OPERATIVE DENTISTRY

AMERICAN ACADEMY OF GOLD FOIL OPERATORS

ACADEMY OF OPERATIVE DENTISTRY

september-october 1993 • volume 18 • number 5 • 169-216

(ISSN 0361-7734)

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SEPTEMBER-OCTOBER 1993 • VOLUME 18 • NUMBER 5 • 169-216

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.

Statement of Ownership

Operative Dentistry (ISSN 0361-7734) is published bimonthly in January, March, May, July, September, and November. *Operative Dentistry* is the official journal of the American Academy of Gold Foil Operators, P O Box 57, Industry, TX 78944 and the Academy of Operative Dentistry, P O Box 177, Menomonie, WI 54751.

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

Subscriptions

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

Contributions

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

Second class postage paid at Seattle, WA and other selected points.

Editorial Office

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

Subscription Manager

Judy Valela

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EDITORIAL

The Giants

Have you ever noticed how we continue to lose the legends in dentistry?

Not surprising, since we are all mortal and have only finite lifetimes; but we miss them just the same. In the past few years we have lost several giants of dentistry. If you didn't take the time and make the attempt to know them, it is your loss. Most of these people are wonderfully accessible and more than willing to talk to each of us. They will even offer sage counsel when it is requested.

I distinctly remember my first-ever Academy meeting in Chicago. I saw the legends. I stood in awe of what these people had done to build our profession. It wasn't until the next year that I screwed up my courage and started going up to these legends and introducing myself. To my great surprise, they were friendly and extremely accessible. Not only that, but for the most part, they were humble. Since that time I have made sure to take every chance I get to meet and spend some time with my dental heroes.

Each of these individuals has a special place in our history. They embody a portion of the history of dentistry and often are important to the founding and perpetuation of our academies. They have had the visions and ideas that have changed and modernized our science and our art: They developed etching, posts, pins, new cements, polymers, bonding agents, casting alloys, amalgams, and most of the materials, techniques, and textbooks we use today. It is instructive to listen to them. They tell wonderful stories about the development of their ideas, perseverance in the face of repeated failure; they speak of the friends and family that supported them, about their philosophy, their visions, their disappointments, and their love of our profession.

There are a number of these legends still among us. They come to the February meetings to share with us and partake in the fellowship of the Academies. They come as most of us do, to listen and to learn. They are open to the new ideas, new techniques, and new approaches to the art and science of dentistry. They have the wisdom to hear an idea without trying to simultaneously form a rebuttal; rather, they provide intellectual argument after the speaker has completed the presentation. They are simultaneously sponges and fountains of knowledge.

Each of us needs to take the time to meet and share a little of their lives. We need to make the effort to single out these dental leaders, teachers, and researchers and share a little of their wisdom before their mortality robs us of the opportunity. If you put it off another year, you may miss yet another chance to improve your understanding of these remarkable people. They have a lot to share about both dentistry and life.

If you miss these chances, your life will be in some measure less rich. Make the effort to share a few moments with a giant.

MAXWELL H ANDERSON
Editor

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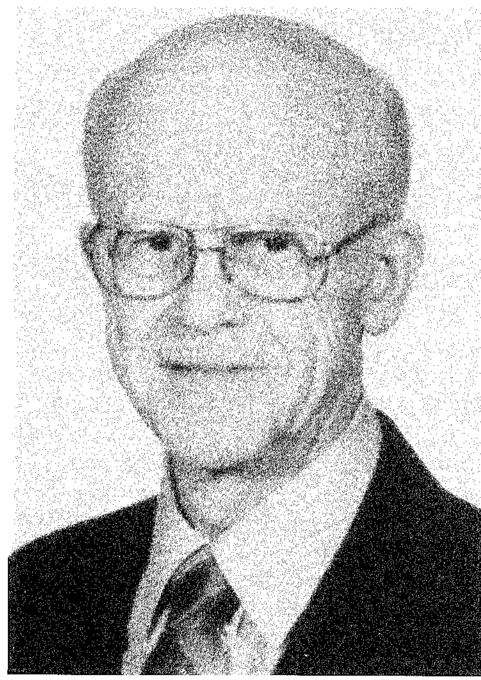
In Memoriam

The dental profession has lost a great teacher and a great friend. Dr Gerald D Stibbs passed away at home on 4 July 1993. He was greatly loved and will be greatly missed.

Gerald Denike Stibbs was born 25 April 1910 in Schreiber, Ontario, Canada. His family later moved to Nelson, British Columbia. Gerry entered North Pacific Dental College in Portland, Oregon, at age 16 and graduated at age 21 with the DMD degree and a BSc degree. After graduation he returned to British Columbia, where he practiced dentistry. He became active in organized dentistry and study clubs and was affiliated with the Vancouver Ferrier Gold Foil Study Club. He was also the mentor for the Vancouver Diagnosis Club. During this time, Gerry served as president of both the Vancouver and District Dental Society and of the British Columbia Dental Association. He was made an honorary member of the Canadian Academy of Restorative Dentistry and of the College of Dental Surgeons of British Columbia.

In 1948 Ernie Jones, dean of the newly established School of Dentistry at the University of Washington, appointed Gerry Professor of Operative Dentistry and chairman of that department. Beginning from scratch, Gerry, with characteristic thoroughness, organized the laboratory and the clinical courses and selected an able staff, most of whom were members of gold foil study clubs. By dint of hard work and scrupulous attention to detail, he developed a department of operative dentistry second to none. The results of his efforts were evident even in the



Gerald D Stibbs
25 April 1910 - 4 July 1993

first graduating class, which had little problem in passing the state board examination, even though it was substantially more difficult than that of today. In 1950 the Department of Operative Dentistry and the Department of Fixed Partial Dentures were combined with Gerry as chairman of both. He was also director of the dental operatory at this time.

Realizing the importance of research in dental education, in 1950 Gerry established a graduate program in operative dentistry.

Gerry's reputation attracted many students to the program over the years. Students came from many parts of North America and from places as far distant as Syria and Chile. Many of these students, in their turn, have become leaders in dental education.

Gerry published a manual, *Cavity Preparations for Operative Dentistry Technic*, which has reached seven editions. He also contributed substantially to dental literature in the form of chapters in books and articles in periodicals, the total exceeding 70. Gerry was also an associate editor of the *Operative Dentistry* journal and a contributing editor to the *Journal of Prosthetic Dentistry*. As part of his preparation of teaching aids, he, with Cliff Freehe as the photographer, made a motion picture film of the preparation and insertion of a class 5 gold foil on a patient. This film won first prize at the Biological Photographic Association in 1961 and Grand Prize at the International Dental Film Festival in Paris in 1962. The film was received with acclaim by dental educators. Many copies have been made, and it has been shown in numerous places around the world. Additionally, Gerry collaborated with Bruce Smith to produce a motion picture film of practical rubber dam application, which was awarded the Diploma of Honor at the International Film Festival in Paris in 1972.

Over the years Gerry received many honors. He was a fellow of The American College of Dentists and in 1984 received the William J Gies Award given by the college. In 1981 he received the Distinguished Member Award from the American Academy of Gold Foil Operators, and in 1986 he received the Award of Excellence given by the Academy of Operative Dentistry. He was a member of CAIC, Sigma Xi Honorary Science Society, the American Academy of Restorative Dentistry, the Academy of Operative Dentistry, the Associated Ferrier Study Clubs, and was a founding member and first secretary of the American Academy of Gold Foil Operators.

Gerry retired from academic teaching in 1970 and became professor emeritus. He loved teaching. Throughout his academic career and in his retirement years his great love was working with students. He was the mentor of three clinical operating study clubs: the Vancouver Ferrier Gold Foil Study Club, the Walter K Sproule Gold Foil Study Club in New Westminster, BC, and the George Ellsperman Gold Foil Seminar in Seattle, Washington. He was a remarkably skilled clinician and speaker. Recognizing that students vary in ability and that excellence is a journey, not a destination, he tried his utmost to help students reach their full potential and to progress as far along the journey as their talents allowed. He encouraged them by example. Many graduates have remarked after a few years in practice that, although the standards demanded by Dr Stibbs may have seemed onerous at the time, they were indeed grateful for his persistence when they discovered how well they had been trained in restorative dentistry. As a tribute, former students and friends honored Gerry at his 80th birthday party by presenting a bronze bust sculpted by Orlando Barrowes, himself a former student. The bust is located in the Department of Restorative Dentistry at the University of Washington. Examiners of dental boards in other states, the Armed Forces, and directors of graduate programs at other dental schools all praised the superior performance of graduates of the University of Washington, who were often called "Gerry Stibbs's boys," all of which attested to the fact that Gerry's Department of Operative Dentistry was the best in the world.

Gerry is survived by his wife Gloria, daughter Denise Porker and grandson Evan Porker of Bellingham, WA, and sons Gerald Stibbs of Spokane, WA, and Douglas Stibbs of Seattle, WA.

Memorials may be sent to The Gerald D Stibbs Endowed Fund in Restorative Dentistry, University of Washington, School of Dentistry, Seattle, WA 98195.

J MARTIN ANDERSON
A IAN HAMILTON

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ORIGINAL ARTICLES

Microleakage of a Dental Amalgam Alloy Bonding Agent

J M SAIKU • H A ST GERMAIN, Jr • J C MEIERS

Clinical Relevance
The tested 4-META product may protect the pulp but does not stop microleakage at the thermocycled amalgam-resin interface.

SUMMARY

Amalgambond (a 4-META derivative resin bond agent) was evaluated for its effectiveness in reducing microleakage compared to copal varnish and no lining agent in class 5 amalgam preparations restored with either an admix alloy (Dispersalloy) or a spherical alloy (Tytin). Teeth were thermocycled between 5 and 55 °C with two 4-META/amalgam groups additionally aged in 37 °C water for 30 days prior to thermocycling. Nonaged, 4-META/amalgam restorations showed significantly less microleakage ($P < 0.05$) at enamel and dentin margins compared to copal varnish or nonlined restorations. Within the 4-META groups, the 4-META/Dispersalloy restorations had significantly less microleakage than the 4-META/Tytin restorations at enamel margins. Microleakage in the aged 4-META/amalgam restorations was significantly greater at both the enamel and dentin margins than in the analogous nonaged groups. SEM evaluation of the 4-META lined restorations found internal cavity surfaces of the preparations to be sealed by the resin liner with separations and apparent microleakage occurring at the 4-META/amalgam interface.

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INTRODUCTION

Microleakage of amalgam restorations results from gaps at restoration cavosurfaces and can lead to tooth discoloration, marginal breakdown, dentinal sensitivity, secondary caries, and pulpal irritation. Mertz-Fairhurst and Newcomer (1988) found voids and incomplete adaptation of amalgam to cavity surfaces in a scanning electron micrography (SEM) study of recently placed amalgam restorations with a mean interfacial gap depth of 41 microns. The particle shape of amalgam may also influence the degree of microleakage. Mahler and Nelson (1984) found the spherical alloy Tytin to have a greater tendency for marginal microleakage than the admix alloy Dispersalloy.

The use of cavity varnish is an accepted technique to help control initial microleakage and to reduce postoperative sensitivity. Ben-Amar and others (1986) found that Copalite cavity varnish significantly reduced microleakage around new spherical and conventional amalgam restorations when applied in two coats, although admix amalgam produced the best results without varnish. Liberman and others (1989) found, however, that over time, the degree of marginal microleakage was not significantly affected by the application of copal varnish and that a permanent seal was not maintained when varnish was used.

Recently, investigators have used dentin bonding agents as amalgam liners and have shown significant reductions in microleakage (Ben-Amar & others, 1987; Ben-Amar & others, 1990; Yu, Wei & Xu, 1987). A further step to enhance the clinical versatility of the amalgam restoration has been the development of materials that chemically bond amalgam to tooth structure. Varga, Matsumura, and Masuhara (1986) reported significant reductions in microleakage with the use of a 4-META (4-methacryloxy-ethyl trimellitate anhydride) resin and Panavia adhesive resin to bond amalgam restorations to dentin and enamel. Staninec and Holt (1988) have also reported similar reductions in microleakage using Panavia.

Amalgambond is the latest 4-META resin specifically marketed for its ability to bond amalgam to dentin, enamel, and existing amalgam restorations. Reported bond strengths of amalgam to dentin using Amalgambond have ranged from 3.31 MPa (Cooley, Tseng & Barkmeier, 1991) to 17.7 MPa (Masaka, 1991). The adhesion of 4-META to metals has been attributed to micromechanical and chemical bonding (Swift, 1989). Bonding to dentin has been described as strictly micromechanical (Misra, 1989).

The purpose of this study was to evaluate the effectiveness of Amalgambond in reducing microleakage in amalgam restorations and to evaluate the nature of the tooth/liner/amalgam interface. Microleakage was compared in class 5 amalgam restorations when no liner (negative control), Copalite varnish (positive control), and Amalgambond were used. Additionally, Dispersalloy and Tytin were compared to investigate whether amalgam particle type influences the degree of microleakage.

METHODS AND MATERIALS

Forty noncarious human molars stored in 0.2% sodium azide were used in this study. The teeth were cleaned of residual tissue tags and thoroughly rinsed in water. Class 5 cavity preparations were placed on the mesial and distal surfaces of each tooth with a #330 high-speed bur. Preparations were 1.5 mm deep and approximately 2 mm wide by 8 mm long with the gingival half of the preparations extending 0.5 mm below the cementoenamel junction (CEJ). Cavosurface walls were finished to a butt joint. Preparations were rinsed for 20 seconds with a water spray and air dried for 30 seconds. Cavity preparations were divided randomly into eight groups of 10 preparations each (Table 1).

In groups 3, 6, 7, and 8, Amalgambond (Parkell Products, Farmingdale NY 11735) was applied according to the manufacturer's

Table 1. Cavity Liner and Alloy Combination for Treatment Groups

Group	Liner	Alloy	Aged before Thermocycling
1	No liner	Tytin	No
2	Copalite	Tytin	No
3	Amalgambond	Tytin	No
4	No liner	Dispersalloy	No
5	Copalite	Dispersalloy	No
6	Amalgambond	Dispersalloy	No
7	Amalgambond	Tytin	Yes
8	Amalgambond	Dispersalloy	Yes

directions and the amalgam [either Tytin (Sybron/Kerr, Romulus, MI 48174) or Dispersalloy (Johnson & Johnson, Skillman, NJ 08558)] condensed while the liner was still unpolymerized. In groups 2 and 5, Copalite (HJ Bosworth Co, Skokie IL 60076) was applied in two air-thinned coats prior to amalgam condensation. In the unlined groups 1 and 4, the preparations were rinsed and air dried before the amalgam was placed. All preparations were overfilled with amalgam and carved to contour. The restored teeth were placed in 37 °C water for 24 hours, after which a sharp carver was used to remove residual traces of Amalgambond or varnish from the tooth surface. Groups 7 and 8 were additionally aged in a 37 °C water bath for 30 days. Prior to thermocycling, root apices were sealed with Vitrebond (3M Dental Products, St Paul, MN 55144) glass ionomer and dental compound, followed by two coats of fingernail polish to within 1 mm of the margins of the restorations. All teeth were thermally stressed for 3,000 cycles between 5 and 55 °C in baths containing 0.5% basic fuchsin dye. Dwell time in each bath was 30 seconds.

After thermocycling, each tooth was cut serially into six sections on a diamond saw (Exakt Medical Instruments Inc, Oklahoma City, OK 73148) with both mesial and distal restorations included on the same section. Sections were treated with 0.5% citric acid for 5 seconds to remove the surface smear layer created during sectioning and rinsed with distilled water. Each section was then viewed under a stereoscopic microscope (Bausch & Lomb, Rochester, NY 14604) at X10 magnification and blindly scored for microleakage by two examiners calibrated for consistency using specimens from an initial pilot study. Microleakage scores were based on the degree of dye penetration according to the following scale:

0 = no leakage;
1 = dye penetration less than halfway to the axial wall;
2 = dye penetration greater than halfway to the axial wall; and
3 = dye penetration along the axial wall.

In cases of disagreement, a forced consensus microleakage score was reached. Microleakage scores were recorded for both the enamel and dentin margins.

Scanning electron micrographs were taken of representative tooth sections from each group to assess the nature of the tooth/liner/amalgam interface. Tooth sections were dehydrated with graded ethanol and infiltrated with Technovit 7200 (Exakt Medical Instruments), gold sputtered, and examined with an Amray 1200B SEM (Amray Inc, Bedford, MA 01730) using an acceleration voltage of 30 kV.

Statistical analysis of variance was performed on the microleakage data using the Kruskal-Wallis test. Pair-wise comparisons between groups were made with the Mann-Whitney U and Wilcoxon Signed Rank tests at a 0.05 level of significance.

RESULTS

Microleakage scores and their medians for the eight treatment groups are listed in Figures 1 and 2. Nonaged Amalgambond-lined restorations showed significantly less microleakage than either the copal varnish or the unlined restorations at both enamel and dentin margins. Within the Amalgambond groups, the Amalgambond/Dispersalloy combination had significantly less microleakage than the Amalgambond/Tytin combination at enamel margins.

When the Amalgambond-lined teeth were aged for 30 days before thermocycling, there was a significant increase in microleakage at both enamel and dentin margins compared to the nonaged Amalgambond groups. Tables 2 and 3 demonstrate the increased microleakage in the nonaged versus aged specimens for Tytin and Dispersalloy restorations respectively.

SEM observations of sectioned samples within the Amalgambond-lined amalgam groups showed intimate adaptation of the 4-META liner to dentin with a gap formation present between the resin liner and amalgam (Figures 3 and 4). Enamel margins of the 4-META-lined restorations were found to be more tightly sealed and to have fewer separations between the amalgam alloy and resin liner than at dentin margins. At the amalgam/tooth interface, unsealed dentin and gaps

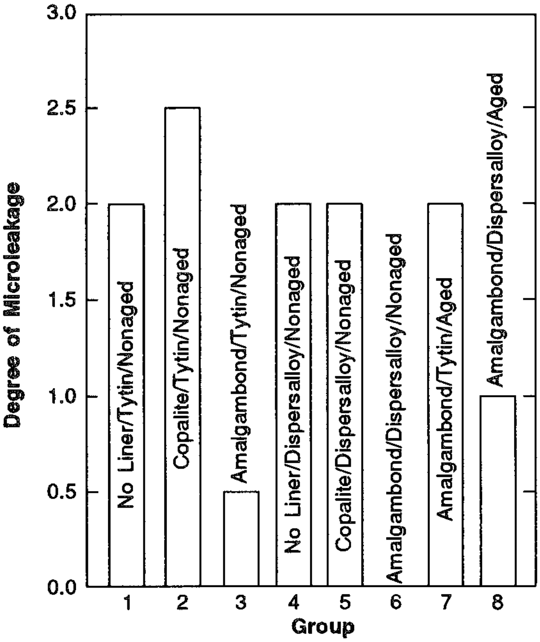

Figure 1. *Enamel microleakage scores*

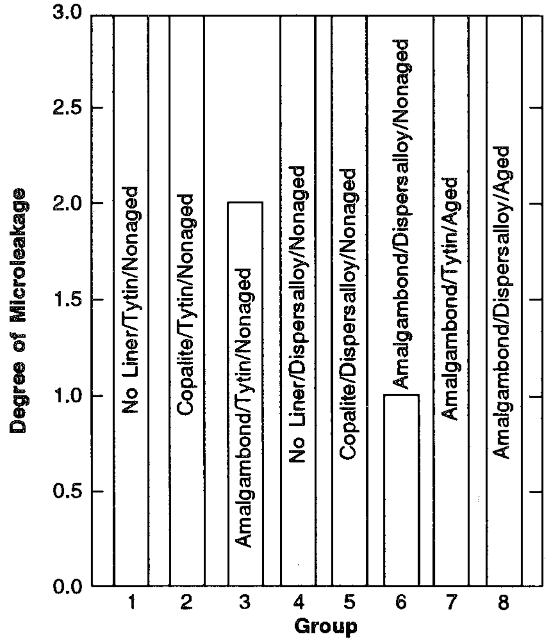

Figure 2. *Dentin microleakage scores*

Table 2. Microleakage of Tytin/Amalgambond Nonaged versus Aged Specimens

Margin Site	Degree of Microleakage** 0	1	2	3	Median Score
Enamel	30	12	17	1	0.5
Enamel (Aged)	14	14	27	5	2
Dentin	21	2	14	23	2
Dentin (Aged)	8	2	9	41	3

**Defined in text

Table 3. Microleakage of Dispersalloy/Amalgambond Nonaged versus Aged Specimens

Margin Site	Degree of Microleakage** 0	1	2	3	Median Score
Enamel	50	8	2	0	0
Enamel (Aged)	26	9	24	1	1
Dentin	26	6	12	16	1
Dentin (Aged)	4	10	12	34	3

**Defined in text

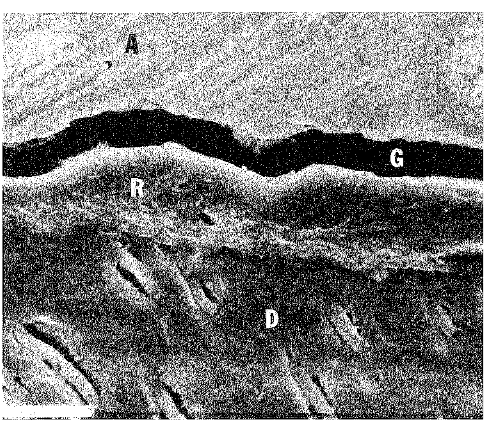

Figure 3. *SEM of a 4-META-lined Dispersalloy restoration demonstrating a sealed internal cavity wall despite the formation of a gap between the amalgam alloy and resin liner and a cohesive fracture within the liner. (X1.2K, Bar = 10 microns; A = Amalgam; D = Dentin; R = Amalgambond Resin; G = Gap.)*

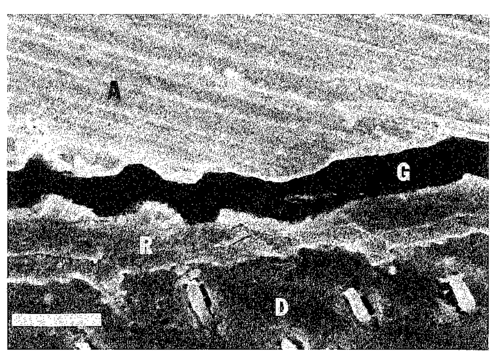

Figure 4. *SEM of a 4-META-lined Tytin restoration demonstrating a sealed internal cavity wall despite the formation of a gap between the amalgam alloy and resin liner. (X1.2K; Bar = 10 microns; A = Amalgam; D = Dentin; R = Amalgambond Resin; G = Gap.)*

were found in both unlined (Figure 5) and Copalite-lined (Figure 6) restorations. This correlates with their higher microleakage scores and more diffuse pattern of dye penetration.

DISCUSSION

Comparing the pattern and extent of microleakage, the 4-META-lined restorations had significantly less penetration of dye into dentin than did either of the control treatment groups. Figure 7 demonstrates the typical microleakage pattern seen for both the unlined and Copalite-lined restorations. Basic fuchsin dye is observed to penetrate into dentinal tubules and invade towards the pulp chamber. In contrast, a more restricted pattern of microleakage is seen in the 4-META-lined restoration. In Figure 8, the basic fuchsin dye

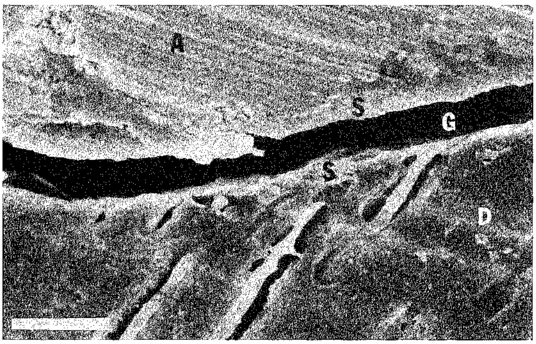

Figure 5. *SEM of an unlined restoration demonstrating a gap at the amalgam/tooth interface and a smear layer micromechanically attached to the amalgam alloy. (X1.3K; Bar = 10 microns; A = Amalgam; D = Dentin; S = Smear Layer; G = Gap.)*

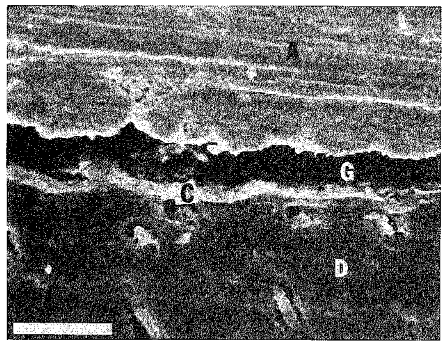

Figure 6. *SEM of a copal-varnish-lined restoration demonstrating a gap and residual Copalite and smear layer covering the dentin at the amalgam/tooth interface. (X1.3K; Bar = 10 microns; A = Amalgam; D = Dentin; C = Copalite/Smear Layer; G = Gap.)*

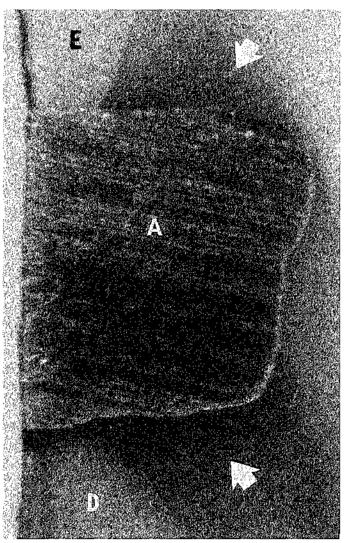

Figure 7. *Unlined Tytin restoration with enamel and dentin margin microleakage scores of 3. Arrows indicate areas of severe, penetrating leakage. (X17.5; A = Amalgam; D = Dentin; E = Enamel.)*

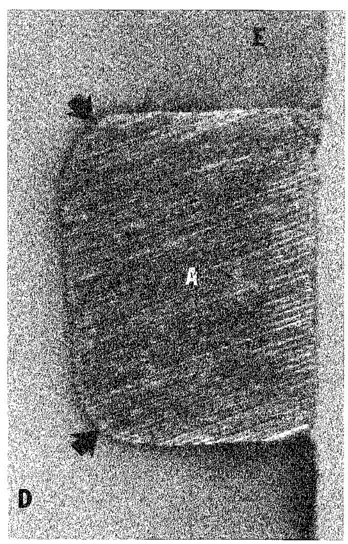

Figure 8. *Aged Amalgambond-lined Dispersalloy restoration with enamel and dentin microleakage scores of 3. Arrows indicate areas where dye penetration is confined to the amalgam/resin liner interface. (X18; A = Amalgam; D = Dentin; E = Enamel.)*

is confined to the amalgam-resin liner interface with restricted penetration into dentin. Both specimens in Figures 7 and 8 were graded 3 for microleakage at enamel and dentin margins; however, the microleakage in the unlined restoration is more invasive and permeates dentinal tubules. Similar patterns of microleakage have been reported by Cooley and others (1991).

In the different liner/alloy combinations tested, microleakage at enamel margins was significantly less than that at dentin margins. This relationship held even in preparations without a liner, suggesting that microleakage at dentin margins is inherently greater. The effects of amalgam shrinkage on setting and differences in the coefficients of thermal expansion for enamel and dentin versus amalgam are factors that contribute to microleakage and may help explain the greater microleakage seen at the dentin margins.

The increased microleakage seen in the aged Amalgambond-lined restoration suggests that the resin undergoes hydrolytic degradation. Nakabayashi, Ashizawa, and Nakamura (1992) suggested that deterioration of 4-META adhesion after long-term immersion in water occurs in a band of exposed collagen that lies between the resin-reinforced "hybrid" dentin layer and the unaltered dentin. With excessive demineralization from etching and incomplete monomer diffusion into the weakened dentin, a band of dentin is left unprotected by resin and accessible to degradation of exposed peptides. Microleakage patterns from this study, however, suggested liner deterioration at both dentin and enamel interfaces.

The location of liner breakdown seen with the SEM is consistent with the observed pattern of microleakage. For both the Amalgambond/Dispersalloy and Amalgambond/Tytin groups, separations and gaps were found at the 4-META/amalgam interface, suggesting an adhesive bond failure of the 4-META resin to the amalgam. In these sections, enamel and dentin surfaces remained sealed with a 5-10 micron layer of Amalgambond remaining attached to the cavity walls (Figures 3 and 4). Separations between the enamel and dentin at the dentinoenamel junction (DEJ) were occasionally noted, suggesting that some gap formation may be an artifact of the SEM processing procedure and not solely due to thermocycling.

The 4-META/Dispersalloy combination produced less microleakage at enamel margins than the 4-META/Tytin combination. The superior performance may be related to better adaptation of the admix alloy to cavity walls through greater condensation forces achievable with the admix particle configuration. For both Dispersalloy and Tytin, minimal micromechanical interlocking was found between the 4-META resin and the amalgam alloy. Although stresses as a result of either thermocycling, amalgam shrinkage, or SEM processing caused separation of the amalgam from the Amalgambond, the mechanical/chemical union between amalgam and liner appears to be weak at best. Charlton, Murchison, and Moore (1991) suggest that the incorporation of adhesive liners in amalgam can affect the compressive strength of the amalgam. Hadavi and others (1991) report evidence that Amalgambond may affect the setting of amalgam alloy and thus create an area of weakness. In the sections viewed with the SEM, the Amalgambond liner was generally less than 10 microns thick, and infiltrations or islands of the resin in the amalgam were not found. Further investigation of the mechanical properties of the "hybrid" amalgam-resin layer and its clinical implications are warranted.

New products are continually being introduced to address the problem of microleakage around amalgam restorations. Results from this study demonstrate the effectiveness of nonaged Amalgambond in sealing the cavity walls of the amalgam restoration in comparison to either copal varnish or no liner. The decreased penetration and level of microleakage with 4-META-lined restorations suggest potential benefits of decreased postoperative sensitivity when used with amalgam restorations. Recurrent caries may also potentially be minimized by an improved dentin seal. With aging, however, increased microleakage in the Amalgambond-lined specimens indicates a level of resin liner breakdown that needs further investigation. Clinical trials are also required to evaluate the long-term in vivo performance of resin-lined amalgam restorations in the oral environment.

CONCLUSIONS

This in vitro evaluation of microleakage in an amalgam restoration lined with a 4-META-based dentin bonding agent found:

1. Microleakage at enamel and dentin margins is significantly reduced when Amalgambond is used as a liner in comparison to either copal varnish or no liner in nonaged amalgam restorations;
2. The Amalgambond/Dispersalloy combination resulted in significantly less microleakage than the Amalgambond/Tytin combination at the enamel margin;
3. Microleakage is significantly increased at both enamel and dentin margins when the Amalgambond-lined restoration is aged for 30 days prior to thermocycling; and
4. The pattern of microleakage for the Amalgambond-lined amalgam restoration was generally restricted to the 4-META/amalgam interface, with low levels of penetration into dentinal tubules.

The opinions or assertions contained in this article are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Navy, Department of Defense, or the US Government.

This project was supported under the Naval Medical Research and Development Command Research Task No M0095-06-3014.

(Received 9 June 1992)

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Review of Periodontal Considerations and Surgical Retraction Techniques for Operative Dentistry

M S HAGGE • T M RECTOR

SUMMARY

Gingival margins of restorations should generally be placed supragingivally or at the gingival crest; however, some valid parameters exist for the extension of margins into the gingival crevice. The successful restoration of teeth in subgingival locations requires familiarity with periodontal anatomy. This paper reviews periodontal considerations, then presents several surgical techniques that facilitate access and improve the periodontal prognosis of teeth that have been compromised through fracture, caries, prior restorative treatment, or habit.

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INTRODUCTION

The operative dentist is required to have an understanding of how restorative materials affect the supporting tissues. Charbeneau (1981) described the importance of eliminating gingival and periodontal inflammation before operative treatment was initiated. Unsupported rubber dam clamps, injudiciously placed retraction cord, and restorations with overhanging or open margins can easily violate the dentogingival junction, initiating iatrogenic periodontitis with attachment loss (Ramfjord, 1988; Schluger & others, 1990). The operative dentist should therefore be familiar with normal periodontal anatomy and have well-founded strategies available when operative dentistry and periodontics overlap.

PERIODONTAL BACKGROUND

The coronal extent of the dentogingival attachment establishes the base of the gingival sulcus and may be accurately located by periodontal probing. Use of a 25-gram probing force will give an accurate determination of sulcular depth and reveal existing inflammation through bleeding on probing (Lang & others, 1991). Such measurements and indices must be determined before initiating subgingival restorative procedures. Although sulcus depth in histological specimens averages 0.69 mm (Gargiulo, Wentz & Orban, 1961), clinical sulcus depths measure between 1-3 mm in a healthy site. Probing measurements may be exaggerated in an inflamed site due to penetration of the connective tissue fibers with accompanying hemorrhage from the ulcerated epithelial lining (Listgarten, Mao & Robinson, 1976; Lang & others, 1991). Depth readings in excess of 3 mm with no hemorrhage on probing may be indicative of inactive periodontal lesions requiring only maintenance therapy. However, restorations should not routinely be extended more than 2.5 mm intrasulcularly, because their margins will be nonaccessible to routine oral hygiene measures (Waerhaug, 1976).

The desirability of supragingival margin placement (Ramfjord, 1988) has been increasingly recognized since the original work by Waerhaug (1960). Sachs (1985) and Ramfjord (1988) have described acceptable restorative indications for subgingival margin placement. These include: (1) replacement or coverage of previously existing subgingival restorations; (2) caries that extends into the sulcus; (3) establishment of a "ferrule" on endodontically treated teeth; (4) esthetics, primarily at the facial margin of maxillary teeth; (5) establishment of proper contours on exposed furcations or resected teeth; and (6) increased retention for teeth with marginally short clinical crowns.

Normal physiologic dimensions of the periodontium have been investigated. Specimens of dentogingival junction (the distance from the alveolar crest to the free gingival margin, composed of connective tissue fibers plus the junctional epithelium) averaged 2.04 mm in a human autopsy study (Gargiulo & others, 1961). This measurement subsequently formed the basis of the "biologic width" concept (Ingber, Rose & Coslet, 1977; Maynard & Wilson, 1979; Wilson & Maynard, 1981; Nevins & Skurow, 1984), which proposed that violation of this dimension by a restoration led directly to apical migration of the junctional epithelium with subsequent loss of the alveolar crest. The biologic width, therefore, needed to be maintained or surgically provided to allow for a healthy periodontium. Ramfjord (1988) took exception to this concept, citing the wide variation reported in Gargiulo and others' study and the paucity of well-designed corroborative clinical studies. He proposed ostectomy only in the amount necessary to properly place and finish restorations, letting the biologic width settle over time, while good oral hygiene measures are followed.

A considerably more resective approach has been proposed by Wagenberg, Eskow, and Langer (1986), who advocate such ostectomy necessary to expose 5.00-5.25 mm of sound tooth structure. Our recommendations follow the moderate approach of Lubow and Cooley (1985), where approximately 3 mm of tooth structure is maintained or provided between the alveolar crest and the ultimate gingival margin of a restoration. This allows 1 mm of root structure for each component of the subgingival area: connective tissue attachment, junctional epithelium, and gingival sulcus. When a cast preparation is to be subsequently placed over a core build-up, an additional millimeter of space is typically incorporated to allow the margins of the casting to be placed on sound tooth structure. This concept has been described as the "ferrule effect" (Eissmann & Radke, 1976; Hoag & Dwyer, 1982; Shillingburg, Jacobi & Brackett, 1987). However, all attempts to improve access or provide biologic width must be tempered with esthetic demands and unnecessary compromise of adjacent teeth through excessive osseous removal.

SURGICAL BACKGROUND

Markley (1955) recommended surgical flaps and limited ostectomy prior to rubber dam application for isolation of deep caries. Drucker and Wolcott (1970) described the gingival blood supply and presented several surgical approaches for class 5 tissue retraction. Xhonga (1971) compared healing rates in these gingival flap methods and found that the design with double vertical incisions placed at the line angles produced the lowest inflammation and least recession. For additional retraction with the ability to reposition the flap apically when necessary, Dilts (1974) recommended extension of vertical incisions past the mucogingival junction. Lubow and Cooley (1985) demonstrated microbial isolates in subgingival caries lesions to be identical with pathogens associated with acute dentoalveolar abscesses. To prevent dissemination of pathogens into and under flaps, they advised that crown extension surgery and subsequent healing take place prior to any restorative procedure where complete isolation of caries with the rubber dam cannot be guaranteed.

SURGICAL PROCEDURES

Gingival and Mucogingival Flaps with Double Vertical Incisions

The double vertical incision technique is easily learned and is performed in class 5 lesions where mechanical retraction alone would produce an irreversible crushing injury to the gingiva. It requires only a scalpel handle and blade, a small periosteal elevator, and a curette or scaler to remove tissue tags. Incisions are begun at the line angles of the tooth, and extended apically in a slightly lateral direction such that the base of the flap is wider than the coronal margin. This ensures noncompromise of the vasculature supplying the healing flap (Barkmeier & Williams, 1978). To improve postoperative adaptation of the flap, these incisions should also be made at a slightly obtuse angle to the external tooth surface. The operator should not hesitate to extend the incisions past the mucogingival junction whenever access remains inadequate with a gingival flap (Dilts, 1974). This is particularly necessary to prevent maceration where minimal attached gingiva remains. The rubber dam is then applied and the operative procedure is completed. A typical gingival flap case is shown in Figures 1a-1e.

Delayed healing or abscess formation may result from retention of tissue or restorative debris, so all flaps must be copiously irrigated before closure (Lubow & Cooley, 1985). With 2 to 3 minutes of moderate to firm pressure, most gingival flaps will not require suturing. Those flaps that have been extended into the alveolar mucosa should be sutured in the mucosal portion. Periodontal dressing may be applied at the operator's discretion. Patient discomfort with gingival flaps has been reported as minimal (Xhonga, 1971; Reagan, 1986), but mild analgesics may be prescribed as necessary. When desired, a mucogingival flap may be apically positioned at the osseous crest to increase the zone of attached gingiva through coronal regeneration (Nabers, 1954, 1957; Ariaudo & Tyrrell, 1957). The facial-lingual thickness of attached gingiva is as important as its coronal-apical width and should always be viewed three-dimensionally (Wennstrom, 1982). Gains in attached gingiva may be achieved with a wide variety of mucogingival surgeries (Hall, 1984; Schluger & others, 1990) but will not be discussed further in this review.

Single Envelope Flap

When facial or lingual caries extends past the mesial or distal line angles, an extension in flap design is indicated. The single envelope flap is typically extended one full tooth anterior and posterior to the teeth requiring restoration. Inversely beveled sulcular incisions are made parallel to the coronal gingival contour, carried into the embrasures, and the flap is reflected. After curettage of the sulcular epithelium, the operative procedure is completed. As with the double vertical incisions, sutures are not generally required unless flap incisions are extended past the mucogingival junction. A simple gingival envelope flap is shown in Figures 2a-2e. Modifications of this design may add single or double vertical incisions at the mesial and distal borders of the flap. The inclusion of vertical incisions decreases the required horizontal extension of the flap. In a majority of cases, osteoplasty (a plastic procedure involving bony recontouring without reduction of supporting bone) is advised to improve flap placement and adaptation. Sutures are placed at each mucosal extension and through the central papilla(e). The mesial and distal papillae may also be sutured if desired.

Double Envelope Flap

The presence of inaccessible class 2 caries necessitates the incorporation of facial and lingual envelope flaps to obtain access and isolation. Flaps are prepared and reflected as described above, and excess connective/granulation tissue is curetted from the interproximal space. Ostectomy (vertical reduction of supporting alveolar bone) is performed to provide the vertical space necessary for a healthy dentogingival attachment when the apical extension of a restoration margin must violate the biologic width. Osteoplasty is virtually always performed in conjunction with ostectomy to contour bony prominences and rough edges that would prevent optimal adaptation of the flap. A useful clinical guideline to follow concerning ostectomy requirements for biologic width is that the gingival margin of the restoration should be visible at the gingival crest following suturing of a well-prepared flap. In Figures 3a-3e, an endodontically treated molar with inadequate vertical crown height and distal violation of the biological width is shown.

Figure 1a. *Facial root caries at cementoenamel junction on tooth #6, preoperative view*

Figure 1b. *Vertical incisions made and tissue reflected. Note visibility of entire carious lesion.*

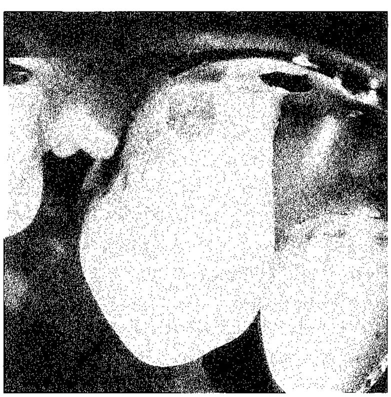

Figure 1c. *Isolation achieved with rubber dam.*

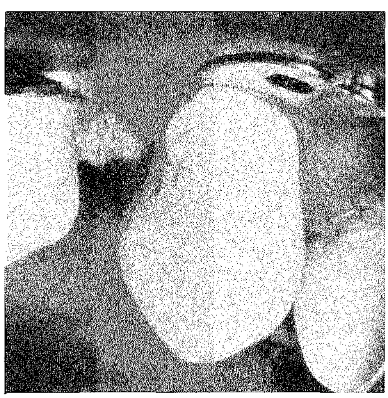

Figure 1d. *Glass-ionomer/microfilled composite resin "sandwich" restoration*

Figure 1e. *One week postoperative view*

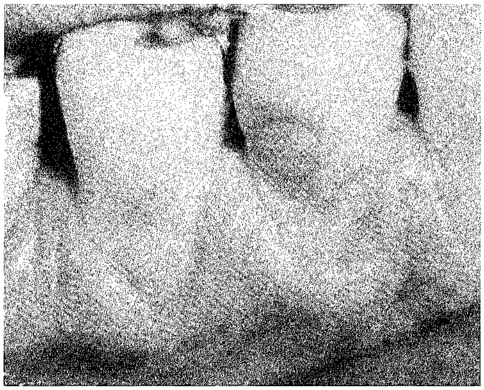

Figure 2a. *Symptomatic facial toothbrush abrasion on teeth #28-29 with defective facial composite resin on tooth #28, preoperative view*

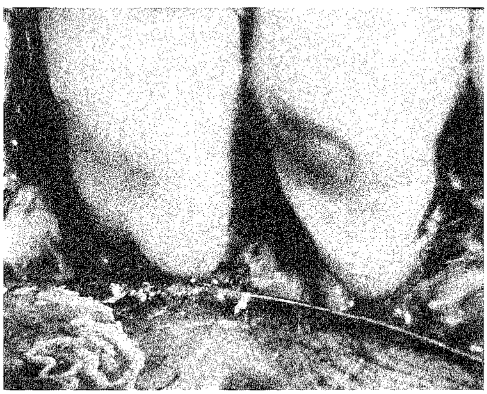

Figure 2b. *Single envelope flap reflected from tooth #27-MF to #31-DF*

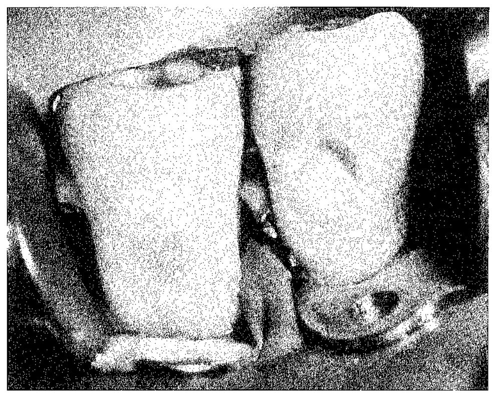

Figure 2c. *Rubber dam isolation and completed preparations*

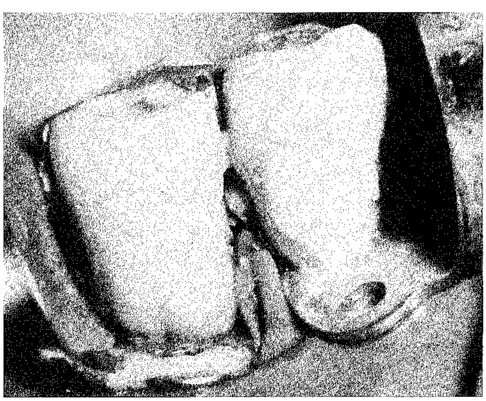

Figure 2d. *Restoration with glass-ionomer cements*

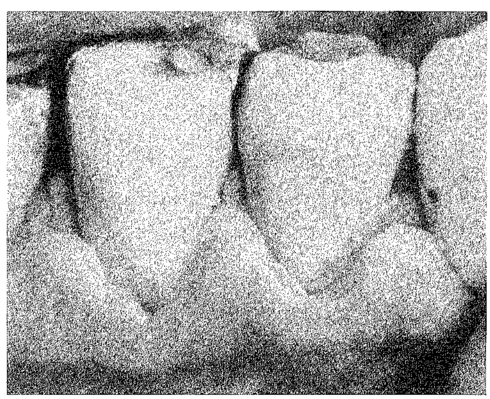

Figure 2e. *One week postoperative view. Despite the clear delineation of the surgical margin, this appearance predictably improves as healing progresses. With time and proper oral hygiene, subsequent gingivoplasty is rarely required.*

Figure 3a. *Endodontically treated tooth #19 with obvious encroachment on biologic width at distal*

Figure 3c. *Facial and lingual flaps are reflected and ostectomy/osteoplasty is performed. Note the fluting contours that have been done in the embrasure and furcal areas. The entrance to the furca has not been exposed.*

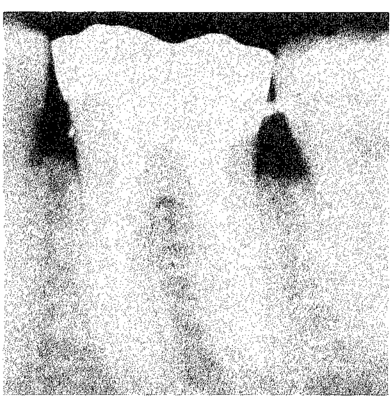

Figure 3e. *Twelve weeks later. A coronal-radicular amalgam restoration was completed. Note that biologic width has been regained at the distal.*

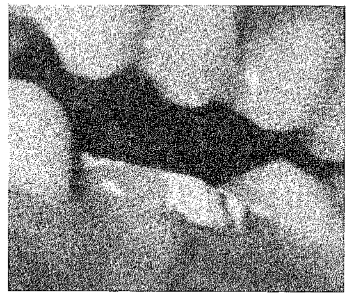

Figure 3b. *Clinical view of tooth #19 demonstrating severely inadequate crown length for restoration*

Figure 3d. *The flap has been apically positioned and closed with three interrupted sutures. Immediate postoperative view*

ADDITIONAL CONSIDERATIONS

Bony dehiscenses and fenestrations were once felt to be more prevalent in areas beneath thin gingiva or mucosa and were routinely treated with partial-thickness flaps (Prichard, 1979) where gingiva/mucosa was sharply dissected away from the underlying connective tissue and periosteum. In most periodontal practices today, partial-thickness flaps are limited to certain corrective mucogingival surgeries such as lateral pedicle flaps, while full-thickness flaps (the gingiva/mucosa and periodontium are elevated simultaneously from bone) are recommended for general use (Lubow & Cooley, 1985).

Following a surgical procedure, further operative treatment in the surgical area must be delayed for 2 to 3 months (Wise, 1985;

Lindhe & others, 1987; Ramfjord, 1988). This interval permits collagen maturation within the connective tissue (required before placement of retraction cord) and final establishment of gingival crest height (essential in esthetic cases).

In certain cases (primarily single-rooted teeth), orthodontic extrusion of the involved tooth may be recommended for teeth with biologic width violations. However, extrusion itself must be followed by a 1-month period of fixed retention and at least 2 additional months to allow for osteoid maturation. Then, because the alveolus and periodontal tissues are extruded with the tooth, crown extension surgery must still be performed with its own 2-3-month healing requirement. A review of orthodontic extrusion techniques has been recently reported by Starr (1991).

CONCLUSIONS

The arbitrary separation of the three surgical techniques presented above has been used solely to simplify description, and the procedures illustrated should not be construed as individually restrictive; that is, the need to overlap or blend any of the techniques presented will occur in clinical practice with their increased use. Provided the operative dentist is intimately familiar with the anatomy of the periodontium, surgical retraction techniques will rapidly become valuable additions to one's clinical repertoire.

Acknowledgment

The authors wish to express their sincerest gratitude to Drs Donald Cummings, Douglas Clarke, Steven Blanchard, and Mary Ellen McLean for their assistance in the completion of this review.

The opinions expressed in this paper are solely those of the authors and are not to be construed as an official position, policy, or decision of the United States Air Force or the Department of Defense.

(Received 9 June 1992)

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Repair of an Aged, Contaminated Indirect Composite Resin with a Direct, Visible-Light-cured Composite Resin

C W TURNER • J C MEIERS

Clinical Relevance
Air abrasion of Concept improves repair strength, and All-Bond provides the highest bond strength.

SUMMARY

This study investigated the interfacial shear bond strength of a contaminated, aged, heat- and pressure-processed, indirect composite resin (Concept) repaired with a direct, visible-light-cured composite resin (Heliomolar). Concept samples were aged by thermocycling and contaminated in tobacco juice. The bonding surfaces were prepared by sanding with 500-grit sandpaper or air abrading with 50-micron aluminum oxide. Prepared Concept surfaces received one or more of the following intermediary resin treatments before the addition of Heliomolar: Heliobond, Special Bond 2, All-Bond system, All-Bond bonding agent, or no bonding agent, and they were immediately thermocycled. Air abrasion produced significantly higher bond strengths than sanding for all intermediary resin surface treatments. The All-Bond-treated Concept surfaces showed the highest interfacial bond strengths within the air abraded and sanded groups. Visual and SEM examination of fractured repair surfaces indicated adhesive failure within all treatment groups.

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INTRODUCTION

Repair is an alternative to the total replacement of a composite resin restoration, because it reduces pulpal trauma and is cost-effective. Indications for a repair procedure include: fracture, abrasion, discoloration and color mismatch of an otherwise clinically sound restoration. Repair situations occur regardless of the type of resin or technique used; i e, macrofill, hybrid, microfill, chemical cure, light cure, heat cure, direct or indirect.

Successful resin repair requires development of an adequate interfacial bond between the old and new resins. Direct composite resin repair studies have shown a wide range of interfacial bond values from 2-85 MPa, and comparisons of those interfacial repair bond strengths to their respective substrate cohesive strengths range from 25%-75% (Azarbal, Boyer & Chan, 1986; Boyer, Chan & Reinhardt, 1984; Chiba, Hosada & Fusayama, 1989; Pounder, Gregory & Powers, 1987; Puckett, Holder & O'Hara, 1991). Composite repair bond strengths above 18 MPa have been reported to give clinically acceptable results (Causton, 1975; Puckett & others, 1991).

There is no consensus within dentistry as to the best repair protocol to follow because of inconsistencies in materials and repair methods used in previous studies. However, some factors have been singled out as potentially significant in influencing interfacial bond strengths: viscosity of the bonding resin, mechanical roughening of the substrate surface, age of the substrate resin, filler concentrations and types, voids, and resin formulation (Chiba, 1983; Gregory, Pounder & Bakus, 1990; Powers & others, 1991; Puckett & others, 1991).

The concentration and availability of unreacted methacrylate groups in the substrate resin and the viscosity of both the bonding agent and repair resin are considered important factors in the formation of interfacial chemical bonds (Azarbal & others, 1986; Boyer & others, 1984; Gregory & others, 1990; Puckett & others, 1991; Vankerckhoven & others, 1982). The concentration of unreacted methacrylate groups and resin viscosity increases as the concentration of aromatic monomer increases (Ruyter & Svendsen, 1977; Vankerckhoven & others, 1982). Monomer types and concentrations vary from brand to brand, thereby introducing inherent differences in their ability to form new covalent bonds with a resin of dissimilar composition.

No primary data have been published regarding either the repair potential or repair techniques for indirect composite resins (Arita & others, 1991; Holder & others, 1991; Mitchem, Ferracane & Gronas, 1991; Supak, Burgess & Summitt, 1992). Indirect resins cured by heat and pressure or high-intensity visible light and vacuum are more highly polymerized than direct resins and therefore have a higher conversion rate of double bonds and more cross-linking (Heymann & others, 1987; Nicholls, 1986). The higher indirect resin conversion rate increases their mechanical properties when compared to direct resins and may prove to be a disadvantage if a repair procedure based on covalent bonding from unreacted methacrylate groups is attempted.

The purpose of this study was to determine the interfacial shear bond strength of an aged, contaminated, heat- and pressure-cured, indirect microfilled composite resin repaired with a visible-light-cured, direct microfilled composite resin using different bonding resins, repair sequences, and surface preparations.

METHODS AND MATERIALS

Ninety Concept (Williams Dental Company, Inc, Amherst, NY 14228) stock samples 6 mm in diameter by 25 mm long with a tip 4 mm in diameter by 2 mm long protruding from the center of the end were made in a split aluminum mold according to the manufacturer's directions (Figure 1). Each stock sample was cut in half (12.5 mm lengths, excluding tip) with a diamond band saw (Exakt Medical Instruments, Inc, Oklahoma City, OK 73148), giving a total of 180 samples. Sample test

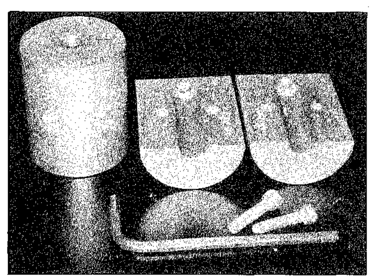

Figure 1. *Split aluminum mold used to fabricate Concept specimens*

surfaces were sanded with 500-grit aluminum oxide sandpaper in a sanding jig to produce a flat surface perpendicular to the sample long axis. Samples were numbered then stored in saline at room temperature when not being manipulated.

Samples were aged by thermocycling for 5,000 cycles between 5 °C and 55 °C with a 1-minute dwell time at each temperature. The samples were then contaminated in tobacco juice for 7 days at 37 °C, rinsed in tap water, and stored in saline at room temperature.

One hundred forty-four samples were randomly assigned to nine test groups (n = 16) using a table of random numbers. A control test group (n = 30) was created to test the cohesive strength of the substrate resin (Table 1).

Table 1. Resin Materials and Test Groups

Test Groups	Repair Sequence	Concept Surface Preparation
Group 1	C / HM	air abraded
Group 2	C / HB / HM	air abraded
Group 3	C / ABS / HM	air abraded
Group 4	C / SB2 / HM	air abraded
Group 5	C / SB2 / HB / HM	air abraded
Group 6	C / SB2 / ABU / HM	air abraded
Group 7	C / HB / HM	sanded
Group 8	C / ABS / HM	sanded
Group 9	C / SB2 / HB / HM	sanded
Control	C	none

Concept (C) (Williams Dental Company Inc, Amherst, NY 14228)
Heliomolar (HM) (Vivadent USA, Inc, Amherst, NY 14228)
Heliobond (HB) (Vivadent USA, Inc)
All-Bond System (ABS) (BISCO, Inc, Downers Grove, IL 60515)
Special Bond 2 (SB2) (Vivadent USA, Inc)
All-Bond unfilled resin (ABU) (BISCO, Inc)

Sample Test Surface Preparation and Bonding

The test surfaces were either sanded with 500-grit aluminum oxide sandpaper for 10 6-inch strokes or air abraded using a Microetcher (Danville Engineering, Danville, CA 94526) with 50-micron aluminum oxide at 80 psi for 3 seconds using a continuous circular motion at 45° to the surface. The prepared surfaces were cleaned with 37% phosphoric acid for 10 seconds and rinsed for 1 minute with tap water, then dried with compressed air.

Sample Test Surface Bonding Sequence

The bonding sequence was performed with the sample secured in a sample holder and base assembly to ensure that the test surface was parallel with and extending about 0.5 mm beyond the surface of the sample holder (Figure 2). The intermediary bonding agents were applied according to manufacturers' instructions following the sequence in Table 1 for each group with the exception that the bonding agents were not light cured before application of the repair composite.

A brass washer (ID = 4 mm, depth = 2 mm) with Teflon tape on the side in contact with the test surface was placed over the sanded or air-abraded test surface to provide a consistent bonding area. The washer was centered on the specimen test area with a plastic jig so that the Teflon surface was stable and flush with the test area to provide a seal.

Heliomolar (Vivadent USA, Inc, Amherst, NY 14228) composite resin was applied to the test area of the washer using a syringe and compule technique. The repair resin was

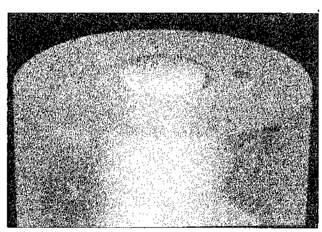

Figure 2. *Concept specimen secured in specimen holder with surface exposed ready for treatment*

made flush with the washer surface using a half Hollenback carver. It was then light cured for 1 minute with a Max (L D Caulk, Milford, DE 19963) light unit that was calibrated prior to use with a Demetron Visible Light Analyzer (Demetron Research Corp, Danbury, CT 06810) to ensure maximum light generation.

The repaired samples were thermocycled for 5,000 cycles between 5 °C and 55 °C with a dwell time of 1 minute at each temperature. The sample holder assemblies were stored in saline at room temperature until testing.

Interfacial Shear Bond Strength Testing

The sample holder assembly was secured in a testing holder, which ensured that the repaired interfacial surface would move only in the transverse direction when loaded (Figure 3). This assembly was placed in a United Universal Testing Machine (United Calibration Corp, Garden Grove, CA 92145) with the brass washer parallel to and engaging the shearing pin. A crosshead speed of 1 mm/min was used to fracture the repaired surface interface.

Scanning Electron Microscope Examination

Representative samples from each test group were examined by scanning electron microscopy (Amray 1200B, Amray, Inc, Bedford, MA 01730) to evaluate prebonding surfaces and interfacial fractured surfaces. The samples were gold sputter coated and examined using an acceleration voltage of 30 kV.

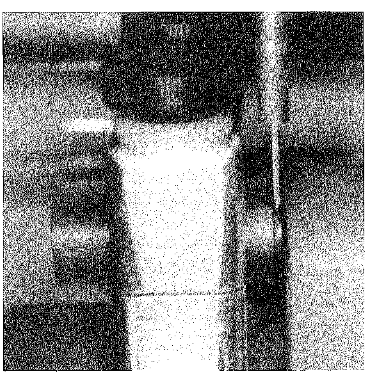

Figure 3. *Concept specimen holder secured in testing assembly holder. Blade of Universal Testing Machine is engaging brass washer.*

Statistical Analysis

Differences in shear bond strengths between the test groups were analyzed using a one-way ANOVA, a Scheffé multiple comparison test and a *t*-test at a significance level of $P \leq 0.05$.

RESULTS

Bond Values

Table 2 summarizes the bond values and the number of bonds that failed during thermocycling for all groups. Concept composite resin that was air abraded and had the All-Bond system applied as the intermediary bonding resin (Group 3) had a significantly higher mean repair bond strength than

Table 2. Shear Bond Strengths of Concept Repaired with Heliomolar

Group (n = 16)	X ± SD (MPa)	Number of Repair Bond Failures during Thermocycling
1	12.3 ± 6.4	2
2	18.9 ± 5.9	0
3	32.1 ± 3.0*	1
4	15.0 ± 8.8	2
5	11.2 ± 7.4	3
6	13.7 ± 12.5	6
7	0.0 ± 0.0	16
8	15.2 ± 6.2	0
9	0.0 ± 0.0	16
Control	18.1 ± 7.3	

*significant difference at $P \leq 0.05$

all the other groups. Concept composite resin that was only sanded and had Heliobond (Group 7) or Special Bond 2 and Heliobond (Group 9) applied as the intermediary bonding resin did not survive thermocycling. The Scheffé Multiple Comparison Test differentiated three subsets of groups, {7,9,5}, {5,1,6,4,8,2}, and {3}, where the groups within each subset were not statistically ($P \leq 0.05$) different from each other. The air-abraded groups had significantly higher bond strengths than the sanded samples when the intermediary bonding resin was kept constant (Figure 4).

SEM Analysis

Air abrading with 50-micron aluminum oxide created a rougher surface than sanding with 500-grit sandpaper (Figures 5 and 6). Examination of selected fractured interfaces from each test group indicated that failure occurred predominantly along the substrate-repair interface. Therefore, adhesive failure was the predominant mode of failure. Figure 7 displays the most common debonded surface features displayed in the Concept specimens. A small number of islands of the repair composite resin were found on some of the substrate interfaces in the air-abraded

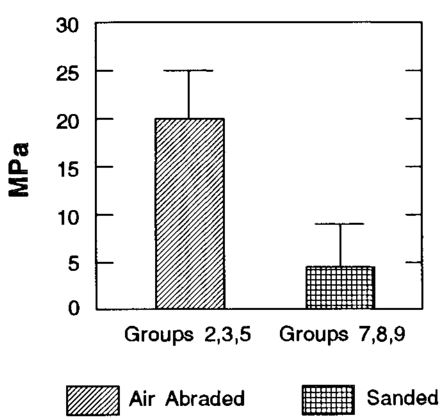

Figure 4. *Comparison of repair bond strengths of air-abraded and sanded Concept samples ($\bar{X} \pm SD$)*

Figure 5. *Concept surface air abraded with 50-micron aluminum oxide at 80 psi (original magnification X400)*

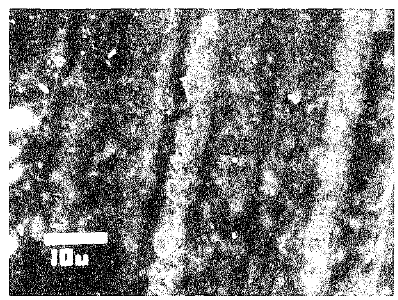

Figure 6. *Concept surface sanded with 500-grit aluminum oxide sandpaper (original magnification X400)*

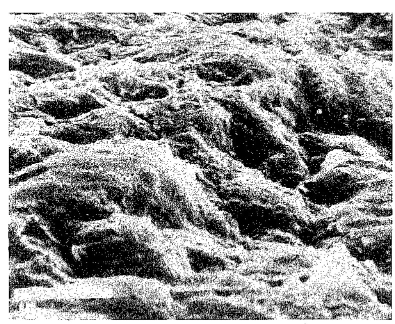

Figure 7. *Fractured Concept surface debonded from surface shown in Figure 6 (original magnification X720)*

groups, which indicated that some cohesive failure of the repair resin occurred (Figure 8). The size but not the number of the islands increased as repair bond values increased from 14 MPa.

Microfractures in the interface surfaces increased in number as repair bond values increased (Figure 9). Voids were found in both the substrate and repair resin interfaces but were more frequent and larger in the repair resin interface (Figure 10). Microfractures were found to connect surface voids in both Concept and Heliomolar composite resin interfaces (Figure 11).

DISCUSSION

The data from this study indicated that surface roughness had more of an influence on the repair bond values for a highly stressed indirect resin surface than did the choice of a bonding agent. Fractured surfaces examined with SEM showed no conclusive evidence that chemical (covalent) bonding contributed to the repair bond values from the evaluation of fractured repaired surfaces.

The sanded Concept surface appeared glossy smooth to the naked eye and was intended to provide a bonding surface free of micromechanical retentive areas. A smooth surface would allow for measurement of any significant covalent bonding between the intermediary treatments and the substrate composite. SEM analysis of the sanded surface showed enough surface roughness that

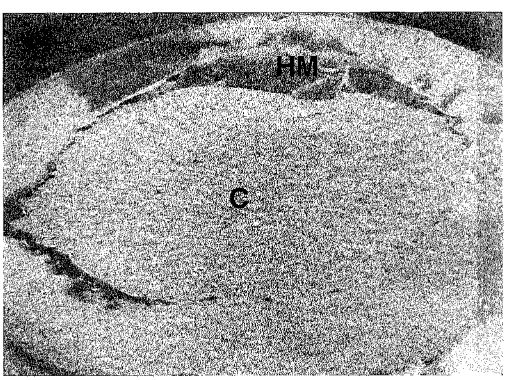

Figure 8. *Debonded surface of Concept (C) showing an island of repair composite, Heliomolar (HM), still attached (original magnification X8.8)*

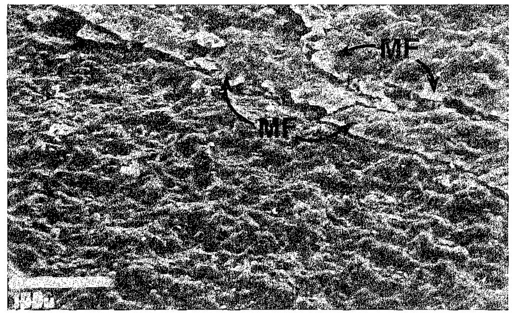

Figure 9. *Debonded repair composite surface, Heliomolar, showing subsurface microfractures (MF) (original magnification X720)*

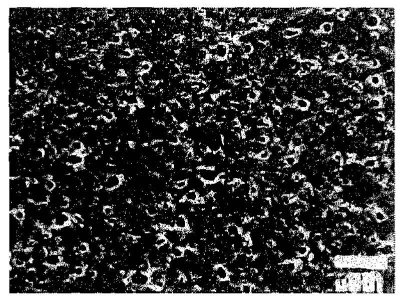

Figure 10. *Debonded repair composite surface, Heliomolar, showing surface voids (V) (original magnification X40)*

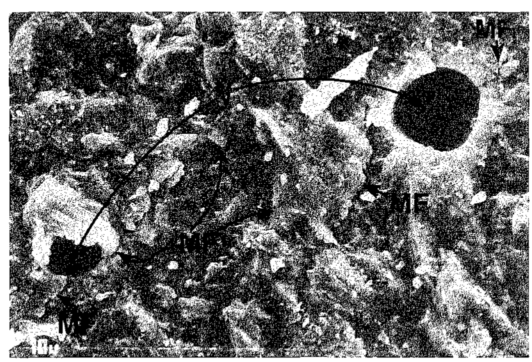

Figure 11. *Debonded repair composite surface, Heliomolar, showing microfractures (MF) connecting voids (V) (original magnification X280)*

micromechanical retention could not be ruled out. Evaluation of direct resin repair bond studies is clouded because the contribution of micromechanical retention and covalent bonding cannot be distinguished by current procedures and analyses. Clinical procedure should reflect the predominant influence on repair bond strength development. Resin to enamel and resin to metal bonding studies further support the adequacy of micromechanical retention alone for clinically successful surface adhesion, thus eliminating the need to rely on covalent bonding (Puckett & others, 1991; Suh, 1991; Laswell, Welk & Regenos, 1971).

Groups 3 and 8 (All-Bond system) had significantly higher bond strengths than the other groups when the intermediary bonding resin was controlled and the surface preparation was varied. This may be indicative of the ability of the All-Bond Primers A and B to wet and penetrate the surface micromechanical retentive areas on the Concept composite resin. All-Bond Primers A and B are hydrophilic monomers with a reported low viscosity and good wettability to enhance surface penetration (Suh, 1991). Puckett and others (1991) in their direct resin repair study also found that a hydrophilic bonding resin gave the highest repair bond strengths.

Repair bond strengths are variable and unpredictable, as was shown in this study by the broad ranges of bond values. Variable technique, resin formulation, filler type and concentration, void concentration, contaminants, polymerization density, and resin age all may in their own way contribute to unpredictable repair bond strengths.

Chemical (covalent) bonding to a cured resin depends on the concentration of unreacted methacrylate groups (double bonds) on the bonding surface. The polymerization density in a cured resin is uneven due to the formation of microregions or microgels (Horie & others, 1975; Korolev & Berlin, 1963). Microregions are caused by steric hindrance as polymerization proceeds and contain around them the highest concentrations of unreacted methacrylate groups (Ruyter & Svendsen, 1977). One can speculate from this that the polymerization density pattern is three-dimensionally random, which would affect the pattern and concentration of available unreacted methacrylate groups at the surface below the air-inhibited layer or in any cut surface. If this theoretical concept is true, the ability to form covalent bonds with additional resin is therefore unpredictable and variable within the substrate resin, and a range of repair bond values based on covalent bonding would be expected. Ranges in bond values with even distributions by group were seen in this study.

Methacrylate radicals in a newly polymerized resin decompose in a logarithmic order, the rate of which is increased with increased filler amount or increased temperature (Burtscher, 1990). Filler type and surface area appear also to affect radical half-life (Burtscher, 1990). Terminal reactions of unreacted double bonds increase over time, further reducing the cohesive (covalent bonding) repair potential of a resin (Grassie, 1956; Ruyter & Svendsen, 1977). Therefore the likelihood of achieving covalent bonding between a substrate resin and a repair resin is inverse to the age of the substrate resin.

The cohesive shear strength for the control group was considerably lower than the manufacturer's published transverse strength for Concept. The low value was most likely due to poor sample design. Polymerization stresses showed up in the samples as transverse cracks or separation of the material. The importance of the sample design and the curing stresses was not fully appreciated until testing of the controls was completed. The curing stresses could have weakened the material by developing microfractures as they released. The microfractures then could provide a path for failure when the material was tested. Voids could have a similar effect. Both voids and microfractures were found during the SEM analysis of control fractures (Figure 10). The microfractures could not be differentiated as the cause, the effect, or incidental to the cohesive failure from loading and fracture.

CONCLUSIONS

This study evaluated the repair potential of highly stressed Concept surfaces that were aged, contaminated, repaired, and thermocycled.

The data analyses allowed the following conclusions to be drawn:

1. Air abrasion was the most important variable that provided significantly higher repair bond strengths;

2. The All-Bond system (Primer A & B, bonding agent) was the intermediary resin treatment that gave significantly higher bond strengths in both the sanded and air-abraded groups; and

3. Micromechanical retention rather than covalent bonding appears to provide the predominant adhesive force in the repair of an indirect, heat- and pressure-cured microfilled composite resin with a direct, visible-light-cured microfilled composite resin.

(Received 9 July 1992)

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The Efficacy of Dental Sealants for an Adult Population

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B N KNUCKLES • M PATTON

Clinical Relevance
Sealants can be retained in adult teeth that are sound, have incipient caries or small amalgam restorations.

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SUMMARY

A 1-year pilot study was conducted to determine the retentive capacities of dental sealants on adult teeth. It proposed to utilize the knowledge and experience gained in sealant application, as a means of attacking the problem of the increase in restored teeth at risk in the aging population. Eighty patients aged 30-50 had Delton tinted sealant applied on one to four contralateral nonhomologous, first or second, acceptable molar pairs. Fifty-five patients completed the evaluation at 1 year, with a 68% retention for 250 teeth: teeth listed as sound, 94.1%; IC and IC-amalgam, 93.7%, and amalgam, 44.9%.

REVIEW OF THE LITERATURE

Introduction

Numerous studies have addressed the methodology, safety, efficacy, and cost-effectiveness of sealants applied to pits and fissures in the teeth of children (Leverett & others, 1983; Gwinnett, 1982; Simonsen, 1982). A consensus was reached at a conference on sealants in 1984: It is necessary to promote the use of sealants in order to reduce the decay in the most prominent sites, pits and fissures, plus those associated with lingual and buccal grooves (National Institutes of Health, 1984; Stamm, 1984). Few studies have addressed the use of sealants for adults (Swango, 1983; Mertz-Fairhurst, 1984; Gerke, 1987; Curro & Levi, 1987; Weintraub, 1989). Douglass and Gammon (1984) made surveys that reported a significant increase in caries incidence among aging people. Beck and others' survey (1985) in Iowa of dentate subjects over the age of 65 showed a 90% rate of coronal decay, 39% for untreated root lesions, and a mean of 2.3 decayed and filled surfaces. They forecast a considerable increase in caries problems for the group if population projections are accurate. Also the decline of caries and retention of teeth are not found in many developing countries (Bureau of Economic and Behavioral Research, 1982; Graves & Stamm, 1985). A feasibility factor to help in the study was the ease of application of sealants and acceptance by adult patients compared to that associated with routine restorative methods.

Purpose

Primarily, the study was conducted to determine if a dental sealant applied to adults' teeth would retain and protect them against decay in the functional occlusion of human maturity and variation. Secondarily, the aim was to establish a basic protocol and patient base from which to carry on a longer study if it were to be funded.

METHODS AND MATERIALS

The study was designed to evaluate the retention of a self-curing, tinted sealant (Delton, Johnson & Johnson Dental Products Co, East Windsor, NJ 08520) by the teeth of patients aged 30-50 years. Screening of these patients determined if they possessed a minumum of one pair or up to four acceptable study pairs. Acceptable teeth were sound, had incipient lesions, or contained small class 1 amalgam restorations without decay or obvious seepage. Contralateral pairs were teeth numbers 3 and 14, 2 and 15, 19 and 30, 18 and 31. Pairs consisted of nonhomologous teeth: combinations of contralateral pairs, mixing sound teeth with those that had incipient caries or teeth with small class 1 amalgam restorations, excluding class 2 caries or restorations. This selection allowed an additional six combinations over the use of homologous pairs only, and increased the opportunity to gain acceptable study teeth. The contralateral paired teeth were selected for testing rather than the use of the half-mouth design, which was considered no longer fair to the patients in view of the results obtained by Mertz-Fairhurst and others in sealing adult teeth.

Sealant was applied to teeth with occlusal amalgam restorations because scanning microscope studies have indicated that the surface of these restorations is quite rough, with many crevices and crannies, and well suited to the retention of sealant (Call-Smith, Newcomer & Mertz-Fairhurst, 1983a; Newcomer, Call-Smith & Mertz-Fairhurst, 1983). Because of this finding, the sealant was applied essentially to protect the margins from the ditching effect and microleakage associated with wear and tear on such margins.

Clinical Consensus of Examiners

The training of examiners was conducted in the operative clinic at Meharry. Each patient was examined by the consultant first and then by each examiner-to-be, using the Modified Ryge criteria (Ryge, 1972) for marginal integrity, caries and the location of caries, restorations, and the presence of sealant. Examiners were coached until each could understand the process with accuracy with the consultant and with each other. A consensus level of 90-95% was attained by each examiner, whose standard was the recorded findings of the consultant, and the individual findings recorded were thus compared. Training for examiner consensus occurred in each of 2 consecutive days with the same group of patients.

Diagnosis of Caries

The examiners established a consensus of the clinical diagnosis of decay as follows: (a) catch and softness, (b) catch and opacity, (c) catch and etching or white spot, or (d) softness and clinically obvious loss of tooth structure. During the screening examination to gain new patients, four bitewing radiographs were taken and analyzed. A consensus was reached by the examiners on the depth of occlusal decay for incipient lesions. Lesions were rated numerically from one to eight, with lesion one barely visible at the dentinoenamel junction (DEJ), and lesion eight more than three-fourths into dentin. For the study, it was agreed that the lesions would be acceptable through level four (more than one-fourth but less than one-half way into dentin), and rejected at levels five through eight. Where the decay was in the central pit area, the distance between the DEJ and the pulp chamber was estimated. However, with decay in the mesial or distal pits, the distance between the DEJ and the nearest pulp horn was estimated.

Marginal Integrity Associated with Sealant Retention

Retention of the sealant was confirmed if the restorations or tooth sites were completely sealed (coded Oscar) or if the restorations of teeth were partially sealed (coded Oscar-Alfa Bravo), or coded Alfa-Bravo if no sealant was retained; yet the latter teeth were clinically acceptable (Ryge & Snyder, 1973). Exposed dentin or base or defective restorations on teeth were coded Charlie or Delta, and the teeth eliminated for consideration at baseline (no coding as Charlie or Delta were called at 3 or 12 months' evaluation (Table 1).

Procedures for Application of the Sealant

The sealant team consisted of two dental hygienist-operators and two dental examiners. The operators were aided by the dental assistant in isolating, drying, etching, and placing the sealant. Soft toothbrushes were used by the patient as an aid to cleaning. Plain pumice on rubber cups was used to clean some teeth prior to sealing. All patient teeth were given a prophylaxis at the 90-day evaluation. The operators were especially checked and admonished to control moisture so that the sealant would remain uncontaminated. The teeth were isolated by cotton rolls and kept dried.

RESULTS

Although the goal of 100 patients with sealant placed at the baseline appointment was not met, the following data were recorded for those who did participate. A total of 80 patients were provided with sealant at the baseline sessions on 368 individual teeth (184 pairs). At 3 months, 64 patients had 292 teeth sealed (146 pairs). During the final check of retention at 1 year, data were obtained

Table 1. Ryge Marginal Integrity Associated with Sealant Retention

Sealant Retained	Sealant Partially Retained	Sealant Not Retained
Oscar: tooth and/or restoration fully covered with sealant. No catches with explorer and no bare areas.	Oscar Alfa: tooth and/or restoration covered partly with sealant and no crevice along a bare margin	Alfa: no sealant or crevice but clinically acceptable
		Bravo: no sealant, crevices present and explorer catches on margins, but clinically acceptable
		Charlie: no sealant and a deep crevice present to dentin; clinically not acceptable
		Delta: teeth not used in the study

on 55 patients with 250 teeth (125 pairs).

Baseline Status

At the baseline evaluation, approximately one-half of all individual teeth were analyzed as sound; 9% had incipient caries (IC); more than one-third were identified as Amalgam-Bravo (AB-37%) for marginal integrity. Teeth listed as incipient caries were 9% (33) of that category, while all other amalgam and mixed categories totaled 4.6% (17 teeth).

Categories of teeth examined at the baseline evaluation were: sound, incipient decay (IC), Amalgam-Bravo (AB), Amalgam-Alfa (AA), Amalgam-Bravo/Incipient Caries (AB-IC), Amalgam Bravo/Amalgam Alfa (AB-AA), and Amalgam-Alfa/Incipient Caries (AA-IC). Teeth with these categories of marginal integrity were evaluated at 3 and 12 months in terms of full, partial, or no retention (Table 2).

Evaluation at 3 Months

With 64 persons participating (down from 80), it was found that 70.5% of all teeth had retained the sealant. Teeth listed as sound and IC made up 55.8% of this group and exhibited the highest retention levels at 82.6 and 84.2% respectively. Forty-four percent of this group were made up of teeth with amalgam and incipient caries (IC) combinations. Of 34 teeth reported with no sealant retention (11.6%), 16 were in the Amalgam-Bravo category (14.5%) followed by 11 teeth in the sound category (7.6%) (Table 3).

Table 2. Status of Individual Teeth at Baseline (N = 80)

Tooth	Sound		IC		AB		AB-IC		AB-AA		AA		AA-IC		Sound-AB		Total	
Number	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
2	26	(43.3)	6	(10.0)	26	(43.3)	1	(1.7)	1	(1.7)	0	(—)	0	(—)	0	(—)	60	(100)
15	24	(40.0)	6	(10.0)	29	(48.3)	1	(1.7)	1	(—)	1	(—)	0	(—)	0	(—)	60	(100)
3	28	(65.1)	3	(7.0)	11	(25.6)	0	(—)	1	(2.3)	0	(—)	0	(—)	0	(—)	43	(100)
14	28	(65.1)	2	(4.7)	13	(30.2)	0	(—)	0	(—)	0	(—)	0	(—)	0	(—)	43	(100)
18	17	(37.8)	4	(8.9)	18	(40.0)	1	(2.2)	0	(—)	3	(6.7)	1	(2.2)	1	(2.2)	45	(100)
31	16	(35.6)	7	(15.6)	19	(42.2)	0	(—)	0	(—)	3	(6.7)	0	(—)	0	(—)	45	(100)
19	21	(8.3)	3	(8.3)	9	(25.0)	1	(2.8)	0	(—)	2	(5.6)	0	(—)	0	(—)	36	(100)
30	22	(61.1)	2	(5.6)	11	(30.6)	0	(—)	0	(—)	1	(2.8)	0	(—)	0	(—)	36	(100)
All teeth	182	(49.4)	33	(9.0)	136	(37.0)	4	(1.1)	3	(0.5)	10	(2.4)	1	(0.3)	1	(0.3)	368	(100)

*Table 3. Retention of Sealant at 3 Months by First and Second Molars (*N = 64)*

			Partially Retained:				Not Retained:					
Tooth	Retained: Oscar		Oscar-Alfa		Oscar-Bravo		Alfa-Bravo					
Number	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
2	37	(78.7)	1	(2.1)	4	(8.5)	0	(0.0)	5	(10.6)	47	(100)
15	32	(68.1)	1	(2.1)	9	(19.1)	0	(0.0)	5	(10.6)	47	(100)
3	23	(74.2)	0	(—)	3	(16.1)	0	(0.0)	3	(9.7)	31	(100)
14	24	(77.4)	0	(—)	4	(12.9)	0	(0.0)	3	(9.7)	31	(100)
18	24	(63.2)	0	(—)	10	(26.3)	0	(0.0)	4	(10.5)	38	(100)
31	23	(60.5)	1	(2.6)	7	(18.4)	0	(0.0)	7	(18.4)	38	(100)
19	23	(76.7)	0	(—)	3	(10.0)	0	(0.0)	4	(13.3)	30	(100)
30	20	(66.7)	0	(—)	7	(23.3)	0	(0.0)	3	(10.0)	30	(100)
Total	206	(70.5)	3	(1.0)	47	(16.8)	0	(0.0)	34	(11.6)	292	(100)

Total: 52 (17.8%)

*Sound = no decay; IC = Incipient Caries; AB = Amalgam Bravo; AA = Amalgam Alfa; AB, IC, AB, AA, and AA-IC = combination of categories.

Evaluation at 1 Year

Fifty-five persons completed their part in the year-long study, with a total of 250 single teeth having sealant applied to them. Retention of the sealant for all categories was found in 170 teeth of 250 total (68.0%), partially retained in 69 teeth (27.6%), and 11 teeth (4.4%) had no retention. Sound and IC categories experienced the best retention at 94.1 and 93.3% respectively (Table 4).

Retention of Paired Teeth

At the 1-year evaluation for 55 patients, the retention for all 125 pairs was 53.6%, partially retained 46.4% (58), with no pairs without some sealant. First molars (3 and 14, 19 and 30) had better retention (69.2 and 65.4%) than second molars (2 and 15, 18 and 31) with 42.5 and 45.4% respectively. Upper teeth had better retention (52%) than lower teeth (48% approximately (Table 5, figure).

Influence of Variables

The ratio of male to female patients was about 51% to 49% respectively, closely approximating the ratio found in the population at large in the United States. A larger sample would be needed before the influence of age, race, and fluoridated water could realistically be considered.

DISCUSSION

The less than optimal rate of retention achieved at the 90-day evaluation was mostly preventable through better supervision of the application process. Factors that cloud this statement somewhat are the loss of nine subjects and the possibility that these nine

*Table 4. Retention of Sealant at 1 Year for Baseline Categories (Condensed) (*N = 55)*

Baseline Category	Retained Oscar Number	%	Partially Retained Oscar-Alfa or Oscar-Bravo Number	%	No Retention (Clinically Acceptable) Alfa-Bravo Number	%	Total	%
Sound	112	(94.1)	7	(5.8)	0	(—)	119	(100)
IC	14	(93.3)	0	(—)	1	(6.6)	15	(100)
AB	35	(35.7)	55	(56.1)	8	(8.16)	98	(100)
AA	6	(66.7)	3	(33.3)	0	(—)	9	(100)
AB-IC	2	(40.0)	2	(40.0)	1	(100.0)	5	(100)
AB-AA	0	(—)	2	(66.7)	1	(33.3)	3	(100)
AA-IC	1	(100)	0	(—)	0	(—)	1	(100)
Total:	170	(68.0)	69	(27.6)	11	(4.4)	250	(100)

*Data for Oscar-Alfa and Oscar-Bravo are combined under Partially Retained.

Table 5. Retention of Sealant by Pairs at 1 Year (N = 55)

Pairs: Teeth Numbers	Retained Number	%	Partially Retained Number	%	Not Retained Number	%	Total Number	%
2 & 15	17	(42.5)	23	(57.5)	0	(—)	40	(100)
3 & 14	18	(69.2)	8	(30.8)	0	(—)	26	(100)
18 & 31	15	(45.4)	18	(54.5)	0	(—)	33	(100)
19 & 30	17	(65.4)	9	(34.6)	0	(—)	26	(100)
All Pairs:	67	(53.6)	58	(46.4)	0	(—)	125	(100)

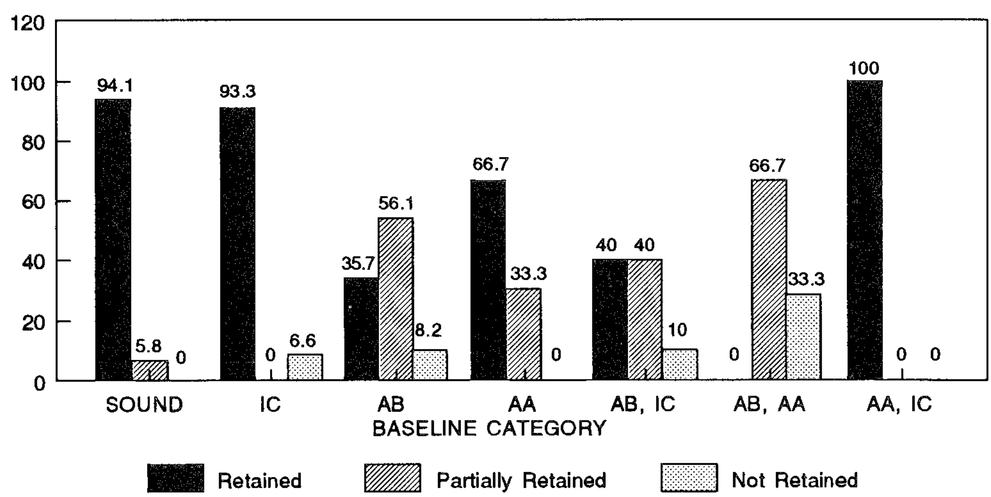
subjects had good retention of sealant. A need for improvement in the supervision of the placement of the sealant is indicated by the increase in partial retention percentage of nonretained teeth at 1 year (4.4) compared to the 90-day evaluation (11.6%) (Table 6). Resealing of all teeth with a bare area (35 patients) was necessary at 90 days. The rate of retention, 68% for 170 of 250 teeth, indicates a favorable view that sealants can be a significant factor in reducing the number of teeth at risk for an aging population. This finding opposes the viewpoint expressed by Weintraub (1989), who stated that sealants " ... can be useful for children and young adults but not for older age groups." She refers to epidemiological evidence (not supplied) and no studies.

Possible Factors Influencing the Results

There may be factors such as operator skill of application, site location on individual teeth or on upper or lower arches, the occlusion and attrition rate of individual subjects, or of age, race, and exposure to fluoridated water. The only factor attaining credence, however, is that of operator skill in the application of the sealant. A possible factor might have been the use of study teeth in the baseline stage with larger occlusal amalgam restorations than feasible.

The data on contralateral pairs for 1 year (Table 6) were interesting, but no conclusion could be drawn from them. Results were hardly uniform for pairs at 12 months. Retention for second molars was 14% to 17%

Retention of sealant at 1 year for baseline categories (N = 55)



*Sound = no decay; IC = Incipient Caries; AB = Amalgam Bravo; AA = Amalgam Alfa; AB, IC, AB, AA, and AA-IC = combination of categories.

Table 6. Gross Retention Rates at 3 Months and 1 Year

Evaluation	Number of Teeth	Sealant Retained	%	Partially Retained	%	Not Retained	%	Patient Sample
3 months	292	206	(70.5)	52	(17.8)	34	(11.6)	65
1 year	250	170	(68.0)	69	(27.6)	11	(4.4)	55

less than first molars in lower and upper arches respectively. This occurrence may be associated with the greater problems of isolation of the teeth from moisture when sealing second molars than when sealing first molars.

Examination of radiographs showed no increase in decay occlusally or interproximally.

CONCLUSIONS

This beginning research, as a pilot study, has shown that there is encouraging promise that a larger, longer research project can answer more positively the extent to which retention of sealants can approach 100%. For a team new to research, in an environment not used to the productivity and concepts applied by experienced investigators, it is felt that the results are promising for the time span, budget, and constraints endured. While much better results and a higher rate of retention would be expected in a longer, more in-depth study, this pilot project has, for the team, attained its goal of breaking ground in the research field and developing a working protocol for continuing research. It was also found that:

1. Retention was highest for teeth that were sound or had incipient caries compared to the combination with amalgam restorations.
2. Overall retention at 90 days and 1 year was close (68-70%) to that found by investigators on sealed restorations (Mertz-Fairhurst & others, 1987).
3. Resealing following the baseline application can be expected, but it can be significantly reduced by close attention to the details of sealant placement.
4. Incipient and approximal caries failed to increase during the months between examination and completion of the study. Apparently sealants retard occlusal decay, and acidulated phosphate fluoride gel seems to inhibit the progress of approximal decay.
5. The experience gained can be built upon by carrying out a study of 3 or more years' duration.

Acknowledgment

The team owes a great debt to its consultant, Dr Eva J Mertz-Fairhurst, Medical College of Georgia, for her irreplaceable input and advice.

(Received 14 July 1992)

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Reasons for Placement and Replacement of Dental Restorations in the United States Navy Dental Corps

A K YORK • J STEPHEN ARTHUR

SUMMARY

This study investigated the reasons for placement and replacement of dental restorations in the United States Navy Dental Corps. The relationship between restoration longevity and the reasons for replacement of restorations was also studied. Data on newly placed dental restorations were collected from restorative dentists working at 11 Naval Dental Clinics located throughout the United States. Participating dentists at each clinic were asked to collect data for all restorations they placed during a two-week period. Data on 4633 restorations were collected from 88 dentists. The most common reasons for placement of restorations varied by age category. Primary caries was the most common reason for patients 18-34 years of age, while noncarious reasons for placement were most common for patients 35 years of age and older. The most common reason for replacement of restorations was secondary caries. For all replacement reasons amalgam restorations had greater longevity than composite resin restorations.

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INTRODUCTION

The treatment planning of dental restorations has traditionally been based more on the individual dentist's beliefs than on sound scientific criteria. Therefore, dentists vary widely in their treatment decisions regarding the need for restorations. A number of studies have attempted to determine the primary reasons, as reported by dentists, for the placement and replacement of restorations (MacInnis, Ismail & Brogan, 1991; Nuckles & others, 1991; Qvist, Qvist & Mjör, 1990a; Qvist, Qvist & Mjör, 1990b; Allander, Birkhed & Bratthall, 1990; Drake, Maryniuk & Bentley, 1990; Klausner, Green & Charbeneau, 1987; Klausner & Charbeneau, 1985; Boyd & Richardson, 1985; Mjör, 1981; Richardson & Boyd, 1973; Healey & Phillips, 1949).

Primary caries has consistently been found to be the most common reason for placement of restorations. Qvist and others (1990a & b) reported that 39% of all amalgam restorations and 38% of all tooth-colored restorations were placed due to primary caries. Klausner and Charbeneau (1985) reported that 59% of all amalgams were placed due to primary caries, while a third study reported 46% of amalgams were placed due to primary caries (Klausner & others, 1987).

Secondary caries has consistently been found to be the most common reason for replacement of amalgam restorations (Healey & Phillips, 1949; Richardson & Boyd, 1973; Mjör, 1981; Boyd & Richardson, 1985; Klausner & Charbeneau, 1985; Klausner & others, 1987; Qvist & others, 1990a). The reported percentage of all reasons for replacement of amalgam restorations due to secondary caries has varied between 34% and 68%, depending upon the population studied. Reasons for replacement of tooth-colored restorations have also been studied. Mjör (1981) reported poor anatomical form as the most common reason for replacement of tooth-colored restorations (40%), while Drake and others (1990) reported that the most common reason for replacement of anterior restorations was recurrent caries (54%).

The literature has demonstrated that the reasons for placement and replacement of dental restorations vary widely, depending upon the population being studied. The present study assessed the reasons for placement and replacement of dental restorations in a United States Navy population. Restoration longevity, as it relates to reasons for restoration replacement, was also evaluated.

METHODS AND MATERIALS

Data on newly placed dental restorations were collected from restorative dentists working at 11 Naval Dental Clinics located throughout the continental United States. Participating dentists at each clinic were asked to collect data for all restorations they placed during a 2-week period. A data collection form was designed specifically for use in this study. Data for 25 restorations were collected on each form, in coded format. The information collected for each restoration was patient military rank, patient age, tooth number, single primary reason for restoration placement, restoration material used for the new and old restoration, tooth surfaces of the new and old restoration, and dates of placement of the new and old restorations. All collected data were entered into a computer data base for analysis.

RESULTS

Data on 4633 newly placed dental restorations were collected from 88 operative dentists. The dental patients, for whom the restorations were placed, were primarily active-duty Navy and Marine Corps personnel (96.9%). The other patients were retired military personnel (2.1%) and military dependents (1.0%). Patients ranged in age from 17 to 84 years, with a mean of 26.2 years and a median of 22 years. The data collection form provided five choices for the type of restorative material used. These choices were amalgam, composite resin, fissure sealant, glass ionomer, and gold foil. Of the 4633 restorations collected, there were 3623 (78.2%) amalgams, 747 (16.1%) composite resins, 214 (4.6%) sealants, 42 (0.9%) glass ionomers, and 7 (0.2%) gold foils. All further analysis was concentrated on amalgam and composite restorations only, due to the small numbers of sealants, glass ionomers, and gold foils placed.

Tables 1 and 2 give the distribution of reasons for placement of amalgam and composite restorations respectively. As shown, 67.1% of amalgams and 51.9% of composite resins were placed due to primary caries. The primary reason for replacement of amalgam restorations was secondary caries, while

Table 1. Distribution of Reasons for Placement of Amalgam Restorations

Reason for Placement	Freq	Percent
1	2033	56.1%
2	420	11.6%
3	531	14.7%
4	194	5.4%
5	246	6.8%
6	91	2.5%
7	7	0.2%
8	92	2.5%
9	9	0.2%
Total	3623	100.0%

Restoration Replacement Codes

1. Primary caries (not involving removal of an existing restoration)
2. Primary caries (involving removal/alteration of an existing restoration)
3. Secondary caries (directly associated with failure of a restoration)
4. Open margin, poor contour, open contact, overhang, no caries noted
5. Broken or lost restoration, no caries noted
6. Fractured tooth, no caries noted
7. Pain/sensitivity, no apparent caries or restoration problems
8. Restoration due to endodontic treatment
9. Restoration to facilitate prosthodontic treatment

Table 2. Distribution of Reasons for Placement of Composite Resin Restorations

Reason for Placement	Freq	Percent
1	354	47.4%
2	34	4.6%
3	78	10.4%
4	36	4.8%
5	71	9.5%
6	82	11.0%
7	54	7.2%
8	11	1.5%
9	27	3.6%
Total	747	100.0%

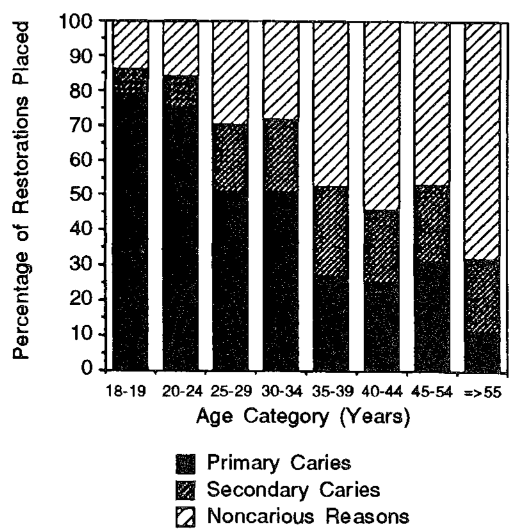
Restoration Replacement Codes

1. Primary caries (not involving removal of an existing restoration)
2. Primary caries (involving removal/alteration of an existing restoration)
3. Secondary caries (directly associated with failure of a restoration)
4. Open margin, poor contour, open contact, overhang, no caries noted
5. Broken or lost restoration, no caries noted
6. Fractured tooth, no caries noted
7. Poor esthetics, no caries noted
8. Pain/sensitivity, no apparent caries or restoration problems
9. Restoration due to endodontic treatment

the most common reasons for replacement of composite resins were fractured tooth, secondary caries, and broken or lost restoration.

Figure 1 shows the percentage of all restorations placed due to primary caries, secondary caries, and for all other (noncarious) reasons, by age category. The graph shows that the percentage placed due to primary caries declined as age increased. It also shows that the percentage of restorations placed due to combined primary and secondary caries declined as age increased. For all age groups 25 years and above, however, the percentage of restorations placed due to secondary caries alone remained fairly constant at around 20%. Therefore, the decline in the percentage of primary caries with advancing age is matched by an increase in the percentage of restorations placed for noncarious reasons. This would be expected,

Figure 1. *Percentage of restorations placed due to primary caries, secondary caries, and for noncarious reasons, by age category*



due to the fact that as the number of filled surfaces increases with age, the number of surfaces at risk to primary caries attack decreases. Also, this increasing number of filled surfaces increases the risk of noncarious restoration failure.

Figures 2 and 3 show the percentage of restorations placed due to primary caries, secondary caries, and for all other (noncarious) reasons, by age group, for amalgam and composite restorations respectively. A comparison of Figures 2 and 3 shows that in the younger age groups (18-29 years of age), the percentage of amalgam restorations placed due to primary caries is significantly greater than the percentage of composite resin restorations placed due to primary caries (18-19: $P = 0.009$; 20-24; $P < 0.001$; 25-29: $P = 0.022$). In older age groups, however, the percentage of composite resin restorations placed due to primary caries is numerically greater than the corresponding percentage of amalgam restorations. This finding is statistically significant, however, in only the 40-44 age group ($P = 0.005$), due in part to the relatively small numbers of composite resins placed in the other age groups 35 years of age and older (i e, 35-39 years of age: 40 resins; 40-44 years of age: 52 resins; 45-54 years of age: 24 resins; 55 years of age or older: 46 resins). Figure 2 shows the decline, as age increased, in the percentage of amalgam restorations placed due to primary caries. Figure 3, however, shows no significant difference in the percentages of composite resin restorations placed due to primary caries between the ages of 25 and 54 years ($P > 0.05$). Also, in the age groups 35 years of age and older (Figure 3), the percentage of composite resins placed due to secondary caries is approximately one-third to one-half the percentage of amalgams placed due to secondary caries. This difference is statistically significant for the age groups 35-39 ($P = 0.007$) and 40-44 ($P = 0.012$).

Figures 4 and 5 show the mean and median longevity of amalgam and composite resin restorations, by reason for replacement. As Figure 4 shows, amalgams replaced for carious reasons had a mean and median longevity of approximately 7.4 and 6.0 years respectively. Those replaced due to open margins, poor contour, open contacts, and overhangs had mean and median longevities of 9.3 and 8.8 years respectively. Amalgams

Figure 2. *Percentage of amalgam restorations placed due to primary caries, secondary caries, and for noncarious reasons, by age category*

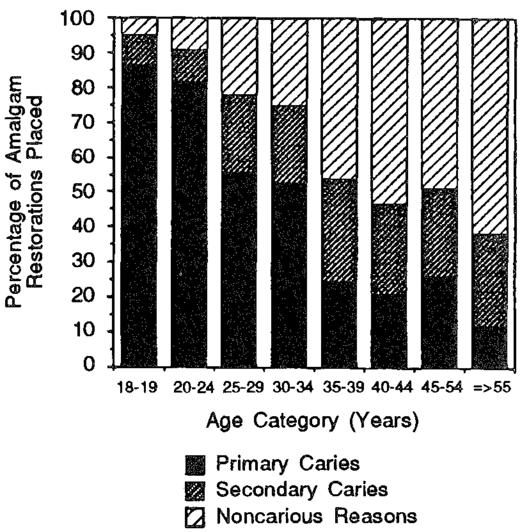
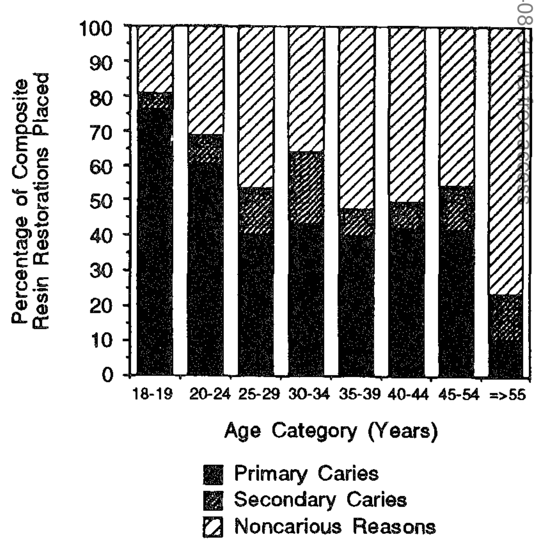


Figure 3. *Percentage of composite resin restorations placed due to primary caries, secondary caries, and for noncarious reasons, by age category*

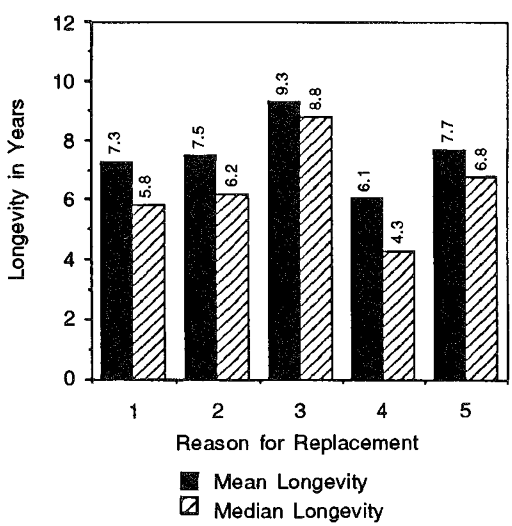


replaced due to broken or lost restorations, with no caries present, had a mean longevity of 6.1 years and a median longevity of 4.3 years. This difference in the mean and median indicates that a few amalgams with exceptionally long longevity are having a large effect on the group mean, while in reality one-half of the restorations were replaced less than 4.3 years from their original date of placement. As shown in Figure 5, the longevity of composite resin restorations replaced due to secondary caries was approximately 6 years, while those replaced due to primary caries, involving removal of an existing restoration, was 3 to 4 years. Those replaced due to open margins, poor contour, open contacts, and overhangs had a mean and median longevity of 7.5 and 7 years respectively. The longevity for those composite resins replaced for esthetic reasons had a mean and median longevity of 8.3 and 9.1 years respectively. It is interesting to note that those composite resins replaced due to broken or lost restorations, for which longevity data were collected (n = 43), had a mean longevity of 1.8 years and a median longevity of only 0.7 years. Therefore, one-half of those composite resins classified as broken or lost lasted slightly over 8 months.

DISCUSSION

This study has provided statistical information necessary for a full understanding of the dental restorative practices of dentists within the United States Navy. All previously cited studies that have looked at reasons for placement of restorations have reported only crude percentages. The reporting of crude percentages is misleading, because the percentage of amalgam restorations placed due to primary caries has been shown in this study to vary,

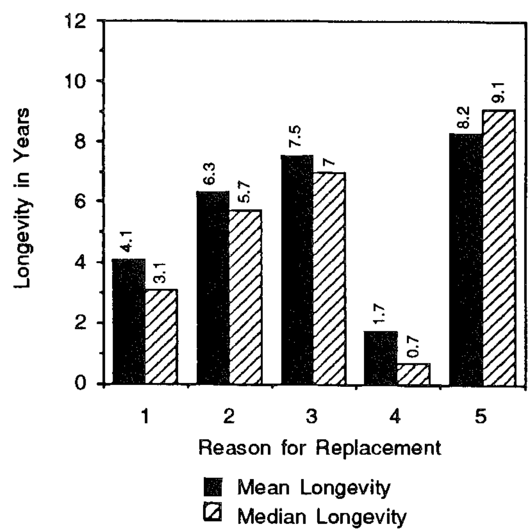
Figure 4. *Mean and median longevity of amalgam restorations by reason for replacement*



Restoration Replacement Codes

1. Primary caries (involving removal/alteration of an existing restoration)
2. Secondary caries (directly associated with failure of a restoration)
3. Open margin, poor contour, open contact, overhang, no caries noted
4. Broken or lost restoration, no caries noted
5. Fractured tooth, no caries noted

Figure 5. *Mean and median longevity of composite resin restorations by reason for replacement*



Restoration Replacement Codes

1. Primary caries (involving removal/alteration of an existing restoration)
2. Secondary caries (directly associated with failure of a restoration)
3. Open margin, poor contour, open contact, overhang, no caries noted
4. Broken or lost restoration, no caries noted
5. Poor esthetics, no caries noted

depending upon the age distribution of the population being studied. In this study, all reasons for restoration placement were stratified by age category and by restorative material. The study also focused on those restorations being replaced. A determination of the mean and median longevity of both amalgam and composite resin restorations stratified by reason for replacement was presented. It is important to emphasize that the reported longevity represents replaced restorations only and not restorations, placed by Navy dentists, that are still functional and therefore not replaced. Previous studies have not provided this amount of stratified analysis.

CONCLUSIONS

The most commonly placed restorative material in this study was amalgam (78.2%) followed by composite resin (16.1%). The most common reasons for placement of restorations varied by age category. Primary caries was the most common for patients 18-34 years of age, while noncarious reasons for placement were most common for patients 35 years of age and older. The most common reason for replacement of restorations was secondary caries (33.4%). For all replacement reasons amalgam restorations had greater longevity than composite resin restorations.

The opinions or assertions contained in this article are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Navy, Department of Defense, or the US government.

(Received 14 July 1992)

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Effect of Grooves On Resistance/Retention Form of Class 2 Approximal Slot Amalgam Restorations

J B SUMMITT • J W OSBORNE • J O BURGESS

SUMMARY

This study evaluated in vitro the effectiveness of resistance/retention grooves in box-only (approximal slot) class 2 preparations. Forty-eight sound, caries-free maxillary premolars were distributed equally into four groups of 12 teeth based on faciolingual dimensions. Teeth were mounted vertically, and class 2 mesio-occlusal slot preparations were cut in each tooth. Resistance/retention grooves were placed in three of the four groups with a #1/4 round bur to a depth of 0.3-0.5 mm. Teeth were restored with amalgam and positioned 13.5° from vertical; an area was flattened on each amalgam marginal ridge, and the flattened areas were loaded to failure using an Instron with a rectangular flat-ended rod at a cross-head speed of 1 mm/min. Mean load (SD) to failure of the group using "conventional" grooves extending in dentin from the gingival floor occlusally to near the occlusal DEJ was 196N (46N). For long grooves extending from the gingival floor to the occlusal surface, the mean failure load was 169N (58N). Slot restorations with short resistance/retention grooves or points (0.5-1.0 mm) just gingival to the occlusal DEJ had a mean failure load of 132N (44N). Slot restorations with no grooves had a mean failure load of 69N (46N). ANOVA and Student-Newman-Keuls tests were used for analysis. The no-groove group provided significantly less ($P < 0.01$) resistance than any group with grooves. Approximal slot restorations with "conventional" grooves were significantly more resistant ($P < 0.01$) than those with short grooves but were not significantly more resistant than those with long grooves.

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INTRODUCTION

The use of approximal resistance/retention grooves has been debated extensively by the profession. The debate has been complicated by advances in bur design and the development of adhesive systems. Reductions in bur dimensions have allowed a minimal removal of tooth structure in intracoronal operative dentistry preparations. Sealants have permitted noncarious fissures to be sealed rather than included in amalgam preparations (Summitt & Osborne, 1992). These advances in technology and philosophy have been supported by long-term clinical data (Osborne & Gale, 1990), which strongly indicates that smaller amalgam restorations may be expected to have greater longevity.

This is our third investigation of effectiveness of approximal resistance/retention grooves or points in class 2 amalgam restorations. The first study (Summitt & others, 1992) evaluated the effect of grooves in conservative class 2 restorations with faciolingually narrow (0.7 mm) occlusal extensions through the central grooves of maxillary premolars. That study concluded that short resistance/retention grooves or points in dentin just occlusal to the axiopulpal line angle provided as much resistance to fracture and dislodgement of the approximal portion of amalgam as did grooves that extended to the occlusal cavosurface margin, and more resistance than no grooves or "conventional" resistance/retention grooves. The study suggested that resistance/retention points or grooves are necessary when the occlusal extension of a class 2 amalgam preparation is faciolingually narrow.

The second study (Summitt & others, 1993) evaluated the effectiveness of resistance/retention grooves in class 2 amalgam restorations with faciolingually wide (1.8 mm) extensions through the central grooves of maxillary premolars and found that the approximal portions of restorations in which there were no resistance/retention grooves were as resistant to fracture and dislodgement as restorations in which resistance/retention grooves were used. This is supported by the clinical studies of Terkla and Mahler (1967) and Terkla, Mahler, and Van Eysden (1973), who found resistance/retention grooves to be unnecessary for the success of the restorations they tested. The preparations in their clinical studies incorporated comparatively wide occlusal extensions through the central grooves.

When approximal caries has been diagnosed and there is no occlusal caries, an approximal slot amalgam restoration may be the restoration of choice. Benefits of the slot amalgam restoration have been put forward by several authors (Almquist, Cowan & Lambert, 1973; Sturdevant & others, 1985; Robinson, 1985) and include maintenance of tooth strength, maintenance of occlusal enamel, and limiting the extent of restoration margin length. These authors advocated the use of resistance/retention grooves in slot restorations. No clinical study has tested the need for resistance/retention grooves in approximal slot amalgam restorations.

This study compared resistance form of approximal slot (box-only) amalgam restorations provided by three different types of resistance/retention grooves and by no grooves.

METHODS AND MATERIALS

Forty-eight extracted human maxillary premolars, free of caries and restorations, were sorted by faciolingual dimensions. Teeth were divided into four groups of 12 teeth each, with sizes distributed to give approximately equal mean dimensions in each group. Roots were notched and embedded in Cerro-Bend Alloy (Cerro Metal Products, Bellefonte, PA 16823) that was confined by cylinders of polyvinyl chloride tubing 3/4 of an inch (19.0 mm) high with an outside diameter of 1 1/16 inches (26.9 mm). Specimens were stored in tap water when not being prepared or tested.

Mesio-occlusal approximal slot preparations were cut by one operator to standardized dimensions (Table 1) using a #330 (ISO size 008) pear-shaped bur and a #1/4 (ISO size

Table 1. Dimensions of Class 2 Slot Preparations

Location		Dimension ± tolerance
Faciolingual dimensions of slot	at occlusal	2.25 mm ± 0.25 mm
	at gingival	2.75 mm ± 0.25mm
Depth of slot gingivally from marginal ridge		3.5 mm ± 0.5 mm
width of gingival floor axially		1.25 mm ± 0.15 mm

005) round bur (Midwest Dental Products Corp, Des Plaines, IL 60018-1884) in a high-speed handpiece (Star Futura 2, Star Dental, Valley Forge, PA 19482), and appropriate sharp hand instruments.

Figures 1a and 1b show a typical preparation from the occlusal and from the mesial aspects. After all cavities were prepared, resistance/retention grooves were placed by one operator to a depth of 0.3 to 0.5 mm and a width of 0.5 mm using a #1/4 round bur in a high-speed handpiece at very low speed. Grooves were cut to bisect the axiofacial and axiolingual line angles. Resistance/retention grooves in three of the four groups are illustrated in Figure 2 and were as follows.

Group	Resistance/Retention Grooves
A	"Conventional" grooves extending from gingival floor occlusally to just gingival to occlusal dentinoenamel junction (DEJ) (Figure 2a)
B	Long grooves extending from the gingival floor to the occlusal surface of the tooth (Figure 2b)
C	Short retention grooves or retention points (0.5-1.0 mm occluso-gingivally) located just gingival to the occlusal DEJ (Figure 2c)
D	No grooves placed (Figure 2d)

Two Tofflemire #1 matrix bands (Union Broach Corp, Long Island City, NY 11101) in a Tofflemire retainer were adapted to each premolar. Amalgam (Valiant PhD, L D Caulk, Milford, DE 19963-0359) was triturated in an amalgamator (Caulk Vari-Mix 111, L D Caulk) for 9 seconds at the "M" setting and inserted by one operator using vertical and lateral condensation with condensers that fit all areas of the preparations. The amalgam was condensed to overfill the preparation by at least 0.5 mm, then carved to contour with a sharp interproximal carver (IPC, Thompson Dental Manufacturing Co, Inc, Missoula, MT 59801).

After aging 1 month in tap water at room temperature, specimens were positioned in a fixture at a 13.5° angle. A #57 (ISO size 010) straight fissure bur (Midwest Dental Products Corp) in a straight handpiece (Bell International, Burlingame, CA 94010) mounted in a paralleling device was used to flatten a 1 mm x 1.5 mm area of the amalgam marginal ridge

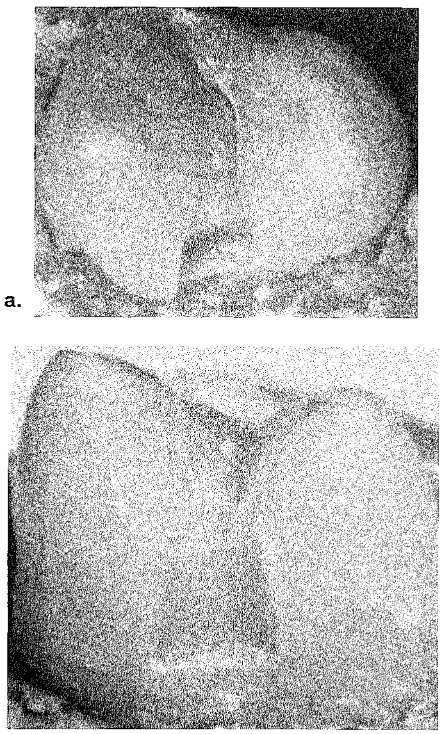


Figure 1. *Typical outline of a preparation shown from the occlusal (a) and the mesio-occlusal (b) aspects.*

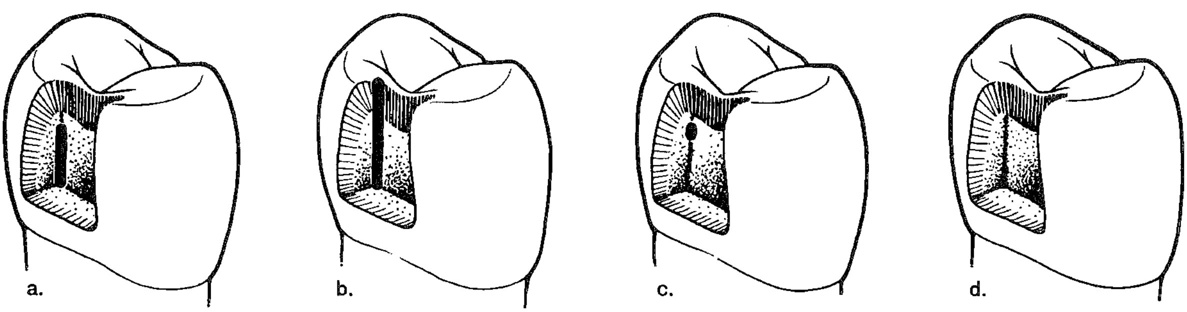


Figure 2. The four preparation designs tested in the study. "Conventional" grooves (a); long grooves (b); short grooves or points located just gingival to occlusal DEJ (c); and no grooves (d).

(Figures 3a, 3b). Specimens were positioned in the same fixture to hold them at a 13.5° angle for loading. A rectangular rod (1.0 mm x 1.3 mm) was used to load the flattened amalgam in compression using a Universal Mechanical Testing Machine (Model 2511, Instron Corp, Canton, MA 02021) at a cross-head speed of 1 mm/minute (Figures 4a, 4b). Failure load in newtons and mode of failure were recorded for each specimen. The data were analyzed using a one-factor analysis of variance (ANOVA) and a Newman-Keuls post-hoc analysis.

RESULTS

Results are summarized in Table 2 and indicated that Group A, with "conventional" grooves (extending from gingival floor occlusally to near the occlusal DEJ), provided the most resistance, but not significantly more than Group 6, which had long grooves that extended to the occlusal surface. Group C, with short grooves just gingival to the occlusal DEJ, had significantly less ($P < 0.01$) resistance than "conventional" grooves, but the difference in this group and that in Group B (long grooves) were not significant. The group with no grooves (Group D) was significantly less ($P < 0.01$) resistant to failure than any of the other groups. In Group D all failures were complete, with no amalgam left in the box. In the other groups, some of the fractured specimens had amalgam remaining in the grooves.

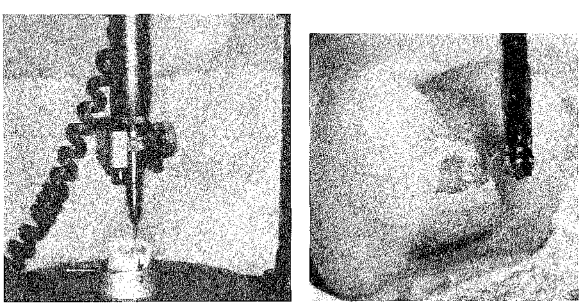
DISCUSSION

This study evaluated the effect of resistance/retention grooves on the resistance form of class 2 approximal slot restorations. Although no clinical study has been conducted to verify the need for resistance/retention grooves in approximal slot restorations, there are clinical indications that distinct resistance/retention grooves are needed. In addition, in three studies of the effectiveness of resistance/retention grooves in class 2 amalgam restorations, the slot prep without grooves provided the least resistance of all combinations tested (Summitt & others, 1992 & 1993). Without grooves in these restorations, there is no undercut retention to prevent dislodgement of the restoration in an approximal direction. Indeed, such a preparation without resistance/retention grooves resembles an inlay preparation, and that type of preparation design is contraindicated for dental amalgam.

The resistance provided to approximal slot restorations by grooves was studied in vitro by Sturdevant and others (1987).

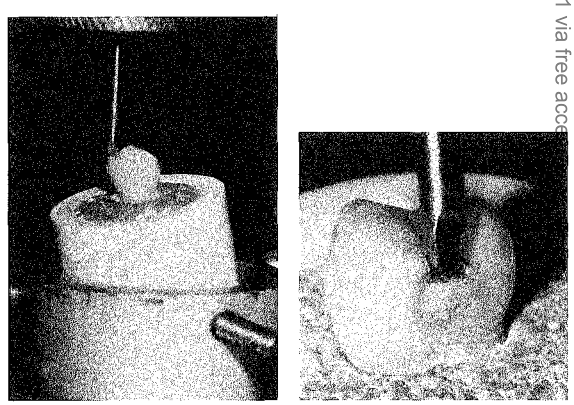
Table 2. Mean Failure Loads {newtons (N)} of Approximal Slot Class 2 Mesio-occlusal Amalgam Restorations in Maxillary Premolars with No Retention Grooves and with Three Configurations of Retention Grooves. Lines connect groups that are not significantly different (P < 0.01)

Group	Type of Retention Grooves	Load to Fracture	SD
A	"Conventional" grooves	196	46
B	Long grooves, extending from gingival floor occlusally to near occlusal DEJ	169	58
C	Short grooves or points just gingival to occlusal DEJ	132	44
D	No grooves	69	46



3a. 3b.

Figure 3. *Specimen positioned in fixture at 13.5° (a), while the marginal ridge area was flattened with #57 bur in a straight handpiece (b).*



4a. 4b.

Figure 4. *Specimen loaded in compression in an Instron Testing Machine (a), using a rectangular loading rod with dimensions 1.0 mm x 1.3 mm (b).*

They compared slot preparations with long grooves to preparations with "conventional" grooves. Both grooves were prepared with #169L tapered fissure burs. The long grooves had a consistent depth (0.5 mm) and extended from the gingival floor to the occlusal surface; those grooves were similar to the long grooves in the study being reported. The "conventional" grooves had a depth of 0.5 mm at their gingival ends and extended from the gingival floor to taper out at a distance of 1.5 mm from the occlusal surface; the "conventional" grooves in the study being reported were of approximately the same length, depth, and location as in the Sturdevant and others (1987) study, but they did not taper at the occlusal ends. Sturdevant and others reported that retention groove length did not significantly affect resistance of the restoration to failure.

This study evaluated resistance form of an approximal slot restoration with no grooves and found it to be significantly less resistant ($P < 0.01$) than slot restorations with grooves. Also evaluated were two types of retention grooves similar to those tested in approximal slot restorations by Sturdevant and others (1987). Both studies had similar findings: no significant difference between long grooves and "conventional" grooves. This study also examined the resistance that resistance/retention points or grooves just gingival to the occlusal DEJ provided. Although these resistance/retention points were found to be effective when used in preparations with narrow occlusal extensions in a previous study (Summitt & others, 1992), they did not provide as much resistance as longer grooves in this study of approximal slot restorations. Approximal slot restorations with resistance/retention points did, however, demonstrate significantly more resistance ($P < 0.01$) than slot restorations without any grooves or points.

In vitro studies such as this do not provide definitive answers to clinical questions, but they provide an indication of what might be expected clinically. It would seem evident from the results of this study that approximal slot restorations with resistance/retention grooves will have a better chance for clinical success than those without grooves. Based on this study and the study of Sturdevant and others (1987), it also would appear that long grooves and "conventional" grooves provide similar resistance to displacement for these slot restorations, and that the shorter resistance/retention grooves, or points, are less adequate for slot restorations.

CONCLUSIONS

1. Approximal slot restorations with no grooves had significantly less ($P < 0.01$) resistance to displacement than approximal slot restorations with 0.5 mm-deep grooves.
2. Long grooves and "conventional" grooves provided similar ($P > 0.01$) resistance to displacement of the approximal slot restoration.
3. Resistance/retention points just gingival to the occlusal DEJ provided significantly less resistance to displacement than "conventional" grooves.

(Received 17 December 1992)

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DEPARTMENTS

LETTER

DEAR MS CLINTON

Your desire to improve dental health in the USA, as outlined in your letter to Hillary Rodham Clinton, is commendable, especially in emphasizing the importance of prevention over treatment. The policy you advocate, however, would do more harm than good, because your analysis of the problem is fatally flawed.

You express particular concern for the poor and aged ("economically disadvantaged" and "senior citizens," in your terms), and to help the aged you recommend adding dentistry to Medicare. But Medicare and Medicaid are costly failures that have added greatly to the problems of medicine today--and to other problems in the economy as well. Your proposal constitutes an attempt to reinforce failure, an error that I recall from having been in the armed forces we were warned never to commit. Rather than expanding Medicare and Medicaid, they should be phased out, but as both have developed enormous bureaucracies with vested interests in maintaining the programs, changes are unlikely to be made soon; bad policies, once begun, are difficult to reverse.

The laws of economics cannot be contravened with impunity, though the lag from cause to effect is usually much longer than in physics. It took about 70 years for socialism in the USSR to collapse; Social Security is now 55 years old and on the verge of collapse; Medicaid and Medicare have been with us for over 20 years and are in deep trouble in both quality and cost of service. Socialism has failed, or is failing, wherever it has been tried, and economics, drawing on cybernetics and the theory of chaos, can explain why this is inevitably so. The desire to help the poor is admirable, and efforts should be made to do so, but when politicians try to help, they usually manage to create more poverty. A minimum wage is bound to cause unemployment and thus hurt the poor, though it may not be manifest for a year or so. Controls over wages and prices have never worked. If the price is set too high, as in subsidies to farmers, a surplus results; if the price is set too low, as in some African countries where the government is the sole purchaser of agricultural products, a shortage results, with accompanying famine; or as a headline in *The Times* (of London) 1 July 1993 states, "NHS [National Health Service] waiting lists 'pass 1 m[illion]'". It was control of wages during World War II that led to the introduction of fringe benefits, which now distort the economy adversely and, by allowing a third party to come between the dentist or physician, have exacerbated the problems of dental and medical treatment.

Health is too important a matter to be delegated to the government. Health should remain a personal responsibility, because the benefits of good health accrue to the individual, not to the fiction called "society." Self-reliance should be encouraged, not dependence on the State. Your solicitude for improving the health of all is praiseworthy, but the policy you advocate to achieve that end is first-class economic nonsense.

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RESPONSE

Thank you for your review of economic theory and history as it pertains to our current health and dental care systems. As always, the depth and breadth of your knowledge are welcome and your counsel is appreciated. You seem to have focused on the one sentence of my editorial that deals with Medicaid and Medicare, and so I will begin my response in this area.

When calibrating observations for "first-class ... nonsense," your paper's underlying supposition that having a social conscience constitutes "socialism" may well serve as the normative standard. The lecture from Econ 101 serves as a wonderful smoke screen for your basic premise that health care "should remain a personal responsibility, because the benefits of good health accrue to the individual, and not the fiction called 'society'." Easy for you to say. Unfortunately, this is a narrow and elitist perspective of the world. Would your response be the same if your wife was in dental pain and you had to choose between feeding your family or paying for the relief of her dental pain? Would your attitude still be the implied "Let those who can afford treatment seek it" and the stated "Self-reliance should be encouraged, not dependence on the State"?

The focus on the history of Medicaid, Medicare, and socialist economics is misguided. The focus should be on people in need. That's what my editorial was about. That's why we entered this healing profession.

I too learned some lessons in the armed forces. An error I was "warned never to commit" was to complain about a situation without also bringing a proposed solution. Your solution appears to be "do nothing...business as usual." So we have come full circle. The people now without oral health care will remain without benefits.

Now that, sir, <u>is</u> first-class nonsense.

MAXWELL H ANDERSON
Editor

Editor's Note: How tough do you think Ian will be on my foil at our next study club meeting?

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