examining the gingiva for possible changes in depth of sulcus, no significant differences were noted between the control and experimental groups (Fig 3).

Height of Free Gingiva

Changes in height of the free gingival margin did not differ statistically between the two groups (Fig 4).

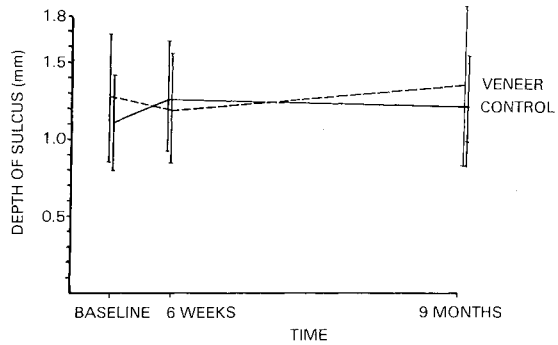

FIG 3. *Average depth of gingival sulcus, with standard deviations, of veneered and control groups at each interval of time*

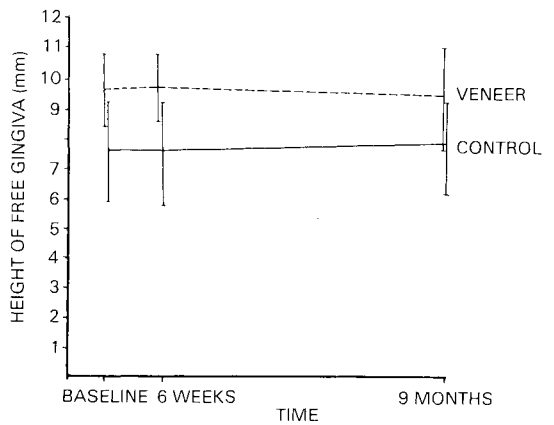

FIG 4. *Average height of free gingiva, with standard deviations, of veneered and control groups at each interval of time*

Plaque Index

The scores for plaque index (veneered, Fig 5; control, Fig 6) were initially low, but increased over time (greater incidence of scores of 1 and 2). However, there were no statistically significant differences in the trends between the veneered teeth and the control teeth. The plaque scores were higher interproximally and lower in the midfacial region in all cases.

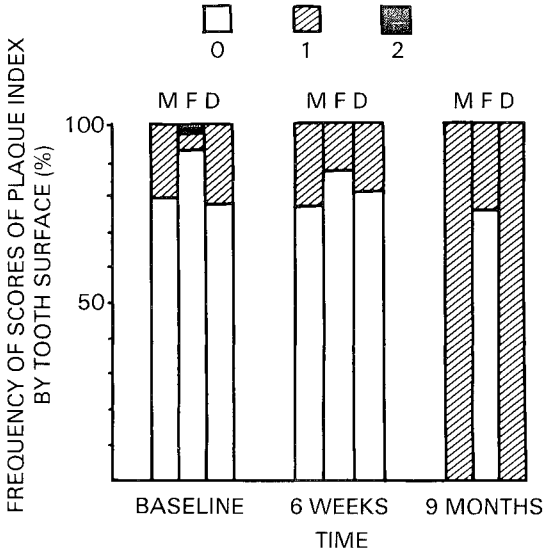

FIG 5. *Frequency of scores of 0, 1, and 2 for index of plaque for each surface of veneered teeth at each interval of time*

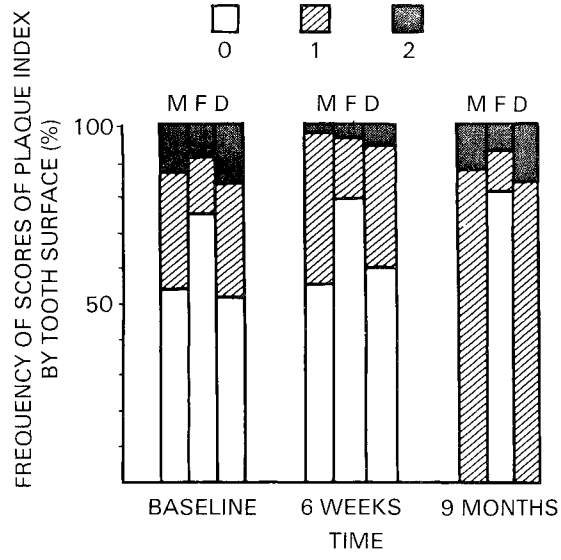

FIG 6. *Frequency of scores of 0, 1, and 2 for index of plaque for each surface of control teeth at each interval of time*

Gingival Index

The scores for gingival index (veneered, Fig 7; control, Fig 8) were also low initially and, similar to the scores of the plaque index, increased over the nine-month period. Again interproximal scores tended to be higher than those in the midfacial regions for all teeth. Ridit analysis revealed a statistically significant difference ($P < 0.05$) in the frequency of 0 scores on the facial surfaces of veneered versus control teeth. That is, the incidence of 0 scores on the facial surfaces decreased more for control teeth compared with veneered teeth.

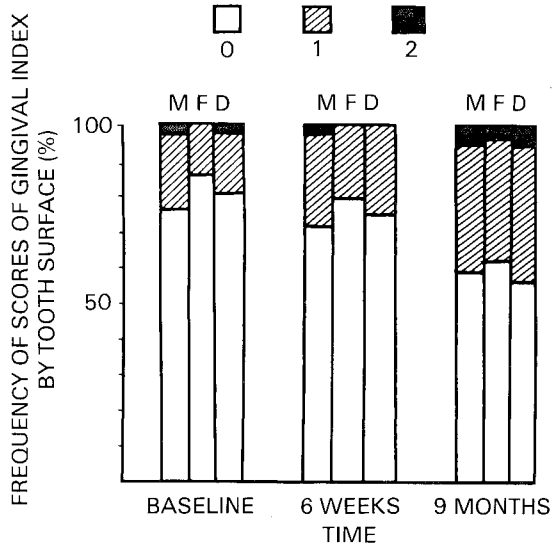

FIG 7. *Frequency of scores of 0, 1, and 2 for the gingival index for each surface of veneered teeth at each interval of time*

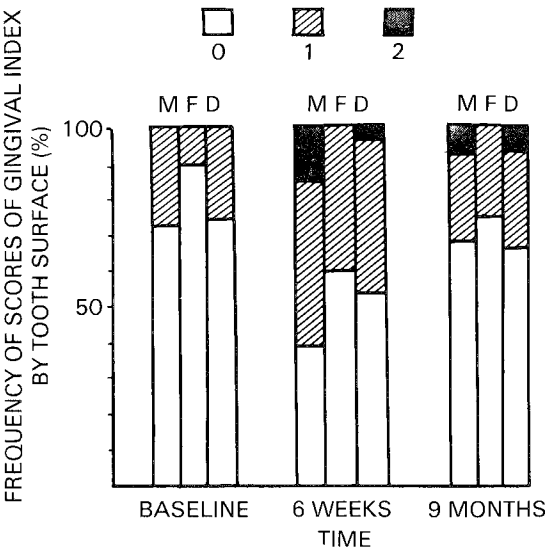

FIG 8. *Frequency of scores of 0, 1, and 2 for the gingival index for each surface of control teeth at each interval of time*

DISCUSSION

The results of this study suggest that the laminate veneer, when used according to the protocol outlined, does not adversely affect the gingivae provided adequate oral hygiene is maintained. With one exception, there were no statistically significant differences between control and experimental groups on five different measures of gingival health over nine months. However, there were some interesting changes over time for both groups.

Rates of flow of sulcular fluid for both experimental and control groups demonstrated a statistically significant decrease over time (baseline and six weeks versus nine months). These data suggest that the overall health of the experimental and control tissues improved with time. Conversely, measurements of the plaque index revealed an increase in plaque in both groups, especially interproximally. The gingival index also showed a slight increase over the same period of time.

Of further interest is the observation that there was a statistically significant difference in the frequency of the 0 scores of the gingival index measured on the facial surfaces of each group of teeth, the greatest change being seen on the facial surfaces of the control teeth.

The measures of sulcular flow, pocket depth, and height of free gingival margin suggest no differences in gingival health, either between the groups or over time. The indices for gingivae and plaque, however, did suggest changes in gingival health.

As a possible explanation it must be stressed that all patients were seen on three- to four-month recalls at which time counseling in oral health and a prophylaxis were provided. This form of maintenance therapy may have prevented the development of a pathogenic plaque capable of producing inflammatory periodontal disease, which would have been reflected as an increased flow of sulcular fluid or a change in depth of pocket or gingival height or both. Professional maintenance and reinforcement of good habits of oral hygiene may be the crucial factors in maintaining the health of these tissues since both groups produced similar data suggesting little or no adverse effect of the veneers on the health of the gingivae.

The increase in the rate of flow of sulcular fluid of the experimental group at the six-week point may represent the trauma from the placement of the veneer and the subsequent healing from that treatment (Fig 2). However, a similar pattern was noted with the control group. Regardless, there were no statistical differences between the scores at baseline and six weeks for either group. Therefore, the results observed are within the realm of chance. This lack of statistical difference is also due, in part, to the large standard deviations observed in the measurement of the flow of sulcular fluid (Fig 2). The protocol for recording the rate of flow tends to be exacting and, even though one operator made all of the measurements, the variation persisted. Nonetheless, there was a significant decrease in the flow of sulcular fluid from the baseline and six-week measurements to the nine-month recordings ($P < 0.05$).

Height of the free gingival margin did not vary significantly between the control and study groups, suggesting that the veneers

caused no additional recession beyond that resulting from factors already present throughout the mouth. In addition, the laminate veneers had no effect on depth of sulcus throughout the period of time examined.

Based on the results presented here, the gingival response to a laminate veneer appears negligible. There seems to be no deleterious effect to the gingivae from the placement of a laminate veneer provided the protocol outlined here is followed. The major factor in gingival health appears to be the periodic maintenance of an environment free of plaque.

CONCLUSIONS

- Laminate veneers placed at, or incisal to, the free gingival margin of maxillary anterior teeth did not produce any significant changes in the health of the gingivae compared with control teeth.
- There were no significant differences between veneered and control teeth in flow of sulcular fluid, depth of sulcus, height of free gingival margin, or plaque index.
- Both plaque and gingival indices demonstrated a steady decline in oral hygiene over the period of the study with the most significant decline noted in the gingival health of the control teeth.

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A Castability Standard for Alloys Used in Restorative Dentistry

P J BROCKHURST • V G McLAVERTY
Z KASLOFF

Summary

A casting for a simulated crown is used to assess the castability of alloys used in restorative dentistry. Castability is measured as the deficiency in reproduction of a sharp margin of 30° on the test crown. It is proposed that alloys for clinical castings should cast to a deficiency of less than 25 μm. Twelve out of 19 alloys tested met the proposed requirement.

The variability of the margin on test castings indicates that the margins of most cast crowns fall short of the proposed requirement.

Australian Dental Standards Laboratory, 240 Langridge Street, Abbotsford, Victoria, 3067, Australia

P J BROCKHURST, PhD, head, Metallurgy

V G McLAVERTY, FAISDT, FIBST

Z KASLOFF, DDS, MSD, professor, Faculty of Dentistry, University of Manitoba, Winnipeg, Manitoba, Canada R3E 0W3

INTRODUCTION

High-gold alloys have a traditional and well-established place in modern restorative dentistry. They cast and work well, have good resistance to tarnish and corrosion, acceptable color, and are well tolerated by the opposing dentition. The high cost of gold alloys, however, has promoted development of many cheaper alloys.

Hundreds of alternative alloys are now available. Their compositions vary widely and for convenience have been classified as low gold, silver palladium, and base metal (Clinical Research Associates, 1980). A group of alloys with palladium as the major constituent has been introduced since that report. The survey by Clinical Research Associates in the United States found that all types of commercial dental alloys were being used by dentists for both metal and metal-ceramic restorations. Our discussions with suppliers, dentists, technicians, and experts in the field and our observation of dental literature and advertising indicate that this trend is continuing.

Are these alternative alloys satisfactory? There is little definitive information because requirements for dental casting alloys have

not been adequately specified. The survey by Clinical Research Associates, while reporting extensive use of all types of alloy, received replies indicating lack of success with some low-gold, silver-palladium, and base-metal alloys. Silver-palladium alloys suffered tarnish, porosity, poor margins, and poor color, while base-metal alloys had poor margins, difficulties in finishing, excessive hardness and resistance to wear, and poor color. Some of these shortcomings, such as color, tarnish, and resistance to wear, are the result of the inherent properties of the alloy, which are not affected by manipulation. Some problems with dental alloys, such as fit and porosity, can be controlled by laboratory procedures. Poor fit with castings made from alternative alloys, especially base metal, has been reported (Duncan, 1980; Duncanson, 1976; Eden & others, 1979; Nitkin & Asgar, 1976). The relationship between melting point and size of casting for standardized conditions of the mold has been clearly demonstrated (Duncan, 1980; Eden & others, 1979). An acceptable fit can be obtained with all alloys by correct selection of investment and the temperature of the mold at casting to provide the correct expansion. Porosity or poor margins may be found where alternative alloys are used with laboratory materials and procedures designed for gold. Porosity can be eliminated in most cases by appropriate melting and spruing. The filling of fine margins, however, depends not only on adequate flow or fluidity of the alloy, but also on adequate force to overcome the surface tension of the molten alloy in the mold.

Many tests have been devised for dental casting alloys. Most determine the extent to which molten alloy flows into an extended cavity (Barreto & others, 1980; de Wald, 1979; Howard, Newman & Nunez, 1980; Thomson, 1982; Tuccillo, 1977; Vincent, Stevens & Basford, 1977; British Standards Institution, 1976). These tests provide a comparison of fluidity more than of any other characteristic. This property is not particularly pertinent to dental restorative casting, as the mold-filling behavior of alloys can be enhanced by appropriate design of the sprue to the point where satisfactory castings can be obtained with most alloys.

The quality of the margins of dental castings has not received much attention. The importance of surface tension with regard to incomplete dental castings, an aspect that has proven to be a problem with the newer alloys, has been noted (Henning, 1972). Nitkin and Asgar (1976) found that the fine sharp margins usually expected with Type III gold were not obtained with the castings of two nickel-chromium alloys, and Lorey and others (1976) noted poor margins from five base-metal alloys.

A test for the ability of alloys to cast fine margins has been reported (Mackert, Moffa & Jendresen, 1975). The same test was used to compare dental casting machines (Eames & MacNamara, 1978). The alloy was cast into the cavity created by a Stanley utility blade, and the width of the meniscus in the solidified metal used as an indicator of castability. The main disadvantage of this method is that the flat casting used for the test differs in size and configuration from a dental casting, so that the observed sharpness of the edge may not relate directly to that of a clinical casting.

None of the tests discussed provides an indication of the minimum castability requirements of an alloy for preparing satisfactory cast dental restorations. The objective of the work described here was to measure the castability of dental alloys so that direct comparison with the requirements for clinical restorations can be made.

MATERIALS AND METHODS

Castability Test

Sharpness of the margin is considered to be the characteristic of dental castings most dependent on the castability of the alloy used. Consequently a test was designed to examine the sharpness of the margin of a test crown. The design selected for a test casting represents a full crown for fused porcelain with walls 0.35 mm thick and a sharp margin of 30°. Instead of the shape of a tooth, a cylindrical form was used. This design has many advantages. A uniform cervical margin 18 mm long can be conveniently examined. The form of the die can be easily machined from metal and patterns can be prepared on the die by means of conventional dental laboratory

techniques. The dimensions of the die are shown in Figure 1. The dies were made from

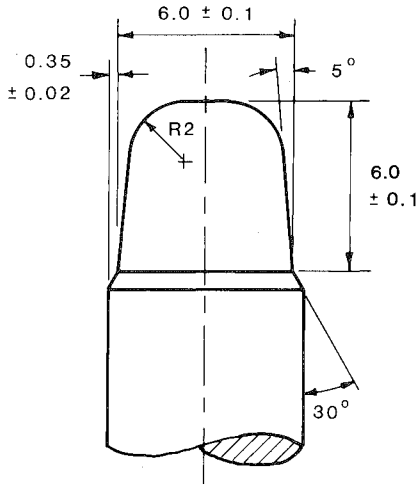

FIG 1. *Dimensions of die for preparation of wax patterns*

an air-hardening steel, heat treated to Rockwell C hardness 45.

Wax patterns were prepared by dipping the die into molten inlay wax and carving to the form shown in Figure 2. The sides of the pattern were cut flush with the cylindrical base with a straight blade (Fig 3), which produced

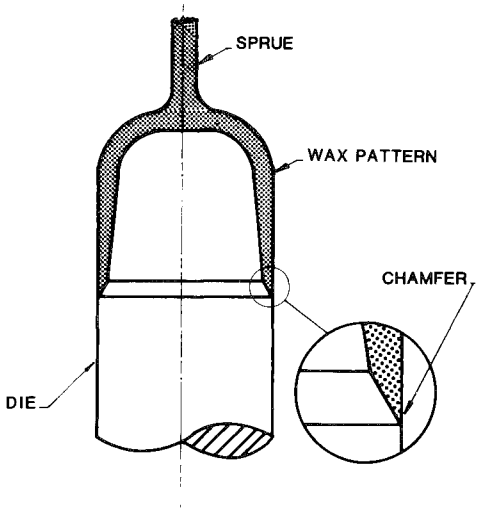

FIG 2. *Cross section of test pattern on die*

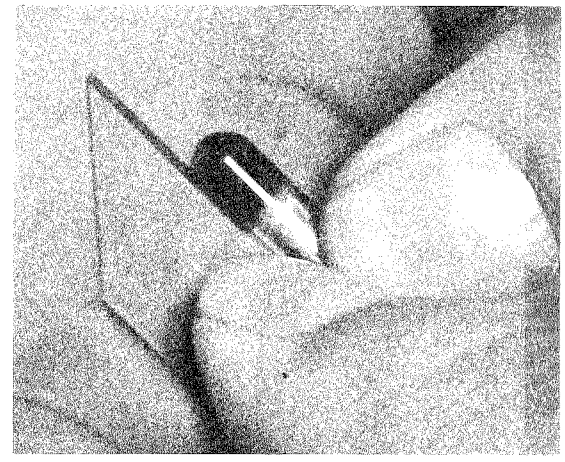

FIG 3. *A method for carving the fine margin on the test pattern*

uniform thickness of the wall and sharp margins. The patterns were sprued and cast by use of materials and procedures identical to those used for clinical castings.

The margins of test castings were examined by an indirect method using a dental impression. The casting was positioned centrally in a ring filled with impression material, Reprosil light body (Dentsply International, York, PA 17404, USA). After setting, the impression was removed from the ring and precisely cut into six segments with a matching tubular jig as shown in Figure 4. Two identical impres-

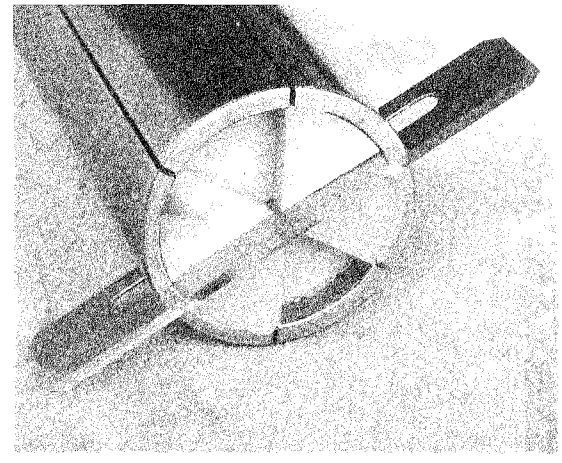

FIG 4. *Tubular jig and razor blade for preparation of sections of margin showing cut impression with positioning notch on the left*

sions were used to prepare 12 radial sections at intervals of 30° around the margin of a test casting. The discrepancy of the margin on each segment was photographed at a magnification of X25 and the photographic image further enlarged 20 times with an optical measuring comparator for a total magnification of X500. The exact magnification of the image was determined from a microscope scale photographed on the same film as the test samples. Figure 5 shows a section of the impression of the cast margins.

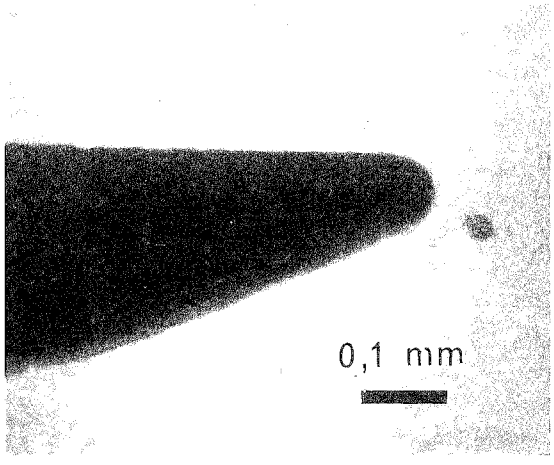

FIG 5. *Photograph of one section of the impression of the margin on a test casting*

The quality of the margins of the castings was expressed in terms of the deficiency (d) between the edge of the casting and the theoretical sharp edge, as shown in Figure 6a. Distortion or irregularity of the margin or adjacent regions was found on some castings, and it proved more convenient to measure the radius of the margin instead of the deficiency. The deficiency was then calculated as shown in Figure 6b. From 12 measurements, the minimum, average, standard deviation, and upper 95% confidence value were calculated for each casting.

The maximum sharpness possible for the margin of a casting is limited by the sharpness of the pattern. Patterns prepared at the Australian Dental Standards Laboratory were examined at magnifications of X20 to confirm that the margins were sharp and complete. For confirmation some wax patterns were also measured with a Reprosil impression. The deficiencies of the wax margin for the most part were less than 2 μm. Most of the wax patterns used for the alloys tested were prepared by the dental technicians that cast the test specimens. These technicians are well known for high-quality workmanship, and their skill was not considered to be a limitation to the quality of the castings produced. Microscopic examination of sections from unused investment molds confirmed that the fine margins of patterns were not damaged by the investing procedure.

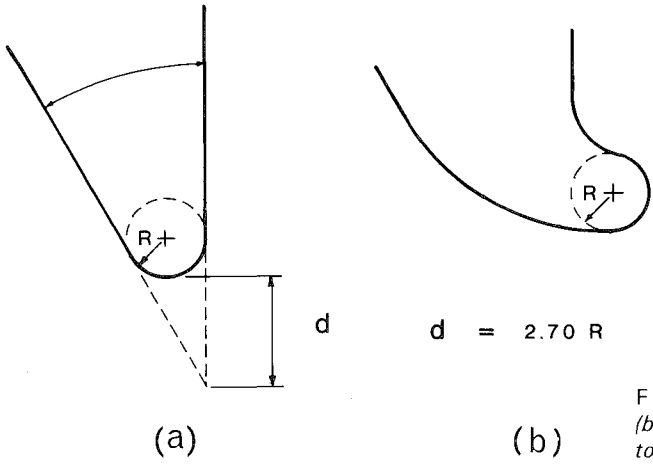

FIG 6. *(a) Definition of deficiency (d); (b) determination of equivalent deficiency for a distorted edge*

Minimum Requirement for Castability

The maximum permissible deficiency for the margin of a crown was determined from a study of clinical requirements. Beginning with the assumption that a margin on which a sharp explorer does not catch is satisfactory, minimum requirements were set. While some finishing of a cast crown is usually necessary, it is preferable that grinding and polishing of a fine margin be kept to a minimum. Hence a castability value was chosen that specified a margin with the sharpness required on the finished restoration.

The maximum size of an acceptable opening of a margin is difficult to describe precisely. Christensen (1966) measured the marginal openings termed clinically acceptable by 10 experienced restorative dentists. The best visible margin that was acceptable was computed, from a formula for predicting linear regression, to be open 39 μm. The range of opening of 40 margins that were barely clinically acceptable was 2 – 51 μm. Examination of visible margins of gold inlays with an explorer was found to be superior to, and more reliable than, examination of concealed margins with an explorer or radiographs. Studies by Dedmon (1982) suggest that most dentists would not detect a 50 μm step with an explorer tip. With these studies in mind, a value of 50 μm was chosen as the maximum opening permitted on an acceptable margin. By this criterion, allowing 25 μm for cement, the deficiency of a casting must not exceed 25 μm if the margin is to be acceptable (Fig 7).

The present test was designed to assess the castability of the alloys, not the quality of dental castings. Where an alloy will cast to a deficiency of less than 25 μm at some point on a test casting made by normal dental procedures, it should be possible to produce a casting with margins adequately complete at all points. Consequently **the smallest value for deficiency found** on a test casting served to describe the castability of the alloy used.

Testing of Alloys

Nineteen alloys were tested, of which four were base metal. The alloys selected are those frequently used in Australia, except for Duracast, which was included for general interest.

Castings of the various alloys were prepared by courtesy of the suppliers of the alloy, or by dental laboratories recommended by suppliers. The alloys tested are listed in Table 1. Duracast and Engelhard G5 were cast at the Australian Dental Standards Laboratory; all other alloys were cast in commercial den-

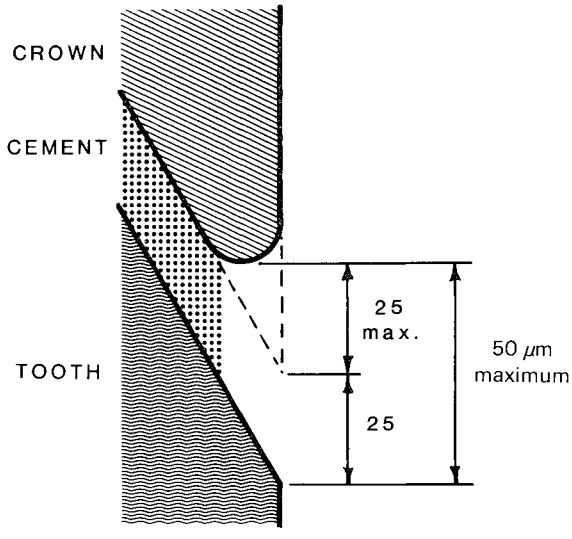

FIG 7. *Diagram of a margin showing the location of marginal deficiency*

Table 1. Brands Tested

Alloy	Supplier	Country	Purpose	ADA Classification	Approximate Composition	Specific Gravity
A-35	Howmedica	USA	Ceramic	Low	Pd59 Ag29	11.0
Argident 3	Argen	Australia	Ceramic	High	Au76 Pt11 Pd9	18.5
Duracast	Odonto	Brazil	Nonceramic	Base Metal	Cu81 Al8 Fe6 Ni4	7.8
G5	Engelhard	Australia	Nonceramic	Medium	Precious Metal 90.7	17.5
Hera SG	Hereaus	West Germany	Nonceramic	Low	Noble Metal 55	13.7
Herador NH	Hereaus	West Germany	Ceramic	High	Noble Metal 96.4	17.7
Herador P	Hereaus	West Germany	Ceramic	High	Au45 Pd45	13.5
Herador S	Hereaus	West Germany	Ceramic	High	Noble Metal 98	18.3
Maingold SG	Hereaus	West Germany	Nonceramic	Medium	Noble Metal 75	15.4
Modulay	Jelenko	USA	Nonceramic	Medium	Au77 Ag14 Cu8	15.9
NP2	Howmedica Inc	USA	Ceramic	Base Metal	Ni67 Cu13 Mo7 Ga7	8.7
Option	Ney	USA	Ceramic	Medium	Pd79 Cu8 Au3	10.6
Protor 3	Cendres & Meteaux	Switzerland	Nonceramic	Medium	Precious Metal 87	15.0
Rexillium III	Jeneric Gold	USA	Ceramic	Base Metal	Ni 76 Cr15 Mo5 Be2	7.8
T-III Lite	Howmedica	USA	Nonceramic	Low	Ag70 Pd25	10.8
T-III Lite "G"	Howmedica	USA	Nonceramic	Low	Ag68 Pd25 Au2	10.8
Unibond	Unitech	USA	Ceramic	Base Metal	Ni66 Cr23 Mo9	8.4
Wilkadium	Wilkinson	USA	Ceramic	High	Au52 Pd38	14.9
Willceram Y	Williams Gold	USA	Ceramic	High	Au88 Pt7 Pd6	17.4

tal laboratories using the materials and procedures routinely employed for clinical cases. Alloys were cast at laboratories where they were frequently used and technicians were familiar with their casting characteristics and special requirements. Hereaus alloys were cast in a Combilabor CL-G-77 vacuum-pressure casting apparatus (Hereaus Edelmetalle GmbH, Hanau, Federal Republic of Germany); the remainder were cast with centrifugal casting machines.

Test castings were cleaned of investment by the procedure recommended for the alloy. No grinding, deburring, or polishing was attempted, and no effort was made to reseat the castings on the original die. All castings were measured at the Australian Dental Standards Laboratory in the manner previously described.

The values of deficiency obtained for each alloy depend on the materials, equipment, procedures, and technical skill as well as the properties of the alloy itself. The castability of an alloy should be determined under the conditions required to produce accurately fitting castings free from porosity and roughness. Within this limitation it may still be possible to optimize conditions for maximum castability. Hence, where more than one casting was made for a given alloy, the lowest value of deficiency recorded is used for assessment against the proposed maximum value. The average values listed are from the pooled measurements of all castings for each alloy.

RESULTS

The value of deficiency varied a great deal around the perimeter of all the test castings. The coefficient of variation describes the spread of values and the upper 95% confidence value the degree of deficiency that must be accommodated in a clinical casting.

Table 2. Experimental Values of Deficiencies of Castings

Alloy	Range μm	Mean μm	Coefficient of Variation	Upper 95% Confidence Level
A-35	52 - 110	61	56	118
Argident 3	63 - 110	84	21	112
Duracast	11 - 74	55	29	89
G5	0 - 55	30	72	66
Hera SG	22 - 47	32	33	50
Herador NH	14 - 46	36	47	64
Herador P	19 - 50	28	14	46
Herador S	55 - 88	63	19	83
Maingold SG	17 - 59	35	51	65
Modulay	8 - 61	20	68	49
NP2	88 - 165	120	25	170
Option	41 - 82	62	20	83
Protor 3	8 - 72	30	63	61
Rexillium III	22 - 123	61	47	108
T-III Lite	70 - 270	141	30	210
T-III Lite "G"	36 - 88	56	26	80
Unibond	25 - 110	53	47	94
Wilkadium	0 - 90	25	136	81
Willceram Y	6 - 40	24	50	44

Table 2 lists the range, mean, coefficient of variation, and upper 95% confidence value for the alloys tested. Figure 8 sets out the mean, standard deviation, and upper 95% confidence values in order of increasing mean value. It can be seen that a wide range of values was obtained, and that the variability for each alloy is also large.

Table 3 lists the minimum values of deficiency in order of increasing value.

Table 3. Ranking of Alloys by Minimum Deficiency of Castings

Alloy	Deficiency μm
G5	0
Wilkadium	0
Willceram Y	6
Modulay	8
Protor 3	8
Duracast	11
Herador NH	14
Maingold SG	17
Herador P	19
Hera SG	22
Rexillium III	22
Unibond	25
T-III Lite "G"	36
Option	41
Herador S	55
A-35	55
Argident 3	63
T-III Lite	70
NP2	88

DISCUSSION

Twelve of the 19 alloys tested cast margins as sharp as or sharper than the proposed requirement of a maximum deficiency of 25 μm. It is possible that the values obtained for minimum deficiency (d_{min}) from the remaining seven alloys could be improved by altera-

Table 4. Comparison with Other Studies

Author	Number of Alloys	Width of Meniscus mean μm	Equivalent Deficiency μm	Coefficient of Variation %
Mackert, Moffa & Jendresen	7	46.4 - 129.3	63 - 175	37 - 73
Eames & MacNamara	4	25.0 - 70.0	34 - 95	35 - 55
This study	19	—	24 - 141	14 - 136

tions to casting procedures within the limitations of producing sound, accurate castings. The castability test proposed appears to be suitable for dental alloys recommended for fixed restorations and the results obtained should relate closely to behavior in the dental laboratory.

It is important to distinguish between the property of castability of an alloy and the deficiency of a test casting representing a dental crown. The potential of an alloy to cast fine margins is shown by the minimum value, whereas the quality of castings produced is indicated by the average deficiency or preferably by a measure incorporating variability such as the upper 95% confidence level. The extent of this value can be seen from Fig 8. From this it appears that present casting methods are inadequate to reliably produce margins of the required detail, and that improvements to this aspect of dental technology are needed.

The variation of deficiency around the circumference of test castings was much greater than expected, with coefficients of variation between 14 and 136% with an average of 45%. These values are similar to the results reported by Mackert, Moffa, and Jendresen (1975) and Eames and MacNamara (1978), whose coefficients of variation were 37.3–72.9 and 35–55, respectively (Table 4). Thus an inherent inconsistency hampers our ability to produce fine detail of dental castings. This must be recognized in the preparation of

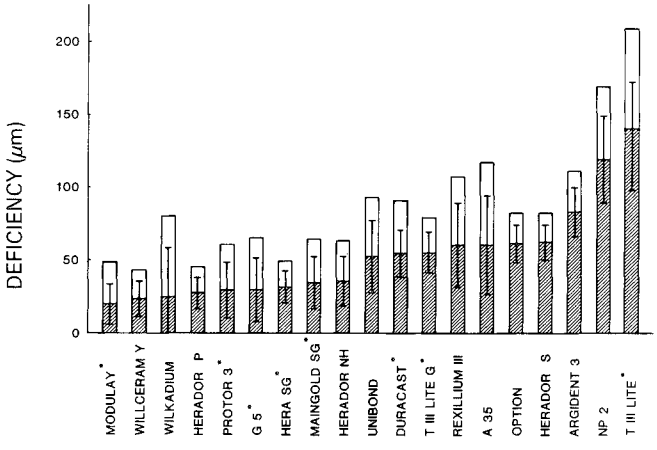

FIG 8. *Deficiencies arranged in order of increasing average value. Internal bars define plus or minus one standard deviation, upper box the upper 95% confidence value. Nonceramic alloys indicated *.*

clinical restorations if margins of the order of precision suggested are to be obtained.

How precise are the margins on dental restorations? The average deficiencies, except for Wilkadium, are greater than the proposed maximum. The upper values of the 95% confidence level are all greater than 25 μm (lowest is 44), which indicates that most castings will have some points on the margin significantly less sharp than the level proposed. Technicians and dentists, however, generally regard most alloys as satisfactory (Clinical Research Associates, 1980). Consequently, an explanation for this difference must be sought. Technicians may in fact overwax margins, then remove metal from the casting to refine the shape of the margin, or alternatively, dental castings may not be as precise as required to meet the standard selected for this study. The latter view is most likely if the reports by Christensen (1966) and Dedmon (1982) are considered. The possibilities for poor marginal adaptation are further enhanced if the conclusion of Gardner (1982) is included: "Most cemented castings do not fit nearly as well as theoretical tests of film thickness would lead us to believe."

According to Cruickshanks-Boyd (1981), high-gold alloys are considered to have superior castability because of their greater density. The results reported in the present study do not support this hypothesis. In Table 3, Duracast, Rexillium III, and Unibond (lower density alloys) have satisfactory castability, while Herador S and Argident 3 (high density alloys) did not cast as well. The influence of density is important mainly for centrifugal casting, but may be overshadowed by other factors. The disadvantage of lower density found with centrifugal casting can be counteracted by higher rotational speed or by longer sprues which produce a greater head of metal. The results tabled here are for alloys cast according to the manufacturers' recommended procedures, which should include measures that take into account particular characteristics of the product.

The question remains, "How good should margins be on restorative castings and how can they be measured?" Until such time as better data are available it is necessary to aim for the best possible margin that the explorer does not catch. A better method of assessment is required.

The method of examination described for this study can be applied as a routine clinical procedure. A dental impression is made of the margin of a restoration when in place in the mouth. Sections perpendicular to the margin can be easily made from the impression with a sharp knife. Inspection by unaided vision, or preferably with magnification, provides a revealing view of the profile of the margin.

CONCLUSIONS

- The sharpness of margins on dental castings is the characteristic most dependent on the castability of the alloy used.
- The discontinuity on acceptable clinical margins should be less than 50 μm.
- The deficiency of the margin on acceptable castings should be less than 25 μm.
- Castability testing demonstrated significant variation in the castability of a range of alloys.
- Deficiencies on test castings suggest that most dental castings require refinement of margins to produce acceptable results.
- The clinical margins of crowns may be conveniently examined by means of cross sections of dental impressions.

(Accepted 24 August 1983)

Acknowledgment

This project was made possible by the willing and effective cooperation of many Australian suppliers of dental alloys and dental laboratories. Their help relieved the Australian Dental Standards Laboratory of the considerable expense and effort of preparing many castings and produced results directly related to dental laboratory practice.

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DENTAL PRACTICE

Use, Abuse, and Misuse of the Electric Pulp Tester

Care must be exercised in interpreting the response to an electric pulp tester because it indicates only the presence or absence of vital pulp tissue, not the degree of health

ERNEST A LADO, JR

INTRODUCTION

Since the development of the electric pulp tester, countless opinions about its value as a diagnostic tool have been rendered. Attempts have been made to correlate the numerical reading on the electric pulp tester (EPT) with the health status of pulp tissue. These attempts have yielded inconclusive results and have thus cast a shadow on the value of using the EPT (Hare, 1969).

VARIATION IN READINGS

There are three major reasons for variation of EPT readings on vital teeth: (1) failure to complete the circuit, (2) errors in technique, and (3) physiologic variations. Correlating EPT readings with the overall health of the pulp becomes highly impractical, since there are so many reasons for variation. At best we can establish only the presence of vital tissue within the pulp chamber (Cooley, 1980; West, 1982). Once vitality has been established, the health of the pulp must be determined by the history of pain, signs, and symptoms elicited from the tooth in question (Cooley & others, 1978; West, 1982).

Failure to Complete the Circuit

When using the EPT it is not sufficient to apply the electrode to the tooth in question. The circuit must be completed from the tip of the electrode back to the conducting ring of the EPT. Starting with the tip of the probe, an electrical contact must be made with enamel (or dentin) through use of an electrolytic conductor. Toothpaste is a common electrolyte, readily available in the dental office. However, variations in conductivity of the electrolyte, as well as amount of electrolyte used,

University of Florida College of Dentistry, Department of Oral Medicine, Box J-414 DSB, J Hillis Miller Health Center, Gainesville, FL 32610

ERNEST A LADO, JR, DDS, assistant professor

may affect the reading. The voltage must be sufficient to overcome the impedance (resistance) of the enamel. The current is conducted from the enamel to the vital tissue of the pulp via dentinal tubules and on to the cutaneous surface of the patient. At this point, the patient must be grounded to the operator to ensure a closed circuit. This is accomplished by skin to skin contact, usually with the operator's free hand contacting the patient. The area of surface contacted is directly proportional to the flow of the current. In other words, the resistance is lowered as the area of the contacted surface is increased and the current flows more readily. The operator then completes the circuit by contacting the conducting ring on the EPT. Again, increased area of contact and even perspiration can lower resistance, thus facilitating the flow of current and resulting in a lower reading.

Errors in Technique

There are several errors in technique, some being very obvious, but requiring particular attention. Rubber gloves (King, 1977) will break the circuit at either the conducting ring, or at the areas of contact of skin, or both. Therefore, they should never be used while testing a pulp with an EPT. If any of the electrolyte touches the soft tissue, the current will not flow through the pulp tissues, but rather take the path of least resistance, and "short" through the soft tissues. Moisture or plaque will also cause the current to "short" through the soft tissues.

When using an EPT with a manual rheostat, it is important to keep the circuit closed during the test. This is accomplished by keeping the tip of the probe in contact with the tooth, and the switch ON. If the EPT is switched OFF, or contact is lost, a surge of current will occur and possibly hurt the patient unnecessarily when the circuit is again completed.

It is important to check that the pulp tester is functioning properly. This is accomplished by placing the tip on the skin just below your thumbnail and turning up the rheostat until the current is felt. Do not test another tooth first. This will serve only to sensitize the patient and cause apprehension in testing the suspected tooth.

Physiologic Causes

The following physiologic variables will also affect an EPT reading: (a) sensory threshold, (b) thickness of enamel, (c) thickness of secondary dentin, (d) traumatized teeth, (e) deciduous teeth, (f) teeth undergoing orthodontic treatment, (g) teeth with wide-open apices or partly erupted, (h) patients on strong analgesic medication (McGuiness, 1981).

Recent advances in pulp testers have eliminated misuse to some degree. One such pulp tester increases the output stimulus automatically, and will turn off when the circuit is broken (West, 1982).

A word of caution — as with all high-frequency electrical equipment, the EPT must not be used on patients with pacemakers.

Because of the many variables in pulp testing, comparing readings contributes very little information in establishing the degree of health of the pulp. **The pulp tester must be used only to establish the presence of vital pulp tissue, not the overall health of the pulp.**

(Accepted 26 September 1983)

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OPERATIVE DENTISTRY, 1983, 8, 142–147.

PRODUCT REPORTS

Gingival Response to Retraction by Ferric Sulfate (Astringedent™)

A cord soaked in a 13.3% solution of ferric sulfate (Astringedent) and then applied to sulcular gingiva resulted in severe changes in the subjacent connective tissue that were resolved in two weeks

DAVID H SHAW • ROBERT F KREJCI
KENNETH L KALKWARF • FRANK M WENTZ

Summary

When a commercial solution of ferric sulfate, Astringedent, was used to retract the gingiva of miniature swine after teeth had been prepared as for crowning, severe changes in the connective tissue were observed within 30 minutes but the tissue had returned to normal by two weeks after retraction.

University of Nebraska Medical Center, College of Dentistry, Lincoln, NE 68583-0740, USA

DAVID H SHAW, PhD, associate professor of oral biology

ROBERT F KREJCI, DDS, professor of adult restorative dentistry

KENNETH L KALKWARF, DDS, MS, associate professor of periodontology

FRANK M WENTZ, DDS, PhD, professor of periodontology

INTRODUCTION

Retraction of gingiva is necessary for obtaining accurate impressions in restorative procedures when subgingival placement of margins of restorations is required. One recommended procedure involves the use of a combination of chemical and mechanical aids. The mechanical effect is obtained when cord is placed into the gingival sulcus while

the chemical action is elicited from drugs impregnated in the cord.

Ideally the drug used should cause neither systemic effect nor local damage to the tissue. Unfortunately, many commonly used drug-impregnated cords produce some injury to the gingiva when left in the gingival sulcus for at least five minutes (Harrison, 1961). The most popular drugs used for retracting tissue before taking an impression include racemic epinephrine, aluminum chloride, potassium alum, and zinc chloride. Racemic epinephrine is often preferred because of the potential adverse reactions of the tissue to the astringents, but injury to the sulcular epithelium after prolonged exposure to epinephrine has also been reported (Harrison, 1961) and adverse systemic reactions to absorbed epinephrine continue to be of concern (Shaw & Krejci, 1976; Forsyth & others, 1969; Buchanan & Thayer, 1982). Injury to the sulcular tissue has been reported also after placement of cord saturated with 100% alum (Harrison, 1961), 8% and 40% zinc chloride (Harrison, 1961; Woychesin, 1964), and 10 – 60% aluminum chloride (Shaw, Krejci & Cohen, 1980; Ramadan, El-Sadeek & Hassanein, 1972). Recently, ferric sulfate has been recommended for use (Fischer, 1981).

The purpose of this study was to determine histologically the effects of a commercial preparation of ferric sulfate, Astringedent (Ultradent Products, Inc, Salt Lake City, UT 84117, USA), on the connective tissue subjacent to sulcular epithelium.

MATERIALS AND METHODS

Animals

Two Hormel miniature swine (Sinclair Research Farms, University of Missouri, Columbia, MO 65211, USA), approximately two years of age and weighing 175 lbs (78.8 kg), were used as experimental animals. The miniature swine is an acceptable animal for a study of this nature. The size of the teeth and the clinical appearance of the periodontium are comparable to man (Weaver, Sorenson & Jump, 1962; Kalkwarf, Krejci & Berry, 1982). Previous histologic studies have shown the characteristics of porcine oral tissue are very similar to those of man (Appleton & Heaney, 1977; Matravers, Heaney & Appleton, 1982). Access for preparation of cavities, retraction of gingiva, and biopsies with standard dental instruments is good.

The animals were housed in an indoor concrete pen with an outdoor run. Prior to this investigation, all animals were maintained on a diet of nonmedicated, high-protein swine concentrate in pellet form. During the course of this study the pellets of concentrate were soaked overnight in water and offered as a soft mash. Additional water was freely available.

The area used for this study received no periodontal instrumentation or removal of bacteria. Prior to the study, all experimental and control sites demonstrated clinical evidence of chronic, diffuse, mild gingivitis.

Light anesthesia was induced with an intramuscular injection of 650 mg ketamine hydrochloride and 1 000 mg pentobarbital sodium. Salivary flow was reduced with an intramuscular injection of 1.2 mg of atropine sulfate. Additional ketamine hydrochloride, up to 1 000 mg, was administered as needed to maintain anesthesia. Lidocaine hydrochloride, 2% with 1:100 000 epinephrine, was infiltrated around each experimental and control tooth. Sixteen teeth were used per animal, including four second incisors, four third incisors, four canines, and four second premolars. Sufficient numbers of teeth were selected to allow the gingiva surrounding each type of tooth to be subjected to the experimental condition as well as serve as an untreated control. Additionally, an equal number of teeth were treated with potassium alum (13.3%) to compare the tissue response. Alum has been shown to be well tolerated by oral tissues when used for short periods of time in retraction procedures (Harrison, 1961; Woychesin, 1964).

Retraction Materials

Untreated cotton cord, No 9 (Pascal Company, Inc, Bellevue, WA 98004, USA) saturated with:

1. Water (cord control)
2. 13.3% ferric sulfate (Astringedent, Ultradent Products, Inc, Salt Lake City, UT 84117, USA)
3. 13.3% potassium alum (common alum) (Fisher Scientific Co, Fairlawn, NJ 07410, USA)

All cords were applied wet to the tissue. The solution of potassium alum was freshly prepared before the experimental procedure. A 13.3% solution of potassium alum is a saturated solution at 25 °C.

Control and Experimental Specimens

Small amounts of enamel within the sulcus surrounding each experimental tooth were removed with a tapered diamond bur as previously described (Shaw, Krejci & Cohen, 1980). This procedure simulated subgingival preparation of a tooth for a crown. The gingiva was retracted by gently placing 1 inch of either a plain cord or a cord saturated with a drug solution into the gingival sulcus. The cords saturated with water and those saturated with potassium alum were allowed to remain for 10 minutes and the sulcus was then flushed with water. The 13.3% ferric sulfate was applied and left in place for 3 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 (Ultradent Products, Inc, Salt Lake City, UT 84117, USA). The treated sulcus was then thoroughly rinsed with water. Gingiva from untreated teeth served as control tissue.

Biopsy Procedure

The biopsy procedure used was identical to that previously described (Shaw, Krejci, & Cohen, 1980). After removal of the cord, biopsies of the gingiva, 2 mm wide and beginning at the distal of each tooth, were taken at 30 minutes, 24 hours, 36 hours, and 14 days. This sequence provided the opportunity to monitor the course of histologic events. Specimens from all sites were obtained at each time interval. The tissues were immediately fixed in buffered formalin and later processed for histologic evaluation.

Histologic Analysis

All specimens were stained with hematoxylin and eosin and coded for later analysis. Histologic evaluation was performed to determine the degree of alteration of the connective tissue. Each specimen was evaluated independently by two investigators for alterations of the connective tissue subjacent to the sulcular epithelium. The investigators were unaware of the type of cord that had been present or the time since its placement. Each specimen was numerically scored on a scale of 0-3.

0 = No alteration in connective tissue. Collagen fibers intact and orientation normal.

1 = Minor alteration in the connective tissue. Collagen fibers virtually intact, but orientation disturbed.

2 = Moderate alteration in connective tissue. Collagen fibers disrupted and fragmented, but identifiable. Orientation of fibers disturbed.

3 = Severe alteration in connective tissue. Collagen fibers not identifiable. The region appeared as an amorphous mass.

The investigators agreed upon initial classification in 89% of the samples. In other instances, they disagreed by one unit of classification. In each case of initial disagreement, the investigators re-evaluated the section and mutually agreed upon a classification.

At the conclusion of the histologic evaluation, the slide code was broken and the data were organized into types of treatment and intervals of time. Data from the multiple sites of biopsy were averaged for each experimental condition.

RESULTS

Histopathologic changes in the connective tissue of the gingiva compared with the experimental variables are summarized in Figure 1. Compared with the changes observed in the normal untreated tissue (Fig 2) and in that with the control cord (Fig 3) the changes seen with the cord saturated with alum were mild (Figs 4 & 5).

Severe changes in connective tissue, including dissolution of fibers, occurred in all specimens exposed to ferric sulfate (Figs 6, 7 & 8). Most of the severe changes subsided within two weeks.

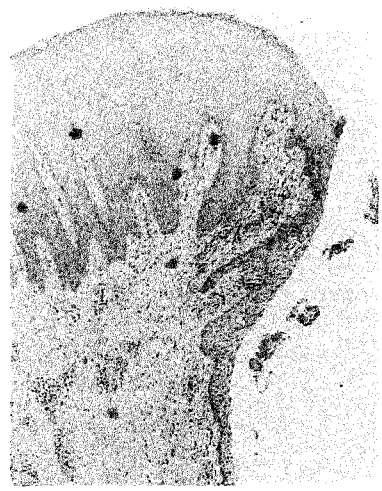

FIG 2. *Control specimen, no treatment, H & E, X100*

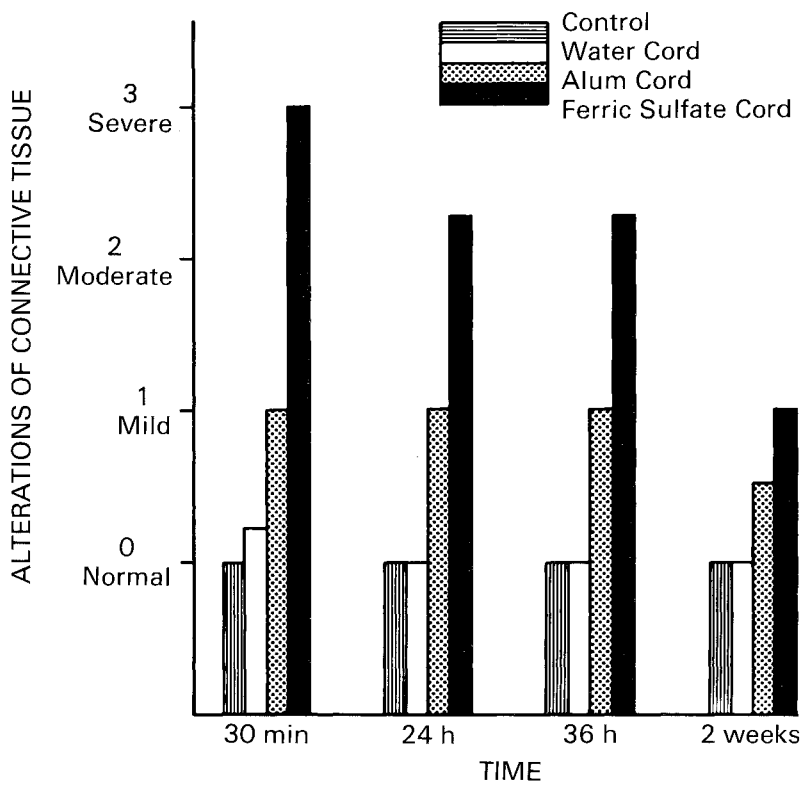

FIG 1. *Alteration of connective tissue in response to gingival retraction*

FIG 3. *Appearance of gingiva 30 minutes after removal of control retraction cord saturated with water. No evidence of damage to tissue. H & E, X100*

FIG 4. *Appearance of gingiva 30 minutes after removal of retraction cord saturated with a 13.3% solution of potassium alum. Orientation of collagen fibers slightly disturbed. H & E, X100*

FIG 5. *Appearance of gingiva 30 minutes after application of a 13.3% solution of ferric sulfate. Severe damage to the connective tissue. H & E, X100*

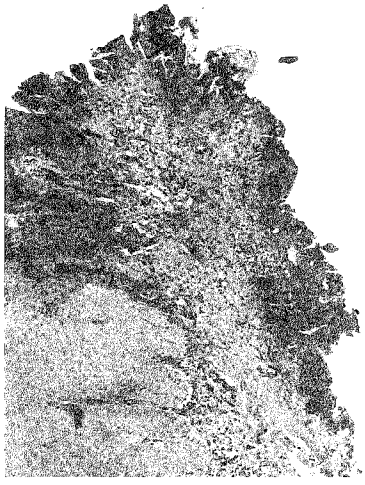

FIG 6. *Appearance of gingiva 24 hours after application of a 13.3% solution of ferric sulfate. Connective tissue still severely deranged. H & E, X100*

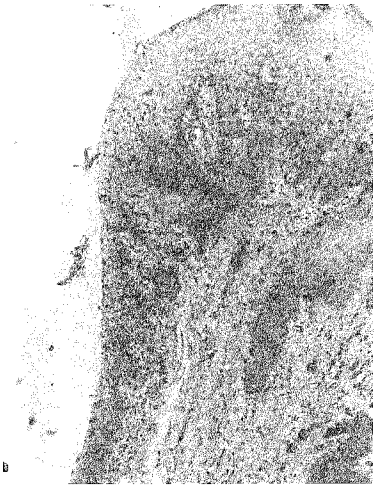

FIG 7. *Appearance of gingiva two weeks after removal of retraction cord saturated with 13.3% solution of potassium alum. Connective tissue almost returned to normal. H & E, X100*

FIG 8. *Appearance of gingiva two weeks after application of a 13.3% solution of ferric sulfate. Connective tissue almost returned to normal. H & E, X100*

DISCUSSION

The mild changes in connective tissue observed with the use of the astringent, alum, were not unexpected, based on previous published reports (Harrison, 1961; Woychesin, 1964; Shaw & others, 1980; Ramadan & others, 1972) and the fact that mild irritation of tissue is the means by which alum aids in retracting tissue. The severe alterations in connective tissue seen with ferric sulfate are significant, since the published directions for application were followed (Fischer, 1981). Whether this damage to connective tissue is induced primarily by ferric sulfate or by the procedure of applying it is yet to be determined.

CONCLUSION

A commercial solution of ferric sulfate, Astringedent, produced severe changes in connective tissue within 30 minutes of application. Moderate to severe alterations persisted for 36 hours, and the tissue had returned to normal by two weeks after retraction.

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OPERATIVE DENTISTRY, 1983, 8, 148–151.

Effect of Four Cavity Varnishes and a Fluoride Solution on Microleakage of Dental Amalgam Restorations

A cavity varnish (Copalite) helps in preventing microleakage around amalgam restorations during the first six months after placement

G ALLEN MURRAY • JERE L YATES
JEFF I WILLIAMS

Summary

Four cavity varnishes (Copalite, Cavi-Line, Balsamic' Azul, and S S White Cavity Varnish) and a fluoride solution (Cavity & Crown Prep) were evaluated for their sealing ability by using microleakage of amalgam restorations placed in extracted teeth. Microleakage was determined at one day, one week, three months, and six months by autoradiographs. The results indicated that Copalite showed little or no leakage at all time periods. Cavi-Line showed an initial sealing ability, which decreased until the six-month period. The other products showed moderate to gross leakage, which was not different from the control samples, which contained no varnish.

University of Tennessee, College of Dentistry, Department of Biomaterials, Center for the Health Sciences, 847 Monroe Avenue, Memphis, TN 38163, USA

G ALLEN MURRAY, DDS, associate professor of biomaterials

JERE L YATES, DDS, MS, associate professor of pedodontics

JEFF I WILLIAMS, DDS, MS, assistant professor of pedodontics

Introduction

The success of an amalgam restoration depends on a multitude of factors. One of these is the control of the consequences of early contraction of the alloy itself. After a period of time the alloy seals the void resulting from early contraction, even with the newer high-copper alloys (Andrews & Hembree, 1980). In the early stages of the contraction it has been shown that a cavity varnish seals the margins so that there is little or no infiltration of irritating fluids and a reduction of sensitivity (Andrews & Hembree, 1975, 1978; Going, 1972). An earlier study showed that cavity varnishes varied in their ability to

seal (Yates, Murray & Hembree, 1980). New products have been introduced and other products have been reformulated to be used as an intermediate between a prepared cavity and the alloy itself. It was the purpose of this study to evaluate the efficiency of four cavity varnishes and a fluoride solution (0.717 % fluoride and 0.303 % tin in an aqueous solvent stabilized for stannous fluoride and acidulated phosphate fluoride) for their ability to seal margins.

Materials and Methods

Two hundred and twenty class 5 cavities were prepared with a No 35 inverted cone bur in sound, extracted human teeth that had been stored in tap water. The samples were divided into five groups of 40 teeth to which four different cavity varnishes and a fluoride solution were applied. Two groups of teeth received only amalgam to serve as the positive control.

Each group of 40 teeth was divided into sections of 10, and one of the products in Table 1 applied to the preparation in each tooth. Each product was applied according to manufacturer's recommendations. All were applied with a cotton pellet except Balsamic' Azul, which was applied with the furnished applicator.

Table 1. Materials Tested

Balsamic' Azul	Peerless International, Inc, Brookline Village, MA 02147, USA
Copalite	H J Bosworth, Skokie, IL 60076, USA
Cavi-Line	L D Caulk, Milford, DE 19963, USA
Cavity & Crown Prep	Gel Kam, Scherer Laboratories, Inc, Dallas, TX 75234, USA
S S White Cavity Varnish	S S White, Philadelphia, PA 19102, USA

After the varnishes and fluoride solution had been placed, each preparation was restored with silver amalgam alloy—Dispersalloy (Johnson & Johnson, East Windsor, NJ 08520, USA)—and the specimens were stored in tap water at 37 °C before being tested. The size of the sample allowed 10 specimens with each brand of varnish or fluoride solution. Before testing, each specimen was cycled thermally by dipping alternately in water at 4 °C and 58 °C, one minute in each, for 100 cycles.

Four different periods of time were chosen for evaluation of the samples—one day, seven days, three months, and six months. The positive controls were tested at one day and six months. With the combination of four time periods, five products, and 20 control samples, the total of 220 was obtained.

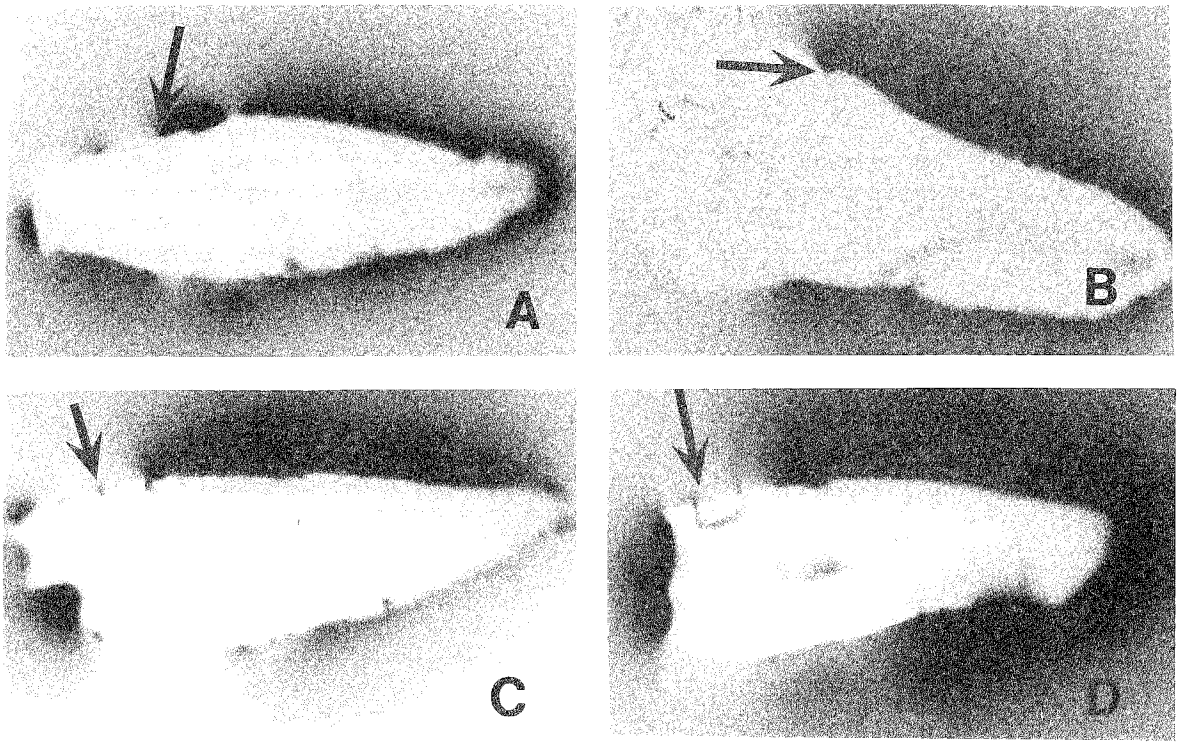
Marginal leakage was determined by the presence of a radioactive isotope, ^{45}Ca, between tooth and restoration as shown on an autoradiograph. Each specimen was soaked for two hours in a solution of $[^{45}Ca]\ Cl_2$ (concentration 0.1 mCi · ml^{-1}, pH 7). Before the teeth were soaked in the radioactive solution, the surfaces of the roots were carefully sealed with nail polish. After removal from the isotope, the teeth were brushed with detergent and then sectioned longitudinally through the restorations by grinding wet on a wheel of aluminum oxide. The sectioned surface of the tooth was placed on an ultraspeed, periapical x-ray film for 17 hours to produce an autoradiograph. The films were processed in an automatic developer (Swartz & Phillips, 1961). Leakage was evaluated on the following scale, examples of which are shown in the figure.

0 = no evidence of the isotope between tooth and restorative material.

1 = evidence of penetration of isotope between tooth and restorative material at the cavosurface margin.

2 = evidence of isotope along the cervical and incisal or occlusal walls but no penetration to the axial wall.

3 = evidence of penetration of isotope to the axial wall.



Examples of the scale of leakage: (A) 0 = no evidence of the isotope between tooth and restorative material; (B) 1 = no evidence of penetration of isotope between tooth and restorative material at the cavosurface; (C) 2 = evidence of isotope along the cervical and incisal or occlusal walls but no penetration to the axial wall; (D) 3 = evidence of penetration of isotope to the axial wall.

Results and Discussion

Table 2 shows the results. The one-day control of amalgam alone showed moderate to gross leakage at the margins. The six-month control showed mostly no leakage at the margins, which is consistent with the finding of Andrews and Hembree (1978).

Copalite seems initially to seal the interface of amalgam and tooth, and this seal continued throughout the six-month period of the study. This result is in agreement with other studies that involved Copalite and microleakage (Yates & others, 1980).

The product Cavi-Line did seal most restorations at one day, but with time an increase in leakage occurred up to the three-month interval. The six-month results showed a sealing of the interface in most of the samples. It may be that the Cavi-Line material dissolved over time to allow for the increase in microleakage up to the three-month interval.

Cavity and Crown Prep, Balsamic' Azul, and S S White Cavity Varnish showed moderate to gross leakage from one day to three

Table 2. Microleakage of Cavity Varnishes and a Fluoride Solution

Time	Degree of Leakage					
	Copalite	Cavi-Line	Balsamic' Azul	S S White Cavity Varnish	Cavity & Crown Prep	Control
	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
1 day	7 2 1 –	4 2 2 2	– – – 9*	– – 3 7	– – 2 8	– – 4 6
7 days	6 4 – –	1 2 4 3	– – 3 7	– – 2 8	– – 2 8	
3 months	7 3 – –	1 3 6 –	– – 4 6	1 2 1 6	– – – 10	
6 months	9 1 – –	6 2 2 –	6 3 1 –	7 1 1 1	7 2 1 –	6 1 3 –

*One lost in sectioning

months. The six-month results were consistent with Copalite, Cavi-Line, and the control in that most restorations showed no leakage at the margins.

In all samples a decrease in leakage occurred between the three-month and six-month interval with the exception of the Copalite group, for which the seal remained constant. During this time interval, the decrease in leakage can be attributed to other factors, such as corrosion, and not the ability of the varnish to seal the margins.

Conclusion

For minimizing marginal leakage of amalgam restorations, Copalite is the varnish of choice.

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DEPARTMENTS

Announcements

NOTICE OF MEETINGS

Academy of Operative Dentistry

Annual Meeting: 16 and 17 February 1984
Westin Hotel
Chicago, Illinois

American Academy of Gold Foil Operators

Annual Meeting: 18 and 19 October 1984
Emory University
Atlanta, Georgia

Book Review

DENTAL HEALTH CARE IN SCANDINAVIA: ACHIEVEMENTS AND FUTURE STRATEGIES

Edited by Asger Frandsen
Published by Quintessence Publishing Co, Inc, Chicago, 1982. $14.00

This book contains the proceedings of a "Symposium on Dental Health Care in Scandinavia," held in Oslo, Norway, January 27-30, 1981.

The introductory chapter gives a general view of the system of delivering dental care in Denmark, Finland, Norway, and Sweden. The rest of the book consists of six work papers prepared for the symposium, comments on the work papers by moderators, and reports prepared by discussion groups and seminars held at the symposium. References are extensive and readability is excellent.

The work papers contain a tremendous amount of information. Scandinavia has been considered a laboratory for the welfare state and more complete dental data is available in Scandinavian countries than in other parts of the world. The reports on the effectiveness of various preventive measures in Scandinavia should prove interesting to all practitioners. The sections on the economics of dental health should also prove interesting to anyone concerned with delivery of dental care.

The work papers present the changing needs and demands for dental care in Scandinavia. The reader can apply these changes to his own situation.

Fleet C Ratliff, DDS
Box 7448
Olympia, WA 98507

Press Digest

Surface microstructure of composite resins after toothbrush-dentifrice abrasion. Ehrnford, L (1983) *Acta Odontologica Scandinavica,* 41, 241-245.

A laboratory study comparing the resistance to abrasion of an experimental composite incorporating a filler of porous glass, a conventional composite (Profile), and a microfilled composite (Silar) showed that the glass phase of the experimental resin demonstrated flat surfaces with rounded peripheries, Profile showed irregular or rounded glass particles, and Silar showed a relatively smooth surface, except for frequent pores. The rate of wear of Silar, however, was comparatively high.

Opacity of glass-ionomer cements. Asmussen, E (1983) *Acta Odontologica Scandinavica,* 41, 155-157.

Measurement of the opacity of the glass-ionomer cements now available shows that they are still more opaque than composite. Fuji II is less opaque than ASPA but Fuji II and ChemFil differ little. The lighter the shade of glass-ionomer cement the less the opacity. Early contact with water increases the opacity.

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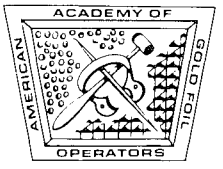

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OPERATIVE DENTISTRY

Aim and Scope

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

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