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Aim and Scope

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

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EDITORIAL

Should There Be Relicensing Requirements?

Dentistry is getting more sophisticated, complicated, and interesting every day. Our capability to provide quality care for the general population has increased ten-fold in the last 20-30 years. Still, we license dentists and other healthcare providers on a one-time basis and allow for continual renewal of licenses with little or no evidence of the quality of care being delivered.

Many dentists take great pride in practicing dentistry "exactly" as it was taught when they were dental students. Greene Vardiman Black stated that dentists should always remain students throughout their careers, and yet some practice in the manner in which they were taught in the forties, fifties, and sixties. It is certainly an asset to keep values, quality, and proven procedures indefinitely. However, what about those dentists who treat periodontal disease as they did when they were in dental school: that is, treat it like either a non-entity or a disease that all are destined to lose their teeth from? At one time there were schools that used zinc-phosphate cement as a pulp-capping agent. Does this mean that it is acceptable to do so today?

Somewhere in our professional life we must learn to keep current with technology, materials, and improved services. Perhaps the largest impact has been brought about by the Academy of General Dentistry, which requires continuing dental education for membership. Also there are a number of states with a requirement for a specified number of continuing education hours for relicensing.

Does the taking of the lecture-type of continuing education course ensure an impact on the broad knowledge base required to practice in today's environment? Perhaps not, but it can be a real asset. And will all these lecture courses cause us to improve our skills?

There are many continuing education courses that are participatory; they usually take place in a laboratory. These courses are a step forward in the teaching of new technical procedures, but the number of courses available as well as the number of people participating fall far short of training all dentists.

How can we ensure that dentists sustain a level of competence throughout their lifetime? Attending meetings and continuing education courses are valuable to all who participate. We know, however, that many dentists never attend a course or go to a meeting where courses are available.

How can we ensure that dentists' skills are indeed current? Obviously, just taking courses does not ensure learning. Perhaps the day is here when we should have requirements for renewal of a license, such as a two-day written examination to be successfully challenged every five years. This would certainly get a large number of dentists into the literature, forcing them to stay current. Such a board examination could be likened to the National Board Examinations. If individuals were to fail the examination, they would have one year in which to retake the examination successfully, or suffer the consequences of losing their license.

Comments anyone?

DAVID J BALES
Editor

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ORIGINAL ARTICLES

Compatibility of Impressions and Die Stone Material

H M OMANA • V W RINNE • T T TRUONG

Summary

The compatibility of four impression materials with 11 different die stones was tested. All the combinations tested performed within the 20 μm ADA standard.

Introduction

Compatibility of impression and die stone material is important to the success of any cast restoration (Craig, 1985). The better the impression and die stone combinations can reproduce the details of a preparation, the greater the accuracy of the resulting casting. Hence the amount of compatibility a die stone has for an impression material will directly affect the amount of detail reproduced on the die.

The purpose of this pilot study is to test the compatibility of four light-bodied polysiloxane impression materials with 11 different die stones. The different combinations were compared one to another in their ability to reproduce 6 μm and 17 μm grooves inscribed in stainless steel blocks. The American Dental Association's Specification No 19 states that in order for an elastomeric impression material to be considered compatible with gypsum materials, it must reproduce a 20 μm-wide line in stone (Council on Dental Materials and Devices, 1977). The degrees of compatibility of the various impression-stone complexes were differentiated by the use of a profilometer (Sloan-Dek Tac Model 1, Sloan Technology Corp, Santa Barbara, CA) which measured the depths and reproductions of the grooves in the stone models. These data were then compared to the profilometric scans of the stainless steel blocks to see if there was any advantage in using one particular combination of impression material and die stone over another.

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Methods and Materials

Two machine-grooved stainless steel standards were constructed with a series of 6 μm and 17 μm grooves. Marks were made on the stainless steel blocks so that the scans of the stainless steel blocks could be compared to the scans of the resulting stone models. Forty-four light-bodied polysiloxane impressions were taken of each block using custom trays with a 3 mm space (Phillips, 1982). The impression materials used were Express (3M Dental Products, St Paul, MN 55144), Extrude (Kerr/Sybron, Romulus, MI 48174), President (Coltene, Inc, Hudson, MA 01749), and Reprosil (LD Caulk, Div of Dentsply, Milford, DE 19963). All impression materials were mixed, syringed, and seated and retrieved according to the manufacturers' instructions. Before being poured the impressions were inspected for any irregularities and photographed at X100 with the aid of a metallograph (Series N, Unitron, Newton Heights, MA).

The 11 different die stones used were Cream Gold, Suprastone, and Velmix (Kerr/Sybron), UTK Blue Die-Stone (Unitek, Monrovia, CA 91016), Die-Stone and Die-Keen (Modern Materials, Inc, Columbus, OH 43206), Jadestone, Prima-Rock, Silky-Rock, and Super-Die (Whip Mix Corp, Louisville, KY 40217), and Super-Cal (Coe Laboratories, Inc, Chicago, IL 60658). Each stone was weighed, water-measured, and vacuum-mixed and prepared according to the manufacturer's instructions. Each stone was then poured up on the four different impression materials. The impression materials were poured in a rotating sequence (so as not to favor one impression material being poured first) and each pour was made parallel to the grooves using a vibrator and a standardized pour-up technique. The die stone/impression complexes were allowed to set overnight before they were separated. They were then dry-trimmed to avoid debris buildup on the models. The dies were then inspected for any irregularities and photographed at X100 with the metallograph. Each of the stone samples were then subjected to two 1 mm scans with the profilometer.

Results and Discussion

In this study the 17 μm grooves were reproduced within a range of ± 3 μm, when compared to the stainless steel standards by all of the impression/die stone combinations (Fig 1). When the actual mean depths of the grooves in the

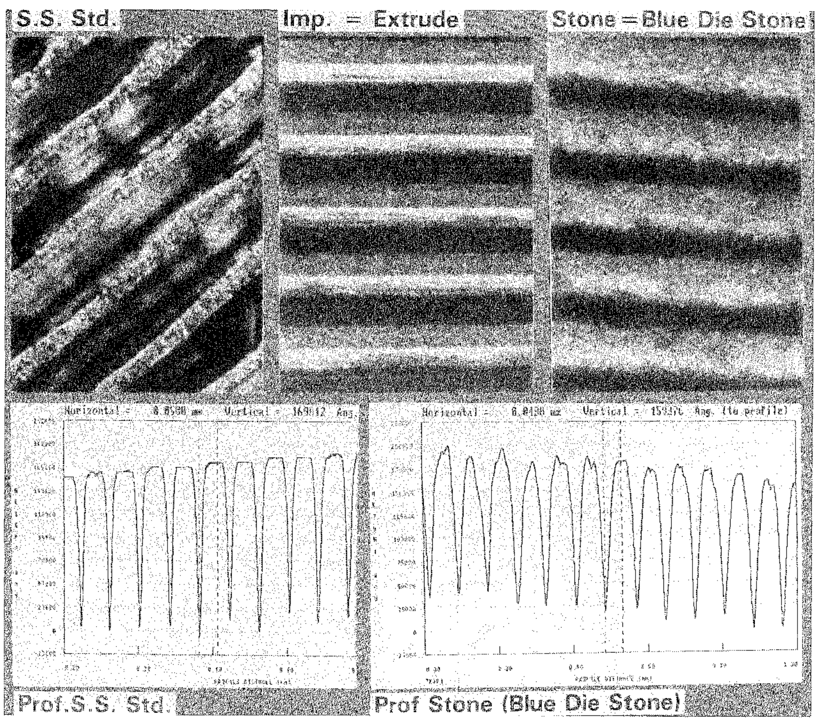

FIG 1. *The photograph on the upper left is of the stainless steel die with 17 μm grooves, in the middle the impression and on the right the stone die reproduced in Blue Die Stone. The lower left tracing is of the steel die and that on the right is of the stone reproduction.*

stones were compared to the mean depth of the standard, all but one of the stones' means were within 2 μm of the standard (table). This data conflicts with research conducted at the University of Texas Health Science Center's Dental School in San Antonio, Texas (Schelb & others, 1987). Research conducted there evaluated five polysiloxane impression materials with 10 different die stones. Of the 50 possible combinations they only had nine reproduce a single 20 μm line in stone. They used a group of six raters checking with low-power magnification.

The impression materials of the 17 μm group were also compared among themselves using the total mean values for each impression material. All four impression material means varied only 1 μm from the standard, which would indicate that there was no significant difference in the four polysiloxane impression materials used in the study.

Most of the 6 μm grooved stone samples demonstrated poor reproductions of the stainless steel standard (Fig 2). Only four of the 44 impression/die stone combinations were able to closely replicate (by ± 1 μm) the 6 μm stainless

Table of Mean Groove Values and Standard Deviations for Each Polysiloxand Die-Stone Combination - 17 μm Group

	Express	Extrude	Reprosil	President	TOTAL MEAN FOR ALL STONES
Super Cal (Coe)	18.1 .64	19.3 .62	17.3 .84	16.9 .60	17.9 1.0
Suprastone (Kerr)	18.2 .45	19.1 .58	19.5 .63	19.0 .40	18.9 .54
Silky Rock (Whip Mix)	17.2 .59	18.2 .33	17.9 .80	17.8 .94	17.8 .42
Blue Die Stone (Unitek)	16.0 1.0	15.4 .49	16.4 .47	18.5 .46	16.6 1.3
Die Stone (Modern Materials)	19.3 1.0	16.7 .88	19.8 .57	15.8 .43	17.9 1.9
Jadestone (Whip Mix)	17.1 .47	16.8 .30	16.3 .25	15.0 .38	16.3 .91
Cream Gold (Kerr)	16.6 1.8	18.5 1.1	17.8 .62	16.4 .61	17.3 1.0
Prima Rock (Whip Mix)	14.9 .41	17.1 1.0	16.6 .55	16.5 1.3	16.2 .95
Velmix (Kerr)	19.0 1.2	16.3 .71	18.6 .66	15.0 .60	17.2 1.8
Super Die (Whip Mix)	16.4 .72	16.7 .83	18.2 1.3	17.5 .33	17.2 .83
Die Keen (Modern Materials)	18.0 .24	15.9 .72	15.2 .33	16.0 .95	16.3 1.2
TOTAL MEAN FOR ALL IMPRESSION MATERIALS	17.3 1.3	17.3 1.3	17.6 1.4	16.8 1.3	17.2 1.3 GRAND MEAN

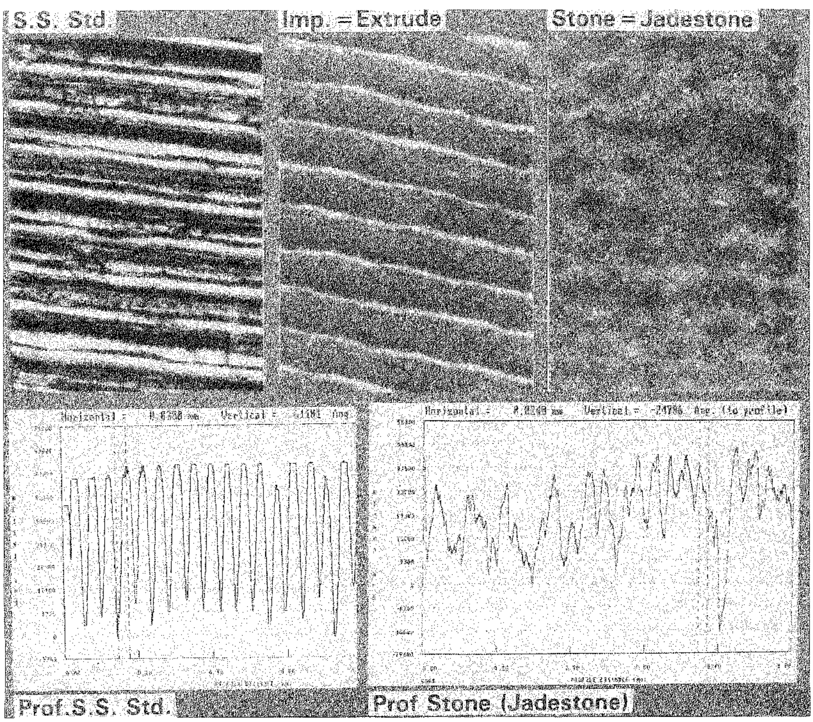

FIG 2. *The photograph on the upper left is of the stainless steel die with 6 μm grooves, in the middle the impression and on the right the stone die reproduced in Jadestone (note the lack of detailed reproduction). The lower left tracing is of the steel die and that on the right is of the stone reproduction.*

steel standard (Fig 3). Three of the four reproductions were with Suprastone using Express, President, and Reprosil. The fourth was with Prima Rock using Extrude. Based on these findings, it may be possible to achieve better results than the standards set forth by the ADA, if the combinations are very carefully selected.

With the study completed and the stone samples scanned by the profilometer, an attempt was made to wax a single 6 μm stone sample. Slik Die die lubricant (Slaycris Products, Portland, OR 97205) was applied to the stone sample and allowed to dry. Standard inlay wax was applied to the stone sample. The wax-up of the 6 μm grooves looked very good with X100 magnification. The wax pattern was sprued and invested in Novocast (Whip Mix Corp, Louisville, KY 40217) investment material and then cast using standard casting procedures. Preliminary evaluations of the casting with the metallograph using X100 revealed fair reproductions of the stone model.

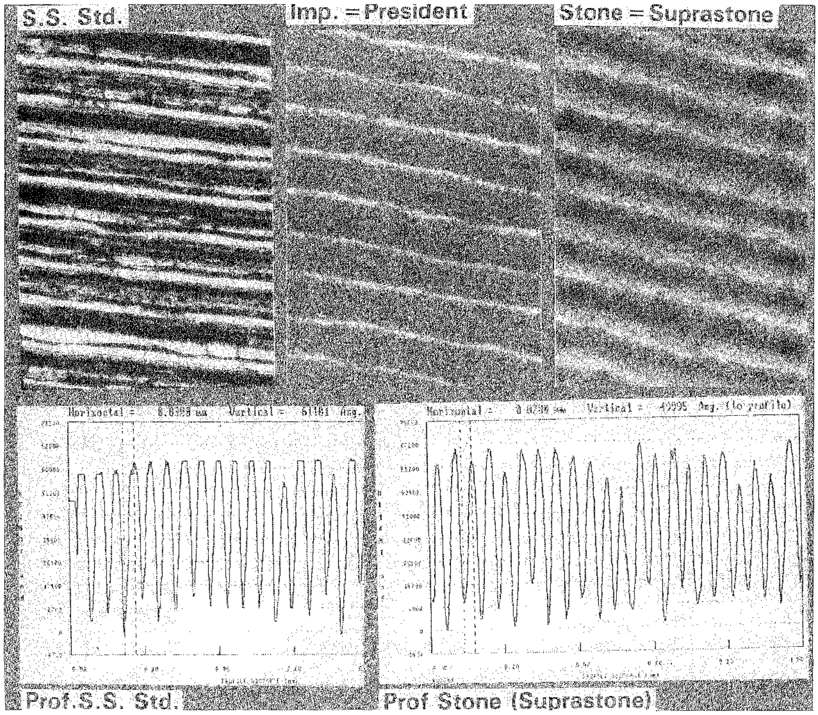

FIG 3. *The photograph on the upper left is of the stainless steel die with 6 μm grooves, in the middle the impression and on the right the stone die reproduced in Blue Suprastone. The lower left tracing is of the steel die and that on the right is of the stone reproduction.*

Conclusions

Based on this pilot study, all 11 die stone and polysiloxane impression combinations performed within the 20 μm ADA standard. With these results the clinician can feel confident that all of the polysiloxane and impression material combinations used in this study should give an acceptable result in regard to reproduction of a preparation. Greater accuracy than the 20 μm ADA standard may be achieved if the impression/die stone combinations are carefully selected. Other factors such as working characteristics, color, and delivery systems of these materials would be merely a matter of personal preference.

Future research on dental waxes and investment materials would be helpful. This would ensure that the level of reproducibility that is provided with the polysiloxane and die stone materials will be maintained through the waxing, investing, and casting procedures necessary for cast gold fabrication.

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Pulp Response to the Combined Effects of Cavity Preparation and Periodontal Ligament Injection

T J PLAMONDON • R WALTON • G S GRAHAM
G HOUSTON • G SNELL

Summary

Thirteen random-source dogs provided 54 experimental and 50 control teeth. Controls received either a periodontal ligament (PDL) injection only, or no injection, with deep cavities prepared and restored. Experimental teeth received both a PDL injection and the deep cavity preparation and were then restored with an IRM base and acid-etched composite. Teeth were surgically removed for observation periods of one and 18 weeks and prepared for histologic evaluation. Results indicated that, in this model system, there was little additive effect to the pulpal reaction due to the PDL injection. Controls that were prepared had essentially the same pulpal response as did the experimental teeth (PDL injection/preparation). In both experimental and control pulps, the effects were primarily related to the depth of the cavity preparation.

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INTRODUCTION

Although the concept of obtaining dental anesthesia by injecting into the periodontal ligament (PDL) has been known since the early 1900s, only recently has this technique been the subject of clinical investigation (Walton & Abbott, 1981; Brännström, Pashley & Garberoglio, 1984) and of general interest (Council on Dental Materials, Instruments and Equipment, 1983). The clinical literature has addressed factors such as efficacy (Walton & Abbott, 1981; Smith, Walton & Abbott, 1983; Brännström & others, 1984; Primosch, 1986; White & others, 1988), pathway of injected solution (Fuhs & others, 1983; Smith & Walton, 1983; Brännström & others, 1984; Roahen &

Marshall, 1984; Lin & others, 1985; Walton, 1986), safety to the periodontium (Smith & Pashley, 1983; Brännström & others, 1984; Pashley, 1986), mechanism of action (Brännström & others, 1984; Kim, 1986; D'Souza, Walton & Peterson, 1987; White & others, 1988), and systemic effects (Smith & Pashley, 1983; Brännström & others, 1984; Pashley, 1986).

An important consideration is the possible direct or indirect adverse effect of the PDL injection on the pulp (Editor's Note, 1983; Kim, 1986). It has been established that the PDL injection technique is most effective when the injected solution contains a vasoconstrictor (Brännström & others, 1984; Kim, 1986; D'Souza, Walton & Peterson, 1987). The use of such vasoconstrictors could have undesirable side effects under certain conditions.

The PDL injection with anesthetic containing epinephrine has experimentally been shown to cause a complete interruption in the pulpal blood flow of rat incisors and dog canines and premolars (Kim & others, 1984; Kim, 1986). Significantly, blood flow did not return to normal levels for over 20 minutes. It has been suggested that this stasis could directly lead to ischemia and pulpal necrosis (Editor's Note, 1983; Roahen & Marshall, 1984; Lin & others, 1985; Kim, 1986). However, studies have shown the PDL injection with anesthetic containing vasoconstrictor has no apparent deleterious effect on the healthy, noninjured pulp (Brännström & others, 1984; Lin & others, 1985; Roahen & Marshall, 1984).

What has not been examined is the possibility for damage from the combined effect of the PDL injection and restorative procedures on the pulp. Preparing a tooth causes release of inflammatory mediators within the pulp (Olgart & others, 1977; Kim & others, 1984; Peurach, 1985; Kim, 1986). Normally these potentially tissue-damaging chemical mediators or other irritants would be rapidly removed by the circulation (Pashley, 1979). Interruption of pulpal blood flow following PDL injection could cause a compounded inflammatory reaction due to a buildup of these mediators. The result could then be severe pulpal hemorrhage, accumulation of more irritants, a compromised pulp, and eventual pulpal necrosis (Editor's Note, 1983; Kim & others, 1984; Peurach, 1985; Kim, 1986).

The purpose of this investigation was to evaluate histologically the response of dog pulp to the combined effects of tooth preparation following the PDL injection using lidocaine 2% with epinephrine 1:100 000.

MATERIALS AND METHODS

Thirteen young, mongrel dogs with teeth with medium to large pulp chambers (as demonstrated radiographically) were used in the study. Random assignments of 54 experimental and 50 control teeth were evenly distributed to avoid possible anatomic contribution to any differences.

The dogs were administered atropine (.05 mg/kg sub q), sodium pentobarbital (calculated dose of 22 mg/kg IV given to effect), and intubated for all procedures.

All PDL injections were made by one operator. Lidocaine 2% with epinephrine 1:100 000 was injected through a 27-gauge short needle attached to a PeriPress pistol-type syringe (Universal Dental Implements, Edison, NJ 08820). The needle was finger-supported and inserted firmly into the PDL with the bevel away from the tooth. Two slow squeezes of the trigger were made on both the mesial and distal of each tooth. An additional injection was made with the needle repositioned if the operator did not feel back-pressure or if gingival blanching was absent. In each animal, two premolars in three quadrants received PDL injections. Premolars in the fourth quadrant received only a sham injection, that is, a needlestick without injection of anesthetic.

A second operator, purposely uninformed as to which teeth received the injection, prepared the teeth. Following a pumice prophylaxis, large class 5 preparations were made using #330 burs in a high-speed handpiece on the facial surfaces of premolars in three of the quadrants. In each dog, one quadrant was not prepared, as a control of the effect of injection alone. The preparations extended from mesial to distal line angle and were located about 1 mm above the gingival crest (Fig 1). Cavities were intentionally deep, so that the pink of the pulp could be visualized through the thin remaining dentin. A new bur was used for each preparation. In each quadrant, one tooth was prepared dry (maximal irritation to the pulp), then one was prepared with water spray coolant (minimal irritation). While the bulk of the reduction was done with water spray in the teeth intended to be prepared wet, the final reduction necessarily was dry in order to

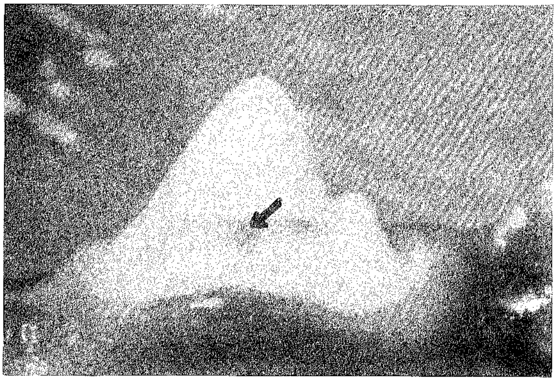

FIG 1. *Dog premolar tooth illustrating extent of preparation. Note that in the center the depth is such that the pulp (arrow) is visible through the thin dentin.*

clearly visualize the pulp through the thin remaining dentin.

Cavities were then restored with a technique designed to minimize bacterial contamination via microleakage, which may cause a resultant additional pulp reaction (Bergenholtz, 1982; Cox & others, 1987). Preparations were cleansed for 10 seconds with dilute polyacrylic acid and then based with IRM. Cavities were then etched for 60 seconds with Scotchbond etching gel (3M Dental Products, St Paul, MN 55144) and washed for 60 seconds. Bonding agent (Scotchbond, 3M) was applied followed by incremental filling of light-cured composite resin (Silux, 3M). The absence of bacterial microleakage was later confirmed using histology stains for bacteria.

To provide two observation periods, teeth associated with the study were surgically removed from six dogs at one week and from the remaining seven dogs at 18 weeks. Teeth were removed while the animals were under general anesthesia. The teeth were then resected in the cervical third of the roots. Mesial and distal surfaces were evenly reduced close to the pulp with high-speed burs under copious water spray in order to facilitate fixative penetration, decalcification, and histologic preparation (Langeland & Langeland, 1970; Czarnecki & Schilder, 1979).

Teeth were immersion-fixed in 10% formalin for one week and decalcified in 10% formic citrate/formic acid. Composite restorations were removed and the teeth were embedded in paraffin. Step serial sections at 6 microns were taken in a facial-lingual plane to include visualization of pulp-to-cavity floor (Fig 2). Most sections were stained with hematoxylin and eosin; occasional sections were stained with modified Brown and Brenn gram stain to determine if there had been bacterial contamination of the cavity via microleakage. Histologic sections were evaluated by two blinded examiners.

EVALUATION

Remaining dentin thickness was determined in three different areas (mesial, middle, distal) qualitatively as to cavity depth by estimating the DEJ/pulp ratio (Fig 2):

1. Shallow-moderate (<2/3 distance, DEJ to pulp)
2. Deep (>2/3 distance, DEJ to pulp)
3. Very deep (near exposure)

Pulp reactions were qualitatively evaluated as to degree of response as follows:

1. Inflammation: presence and severity (localized or generalized)
2. Odontoblast layer: disruption (localized or generalized)
3. Vasculature changes: vasodilatation and erythrocyte extravasation

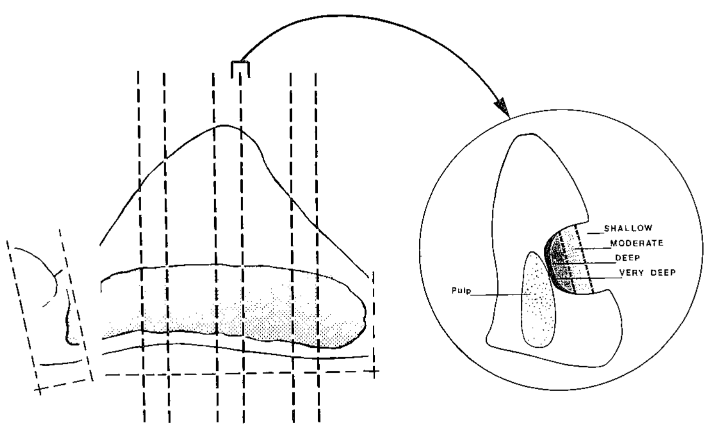

FIG 2. *Left diagram–region between dashed lines shows three areas from which histologic sections were taken. Right sagittal diagram–method for determining depth of preparation (remaining dentin thickness).*

4. Calciotraumatic line and/or irregular secondary dentin: presence or absence

On each section, comparison was made between areas subjacent to the preparation and the remainder of the pulp in order to provide an internal comparison (Langeland & Langeland, 1970).

The odontoblast disruptions and inflammatory responses of each specimen were each graded according to the following categories:

0) None

1) Mild
   Odontoblasts: slight disruption
   Inflammation: a few inflammatory cells adjacent to the preparation

2) Moderate
   Odontoblasts: more disruption as demonstrated by abnormal cellular arrangement
   Inflammation: scattered inflammatory cells

3) Severe
   Odontoblasts: complete disruption or absence
   Inflammation: microabscess

Vascular changes, irregular secondary dentin, and calciotraumatic line were scored as either present or absent.

For statistical analysis, only odontoblast disruption and inflammatory response scores were considered. The specimen was scored indicative of the most severe response in any one of the sections. In addition, the data were arranged according to preparation depth. A tooth could have a shallow, deep, or very deep preparation, depending on which section was being examined; the responses of each section were recorded and then related to the independent variables of depth, injection, and type of preparation. This provided a greater number of data points than the number of teeth in the study, each tooth providing three distinct sections for analysis.

After the code was broken, the number of specimens in each category was placed into categories as to the degree of pulpal changes. The mean number in the experimental and control groups were then compared with the Mann-Whitney U Test.

RESULTS

The PDL injection had no demonstrative additive effect to the cavity preparation affecting pulp response. By comparing teeth with PDL injection plus preparation (experimental) with needlestick alone (control), there was no difference at either one ($P = 0.85$) or at 18 ($P = 0.31$) weeks' observation. The only variable which affected the severity of pulp response was depth of cavity preparation; deeper preparations showed significantly more odontoblast disruption ($P = 0.008$) at one week and at 18 weeks ($P = 0.008$).

One-week Observations

In the samples recovered at one week, any pulpal changes noted were primarily related to the depth of preparation and to the type of preparation (wet or dry), but not to the nature of injection (PDL or needlestick).

With the exception of one control tooth that had scattered chronic inflammatory cells in the pulp, none of the other controls (PDL injection--no preparation) showed any inflammatory changes or significant disruption of odontoblasts. A few controls (PDL injection--no preparation) had very slight disruption of odontoblasts. Of the experimental teeth (PDL injection--cavity preparation) several pulps demonstrated inflammation and odontoblast disruption (Figs 3 and 4). Most specimens demonstrated mild pulpal responses; the more marked reactions were seen in sections found beneath the

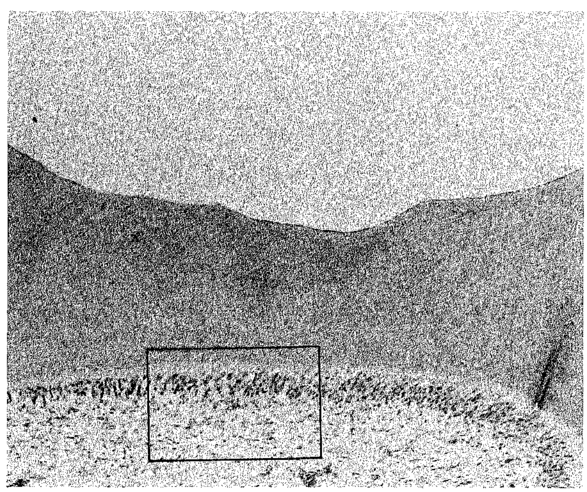

FIG 3. *One-week specimen. This was categorized as a deep preparation, greater than 2/3 dentin removed (H & E stain, original magnification X100).*

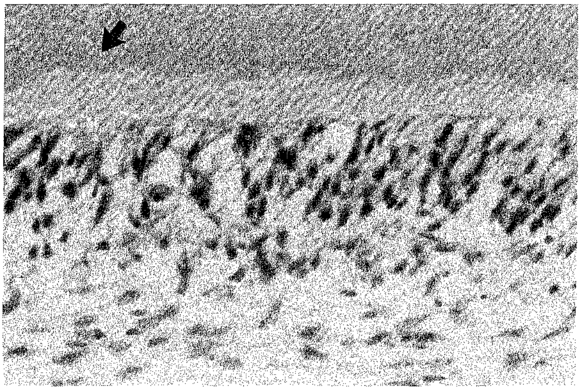

FIG 4. *Higher magnification of specimen shown in FIG 3 (box) illustrating minimal pulpal changes of moderate odontoblast disruption and mild inflammation. A faint calciotraumatic line (arrow) formed in response to slight injury during preparation (H & E stain, original magnification X400).*

very deep preparations. Similar reactions were noted in the teeth that received only a needlestick followed by cavity preparation (Fig 5). In two PDL-injected teeth with pulp exposures, a severe pulp reaction occurred adjacent to the exposure. Sections away from the exposures showed only slight or moderate changes.

Vascular changes (dilatation and red blood cell extravasation) were observed in both control and experimental teeth.

None of the one-week specimens demonstrated irregular secondary dentin. Specimens (both control and experimental) with very deep cavity preparation had calciotraumatic lines adjacent to the pulp (Fig 3).

18-week Observations

Findings were similar to those of the one-week specimens. Depth of preparation and type of preparation (wet or dry) had more influence on pulpal responses than did PDL injection versus needlestick (Figs 6 and 7). Statistically, there

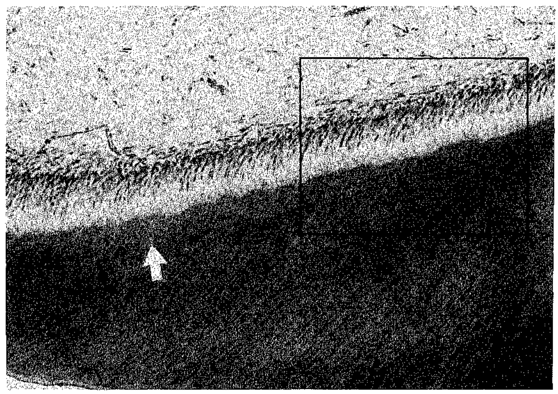

FIG 6. *Eighteen-week specimen categorized as a deep preparation. Note the calciotraumatic line (arrow) which formed in response to the earlier cavity preparation (H & E stain, original magnification X100).*

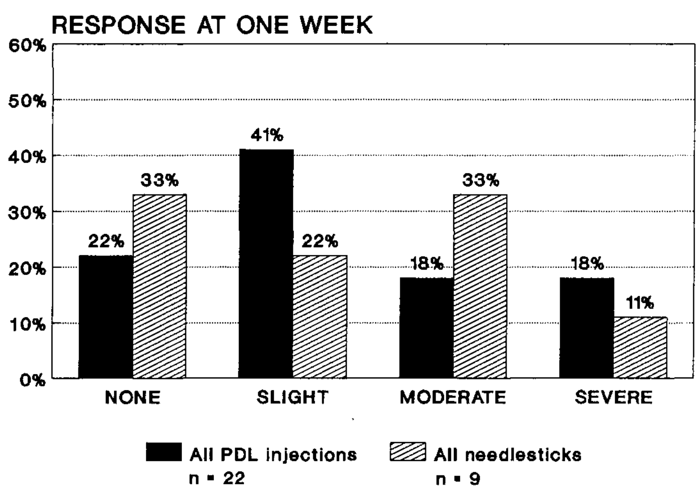

FIG 5. *Comparison of experimental (PDL/preparation) and control (needlestick (NS)/preparation teeth. Percentages are those that exhibited a given pulpal response at one week, as determined by the most severe reaction in any section. Statistically, there is no difference between any of the experimental and control groups.*

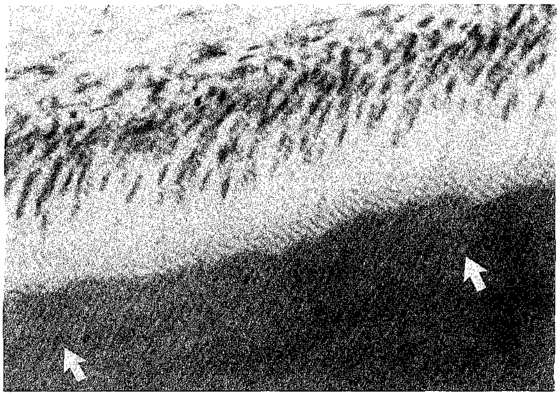

FIG 7. *Higher magnification of the specimen in FIG 6 (box). There is no odontoblast disruption or inflammation. Previous pulp damage is indicated by calciotraumatic line (arrow) with subsequent slightly irregularly formed secondary dentin (H & E stain, original magnification X400).*

was no difference in pulp response between PDL/preparation and needlestick/preparation (Fig 8).

Vascular changes were again noted in controls in a pattern similar to experimental teeth.

Secondary dentin of varying irregularity was found pulpward to a calciotraumatic line in both PDL (experimental) and needlestick (control) specimens and was related to a previous deep cavity preparation (Fig 7).

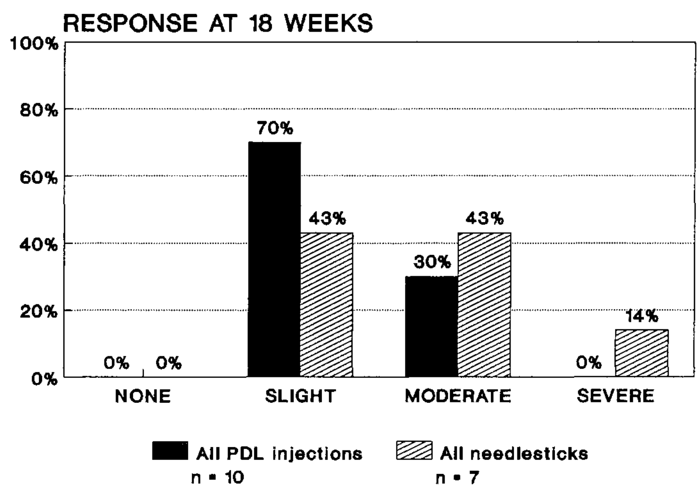

FIG 8. *The same comparison as FIG 5 at 18 weeks. Note that overall slight reaction was the most common. Again there was no difference between experimental and control groups.*

Very few of the sections stained with Brown and Brenn demonstrated bacteria, indicating essentially no microleakage. In the few cavities showing bacteria along the cavity wall, the pulpal responses were never scored worse than moderate. Most of the teeth that had evidence of bacteria had a slight response.

DISCUSSION

The significant and clinically important findings in our study were that, in this model system, the periodontal ligament injection had virtually no effect on the pulp of the injected tooth. An irritating cavity preparation had no additive injurious effect. This noninjury corresponds to those studies that showed the PDL injection to be safe to the already healthy pulp (Roahen & Marshall, 1984; Linn & others, 1985; Peurach, 1985) and to the periodontium (Walton & Garnick, 1982; Fuhs & others, 1983; Brännström & others, 1984; Roahen & Marshall, 1984; Walton, 1986). Further, our findings would not support the concerns of those (Kim & others, 1984; Kim, 1986) who speculate that the marked reduction in pulpal blood flow following PDL or intraseptal injection would render the pulp more susceptible to injury from cavity preparation. This conclusion from our findings would be predicated on the assumption that pulpal blood flow was suppressed. Although blood flow was not measured, the probability is that there was suppression, as our model system and PDL injection technique mimicked those of investigators that did produce such a marked and prolonged reduction in pulpal blood flow (Kim & others, 1984).

While the PDL injection in this model was not harmful to pulpal tissue, it must be remembered that the experimental teeth were sound. Pulps that have previously been subjected to caries, previous restorative procedures, abrasion, periodontal disease, or other irritants may respond adversely because of pre-existing inflammation.

Indeed, it has been suggested that no matter what procedure or restorative material is used, the critical factors relating to pulpal health are bacterial penetration and microleakage (Bergenholtz & others, 1982; Cox & others, 1987). Our procedures were designed to and did effectively limit bacteria by first cleansing the preparations with polyacrylic acid and then sealing them with IRM and acid-etch composite resin. There was no softening or hindrance of the set of the light-cured composite in contact with the IRM, a finding also reported by Leinfelder (personal communication, 1987).

Although remaining dentin thickness was not precisely measured, every effort was made to prepare each tooth as close to the pulp as possible without creating exposures. When there were mechanical pulp exposures (two teeth, both PDL/prep) the teeth were restored and served as a type of positive control. Interestingly, the expected severe pulpal reaction of localized microabscess formation did occur, showing that these dog pulps would respond with severe inflammation to a severe injury.

Since vascular changes were seen in many control teeth as well as experimental teeth, this criterion was not used in data analysis. Extravasated red blood cells were considered artifacts due to the technique for obtaining the samples, possibly from the surgical removal or from the subsequent approximal reduction.

It was interesting, but not surprising, that regardless of the factors (independent variables) examined, the only significant variable was cavity depth as to odontoblast disruption. These results further support the conclusion that the depth of preparation was the critical factor determining severity of pulpal response, and the PDL injection seemed to have little effect.

While every effort was made to control the procedures and their resulting pulpal effects, there are a number of variables relating to the PDL injection itself. These include needle placement, pressure applied, amount injected, infectious contamination, and periodontal condition (Brännström, Nordenvall & Hedström, 1982). Whether these factors would modify the effects of the injection on the pulp is unknown.

CONCLUSIONS

The purpose of this study was to determine if dog premolar pulps would demonstrate increased disruption and/or inflammation with the additive effects of a PDL injection and deep cavity preparation.

Premolars from 13 dogs were used. Controls had no injection or no cavity preparation. Experimental teeth had PDL injections and deep preparations. After one- and 18-week observation periods, teeth were removed and examined histologically for pulp and dentin changes.

Analysis of the subjective histologic examination as to the severity of responses gave the following conclusions:

1. The PDL injection with anesthetic containing vasoconstrictor, in conjunction with deep cavity preparation, did not produce a more severe reaction than the controls.

2. Cavity preparation depth was the most important factor; the most marked pulpal responses were seen in the deeper preparations of both control and experimental specimens. Shallow preparations showed minimal or no pulpal response.

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PRODUCT REPORT

Comparison of Commercial Elastomeric Impression Materials

R G CRAIG • N J URQUIOLA • C C LIU

Summary

The properties of some recently marketed rubber impression materials were compared with some earlier products. In general, the qualities of addition silicones and polyethers were superior to polysulfides and condensation silicones. However, there were significant differences in the properties of products of the same type and class and thus the selection of a product for a particular application should be based on actual property data rather than on the type and class of rubber impression material.

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INTRODUCTION

A review of elastic impression materials was presented in 1986 and was published two years later (Craig, 1988). At that time it was proposed that (1) the use of polysulfides would decrease, (2) the development of single viscosity materials would increase, (3) the modification of hydrophilic materials would increase, (4) the use of automatic mixing systems would increase, (5) emphasis would be increased on the ability of impression materials to be disinfected, and (6) development of techniques would continue. The first five of these predictions have been borne out while the sixth has been partly confirmed.

A detailed comparison of the properties of the earlier addition silicones to polyethers, polysulfides, and condensation silicones was published in late 1986 (Craig, 1986). Recently, a qualitative ranking of crown and bridge impression materials was reported (Farah & Powers, 1989).

The rankings were based on unpublished data (Craig, 1989) and the rankings were used to conclude that hydrophilic addition silicones were the impression materials of choice. The current paper presents the quantitative data for a comparison of the more recently introduced commercial rubber impression materials with the more commonly used products of a few years ago. These data provide the clinician with the basis for selecting the product for a specific application.

MATERIALS AND METHODS

A list of products by type and viscosity class plus the manufacturer and the batch or identification number is given in Table 1. The letter H after the product name of an addition silicone indicates the material is hydrophilic and the contact angle of a water drop on it is about 50°, which is comparable to values for water on polyether and polyurethane dimethacrylates (Pratten & Craig, 1989; Craig & Hare, 1989).

The properties of the various products were determined according to ADA/ANSI Specification No 19 with the following exceptions (Council on Dental Materials and Devices, 1977). The working time was measured as the loss of tackiness of the mixed impression materials using a 5-mm-diameter, polished hemispherically, tipped stainless-steel rod. For addition silicones supplied as automatic mixing systems, the mixing time was considered to be zero and samples for the various mechanical and dimensional properties were placed in the 32 °C water bath 0.5 minutes after extrusion from the static mixing tips. The tear strengths were determined as described (Craig, 1986) on a type C tear specimen 1.5 minutes after removal from the 32 °C water bath at a crosshead rate of 30 cm/min. The dimensional change after seven days was determined on the specimens used to measure the one-day dimensional change. The number of replications of all tests except tear strength was three; because of the wider variance in the tear strengths five replications of the tests were made.

The milliliters of addition silicone wasted in the static mixing tip for each mix was determined by weighing the tip before and after mixing and converting the weight to volume by determining the density of the dimensional change disks.

RESULTS AND DISCUSSION

The products, their viscosity class, working time, time in the mouth, permanent set, strain in compression, flow, tear strength, and dimensional change at one and seven days are given in Tables 2-6. The Tukey multiple comparisons (at the 95% confidence level) between types of impression materials for various properties are given in Table 7, while the Tukey intervals for the pair-wise comparison of properties between products of the same consistency are listed in Table 8. The properties of newer addition silicones supplied as two pastes to be spatulated are listed in Table 2. President was included for comparison since it was the initial commercial product. Table 3 contains the properties of addition silicones supplied in automatic mixing cartridges. Tables 4 and 5 show the data for polysulfides and condensation silicones while Table 6 lists the data for the polyethers.

Working Time and Time in the Mouth

Although there were variations in the working times for the spatulated addition silicones (100 to 290 seconds), they generally had longer working times than addition silicones supplied as automatic mixing systems (90 to 240 seconds). This difference is reasonable since for practical purposes the automatic mixing systems have zero mixing times rather than the 30-40 seconds required for hand spatulation. A similar comparison can be made of the manufacturer's recommended times in the mouth for spatulated and automatically mixed addition silicones. As is recognized, the working times and times in the mouth for the polysulfide rubbers were longer than the typical times for the addition silicones (see Table 4). The condensation silicones (Table 5) and polyethers (Table 6) had short working times and times in the mouth, requiring prompt mixing and placement of the impression material. The working-time test is not applicable to the polyether urethane dimethacrylate; the material will gel in about 20 minutes if left on the bracket table exposed to fluorescent light. If a yellow fluorescent lamp is used, the working time is unlimited; the time in the mouth depends on the exposure to blue light, but a quadrant impression can be polymerized readily in less than two minutes.

Permanent Set

The permanent set is an indication of the recovery from deformation resulting from removal of the impression from undercut areas, and thus low values are desired. As illustrated in Table 7, the polysulfide and hand-mixed silicone types were different from each other and from the other types. The condensation silicone type could not be distinguished from the polyethers, and the polyethers could not be distinguished from the automixed addition silicones. In general, the order of the values for permanent set was polysulfides > condensation silicones, polyethers, automixed addition silicones > hand-mixed addition silicones. Automixed addition silicones as a group had higher values for permanent set than hand-mixed addition silicones because of the wide range of values for the former. Examination of Table 3 shows that some automixed addition silicones had permanent set values of the order of those for the hand-mixed silicones.

In order to determine which products of the same type and viscosity class have different values for permanent set, the Tukey intervals listed in Table 8 should be used; if the difference between the values for two products is greater than the Tukey interval, then the permanent-set values are different at the 95% level of confidence. For example, the permanent deformation of Exaflex H viscosity class 1 (0.29%) is not different from Impress (0.39%) of the same class since the Tukey interval is 0.32%; however, it is different than the value for President (0.05%). This same procedure can be used for the other physical and mechanical properties.

Strain in Compression

The strain in compression of the polysulfide type is higher (more flexible at the time of removal of the impression) and different from all the other types of rubber impression materials, and the condensation silicones, addition silicones, and polyether types could not be distinguished from each other (Table 7). Of course, there are differences between some products of the same type and viscosity based on the Tukey intervals listed in Table 8. For example, Exaflex H class 1 is more flexible (5.17%) than Absolute class 1 (3.59%), since the Tukey interval is 0.44%. Using this interval the appropriate flexibility for a particular application can be selected.

Flow

Flow estimates the permanent deformation and distortion of an impression under small forces one hour after the impression had been removed from the mouth. High values indicate care must be taken when sending or shipping impressions to laboratories, and models would probably be more accurate if poured in the dental office. Based on the comparison of types of impression materials, the flow values for the polysulfide type were higher and different from any of the other types, and the various silicone types and the polyether types were not different. Again when comparing pairs of products of the same type and class, differences can be found. For example, Exaflex H class 1 had a statistically higher flow (0.05%) than President class 1 (0.01%), since the Tukey interval was 0.02%.

Tear Strength

The polysulfides as a type had higher tear strengths than all the other types, which could not be distinguished from each other statistically (Table 7). This result is considerably influenced by the unusually high tear strength for the Healthco polysulfide (approximately 7000 g/cm). The difficulty in discriminating between types and products is the high variance associated with the Tukey intervals of the tear strengths (Table 8), which range from 600 to 1400 g/cm. As before, statistical differences did exist between products of the same type and class; President Jet had a statistically higher tear strength (3900 g/cm) than Reprosil class 1 automix (2600 g/cm), as shown in Table 3, since the Tukey interval in Table 8 was 1000 g/cm.

Dimensional Change

In general, the Tukey multiple comparisons showed (Table 7) that the dimensional change of polysulfide and condensation silicone types were not different from each other and were greater than the addition silicone and polyether types (Table 7). In order to compare differences between products of the same type and class, the Tukey intervals listed in Table 8 should be consulted. It should be mentioned that the polyether type had higher dimensional change at one day than the automixed addition silicones; however, this difference disappeared at seven days. Also, it should be emphasized that the dimensional change at seven days was consistently higher than at one day for any given product of the same viscosity class.

Polyether Urethane Dimethacrylate Type

Since there was only one product of this type of impression material, its properties (Table 6) were not discussed with the other types. The permanent set for this type is comparable to those for condensation silicones and strain in compression, flow, and dimensional change comparable to the types other than polysulfides; however, the polyether urethane dimethacrylate is noted for high tear strength (6000-7000 g/cm) and unlimited working time if not exposed to blue light.

Automixed Addition Silicone Left in the Static Mixing Tip

Some concern has been expressed about the amount of addition silicone wasted from each automatic mix, since the static mixing tip is changed after each mix. The volume of material lost with each mix for various products is listed in Table 9. Six of the automixed products wasted about 1 ml per mix, two about 1.5 ml, and two wasted about 2 ml; however, these amounts are one-quarter to one-half the typical 4 ml of excess material with the two paste addition silicones (Craig, 1985).

Anecdotal Observations

There appears to be an inverse relationship between ease of handling and mixing silicone putties and their ability to record detail. Putties that are sticky and adhere to the dispensing spoon and fingers reproduce detail well; examples are Panasil, Omnisil, and Reprosil.

The Omnisil static mixing tips were larger in diameter and less force was needed on the mixing gun to extrude the addition silicone; however, about twice as much (2.2 ml) impression material was wasted in the static tip for each mix compared to the other products (1-1.5 ml). The Omnisil mixing gun also has a locking device for the cartridge; this locking device is awkward to use and no problems resulted when the device was not used.

Consistent problems were observed with the plugging of the tips of the cartridges of the Blumousse after the first mix. A wax carver or paper clip was used to remove the set rubber in order to make the next mix. The mixes were not always uniform and this resulted in poor setting of the material.

The condensation silicone, Rapid, has been reformulated with a new activator system which has resulted in a decrease in the dimensional change on setting (Table 5); however, the dimensional change after one day is still high for the low-viscosity class (-0.49%) and thus should only be used as a putty-wash impression. A combination impression of the putty and low viscosity would have a dimensional change after one day of about -0.3%.

CONCLUSIONS

Working times were in decreasing order: polyether urethane dimethacrylates, polysulfides, hand-mixed addition silicones, condensation silicones and polyethers, and automixed addition silicones. The working time of the polyether urethane dimethacrylate is unlimited if the material is not exposed to blue light. The short working times for the automixed addition silicones are compensated for by a zero mixing time compared to the 30- to 45-second mixing time for the hand-spatulated impression materials.

The permanent set, or lack of recovery from deformation, of polysulfides was the highest and lowest for the hand-mixed addition silicones when evaluated as a group with the condensation silicones, polyethers, and automixed addition silicones usually having intermediate values. Significant differences did exist between products of the same type and class, and these data should be used if one desires to select the product with the highest recovery from deformation on removal of impressions from undercut areas.

The strain in compression, flow, and tear

Table 1. Product Name, Type, Viscosity Class, Manufacturer, and Batch Identification

ADDITION SILICONE TYPE

Hand-mixed Systems

Product	Viscosity Class*	Manufacturer	Batch Identification
Absolute	1	Coe Laboratories, Inc	11 26 84
	2	Chicago, IL 60658	06 04 86
	3		01 22 85
	4		07 01 86
Baysilex	3	Bayer, marketed by	C10 04 85 B08 30 85
		Cutter Dental,	
		Div of Miles Laboratories	
		Berkeley, CA 94710	
Bisico	1	Pulpdent Corp of America	03 00 K5
	2	Brookline, MA 02147	09 74 K5
	3		—
	4		S1a 80976065
			S1680976065
Exaflex H	1	G-C Industrial Corp	01 06 89
Exaflex H	2	Scottsdale, AZ 85260	09 16 88
Hydrosil H	2	The LD Caulk Div,	02 04 87
		Dentsply International, Inc	
		Milford, DE 19963	
Impress	1	E & D Dental Mfg Co	08 07 86
	2	Hillside, NJ 07205	08 06 86
	3		08 07 86
	4		08 08 86
Panasil	1	Kettenbach Dental	08 02 89
	2	Eschenburg, West Germany	20 02 89
	3	Distributed in USA by	16 02 89
		Temket, Inc,	
		Chicago, IL 60615	
Perfourm	1	Cutter Dental	C01 16 85 B01 15 85
	2	Emeryville, CA 94608	C01 18 85 B08 08 84
	3		C01 17 85 B07 19 84
	4		C01 25 85 B01 25 85
Pol-E-Lastic	3	Kerr/Sybron	02 27 86
		Romulus, MI 48174	
President	1	Coltene, Inc	02 01 87
	2	Hudson, MA 01749	02 01 87
	3		02 01 87
	4		02 01 87
Repeat	1	E & D Dental Mfg Co	08 07 86
	2		08 06 86
	3		08 07 86
Reprosil	1	The LD Caulk Div,	10 09 84
	2	Dentsply International, Inc	09 20 84
	3		10 08 84
	4		10 01 84
Supersil	1	Harry J Bosworth Co	09 17 84
	3	Skokie, IL 60076	05 08 85

Automixed Systems

Product	Viscosity Class*	Manufacturer	Batch Identification
Blu-mousse		Parkell Products, Inc,	08 01 88
		Farmingdale, NY 11735	
Examix H	1	G-C Industrial Corp	11 08 88
	2		02 15 88
Express H	1F	3M Dental Products Div,	86 08 22
	1R	St Paul, MN 55144	86 09 11
	2		EXI-28
	4		CEBI B-XI
Imprint H	2	3M Dental Products Div	8 AB 1 F1
Mirror 3	1	Kerr/Sybron	12 23 86
Extrude H			
Extrude H	2		12 02 87
Extrude	4		12 23 86
Omnisil	1	Coe Laboratories, Inc	10 28 88
	2		11 09 88
	4		11 18 88
Panasil	1F	Kettenbach Dental	5088; 21541-1788
	1R		5088; —
	4		27 02 89
Perfourm	1	Cutter Dental	09 15 87
CD	2		08 31 87
	4		08 17 87
President	1	Coltene, Inc	15 06 88
Jet	4		06 20 88
Reprosil H	1	The LD Caulk Div,	12 01 87
	2	Dentsply International, Inc	01 08 88
	4		01 07 88

*class 1 = light, class 2 = medium, class 3 = heavy, class 4 = putty.

Table 1 continued

POLYSULFIDE TYPE

Product	Viscosity Class*	Manufacturer	Batch Identification
Coe-flex	1	Coe Laboratories, Inc	03 22 85
	2		03 — 85
	3		02 18 85
Healthco	1	Healthco, Inc	06 17 85
	2	Boston, MA 02116	02 15 85
	3		05 29 85
Neo-plex	1	Columbus Dental	10 17 84
	2	St Louis, MO 63188	06 10 85
Permlastic	1	Kerr/Sybron	06 07 85
	2		06 07 85
	3		04 22 85

CONDENSATION SILICONE TYPE

Product	Viscosity Class*	Manufacturer	Batch Identification
Coltex	1	Coltene, Inc	C07 03 89 B05 04 89
	2		C07 03 89 B02 02 89
Coltoflax	4		C13 02 89 B10 02 89
Rapid	1		C11 13 86 B12 02 86
	4		C11 26 86 B11 19 86
Rapid (new)	1		C07 10 88 B21 11 88
	4		C25 10 88 B07 11 88

POLYETHER TYPE

Product	Viscosity Class*	Manufacturer	Batch Identification
Impregum F	2	ESPE/Premier Norristown, PA 19404	C 0045 B 0103
Polyjel NF	2	The LD Caulk Div, Dentsply International	C06 09 88 B06 04 88
Permadyne	1	ESPE/Premier	03 29 82
	3		03 29 82

POLYETHER URETHANE DIMETHACRYLATE TYPE

Product	Viscosity Class*	Manufacturer	Batch Identification
Genesis	1	The LD Caulk Div,	03 23 88
	3	Dentsply International, Inc	03 15 88

*class 1 = light, class 2 = medium, class 3 = heavy, class 4 = putty

Table 2. Properties of Some Recent Addition Silicones

Product	Viscosity Class	Working Time, Sec	Time in Mouth, Sec	Permanent Set %	Strain in Compression, %	Flow %	Tear Strength g/cm	Dimensional Change, % 1 Day	7 Days
ABSOLUTE	1	190 (6)	300	0.26 (0.06)	3.59 (0.30)	0.03 (0.01)	2800 (300)	-0.11 (0.01)	-0.12 (0.01)
	2	270 (6)	300	0.22 (0.04)	2.42 (0.08)	0.02 (0.01)	3500 (600)	-0.15 (0.01)	-0.17 (0.01)
	3	170 (6)	300	0.27 (0.05)	2.64 (0.12)	0.02 (0.01)	—	-0.17 (0.02)	-0.21 (0.01)
	4	210 (6)	350	0.40 (0.02)	1.55 (0.05)	0.03 (0.01)	—	-0.18 (0.01)	-0.26 (0.02)
BAYSILEX	3	180 (6)	210	0.17 (0.01)	4.60 (0.07)	0.04 (0.00)	3860 (20)	-0.17 (0.01)	-0.19 (0.01)
BISICO	1	290 (6)	270	0.15 (0.02)	2.85 (0.05)	0.01 (0.00)	2700 (700)	-0.13 (0.01)	-0.16 (0.01)
	2	210 (6)	270	0.23 (0.03)	2.64 (0.06)	0.01 (0.00)	3300 (200)	-0.09 (0.01)	-0.11 (0.01)
	3	220 (6)	270	0.15 (0.02)	2.85 (0.13)	0.01 (0.00)	—	-0.10 (0.01)	-0.12 (0.01)
	4	170 (6)	270	0.32 (0.03)	1.56 (0.05)	0.13 (0.01)	—	-0.22 (0.02)	-0.23 (0.02)
EXAFLEX H	1	155 (6)	240	0.29 (0.03)	5.17 (0.07)	0.05 (0.01)	2840 (270)	-0.17 (0.01)	-0.21 (0.01)
	2	100 (6)	240	0.43 (0.04)	4.65 (0.13)	0.03 (0.01)	2900 (310)	-0.16 (0.01)	-0.21 (0.01)
HYDROSIL	2	160 (8)	270	0.50 (0.07)	1.88 (0.01)	0.02 (0.01)	2400 (400)	-0.17 (0.01)	-0.30 (0.02)
IMPRESS	1	210 (10)	330	0.39 (0.03)	5.37 (0.07)	0.06 (0.01)	2600 (400)	-0.21 (0.01)	-0.27 (0.01)
	2	180 (6)	330	0.28 (0.02)	3.74 (0.05)	0.03 (0.00)	3000 (300)	-0.22 (0.01)	-0.36 (0.01)
	3	200 (6)	330	0.20 (0.03)	2.34 (0.06)	0.02 (0.00)	—	-0.17 (0.01)	-0.26 (0.01)
	4	170 (6)	330	0.47 (0.03)	1.84 (0.06)	0.03 (0.00)	—	-0.16 (0.01)	-0.22 (0.01)
PANASIL	1	170 (6)	240	0.16 (0.03)	6.67 (0.26)	0.04 (0.01)	3500 (1020)	-0.15 (0.02)	-0.19 (0.02)
	2	230 (10)	270	0.26 (0.01)	3.00 (0.04)	0.04 (0.02)	3290 (270)	-0.14 (0.03)	-0.16 (0.02)
	3	180 (10)	270	0.27 (0.04)	3.42 (0.12)	0.07 (0.01)	—	-0.13 (0.01)	-0.14 (0.00)
PERFOURM	1	180 (6)	270	0.12 (0.01)	3.61 (0.12)	0.03 (0.00)	2800 (800)	-0.21 (0.01)	-0.26 (0.01)
	2	190 (6)	270	0.12 (0.01)	3.04 (0.01)	0.02 (0.01)	3000 (200)	-0.21 (0.02)	-0.23 (0.01)
	3	160 (6)	270	0.12 (0.01)	2.62 (0.02)	0.03 (0.00)	—	-0.24 (0.02)	-0.27 (0.02)
	4	190 (6)	270	0.24 (0.01)	2.39 (0.13)	0.04 (0.00)	—	-0.08 (0.02)	-0.12 (0.01)
POL-E-LASTIC	3	190 (6)	270	0.12 (0.03)	2.84 (0.05)	0.03 (0.00)	4300 (700)	-0.9 (0.01)	-0.12 (0.01)
PRESIDENT	1	150 (6)	240	0.05 (0.01)	3.48 (0.07)	0.01 (0.00)	2700 (100)	-0.12 (0.01)	-0.15 (0.01)
	2	230 (6)	240	0.04 (0.01)	2.59 (0.10)	0.01 (0.00)	5500 (1000)	-0.12 (0.01)	-0.18 (0.01)
	3	190 (6)	240	0.01 (0.00)	2.19 (0.08)	0.01 (0.00)	—	-0.12 (0.01)	-0.18 (0.01)
	4	150 (6)	240	0.24 (0.02)	1.73 (0.12)	0.01 (0.00)	—	-0.11 (0.01)	-0.20 (0.01)
REPEAT	1	160 (6)	330	0.53 (0.04)	11.6 (0.20)	0.09 (0.01)	1500 (100)	-0.24 (0.01)	-0.33 (0.01)
	2	170 (6)	330	1.09 (0.03)	8.3 (0.20)	0.04 (0.01)	2200 (300)	-0.29 (0.01)	-0.39 (0.01)
	3	100 (6)	330	0.21 (0.01)	4.0 (0.20)	0.03 (0.00)	—	-0.26 (0.01)	-0.34 (0.01)
REPROSIL-H	1	170 (6)	390	0.18 (0.02)	4.14 (0.07)	0.02 (0.00)	2560 (20)	-0.29 (0.02)	-0.35 (0.04)
	2	160 (6)	390	0.16 (0.02)	3.63 (0.07)	0.02 (0.00)	3100 (200)	-0.24 (0.02)	-0.28 (0.02)
	3	180 (0)	390	0.15 (0.02)	2.60 (0.04)	0.02 (0.00)	—	-0.22 (0.02)	-0.27 (0.01)
	4	210 (6)	390	0.15 (0.02)	1.71 (0.06)	0.02 (0.00)	—	-0.19 (0.01)	-0.21 (0.02)
SUPERSIL	1	120 (6)	240	0.26 (0.01)	5.64 (0.05)	0.03 (0.01)	1800 (200)	-0.17 (0.01)	-0.18 (0.01)
	3	210 (6)	240	0.26 (0.03)	2.42 (0.05)	0.02 (0.01)	2500 (200)	-0.18 (0.01)	-0.22 (0.01)

Table 3. Properties of Automixed Addition Silicone Impression Materials and Accompanying Putty Types

Product	Viscosity Class	Working Time, Sec	Time in Mouth, Sec	Permanent Set, %	Strain in Compression, %	Flow %	Tear Strength g/cm	Dimensional Change, % 1 Day	7 Days
BLU-MOUSSE	2	103 (6)	120	1.40 (0.09)	0.90 (0.06)	0.01 (0.006)	2700 (500)	-0.13 (0.01)	-0.25 (0.01)
EXAMIX H	1	150 (6)	240	1.23 (0.05)	5.77 (0.06)	0.03 (0.006)	2800 (200)	-0.14 (0.01)	-0.21 (0.01)
	2	100(0)	240	0.63 (0.03)	5.25 (0.07)	0.01 (0.000)	2900 (200)	-0.10 (0.01)	-0.14 (0.01)
EXPRESS-H	1F	90 (10)	180	0.35 (0.07)	3.94 (0.02)	0.05 (0.01)	3300 (300)	-0.17 (0.08)	-0.26 (0.01)
	1R	180 (13)	300	0.42 (0.10)	5.32 (0.04)	0.03 (0.01)	3300 (500)	-0.20 (0.02)	-0.22 (0.01)
	2	150 (0)	300	0.25 (0.13)	4.64 (0.15)	0.02 (0.01)	3300 (200)	-0.21 (0.01)	-0.26 (0.01)
	4	150 (6)	300	0.51 (0.04)	5.90 (0.17)	0.09 (0.01)	—	-0.09 (0.01)	-0.16 (0.01)
IMPRINT	2	133 (6)	240	0.41 (0.08)	2.71 (0.03)	0.03 (0.01)	3900 (300)	-0.10 (0.01)	-0.15 (0.01)
MIRROR 3	1	240 (6)	330	0.23 (0.04)	5.76 (0.14)	0.03 (0.01)	2200 (200)	-0.26 (0.004)	-0.52 (0.02)
EXTRUDE	2	170 (10)	240	0.18 (0.02)	4.0 (0.1)	0.02 (0.01)	4700 (900)	-0.07 (0.01)	-0.15 (0.02)
	4	180 (6)	270	0.30 (0.03)	2.53 (0.07)	0.03 (0.01)	—	-0.17 (0.01)	-0.28 (0.03)
OMNISIL	1	100 (6)	210	0.17 (0.02)	4.95 (0.05)	0.02 (0.01)	2600 (200)	-0.12 (0.06)	-0.20 (0.02)
	2	160 (17)	210	0.26 (0.10)	4.72 (0.06)	0.02 (0.01)	1850 (150)	-0.17 (0.03)	-0.22 (0.03)
	4	140 (6)	240	0.35 (0.02)	1.62 (0.10)	0.07 (0.01)	—	-0.10 (0.03)	-0.16 (0.02)
PANASIL-F	1	160 (10)	240	0.37 (0.11)	5.59 (0.06)	0.03 (0.01)	2480 (170)	-0.14 (0.03)	-0.23 (0.03)
PANASIL-R	1	240 (10)	330	0.73 (0.21)	5.26 (0.03)	0.03 (0.01)	2430 (240)	-0.16 (0.01)	-0.23 (0.01)
PANASIL	4	210 (10)	240	6.32 (0.05)	1.97 (0.09)	0.08 (0.01)	—	-0.05 (0.02)	-0.05 (0.02)
PERFOURM	1	140 (10)	270	0.75 (0.20)	4.00 (0.76)	0.03 (0.01)	2900 (400)	-0.07 (0.01)	-0.12 (0.02)
CD	2	140 (17)	270	0.62 (0.10)	2.93 (0.16)	0.03 (0.01)	3000 (300)	-0.10 (0.02)	-0.10 (0.03)
	4	147 (6)	270	1.45 (0.34)	3.46 (0.57)	0.05 (0.01)	—	-0.20 (0.01)	-0.22 (0.02)
PRESIDENT									
JET	1	217 (6)	300	0.45 (0.06)	2.78 (0.04)	0.02 (0.01)	3900 (800)	-0.11 (0.02)	-0.13 (0.01)
SOFT	4	147 (6)	180	0.29 (0.06)	1.92 (0.07)	0.04 (0.01)	—	-0.16 (0.02)	-0.19 (0.01)
REPROSIL	1	127 (6)	390	0.17 (0.02)	4.1 (0.1)	0.02 (0.01)	2600 (600)	-0.19 (0.03)	-0.22 (0.02)
	2	133 (6)	390	0.10 (0.03)	3.6 (0.1)	0.01 (0.00)	2430 (80)	-0.21 (0.02)	-0.24 (0.03)
	4	147 (6)	240	0.17 (0.01)	1.86 (0.04)	0.03 (0.01)	4300 (250)	-0.15 (0.07)	-0.18 (0.06)

Table 4. Properties of Polysulfide Rubber Impression Materials

Product	Viscosity Class	Working Time, Sec	Time in Mouth, Sec	Permanent Set, %	Strain in Compression, %	Flow %	Tear Strength g/cm	Dimensional Change, % 1 Day	7 Days
COE-FLEX	1	250 (6)	480	4.13 (0.10)	13.5 (0.2)	0.45 (0.02)	3290 (80)	-0.44 (0.05)	-0.54 (0.03)
	2	340 (10)	480	4.39 (0.11)	13.9 (0.6)	0.45 (0.03)	3560 (130)	-0.48 (0.01)	-0.60 (0.01)
	3	440 (6)	480	5.55 (0.29)	11.1 (0.5)	0.42 (0.03)	—	-0.42 (0.02)	-0.54 (0.03)
HEALTHCO	1	240 (12)	420	3.70 (0.09)	17.2 (1.9)	1.44 (0.18)	6800 (300)	-0.38 (0.01)	-0.49 (0.02)
	2	280 (6)	420	4.18 (0.27)	14.7 (0.9)	0.99 (0.07)	7410 (80)	-0.35 (0.02)	-0.68 (0.02)
	3	210 (6)	420	4.15 (0.10)	8.5 (0.1)	0.58 (0.10)	—	-0.39 (0.02)	-0.60 (0.02)
NEO-PLEX	1	250 (6)	420	3.87 (0.09)	17.1 (1.7)	1.46 (0.48)	2500 (150)	-0.39 (0.01)	-0.52 (0.03)
	2	290 (6)	420	5.23 (0.55)	11.1 (0.5)	0.57 (0.14)	4000 (600)	-0.52 (0.03)	-0.97 (0.02)
PERMLASTIC	1	440 (6)	630	3.10 (0.17)	16.3 (0.06)	1.92 (0.12)	2240 (240)	-0.61 (0.04)	-0.96 (0.04)
	2	170 (6)	360	3.31 (0.28)	20.0 (0.6)	3.42 (0.36)	3080 (30)	-0.65 (0.05)	-1.47 (0.03)
	3	230 (10)	360	3.52 (0.33)	12.8 (0.6)	1.34 (0.15)	—	-0.50 (0.04)	-0.95 (0.04)

Table 5. Properties of Condensation Silicones

Product	Viscosity Class	Working Time, Sec	Time in Mouth, Sec	Permanent Set, %	Strain in Compression, %	Flow %	Tear Strength g/cm	Dimensional Change, % 1 Day	7 Days
RAPID	1	190 (10)	180	2.15 (0.30)	3.87 (0.22)	0.09 (0.01)	2200 (400)	-1.2 (0.1)	-1.3 (0.1)
	4	110 (10)	120	2.34 (0.05)	1.59 (0.13)	0.02 (0.00)	—	-0.37 (0.03)	-0.56 (0.02)
RAPID (new)	1	145 (6)	180	1.90 (0.24)	3.77 (0.12)	0.09 (0.02)	3290 (460)	-0.49 (0.02)	-0.69 (0.01)
	4	115 (6)	120	1.39 (0.07)	1.58 (0.23)	0.02 (0.01)	—	-0.20 (0.01)	-0.23 (0.02)
COLTEX	1	220 (10)	270	1.18 (0.05)	11.1 (0.25)	0.11 (0.02)	1600 (210)	-0.66 (0.03)	-0.75 (0.03)
	2	200 (0)	270	1.50 (0.09)	5.66 (0.20)	0.15 (0.02)	2610 (320)	-0.65 (0.03)	-0.75 (0.04)
COLTOFLAX	4	150 (10)	270	1.41 (0.08)	2.13 (0.07)	0.08 (0.01)	—	-0.25 (0.01)	-0.43 (0.04)

Table 6. Properties of Polyether and Polyether Urethane Dimethacrylate Impression Materials

Product	Viscosity Class	Working Time, Sec	Time in Mouth, Sec	Permanent Set, %	Strain in Compression, %	Flow %	Tear Strength g/cm	Dimensional Change, % 1 Day	7 Days
IMPREGUM F	2	165 (6)	270	1.10 (0.07)	1.93 (0.05)	0.02 (0.00)	4800 (400)	-0.32 (0.02)	-0.39 (0.02)
POLYJEL NF	2	150 (0)	270	0.99 (0.16)	2.65 (0.22)	0.02 (0.01)	3500 (400)	-0.31 (0.07)	-0.40 (0.03)
PERMADYNE	1	150 (6)	270	1.52 (0.04)	3.31 (0.05)	0.03 (0.00)	1800 (300)	-0.23 (0.01)	-0.28 (0.01)
	3	150 (0)	270	1.70 (0.05)	2.91 (0.04)	0.02 (0.00)	3000 (300)	-0.19 (0.01)	-0.26 (0.01)
GENESIS	1	NA	NA	1.56 (0.31)	4.23 (0.46)	0.12 (0.01)	5900 (600)	-0.05 (0.04)	-0.08 (0.02)
	3	NA	NA	1.70 (0.20)	1.94 (0.07)	0.05 (0.01)	7400 (500)	-0.11 (0.02)	-0.11 (0.02)

Table 7. Tukey Multiple Comparisons between Types of Impression Materials

Property	Type of Material*				
Permanent set	PS	CS	PE	AS-Auto	AS-Hand
Strain in compression	PS	CS	AS-Auto	AS-Hand	PE
Flow	PS	CS	AS-Auto	AS-Hand	PE
Tear strength	PS	CS	AS-Auto	AS-Hand	PE
Dimensional change, 1 day	PS	CS	PE	AS-Hand	AS-Auto
Dimensional change, 7 days	PS	CS	PE	AS-Hand	AS-Auto

*PS = polysulfide, CS = condensation silicone, PE = polyether, AS-Auto = addition silicone automix, AS-Hand = addition silicone hand-mix

Table 8. Tukey Interval for Pair-wise Comparisons of Physical Properties between Products of the Same Consistency

Type	Viscosity Class	Permanent Set %	Strain in Compression, %	Flow %	Tear Strength g/cm	Dimensional Change, % 1 Day	Dimensional Change, % 7 Days
Polysulfide	1	0.31	3.30	0.69	600	0.08	0.08
	2	0.90	1.77	0.52	900	0.08	0.05
	3	0.65	1.08	0.26	NA	0.07	0.07
Polyether	1	*	*	*	*	*	*
	2	0.28	0.36	0.01	1200	0.11	0.06
Condensation Silicone	1	0.56	0.52	0.04	*	0.15	0.14
	2	*	*	*	*	*	*
	4	0.20	0.40	0.02	NA	0.04	0.06
Addition Silicone (hand-mixed)	1	0.09	0.44	0.02	1200	0.05	0.04
	2	0.09	0.31	0.06	1300	0.04	0.04
	3	0.07	0.29	0.01	1400	0.04	0.03
	4	0.06	0.23	0.01	NA	0.04	0.04
Addition Silicone (automixed)	1	0.32	1.14	0.03	1000	0.07	0.05
	2	0.26	0.27	0.02	900	0.05	0.05
	4	0.37	0.65	0.02	*	0.08	0.08

*Only one product was tested
N A (not available)

Table 9. Addition Silicone Material Left in Static Mixing Tip

Product	ml
Express	0.97
President Jet	1.03
Examix	1.05
Perfourm CD	1.05
Blu-mousse	1.06
Panasil	1.13
Imprint	1.55
Reprosil	1.55
Extrude	1.87
Omnisil	2.23

strength of polysulfides as a group were different and higher than those of the various silicones and the polyether. Thus in general the polysulfides are more flexible, and have higher flow and tear strength than the other rubber impression materials. Again, there are significant differences in values for the same type and class of impression material, and statistical comparisons should be made to select the product with the most satisfactory properties for a particular application.

The dimensional-change tests classified the types into two major groups: the polysulfide and condensation silicones consist of one group with high dimensional change and a second group consists of addition silicones and polyethers with low dimensional change. Again, there were significant differences between values for the same type and class, and a material should be selected on the basis of experimental values and not on the general type of impression material. It should be emphasized that all materials had higher dimensional change after seven days than at one day, although at times the difference was small or not statistically different; however, in general, models and dies poured after one hour will be more accurate than those poured after one week.

In conclusion, although generalizations can be made about the properties of types of rubber impression materials, not all products of the same type and class have the same qualities. Thus, to make a valid choice of product for a particular application, data for critical properties should be used rather than basing the selection on general characteristics of a particular type of rubber impression material.

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LITERATURE REVIEW

Classic Articles in Operative Dentistry: A Collection of the Most Significant Articles in Operative Dentistry in the Twentieth Century

JAMES W O'HARA • LARRY L CLARK

Introduction

This collection was originally conceived as a research project and a tribute to the authors of some of our finest journal literature, a tribute similar to the collection *Classic Prosthodontic Articles*. Unfortunately, financial support was not available to reproduce the 10 most significant articles as we had planned. Instead, they are listed in this paper in a special grouping and are completely referenced.

Even without the special honor to the "Top Ten" of reproducing the articles in their entirety, we felt that the results of our research were of sufficient interest to the profession to merit publication. The Editor of *Operative Dentistry* agreed and was kind enough to accept our manuscript in its abridged form.

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Classic Articles

The idea of classic articles in dentistry is not original. This collection was suggested by *Classic Prosthodontic Articles* (3 Volumes, 1976-1978), sponsored by the American College of Prosthodontists. In that collection, the College honored articles/authors who had contributed articles considered to be classic in the prosthodontic literature between 1895 and 1954.

The editors of this collection arbitrarily limited the time frame for articles considered as classic operative dentistry articles to the post-Black era, roughly 1900 to the present. Any attempt to select the most important articles before this time would consist mainly of republishing Black's work, due to his prodigious contributions to the field of operative dentistry. The twentieth century represents a period of enormous advances in the art and science of operative dentistry. These classic articles were selected by interested individuals in several sectors of the profession, private practice, academia, and the federal services. Articles that were selected as one of 10 classics by a majority of the selectors are listed here, and 100 additional articles that received substantial support from selectors are listed in an addendum.

In undertaking this project, the editors were aware of the daunting task they were undertaking and well-wishers frequently reminded them of the fact. The project was extremely rewarding as it revealed the wealth of our operative dentistry literature. The difficult part of the project was limiting the number of articles. We offer no apology for the articles selected, but only for those deserving articles that could not be included.

This collection is dedicated to those authors who have made highly significant contributions to the advancement of operative dentistry through our literature. We also offer this collection to honor all of those who have contributed and will contribute to our literature in the future. We hope that this collection will serve to make newer members of our profession aware of our rich heritage in operative dentistry literature.

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THE TEN MOST SIGNIFICANT ARTICLES IN OPERATIVE DENTISTRY LITERATURE

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ADDENDUM

There are some obvious omissions from this list of classic articles. Some individuals have made many outstanding literary contributions to one or more areas in operative dentistry. In these circumstances, it is often impossible to select one article to honor. For these individuals, the editors have chosen to declare their whole body of work a classic in operative dentistry literature.

Asgar, K
Asmussen, E
Black, A D
Craig, R G
Douglas, W H
Flagg, F
Fusayama, T
Gwinnett, A J
Gabel, A B
Leinfelder, K F
Massler, M
Osborne, J W
Paffenbarger, G W
Phillips, R W
Rule, R W
Seltzer, S
Silverstone, L M
Skinner, E W
Stanley, H R
Stibbs, G D
Swartz, M L
Sweeney, J T
True, H A
Woodbury, C E
Zander, H A

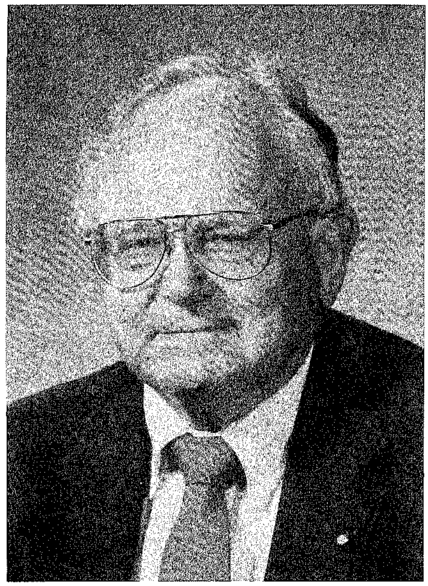
OPERATIVE DENTISTRY, 1990, **15**, *110-111*

Award of Excellence

Recipients of this most prestigious annual honor have been chosen for their service to the Academy, the teaching of operative dentistry, the promotion of good dentistry on a national and international level and, most importantly, exhibiting excellence in dentistry. This year's awardee is Ralph J Werner.

Dr Werner graduated from the University of Minnesota School of Dentistry in 1945. He then served in the U S Navy until 1947, when he started private practice with an older practitioner who for many years had been associated closely with the G V Black Study Club. After mastering the operative instruction offered by this study group, Dr Werner became associated with the American Academy of Gold Foil Operators. It was there his clinical skills were nationally recognized by way of operative demonstrations at various dental schools throughout the country. His organizational capabilities also were discerned and, in time, he became president of the Gold Foil Academy. Through program arrangement and fellow-membership association, he became intimately linked with most of the operative departments of the active dental schools in the country.

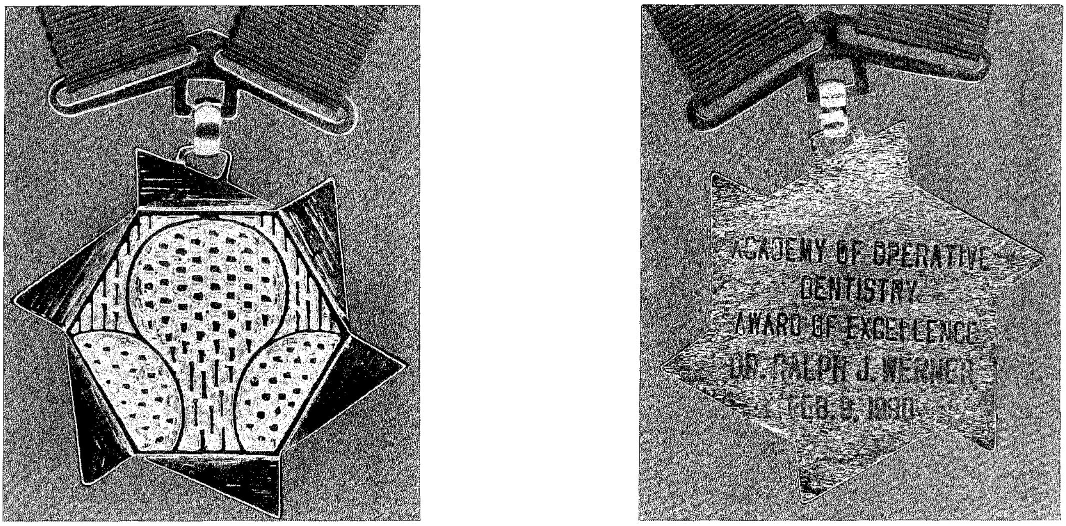
Ultimately, the Gold Foil Academy helped to launch the creation of the Academy of Operative Dentistry in order to provide a broader expression for operative interests. Dr Werner was the founding secretary-treasurer for that group, and he continues to function actively in that capacity. This responsibility brought him in contact with even more teachers, practitioners, and military personnel interested in the field of operative dentistry. Throughout all these years, Dr Werner was avidly attending seminars, intramural faculty retreats and post-graduate courses, and he is now a fellow in all the colleges, and a member of many outstanding academies. He has presented many lectures



Ralph J Werner

and clinical demonstrations, as well as being deeply involved in teaching and organized dentistry.

Dr Werner is a past president of the Minnesota Alumni Association, his alma mater. He was named a Fellow of the Academy of General Dentistry for his extensive participation in post-graduate study. He earned a Certificate of Orthodontics at the University of Minnesota in 1951. It is almost prophetic that, because of his exposure to the heritage of G V Black's teaching and the early years of Minnesota dental education, he holds an appointment as clinical professor at both Northwestern University and the University of Minnesota. He was selected by the American Dental Association to be the chairman of the Operative Section for the Scientific



Front and back sides of medallion

Sessions in 1981. He was named chairman of the Operative Section of the American Association of Dental Schools, a distinct honor for a general practitioner. Perhaps Ralph's most salient accreditation supporting this award is the aggressive and untiring service that he has given to the Operative Academy. Through his stewardship as secretary-treasurer, this Academy has grown to international stature and has been identified with the preservation and pursuit of excellence. Even though gifted and dynamic presidents and their hard-working committees are essential to the Academy, they come and go. We all know it is the abiding, enduring secretary that keeps an organization buoyant and on course. I know of no person who has so faithfully cared for this Academy more than Ralph Werner, except for one—his exceptional wife, Bonna Werner. An outdated old saying goes, "Behind every good man there's a good woman," but Ralph confides that Bonna is not behind but rather alongside him and, some of the time, ahead of him. Bonna, the entire Academy wishes to convey to you their sincere thanks and admiration for your years of sacrifice, support, and service to this Academy.

Ralph Werner is a resourceful man. Many years ago, even antedating pyroplast, we resorted to cutting a facial window in a full-cast-gold anterior crown, curing in methyl methacrylate, to make it more tooth-like. One day, Ralph cemented such a crown for one of his more colorful patients, hoping to surprise him with this nice homemade, esthetic crown. The patient was dismayed! "But you promised me a gold tooth!" he protested. Unnerved but still in control, Ralph whipped out a #45 inverted cone, located all the gold-dent and one-sixteenths he could find and, half an hour later, the patient walked out of the office a happy man, displaying his gold tooth.

Those of us who have been close to Ralph have a special debt of gratitude to pay to him. We are, each one, deeply appreciative for his leading us to a number of distinguished people in dentistry, sharing them with us, allowing us to benefit markedly in professional and personal ways. Our lives have been especially enriched, just as each member of this Academy has benefited deeply from his commitment and service.

On behalf of the entire membership of this organization, and with great pride and respect, it is my privilege to present to Dr Ralph Werner the Award of Excellence from the Academy of Operative Dentistry.

ANTHONY D ROMANO, DDS

DEPARTMENTS

Press Digest

The editor wishes to thank the General Dentistry Residents at the Naval Dental School, Naval Medical Command, Bethesda, MD, for their assistance in the preparation of the following abstracts.

Microleakage with Gluma: Effects of unfilled resin polymerization and storage time. *Hansen, S E & Swift, E J, Jr (1989) *American Journal of Dentistry* 2 266-268.

(*The University of Iowa, School of Dentistry, Department of Operative Dentistry, Iowa City, IA 52242)

This study utilized 40 extracted teeth with class 5 preparations placed with incisal margins in enamel and gingival margins in dentin or cementum. Gluma bonding system was used in all restorations. Half the samples were restored by curing bonding resin and micro-filled composite together (as per manufacturer instructions). The remaining samples were restored by curing the bonding resin before the composite build-up cure. Half of each of the above technique samples were stored for 24 hours or 30 days in deionized water prior to microleakage evaluation utilizing silver nitrate dye penetration. Significantly less microleakage occurred when the unfilled resin was polymerized separately. Also less leakage occurred in both technique groups following 30-day storage. This is most likely due to greater hygroscopic expansion of the composite. The authors advise curing of the bonding agent prior to placement of composite resin.

The bonding of glass-ionomer cements to dental amalgam. *Aboush, Y E Y & Jenkins, C B G (1989) *British Dental Journal* 166 255-258.

(*Bristol Dental Hospital and School, Lower Maudin St, Bristol BS1 2LY, England)

Three glass-ionomer cements were tested for bond strength in comparison to a conventional and a high-copper amalgam. Amalgam restorations were aged in water for at least three days and the surface abraded using silicon carbide paper. A glass-ionomer cement was applied to each amalgam and the specimen tested in tension until failure occurred. Nine specimens were prepared and tested in each group. The bond strength of glass-ionomer cement to amalgam was similar to its bond strength to enamel. All specimens bonded to high-copper amalgam failed cohesively; i e, through the glass-ionomer cement. Bonds to conventional amalgam failed either cohesively or adhesively. Glass-ionomer cements may be potentially useful for repair of ditched amalgam restorations.

The use of a caries detector dye in cavity preparation. *Kidd, E A, Joyston-Bechal, S, Smith, M M & Smith, S R (1989) *British Dental Journal* 167 132-134.

(*University of London, United Medical and Dental Schools of Guy's and St Thomas's Hospitals, Department of Conservative Dental Surgery, London Bridge, SE1 9TT, London, England)

This study compared the conventional visual and tactile method of detecting carious dentin with a mirror, probe, and excavator with a visual method enhanced by a dye (1% acid red in propylene glycol). One hundred cavity preparations, completed by dental students and passed as clinically satisfactory by their teachers, were stained with the dye. Results showed dye staining at the DEJ in 57 (57%) of the preparations, corroborating an earlier, similar study by Anderson and Charbeneau using basic fuchsin dye (59 of 100 preparations had dye at the DEJ). Further, a laboratory study was conducted on extracted carious teeth and it was confirmed histologically that the dye stains demineralized dentin. In view of the current drive for conservatism in cavity preparations, the dye may be important in enhancing conventional caries-detection techniques.

Colour changes of curing light-activated restorative resins. *Makinson, O F (1989) *Australian Dental Journal* 34 154-159.

(*Department of Dentistry, The University of Adelaide, Box 498 GPO, Adelaide, South Australia 5001)

Twenty-two composite resins from nine manufacturers were evaluated for color, translucency, and surface reflective changes due to light-curing. Standardized disk samples with class 3 slot restorations, and veneer restorations prepared on extracted teeth were evaluated. Each resin showed a consistent color change tendency in both class 3 and veneer groups, which was usually matched in the corresponding disk samples. Most resins showed a shift toward greater translucency, which occurred within the first 20 seconds of curing-light exposure. Surface reflectance was partly dependent on background color. The author suggests use of opaquers to control background effects and custom shade guides for each resin product used.

Tissue management with dental impression materials. Morgano, S M, *Malone, W, Gregoire, S E, Goldenberg, B S, (1989) *American Journal of Dentistry* 2 279-284.

(*Department of Restorative Dentistry, Washington University School of Dentistry, 4559 Scott Avenue, St Louis, MO 63110)

This article suggests procedures for obtaining accurate casts to fabricate indirect restorations. Healthy tissue is essential to successful impressions. Three helpful approaches to predictable tissue management were suggested: crown lengthening, judicious electrosurgery, Ultrapak tissue dilation or combinations of the above. The selection of the type of dental elastomeric impression material varies depending upon its physical properties and the clinical conditions. Although the introduction of the Ultrapak displacement cord has eased some of the frustration, it is still the coordination between tissue management, tooth preparation, and selection of impression material that is the essential factor for accurate impressions.

Retention of amalgam restorations: Undercuts versus bonding. *Staninec, M (1989) *Quintessence International* 20 347-351.

(*Department of Restorative Dentistry, University of California, San Francisco, School of Dentistry, San Francisco, CA 94143-0758)

This study in vivo compared resin-bonded amalgam without undercuts to undercut-retained amalgam restorations under simulated occlusal load. Amalgam restorations of mesial box preparations were loaded on the marginal ridge at a 45° angle in an Instron Testing Machine. Force required to dislodge adhesive resin-bonded amalgam was significantly higher than that required for amalgam restorations with approximal grooves or occlusal dovetail. The author suggests that this technique may allow more conservative preparation design.

A comparison of glazed and polished dental porcelain. *Rosenstiel, S F, Baiker, M A & Johnston, W M (1989) *International Journal of Prosthodontics* 2 524-529.

(*Section of Restorative and Prosthetic Dentistry, Ohio State University College of Dentistry, 305 W 12th Avenue, Columbus, OH 43210-1241)

Greater control of the surface luster of a ceramic restoration may be achieved by polishing rather than glazing the porcelain; however, polishing rather than glazing the porcelain may reduce the strength of a porcelain-fused-to-metal restoration. The purpose of this study was to compare the fracture toughness and the stainability of glazed and polished dental porcelain. Twenty-two standard porcelain-fused-to-metal squares were prepared and randomly divided into two groups. In one group, the porcelain was glazed according to the manufacturer's recommendations. In the other group, the porcelain was polished with pumice until the luster was judged to match the glazed samples. Fracture toughness was studied using the Vickers indentation technique. Stainability was measured with a colorimeter after soaking the samples in a coffee solution. Greater fracture toughness values were found in the polished samples. There was no significant difference in staining of the glazed and polished samples.

Retention of amalgam restorations: Undercuts versus bonding. *Staninec, M (1989) *Quintessence International* 20 347-351.

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Book Reviews

PERIODONTAL DISEASES: Basic Phenomena, Clinical Management, and Occlusal and Restorative Interrelationships

Saul Schluger, DDS, Ralph A Youdelis, DDS, MSD, Roy C Page, DDS, PhD, Robert H Johnson, DDS, MSD

Published by Lea & Febiger, 1989. 759 pages, 416 illustrations. $72.50.

This is a complete text on everything one needs to know about periodontal diseases. It contains 32 chapters and is divided into four sections: "Basic Phenomena," "Clinical Management," "Occlusal and Restorative Interrelationships," and "Maintenance." A chapter is included on the peridontal implications of endosseous implants.

Photographs and illustrations are voluminous and of excellent quality. References often number in the hundreds per chapter and are very complete--with the exception of some of the gnathologic literature. The continuous use of the term "centric occlusion" is bothersome, as the current version of the *Glossary of Prosthodontic Terms* attempts to discourage its use.

This text is a valuable addition to the library of either the periodontist or the restorative dentist; both can benefit.

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MORFOLOGIA E MODELLAZIONE DENTALE

Dr Guido Gori

Published by Edi-Ermes, Milano, Italy, 1988. 159 pages. $58.00. (Text in Italian)

Proper knowledge of dental morphology is requisite for a careful and well-thought-out approach to dental treatment. The success of most of the dental procedures performed on a daily basis depends on the familiarity of the operator with the natural position of cusps and fossae, the contour of the crown surfaces, the extent of the pulp chamber, and the location of root furcations. It is with these objectives in mind that the author has written *Morfologia e Modellazione Dentale (Tooth Morphology and Modelling).*

The text is divided into four sections. The first includes a very thorough glossary of the anatomical components of the teeth and an overview of the relationship between the shape of each of these components and their mechanical action. An analysis of the self-protective features of the individual teeth and of the entire dentition is also included.

In Chapter 2 the author progresses from giving a detailed description of each maxillary and mandibular tooth to suggesting a practical approach for learning tooth anatomy, since he believes that with manual activity individual perception and creativity are stimulated. In Chapter 3, the reader is encouraged to draw in prepared tables the different teeth in 5:1 scale and to verify their accuracy by using transparent overlays included in a pocket on the back cover. Finally, Chapter 4 is a step-by-step introduction to wax or soap block carving to teach the student how to sculpture various geometric models and the individual teeth.

The only criticism of the book is that in the second chapter it would have been helpful to include photographs of the teeth next to the text to better visualize what is being described.

Nevertheless, this book is a very good self-teaching guide for both dental students and practitioners eager to improve their own knowledge of tooth anatomy as a starting point for a better understanding of the interrelationship between form and function of the entire masticatory system.

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Graduate Student
Department of Restorative Dentistry
School of Dentistry, SM-56
University of Washington
Seattle, WA 98195

THE BRÅNEMARK OSSEOINTEGRATED IMPLANT

Edited by T Albrektsson, MD, PhD, and G Zarb, BChD, DDs, MS, FRCD

Published by Quintessence Publishing Co, Inc, Chicago, 1989. 262 pages, 357 illustrations (237 color). $128.00.

This new implant textbook is an update of Professor Brånemark's publication of *Tissue Integrated Prosthesis: Osseointegration in Clinical Dentistry* (Quintessence, 1985). This original text was dominated by the Swedish research group. During the past four years there have been significant international research and clinical applications for osseointegrated implants. Drs Albrektsson and Zarb have assembled these international leaders in osseointegration to give updates in their research and clinical experiences.

The 18 chapters are divided into five parts: I. "Osseointegrated Implants from a Biological Perspective," II. "Role of Soft Tissue," III. "The Impact of Osseointegration on Oral Rehabilitation," IV. "Clinical Outcome with Osseointegrated Implants," and V. "Osseointegrated Implants in ENT Surgery and Orthopedics."

Each chapter was written by an expert or experts on the subject matter covered, with a total of 31 contributors. Due to the diverse authorship, each chapter varies in its format. The chapters are well-written, easy to follow, and references are supplied at the end of each chapter. The chapter entitled "Implant Treatment of Missing Posterior Dentition" addresses the problem of the inferior alveolar nerve and the maxillary sinus in the treatment of the partially edentulous. The author stresses the importance of computerized tomography scanning for the exact location of these anatomical structures; however, none of the chapters address the surgical procedures used to relocate the inferior alveolar nerve or augment the maxillary sinus. Also absent is a discussion of hydroxylapatite coating of dental implants.

This new text has expanded Professor Brånemark's original text in the areas of single tooth replacements, overdentures, extraoral applications, and orthopedics.

The field of osseointegration is expanding rapidly. This text should be read by all general practitioners and dental specialists who want to stay in the forefront of implant therapy.

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DENTAL MAINTENANCE FOR PATIENTS WITH PERIODONTAL DISEASES

Thomas G Wilson, Jr, DDS

Published by Quintessence Publishing Co, Inc, Chicago, 1990.
224 pages, 345 illustrations. $64.00.

This book is the result of an eight-year retrospective study that the author and colleagues conducted on the compliance of patients in his private periodontal practice. Discovering that only 16% of approximately 1000 patients complied with suggested recall intervals and 35% failed to return for any follow-up care, the author recruited a group of well-respected dentists and hygienists to write a book designed to help the practicing dental community deal with the problems of maintenance therapy.

A wide range of topics are included. Practical guidelines on conducting a periodontal examination and designing a treatment plan are outlined. The significance of various clinical findings are discussed. Hints on oral hygiene instruction are given. The section on root curettage is detailed and includes an illustrative review on the anatomy of tooth roots that demonstrates the difficulty of gaining access to accretions. Favorite instruments are recommended.

The maintenance of restorative dentistry is well-covered. Informative instructions for the denture patient and suggested solutions for common complaints make this part of the text particularly valuable. Troubleshooting in fixed prosthodontics is equally well-done. The chapter on implants is timely and contains many good suggestions on their maintenance.

The section dealing with compliance in the child patient is refreshingly candid. This excellent chapter provides helpful hints on the care of orthodontic appliances for patients of all ages. The "marriage" of orthodontic and periodontal therapy is enlightening.

Clinical diagnostic tests are featured in the endodontic-periodontal chapter, followed by an overview of conservative and surgical endodontic techniques. The figures illustrating repair of restorative failures are worthwhile; perhaps more of this type of material could have been included.

This reviewer (admittedly biased) did not find the chapter on "Maintenance for the TMJ patient" very satisfying.

Topics of special concern round out the text. Difficulties facing patients with oral cancer and their dental therapists were particularly well-done. Suggestions on how to manage the patient with diabetes mellitus could have been more explicit.

Sprinkled throughout this practical book are detailed reviews of periodontal microbiota, plaque-control devices and agents, occlusion and periodontal disease, desensitizing agents, and oral changes attributed to radiation and chemotherapy. They add a scholarly touch to the text.

In matters of style rather than substance, the author's use of "we" leads to some confusion. "We" serves as a substitute for "I" (the author), his office personnel, and the collective scientific and clinical dental community. The frequently used term "keratinized gingiva" represents an unnecessary redundancy. The contributors may not differentiate between "attached gingiva" and "gingiva," which makes some dimensional recommendations questionable.

The quality of the photos, printing, paper, and the layout of the text make it a pleasure to read, although the numerous color photos may add unnecessarily to the price. A helpful feature is "At a Glance," which highlights the important issues found in each chapter. The book should represent a welcome addition to the busy dental practitioner's office library.

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CRANIOMANDIBULAR AND TMJ ORTHOPEDICS

Franco Mongini, MD, DDS, and Wihelmine Schmidt, MD, DDS

Published by Quintessence Publishing Co, Inc, Chicago, 1989. 206 pages, 491 illustrations. $54.00.

This book is the culmination of many years of clinical experience and research concerning the TMJ and masticatory muscle pathophysiology and their relation to occlusion, and it was written to help students, general practitioners, and specialists in orthodontics and occlusion. For clinical application, their emphasis on diagnosis and treatment of craniofacial asymmetries, however, tends to gear the book more to orthodontists.

The authors are both well-qualified to write such a book, judging from their previous publications and experience. Dr Mongini is also the author of *The Stomatognathic System* (Quintessence, 1984) and the director of the Center for Gnathology and Craniofacial Pathophysiology at the University of Turin, Turin, Italy. Dr Schmidt is on the faculty of the Postgraduate School of

Orthodontics at the University of Turin.

The book is well-organized and provides an extensive review of research on the stomatognathic system. Chapters are devoted to craniofacial growth, articular remodeling, stomatognathic function and dysfunction, craniomandibular asymmetries and orthopedics, and treatment of stomatognathic dysfunction.

Illustrations, although all are black-and-white, are numerous and complement the text. The treatment section is well-documented with clinical cases.

This book is extremely valuable in that it attempts to bridge the gap between orthodontists and gnathologists in the assessment and treatment of occlusal and temporomandibular dysfunctions (TMD). Perhaps its most valuable contribution is the awareness it provides for the adaptive capability of the TMJ and the vital role that orthopedics plays in treatment-planning. It is highly recommended to anyone involved in the diagnosis and treatment of TMD.

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Letters

HISTOLOGICAL STUDY OF AN ACID RED CARIES DISCLOSING DYE

I read the article by Boston and Graver (14(4): 186-92) with great interest but must make a very important comment. The conclusion stating that the use of the dye solution greatly decreases but does not eliminate the chance of viable bacteria remaining is a result of the incorrect experimental technique used, which is different from ours. This is misleading to the readers.

The authors used permanent teeth with large caries lesions to be extracted for prosthetic or periodontal reasons. The caries used in this experiment is therefore considered to be very chronic. It was stated that when no further staining occurred the dentin usually exhibited a tan or brownish discoloration. This indicates that a markedly discolored layer was left on the floor. Such discolored tissue should not be left.

We have always advised that the heavy natural discoloration of chronic decay should be removed together with the detector-stained tissue, because it masks the staining front of the detector. Complete removal of the discoloration does not result in much overreduction even without clearly distinguishing the staining front because the fronts of discoloration and bacterial invasion are quite close to each other in chronic decay. The basic requirement is thus to remove the detector-stainable dentin in acute or moderate decay and to remove the heavy natural discoloration together with the detector-stainable dentin in chronic decay.

Please refer to the following literature: 1) Sato Y and Fusayama T, "Removal of dentin by fuchsin staining," *Journal of Dental Research* 55:682, 1976, 2) Fusayama T, "Two layers of carious dentin: diagnosis and treatment," *Operative Dentistry* 4:66, 1979, and 3) Fusayama T, "Clinical guide for removing caries using a caries-detecting solution," *Quintessence International* 19:397, 1988 (Fig 5).

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RESPONSE

Thank you for your interest and comment regarding our article, "Histological study of an acid red caries-disclosing dye," *Operative Dentistry* 14(4):186-192, 1989. Your assumption that we chose teeth with "very chronic" decay for this study is incorrect. All lesions in this study were, in fact, clinically acute caries with very soft superficial decay and with only occasional lightly colored tan or brown staining. In addition, as stated in the article, "A depth of excavation was eventually reached whereby further dye application did not result in staining of the dentin." This endpoint for excavation was always visually distinct in our study. The minimum amount of tan or brown stain sometimes remaining after the final excavation in no way obscured detection of dye retention, nor did it obscure detection of dye staining in the dye application/excavation cycles prior to reaching the endpoint of excavation.

Anderson MH, Loesch WJ & Charbeneau GT ("Bacteriologic study of a basic fuschin caries-disclosing dye," *Journal of Prosthetic Dentistry* 53:643-646, 1985) similarly found bacteria remaining in the dye-unstained dentin pulpal to the cavity floor using bacteriologic means to investigate this question. That study is in accord with our findings.

The studies you reference do indicate to us that discolored dentin should be removed when excavating the chronic carious lesion in order to remove all bacteria. Because natural staining in acute carious lesions is light and only variably present, the use of acid red dye can provide a definitive visual endpoint for excavation that the natural staining will not provide. Selection and excavation of the acute carious lesions in our study was therefore appropriate for investigation of the histologic relationship between the acid red excavation endpoint and the bacterial invasion front in acute carious lesions.

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Announcements

The American Board of Operative Dentistry

The American Board of Operative Dentistry held its annual meeting on 7 February and celebrated the awarding of certification documents to six new members: Drs Olin D Parr, Francis J Robertello, Clyde Roggencamp, Henry A St Germain, Richard C Vinci and Steve W Wallace, and inducted them into membership on the Board. Additionally, six individuals participated in the first part, the written examination, of the certification program.

Officers elected for the next two years are: Dr James V Gourley, president; Dr Chester J Gibson, vice-president; and Dr David O Moline, secretary/treasurer. In addition to the officers, the members of the executive council are Drs Ronald C House, Robert C Keene, José E Medina, William T Pike, John W Reinhardt and Daniel T Snyder.

Anyone interested in information about the certification process should contact the secretary/treasurer: Dr David O Moline, Department of Hospital Dentistry, University of Iowa Hospitals, Iowa City, Iowa 52242.

Academy of Operative Dentistry

The nineteenth annual meeting of the Academy of Operative Dentistry was held 8 and 9 February in Chicago at the Westin Hotel. Another outstanding program comprised of meetings, essays, and table clinics was presented. The ninth annual Buonocore Memorial Lecture was delivered by Nairn H F Wilson of Manchester, England. At lunch on the first day the Hollenback Memorial Prize was presented to Dennis C Smith for his many contributions to the science of dentistry. Ralph J Werner, our esteemed Academy secretary, was presented the Award of Excellence at the luncheon on the second day.

Officers elected for 1990 are: president, R Craig Bridgeman; immediate past president, Anna T Hampel; president-elect, José Medina; vice-president, Ralph M Phelan; treasurer, Ralph J Werner; and secretary, Gregory E Smith. Councillors for 1990 are Thomas G Berry and Joel Morris Wagoner; for 1991, Joseph B Dennison and Warren K Johnson; and for 1992 Ebb A Berry III and Ronald C House.

Student Clinician Winner

Shelley Stombroe, third-year dental student from the University of Texas Health Science Center at San Antonio, School of Dentistry, was recognized at the Thursday luncheon as the

Student Clinician for 1990. Ms Stombroe presented her award-winning table clinic at the Friday session. Her clinic entitled "The dentist's role in the recognition, treatment, and referral of domestic violence victims" was truly outstanding.

Scenes from the AOD Meeting

Shelley Stombroe, Clinician Winner, 1990

Dr and Mrs Werner

NOTICE OF MEETINGS

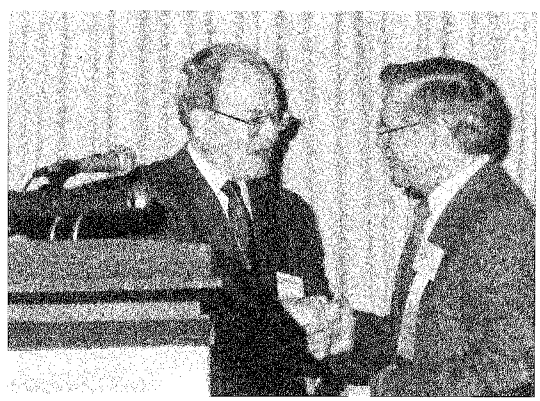
American Academy of Gold Foil Operators

Annual Meeting:
10-12 October 1990
Tufts University
School of Dentistry
Boston, Massachusetts

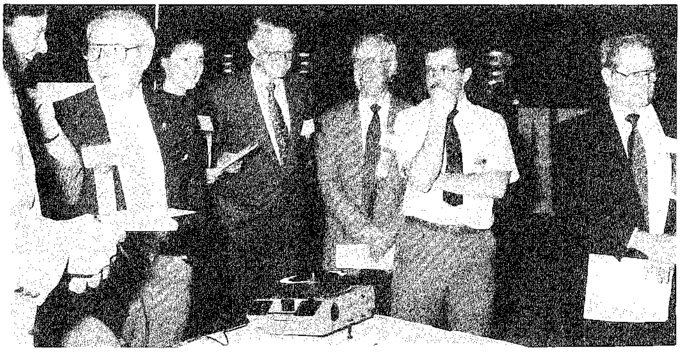
Academy of Operative Dentistry

Annual Meeting:
14-15 February 1991
Westin Hotel
Chicago, Illinois

Michael Cochran presents table clinic



Richard Norman presenting Buonocore Award to Dr Smith



Another great clinic

Officers for 1990

Toni Romano congratulates Ralph Werner on the Award of Excellence as Bonna Werner looks on

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

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

Exclusive Publication

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

Manuscripts

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

Authors who prepare their manuscripts on a word processor are encouraged to submit an IBM compatible computer disk of manuscript (3½ or 5¼ inch) in addition to original typed manuscript; authors need to identify the word processing program used.

Tables

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

Illustrations

Submit two copies of each illustration. Line drawings should be in india ink or its equivalent on heavy white paper, card, or tracing vellum; any labeling should be on an extra copy or on an overleaf of tracing paper securely attached to the illustration, not on the illustration itself. Type legends on separate sheets. Photographs should be on glossy paper and should be cropped to remove redundant areas. For best reproduction a print should be one-third larger than its reproduced size. Maximum size of figure is 15x20 cm (6x8 inches). Only black and white photographs can be accepted. On the back of each illustration, near the edge, indicate lightly in pencil the top, the author's name, and the number of the figure. Type legends on a separate sheet. Where relevant, state staining techniques and the magnification of prints. Obtain written consent from holders of copyright to republish any illustrations published elsewhere.

References

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

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EDITORIAL

ORIGINAL ARTICLES

PRODUCT REPORT

LITERATURE REVIEW

AWARD OF EXCELLENCE

DEPARTMENTS

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