OPERATIVE DENTISTRY

summer 1979 • volume 4 • number 3 • 89-136
(ISSN 0361-7734)

OPERATIVE DENTISTRY

SUMMER 1979 • VOLUME 4 • NUMBER 3 • 89-136

Aim and Scope

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

Publisher

Operative Dentistry is published four times a year: Winter, Spring, Summer, and Autumn, by the American Academy of Gold Foil Operators and the Academy of Operative Dentistry.

Subscriptions

Yearly subscription in U.S.A. and Canada, $20.00; other countries, $24.00 ($27.00 air mail); dental students, $13.00 in U.S.A. and Canada; other countries, $17.00; single copy in U.S.A. and Canada, $7.00; other countries, $8.00. Make remittances payable (in U.S. dollars only) to *Operative Dentistry*.

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EDITORIAL

Quality Control: Look for Causes

We notice often in the newspapers nowadays that some automobile manufacturer has had to recall several hundred thousand cars because of a defective part. This reflects growing awareness by consumers that commodities they buy are often defective. More and more, it seems, producers are being held responsible for the failure of their products.

Dentistry has not escaped the scrutiny of consumers. Much of the impetus for the control of quality in dentistry has come from third parties such as insurance companies and service corporations, who want to make sure they are getting value for their money. Once the notion of checking the quality of dental treatment appeared, the next step was to determine what was satisfactory and what was not. Much time, effort, and money have been expended on developing means of evaluation. Valuable though these exercises may be, we must be wary of mistaking the process of inspection for the goal of improvement. Quality is controlled not so much by inspection but by dealing with causes.

What are the causes of low quality in dentistry? Apart from difficulties with patients and economic considerations that preclude service of high quality, two causes for dental service of low quality are foremost. One is a dentist lacking competence; the other is a problem of ethics, a competent dentist loath to strive for high quality.

Leaving aside matters of ethics for the moment, what can we do to increase the competence of dentists? If we seriously want to raise the quality of dental treatment we should look to the source of training for dentists. There is now much evidence from state board examiners, the armed forces, and those who give special courses for state board examinations, that in recent years the quality of operative dentistry as taught in many of our dental schools has indeed declined. Without a sound foundation in the art and science of operative dentistry, which constitutes the greater part of general practice, a dentist is likely to flounder in trying to provide treatment of high quality. Nor are the chances great that he will improve with time; often the reverse is true, continuing education notwithstanding. It is difficult to build anything substantial on a flimsy foundation; buttresses, bandages, and baling wire affixed as appendages do not suffice.

Surely the first step, and the most effective one, on the road to improved quality of dental service is to ensure that all graduates of dental schools are well trained, especially in operative dentistry. The techniques of good treatment are with us; would that they were espoused and used more widely and effectively. Unfortunately the way is often blocked by academic ostriches, who prefer sand to light. It is incredible that our universities, the very institutions charged with scientific leadership, should be so eager to accept mediocrity, so reluctant to face reality. Just as car manufacturers must recall defective automobiles, perhaps dental schools should be asked to recall substandard practitioners.

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 OPERATIVE DENTISTRY, 1979, 4, 90-99.

REVIEW

Guidelines for Locating the Cervical Margins of Dental Restorations

RICHARD A REINHARDT

Summary

A review of the effect of subgingival margins of restorations on the health of the gingiva suggests that whenever possible cervical margins should be located supragingivally. When this is not possible because of esthetics, retention, or the extent of the carious lesion, scrupulous care should be taken to ensure that the margins are finished flush and the restoration well polished.

INTRODUCTION

In recent years there has been much discussion about the best location for the cervical (gingival) margin of a restoration in relation to the gingival sulcus. Major influences on the location of margins include the extent of original caries, the potential for recurrence of caries, esthetics, and the possibility of gingival inflammation.

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The objective of this article is to review the literature on the placement of cervical margins of restorations and the relationship of the margins to gingival health, and to formulate guidelines for determining the most practical location of the cervical margin of a given dental restoration. The article is divided into two parts. The first deals with restorations that have cervical margins adjacent to only a limited segment of the gingiva. In these the location of the carious lesion is usually the primary factor in determining the placement of the cervical margin. Restorations of this type include silicate cement, acrylic resin, amalgam, gold inlay, and cohesive gold. The second part of the article is concerned primarily with those restorations about which a decision often must be made as to the placement of the cervical margin regardless of the location of the caries. Full cast crowns, porcelain crowns, and crowns of porcelain-fused-to-metal constitute the second group.

AMALGAM, CEMENT, RESIN, COHESIVE GOLD, AND GOLD INLAY RESTORATIONS

Since 1908 when Black stressed extension for prevention, dentists have been placing cervical margins of restorations below the gingival crest. What was it that caused Black to give the dental profession such advice? It might be interesting to reflect on the evidence that prompted researchers of Black's era to recommend subgingival location of the cervical margin. It was believed that the bottom of the gingival sulcus reached the cemento-enamel junction as soon as the tooth erupted into occlusion. On extracted young teeth a zone of whitish, intact enamel was often observed just coronal to the cemento-enamel junction. This zone, within the gingival sulcus, was thought to be an area immune to caries (Fig 1). This area seemed to be the ideal location for the cervical margins of restorations.

It was later discovered, however, that in newly erupted teeth the floor of the sulcus is about one-half to two millimeters coronal to the cemento-enamel junction (Gottlieb & Orban, 1938). The whitish enamel seen on extracted young teeth was not an area immune to caries, but rather that portion of the enamel covered by the attached epithelial cuff. Therefore, restorations extended into this area would be beyond the limits of the gingival sulcus and would extend into the attachment apparatus.

Problems of Subgingival Margins

Problems associated with the placement of cervical margins below the gingival crest include: 1) foreign-body reaction to the restorative material in the gingival sulcus; 2) difficulty in finishing the margin flush with the tooth; and 3) difficulty in obtaining a high polish on the surface of the restoration.

FOREIGN BODY REACTIONS

There has been a question whether certain dental materials cause a true foreign-body reaction or whether the chronic gingivitis is caused by the rough surfaces of the restora-

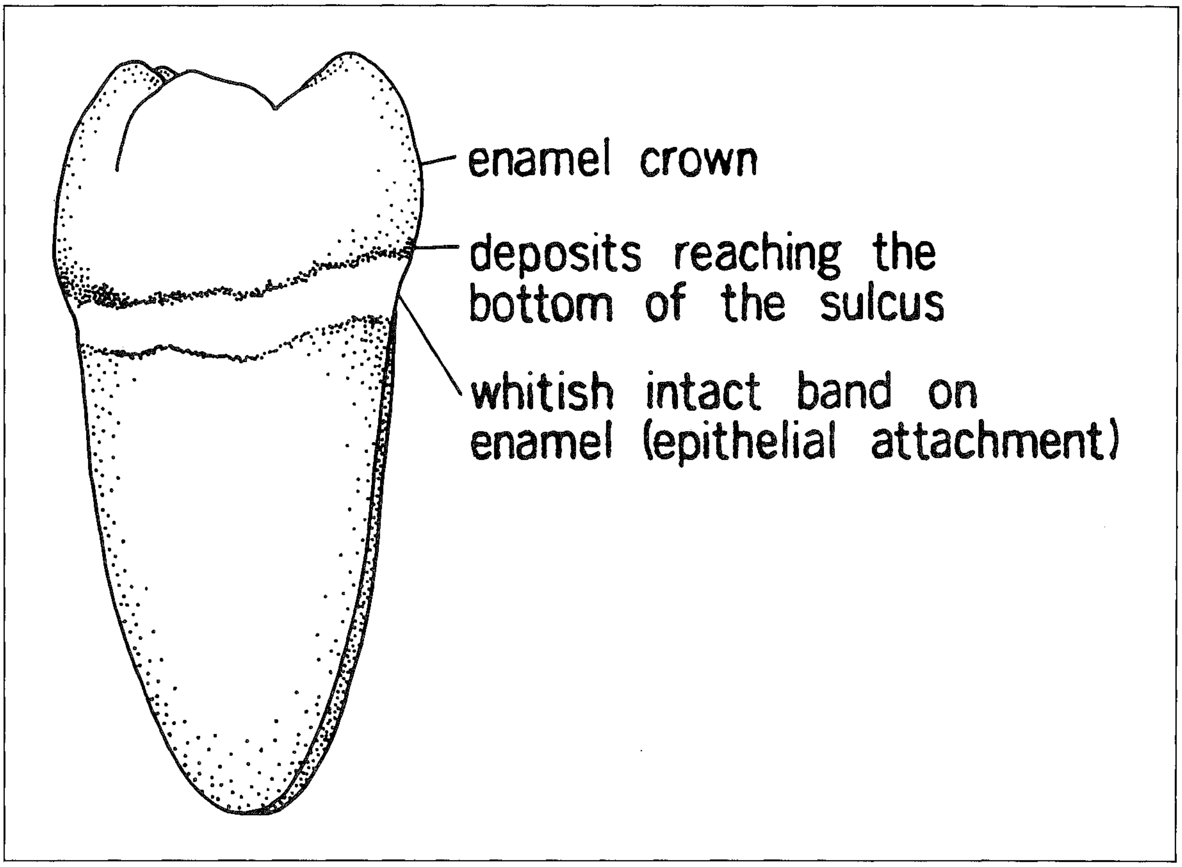

FIG 1. Schematic drawing illustrating the whitish, intact enamel zone as discussed by Gottlieb & Orban (1933)

tions and subsequent accumulation of plaque. Waerhaug (1956) reported that gingiva adjacent to roughened enamel (artificially produced by coarse diamond stones) showed complete readaptation with little, if any, inflammatory response. Since inflammation was seen in the gingiva adjacent to polished restorations in the same study, this may indicate a true foreign-body reaction.

The foreign-body theory is supported by other investigators who have suggested that silicate cement, acrylic resin, and amalgam produce a toxic effect on cell growth (Leirskar & Helgeland, 1972). Gold alloys, on the other hand, showed no effect on cell growth.

FINISHING SUBGINGIVAL MARGINS

The difficulty encountered in finishing subgingival margins has led to the production of irregular margins and surfaces adjacent to gingiva. Zander (1958) proposed that irregularities in the cervical areas of tooth fillings and restorations act as foci allowing plaque to form in proximity to the gingiva. These defects, promoting the formation of plaque, together with the subgingival location of the margin, do not allow self-cleaning mechanisms to operate. Oral hygiene performed by the patient is difficult, if not impossible.

Waerhaug's (1956) research supported the concept of plaque foci in demonstrating that epithelial cells of the gingival margin can adapt themselves to irregularities in the surface of a restoration provided it is clean and free of a bacterial coating. From this we may conclude that the irritating effect on gingiva around such restorations is primarily bacterial.

Clinical investigations have shown marginal defects to be associated with a high incidence of chronic gingivitis. Wright (1963) has studied restorations with overhanging margins and found gingival inflammation associated with 85.5% of these restorations. An examination of 82 dental and medical students has revealed a greater incidence of gingival disease adjacent to overhanging restorations than adjacent to "good" restorations in the same individual (Trott & Sherkat, 1964). Gingival health was determined by the amount of hemorrhage produced during gentle probing.

Björn, Björn & Grkovic (1969) took the study of gingival inflammation a step further by analyzing the relationship between defects in the margins of restorations and the height of approximal bone as revealed in radiographs. They found that about 75% of the measurable margins were defective, with an excess of filling material about 20 times more common than a deficiency. Large defects were associated with a highly significant loss of marginal bone whereas moderate defects were related to a moderate loss of bone.

SURFACE POLISH OF RESTORATION

The inability to obtain a high polish on certain restorations adjacent to gingiva due to their location or the characteristics of the restorative material may also lead to the presence of multiple microfoci for accumulation of plaque. App (1961) placed and studied class 5 restorations with subgingival cervical margins in dogs. Silicate cement, amalgam, and cast gold were the materials used. He found tissue adjacent to these restorations to be clinically normal after 30 days. Histological examination showed an inflammatory response to silicate cement and amalgam, but gold inlays (with the most highly polished surface) produced no inflammation.

Larato (1969) studied 613 white male patients with a variety of class 5 restorations with cervical margins at various levels. Inflammation was determined by clinical signs including changes in tissue tone, color, stippling, and whether or not bleeding occurred upon gentle probing of the gingival sulcus. All patients had received thorough instruction in toothbrushing. Of the restorations with subgingival margins, it was found that 73% had inflamed gingiva contacting the restorations. Those restorations with cervical margins even with the gingival crest showed inflammation in 37% of the cases whereas with margins slightly above the crest, 23% had inflamed gingiva. Inflammation was seen in 89% of the cases in which silicate cement or acrylic resin contacted gingiva as compared with 68% for amalgam and only 30% for cohesive gold. When margins were placed above the free gingiva, silicate cement and acrylic resin still were associated with a relatively high incidence of inflammation in adjacent tissue. The incidence of inflammation adjacent to cohesive gold and amalgam was significantly less.

In a later study, Larato (1972) placed class 5 composite restorations in 59 patients with healthy gingiva and good oral hygiene. He found that 64% of those subjects receiving restorations with subgingival margins showed signs of marginal gingivitis at two months while contralateral nonrestored teeth and teeth with supragingival restorations showed little or no accumulation of sulcular plaque and no gingival inflammation. These results were attributed to the increased adherence of plaque to the surface of the composite of resin-bonded quartz. This characteristic of composite makes removal of subgingival plaque difficult even among patients who practice good oral hygiene.

Sotres, Van Huysen & Gilmore (1969) studied the effects of polished surfaces of class 5 restorations on gingiva in dogs. More inflammation was associated with unfinished than with polished restorations, whereas the unprepared areas (control) showed the least inflammation. This was true for all materials tested though silicate cement promoted the greatest inflammatory reaction.

Inflammation in these tests was attributed to the chemical characteristics of the plaque rather than the mechanical irritation of the roughened surface of the restoration. It was also concluded that all subgingival surfaces must be carefully polished to prevent accumulation of plaque.

Trivedi & Talim (1973) confirmed the findings of Larato (1969, 1972) and Sotres & others (1969) when they histologically evaluated gingiva adjacent to class 5 restorations in premolars in humans. They concluded that the gingival inflammation can be explained by a combination of factors including: 1) chemical injury (silicate cement and acrylic resin); 2) unpolished restorative materials (plaque accumulation); 3) poor marginal adaptation (due to solubility, contraction or expansion of material, or poor finishing); and 4) inadequate oral hygiene.

Gingiva adjacent to well-adapted proximal amalgams studied by Renggli & Regolati (1972) showed significantly higher inflammation (as scored on the Sulcus Bleeding Index of Muhlemann and Son, 1971) when the margins were subgingival compared with supragingival. This is consistent with the findings presented in the previously mentioned studies of class 5 restorations.

FULL CROWN RESTORATIONS

In class 2 and class 5 restorations the location of the carious lesion often dictates where the dentist must place the gingival margin. This applies less often with full crowns; with these the operator may have a choice of location of margin. What effect do full crowns and the placement of margins have on gingiva?

Alexander (1968) examined 400 patients, some of whom had full crowns, and assessed the condition of their gingiva by using a modification of the PMA system (Heylings, 1961; Rosenzweig, 1960). He found the mean score of gingival inflammation for crowned teeth was significantly greater than that for the remaining uncrowned teeth. The papillary area of the gingiva was found to be the most affected by inflammation.

Hoover & Lefkowitz (1965), in a study of the fluctuating pattern of marginal gingivitis, found that teeth restored with gold crowns in contact with the sulcular gingiva have more gingivitis and fluctuating areas than do unrestored teeth.

Marcum (1967) observed a beneficial response in gingiva if margins were located at the gingival crest, compared wih either subgingival or supragingival placement. These studies were conducted on dogs and only four crowns in each position were evaluated. Marcum's results have not been duplicated in most subsequent investigations.

Karlsen (1970) used histologic studies in adult dogs and monkeys to test the effect of full gold crowns and microbond crowns, as well as class 5 gold inlays and resin inlays, on gingiva. One-third of the restorations were finished one millimeter or less above the gingival margin whereas the rest were extended into the sulcus. He discovered that nearly all subgingival crowns were associated with inflammation of varying degrees. Inflammation increased as marginal discrepancies increased. Crowns and inlays finished supragingivally gave undoubtedly the best results. On those teeth where subgingival preparations were made without placing restorations, only minor gingival reactions occurred. In all cases plaque was blamed for the inflammation observed.

Rantanen (1970) found in a study of 180 teeth with filled root canals that teeth with crowns were associated with significantly more gingivitis than teeth without crowns. Ill-fitting margins of crowns resulted in more severe gingivitis than crowns that fit well. Even "perfect" margins of crowns were found to cause inflammation of the gingiva if extended into the sulcus.

Valderhaug (1971) reported that gingiva adjacent to subgingival margins of crowns showed more inflammation and greater recession over a two-year period than gingiva adjacent to the supragingival margins.

In evaluating the proper location of crown margins, factors other than potential inflammation of the gingiva must be addressed. One of these factors is the potential for recurrent caries. It has been reported that marginal caries can be reduced by placing the margin of the restoration below the margin of the gingiva (Karlsen, 1970; Carranza & Romanelli, 1973). Budtz-Jørgensen (1971) examined 341 restorations in dental college patients for the status of the adjacent gingiva and the frequency of secondary caries. He found that the gingival index score was highest and the incidence of secondary caries lowest when margins of restorations were extended into the gingival sulcus. The opposite was true when the margin of the restoration was located more than one millimeter above the gingival margin.

Despite the reports that subgingival location of margins reduces the potential for secondary caries, it must be suggested that the accumulation of plaque in this area due to irregularities in the margin of the crown can lead to periodontal destruction and exposure of new surface of the tooth on which decay can develop. From the practical point of view the margins of all crowns are ill-fitting (Waerhaug, 1953; Löe, 1968). A space exists for cement between the crown and cavity wall. This cement may dissolve somewhat in oral fluids or may be porous and leave microscopic spaces between itself and the crown due to the difference in the thermal contraction of gold and cement (Fig 2). In any case concavities exist in which bacteria can grow and initiate gingival inflammation and subsequent recession.

All things considered, it would appear that the best location for the margin of a crown is where the dentist can best control its preparation and adaptation, and where the patient can best keep it clean. In most cases this location is supragingival.

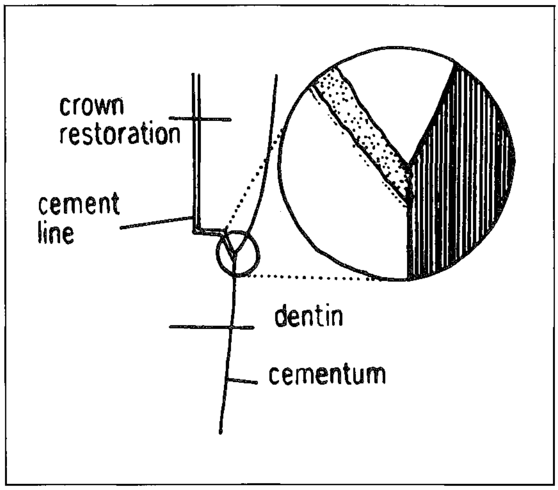

FIG 2. A diagram illustrating the gingival margin of a cast crown. Note the cement space with its irregularities and porosities.

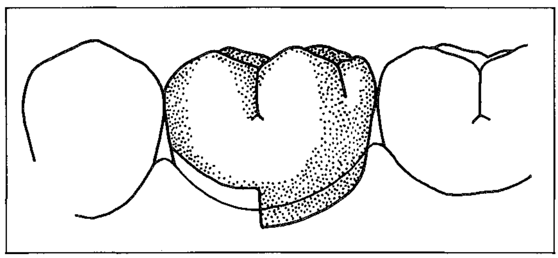

FIG 3. Schematic drawing showing design for full cast crown. Note that one half of the facial margin is positioned subgingivally and one half supragingivally. From Richter & Ueno (1973).

Results obtained by Richter & Ueno (1973) tend to soothe the conscience of the practitioner that finds he must extend the cervical margin of his crown into the gingival sulcus. They prepared and placed crowns with one-half of the facial margin positioned subgingivally and one-half supragingivally (Fig 3). Great care was taken to create well-finished, accurate margins. Recalls were made over a three-year period in which Löe's Gingival Index, sulcus depth, gingival contour, and plaque accumulation were measured. They found no significant difference in any of the above criteria between supragingival and subgingival placement of margins. Their results suggest that the fit and finish of full crown restorations may be more significant to gingival health than the location of the finish line.

In those cases where subgingival location of margins is a necessity, the operator must be careful not to encroach on the epithelial attachment. As a tooth progresses through the four stages of passive exposure, the length of its epithelial attachment decreases and the relationship of this attachment to the cemento-enamel junction changes. A chart of normal values for the relationship of the components of the periodontium may be helpful in determining placement of subgingival margins (Fig 4). Special attention should be given to the distance between the bottom of the sulcus and the crest of the alveolar bone in the various stages. This dimension should not be violated. In some cases, contours of bone and soft tissue must be modified to allow for this healthy sulcular relationship.

PORCELAIN CROWN AND PORCELAIN-FUSED-TO-METAL CROWN RESTORATIONS

The placement of the gingival margin of esthetic restorations usually requires extending the margin to or below the gingival crest. In evaluating the effect of the margins or porce-

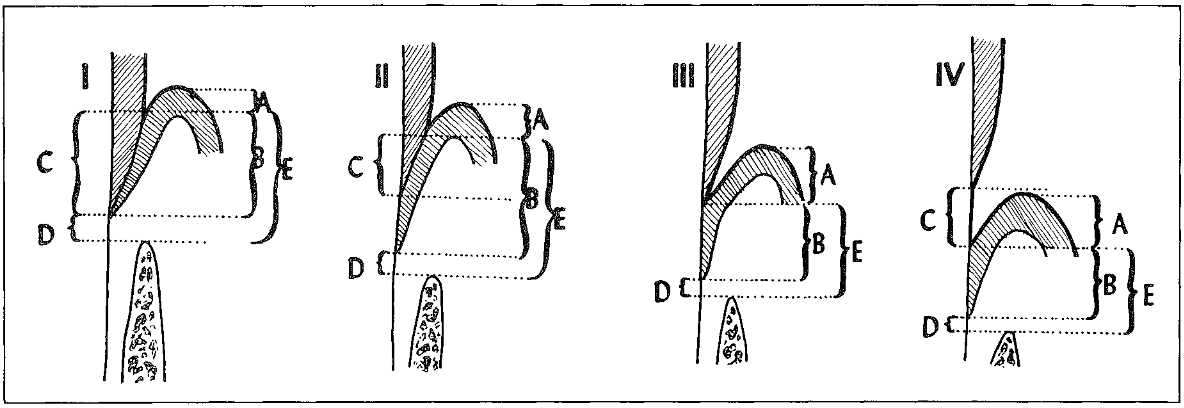

FIG 4. Dimensions of the components of the dentogingival junction in man related to the four stages of passive exposure.

Measurement	Phase averages (mm) I	II	III	IV	Total averages (mm)
(A) Sulcus depth	0.80	0.61	0.61	0.76	0.69
(B) Attached epithelium	1.35	1.10	0.74	0.71	0.97
(C) Bottom of sulcus from cemento-enamel junction	+1.35	+0.68	0.00	−1.14	
(D) Deepest point of epithelial attachment to alveolar bone	1.08	1.07	1.06	1.06	1.07
(E) Bottom of sulcus to alveolar bone	2.43	2.17	1.80	1.77	2.04

From Gargiulo, Wentz & Orban (1961)

lain crowns on the facial gingiva, Mannerberg (1971) pointed out that it is difficult to be objective and not consider the esthetic appearance of the crown. To discover the severity of gingival inflammation he sampled leukocytes according to the technique described by Attström (1970) and determined the volume of gingival exudate according to Brill (1962) and Egelberg (1964). In all thirteen cases the leukocyte count and the amount of exudate were found to be higher with porcelain crowns than with adjacent natural teeth.

It was concluded that even with the best adaptation of porcelain crowns, the margin is never so smooth as not to interfere with oral hygiene. Plaque will therefore accumulate and inflammation will occur. Improper contours in the cervical and interdental areas of porcelain crowns will also contribute to the retention of plaque.

The same factors bear on porcelain-fused-to-metal restorations. On the theory that subgingival margins lead to inflammation and eventual recession, some authors believe that the best solution is to end the crown margin level with the gingival margin (Carranza & Romanelli, 1973).

FIXED BRIDGE RESTORATIONS

Silness (1970) studied unilateral fixed bridges involving 146 abutment teeth that were placed in patients in which contralateral uncrowned teeth could be evaluated. Each bridge had two abutment teeth and all teeth involved in the study were in occlusion. The Gingival Index (Löe & Silness, 1963), Plaque Index (Silness & Löe, 1964), and pocket depth (Glavind & Löe, 1967) were measured and the locations of the crown margins were noted. Results showed that when the location of margins was considered, scores for Plaque Index and Gingival Index were higher as crown margins approached and entered the gingival sulcus. This was true particularly in the interproximal areas. Margins at least two millimeters above the gingival margin registered the lowest combined scores. Pocket depths were not affected by abutment crowns during the short course of this study. The author concluded that the increased scores in patients with subgingival margins of abutment crowns were due to retention of plaque, especially in the subgingival area of the zinc phosphate cement between the tooth and artificial crown. These areas are regularly covered by bacterial plaque harbored in the porosities of the cement or in the spaces that may be present after cementation (Waerhaug, 1960). This roughened surface of exposed zinc phosphate between the crown margin and the tooth may amount to several square millimeters (Silness & Hegdahl, 1970). Not only is the complete removal of the plaque from the porosities and spaces impossible, but soft deposits may also remain undetected on clinical examination.

REMOVABLE PARTIAL DENTURE RESTORATIONS

Finally, the effect of partial dentures on gingival health must be considered. Bergman, Hugoson & Olsson (1971) conducted a two-year study on the effect of removable partial dentures and artificial crowns on the periodontium. Results showed that while gingival inflammation was slightly higher when crown margins were placed subgingivally as opposed to supragingivally, no significant deterioration was found in the clinical periodontal status of remaining teeth in patients wearing properly designed partial dentures compared to the control group without partial dentures. The authors emphasized that the partial dentures in this study were carefully constructed to keep denture material, clasps, bars, and artificial teeth as far away from the gingival margin as possible.

It is interesting to note that mobility of abutment teeth in the group wearing partial dentures decreased over the two-year period.

Results of this study would seem to contradict reports by others that partial dentures frequently damage biological tissues and may produce periodontal lesions (Carlsson, Hedegärd & Koivumaa, 1965). The main differences implemented in this investigation were thorough preprosthetic preparation of soft tissue as well as careful postinsertion follow-up.

CONCLUSIONS

1. The gingival margins of all restorations should be kept well above the gingival crest where possible. Factors that may preclude this

practice include the extent of the original caries or of the original restoration, esthetic considerations, or retention requirements. When subgingival margins are indicated, the ideal location would seem to be just below the crest of the gingiva. This allows space for a healthy epithelial attachment and for efficient cleaning of the sulcus (Fig 5).

2. As margins of restorations approach the gingival sulcus, care must be taken to ensure that the contours of the restorations do not impinge on healthy gingiva or do not interfere with good oral hygiene. Excess bulk in cervical contours is the most common error of this type (Fig 6).

3. In the event that subgingival margins are necessary, much attention must be devoted to obtaining the most well-adapted and highly polished margin possible. More research aimed at refining clinical techniques for finishing restorations is needed, particularly as it pertains to proximal amalgams and composites.

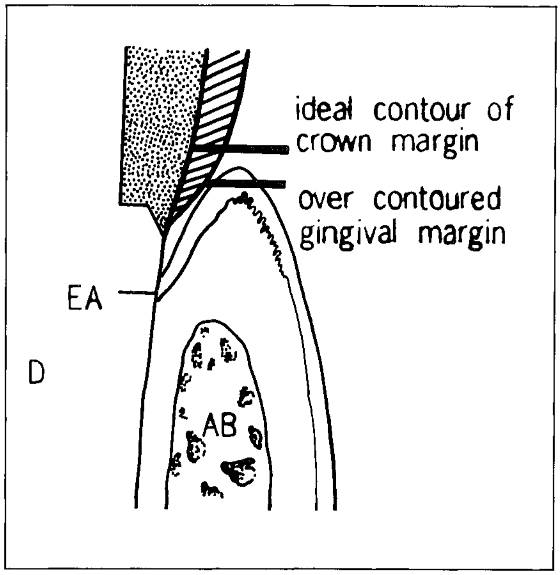

FIG 6. The ideal gingival contour of the subgingival crown margin promotes the opportunity for adequate oral hygiene by the patient. The overcontoured gingival margin impinges on healthy tissue and impedes plaque removal.

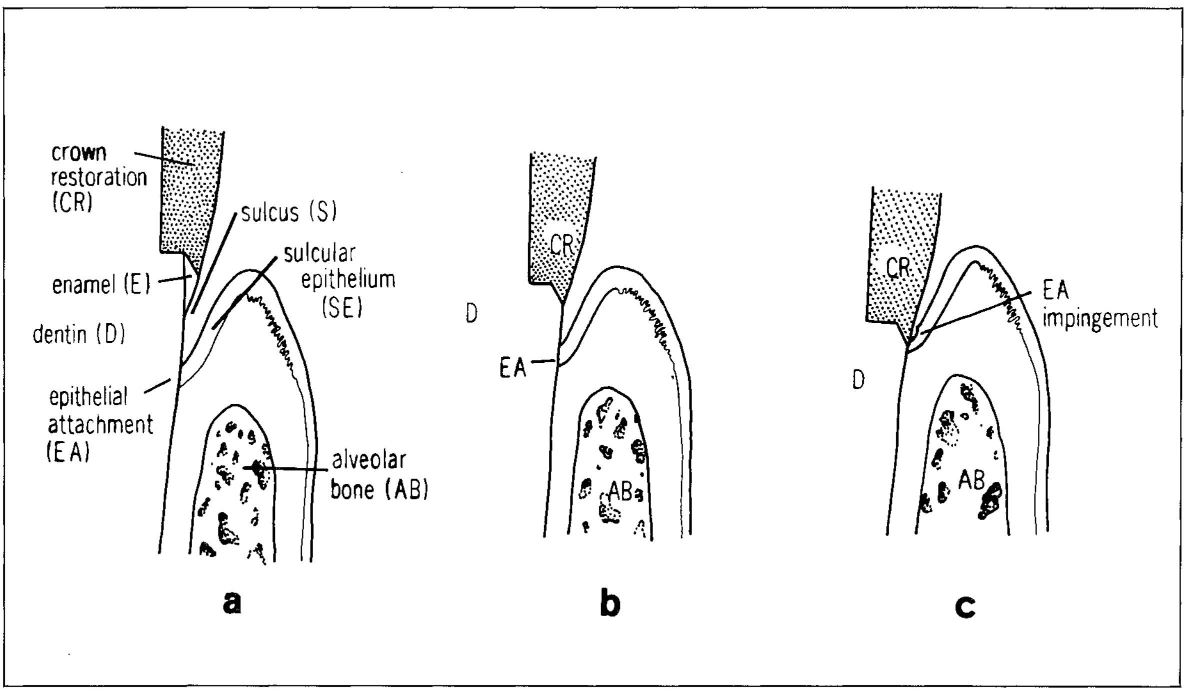

FIG 5. (a) Ideal location for margin. (b) Acceptable relationship of margin, epithelial attachment, and alveolar crest for subgingival margins. (c) Crown margin impinging on epithelial attachment and alveolar bone—a relationship that will certainly lead to future periodontal breakdown.

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(Accepted 5/15/78)

ORIGINAL ARTICLES

Wetting Properties of Sealants and Glazes

Sealants and glazes have the properties necessary for good penetration of etched enamel.

P L FAN • W J O'BRIEN
R G CRAIG

Summary

Contact angles on etched human enamel and glass were determined for Adaptic Bonding Agent, Adaptic Glaze, Concise Enamel Bond, Delton, and Nuva Seal. The sealants that are accelerated by chemicals (Adaptic Bonding Agent, Adaptic Glaze, Concise Enamel Bond, and Delton) wet enamel completely, their contact angles on glass being approximately 15°. The sealant accelerated by ultraviolet light (Nuva Seal) wet enamel and glass about equally but less than did the chemically accelerated materials, the contact angles being about 30°. Penetration coefficients for these materials against enamel were calculated from these data. The coefficients averaged 9% higher than those measured when glass capillary tubes were used but the relative values remained the same. This justifies the use of glass capillary tubes in measuring the penetrativity of sealants.

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Introduction

Pit and fissure sealants are used to prevent caries. The effectiveness of a sealant depends on its ability to penetrate narrow crevices. Adhesion of a sealant results from its penetration of the rough surface of etched enamel to form tags on polymerization. Penetrativity and adhesion are enhanced when the sealant wets the surface well. The ability of a sealant to wet a surface is indicated by a contact angle, a low contact angle indicating good wetting. Penetrativity of sealants has been evaluated on glass (Fan, Seluk & O'Brien, 1975; O'Brien, Fan, & Apostolides, 1978). The penetrativity of sealants on human tooth enamel can be obtained by comparing contact angles with those on glass. The purpose of this study was to de-

Table 1. Sealants, Glazes, and Bonding Agents for which Contact Angles Were Determined

Product	Accelerator	Manufacturer
Adaptic Bonding Agent	chemical	Johnson and Johnson East Windsor, NJ 08520, USA
Adaptic Glaze	chemical	Johnson and Johnson East Windsor, NJ 08520, USA
Concise Enamel Bond	chemical	3M Company St Paul, MN 35101, USA
Delton	chemical	Johnson and Johnson East Windsor, NJ 08520, USA
Nuva Seal	ultraviolet light	LD Caulk Company Milford, DE 19963, USA

termine the wetting properties of sealants on human tooth enamel and glass by measuring contact angles.

Materials

Four sealants accelerated by chemicals and one accelerated by ultraviolet light were used in this study and are listed in Table 1. Human incisors with smooth plane surfaces were selected. The enamel surfaces were etched with the etchant supplied with the sealant to be studied. Surfaces of clean cover glasses (Scientific Products, McGraw Park, IL 60085, USA) were used for comparison.

Method

The drop profile method was employed for measuring contact angles. The sealants with chemical accelerators were mixed according to manufacturers' instructions. The sealant accelerated by ultraviolet light was used after the addition of an activator and was illuminated by an ultraviolet light (Spectroline B-100, Spectronics Corp, Westburg, NY 11590, USA) immediately after the drop had been applied. A drop of sealant was placed on a surface in an environmental chamber for measuring contact angles (Rame-Hart Inc, Mountain Lakes, NJ 07046, USA). Contact angles were measured with the surface tilted at 0° and at 15°. The latter angle was used for measuring advancing and receding contact angles. The contact angles were measured from photographs. Four or more separate drops were evaluated for each experiment.

Results and Discussion

Profiles of drops of Delton and Nuva Seal on etched human enamel and glass are shown in Figure 1. Contact angles of sealants on enamel and glass are shown in Table 2.

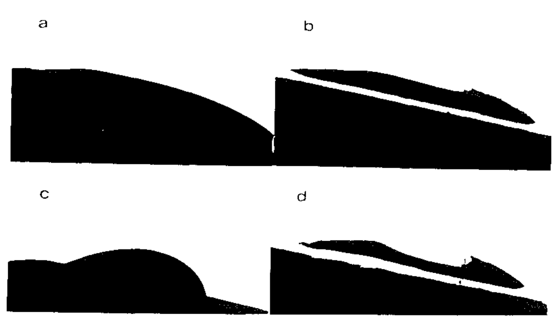

FIG 1. Drop profiles of sealants. Delton on enamel (a) and on glass (b). Nuva Seal on enamel (c) and on glass (d).

Table 2. Contact Angles of Sealants, Glazes, and Bonding Agents on Enamel and Glass

Material	Enamel			Glass		
	θ_A	θ_R	$\overline{\theta}$	θ_A	θ_R	$\overline{\theta}$
Adaptic Bonding Agent	0	0	0	25	8	15
Adaptic Glaze	0	0	0	24	15	19
Concise Enamel Bond	0	0	0	19	10	14
Delton	0	0	0	28	13	14
Nuva Seal	42	23	28	32	20	30

θ_A = advancing, θ_R = receding, $\overline{\theta}$ = horizontal

The values of advancing contact angles at different times for Delton and Adaptic Glaze are shown in Figure 2. The time taken by Delton to reach a constant contact angle was 10 seconds and that for Adaptic Glaze 30 seconds.

Chemically activated sealants exhibit contact angles of 0° on etched human enamel, indicating complete wetting; glass surfaces are not wet as well by these sealants as indicated by higher contact angles. The sealant accelerated by ultraviolet light (Nuva Seal) wet both glass and enamel less than the chemically activated materials as indicated by higher contact angles.

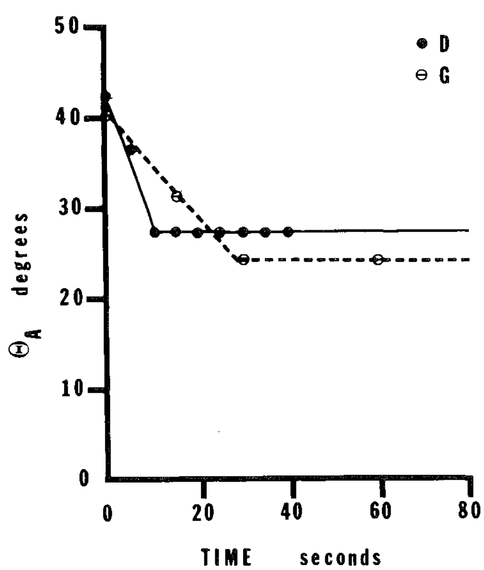

FIG 2. Advancing contact angles vs time for Delton (D) and Adaptic Glaze (G).

The difference in wetting properties of the two types of sealant may be explained by the differences in their chemical composition. In general, a sealant consists of a bis-GMA polymer, a diluent of methyl methacrylate or glycol dimethacrylate, an accelerator, and an activator. In chemically accelerated sealants, the amine accelerator and the peroxide initiator are in separate parts of a two-part system. The contact angle of each part of the sealant system on enamel is 0°. The wetting property of these sealants is not likely due to the amine accelerator.

The contact angle affects the penetrativity of a sealant. The ability of a sealant to penetrate a capillary is indicated by a penetration coefficient (PC):

$$PC = \frac{\gamma \cos\theta}{2\eta}$$

where γ is the surface tension of the sealant, η the viscosity, and θ the contact angle. Penetrativity of sealants in etched enamel can be obtained from penetration coefficients measured in glass capillaries by using the equation:

$$PC_{enamel} = PC_{glass} \frac{\cos\theta \text{ enamel}}{\cos\theta \text{ glass}}$$

Penetration coefficients of the sealants on enamel were calculated by using this equation with the penetration coefficients previously obtained on glass (O'Brien, Fan & Apostolides, 1978) and the value of the contact angles listed in Table 2. These calculated values are given in Table 3 and are all slightly higher with an average difference of 9%. The higher values for the penetration coefficients calculated for enamel are to be expected since the sealants wet enamel better. The close agreement between the values of the penetration coefficients for enamel and glass justifies the use of glass capillary tubes for performing these measurements. Furthermore the ranking of the values of the penetration coefficients of the materials is the same for glass and enamel.

Contact angles measured by this method are lower than dynamic contact angles. The dynamic contact angle has been shown to in-

Table 3. Penetration Coefficients of Five Commercial Materials on Dental Enamel and Glass

Material	Penetration Coefficients		
	Enamel cm/s	Glass cm/s	Difference %
Adaptic Bonding Agent	12.8	11.5	11.30
Delton	10.0	8.8	13.64
Concise Enamel Bond	4.8	4.5	6.67
Nuva Seal	3.0	2.9	3.45
Adaptic Glaze	0.62	0.57	8.77

crease with velocity, eventually reaching a steady state at high velocities (Elliott & Riddiford, 1962; Rose & Heins, 1962).

The rate of spreading of Delton was greater than that of Adaptic Glaze as shown by the change in contact angles with time. Delton reached a constant contact angle sooner than did Adaptic Glaze. Spreading of a liquid drop involves the same properties as penetrativity—surface tension, viscosity, and contact angle (Van Oene, Chang & Newman, 1969). In all cases, the constant values of contact angles were reached before solidification.

Conclusion

Wetting properties of sealants on enamel and glass were studied by measuring contact angles. The contact angle on human enamel was 0° for all chemically accelerated sealants. The sealant accelerated by ultraviolet light had a higher contact angle. The rate of spreading of a drop of sealant on a surface depends on the same characteristics as does penetrativity. Higher penetrativity is associated with a faster rate of spreading. The penetration coefficients for the sealants on enamel were calculated using the values for the contact angles and were an average of 9% higher than those on glass, without any change in the ranking of the values. Therefore, the method of using the glass capillary tube for determining penetration coefficients of sealants is justified as a reasonable estimate of the value on enamel.

This study was supported by Research Grants DE 03480 and DE 02731 from the National Institute of Dental Research, National Institutes of Health, Bethesda, MD 20014.

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(Accepted 4/19/78)

OPERATIVE DENTISTRY, 1979, 4, 104-107.

Effect of Die Relief on Retention of Cast Crowns and Inlays

Providing space for cement by applying die spacer to the die does not diminish the retention of full crowns and inlays

JOHN H HEMBREE, JR • ERNEST W COOPER, JR

Summary

When a die spacer, Tru-Fit, was applied to preparations for crowns and inlays on extracted teeth, the retention of the castings, whether cemented with zinc phosphate, polycarboxylate, or EBA cement, was similar to that obtained when no die spacer was used.

INTRODUCTION

A prime objective in constructing cast crowns and inlays is to have the casting fit the prepared tooth perfectly. This poses a problem, however, because the closer the casting fits the tooth the more difficult it is for the cement to escape from between the tooth and the casting (Jones, Dykema & Klein, 1971); hydraulic pressure created within the cement prevents the crown from seating properly (Dimashkieh, Davies & von Fraunhofer, 1974). Many clinicians recommend perforating or venting the occlusal surface of cast restorations to permit the escape of excess cement and reduce the hydraulic pressure during seating (Jones & others, 1971; Dimashkieh & others, 1974; McCune, 1968; Cooper, Christensen & Laswell, 1971). Other clinicians have advocated the use of die spacers to accomplish the same result (Fusayama, Ide & Hosoda, 1964; Eames & others, 1978). A recent report indicates that besides improving marginal integrity, die spacing provides retention 25% better than when stress areas are not relieved (Eames & others, 1978).

The purpose of this study was to compare the retention of cast gold inlays and crowns when stress areas were relieved and when they were not. For luting agents we used a zinc phosphate cement, an ethoxybenzoic acid (EBA) cement, and a polycarboxylate cement.

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MATERIALS AND METHODS

Ten extracted maxillary molar and ten maxillary premolar teeth were selected as test specimens. The roots of each tooth were notched

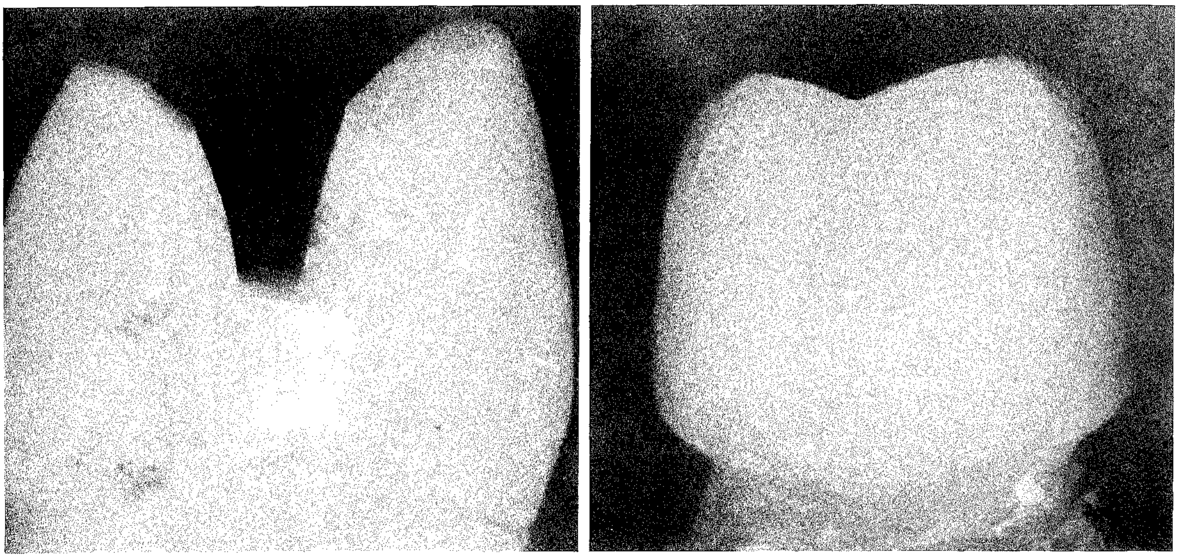

FIG 1. MOD inlay preparation and full crown preparation

with a carborundum disc and each tooth was then embedded in an autopolymerizing acrylic (Duralay, Reliance Dental Mfg Co, Worth, IL 60482) leaving the crown exposed. The molar teeth were prepared for full crowns and the premolars for MOD inlays (Fig 1). The preparations were made to resemble each other as closely as possible.

A Type II, Class I inlay casting wax (Kerr Blue Inlay Wax, Kerr Mfg Co, Romulus, MI 48174) was used to fabricate wax patterns directly on each crown and inlay preparation. Each pattern was invested in vacuum with Cristobalite casting investment (Whip-Mix Corp, Louisville, KY 40217) and allowed to set on the bench for 30 minutes. The wax patterns were placed in a burn-out oven for 1 hour at 900 °F (482 °C). The molds were cast in a Type III gold (Firmilay, J F Jelenko & Co, New Rochelle, NY 10801). The castings were then fitted to their respective preparations. These castings acted as controls since they were constructed to fit the prepared teeth as intimately as possible.

The three cements used in the study, and their liquid/powder ratios, are listed in the table. All cements were mixed as outlined by the manufacturer. Each casting was cemented to the preparation with one of the cements. The type of cement was selected randomly un-

Cements in the Study

Cement	Manufacturer	Liquid ml	Powder gm
Zinc phosphate (Flecks)	Mizzy Inc	1.0	2.0
Polycarboxylate (Durelon)	Premier Dental Products	1.0	0.2
Ethoxybenzoic acid	Codesco, Inc	0.5	1.2

til each casting had been cemented with all three cements. During cementation each sample was placed in the Instron Universal Testing Instrument operating in a compressive mode with a crosshead speed of 0.02 in min^{-1} (0.51 mm min^{-1}). Each specimen was subjected to a pressure of 20 lbf (88 N) maintained for 10 minutes. The specimen was removed from the Instron and allowed to set on the bench for a minimum of 30 minutes. The excess cement at the margins was removed with a sharp instrument. The specimens were allowed to set in tap water at 37 °C for 24 hours before testing.

Each specimen was placed back in the Instron, but this time in the tension mode, operating with a crosshead speed of 0.02 in min^{-1} (0.51 mm min^{-1}). The maximum force required to remove each casting from its preparation was determined and recorded.

After removal of the casting any remaining cement was first removed from the preparation with a sharp instrument and then by placing the tooth in an ultrasonic cleaner.

Each casting was cleaned by soaking in hydrofluoric acid to remove any remaining cement. All castings and preparations were washed and dried before cementation with another cement.

The second part of the study was accomplished with the use of a die relief material (Tru-Fit, George Taub Products, Jersey City, NJ 07307). Four coats of Tru-Fit were applied to each tooth with a drying interval of 1 minute between coats. The die relief was applied to within approximately 1 mm of the cavosurface angle of the preparation (Fig 2). In a clinical situation the die relief material would be applied to a gypsum die, but in this study, to eliminate the variables of impressions and dies, the die relief was applied to the natural tooth.

The construction of the castings, their cementation, and the method of testing were the same for the die relief specimens as for the controls. All of the data were collected, averaged, and subjected to a standard *t* test.

RESULTS AND DISCUSSION

Crowns

The results are shown in Figure 3. It can be seen that the retentive strengths of the zinc phosphate cement and of polycarboxylate ce-

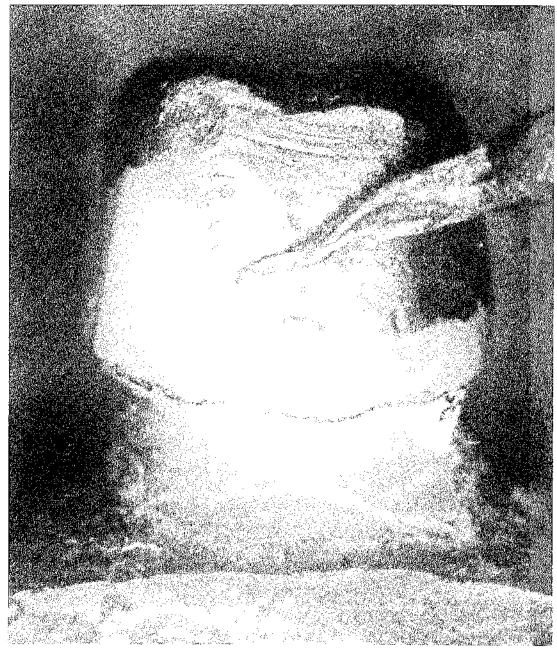

FIG 2. Application of die spacer on a full crown preparation

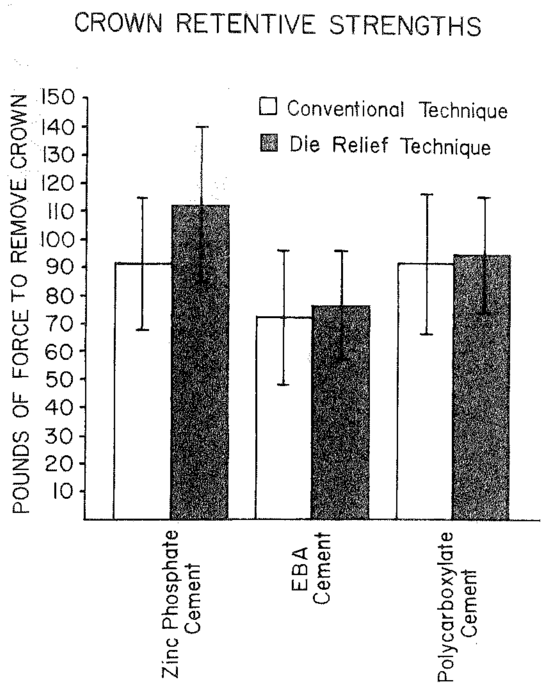

FIG 3. Graph of results of full crown portion of study

ment were higher than that of EBA cement, with either the conventional technique or the die relief technique. The differences in retention between the conventional technique and the die relief technique, however, are not statistically significant.

Inlays

It can be seen from Figure 4 that when used to cement MOD inlays made with either conventional or die relief technique, zinc phosphate cement and polycarboxylate cement

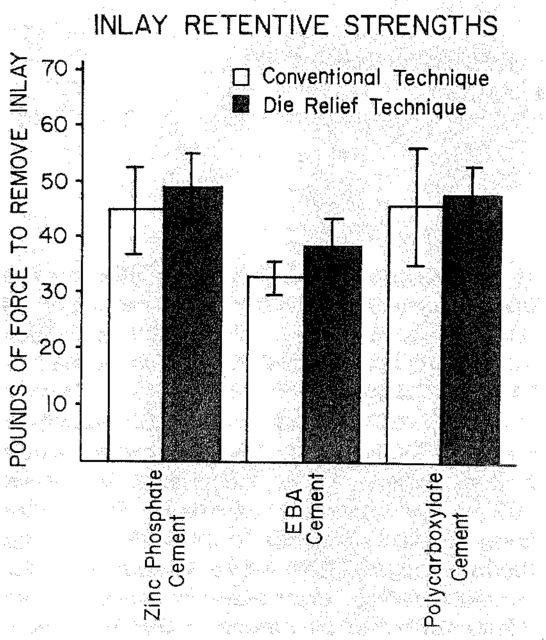

FIG 4. Graph of results of inlay portion of study

again show greater retentive strengths than does EBA cement. The only cement demonstrating a statistically significant difference in retention between the conventional technique and the die relief technique is EBA, which shows increased retention with die relief.

From Figures 3 and 4 one can see that the standard deviation is much greater for the full crown preparations than for the MOD inlay preparations. This might suggest that it is more difficult to standardize preparations and casting technique for full crowns than for MOD inlays. In addition, it can be seen that a full crown has approximately twice as much retention as does an MOD inlay.

CONCLUSIONS

This study has demonstrated that relieving dies does not sacrifice any cementing retention when the technique is used on either a full crown or an MOD inlay. Statistically, the only significant increase in retention was found in the EBA cement and the MOD inlay preparations. Therefore, clinically, the increase shown with the various cements probably is not significant.

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(Accepted 5/26/78)

OPERATIVE DENTISTRY, 1979, 4, 108-112.

DENTAL PRACTICE

Management of Proximal Caries on the Roots of Posterior Teeth

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Summary

Caries on the proximal surfaces of the roots of posterior teeth, now found frequently due to longer retention of teeth, may be treated by placing amalgam in a cavity prepared from either the facial or lingual aspect or by using an onlay.

INTRODUCTION

Most people, as a result of improved methods of dental treatment and the practice of preventive dentistry, expect to retain their teeth throughout life. As a result, more carious lesions on cemental surfaces are observed (Banting & Courtright, 1975; Banting & Ellen, 1976; Del Regato, 1939; Hazen, Chilton & Mumma, 1972, 1973; Hix, 1975; Jordan & Sumney, 1973; Mills, 1881; Schamschula, Keyes & Hornabrook, 1972; Sumney, Jordan & Englander, 1973; Westbrook & others, 1974). The literature expresses the frustrations of past clinicians in attempting to treat these problems. The same frustrations afflict current practice. The pattern of caries on roots differs from that on crowns in that the lesions are excavations without distinct boundaries. The restorations are sensitive to thermal changes and caries tends to recur. This article will outline causes of this carious problem and present methods of restoring these defects.

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CERVICAL LESIONS

The patient with numerous cervical lesions is not a good candidate for a conservative approach to restorative dentistry. The basis of success for conservative restoration is good oral hygiene established by instruction and routine prophylaxis. Periodontal surgery may be required to simplify the home care regimen of some patients. In spite of good care some patients may develop isolated cervical lesions. As a result of proximity to the pulp these lesions frequently require emergency care.

Predisposing Factors

The predisposing factors may be divided into two general groups:

Factors directly related to anatomy

- Malocclusion
  - Drifting—bodily movement in any direction
  - Tipping
  - Plunger cusp
  - Supraeruption
  - Iatrogenic factors
- Tooth Morphology
  - Broad, heavy, or no contact area
  - Excessive cervical constrictions

General factors which are of concern to the patient

- Habits
  - Dietary, for example, increased consumption of carbohydrates
  - Toothpick habits
- Dysfunction of motor skill, for example, Parkinsonism, old age
- Radiation caries—secondary to xerostomia
- Drug-induced factors, for example, xerostomia, sodium dilantin therapy

Diagnosis

Caries on the proximal surfaces of roots cannot always be detected with ease by clinical examination. Accurate interpretation of radiographs is important because this lesion is often overlooked or misdiagnosed as cervical radiolucency or "burnout." Radiographic contrast, always desirable on the film, may be accomplished by varying the KVP.

The caries may be apical to an existing restoration and may or may not communicate with it; or the caries may be at or apical to the cemento-enamel junction, with no proximal restoration of the tooth. The location and extent of the lesion will help determine which of the available materials should be chosen for the restoration. Dental amalgam is most commonly selected, the remaining lesions being treated with resin or castings and on occasion some of the accessible lesions restored with direct gold.

If a posterior tooth has no restoration, or only an occlusal restoration, but has a cervical lesion, then a horizontal (or faciolingual) slot type of preparation for dental amalgam is the best option. When caries occurs apical to the cemento-enamel junction and connects with an existing defective restoration, a cast gold restoration is frequently the treatment of choice. If the caries is adjacent to a sound amalgam restoration the new preparation will extend into the existing restoration and will be the same as an amalgam repair.

THE AMALGAM RESTORATION

The amalgam restoration serves well where the lesion is 2–3 mm from any existing restoration (Fig 1A). An appropriate rubber dam clamp is selected and a heavy dam is applied. A suitable rubber dam clamp is placed on the tooth distal to the one being restored. If, however, the clamp must be placed on the tooth with the lesion, an SSW 207 (S S White, Philadelphia, PA 19102, USA) or Ivory 2A (Ivory/Eastern, Philadelphia, PA 19135, USA) may be useful. The amount of rubber dam placed interproximally often is greater than normal to displace the interdental papilla cervically to allow observation of and access to the lesion.

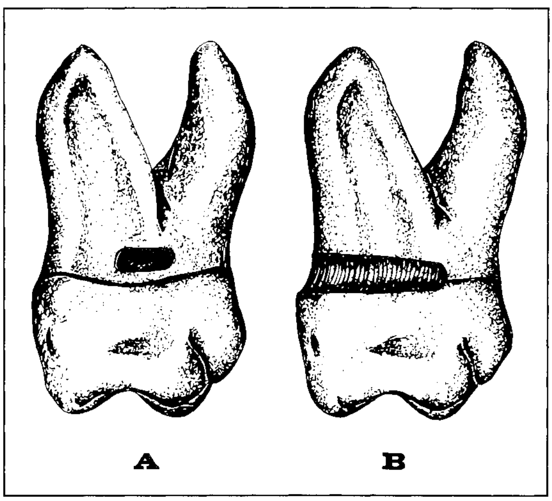

FIG 1. A. Caries located interproximally and cervical to the cemento-enamel junction. B. Initial facial access created by a 170 bur.

Preparation of Cavity

When preparing a cavity for a cemental lesion on a proximal surface the easiest and most direct way of reaching the area with burs and instruments must be determined. For most teeth the direct path will be from the facial. For some teeth, primarily in the upper arch, the lingual location of the caries or the rotation of the tooth makes the lingual approach best (Fig 1B).

With a 170L bur the initial outline is formed by guiding the bur perpendicular to the long axis of the tooth until the bur drops into the lesion. The preparation is cut into the form of a slot (Fig 2A). The resultant preparation is larger at the facial or lingual opening and tapers toward the area opposite the entry point (Figs 1 & 2). This provides convenience form for condensing the amalgam.

Following removal of caries with a round bur or by hand excavation, an undercut is made to ensure retention (Fig 2B). This undercut may be formed with a smaller tapered bur (169L) moving in an occluso-cervical direction. The undercuts are the most definite at the more remote portion of the preparation.

If room allows, these preparations should be lined with an intermediate material such as calcium hydroxide or zinc oxide and eugenol. Following placement of these materials the remaining dentin and enamel should be coated with a copal varnish. If possible the varnish should not be placed directly on the base or at least the amount should be minimized. If no cement base or liner is used the enamel and dentin should always be coated with a copal varnish.

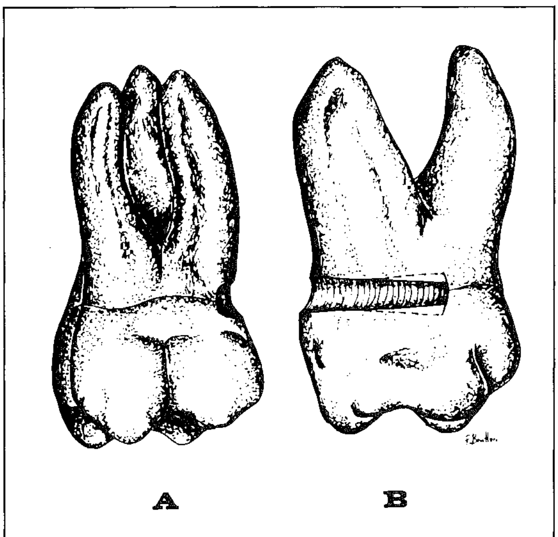

FIG 2. A. Facial view of the slot preparation. B. Completed preparation indicating lingual extension and location of retention.

Matrix

A thin metal matrix, .015 inch, is cut and formed to be placed between the preparation and the adjacent tooth. A matrix retainer is of no value unless the preparation opens through the occlusal. The segment of matrix band is secured in position by wedging against the next tooth (see Fig 3). A wedge of proper size is selected to avoid having the band encroach on the preparation. The wedge may require contouring to provide the best stability to the matrix. Adequate placement of the wedge will prevent gross excess of amalgam from extruding through the remote margins of the preparation. The greatest concern is that the gingival margin be smooth.

Insertion and Finishing of Amalgam

The amalgam is condensed as far as possible in a conventional manner. The size of the condenser must allow for convenience and

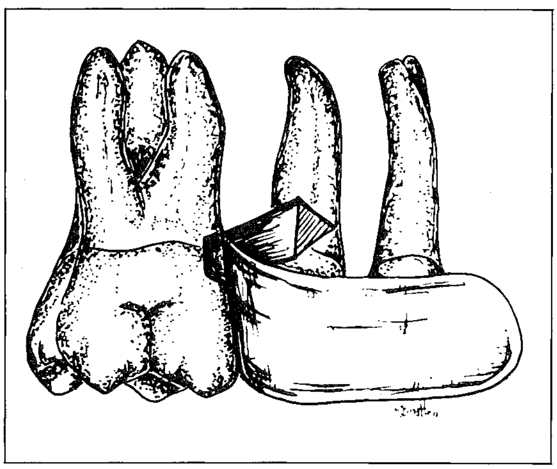

FIG 3. A contoured matrix wedged for condensation of amalgam

accuracy of condensation. After removal of the matrix the obvious flash is removed with thin interproximal carvers (American Dental Mfg Co, Missoula, MT 59806, USA) following which selected carvers are used to complete the restoration. Dental floss is passed carefully through the contact and over the surface to remove any amalgam flash. If a high-copper dental amalgam is used it may be burnished with a smooth metal instrument to provide a smooth restored surface. The metal surface is polished with any of the commonly used technics for finishing, the simplest being recommended. The available selection of instruments includes finishing burs, rubber polishing cups and points, abrasive and fine polishing powders, and linen strips. Linen strips are effective for some of the interproximal restorations (Moyco Industries, Inc, Philadelphha, PA 19132, USA).

CAST GOLD RESTORATION

A casting is recommended as a replacement when an existing amalgam is large and defective and the casting would provide the most stability. On occasion it is easier to make a preparation for a casting than for an amalgam.

Prior to preparation the occlusion of the patient must be observed and any discrepancies noted in centric and lateral movements. It is best to adjust any occlusal disharmony, but in no case should the existing problems be accentuated.

The patient should be apprised of the projected esthetics. In some instances this may lead to crowns with ceramic or resin on the facial aspect. In the best interest of the patient function must be considered more important than esthetics.

Preparation of Cavity

The preparation should be achieved as simply as possible but should assure the stability of the restoration. All the occlusal surface should be included within the preparation. This includes all variations from a two-surface onlay to a full crown. The preparation should include the carious areas and then be limited to just enough additional axial surface needed for stability of the casting (Figs 4–6). Where

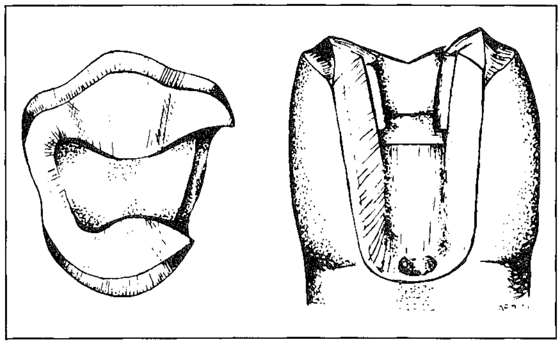

FIG 4. The walls of the preparation are formed with a 170L bur and hand instruments while the chamfers are made with tapered diamonds.

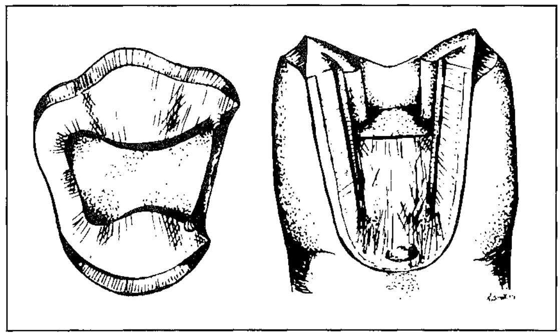

FIG 5. Axial resistance improved by using tapered proximal grooves

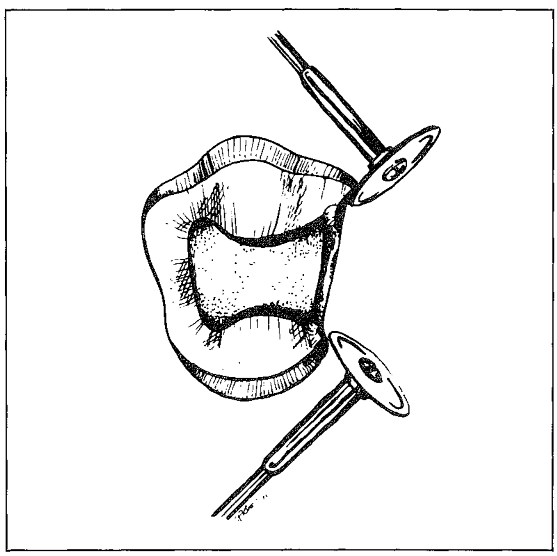

FIG 6. Paper discs are used to smooth the proximal flares.

possible the margin of the restoration should be left exposed or above the gingiva for ease of finishing and for easy maintenance by the patient.

CONCLUSIONS

- The frequency of root caries increases as patients grow older and is related to recession of the gingiva.
- Treatment for caries 2–3 mm gingival to the cervical line or existing restoration may be achieved using a faciolingual slot type of amalgam restoration.
- If the root caries is adjacent to an existing interproximal restoration that is defective, a casting may be the restoration of choice. If the stated restoration is stable an amalgam repair is advocated.
- Conservative principles must be used as guides to the preparation though they may be difficult to follow.

The illustrations are provided by Robert Bratton, DDS, Indiana University School of Dentistry.

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(Accepted 10/12/77)

OPERATIVE DENTISTRY, 1979, 4, 113-117.

Visual Aids for the Dentist

Good vision is required for many of the procedures of restorative dentistry. Adequate illumination and magnification with a binocular loupe enhance the visual acuity of the dentist.

NORMAN C FERGUSON

Summary

A source of light that is sufficiently intense and contains all the colors is needed to illumine the mouth when the dentist is operating on teeth or selecting shades. Such lights are available. A slight magnification, as obtained with a binocular loupe, also enhances visual acuity.

INTRODUCTION

The advent of the high-speed handpiece, with its rapid cutting and lack of tactile sense, has increased the demands on the eyesight of the dentist. The higher standards of esthetics of the new era of porcelain have added further complications. Although training will increase the accuracy of vision, it is now necessary to review the aids to vision that are available and to suggest their best use.

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LIGHTING

Intensity

The intensity of the light must be adequate not only to see small objects but also to choose colors, because the human eye loses its sensitivity to blue and red as the intensity of the light decreases. In addition, one must be aware that magnification requires the intensity of the source of light to be increased by the same factor as the magnification to maintain the same intensity of illumination.

Quartz-halogen lamps produce a very intense light, aiding visual acuity in the mouth, but contrast causes eyestrain and the general level of illumination should be increased in the same proportion when these lights are installed. A high general level of illumination will cause the iris to contract, thus increasing the depth of focus of the eyes and lowering the need for auxiliary lenses.

Man is a daylight animal and a light level of 1,000–5,000 foot-candles (10800–43800 lx)—porch or open shade on a sunny day—seems to be a most comfortable level of light for reading and examining small objects. Dental office light of 250 foot-candles (2700 lx) at the bracket table cannot be considered excessive (Ferguson, 1969). The color of the walls should be light and neutral so as not to modify the color and intensity of the illumination.

Color

If colors are to be chosen, the light must contain all colors of the materials to be matched. Most fluorescent tubes are notoriously deficient in the output of red and high in yellow and blue. As a result, a pink or orange tone may appear gray under fluorescent light, making a color match impossible. Full spectrum fluorescent tubes, whose light approximates the spectrum of north sky daylight, are available and solve the problem very well.

One should be aware, however, of the effect of metamerism—that is, two colors may appear the same under one light source but a change of light source will destroy the color match. Therefore, when selecting a shade, a mixture of fluorescent and incandescent lighting should be used. The incandescent lamp should be swung on and off the subject to check the effects of metamerism.

AUXILIARY LENSES

Young, normal eyes are capable of changing the refractive power of the lens and unaided can serve the dentist in all but the very finest work. Eyes that are myopic (short-sighted) require negative lenses and hyperopic (long-sighted) eyes require positive auxiliary lenses to correct the distance of critical focus to the normal working range. The young eye is sufficiently flexible to focus over an adequate range. Magnifying loupes are required for only the finest detail. Astigmatism in the young may require glasses, but the focusing range remains adequate.

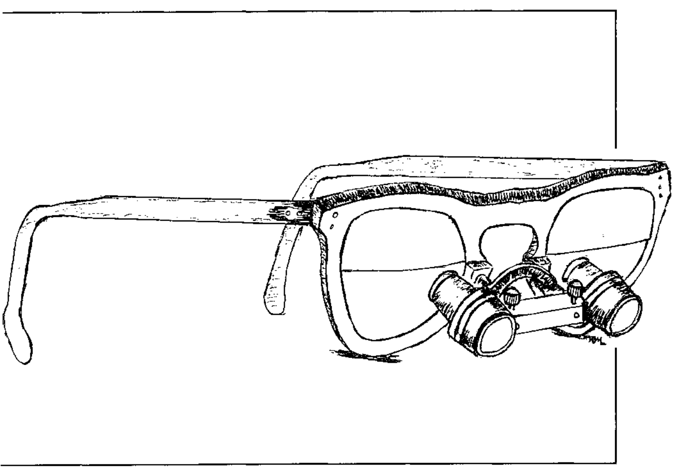


FIG 1. First style of loupe: small Galileo telescopes that sit against the eyeglasses

At about age 40, the ability of the lens to accommodate to shifting focal distance will have decreased so that glasses become necessary. Because the distance of critical focus becomes greater, the myopic dentist may require less negative correction and the hyperopic more positive correction.

The corrective power of lenses is measured in diopters, which is the reciprocal of the focal length in meters. A lens of +1 diopter has a focal length of 1 meter, a +5 diopter lens has a focal length of 1/5 meter. Bifocal or trifocal lenses may be required to allow adequate focus at different ranges. For the long-sighted dentist, it is possible to increase the power of the reading portion of the bifocal lens by decreasing the focal length, thus increasing the magnification but shortening the working distance. This has the effect of a magnifying loupe but the method has all the disadvantages of a loupe mounted close to the eye. The best approach is to wear a simple lens in eyeglasses to allow general vision, supplemented by binocular loupes.

Binocular Loupes

Magnification is proportional to the product of the strength of the lens and the distance from the lens to the focal plane. By increasing the distance of the lens from the eye, within reason, we increase the magnification and shorten the object distance. This increases the magnification without the distortions and aberrations of a lens of shorter focal length—a stronger lens. The distance of the loupe from the eye also allows the dentist to look around the lens more easily, minimizing the vertigo effect of powerful lenses close to the eyes.

Available binocular loupes offer a choice among three styles. The first style (Fig 1), small Galileo (2 lens) telescopes that sit against the eyeglasses, offers the advantages of small size and convenience of transport, but suffers the disadvantages of extra cost, the extra distortions and loss of transmitted light associated with multiple lenses, frames in the line of vision, and a lack of flexibility due to lenses close to the eyes, with resultant tendency to vertigo when one is walking around.

The second type of loupe (Fig 2) consists of a pair of positive lenses on a hinged bar that attaches to eyeglass frames. Because the lenses are farther from the eyes a weaker lens can be used, which eliminates some of the defects noted above. The extension bar is relatively short so as not to make the eyeglasses unstable on the face.

The third type of loupe (Fig 3) consists of a pair of positive lenses on a hinged bar attached to a headband. This unit is bulky but it allows the ideal lens distance, maximum flexibility of vision, and minimum distortion. The headband made of metal with cotton sweat pads is more comfortable than the plastic headband with plastic sweat pads, whose wick effect in getting rid of moisture is poor.

Of the loupes with simple lenses a choice may be made between double convex (spherical) and convex-concave (meniscus) lenses. The former tend to have distracting reflections

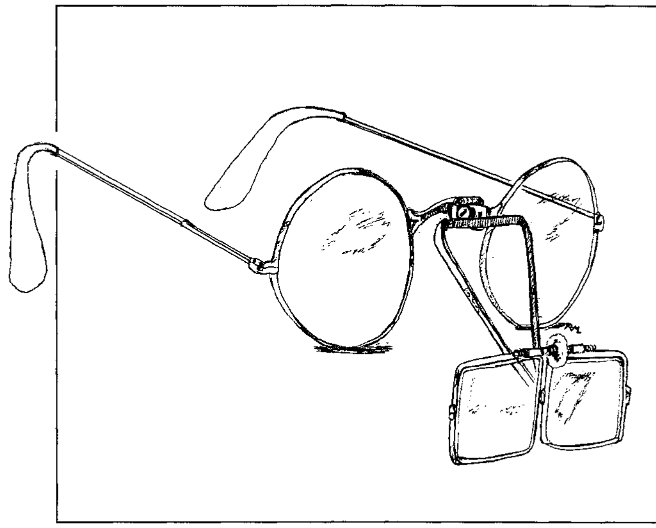
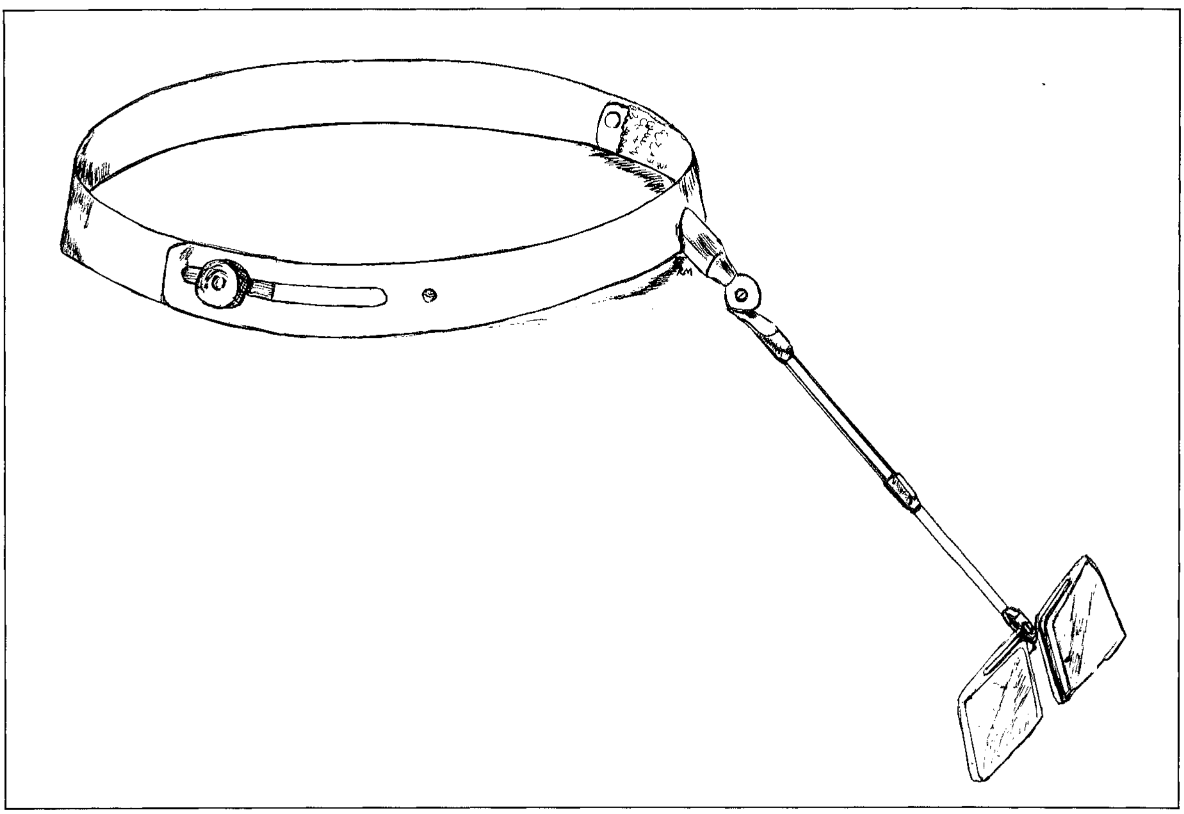


FIG 2. Second type of loupe: positive lenses on a hinged bar that attaches to eyeglass frames



Drawings by Roberta Merryman

FIG. 3. Third type of loupe: headband with positive lenses on hinged bar

from off-axis sources of light (Fig 4). These reflections can be partly eliminated by swiveling the lenses. Unfortunately this may eliminate one reflection and introduce another. The best simple lens is of the convex-concave configuration, which minimizes reflections and distortions. The two lenses should be symmetrical, ground as if they were sections of one large lens, with the central axis of each part separated by the interpupillary distance, and then the sections moved together (Fig 5).

It should be remembered that magnification reduces the depth of focus, and also, by reducing the intensity of light causes the iris to expand, further reducing the depth of focus.

DEFECTS OF THE EYE

Certain defects of the eye cannot be helped by light or lenses. A possible great handicap to a dentist is a lack of stereoscopic vision due to blindness or near blindness of one eye. The "lazy-eye" syndrome is a subtle case of the above. Afflicted people have little sense of perspective or relative distance. Unfortunately, the small sizes of objects and short distances involved, coupled with magnification, make relative sizes of objects a poor clue to relative distance in the mouth. Because the field is so small and close, movement of the head gives little aid in establishing distance. Persons with a lack of stereoscopic vision are unlikely to be happy and successful in the field of operative dentistry. They should be screened before they begin their careers.

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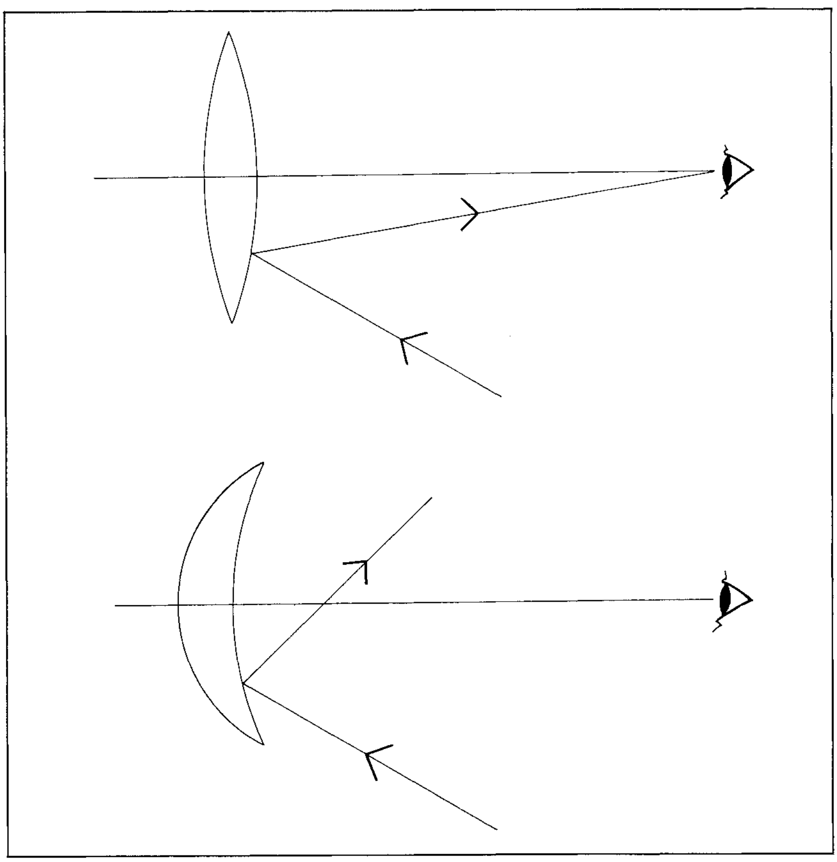

FIG 4. Because of the greater angle of incidence, light from a concave surface tends to be reflected away from the eye. Light falling on a convex surface is reflected toward the eye.

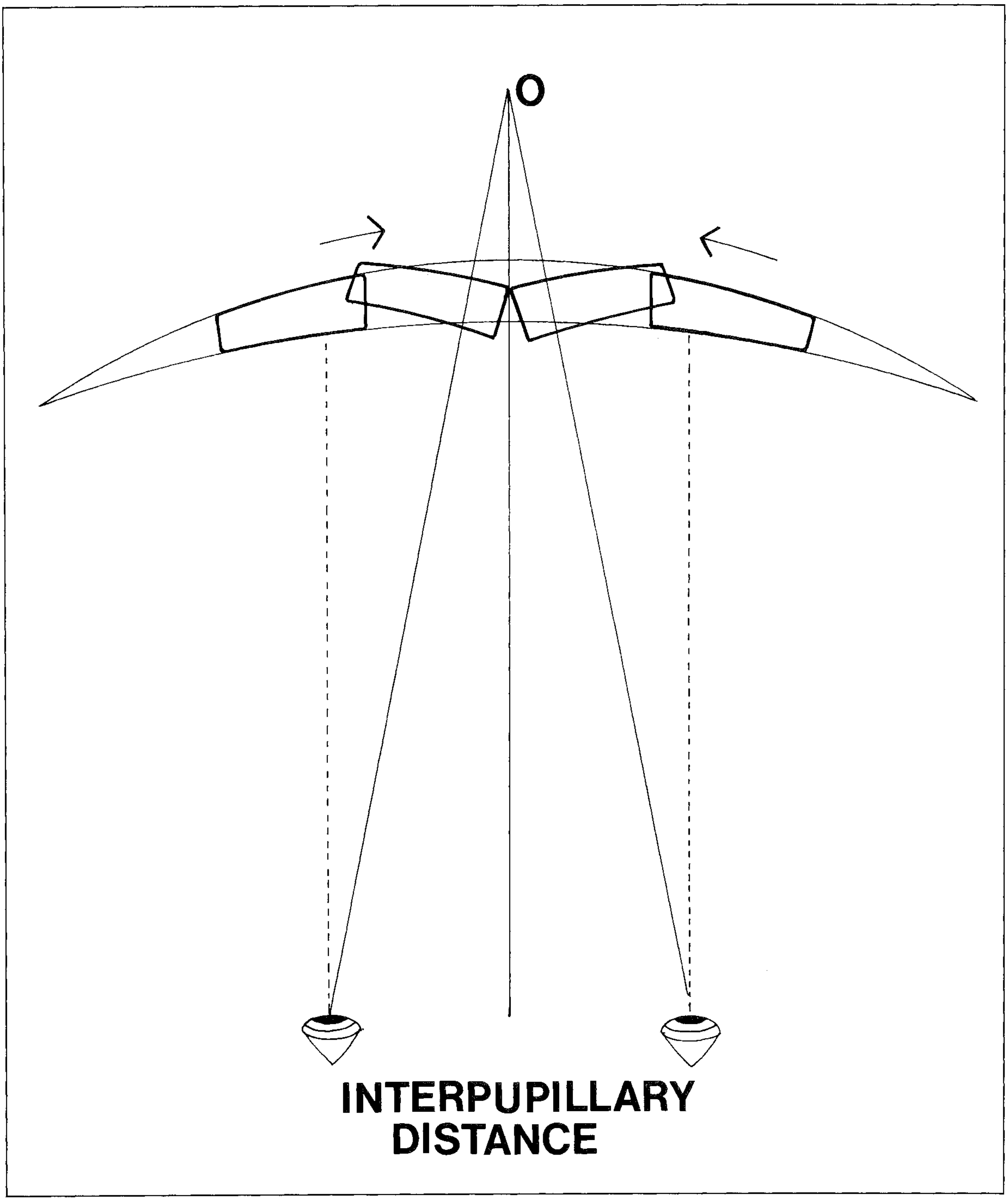

FIG 5. The lenses are ground as segments of one lens, making light paths symmetrical.

PRODUCT REPORTS

Clinical Evaluation of Cervident and Aspa in Restoring Teeth with Cervical Abrasions

When restorations are placed in cervical abrasions in which cavities are not prepared but whose surfaces are etched, about 20% of the restorations are missing at the end of two years.

MARGRIT FLYNN

Summary

Eighty teeth with cervical abrasions, in 10 patients, were restored with either Cervident or Aspa after etching the surfaces of the lesions with acid, and without preparing cavities. At the end of six months 85% of Cervident and 84% of Aspa restorations remained. This decreased to 82% of Cervident and 83% of Aspa after one year, 80% of Cervident and 80% of Aspa after two years, and 77% of Cervident after three years. The color and margins of Cervident were better than those of Aspa though the margins of Cervident discolored as a result of leakage.

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Published concurrently in the *Journal of the Academy of General Dentistry*

INTRODUCTION

For many years the treatment of noncarious lesions of the cervical regions of teeth has been a difficult problem in restorative dentistry (Fig 1). Common techniques of restoration generally employ amalgam, gold, or composite resin. Usually preparation of a cavity is required, which necessitates further removal of

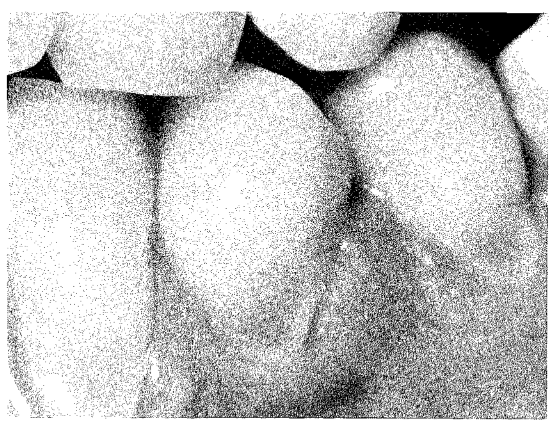

FIG 1. Typical noncarious lesions in the cervical areas of teeth

tooth structure. The recent introduction of two tooth-colored materials makes possible conservative treatment without cavity preparation. Acid etching in lieu of cavity preparation is employed to obtain adherence between the restorative material and the tooth.

The principles of acid etching and bonding to enamel have been studied, discussed, and documented extensively. Adhesion to dentin and cementum, on the other hand, is still questioned and only a limited number of clinical studies have been reported (Camara & others, 1978; Harris, Phillips & Swartz, 1974; Jendresen, 1978; Reisbick, Sellers & Shutte, 1978). The purpose of this article is to report on the performance of a composite resin, Cervident (S S White, Philadelphia, PA 19102, USA), over a period of three years and a glass ionomer cement, Aspa (DeTrey Claudius Ash, Inc, Niagara Falls, NY 14304, USA), over a period of two years as restorations for teeth with cervical abrasions.

CLINICAL PROCEDURE

Eighty noncarious lesions of the cervical region, involving areas of enamel, dentin, and cementum, in the teeth of 10 patients, were selected. Color photographs were taken of the teeth.

Wherever possible several restorations of each material were placed for each patient to provide environmental consistency and isolate the effect of the patient on the material. Contralateral teeth were selected for comparison and similar lesions were chosen. Wherever possible a rubber dam and a cervical clamp stabilized with low-fusing modeling compound were used to protect the gingiva and to avoid contamination. Conventional cavity preparation and beveling were not employed. After prophylaxis with pumice, the involved area was etched with 50% phosphoric acid for Cervident and 40% citric acid for Aspa, washed with water, and dried with air. Deep lesions were not protected with bases. Teflon-coated instruments were used to place the materials and cervical matrices applied (Cervical Matrix Forms, Premier Dental Products, Norristown, PA 19401, USA; Cervical Matrices, Amalgamated Dental, Niagara Falls, NY 14304, USA). Finishing was begun 20 minutes after the elapsed curing time for Cervident and 48 hours after placement for Aspa. Original conditions and results over time were recorded by color photographs at intervals of one week (base line examination), six months, 12 months, 24 months, and 36 months (Cervident). The properties evaluated were retention, wear and surface texture, and color match and stability.

RESULTS AND DISCUSSION

Retention

The proportion of restorations of each material retained over the experimental interval is shown in the table. Both materials exhibited losses from inadequate retention.

Since the restorations were without mechanical retention and involved areas of dentin and cementum, the high rate of failure due to loss of the two materials is not surprising. Harris & others (1974) have shown even higher rates of failure for these commercial materials employed in the restoration of class 5 abrasions without cavity preparation. Jendresen (1978) observed that 72% of class 5 restorations of Cervident placed without cavity preparation were retained at one year and 62% at three years. A similar study by Reisbick & others (1978) revealed that 73% of class 5 restora-

Retention of Cervident and Aspa

Material	Restorations Retained (%)				
	1 week	6 months	1 year	2 years	3 years
Cervident	97.5	85	82	80	77
Aspa	100	84	83	80	

tions of Cervident and 66% of Aspa were retained at the end of a year.

Discoloration of margins before loss of restorations indicates that gaps have been left between the dentin and the restorative material. Fortunately, restorations were lost before caries could develop. Because of the opacity of Aspa, marginal discoloration could not be observed. Camara & others (1978) have reported marginal discoloration for Cervident only.

Wear and Surface Texture

Both materials exhibited slight wear in the bulk of the restoration and around all margins, wear being greater in the gingival area. Wear was continuous but slow for both materials. Aspa showed more wear than Cervident, in many cases revealing small irregularities and voids (Fig 2). Abrasive brushing of teeth in some instances removed restorative material from the gingival areas. Since Cervident could be finished more easily than Aspa, restorations of Cervident were left with a smooth finish at all cavosurface margins. A smooth, featheredge could not be achieved with Aspa. The margins of Aspa deteriorated rapidly over the 24 months necessitating the replacement of some of the restorations (Fig 2). Further studies have indicated that Aspa's resistance to wear is substantially better in prepared cavities than in lesions whose only treatment is etching with acid.

Color Match and Stability

The color match of Cervident was good, that of Aspa fair. The color of Cervident was stable whereas that of Aspa displayed a change that tended to improve the color match but never equaled that of Cervident. Cervident has excellent color for canines and good color for incisors. The color of Aspa restricts its use to posterior teeth.

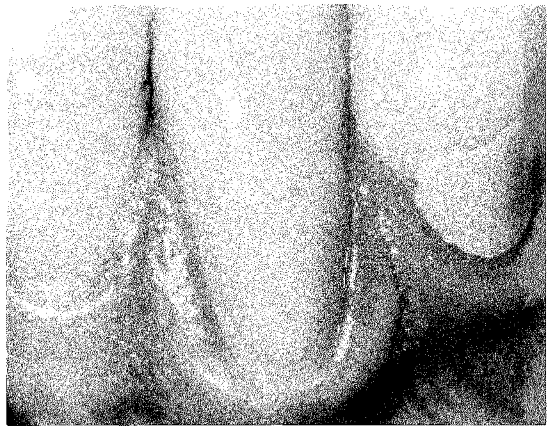

FIG 2. First premolar restored with Aspa, canine restored with Cervident, 24 months after placement

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Five Amalgam Carriers: A Comparison of Wear

WILMER B EAMES • WILLIAM H BUCK, JR

Summary

Three amalgam carriers of each of five manufacturers were tested for wear, using an abrasive slurry of 80 grit silicon carbide in lieu of amalgam, to determine accelerated wear.

The rankings of wear were uncommonly diverse and when the carriers were ranked according to resistance to wear the order was: an experimental carrier (Sultan), S S White, Pulpdent, Buffalo, and Ivory. The plunger of the Ivory wore eight times faster than the carbide steel of the experimental instrument.

This wear reflects directly upon the residual amalgam, which collects and clogs in the space between the plunger and the cylinder.

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Published concurrently in the *Journal of the Academy of General Dentistry.*

Introduction

The amalgam carrier occupies a brief but important role in the chairside manipulation of dental amalgam. The repair of carriers and the replacement of parts are surprisingly frequent and expensive. There have been no advances in the design of carriers for 30 or 40 years, the most recent patent being dated about 25 years ago. Complaints of dentists about clogging and malfunctions of amalgam carriers are a major problem and returns of carriers from disappointed dentists are extremely high. Many attempts to repair or replace worn parts are made by the dentist himself.

This study disclosed a surprising lack of quality control and expertise in the manufacture of some well-known carriers; an experimental carrier, on the other hand, gave a relatively outstanding performance.

Methods of Testing

The names of carriers tested are listed in Table 1. The Sultan carrier contains a 4 mm plunger of silicon carbide steel. Three amalgam carriers, of standard size, from each manufacturer were tested. The size of the orifice of each approximated 2 x 4 mm. A stiff slurry of 80 grit silicon carbide mixed with water in a ratio of 2.5 g to 1 ml was used as a substitute for amalgam. The slurry was of a consistence similar to that of amalgam but accelerated the wear of both the plunger and cylinder. The slurry was placed in a dappen dish and the carrier filled by four thrusts, each with a force of approximately 0.5 pounds. The slurry was then expelled. This cycle of filling and expelling was repeated 500 times for each carrier. After each carrier had been filled and emptied 100 times, it was rinsed to remove slurry that had accumulated.

Carriers were disassembled and the cylinders as well as the plungers weighed on a Mettler HGT balance before and after each test. The loss of weight was used as a measure of wear.

Results

The range of wear was extremely wide (Table 2). The plunger of the experimental carrier showed the least wear and the Ivory the most, which was almost double that of the next poorest in rank, the Buffalo (Figs 1 & 2).

Table 1. Amalgam Carriers Tested

Buffalo Dental Manufacturing Co, Inc
Brooklyn, NY 11207

Ivory Company, Inc
Philadelphia, PA 19135

Pulpdent Corporation of America
Brookline Village, MA 02146

S S White, Dental Products Division
Philadelphia, PA 19102

(Experimental Carrier)
Sultan Chemists Incorporated
Englewood, NJ 07631

Discussion

Amalgam carriers have not been considered to be precision instruments, and the attrition rate is unduly high. In some instances in this experiment the cylinder wore more rapidly than the plunger, probably because the packing of the mass at the interface caused wear of both components. To give credence to this theory, a further experiment was performed. After the experimental and Ivory carriers had been abraded with silicon carbide they were tested for interface toler-

Table 2. Wear of Amalgam Carriers Expressed as Loss of Weight after Tests of Accelerated Abrasion

	Plunger		Cylinder		Total
	mg	SD	mg	SD	mg
Experimental Sultan	0.57	± 0.12	0.97	± 0.4	1.54
S S White	1.23	± 0.15	2.07	± 0.8	3.30
Pulpdent	2.13	± 0.4	1.53	± 0.23	3.66
Buffalo	2.67	± 1.12	3.33	± 1.03	6.00
Ivory	4.23	± 0.95	2.57	± 0.51	6.80

OPERATIVE DENTISTRY, 1979, 4, 124-136.

Ten High-Speed Handpieces: Evaluation of Performance

WILMER B EAMES • BARRY S REDER • GLEN A SMITH
KIRK D SATROM • BRENDAN M DWYER

Summary

High-speed handpieces of ten manufacturers were tested to compare performance in seven categories: coasting time, eccentricity, free-running speed, longevity, power, noise, and stall torque.

An approximate overall ranking of the handpieces is: Litton, Lares, Mytee Micron, Midwest, S S White, Schein, Star, Dentsply, and two handpieces found to be totally unacceptable, Densco and Den-Tal-Ez.

In most of the testing categories, with the exception of that for noise, there was little or no change when initial values were compared with those obtained after 100 hours of cycling in a test designed to simulate an average lifetime of wear.

Most handpieces will operate well for a period of well over a year if manufacturers' instructions on cleaning and lubricating are followed.

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KIRK D SATROM, student investigator, class of 1980

BRENDAN M DWYER, student investigator, class of 1981

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Published concurrently in the *Journal of the Academy of General Dentistry.*

INTRODUCTION

Many papers have been written on the clinical use of the air turbine handpiece but few have been written on its general characteristics or performance (Taylor, Perkins & Kumpula, 1962). Even fewer papers have been published on specific handpieces and none on the performance of those sold today. The Subcommittee for Handpieces of the American National Standards Committee MD156 for the Council on Dental Materials and Devices is developing specifications for the manufacture of handpieces, but, as yet, dentists must decide which of these expensive precision instruments to buy on the basis of appearance, "feel," and generalized statements in promotional advertising.

The purpose of this study is to establish a battery of simple reproducible tests to be used for evaluating high-speed handpieces and to report the results of these tests so that dentists may make more informed decisions about which handpiece to buy.

METHODS AND RESULTS

All handpieces (Fig 1) were tested at the maximum air pressure recommended by the manufacturer except where specifically noted.

ance. This was done with mixes of spherical amalgam made of precapsulated Sybraloy (Sybron/Kerr, Romulus, MI 48174, USA). Fifty series of 10 strokes of loading and expelling were made of each carrier. The Ivory accumulated 2.8 mg of residual amalgam in the interface; the experimental model accumulated none.

Method of Carrying Amalgam to the Cavity

The technique of carrying amalgam to the cavity varies substantially with the individual dentist, but little is written about this routine procedure. If amalgam remains in the cylinder and becomes clogged there is danger of condensing these hardened particles in a subsequent mix. The simplest method of filling the carrier may be from an amalgam well or a dappen dish, unless the operator still prefers the squeeze cloth.

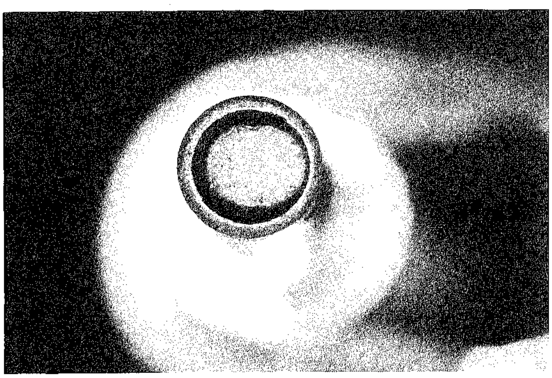

FIG. 1. Carrier which ranked poorest, showing wear after experiment. Amalgam clogging is inevitable.

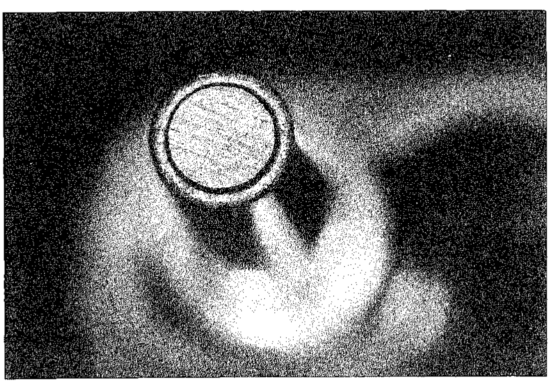

FIG 2. Experimental carrier with silicon carbide plunger, showing the least wear of five carriers tested.

We offer two suggestions to save time and to facilitate the procedure:

1. Have your assistant carry the amalgam into the cavity. She can do it as well, and this saves transferring the carrier instrument.
2. Don't attempt to pack too much amalgam into the carrier. Use only about five thrusts to fill it. Otherwise the continuous packing into the dish or well tends to condense amalgam and expresses mercury, which is left in the well as a plashy mass. This mass, which is too wet, is then used at the end of the condensing procedure when a drier mix is needed.

Conclusion

The tolerance of amalgam carriers varies widely and some require frequent replacement and repair.

An experimental carrier by Sultan contained a 4 mm silicon carbide steel plunger, which produced infinitely better resistance to wear and less tendency to clog.

This study was supported in part by Research Grant 5 RO 1 DE 03504-09 from the National Institute of Dental Research, National Institutes of Health, and by the Fifth District Dental Society of Atlanta.

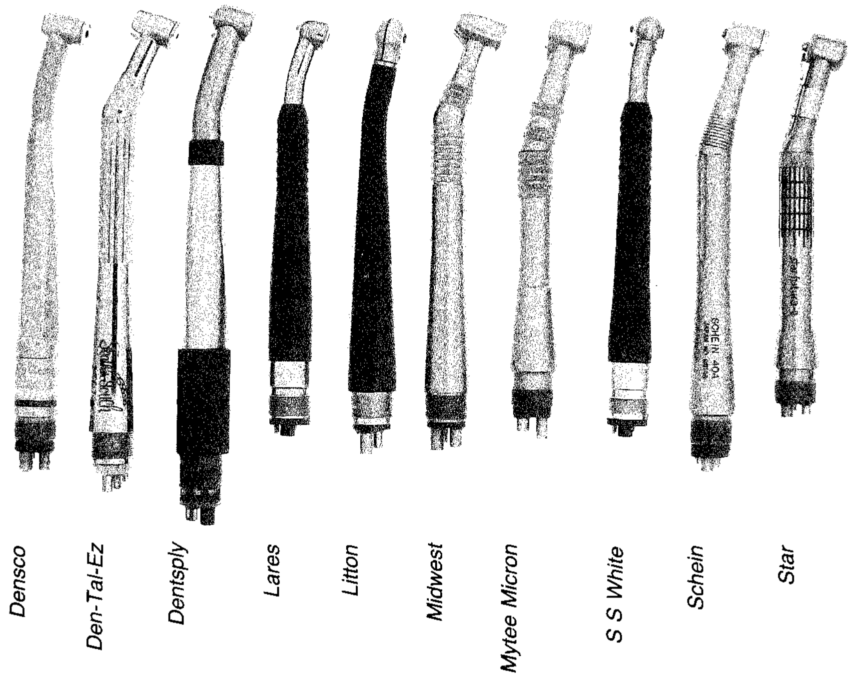

FIG 1. Handpieces used in study shown alphabetically. Manufacturers are listed below.

Densco Blu-White Handpiece	Teledyne Dental, Densco Div Denver, CO 80207
Den-Tal-Ez Feather Touch	Den-Tal-Ez Mfg Co Columbus, OH 43219
Dentsply Triad	Dentsply International York, PA 17404
Lares "370"	Lares Mfg Co, Inc. San Carlos, CA 94070
Litton LH:400	Litton Dental Products Bensenville, IL 60106
Midwest Quiet-Air	Midwest American Melrose Park, IL 60160
Mytee Micron	Micron Components Scottsdale, AZ 85260
S S White Flaire	S S White Dental Products Intl Philadelphia, PA 19102
Schein Masterpiece	Henry Schein, Inc Flushing, NY 11358
Star Futura-2	Star Dental Mfg Co Inc Conshohocken, PA 19428

The pressure was measured at the rear of the handpiece to avoid errors caused by loss of pressure in tubing and coupling.

A battery of tests consisting of coasting time, eccentricity, free-running speed, noise, and torque as a function of speed was performed at three different times: initially, after 50 hours of cycling, and again after 100 hours of cycling. Each of these tests is individually reported below, and the handpieces are ranked from best to worst. Ten handpieces of each manufacturer were used in each test.

Coasting Time

Coasting time is the time required for the turbine to stop rotating after the foot control is released. Times were measured to the nearest tenth of a second (Table 1).

Table 1. Coasting Time (in seconds) after 0, 50, and 100 Hours of Cycling

	0 h	50 h	100 h
Densco	1.0	1.0	1.2
Mytee Micron	1.5	1.4	1.4
Litton	1.4	1.7	2.2
Midwest	1.9	2.3	2.3
Star	2.0	2.2	2.5
Schein	2.4	2.9	2.8
S S White	4.1	4.5	4.7
Lares	4.1	4.6	5.0
Dentsply	9.4	8.6	8.9

Eccentricity

Eccentricity was tested with a noncontacting electronic probe (Kaman Sciences Corp, Colorado Springs, CO 80933 USA). A blank bur (Carbo Corp, Lawndale, CA 90260 USA) was placed in the handpiece and secured over the probe (Fig 2). An oscilloscope (Tektronix, Beaverton, OR 97005, USA) was used to give a visual display of both eccentricity and speed (Figs 3a & 3b). Maximum displacements as

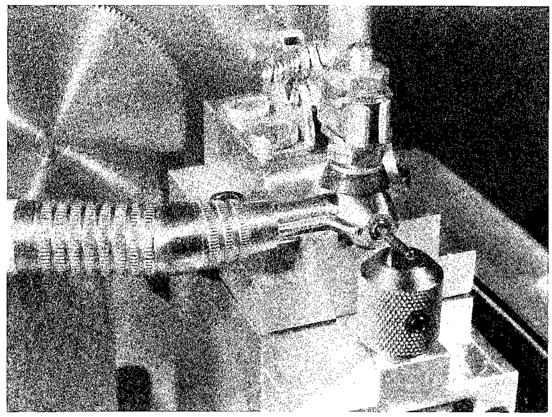

FIG 2. Electronic probe used to measure eccentricity

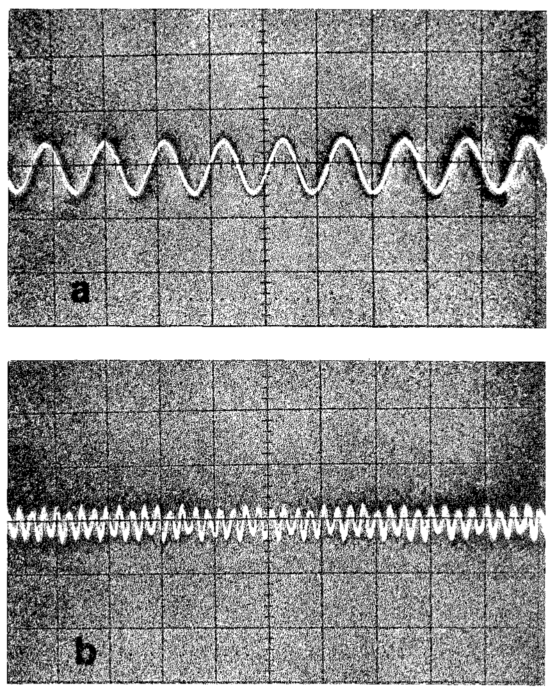

FIG 3. Oscilloscope displays showing (a) low speed and high eccentricity, and (b) high speed and low eccentricity

well as displacements at various speeds were recorded. Air pressures were reduced to obtain data below maximum free-running speeds. All handpieces show a curve similar to that in Figure 4.

In Table 2 the ranking order is based on lowest maximum eccentricity and lowest eccentricity in area "C" of Figure 4.

Free-running Speed

Maximum free-running speed was measured with a photocell tachometer (Moviport,

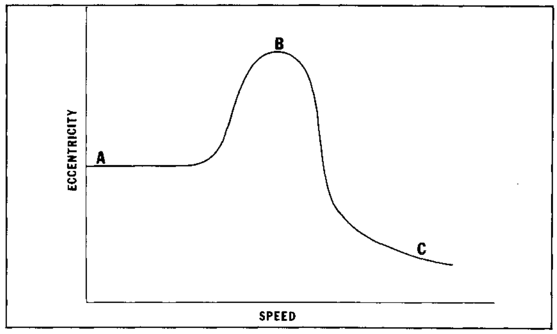

FIG 4. Characteristic eccentricity curve

Table 2. Eccentricity after 0, 50, and 100 Hours of Cycling

		Critical Speed rev/min (in thousands)	Maximum Eccentricity 10^{-3} in	Area "C" Eccentricity 10^{-3} in
Litton	0 h	165	1.0	0.3
	50 h	180	1.2	0.3
	100 h	180	1.1	0.3
Schein		180	0.5	0.3
		200	1.3	0.5
		165	1.1	0.4
Midwest		190	1.3	0.5
		165	1.2	0.5
		165	1.2	0.5
Mytee Micron		165	2.0	0.4
		170	2.0	0.4
		175	1.8	0.3
Lares		50	1.4	0.6
		90	1.5	0.6
		110	1.6	0.6
S S White		90	3.2	0.5
		50	3.0	0.5
		55	3.1	0.5
Densply		140	1.6	0.8
		140	2.3	1.1
		120	2.1	0.9
Star		310	3.4	3.4
		290	4.3	4.3
		275	3.8	3.8
Densco		185	3.2	1.0
		140	11.3	0.9
		160	3.5	1.7

Industrie Electronic, Stuttgart, Germany). Each handpiece was tested with three burs: a blank, a No 556, and a No 37 (Table 3).

Table 3. Free-running Speed (rev/min in thousands) after 0, 50, and 100 Hours of Cycling

	0 h	50 h	100 h
Lares	465	465	465
S S White	460	445	440
Densco	405	410	400
Midwest	390	395	395
Schein	385	370	370
Litton	325	355	350
Dentsply	345	345	345
Mytee Micron	390	330	305
Star	345	340	295
Den-Tal-Ez	295	—	—

Noise

Noise was tested both subjectively and objectively. In the subjective test 50 dental students and 50 dental instructors were asked to evaluate levels of annoyance of ten handpieces (Fig 5). The handpieces were enclosed in balsa wood and tissue paper to remove visual bias.

In the objective test for noise, a decibel meter (General Radio Co, Concord, MA 01742, USA) was used. The "A" band was used for weighted analysis and individual measurements were made at ten octave bands with center frequencies ranging from 31.5 Hz to 16 KHz. Using Litton's initial values in the 0.5, 1, and 2 KHz frequencies the net differences over these frequencies at 0, 50 and 100 hours are shown in Figure 6.

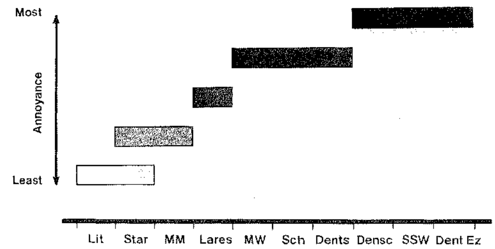

FIG 5. Comparative levels of annoyance as determined subjectively

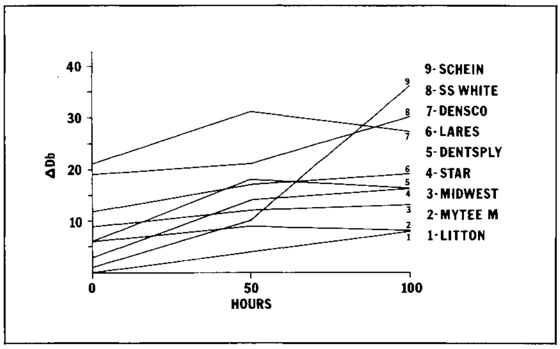

FIG 6. Relative increase in noise in decibels as influenced by time. Lower numbers indicate degree of change.

Stall Torque and Power

Data on stall torque and power were obtained by placing the handpiece with a geared bur against the geared wheel of a dynamometer. Torque was added to the running handpiece in increments of 0.2 oz inches and resulting speeds were recorded from a digital readout system (Magtrol Inc, Buffalo, NY 14224, USA) at each increment. Torque was increased until the handpiece stalled (Table 4). Power was calculated from the results of the torque test (Table 5).

Longevity

Testing for longevity was carried out on a cycling fixture provided by Star Dental Manufacturing Company, Valley Forge, PA 19481, USA (Fig 7). The machine automatically activated the handpieces, allowed them to reach maximum speed, applied a 4 oz load (Fig 8), removed the load, shut off the air supply, and allowed the handpiece to stop in a total cycle time of approximately 15 seconds.

Table 4. Stall Torque (oz in) after 0, 50, and 100 Hours of Cycling

	0 h	50 h	100 h
S S White	.162	.164	.164
Lares	.154	.154	.154
Litton	.152	.149	.152
Mytee Micron	.121	.121	.120
Densco	.102	.100	.100
Star	.091	.094	.094
Schein	.088	.092	.094
Midwest	.085	.085	.085
Dentsply	.081	.081	.082

Table 5. Maximum Power (hp x 10^{-3}) after 0, 50, and 100 Hours of Cycling

	0 h	50 h	100 h
S S White	3.03	2.99	2.96
Lares	2.86	2.87	2.86
Litton	2.32	2.30	2.39
Densco	1.74	1.74	1.82
Mytee Micron	1.86	1.63	1.51
Schein	1.48	1.61	1.54
Midwest	1.40	1.41	1.41
Star	1.29	1.33	1.31
Dentsply	.95	.92	.96

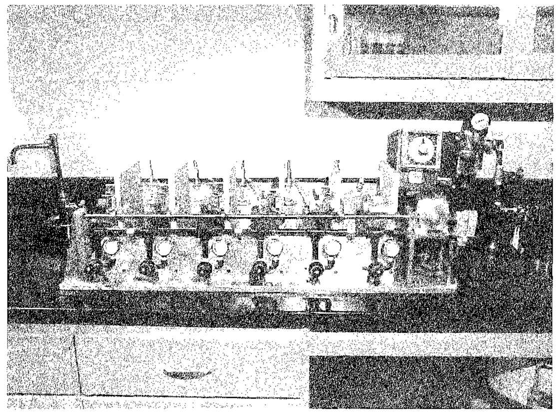

FIG 7. Handpiece life-testing fixture, courtesy Star Dental Mfg Inc

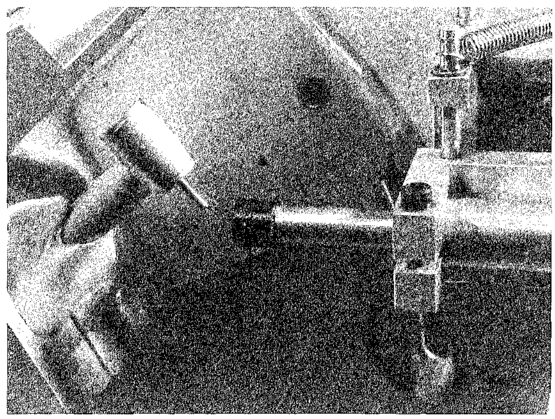

FIG 8. Applying 4 oz load in life-testing fixture

After each 15 minutes, the handpieces were automatically lubricated with the exception of the Schein which was manually greased every two hours.

After 50 hours of cycling the handpieces were removed from the machine and retested. The handpieces were repositioned for another 50 hours of cycling and again tested. Table 6 lists alphabetically the percentage of handpieces functioning after 100 hours of cycling.

DISCUSSION

Coasting Time

No significant changes in coasting time were evident after 100 hours of cycling. It appears from limited clinical responses, using Lares

Table 6. Longevity (Percentage of Handpieces Still Functioning after 100 Hours)

Densco	40
Dentsply	100
Lares	100
Litton	100
Midwest	100
Mytee Micron	100
S S White	100
Schein	77*
Star	100

*Only nine handpieces were tested for longevity, seven of which remained functional.

handpieces that coasting times of four seconds and over are highly aggravating to some clinicians, while to others these coasting times have no bearing on the acceptability of the handpiece.

Eccentricity

Large changes in eccentricity were seen in the Densco handpiece and in the Schein; the latter doubled in eccentricity in the first 50 hours. Even though the eccentricity of the Schein handpiece increased, it ranked as one of the best overall and showed no further increase at the 100-hour test. The Densco's eccentricity first increased, and then decreased. The decrease is due to the failure of the poorest handpieces, and their subsequent removal from the life test, leaving only the better handpieces to continue to be tested for the entire 100 hours.

Critical speed, the point at which maximum eccentricity occurs, is an important factor, because ideally it is desirable to cut the tooth rather than chop it. The critical speed of the Star (approximately 290,000 rev/min) is highly undesirable, because this places the maximum eccentricity in the speed range where most cutting should be accomplished. Problems may also be encountered with the other handpieces if cutting is done at slower speeds, such as may happen when preparing margins or applying loads that will stall the handpiece.

Each of the handpieces that failed showed a substantial increase in eccentricity. This information might be used to predict failure, or by manufacturers as a criterion for failure.

This test did not show the effect of side loading on eccentricity or the clinical significance of various levels of eccentricity.

Free-running Speed

Significant decreases in free-running speed were seen in the Mytee Micron and the Star.

Noise

Initial objective testing of noise determined that measurements below 0.5 KHz were within the level of background noise. Therefore, further tests were done only at the frequencies of 0.5, 1, 2, 4, 8, and 16 KHz. The Student-Neuman-Keuls test determined a correlation between objective and subjective tests. A correlation was found at the 0.5, 1, and 2 KHz ranges, which are also the frequency ranges used mainly in human conversation (Park, 1978). Exceptions to the above correlation occurred with the Dentsply and the Schein. The Dentsply often scored poorly in the subjective test due to the long coasting time. Many commented that the noise of the Schein was shrill, but this was not verified by the decibel meter. A possible explanation is that this handpiece may have a peak noise at a frequency lying between those measured by the meter.

Stall Torque and Power

Speed and power are related in a hyperbolic fashion as can be seen in Figure 9. The maximum power is found at approximately one half the maximum speed. Power is the mathematical product of speed and torque and expresses the rate at which work can be done. From this curve it can be seen that as the speed decreases after the point of maximum power, less work will be done in a given time. Because heavy loads are less efficient, the operator who constantly stalls his handpiece is

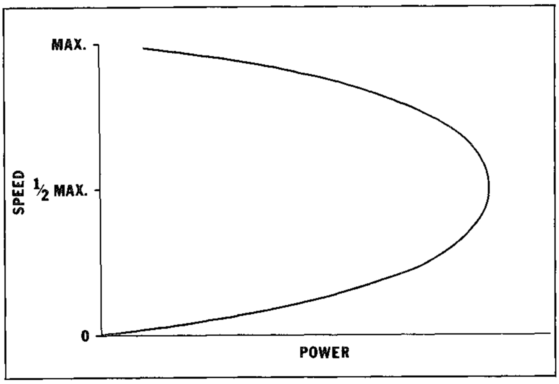

FIG 9. Characteristic speed-power curve

wasting time and probably overheating the tooth.

The values listed for power are not absolute but are relative since, due to the testing method, we were not able to determine the amount of power lost to friction and other causes. Theoretically the handpieces with higher power should cut faster but this has not been confirmed clinically.

Longevity

Previous studies have concluded that the average time a handpiece runs per day is approximately 15 minutes. Therefore, our 100 hours of cycling would be the equivalent of 400 working days, or about two years. The lack of water spray may have increased the performance of the handpieces by removing the potential for rusting of the internal parts, but the clinician can help avoid this problem by cleaning and lubricating after each use of the handpiece instead of only once in the morning before its use.

Our criterion for failure of a handpiece was seizure of the bearings. Sixty percent of the Densco handpieces failed and two of nine Schein handpieces failed.

The Den-Tal-Ez has a friction grip chuck that requires the bur to be removed from behind the head. The force required to remove the bur often was enough to cause the head to break free of the body of the handpiece. Our sampling of handpieces was soon too small to give valid data, so the Den-Tal-Ez was left out of many of the tests.

At the time of the completion of these tests the handpieces were two years old; changes in materials and designs may have occurred in any of these handpieces.

This study was supported in part by Research Grant 5 RO 1 DE 03504-09, National Institute of Dental Research, and USPHS Grant RR 05308, National Institutes of Health, and by the Fifth District Dental Society of Atlanta.

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OPERATIVE DENTISTRY, 1979, 4, 132-133.

POINT OF VIEW

Dental Education: Where Are the Voices for Operative Dentistry?

CHESTER J GIBSON

If dentistry is to continue to be the precise skill that it ought to be—has in fact a long tradition of being—something needs to be done about dental education today. Surely the position in clinical training once devoted to operative dentistry needs to be put back in balance. It is only in the actual practice of operative dentistry—not in the theory—that good co-ordination of hand and eye and good techniques of instrumentation are developed. No amount of observation or demonstration will substitute for first-hand experience.

The present deterioration in the attention paid to the skills of operative dentistry began with the Comprehensive Health Manpower Training Act of 1971 and the intrusion of the US Public Health Service into dental education. New programs heretofore foreign to dental education have been forced into the curriculum. Pressures exerted on state and regional examining boards by legislatures, governors, citizens groups, and educators have led to the lowering of standards by testing institutions. Today less than half of the state and regional examinations require gold foil; many have dropped even the cast restoration.

Government today is not interested in improving the quality of dental care for its citizens. Short-term economy and quantity seem to be the overriding concerns of HEW and the US Public Health Service. In Oregon the recent overwhelming vote on measure No 5 introducing denturism into the state suggests the people themselves condone mediocrity rather than reward excellence.

Education, however, continues to be the chief issue. Recently in Oregon a young graduate from another state cut his first preparation for a class 2 amalgam on a patient for the state board examination. It is possible to graduate from the University of Oregon Dental School without ever having extracted a tooth. One school is trying to maintain a graduation requirement of a single unit of prosthetics. Some schools have no requirements in removable prosthetics. Clinic time in operative dentistry has been so eroded that much basic

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training is lost. Several schools are not even requiring the students to do any of their own laboratory work.

Let's look at what is happening to the dental curriculum. True, the dental student must still attend school for four years, admittedly not the 44 hours a week as when many of us were in school, but nonetheless, four years. Much more time is devoted to diagnosis, more time to periodontics, more to endodontics, to hospital dentistry, to community dental projects.

Where are our values! We are producing a student that can diagnose but not treat. He can do a sclera graft but he cannot restore the tooth. He can complete a root canal but he cannot fill with gold foil the hole he has made in the crown. He can don a hospital gown in the sterile mode but what does he do then? He does not know how to extract a third molar or complete a proper restoration.

Recently I heard one of the members of the Commission on Education of the American Dental Association remark with pride that all dental schools are now required to have a real hospital program. Less than two percent of graduating dentists, however, become involved in hospital dentistry, and fewer than one of each graduating class goes into community or social dentistry for the indigent.

We constantly hear the complaint that we are graduating young people from high school who cannot read and can hardly write. Last week one of my patients, who has been a teacher for many years, quit simply because, as he said, "They will not give me time to teach my kids how to read or write. So much time is taken up with social studies and trivia that there is no time left for the basics." My question is, "How much better are we doing in our professional schools?" Are we not falling into the same trap?

Dentistry is the art and science of restoring the mouth and its related structures to a normal state of health and then maintaining that state of health. Not blood pressure, not hospital procedures, not community dental clinic management, not outreach programs. We must get back to the basics of what dentistry is all about. Let's prepare our students to be dentists. Then, anyone who wishes to expand his knowledge into the specialties should get this training in graduate studies or continuing education. Operative dentistry is the foundation of the profession, not a specialty of it. Gold foil is not a specialty. It is essential. An amalgam restoration is not something to be delegated to a subordinate; it is a fundamental.

I feel very deeply about this and I am aware that changes in our educational process will come about only when complaints are heard. Moreover, it will do no good to decry the conditions if we do not act. Single voices crying in the wilderness are ineffective. Results will take the combined efforts of the organizations involved in operative dentistry. If the Academy of Operative Dentistry, the American Academy of Gold Foil Operators, the Academy of General Dentistry, the International College of Dentists, and the American College of Dentists are willing to raise their voices we can be the E F Hutton of dental education. When we speak, people **will** listen.

DEPARTMENTS

Dear Woody

Question from Last Issue

With the universal acceptance of the conservative preparation for amalgam restorations, the centric and working areas are more frequently being maintained in natural tooth structure. When it is essential, however, to restore these occluding surfaces with amalgam, how can the operator carve and shape those surfaces to ensure proper occlusal function?

Answers

Ensuring proper occlusion for an amalgam restoration begins **before** the cavity preparation is started, not **after** the restoration is completed. Besides the tooth in question, the type of occlusion, amount of occlusal wear, and cusp contours of adjacent and opposing teeth are important. Careful evaluation of these factors can save the operator much postoperative time trying to re-establish the proper occlusion for his patient.

Unfortunately, many of us were taught in dental school to rely on "blue marks" or patient acceptance for restoring the proper occlusion to our restorations. Blue articulating paper is too thick and gives far too many false markings to be used for perfecting occlusal contacts. Immediately after the procedure, patients can seldom tell if their occlusion is correct. I have found that preoperative and postoperative evaluation of the position of occlusal contacts with a piece of 0.0005 inch silver shim stock (Artus Corp, Englewood, NJ 07631, USA) offers the most professional method for ensuring proper occlusion. Determining the degree of contact by pulling the shim material from between contacting surfaces is far more accurate than relying on colored marks to verify these contacts. Marking ribbons should be used to mark high spots, but only after the use of shim stock has pinpointed the specific problem area.

Shim stock is a nonmarking plastic material which is similar in thickness to 0.5 mil recording tape, but offers the additional advantage of being available in 10 x 20 inch sheets as well as other sizes. This allows the clinician the latitude of cutting the size he desires. Generally, the dentist will have his assistant cut a piece of the shim material the width of one cusp, and long enough to be held in a ribbon holder. This allows him to check each contacting area in centric and lateral excursions. Even though there are many extremely thin articulating tapes and ribbons available, they are all capable of recording false contacts. Using the shim technique eliminates this problem by relying on the more accurate tactile sense of the dentist to determine adequate and even contacting points.

This technique will save you time and money in the long run, for you will be able to regain proper occlusal contacts without relying on your patients to tell you if the restorations feel "high," as well as offering an accurate method for avoiding "overcarving" your amalgam restorations.

Capt Richard B McCoy
National Naval Dental Center
Bethesda, MD 20014

There are two answers to Dr Titus' question:

1. Restore only teeth without opposing occlusion.

2. Most skilled operators carve with their thumbs, but those who are more sophisticated can, with a few deft movements, carve and contour to perfect masticatory function with long fingernails.

What Dr Titus considers, and what other operators consider, "proper" occlusal function runs the gamut of chewing Red Dawg through an entire ball game to biting one's nails under stress.

The only proper function of the jaw is to keep the mouth open, while the body is prone or supine, eyes shut and making no conversation whatsoever. All other functions are traumatic.

The thing that begets the occlusion controversy is rhetoric. So if you quash one function you can automatically squelch this troublesome syndrome.

Wilmer B Eames, DDS
14390 E Marina Drive, Apt 501
Aurora, CO 80014

New Question

In preparing a typical MO cavity, particularly in a bicuspid, I often notice as the distal fossa is entered a crack appears in the distal marginal ridge, a crack which extends in a mesiodistal direction. I work with a magnifying loupe so the cracks are readily visible. This phenomenon occurs also in molars but not as frequently. I use Star Futura high-speed handpieces and sharp S S White No 558 burs. My question is: Have other dentists noticed this phenomenon and what is its cause? Also I see many more fractured cusps in patients I have treated as well as in those of other practitioners. Please comment.

Benjamin Ogman, DDS
115 Washington Place
New York, NY 10014

Book Review

OCCLUSION—THE STATE OF THE ART

Edited by Frank V Celenza and John N Nasedkin

Published by Quintessence Publishing Co, Chicago, Berlin, Rio de Janeiro, and Tokyo, 1978. 165 pages. Illustrated. $32.00

The one subject of dentistry that is an integral part of all the other disciplines and, therefore, demands a thorough understanding, is occlusion. Yet, ironically, mere mention of the word very often evokes heated controversy, frustration, and a somewhat warranted insecurity. What has caused much of the dismay is the apparent impasse created by frequent references to the wide abyss of disagreement among the various philosophies of occlusal treatment.

This book reports the proceedings of the Occlusion Focus Symposium of November, 1976. Nine distinguished and respected men of different occlusal persuasions conducted a workshop to investigate whether there existed any unanimity of opinion regarding some basic concepts of dental occlusion. Three basic occlusal concepts were considered:

1. The optimum condylar position at maximum intercuspation
2. The optimum character of the intercuspal position
3. The character of eccentric relationships

The format of the book is a position paper, delivered by each of the panelists, followed by a group discussion. Due to restrictions on both topics and time the book must be considered only for those serious students with a good working knowledge of occlusion. Anyone else would find it impossible to understand—somewhat akin to watching a foreign film without translated subtitles. Additionally, not all the panelists were able to restrict themselves to a discussion of the selected topics, nor support their theories by well-founded evidence. The net result is a series of papers sometimes difficult to read and based often on individual conjecture, followed by bickering between the panelists over the "truth."

When one considers the reputations of the contributors, and the well-defined goals of the meeting, it is a pity that the quality of presentations and their ensuing discussions were allowed to decay to the level of an imbroglio. There are a number of typographical errors in the text.

The editors conclude by hoping for a broader understanding of these basic concepts. This did not appear to be the case. The saving grace and probably most meaningful contribution of the text were the reports of the consolidation committees. These reports sum up the agreement of the participants well and are an effort to clarify a subject that is of interest and importance to all dental practitioners.

Robert R Faucher, DDS, MSD
Department of Restorative Dentistry
School of Dentistry
University of Washington

Announcements

NOTICE OF MEETINGS

Academy of Operative Dentistry

Annual Meeting: February 14 and 15, 1980
Hyatt Regency Hotel
Chicago, Illinois

American Academy of Gold Foil Operators

Annual Meeting: October 9 and 10, 1980
Louisiana State University
New Orleans, Louisiana

NEWS OF STUDY CLUBS

W P Whittaker Gold Foil Study Club

On 20 April 1979 the W P Whittaker Gold Foil Study Club met in Libby, Montana, to participate in the club's seventh session of the 1978–79 year. This year the club honored Mrs. Paul Whittaker, wife of the original mentor. After Paul's death in November 1977 the Inland Empire Gold Foil Study Club was renamed in his honor. A memorial plaque designating this fact was presented in June.

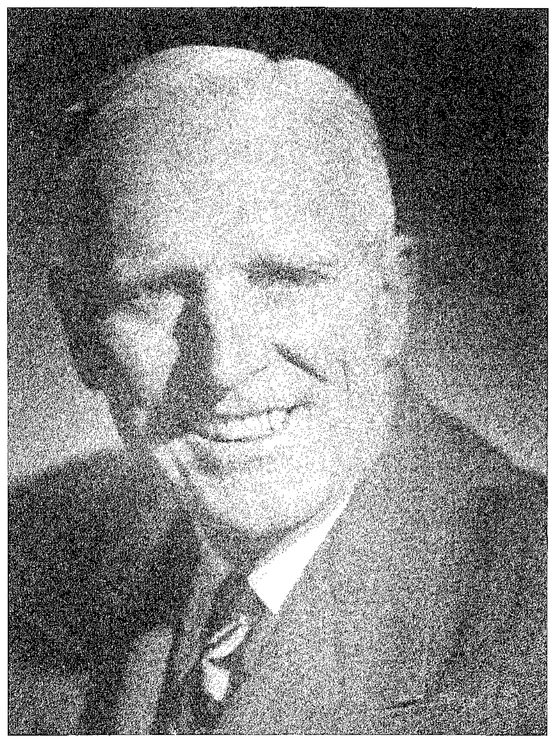
Present for the second consecutive year was the club's mentor, Lyle E Ostlund from Everett, Washington. The club meets the last Monday of each month from September through March in Spokane, Washington, and the third Friday of April in Libby, Montana.

Associated Ferrier Study Clubs

The 49th annual meeting of the Associated Ferrier Study Clubs was held 11 May 1979 in Vancouver, British Columbia. This meeting was dedicated to the memory of Walter K Sproule (1892–1967), a former member of the Vancouver Ferrier Study Club and former mentor of the Intercity Gold Foil Study Club, now renamed the Walter K Sproule Study Club in his honor.

During the morning there were 17 clinical demonstrations of gold foil. The afternoon was devoted to golf, trap shooting, and tennis. A dinner meeting was held in the evening with George S Beagrie, the new dean of the Faculty of Dentistry at the University of British Columbia, as principal speaker. The meeting was graced by the presence of Chester J Gibson and Jack G Seymour, president and secretary-treasurer, respectively, of the American Academy of Gold Foil Operators.

Dan Frederickson, president of the W P Whittaker Gold Foil Study Club, presents a memorial plaque to Mrs June Whittaker, 20 April 1979.



Walter K Sproule, 1892-1967

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

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

Exclusive Publication

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OPERATIVE DENTISTRY

SUMMER 1979 • VOLUME 4 • NUMBER 3 • 89-136

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