OPERATIVE DENTISTRY

winter 1977 • volume 2 • number 1 • 1-48

OPERATIVE DENTISTRY

WINTER 1977 • VOLUME 2 • NUMBER 1 • 1-48

Aim and Scope

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

Publisher

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

Subscriptions

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

OPERATIVE DENTISTRY
University of Washington
School of Dentistry SM-57
Seattle, WA 98195, U.S.A.

Contributions

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

Permission

For permission to reproduce material from *Operative Dentistry*, please apply to the University of Washington, Office of Scholarly Journals, 4045 Brooklyn Avenue NE JA-15, Seattle, Washington 98105, U.S.A.

Second-class postage paid at Seattle, WA.

Editorial Office

University of Washington, School of Dentistry SM-57, Seattle, Washington 98195, U.S.A.

Editorial Staff

Editorial Board

Editorial Advisers

The views expressed in *Operative Dentistry* do not necessarily represent those of the Academies, or of the Editors.

EDITORIAL

Expanded Duties: An Economic Fallacy

Increased productivity and lower prices are worthy aims for any economy. Over the years industry has adopted various methods to achieve these objectives. Dentistry, though a profession, is no less obliged to do likewise.

Recently it has been recommended that some of the tasks of operative dentistry, such as placing and finishing restorations of amalgam and composite resin, be assigned to dental auxiliary personnel, with the idea that this will increase productivity and lower costs. The proponents of expanded duties—mainly government employees and academics—already have spent enormous sums of money to demonstrate that dental assistants and hygienists can in fact learn to perform these operations. Much of this research, however, was unnecessary because it had already been shown, in the 1920s in New Zealand and in the 1960s in Britain, that within a period of two years young women can be taught to give prophylaxes, prepare cavities, place restorations of amalgam and silicate, extract teeth for children, and provide education for patients. Moreover, the quality of the treatment has been shown to compare favorably with that provided by dentists. This information was readily available and, had it been consulted, much costly research could have been avoided.

Having demonstrated to their own satisfaction that auxiliaries could learn to perform the dental tasks assigned to them, the proponents of the scheme began at once to campaign vigorously for its implementation—almost, it seemed, on the maxim that because it can be done it should be done. We need only remind ourselves that we can also jump off the Space Needle to see the fallacy in this kind of argument. To make it legal for dental auxiliaries to treat patients, state dental associations were pressured and intimidated to change the legal acts governing the practice of dentistry. Those state officials with little courage and less foresight capitulated in the name of progress and supported the requested changes; as a result, in some states dental auxiliaries may now provide some forms of treatment for patients.

To support the contention that a system of expanded duties for dental auxiliaries will reduce the cost of providing dental service, the costs of educating a dentist and an auxiliary have been compared. We are told that the cost of educating a dentist, including four years of predental education, is about $60,000, whereas the cost of educating a dental auxiliary is about $8,000. The difference in these costs is advanced as the reason for the cost of treatment being less when it is provided by an auxiliary. An important element, however, is missing from the calculations, and that is the comparable working life of the dentist and the auxiliary. A dentist, graduating in his early twenties and retiring in his sixties, works about forty years. The cost of his education distributed over his working life is about $1,500 per year. Information on the working life of a dental auxiliary is not plentiful but an average of four years would probably be a generous estimate, making the cost of education about $2,000 per year of working life. The estimated cost of a dental education may be comparatively high because it includes four years of predental education, not all of which is required. On the other hand, the estimated cost of educating a dental auxiliary may be comparatively low because in support of programs such as this, costs tend to be underestimated just as benefits tend to be overestimated. Add to this the further training that is often required

to adapt to a particular dental practice and the cost of educating dental auxiliaries could well be double the cost of educating dentists. Some saving!

Even more important is the difference between the two in the scope of their training. The more diverse skill of the dentist, compared with the limited repertoire of the auxiliary, enables him to treat the patient as a whole, that is, comprehensively. This is immensely important because there is a tendency for the specialized worker to acquire a narrow view of the overall purpose of his task, as was recognized by Adam Smith, the first to describe the advantages of the division of labor. It is a tribute to Smith's foresight that he was also able to predict other disadvantages of the division of labor, namely, overspecialization and the monotony of doing simple repetitive operations. The specialized worker doing his specific task on the assembly line played a crucial part in the Industrial Revolution of the eighteenth century. Within the last three decades, however, there has been a marked departure in the course of industrialization. The continuing desire for greater efficiency and the need to reduce the costly labor component have led to the introduction of automation and this, in turn, has engendered the Second Industrial Revolution.

For dentistry this means we should be looking to new technology as our expanded auxiliary. Future techniques of automation, such as milling devices controlled automatically and programmed to prepare several cavities simultaneously and perhaps allow the preparation of cavities for more than one patient at a time, would enable dentists to increase productivity substantially. At the same time the comprehensive service that comes from our education and experience as professionals would be preserved.

In the final analysis, there are humans attached to teeth, and, in any event, human beings are not machines. They deserve better than task-oriented, assembly-line treatment. To reduce a particular operation, such as the placement of a silver amalgam, to its component parts and have a dental auxiliary complete part of this operation, the insertion of the amalgam, for example, is just such an assembly-line process. While this type of system might have worked well in the eighteenth century, it is not appropriate in the Age of Automation.

The spurious economics used to support expanded duties for dental auxiliaries, foisted on the dental profession by those who couldn't tell a demand curve from a knuckle ball, should be rejected. The government should abandon these worthless projects on which it is wasting huge sums of the taxpayers' money. Instead the government should give more support to the teaching of operative dentistry to dental students. Good teachers of operative dentistry are scarce and should not be wasted on teaching auxiliaries whose working life is short, especially as so much needs to be done to improve the competence of dental students who will be spending a lifetime in their chosen profession. It is by graduating dentists that are better trained in operative dentistry that we can provide a better service for the patient.

A. IAN HAMILTON

ORIGINAL ARTICLES

Radiopacity of Restorative Materials

The resins that are commonly used as restorative materials cannot be clearly recognized in dental radiographs. This is a great disadvantage for dentists and consequently manufacturers should try to correct the shortcoming.

MURILLO JOSE NUNES DE ABREU • DELMO TAVARES • DIORACY FONTERRADA VIEIRA

Summary

The radiopacity of 28 materials commonly used for dental restorations has been determined by photodensitometry. The materials have been ranked in order of increasing radiopacity and the minimum radiopacity required by a material to be readily distinguished in a radiograph has been determined. None of the resins used as material for dental restorations has this minimum radiopacity. Addition of barium sulfate to the materials reveals that some of them can be made sufficiently radiopaque with small additions of barium sulfate but others require so much that their physical properties are affected adversely.

Murillo Jose Nunes de Abreu, D.D.S., Ph.D., Universidade Federal de Santa Catarina, Curso de Odontologia, Department of Radiology, Florianópolis, Brazil.

Delmo Tavares, D.D.S., Ph.D., Universidade Federal de Santa Catarina, Curso de Odontologia, Department of Radiology, Florianópolis, Brazil.

Dioracy Fonterrada Vieira, D.D.S., M.S.D., Ph.D., Universidade de São Paulo, Faculdade de Odontologia, Department of Dental Materials, São Paulo, Brazil.

Professor Vieira is chairman of the Department of Dental Materials.

Radiopacity is a desirable characteristic for dental restorative materials because radiographically we need to be able to distinguish them from caries, to detect excess material at the cervical margins of proximal surfaces, to depict proximal contours, and to locate material that accidentally has been swallowed or inhaled. Metallic materials such as gold and silver amalgam, and salts of heavy metals such as zinc phosphate, have adequate radiopacity for dental purposes. Acrylic resins, on the other hand, are radiolucent and thus are difficult or impossible to detect in radiographs.

Studies of the radiopacity of dental materials have been reported (Degering & Buseman, 1962; Benazzi & Gorini, 1964; Gonçalves & Boscolo, 1970; Combe, 1971; Lee & Orlowski, 1973), but with the increasing number of new materials on the market it is time to reevaluate our knowledge of the radiopacity of materials used for dental restorations. The study reported here has three objectives: (1) to measure the radiopacity of a selection of common restorative materials and classify them in order of increasing radiopacity; (2) to determine the minimum radiopacity that a material must have to be detectable in a dental radiograph; and (3) to determine the amounts of radiopaque substance that must be added to radiolucent materials to make them sufficiently radiopaque for dental purposes.

RADIOPACITY OF RESTORATIVE MATERIALS

The purpose of this part of the study is to measure the radiopacity of 28 restorative materials.

Materials and Methods

The 28 restorative materials selected for study (Table 1) were prepared according to manufacturers' directions, inserted to excess in copper rings, and compressed between two glass plates to give parallel surfaces. The copper rings had an internal diameter of 4.5 mm and lengths of 2, 4, 6, and 8 mm to provide specimens of various thickness. Four samples of each thickness were prepared for each material. All of the 488 samples were radiographed on Morlite ultraspeed X-ray film (Eastman Kodak Co., Rochester, NY 14650, U.S.A.) with THUR D-36 X-ray equipment (VEB Transformatoren und Roentgenwerk, Dresden, German Democratic Republic) at 65 Kvp and 10 mA with a distance of 40 cm from film to target. The radiographs were developed in Kodak developer for 4 min at 21° C. For each material, four samples, one of each thickness, were radiographed on a single film. Radiopacity was determined by measuring optical transmittance with a photodensitometer (Rapid Photometer II, Carl Zeiss, Jena, German Democratic Republic). The scale of this instrument varies from 0 (total transmission of light) to 1000 (no transmission of light). The optical transmittance of each image was measured four times and arithmetic means with standard deviations were computed for the 16 readings for each sample. Low transmittance of the image indicates low radiopacity and high transmittance indicates high radiopacity.

Results

The radiopacities of the 28 materials are listed in Table 2. The materials are arranged in order of increasing radiopacity of the 2 mm thick sample. This thickness was used because it most closely approximates that of dental restorations. The information is depicted graphically in Figures 1 to 3.

Discussion

The materials separate conveniently into three groups based on degree of radiopacity.

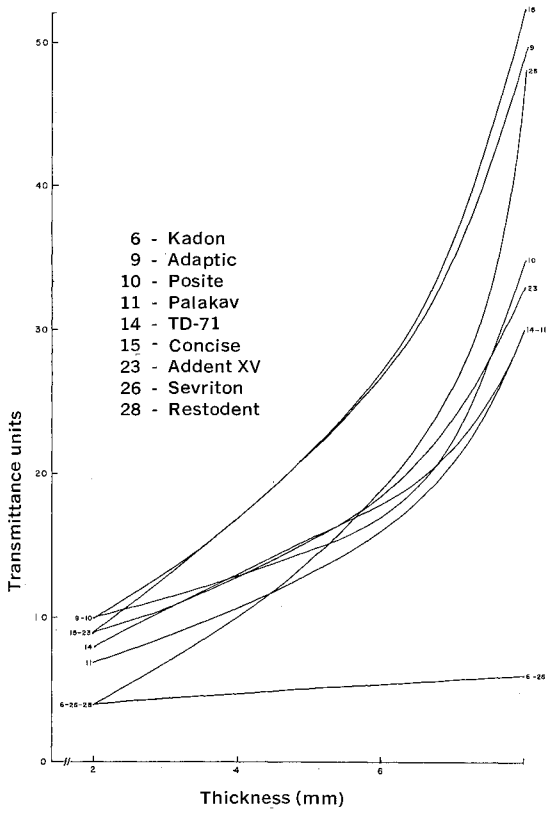


FIG. 1. Transmittance curves for materials considered as highly radiolucent, as a function of their thickness.

Group 1. Radiopacity 0-60 in any thickness: Kadon, Sevriton, Restodent, Palakav, TD 71, Concise, Addent XV, Adaptic, and Posite. These would not be detectable in dental radiographs. In this group radiopacity does not increase proportionally with thickness of specimen—Kadon and Sevriton change little with increasing thickness whereas the radiopacity of the others increases markedly, that of Adaptic and Restodent increasing five and ten times respectively as thickness changes from 2 to 8 mm. This may not be advantageous, however, because the materials are not often used in thicknesses greater than 2 mm. The differences in the shapes of the radiopacity curves is worth noting (Fig. 1). The gradual slope of the curve for Kadon and Sevriton gives some indication of the problem of making these materials sufficiently radiopaque. It would require the addition of such a large amount of radiopaque material that the other properties of the acrylic resin would be affected adversely for dental restorations (Atkinson, 1954); for other

purposes (Alvares, 1966; Rezende, 1973) smaller amounts of barium sulfate added to acrylic resins may be satisfactory for radiography.

Group 2. Radiopacity 7.1-77.3 in 2 mm thickness but not above 550 in any thickness: Enamelite, Cimencol, S.S.W. silicate cement, Silikolith, Hydrex, CBA-9080, Drala Stahl, Prestige, Smile, Dycal, and HL-72. Some of these have relatively low radiopacity even in a thickness of 8 mm. Hydrex and Dycal, in the thickness in which they are commonly used, are not likely to be detected in dental radiographs. CBA-9080, Prestige, Smile, and HL-72 contain additions of radiopaque substances but have low radiopacity nevertheless in the thickness usually required, and may not be detectable in dental radiographs. The most convenient radiopacity for restorative materials is said to be that between enamel and dentin (Bowen & Cleek, 1972; Lee & Orlowski, 1973). The results of this experiment do not substantiate statements that Prestige and HL-72 fulfill this requirement or that the radiopacity of Smile is nearer that of dentin (Lee & Orlowski, 1973). With some materials, such as Smile, the radiopacity appears homogeneous, or evenly distributed, whereas with others, such as Prestige, radiopacity appears heterogeneous, or granular.

Group 3. Radiopacity 194.7-622.0 in 2 mm thick samples: Opotow, EBA-Plus, ZOE cement, Fynal, S.S.W. zinc phosphate cement, Durelon, EBAC, and AH-26. These materials all contain zinc oxide as an ingredient, except for AH-26 which contains salts of bismuth and silver. The curves of radiopacity for materials in group 3 (Fig. 3) differ markedly from those of groups 1 and 2 in that the concavities of the curves in group 3 face downward. The radiopacity for some of these materials is so high that it does not increase in thicknesses greater than 4 mm.

The classification of radiopacity used here is in accord with that of Degering and Buseman (1962) and supports the observations of others (Alvares, 1966; Atkinson, 1954; Bursey & Webb, 1960; Gonçalves & Boscolo, 1970; Maisto, 1967; Mattaldi, 1968; Wainwright, 1965).

It is not practical to establish a particular measure of optical transmittance as the division between radiopaque and radiolucent materials. Other factors, such as the observer's evaluation of the radiograph, the conditions

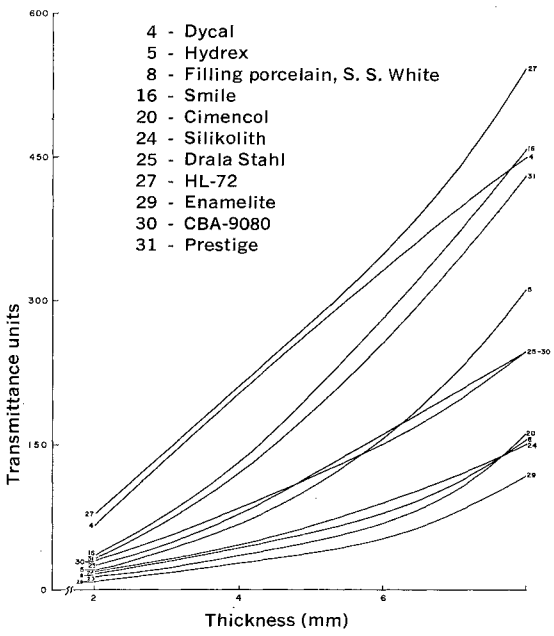


FIG. 2. Transmittance curves for materials considered of medium radiopacity, as a function of their thickness.

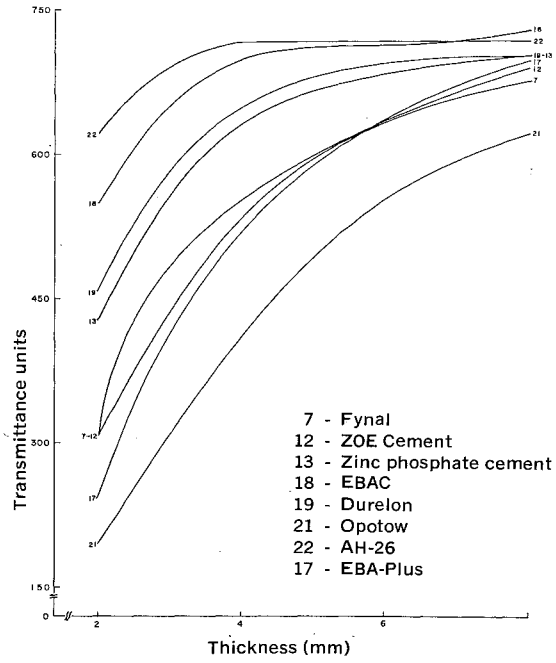


FIG. 3. Transmittance curves for highly radiopaque materials, as a function of their thickness.

Table 1. *Restorative Materials Studied for Radiopacity*

Material	Trade Name	Manufacturer
Composite resin	Palakav*	Külzer & Co., Germany
	TD 71*	Dental Fillings, England
	Addent XV*	3M Co., U.S.A.
	Adaptic*	Johnson & Johnson, U.S.A.
	Posite*	AMCO, U.S.A.
	Concise*	3M Co., U.S.A.
	Smile*	Kerr Mfg Co., U.S.A.
	Enamelite*	Lee Pharmaceuticals, U.S.A.
	Restodent*	Lee Pharmaceuticals, U.S.A.
	HL-72*	Lee Pharmaceuticals, U.S.A.
	Prestige*	Lee Pharmaceuticals, U.S.A.
Silicate and silicophosphate cement	Filling porcelain S.S. White*	S. S. White Dental Products, U.S.A.
	Silikolith*	A. Platzer, Austria
	Drala Stahl*	Dralla GmbH, Germany
Self-curing acrylic resin	Kadon Colorfast*	L. D. Caulk Co., U.S.A.
	Sevriton*	Amalgamated Dental, England
Zn oxide-eugenol cement	Opotow**	Opotow Dental Mfg Corp., U.S.A.
	EBA-Plus **†	William Dixon Inc., England
	EBAC**†	Lorvic Corp., U.S.A.
	ZOE Cement**	S. S. White, U.S.A.
	Fynal†	L. D. Caulk Co., U.S.A.
Zinc phosphate cement	Zinc Phosphate Cement S. S. White**†	S. S. White Dental Products, U.S.A.
Polycarboxylate cement	Durelon**†	ESPE GmbH, Germany
	Cimencol†	Cedia Promotion, France
Calcium hydroxide cement	Hydrex**	Kerr Mfg Co., U.S.A.
	Dycal**	L. D. Caulk Co., U.S.A.
Resin cements (BPA-GMA)	CBA-9080†	Lee Pharmaceuticals, U.S.A.
	AH-26‡	De Trey Frères S. A., Switzerland

* Restorative material
** Cement base or lining material
† Luting material
‡ Material for endodontic fillings

Table 2. *Mean Radiopacities ($\bar{X}$) and Standard Deviations (S) of Restorative Materials as a Function of Their Thickness*

Material \ Thickness (mm)	2		4		6		8	
	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S
Kadon	4,0	0,0	4,1	0,2	6,0	0,0	6,1	0,2
Sevriton	4,0	0,0	4,2	0,4	6,1	0,3	6,2	0,4
Restodent	4,2	0,4	9,8	1,6	18,8	2,6	47,5	4,2
Enamelite	7,1	1,5	26,4	2,7	51,4	3,4	119,6	5,9
Palakav	7,4	0,5	10,8	1,2	16,1	3,2	29,9	3,6
TD-71	8,1	1,0	13,0	1,4	18,4	2,5	30,2	3,6
Concise	8,8	1,6	17,5	3,3	27,3	5,9	53,4	8,3
Addent XV	9,4	0,9	14,3	1,5	15,9	2,1	32,9	4,5
Adaptic	9,7	0,6	16,7	2,1	27,0	3,7	49,9	5,6
Posite	9,9	0,2	12,8	1,3	16,9	2,6	35,0	4,2
Cimencol	13,6	1,0	36,8	2,0	68,1	5,9	160,4	6,2
Silicate cement S.S.W.	15,9	1,8	43,7	5,3	78,1	10,1	154,7	14,1
Silikolith	17,7	2,3	43,8	7,7	86,8	11,1	149,9	13,6
Hydrex	21,4	2,7	69,2	5,2	156,4	7,8	310,3	8,1
CBA-9080	25,0	1,8	84,1	5,0	150,0	6,6	245,6	8,5
Drala Stahl	26,7	2,4	77,8	5,3	162,6	9,4	245,1	8,8
Prestige	34,6	3,7	121,8	6,0	258,3	7,5	430,4	6,3
Smile	36,8	3,0	131,7	8,3	284,6	9,9	454,0	6,9
Dycal	66,6	2,6	202,1	8,1	330,3	20,9	450,4	11,6
HL-72	77,3	7,5	210,2	10,9	348,8	15,1	539,5	12,3
Opotow	194,7	17,1	409,7	12,9	554,6	13,6	623,8	20,9
EBA-Plus	244,9	13,8	523,1	9,5	640,1	9,8	698,8	9,6
ZOE Cement	305,0	8,0	552,1	7,2	635,4	5,3	691,4	16,7
Fynal	310,4	8,6	536,9	13,0	635,1	10,1	678,9	10,0
Zinc phosphate cement	424,7	9,2	631,9	4,1	684,8	12,9	703,9	6,1
Durelon	457,7	8,6	651,9	10,3	696,4	9,5	704,3	11,4
EBAC	548,1	6,6	702,6	10,7	714,3	6,0	731,4	5,4
AH-26	622,0	12,7	717,9	14,6	718,3	20,2	719,3	23,8

Note: Radiopacity increases with size of number.

Table 3. *Distribution of Radiopaque Materials in a Decreasing Order of Radiopacity, by Examiners' Evaluation*

Observers	Order of Radiopacity								
	1st*	2nd	3rd	4th	5th	6th	7th	8th	9th
E_1	AH-26	EBAC	EBA-Plus	ZOE Cement	Zinc phosphate cement	Durelon	Fynal	Opotow**	—
E_2	AH-26	EBAC	Durelon	EBA-Plus	Zinc phosphate cement	ZOE Cement	Fynal	Opotow**	—
G_1	EBAC	AH-26	Durelon	EBA-Plus	Zinc phosphate cement	ZOE Cement	Fynal	Opotow	Smile**
G_2	EBAC	AH-26	Durelon	Zinc phosphate cement	EBA-Plus	ZOE Cement	Fynal	Opotow**	—
R_1	AH-26	EBAC	Durelon	Zinc phosphate cement	EBA-Plus	ZOE Cement	Fynal	Opotow**	—
R_2	AH-26	EBAC	Durelon	EBA-Plus	ZOE Cement	Fynal	Zinc phosphate cement*	—	—

E: endodontist
G: general practitioner
R: radiologist
* The most radiopaque material
** The least radiopaque material

under which it was taken, and the density and thickness of the structure radiographed, affect the quality of the result. The relativity of radiopacity is exemplified by materials that may be considered radiolucent when used for dental restorations but radiopaque when used for prosthetic appliances.

MINIMUM RADIOPACITY REQUIRED

The importance of radiopacity in dental materials has been established but the minimum radiopacity required of a material to enable it to be detected easily in a radiograph has not been determined. The determination of this degree of minimum radiopacity is the purpose of this part of the study.

Materials and Methods

Cavities were prepared in the cervical third of the facial surface of each of eight sound teeth recently extracted. These were the upper central incisor, canine, premolar, and molar, and lower lateral incisor, canine, premolar, and molar. The cavities were cylindrical, 2 mm in diameter and 2 mm deep. Into each of these cavities were inserted successively all the materials listed in Table 1 except Enamelite, Restodent, HL-72, Prestige, and CBA-9080. After each tooth was radiographed the restorative material was removed from the cavity so that it could be filled with another material. To avoid enlarging the preparation the material was removed carefully under a stereomicroscope at a magnification of 25 times. The original dimensions of the cavity were confirmed each time with calipers precise to 0.05 mm. After restoration with each of the materials the teeth were radiographed in both faciolingual and mesiodistal directions under the same conditions as described previously. The films were developed in Kodak developer for 4 min at 21° C. The 16 radiographs for each material were mounted together in a cardboard mount for observation. In addition radiographs were taken of the teeth with the cavities empty and these radiographs were mounted in the same way. These experimental conditions presented a great range of thickness of enamel and dentin.

The radiographs were evaluated by six dentists (two endodontists, two radiologists, and two general practitioners) who indicated for each radiograph whether there was a cavity in the tooth, if so whether the cavity was filled, and whether the radiopacity of the filling material was less than, similar to, or greater than the radiopacity of the tooth. The identities of the radiographs were concealed from the evaluators. The purpose of the evaluation was to separate the materials into two groups, those that could be distinguished with certainty from tooth structure in all 16 radiographs and those that could not, and to determine which of the radiopaque materials had the least radiopacity that could be detected with certainty.

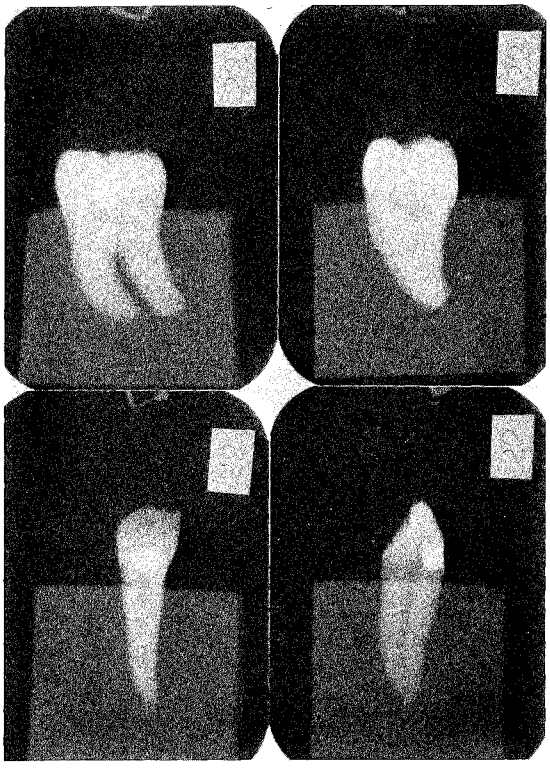
Results

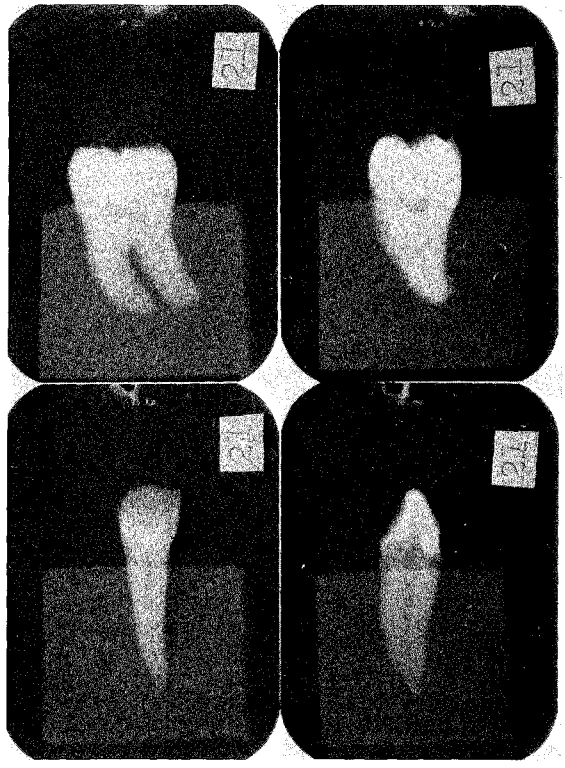
The results are shown in Table 3. It can be seen that there was good agreement among the evaluators. Four of them found eight materials of sufficient radiopacity to be detected unequivocally, one found seven and another found nine. The evaluation of the examiners shows that the order of decreasing radiopacity of the materials is: AH-26, EBAC, Durelon, EBA-Plus, S.S.W. zinc phosphate cement, ZOE cement, Fynal, and Opotow. One examiner omitted Opotow from the list of radiopaque materials and another added Smile but it was agreed generally that Opotow has the minimum radiopacity for easy detection. None of the examiners recognized that one of the mounts contained radiographs of teeth with empty cavities. These were rated in several cases as having restorations of low or medium radiopacity. Figures 4-6 illustrate the radiographic appearance of materials with the highest (AH-56), minimum (Opotow), and lowest (Kadon) radiopacities, respectively.

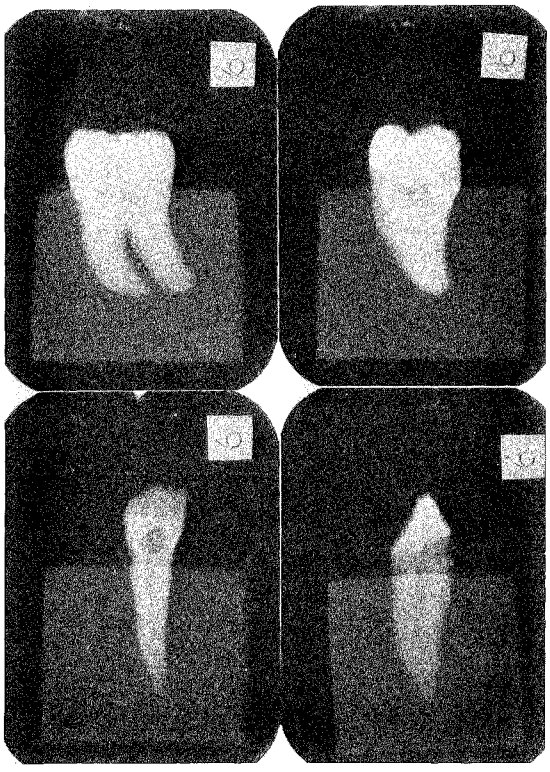
The materials with less than the required minimum radiopacity can be separated into two groups, one with low and the other with moderate radiopacity (Table 4). For the most part the examiners evaluated radiographs of teeth filled with materials in group 1 as empty cavities. In the case of group 2 materials, in only 64.3% of the cases the examiners said that the teeth were filled with materials of low or medium radiopacity. These results agree with previous evaluations (Degering & Buseman, 1962; Gonçalves & Boscolo, 1970; Sahs, 1967; Wuehrmann, 1960). Those materials with moderate radiopacity were usually identified as materials having low or medium radiopacity.

Table 4. *Evaluation of Materials with Less than Minimum Radiopacity*

Group	Material	Radiopacity	Units of Transmittance	Radiographic Evaluation			
				Tooth with an Empty Cavity	Tooth without Material or Cavity	Tooth with a Material of Low Radiopacity	Tooth with a Material of Medium Radiopacity
1	Sevriton	null	4	69	1	12	14
	Palakav	null	7	68	1	15	12
	TD-71	null	8	67	1	14	14
	Addent XV	null	9	68	0	14	14
	Concise	null	9	68	0	14	14
	Adaptic	null	10	67	4	17	8
	Posite	null	10	67	2	16	11
	Kadon	low	4	58	0	28	10
	Silicate cement	low	16	42	17	24	13
	Average	—	—	63,8	2,9	17,1	12,2
2	Cimencol	moderate	14	0	35	11	50
	Silikolith	moderate	18	22	20	40	14
	Hydrex	moderate	21	5	17	42	27
	Drala Stahl	moderate	27	3	60	32	1
	Smile	moderate	37	0	0	14	82
	Dycal	moderate	67	1	15	32	41
	Average	—	—	5,1	24,5	28,5	35,8







ABOVE LEFT:
FIG. 4. Radiographs of AH-26, *showing the lower lateral incisor and the lower molar, in the faciolingual and mesiodistal aspects.*

ABOVE RIGHT:
FIG. 5. Radiographs of OPOTOW, *showing the lower lateral incisor and the lower molar, in the faciolingual and mesiodistal aspects.*

AT LEFT:
FIG. 6. Radiographs of KADON, *showing the lower lateral incisor and the lower molar, in the faciolingual and mesiodistal aspects.*

Except for silicate cement there was general correspondence between transmittance values of the materials and their radiopacities as judged by the examiners.

Discussion

The fact that the examiners did not agree entirely and that they all misinterpreted the radiographs of the unfilled cavities emphasizes the need for a restorative material to be undeniably radiopaque so that it is distinguishable from caries or a prepared cavity and so that the distance from the cavity floor to the pulp may be judged (Mattaldi, 1968). The greater thickness of enamel and dentin in posterior teeth makes it more difficult to detect filling material in them than in incisors. The radiopacity of a material may be so marginal that it can be recognized as a Class III restoration in a lateral incisor but not as a Class V restoration in a bulky molar.

Though Restodent, CBA-9080, HL-72, Enamelite, and Prestige were not evaluated in this part of the study, it is obvious from the values obtained in the first part of the study that these materials do not have sufficient radiopacity to be detected radiographically.

ENHANCING RADIOPACITY WITH BARIUM SULFATE

The lack of adequate radiopacity in dental materials may lead to misinterpretation of radiographs (Benazzi & Gorini, 1964; Jackson, 1927; Collon, 1962; Drinnan, 1967; Mattaldi, 1968; Harvey, 1971; Kakar et al., 1966; Kerr, 1966; Primack, 1972; Sahs, 1967; Sheldon, 1960; Singleton & Richards, 1967; Thomson & Negus, 1948; Wuehrmann & Manson-Hing, 1969). As a consequence there have been efforts to make these materials radiopaque and two basic methods have been described:

1. Inclusion of metals: lead (Wainwright, 1965), silver filings (Bursey & Webb, 1960; Degering & Buseman, 1962), gold (Bursey & Webb, 1960; Degering & Buseman, 1962), and stainless steel.

2. Addition of heavy salts: bismuth (Bursey & Webb, 1960; Elzay, Pearson & Irish, 1971), barium sulfate or fluoride (Alvares, 1966; Bursey & Webb, 1960; Combe, 1971; Elzay, Pearson & Irish, 1971; Primack, 1972; Rezende, 1973), and substances used for radiographic contrast (Bursey & Webb, 1960).

Recently radiopaque glass spheres containing barium fluoride have been added to composite resins (Bowen & Cleek, 1972; Chandler et al., 1970; Primack, 1972), glass beads of a similar type containing bismuth oxide have been added to acrylic resins (Stafford & MacCullough, 1971), and radiopaque substances have been added to calcium hydroxide (Sheldon, 1960; Sahs, 1967).

The purpose of this part of the study is to determine the quantity of barium sulfate that must be added to 15 radiolucent restorative materials to make them sufficiently radiopaque to meet the criterion of minimum radiopacity, that is, when their presence as restorations can always be determined regardless of the size of tooth or direction of the X rays.

Materials and Methods

The materials were prepared according to their respective manufacturer's instructions and mixed with barium sulfate in the following proportions: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50%. The materials were then placed, as described previously, in copper rings 2 mm long. Four samples were prepared of each material in each proportion of barium sulfate. The samples were radiographed on Kodak DF-58 periapical films and these were processed as described earlier. The optical transmittance of the image of each sample was measured at ten different points.

Results

The mean values of transmittance and their respective standard deviations for each set of four samples of each experimental condition are listed in Table 5. Examples of the radiographic appearance of the specimens are shown in Figure 7.

Some materials did not reach the minimum standard of radiopacity—that of Opotow at a value of 194.7—even when up to 50% of barium sulfate had been added. These are Kadon, Sevriton, TD-71, Addent XV, and Palakav. On the other hand, the radiopacities of Dycal, Smile, Hydrex, Drala Stahl, Concise, and Adaptic increased rapidly as barium sulfate was added.

Discussion

The results of this experiment agree with those of other investigators (Bowen & Cleek, 1972; Chandler et al. 1970; Collon, 1962; Degering & Buseman, 1962; Gonçalves & Boscolo, 1970; Lee & Orlowski, 1973; Sheldon, 1960; Wuehrmann & Manson-Hing, 1969). Some materials become sufficiently radiopaque with small additions (5-25%) of barium sulfate, but others require large amounts. The addition of large amounts of barium sulfate to those materials that require it, however, makes them whitish and adversely affects their desirable physical properties.

CONCLUSIONS

- The 28 materials studied presented a large range of radiopacity.
- Radiopacity generally increases with the thickness of the materials; for the most radiopaque this increase is very small. Some materials are so radiopaque that their radiopacity did not increase for thicknesses greater than 4 mm.
- The restorative materials were classified in three groups according to radiopacity: (1) Those with radiopacity no greater than 60.0 for any thickness studied; (2) materials with radiopacity ranging from 7.1-77.3, for the 2 mm thick samples; (3) materials with radiopacity for the 2 mm thick samples ranging from 194.7 to 622.0.
- Some materials have so much radiopacity that their presence as dental restorations is easily detected in dental radiographs; on the other hand, some materials have so little radiopacity that it is not always possible to detect their presence in radiographs of teeth restored with them.
- In radiographic diagnosis, a filled cavity is judged to be empty in some cases; in others the restored teeth may be said to have neither cavity nor filling; or an empty cavity may be said to be filled with a material of low radiopacity.
- The radiographic interpretation of radiopacity depends on subjective factors, thus increasing the difficulty of judgments.
- Some materials may become sufficiently radiopaque with the addition of small percentages of barium sulfate; for acrylic resins and some composite resins, however, even the addition of 50% barium sulfate did not increase their radiopacities sufficiently.

In sum, this study has shown that none of the resins used for dental restorations has sufficient radiopacity to be clearly distinguishable radiographically from caries or tooth structure. There are important advantages in being able to make this distinction. For this and other reasons manufacturers should try to make these materials radiopaque. Additions of barium sulfate are effective in increasing the radiopacity of some resins but others require such large additions of barium sulfate that other desirable properties are affected adversely.

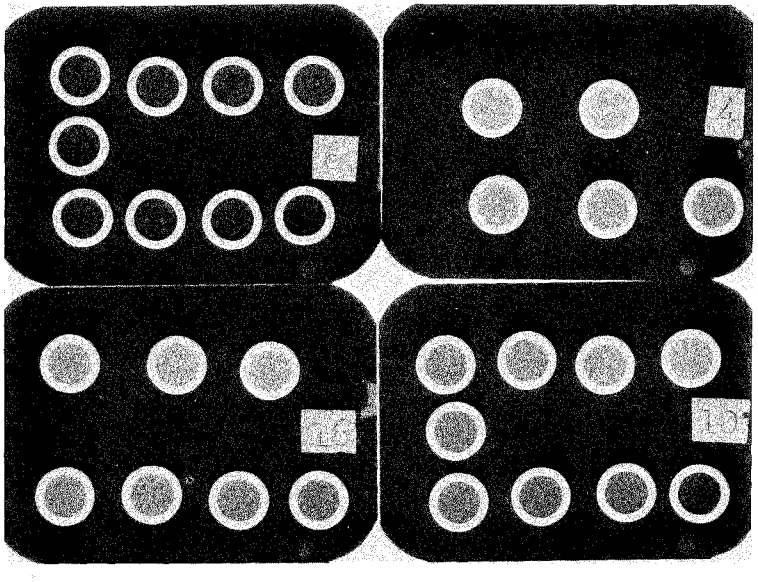


FIG. 7. Examples of the radiopacities reached by some materials with barium sulfate additions:
6 - KADON
7 - DYCAL
16 - SMILE
10 - POSITE
Clockwise from bottom right on each: the increase in barium sulfate addition according to Table 5.

Table 5. *Transmittance Values for the Materials Studied, with or without Addition of Barium Sulfate*

Material		Percent of Barium Sulfate				
		0	5	10	15	20
Dycal	$\bar{X}$	66,80	114,90	143,00	178,90	209,00
	S	2,22	3,47	3,46	5,62	2,00
Hydrex	$\bar{X}$	20,80	49,70	83,20	112,80	120,20
	S	2,95	4,31	1,98	4,74	5,28
Kadon	$\bar{X}$	4,00	8,40	10,90	14,30	16,00
	S	0,00	0,91	2,07	1,00	0,63
Silicate cement	$\bar{X}$	15,70	30,90	45,30	68,30	73,40
	S	1,48	1,13	2,53	2,86	2,20
Adaptic	$\bar{X}$	9,80	20,00	36,10	56,20	62,30
	S	0,40	1,18	0,94	1,53	1,26
Posite	$\bar{X}$	9,90	43,10	51,00	63,70	94,90
	S	0,40	1,81	2,23	2,23	2,30
Palakav	$\bar{X}$	7,30	13,10	21,80	28,60	40,70
	S	0,45	1,92	1,46	1,68	2,79
TD-71	$\bar{X}$	7,90	21,80	27,80	38,60	46,40
	S	0,83	1,46	1,46	4,22	2,45
Concise	$\bar{X}$	9,20	29,20	41,70	56,30	79,70
	S	1,53	0,74	2,60	2,03	1,79
Smile	$\bar{X}$	37,10	62,20	86,90	107,20	140,00
	S	2,25	2,78	2,54	2,44	2,24
Cimencol	$\bar{X}$	14,00	24,20	30,90	43,10	48,70
	S	1,09	0,97	1,57	1,57	2,75
Addent XV	$\bar{X}$	8,90	14,70	18,10	26,80	36,30
	S	0,94	1,61	1,44	1,93	1,84
Silikolith	$\bar{X}$	18,20	39,20	51,80	66,80	74,30
	S	1,83	1,88	4,40	3,76	2,90
Drala Stahl	$\bar{X}$	27,10	44,00	61,80	76,90	99,10
	S	2,46	4,00	2,67	3,83	2,80
Sevriton	$\bar{X}$	4,00	10,00	19,30	23,20	27,40
	S	0,00	0,89	0,78	1,07	1,68

* Not used because the material had already attained the minimum radiopacity.
** Not used for the respective materials.
Note: Each value is the mean of 10 readings.

Percent of Barium Sulfate					
25	30	35	40	45	50
*	*	*	*	*	*
124,80 4,93	137,00 2,44	181,20 5,11	205,00 4,56	227,10 2,07	*
**	21,80 1,88	**	25,00 1,09	29,40 2,41	31,60 1,85
80,90 3,01	84,70 2,10	124,90 2,46	136,10 2,38	159,80 3,09	174,20 3,73
95,80 3,84	125,90 4,22	142,10 3,39	170,20 1,60	200,70 2,45	209,80 5,05
**	110,80 2,74	**	122,70 4,73	154,30 4,98	169,10 2,62
46,30 3,40	56,30 3,66	65,90 1,86	70,70 2,32	80,70 3,76	90,00 8,72
**	46,80 3,02	**	58,20 3,57	63,60 3,66	75,30 5,23
94,10 1,75	123,10 3,04	153,90 3,23	173,10 5,16	192,90 4,70	210,90 5,31
169,90 3,44	194,10 2,02	*	*	*	*
**	63,10 2,87	78,30 1,90	101,10 3,08	115,30 3,31	156,80 6,74
**	53,90 2,02	58,00 1,73	66,20 2,48	72,10 3,14	81,10 2,77
92,10 2,87	106,80 3,34	120,00 3,94	131,70 3,16	140,10 3,64	165,10 4,03
105,20 4,39	106,90 5,55	143,10 2,88	165,20 3,06	201,70 2,10	215,20 4,79
**	33,00 1,89	**	42,40 2,10	49,20 1,83	52,00 3,68

References

ALVARES, L. C. (1966) Radiopacity of acrylic resins. *Oral Surgery, Oral Medicine and Oral Pathology,* **22,** 318-324.

ATKINSON, H. F. (1954) Partial denture problems. The lack of radio-opacity in methyl methacrylate. *Australian Journal of Dentistry,* **58,** 349-351.

BENAZZI, A. & GORINI, E. (1964) Contributo alla conoscenza della radiopacitá di alcuni materiali plastici impiegati nella terapia conservativa della corona dentale. *Mondo Odontostomatologico,* **6,** 324-330.

BOWEN, R. L. & CLEEK, G. W. (1972) A new series of X-ray opaque reinforcing fillers for composite materials. *Journal of Dental Research,* **51,** 177-182.

BURSEY, D. C. & WEBB, J. J. (1960) Incorporation of radiopaque materials into denture plastics. *United States Armed Forces Medical Journal,* **11,** 561-566.

CHANDLER, H. H., BOWEN, R. L., PAFFENBARGER, G. C., & MULLINEAUX, A. L. (1970) Clinical investigation of a radiopaque composite restorative material. *Journal of the American Dental Association,* **81,** 935-940.

COLLON, D. J. (1962) The hazard of roentgenolucency in plastics used in oral prosthesis. *Oral Surgery, Oral Medicine and Oral Pathology,* **15,** 310-313.

COMBE, E. C. (1971) Studies on radio-opaque dental materials. *Dental Practitioner,* **22,** 51-54.

DEGERING, C. I. & BUSEMAN, R. H. (1962) A roentgenographic film density study of dental restorative materials. *Oral Surgery, Oral Medicine and Oral Pathology,* **15,** 944-947.

DRINNAN, A. J. (1967) Dangers of using radiolucent dental materials. *Journal of the American Dental Association,* **74,** 446-450.

ELZAY, R. P., PEARSON, G. O. & IRISH, E. F. (1971) Clinical and histologic evaluation of commercially prepared radiopaque denture material. *Journal of Prosthetic Dentistry,* **25,** 251-257.

GONÇALVES, N. & BOSCOLO, F. N. (1970) Estudo comparativo de absorção dos raios X pelos materiais dentários. *Revista Brasileira de Odontologia,* **27,** 246-254.

HARVEY, W. (1971) Radiopaque denture base materials. *British Dental Journal,* **131,** 141.

JACKSON, C. (1927) Bronchoscopic cases of dental interest: Dental foreign bodies in the air and food passages. *Journal of American Dental Association,* **14,** 1341-1370.

KAKAR, P. K., KAKAR, R. C., SAWHNEY, K. L. & SALARIA, P. S. (1966) Denture in oesophagus: Problem of partial dentures. *Journal of the All-India Dental Association,* **38,** 14-17.

KERR, A. G. (1966) Swallowed dentures. *British Dental Journal,* **120,** 595-598.

LEE, H. & ORLOWSKI, J. (1973) *Handbook of dental composite restoratives.* 2nd edition, pp. 3-109. California: Lee Pharmaceuticals.

MAISTO, O. A. (1967) *Endodoncia.* P. 40. Buenos Aires: Mundi.

MATTALDI, R. A. G. (1968) *Radiologia Odontológica,* pp. 61-62, 290-291. Buenos Aires: Mundi.

PRIMACK, J. E. (1972) Radiopaque denture materials. *Journal of Prosthetic Dentistry,* **28,** 363-368.

REZENDE, J. R. V. DE (1973) A radiopaque internal prosthetic acrylic resin. *Oral Surgery, Oral Medicine and Oral Pathology,* **36,** 599-602.

SAHS, E. A. (1967) Radiopacity of pulp-capping materials. *North-West Dentistry,* **46,** 113-115.

SHELDON, H. B. (1960) Study of silver-impregnated calcium hydroxide in pulp capping. *Journal of Dental Research,* **39,** 756.

SINGLETON, J. M. & RICHARDS, S. (1967) Acquired tracheo-oesophageal fistula. *British Dental Journal,* **123,** 434-436.

STAFFORD, G. D. & MACCULLOCH, W. T. (1971) Radiopaque denture base materials. *British Dental Journal,* **131,** 22-24.

THOMSON, S. & NEGUS, V. E. (1948) *Diseases of the nose and throat.* 5th edition. New York: Appleton-Century-Crofts.

WAINWRIGHT, W. W. (1965) *Dental radiology.* P. 89. New York: McGraw-Hill.

WUEHRMANN, A. H. (1960) A roentgenographic appearance of restorative materials. *Oral Surgery, Oral Medicine and Oral Pathology,* **13,** 68-69.

WUEHRMANN, A. H. & MANSON-HING, L. R. (1969) *Dental Radiology.* 2nd edition, pp. 273-276. St. Louis: C. V. Mosby.

Accuracy and Smoothness of Gypsum Die Stones with Reversible Hydrocolloid Impression Material

Different die stones used with the same impression material produce dies that differ in accuracy and smoothness. Select the proper combination to give the best results.

RONALD J. NICHOLSON • KENNETH B. SOELBERG •
MARVIN M. STARK • DANIEL KEMPLER • RALPH L. LEUNG

Summary:

Three different Class II die stones, Die-Keen, Duroc, and Vel Mix, were tested for dimensional accuracy and surface smoothness when poured in impressions taken of a metal model with the reversible hydrocolloid impression material, Rubberloid. Vel Mix proved to be the most accurate of the die stones tested and Die-Keen to have the smoothest surface.

Ronald J. Nicholson, D.D.S., is associate professor of operative dentistry and endodontics.

Kenneth B. Soelberg, D.D.S., is clinical professor of operative dentistry.

Marvin M. Stark, D.D.S., is professor of operative dentistry and oral biology.

Daniel Kempler, D.M.D., is lecturer in prosthodontics.

All four are at the University of California, School of Dentistry, San Francisco, CA 94143, U.S.A.

Ralph L. Leung, D.D.S., is a resident in restorative dentistry at the University of Michigan, School of Dentistry, Ann Arbor, MI 48109, U.S.A.

The high degree of precision needed for cast restorations requires accurate impressions and dies. The materials for the dies must be not only accurate but also compatible with the materials for the impressions. Modern impression materials can provide reliable impressions (Sawyer *et al.* 1973; Stackhouse, 1975; Podshadley *et al.* 1970). Improved Class II stones—often called 'Densite'—which are used in fabricating dies, provide good stability, are easy to pour, and have water:powder ratios that are lower than those of Class I, or hydrocal, stone materials (Phillips, 1973). Class II die stones can generally be used with all impression materials and are the only ones used with reversible hydrocolloids (Gettleman & Ryge, 1970). Different die materials have been shown to give different results when used with the same impression material (Astiz & Lorencki, 1969; Gettleman & Ryge, 1970). The wide variety of impression and die materials available presents a choice of numerous combinations to the dentist who, if he selects the materials randomly, may not achieve the best possible result.

This study investigates the accuracy of several commercially available die stones when used with a particular brand of reversible hydrocolloid impression material. The resulting dies are compared for dimensional accuracy as well as for surface roughness.

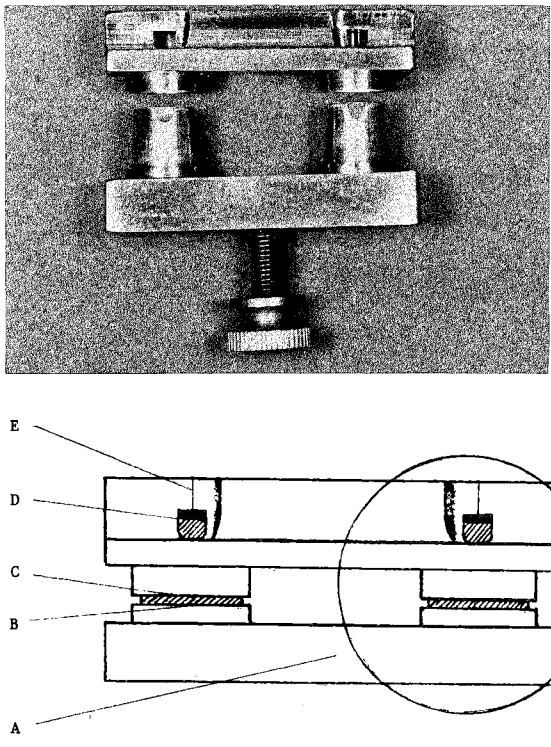


FIG. 1. Machined metal test die at top.

FIG. 2. Components of metal testing die and coping. A, master die; B, base of die; C, base of coping; D, top of die; E, measuring reference line.

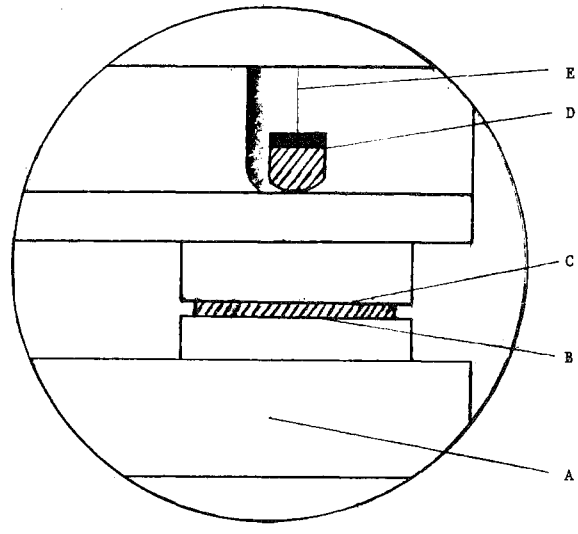


FIG. 3. Magnification of measuring area. A, master die; B, base of die; C, base of coping; D, top of die; E, measuring reference line.

Materials and Methods

The materials consisted of:

1. Reversible hydrocolloid impression material: Rubberloid (Van R Dental Products, Inc., Los Angeles, CA 90034, U.S.A.).
2. Gypsum die stones: Duroc (Ransom & Randolph Co., Toledo, OH 43604, U.S.A.); Die-Keen (Modern Materials Mfg Inc., St Louis, MO 63104, U.S.A.); Vel Mix (Kerr Mfg Co., Romulus, MI 48174, U.S.A.).
3. Standard testing die of metal consisting of a machined metal base with two tapered cylinders and a precisely machined coping with calibrated windows for viewing (Figs. 1, 2 & 3).

Forty-five impressions were taken of the male section of the test die. Fifteen impressions were poured with each die material.

The stones were mixed mechanically under vacuum and, after pouring, the casts were allowed to set in an environment of 100% humidity. After they had set they were separated from the impressions and trimmed of excess material (Fig. 4). The casts were then examined for dimensional accuracy and surface roughness.

Dimensional accuracy: Each cast was placed in the female part of the test die and loaded with 453 g applied by a Gillmore needle so that all casts would be seated with uniform pressure. The width of the gap between the cast and the test die was measured with a micrometer slide microscope (Gaertner Scientific Corp., Chicago, IL 60614, U.S.A.). The stone

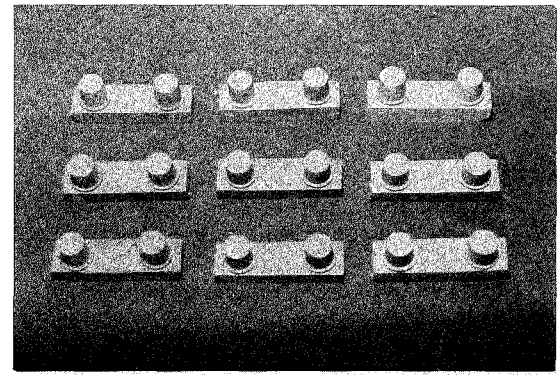


FIG. 4. Representative casts made from hydrocolloid impression, utilizing three die stones: Duroc, Vel Mix, and Die Keen.

casts were then sectioned to form two separate dies. These dies were seated individually in the test die and the gaps measured again.

Surface roughness: Roughness was measured with a profilometer (Pilotor type AE-QB Amplimeter, Bendix Corp., New York, NY 10016, U.S.A.).

Results

The discrepancies of fit between the stone dies and the female part of the test die are recorded in Table 1. Vel Mix produced a die of substantially greater accuracy than did the other stones tested. After the stone models were sectioned, creating two individual dies, the fit of the copings improved.

Table 1. *Discrepancy in fit of stone dies*

Material	Discrepancy	
	Units	mm
Vel Mix	5.85 ± 3.38	0.02925
Duroc	13.13 ± 5.04	0.06565
Die-Keen	23.48 ± 7.80	0.1174

1 unit = 0.005 mm

The roughness of the surfaces of the dies is recorded in Table 2. Die-Keen produced the smoothest surface.

Discussion

The difference in dimensional accuracy of the three stones probably results from differences in setting expansion because it has been shown that the setting expansion of Class II stones ranges from 0.05% to 0.27% at 24 hours (Hollenback & Smith, 1967). Setting expansion can be controlled—by altering the water:powder ratio of the mix, for example. A higher proportion of water reduces setting expansion but only at the expense of compressive strength, hardness, and abrasion resistance of the die (Gettleman & Ryge, 1970). A hard surface and resistance to abrasion, however, are properties that are valuable in a stone die and should not be compromised. In fact, the use of conditioning solutions that improve these qualities has been recommended (Toreskog, Phillips & Schnell, 1966; Hosoda *et al.* 1962; Peyton, Leibold & Ridgley, 1952; Ellman, 1968).

Table 2. *Surface roughness of die*

Material	Roughness μm
Die-Keen	27 ± 2.27
Vel Mix	50 ± 8.80
Duroc	56 ± 12.38

The improved fit of the dies after sectioning to create two individual dies can also be explained by setting expansion, which is accentuated when multiple units are reproduced in a single cast (Hollenback & Smith, 1967).

The difference in surface roughness of the stones can be explained by the difference in the size of the particles of powder and the proportion of ß-hemihydrate added (Phillips, 1973). Materials with finer powders reproduce finer irregularities and hence give dies with rougher surfaces.

Conclusions

Vel Mix has been shown to provide more accurate casts for both single and multiple units than either Duroc or Die-Keen. Die materials of lower accuracy should possibly be reserved for fabricating single dies. Die-Keen die stone proved to have a smoother surface than the other die stones tested.

We gratefully acknowledge the help of Rosalie Cody in typing and proofreading.

References

ASTIZ, P. H. & LORENCKI, S. F. (1969) Comparative accuracy of commonly used dental die materials. *Journal of the Canadian Dental Association,* **35,** 320-323.

ELLMAN, I. A. (1968) Precision gold inlays on epoxy-hardened stone dies. *Dental Digest,* **74,** 206-209.

GETTLEMAN, L. & RYGE, G. (1970) Accuracy of

stone, metal and plastic die materials. *Journal of the California Dental Association,* **46,** 28-31.

HOLLENBACK, G. M. & SMITH, D. D. (1967) A further investigation of the physical properties of hard gypsums. *Journal of the California Dental Association,* **43,** 221-227.

HOSODA, H., OTANI, H., HIRANO, T. & FUSAYAMA, T. (1962) Measurement and reinforcement of the superficial hardness of indirect stone models. *Journal of Dental Research,* **41,** 752-759.

PEYTON, F. A., LEIBOLD, J. P. & RIDGLEY, G. V. (1952) Surface hardness, compressive strength, and abrasion resistance of indirect die stones. *Journal of Prosthetic Dentistry,* **2,** 381-389.

PHILLIPS, R. W. (1973) *Skinner's Science of Dental Materials.* 7th edition, p. 76. Philadelphia: W. B. Saunders.

PODSHADLEY, A. G., DILTS, W. E., NEIMAN, R. & ELLISON, E. (1970) Accuracy of relined mercaptan-rubber impressions. *Journal of Prosthetic Dentistry,* **24,** 503-511.

SAWYER, H. F., BIRTLES, J. T., NEIMAN, R. & PODSHADLEY, A. G. (1973) Accuracy of casts produced from seven rubber impression materials. *Journal of the American Dental Association,* **87,** 126-130.

STACKHOUSE, J. A. (1975) A comparison of elastic impression materials. *Journal of Prosthetic Dentistry,* **34,** 305-313.

TORESKOG, S., PHILLIPS, R. W. & SCHNELL, R. J. (1966) Properties of die materials: a comparative study. *Journal of Prosthetic Dentistry,* **16,** 119-131.

DENTAL POLITICS

Expanded Functions: An Honest Appraisal

An astute analysis of the attempts of the federal government and others to commit the dental profession to the use of auxiliary personnel trained to perform some of the fundamental procedures of operative dentistry.

FREEMAN C. SLAUGHTER

Freeman C. Slaughter, D.D.S., 201-205 Professional Building, Kannapolis, NC 28081, U.S.A.

Dr Slaughter has been in private practice for 25 years. He is chairman of the North Carolina Dental Society Legislative Committee, has served as chairman of the American Association of Dental Examiners/American Dental Hygiene Association Liaison National Committee, and from 1966 to 1975 was a member of the North Carolina State Board of Dental Examiners—being president for one year and secretary-treasurer for three-and-a-half years. He is past president of the North Carolina Dental Society of Anesthesiology, past president of the North Carolina Society of Dentistry for Children, past vice-president of the Southern Conference of Dental Deans and Dental Examiners, immediate past chief of dental staff at Cabarrus Memorial Hospital, and adviser to the Dental Assisting Program at Rowan Technical Institute in Salisbury. He is a member of Omicron Kappa Upsilon Honorary Dental Society and a Fellow of the American College of Dentists. In May 1975, Dr Slaughter was awarded a Resolution of Commendation for outstanding service to the Dental Society and the State Board of Dental Examiners by the North Carolina Dental Society. He also received the American Association of Dental Examiners Dentist Citizen of the Year Award.

In recent years it has become fashionable for some dentists—especially officials of the Department of Health, Education and Welfare, as well as some deans and faculty of our dental schools—to advocate eliminating the right of states to regulate dental practice through licensure. With this thrust toward liberalizing laws and socializing our profession have come intensified efforts by the federal government to implement programs for training and using auxiliaries in expanded functions. Practicing dentists should be concerned with the politics of training assistants in expanded functions for, as Mark Twain observed, a businessman who says he is not interested in politics is like a drowning man who says he isn't interested in water.

Regulation of Dentistry

Dentistry in the United States has been regulated by laws for only the past 100 years. Before that time anyone could practice dentistry without standing an examination. Impostors and incompetents professed to be dentists and, consequently, citizens were subjected to

From a paper read at the Ninth Annual L. H. Bowden Conference of the Louisiana Dental Association, January 24, 1976, in Baton Rouge, Louisiana.

unnecessary abuse, sometimes incurring lifelong disabilities. The state legislatures decided that the most effective way to assure the public of competent treatment by qualified practitioners was to enact laws to regulate and control dentistry. Alabama was the first in 1841. Later all the states enacted similar laws, so that today anyone holding himself to be a dentist has a specified academic background, a specified amount of training in the art and science of dentistry, and has demonstrated his proficiency in dentistry before a board of practicing dentists to receive a license granting him the privilege of performing dental operations on the people of that state. Considering that of the 21,741 occupations listed, only five or six, including dentistry and medicine, are allowed to operate on living tissue, to prescribe drugs, and to relieve pain, legal regulation of dentistry is to be expected.

Federal Government Encourages Use of Dental Auxiliaries

The federal government entered the field of dental auxiliaries about 1963, stating that there was a shortage of health manpower of crisis proportions requiring alterations in the system of delivering dentistry. Federal funds were made available for research into the use of dental auxiliaries to perform certain acts of dentistry previously done only by dentists. Programs for Dental Auxiliary Utilization (DAU) were initiated in dental schools to produce better trained and qualified dental assistants as well as dentists more capable of using such assistants in a "four-handed practice of dentistry."

A proliferation of programs for expanding the functions of auxiliaries followed, sponsored and paid for by the federal government. DAU programs were replaced by programs for Training in Expanded Auxiliary Management (TEAM), programs for Therapists, and programs for Expanded Function Dental Auxiliaries (EFDA). Each new program required that dental auxiliaries—usually dental assistants—be allowed to do additional functions previously done exclusively by the dentist or hygienist.

Some of these programs were in disregard of state laws regulating the practice of dentistry. TEAM programs, initially funded to provide dental students an opportunity to learn to manage expanded function auxiliaries, have also become programs that require auxiliaries to place and finish permanent restorations regardless of whether or not these functions violate state laws. Even officials of HEW seem to have difficulty explaining this inconsistency. In EFDA programs, functions taught to auxiliaries must be lawful in the state, but in TEAM programs the functions taught do not have to be lawful in the state. Institution of these programs frequently has been accomplished by the administration of a dental school misrepresenting the nature of the program to the Board of Dental Examiners, or by intimidating an already overextended board into agreeing not to interfere with the program because it was "research only," and by assuring the board that these auxiliaries would not be allowed to perform unlawful functions outside the project. Also the schools needed the money offered by the Department of Health, Education and Welfare to supplement other struggling disciplines of the curriculum.

If guidelines advocated by HEW for the EFDA, TEAM, and Therapist programs are fully implemented we may, in the years ahead, see the demise of the dental hygienist as a part of our profession, and very probably the phasing out of dentists from the field of restorative dentistry. Dentists in the Dental Division of HEW have repeatedly expressed the opinion that studies have demonstrated conclusively that dental auxiliaries trained in expanded functions, such as operative procedures, perform them as well as, and perhaps better than, senior dental students and practicing dentists.

Defining Expanded Functions

Though many dentists may believe in the concept of expanded functions for auxiliaries, few would agree on:

1. What they are:
2. What they should be allowed to do.
3. What training would be adequate for them.
4. Who would train them.
5. How their training might be accomplished.

At a two-day conference in Ohio in 1975 we never did adequately define an expanded function auxiliary. The term was, and still is, bounced around as if we knew its meaning, but during the Ohio conference it was brought out

that ten functions considered routine and normal for dental assistants in Alabama and North Carolina are considered expanded functions in some neighboring states.

We describe the EFDA variously as "an auxiliary, a subprofessional, or a paraprofessional who will do dental operations previously reserved for the dentist." Which dentist? If we are talking about the paper-shuffling dentists at HEW, looking in a patient's mouth would be an expanded function.

Recently on the national level we have heard much about the new expanded function for dentists—taking blood pressures. In North Carolina that has long been a regular function of the dentist. Moreover, it is normal and routine for dental assistants to take blood pressures; it is not an expanded function. Thus, when we speak of expanded functions, to what are we referring—something as innocuous as taking blood pressures and evacuating debris from the mouth, or something as irreversible as removing teeth or placing permanent restorations? It is of utmost importance to determine if we are talking about the expanded function assistant envisioned by a dentist who considers the taking of blood pressures under his direct supervision as an expanded function for his dental assistant, or if we are talking about the expanded function assistant envisioned by a dentist who wants a dental assistant to perform restorative dentistry and other services even when he is out of the office—services for which the dentist receives payment; in other words, someone to conduct the practice of dentistry whether the dentist is there or not. This point may be crucial.

Until just a few years ago, the term 'expanded function' usually referred to any procedure requiring the dental assistant to put her hands in a patient's mouth. Today the term 'expanded function' has become the sacred cow of dentistry, used not only for legal delegation but also, in some instances, to justify totally illegal delegation of functions to auxiliaries. There are those today who believe the term 'expanded function' covers delegating anything they choose.

At meetings I have attended during the past several years on the subject of expanded functions for dental auxiliaries, there has been ever-present confusion not only of the definition but also of the use of an expanded function auxiliary. Expanded functions to the dentist mean additional hands to perform services for which he will receive payment. Expanded functions to the auxiliary mean performing new and interesting tasks for which there will be greater compensation, additional fringe benefits, and increased security of employment. Expanded functions to the consumer and to some of our legislators mean paraprofessionals that are competent to perform dental services, having been trained thoroughly and tested—paraprofessionals that will not charge as much as dentists. After all, legislators and other consumers have been assured by HEW and various officials of schools that this new auxiliary can do the job of the dentist at least as well as the dentist can. Thus the consumer and the legislator envision a large supply of manpower available at all hours of the day and night at reduced cost. Expanded function auxiliaries to the administration of the dental school mean an open purse at HEW, with strings attached, yes—but more money!

In 1975, in Chicago, the House of Delegates of the American Dental Association adopted Resolution 861 to establish a policy on expanded function dental auxiliaries. A similar statement had been adopted in 1974 as Resolution 221, but because of a contorted interpretation by the staff of the American Dental Association and the Council on Dental Education, Resolution 861 was introduced and passed in 1975. It states:

Study and Re-evaluation of Expanded Functions for Dental Auxiliaries:

861. *Resolved,* that in the training, education and utilization of dental auxiliaries for the purpose of assisting the dentist in providing high quality dental care through expanded functions, it shall be the policy of the American Dental Association that expanded functions shall be performed under the direct supervision of the dentist and that auxiliaries shall perform only those functions as defined in state dental practice acts for which they have had appropriate education and training, and be it further

Resolved, that final decisions related to dental practice and utilization of dental auxiliaries rest with the state society and the State Board of Dentistry, and be it further

Resolved, that the American Dental Association opposes the preparation of teeth, the placement,

carving and contouring of dental restorations and the injection of local anesthetics by dental auxiliaries, and be it further

Resolved, that the American Dental Association opposes any program, or the funding of such program, of training, education or utilization of dental auxiliaries that is not in accord with these policies, and be it further

Resolved, that the Board of Trustees take action to effect the intent and purpose of this resolution through appropriate legislative efforts.

Now if that were law in each of the 50 states, we should understand pretty clearly what an expanded function dental auxiliary is. But Resolution 861 is not law; it is only the policy that the American Dental Association adopted in 1975.

Dental Schools Try to Change Dental Practice Acts

In 1975 the University of North Carolina School of Dentistry introduced into the legislature a proposed change to the Dental Practices Act that would have allowed an undefined dental assistant or dental hygienist to do any act that a dentist does anywhere in the state as long as the acts were performed in a research project of the school of dentistry. Similar laws have been introduced in other states, illustrating what happens when unlawful practice of dentistry is made respectable by calling it 'expanded functions', or 'experimentation', or 'research'.

In North Carolina we have seen that tolerance of a little violation of the law leads to expected tolerance of more violation of the law; we have seen this in National Health Service Corps, TEAM programs, EFDA programs, all types of extramural programs, and Area Health Education Center programs (AHEC). We have also been through the trauma and consequences of having to enforce the law and terminate some of these unlawful activities. The faculty and administrators affected by the legal action to stop such programs immediately feel that their rights have been intruded upon, and in North Carolina, Virginia, Massachusetts, and Alabama have either gone, or indicated they will go, to the legislatures asking for enactment of liberalized laws to permit activities, previously known to be illegal, to be continued unabated and even expanded.

Are EFDAs Needed?

A multitude of research and demonstration programs have proved that dental assistants can be trained to perform expanded functions. There is no doubt in my mind that dental assistants with adequate education and training can be taught to do anything a dentist does. You and I as dentists have been trained to do these duties, and anybody with average intelligence and skill can be trained to do the same. This is not the question. The question is whether or not auxiliaries *should* be trained to do these duties. Unless there is a demonstrated shortage of manpower that cannot be met by professionals, that is, dentists—and this shortage has not yet been shown—why should we train and delegate to somebody with less academic background and clinical experience the most intricate tasks of dentistry, those involved in operative procedures?

Who Advocates Expanded Functions?

As I view it, the strongest advocates for this type of expanded function dental care during the past few years have been not the public but educators seeking grant money from HEW and the federal government. The impetus has come from a small group of people who have decided that this country should be pursuing a system of delivering dental care patterned after the New Zealand dental nurse and the Canadian therapist. This movement was brought to my attention in February 1972 in a speech by John I. Ingle, at that time dean of the University of Southern California School of Dentistry. Ingle reported that his school expected to be graduating 50 dental therapists a year beginning in 1973. He defined the School Dental Therapist as someone with one or two years of education, examined and licensed, working in a school clinic, and performing, independent of direct supervision by the dentist, any of the procedures allowed for the dental assistant, technician, hygienist, or therapist. In addition, the School Dental Therapist would prepare cavities in children's teeth as well as extract deciduous teeth, prepare and place space-maintaining devices, and would be supervised by a traveling dentist.

Ingle is no longer dean at the University of Southern California School of Dentistry—he is with the Institute of Medicine at the National

Academy of Sciences, an advisory body to the federal government—but his philosophy is just as active as ever, as shown by recent testimony before the Health Subcommittee of the House of Representatives by Jay W. Friedman. Friedman, who was invited to testify, is dental director of the Quality Assurance Program of U.S. Administrators, and clinical professor of Community Dentistry at the University of Southern California. He stated (on page 63): ". . . I and many of my colleagues advocate adoption of the New Zealand school dental nurse system, . . ." Further, he stated to this committee:

> In Saskatchewan where a school-based program utilizing New Zealand-type dental nurses has completed its first year of operation, costs are estimated at about $35 per child. In our proposal for a similar pilot project a few years back, Dr John I. Ingle (former Dean of the University of Southern California School of Dentistry and now with the National Academy of Sciences Institute of Medicine) and I came up with a similar estimate, amortizing start-up costs of training and equipping the clinics over a ten-year period. At current dental fees, a single visit to a private dentist would cost that much just for an examination, cleaning and x-rays. With four or five fillings, the cost could easily exceed $100. Thus, a school-based program would save up to 65% of the cost for the same services provided by private dentists. I believe this same estimate of costs should be applied whether dental nurses or dentists are the primary providers in the school clinics.

I hope you have noticed that the same fee is to be paid for the service whether it is done by the dentist or by the auxiliary, so you can guess who would be doing the service.

Federal Intervention

As members of a profession considering the feasibility and desirability of delegating functions to an auxiliary, our task would be greatly simplified if we could work knowing that there would be no intervention by the federal government; but that is totally impossible. I agree with Mark Twain when he said that the only time our country is in danger is when Congress is in session. And I agree even more with his statement that a man who loves the law and sausage should never watch either one of them being made.

House Resolution 5546: I direct your attention to H.R. 5546, a bill that has been before Congress for some time. This bill revises and extends programs "for training in the health and allied health professions." This bill continues the provisions of the Comprehensive Health Manpower Training Act of 1971, which created "Therapists" and provided funds for TEAM and other programs. In 1975 this bill, H.R. 5546, was read twice in the House and sent to Senator Edward Kennedy's Committee on Labor and Public Welfare. Among other things, this bill gives czar powers to the secretary of HEW as did P.L. 93-641 enacted in 1974. He can make grants, loan money, set interest rates, designate underserved areas, and so on.

H.R. 5546 throws billions of dollars into Health Manpower Programs. Capitation payback by students is the issue that has been given the most publicity. Double the amount of capitation money granted to the school by the federal government plus interest at the maximum rate would have to be repaid by the dental graduate unless he serves in the National Health Service Corps, a rural area, or an inner city ghetto, or some other area designated by the secretary of HEW. But, in my opinion, equally and perhaps more important sections of H.R. 5546 are those portions relating to expanded functions of dental auxiliaries.

During the past two years, each time we have talked to officials of the Department of HEW about their Guidelines for Expanded Function Dental Auxiliary (EFDA) Programs, they have assured us that EFDA is a very small program and involves only a couple of million dollars. Page 113 of H.R. 5546 sets aside for payment of grants and contracts for physicians' assistants and expanded function dental auxiliaries $90 million—$25 million for fiscal year 1976, $30 million for 1977, and $35 million for 1978. Ninety million dollars is more than a "couple" of million dollars—to me!

The amount of the money, however, doesn't concern me as much as the description of the program. On page 11:

> (9)(A) The term "program for the training of expanded function dental auxiliaries" means an educational program which (i) has as its

> objective the education of individuals who will, upon completion of an accredited program of studies, be qualified to assist in the provision of primary dental care under the supervision of a dentist. . . .

(That's not bad.) Then it sets out that the secretary shall prescribe guidelines for the training of expanded function dental auxiliaries, requiring one academic year and consisting of supervised clinical practice and classroom instruction ". . . directed toward preparing students to deliver primary dental care. . . ." (That bothers me!) The first section doesn't require direct supervision, only "supervision," and from the first section to the second, the description has been changed from "assist in the provision of primary dental care" to "directed toward preparing students to deliver primary dental care."

Those are significantly different statements of the type frequently put into bills so that HEW officials can then write whatever guidelines they want by placing Rules and Regulations in the *Federal Register.* Those Rules and Regulations then become law. That was the procedure used to establish the functions now required in TEAM and other programs.

> On page 65, H.R. 5546 states:
> The Secretary . . . shall conduct . . . studies of methods of assigning National Health Service Corps personnel to medically underserved populations and of providing health care to such populations. Such studies shall be for the purpose of identifying (A) . . .; (B) . . .; (C) the appropriate conditions for assignment of nurse practitioners, physicians' assistants, and expanded function dental auxiliaries in areas in which medically underserved populations are located.

(That bothers me!)

> On page 121 this resolution states:
> For purposes of this part, the term 'allied health personnel' means individuals with training and responsibilities for (1) supporting, complementing, or supplementing the professional functions of physicians, dentists, and other health professionals in the delivery of health care to the patients. . . .

(And that bothers me!)

In my opinion, this bill, or one so close to it that you won't be able to tell the difference, will be enacted into law, probably in the same quiet and efficient manner of P.L. 93-641. That was enacted into law in December 1974, but we didn't hear about it for almost a year. [Since this paper was presented, H.R. 5546 underwent some changes before it was enacted into law in 1976 but the final bill retains some of the original undesirable sections. Rules and regulations applying to it will not be available perhaps for another year.]

As an aside, but to give you one further example of how your tax dollars are being spent, on page 97 this bill sets aside $60 million for health or educational entities to use in "identifying, recruiting, and selecting individuals from disadvantaged backgrounds . . ." This is enough money to build eight or ten outstanding dental schools. Our existing schools already have waiting lists of hundreds of qualified students. I have been told that the University of North Carolina had nearly 1,000 applications for 83 places. Sixty million dollars to look for more!

Dental functions can be delegated to auxiliaries to any extent that the legislature chooses by enacting laws, but for the legislature to enact laws that allow anyone who can be trained to perform a dental service the right legally to do so would be totally ignoring the attitude that the public and the profession have developed over the last hundred years—holding that people should attain certain basic educational backgrounds and be required to demonstrate competence before being permitted legally to practice dentistry.

Forsyth Program

As I indicated previously, the federal government is going to continue to promote programs to demonstrate that subprofessionals and nonprofessionals can do your job as well as you can and for less money. A specific example has occurred at Forsyth Dental Center in Boston.

The federal government funded this Forsyth Program with $1½ million as an "experimental" program allowing dental hygienists with minimal training to do expanded functions in restorative dentistry. Dental hygienists were trained in preparing cavities, including cusp reductions and pins, and in placing filling materials. The Forsyth report stated that the

"study demonstrated conclusively that the advanced skills hygienist is capable of providing high quality restorative dentistry. . . ." These hygienists, after 25 weeks working under conditions identical to those of the staff dentists in the project, produced five surfaces of completed restorations for every hour spent with the patients while staff dentists produced six surfaces, and the hygienist with a chairside assistant would require only half an hour supervision per day, or 14% of the supervising dentist's time, according to the report.

The Massachusetts Board of Dental Examiners asked the U.S. attorney general for a ruling on the legality of this program at Forsyth. The attorney general determined that the program was illegal practice of dentistry. The directors of the program, John W. Hein and R. R. Lobene, called press conferences with United Press International (UPI) to castigate the Massachusetts Board and to advertise their program nationwide without having published the data to substantiate the claims made. Also, they asked the Massachusetts legislature to change state laws to make such "experimental" programs legal and beyond the reach of the policing of the board.

The conclusions from the study have already been reported to Congress by Lobene by invitation of the Subcommittee on Health, Committee on Ways and Means, where he testified November 18, 1975.

Hein, one of the dentists involved in the Forsyth Research Program, announced at one of our meetings with HEW officials that already a study has been done indicating that expanded function dental auxiliaries can be trained in a period of three weeks to make impressions and fabricate dentures which Board Certified Prosthodontists cannot distinguish from dentures constructed by licensed dentists! When this study is reported publicly, dentistry should be prepared for some new raw spots—from the denturists.

HEW Programs of Research and Training

To give you an idea of some of the research and training that is being funded by HEW, you may be interested in these: At the University of Iowa dental hygiene students are taught aspects of restorative dentistry, periodontal therapy, and anesthesiology. The University of Colorado contract indicates that dental hygienists are to be taught according to the HEW guidelines, and "certified dental assistants will be trained also." At the University of Kentucky dental hygienists have already been graduated with advanced skills in restorative dentistry, and the curriculum is being reviewed to see if these additional duties can be taught without lengthening the time in school. Dental auxiliaries in the EFDA Program at Kentucky are required to have a high school diploma or equivalent and are trained in seven of the nine basic EFDA functions and eleven of the fifteen advanced functions, including all of those traditionally done by the dental hygienist. Louisville graduated its first class of 27 EFDAs in May 1975.

There are many more, but these will give you an idea of some of the programs being funded by HEW. It has been our experience in the past that "research" programs have been followed by "demonstration and training" programs, with pressure from the school to allow those trained to perform the services outside the confines of the school.

Schools conducting TEAM and EFDA programs are teaching auxiliaries functions that violate the state laws and are creating a vast reservoir of people who are potential violators of the law. In the Alabama Extended Duty Dental Assistant (EDDA) program there was a very high rate of attrition—17 of the 20 EDDAs recruited each year into the program were lost to private practice where they continued to do expanded functions learned in the program in violation of the state laws regulating the practice of dentistry. With these programs creating a body of lawbreakers, or potential lawbreakers, it is only a matter of time until such people will seek recognition from the legislatures and the legal right to work at the tasks for which they have been trained. They have not received enough training to be licensed as dentists, but they have received enough training for the legislature to license them as something else—and they will pursue it.

Perhaps we have not considered adequately the concept of expanded function auxiliaries who may ultimately be autonomous, in their own offices, and out from under the control of the dentist completely; a concept now envisioned by some. Those who advocate expanded functions for an auxiliary that is neither defined nor restricted by the Dental Practices

Act must remember that congressmen and state legislators may assume that much more is being advocated than intended. Any change of law can be interpreted differently from that intended, especially when related to the delivery of health care, because very few lawmakers are physicians or dentists.

There is an analogy here with the denturists. Why has it taken the dental profession so long to realize that there is a correlation between allowing undefined, unlicensed people to make dentures and allowing undefined, unlicensed people to restore teeth and do other dental functions? If we oppose allowing denturists to make dentures, then by the same logic we must oppose the expanded function dental auxiliary who is allowed to perform health procedures that are even more intricate.

Maintain Our Excellent Dental Service

Those functions that are not acts of dentistry should already be delegated to auxiliaries, but those things that affect the health and well-being of our patients should not, in my opinion, be delegated as expanded functions. To do so will result in fragmentation of services with the likelihood of the formation of a multitude of autonomous and unionized paraprofessionals rendering various parts or components of dental care to the public. There are no valid data or evidence indicating that delegating dental procedures to paraprofessionals will reduce the cost of dental care to the consumer.

The paper-shuffling bureaucrats in Washington have made a mess out of the railroads, the post office, the utilities, Medicare, and Medicaid, and there is not the remotest possibility that they can handle the system of delivering dentistry in this country more efficiently, more effectively, or more economically than it is being handled now by those of you who are doing the job. You can be assured, though, that the government's increasing involvement will be more costly.

Dentistry in this country today is the greatest bargain available in health services. There is room for improvement in our system of delivering health care, but dentistry is not the place to begin. The medical profession, the nursing home industry, the hospitals, and all other systems of health care should look to dentistry and emulate it for methods of containing costs. Nowhere else in the health system can the public receive the services of a professional doing surgical and other operative procedures where the professional provides the operating room, the nursing staff, the anesthetic, and the drugs and includes their cost in his fee for the service; a medical surgeon's fee, for example, does not usually include the cost of these facilities and services—the patient must pay additional charges for them. This system of dental service has survived because of the dedication and sacrifices of the dentists and their assisting auxiliaries—not by the creation of a multitude of autonomous auxiliaries.

It took dentistry 100 years to reach the place it is today, but it won't take 100 years for it to go back to where it started—with dentistry being performed by various nonprofessionals —if the government continues to pursue the programs being espoused today by those of socialistic inclination who long ago abandoned the pursuit of excellence in favor of pursuit of the endless leveling of all dental services to the lowest acceptable standard.

If we as a profession are to maintain the excellence that has characterized dentistry in this country, we must not allow delegation of any function to an auxiliary that should be performed only by the dentist, and we should insist that HEW adhere rigidly to a policy that any additional programs to train dental auxiliaries in so-called expanded functions be based on an honest and precise assessment of actual demands for dental care and on the productive capability of the present dental manpower.

That task is not an easy one, but as Sir Winston Churchill wrote in *The Gathering Storm:*

> . . . if you'll not fight for the right when you can easily win without bloodshed; if you will not fight when your victory will be sure and not too costly; you may come to the moment when you will have to fight with all the odds against you and only a precarious chance of survival. There may even be a worse case. You may have to fight when there is no hope of victory, because it is better to perish than to live as slaves.

Reference

CHURCHILL, W. S. (1948) *The Gathering Storm.* P. 348. Boston: Houghton Mifflin Company.

SPECIAL ARTICLE

Skinner Memorial Lecture

Eugene Skinner: His Influence Abroad

GUNNAR RYGE

Eugene W. Skinner

Gunnar Ryge, M.S., D.D.S., University of the Pacific, School of Dentistry, 2155 Webster Street, San Francisco, CA 94115, U.S.A.

Professor Ryge is assistant dean for research at the School of Dentistry of the University of the Pacific. He was formerly director of the Dental Health Center in San Francisco of the Division of Dental Health of the U.S. Public Health Service and was also chief of the Materials Branch of the same division. From 1950-64 he engaged in teaching and research in dental materials at Marquette University School of Dentistry. He is a past president of the International Association for Dental Research and he won the Wilmer Souder Award in 1966.

It is indeed a privilege for me to present the Eugene W. Skinner Memorial Lecture. It is a privilege because I have known Gene Skinner not only as an authority in my chosen field—dental materials—but also as a personal friend. In both capacities Gene Skinner earned my deep respect and warm feelings and I am very pleased to have the opportunity to acknowledge this officially.

Also, it is a challenge. It is a challenge because I know that most of you did not know Dr Skinner, and I would like to make you feel that Eugene W. Skinner is part of the heritage that you are receiving as students at Northwestern University Dental School—that his name and his work have been important in establishing the reputation of this school.

It is a challenge also because I know that some of you did know Gene, as a teacher, as a colleague, or as a friend—or maybe even in all of those capacities. This challenge consists of presenting to you a few facts that you may not know.

Specifically, I have chosen to speak about Dr Skinner's influence abroad. I can speak about this subject with authority since I obtained my dental qualifications abroad—namely, in Denmark—so that I personally have

---

This second lecture, dedicated to the memory of Dr Eugene W. Skinner, was delivered on April 7, 1976, at Northwestern University Dental School, Chicago, Illinois.

experienced Gene's influence. For example, I studied his book, *The Science of Dental Materials,* in the dental school library in Copenhagen while I was a dental student, and I bought my own copy of the third edition over there upon its publication in 1946. Prior to that time I had corresponded with Dr Skinner to obtain reprints of articles he had published, so that I really felt that I knew the man when I first met him here in Chicago at the June 1949 meeting of the Dental Materials group of the International Association for Dental Research.

One year later I returned to the United States to take a teaching position at Marquette University Dental School in Milwaukee. I made a point to consult with Dr Skinner about his teaching program, and my early efforts at Marquette were to a large extent based upon Gene's advice and suggestions.

"Eugene W. Skinner's Influence Abroad" can be described under four main headings:

1. The Book
2. The Graduate Program
3. The Undergraduate Students from Abroad
4. The Visiting Teachers from Abroad

1. The Book

The first edition of *The Science of Dental Materials* was published in 1936. It was the first real text on dental materials. Previously the subject had not been perceived as a basic science discipline—most dental schools offered metallurgy courses and covered all other materials very superficially as part of their technic courses. Dr Skinner was the first to take on the job of gathering the fundamental and relevant information from the literature of physics, engineering, and chemistry, and to select those aspects that were pertinent to dentistry. He must have done a pretty good job—the book was sold out in three years. The second edition was published in 1940, the third in 1946, and it was reprinted several times. Many copies were sold overseas.

Interest in translations had been expressed as early as the late '40s, the first one being the Portuguese edition translated by Francisco Degni, one of the illustrious graduate students of this school. Before it appeared on the market in 1956, it had been updated to reflect the content of the fourth edition, published in the United States in 1954. Many copies of the fourth edition in the English language were also sold abroad. A Spanish translation by Dr Fernando Pinto followed in 1957, and a Japanese translation in 1958, with additional editions in 1964 and 1968. The total sales of the Japanese version alone exceed 6,000 copies, and the first Spanish edition sold over 2,500 copies. The Portuguese version was updated by Dioracy Vieira of São Paulo, another student and visiting teacher of Northwestern University Dental School.

The sixth edition was in page proof when Gene Skinner passed away in 1966. It was subsequently translated into French, Japanese, Spanish, and Portuguese and, although I do not have access to the publication data for the English edition, I have been able to ascertain that more than 8,000 copies of the sixth edition, printed in languages other than English, have been sold; indeed an impressive indication of Dr Eugene W. Skinner's influence abroad.

These books are not only found in dental school libraries all over the world, they are by far the most used textbook in dental schools abroad and have been used as the standard reference in the field of dental materials for approximately 40 years. The literature of dental materials contains more references to this text than to any other textbook of dental materials.

2. The Graduate Program

During his term as professor of physics at Northwestern University Dental School, Dr Skinner personally directed 57 master's theses and served on the thesis committee for many more. He was a member of the Faculty Committee on Research from 1957-64, served on the Administrative Board of the Graduate School of the University from 1940-64—24 years. He was in charge of graduate work in the dental school, first as chairman of the Committee on Graduate Study and later as director of Graduate and Postgraduate Study in Dentistry over the same period of 24 years. No one has had as profound an influence on the development of graduate programs in this institution as Gene Skinner, and, as you read the bulletins and announcements over the years, you recognize in them his style, his logic, his analytical mind.

Of the 57 master's theses that Dr Skinner directed, I have so far been able to identify 14

by foreign students. The titles show the range: "The Possible Cause of Internal Porosity in Vulcanite" by Dube in 1937, "Study of Hygroscopic Expansion of Dental Investments" by Degni in 1946, "Clinical Studies of Forces Required to Dislodge Maxillary Denture Bases of Various Designs" by Campbell in 1952, and I could go on and on.

In addition to the students who did their research in dental materials in Gene's laboratory, many graduate students in other departments received help from Gene Skinner, and so did many faculty members over the years. At the same time Dr Skinner conducted important research projects of his own resulting in published articles that were read and that provided stimulus for additional research abroad as well as in the United States of America. Dr Skinner was involved in research on the cutting efficiency of burs, he worked on the casting procedure, dental amalgam, dental resins, and numerous other materials. A research report with Eugene W. Skinner's name as author or coauthor would always result in a large number of requests from abroad for reprints.

3. The Undergraduate Students from Abroad

Northwestern University Dental School began to develop an international reputation during the days of Dr G. V. Black. Dental educators as well as young graduates from all over the world came to Northwestern University Dental School to learn from Dr Black and his contemporaries.

For a good many years a fixed course of study of one year leading to the D.D.S. degree was offered to graduates of foreign dental schools. In the year 1934, when Dr Skinner joined the faculty here, there were, for example, 41 foreign dental students, 21 of whom were enrolled in formal graduate or postgraduate studies, and 20 who were undergraduate students working toward the D.D.S. degree. All students in the undergraduate program, of course, took Dr Skinner's regular course in dental materials and many of them were inspired to return for graduate courses.

Students that have the desire to go to another country for study and that are able to obtain scholarships or travel stipends for study in a foreign country or that are willing to make the financial sacrifice to do so on their own are among the most highly motivated young professionals in their own country and most often rank high among their peers both in knowledge and in skill. Inherently, they are not timid. A timid person does not make the decision to go to a foreign country to study, perhaps in a foreign language, and in competition with students who are—and this is well known abroad—a highly select group, chosen on the basis of stringent entrance requirements. It also takes a special spirit of enquiry to subject oneself voluntarily to one more year of dental education after having completed the requirements for graduation and licensure in one's own country. Therefore, it is not surprising that the students from abroad who, over the years, enrolled as students at Northwestern University Dental School emerged as leaders in their own countries in dental education, in dental research, and in dental practice. With the assistance of Mrs Skinner and your famous library, I have identified 234 foreign dentists who took either undergraduate or graduate studies at Northwestern University Dental School over the years while Dr Skinner was active. This number does not include numerous Canadian students or dentists who have passed away—only those who are still going strong! These dentists in turn have influenced others to come to Northwestern University Dental School.

4. The Visiting Teachers from Abroad

There is nothing new about dental school teachers from abroad visiting Northwestern University Dental School. As I have mentioned they have come to Northwestern University to learn from G. V. Black, from Edward H. Hatton, from R. O. Schlosser, and from other fine educators, scholars, and research workers in this school—and they still do. However, some 22 years ago Dr Skinner made history by convincing the administration of the dental school to set aside a salary each year for a Visiting Associate Professor of Dental Materials. George A. Lammie from Liverpool, England, was the first, in the 1955-56 school year. Those of us who came to know Dr Lammie, affectionately known as Sandy, found him to be a most stimulating and knowledgeable person who contributed to the research program in both materials and prosthetics as well as to the teaching program. He was followed by Pro-

fessor John Osborne from Birmingham, England, later to become dean of his own school.

The third visiting teacher was Richard G. Earnshaw from Australia, who was here during 1957-58. Dr Earnshaw, now Reader in Prosthetics at the University of Sydney, is very active in research and still publishing excellent articles that are, in a way, a continuation of the research work he initiated while he was working in Dr Skinner's laboratory almost 20 years ago. He returned to Northwestern in 1971 as an International Association for Dental Research Senior Foreign Dental Scientist and visiting professor in Biological Materials.

Next, in 1958-59 came Björn Hedegård, then a young and very promising professor from Stockholm, Sweden. Dr Hedegård was attuned to clinical research and stimulated several departments in the school. He, too, came back as an International Association for Dental Research Senior Foreign Dental Scientist and visiting professor in 1966-67. He served as dean of the dental school of Karolinska Institute in Stockholm, later giving up this position to get back into teaching and research on the faculty in Göteborg.

Other visiting teachers include, in sequence, Richard A. Roydhouse from New Zealand, now at the University of British Columbia, Vancouver; Dennis C. Smith from Manchester, now professor of Dental Materials Science in Toronto; Roy Storer from Liverpool; Wesley Johnson from Manchester; and Dioracy Vieira from São Paulo, Brazil.

The very fact that these most competent teachers and research workers came to Northwestern University Dental School is in itself a testimonial to Gene Skinner's influence abroad, because all of them had made it in their own countries.

The sequence of visiting professors in dental materials, often combined with one of the clinical departments, continued several years after Dr Skinner's appointment to professor emeritus and Dr Greener's appointment as chairman of the department. As a result the next four visiting professors also had the privilege of personal association with Dr Skinner, an association which has, I am sure, been of great value to these teachers and research workers. They include Edward A. Wain and Edward C. Combe from Manchester, Alan A. Grant from Melbourne, and Karl F. W. Eichner from the Free University of Berlin. Incidentally,

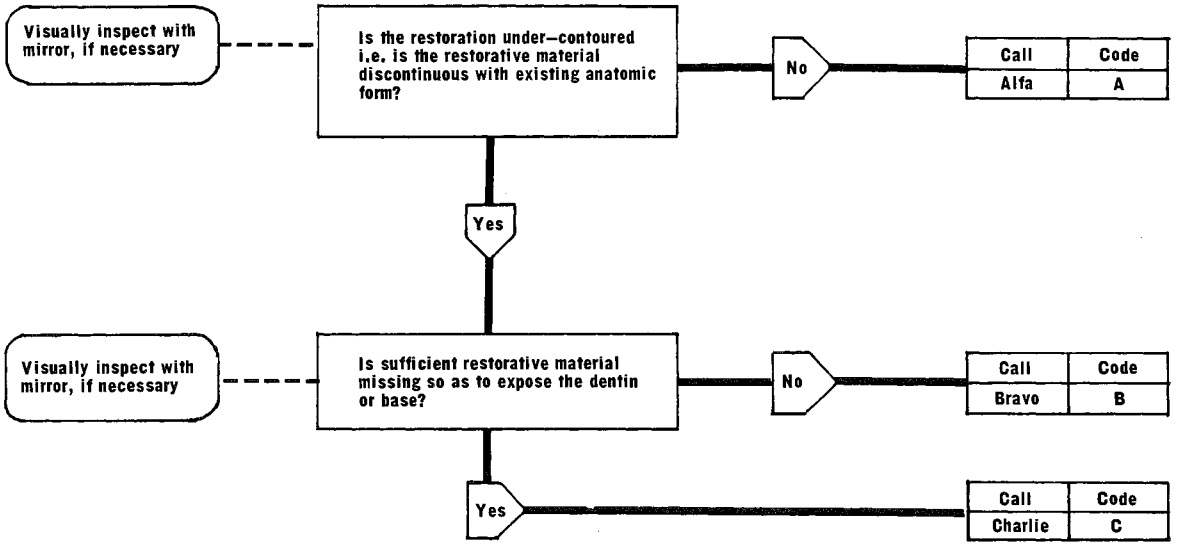


FIG. 1. Criteria for clinical evaluation for anatomic form

ABOVE AND ON RIGHT: *A system for direct clinical observation and rating of restorations developed by the author and his co-workers.*

Dr Combe was back at Northwestern in 1974-75, and many of the present students probably met him then.

I cannot finish the theme of Gene's influence abroad without mentioning that in 1954 he went to Scotland to serve as an honorary lecturer at the University of Edinburgh, an appointment that clearly reflected his international reputation and, I am sure, gave considerable impetus to the program of visiting professorships that was initiated subsequently and of which I have already spoken.

Clinical Research Methodology

I could go on citing examples of Dr Skinner's influence abroad. However, Dr Olsen and Dr Greener have indicated that they would like to see tribute paid to the memory of Dr Skinner, not only by biographical data, or by eulogy, but also by presentation of technical information in the field of materials. I have a great deal of personal interest in this subject, which, as Dr Phillips pointed out last year, also was considered very important by the late Dr Skinner—clinical research methodology.

In 1938 John Shell wrote a noteworthy paragraph. Under the heading, "Method for Checking Amalgam Technique" (Shell, 1938), he wrote: "Clinical data are of considerable value in estimating the success or failure of dental materials, but they are often difficult and tedious to obtain." He continues, "Information on new materials could be collected only by following cases over a period of years, making their immediate use hazardous, and some practical method of testing *in vitro* is desirable for a number of reasons." John was really saying: Clinical research is important, but not feasible, so let's test in the laboratory instead. That point of view has dominated our field up until the mid-sixties.

The many years of laboratory testing gave us excellent information about physical, chemical, metallurgical, mechanical, and biological properties and about interaction between properties and manipulative variables. Still, we have finally become aware that all the laboratory testing in the world, as Gene Skinner said, cannot provide conclusive evidence as to the clinical usefulness or service life of a new restorative material or the efficacy of a new therapeutic agent.

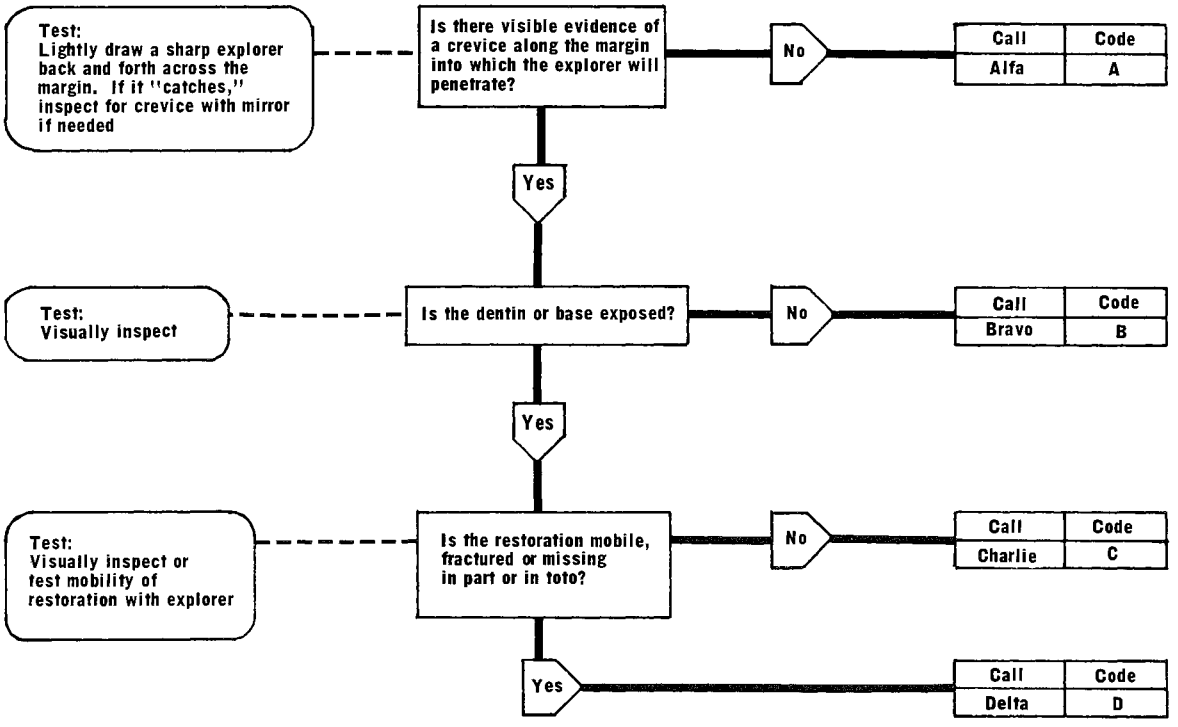
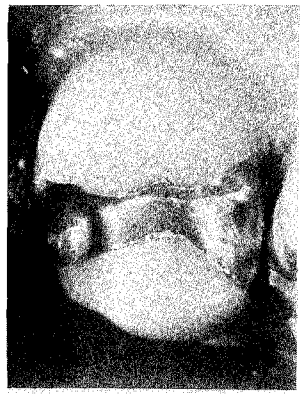


FIG. 2. Criteria for clinical evaluation for margin adaptation

1

2



3

4

1½ 2½ 3½

Requirements of the Food and Drug Administration and of the American Dental Association Council on Dental Materials and Devices and Council on Dental Therapeutics for the programs of certification and acceptance have stimulated the development of clinical research methodology, and slowly but surely we are moving toward recognition of clinical research as a legitimate and, indeed, important research discipline. Many dental manufacturers, dental schools, and dental practitioners have accepted that this is the age of clinical evaluation and clinical research in dentistry.

Basically, there are three or four different philosophies of clinical research on dental materials, and I should like to touch upon the systems that have emerged in recent years.

A system for direct clinical observation and rating of restorations was developed about ten years ago by myself and my co-workers at the late Dental Health Center in San Francisco. Some of you are familiar with this system. Restorations are evaluated shortly after their placement and at annual recall examinations using specific criteria that are formulated as a series of bipolar decisions aimed at judging certain important characteristics of the restorations according to relatively broad but clinically meaningful categories, such as anatomic form, margin adaptation, and caries (Figs. 1-2).

For determining the marginal breakdown of dental amalgam, Mahler and his group have used a different approach. Their evaluation system can be characterized as a method of indirect observation, using photographs of the restorations. The evaluation is made by comparing the photographs with a set of "standards" which depict a progression of deterioration of the margins of restorations. Mahler's method also falls in the category of a rating system (Fig. 3).

Eick has attempted to quantify changes in margin adaptation by stereophotogrammetry, a system of stereophotography using a grid to establish "contour lines" by which changes can be translated to measurements (Fig. 4).

Other investigators have added to or subtracted from these three systems. As an example, I should mention that the American Dental Association research division at the National Bureau of Standards has used stepwedges and test blocks in order to quantify characteristics such as margin adaptation, surface roughness, and the like. All of these systems have their advantages and disadvantages, and the choice of evaluation or test method will be dictated by the objectives of the specific investigation.

For each system, training and standardization of examiners is important, and so is the interpretation and statistical evaluation of the results, a subject that is in itself too extensive to include in this presentation. Suffice it to say that each system is capable of providing meaningful information when properly used and interpreted. Jendresen, Moffa, Leinfelder, and coworkers as well as the teams at Indiana, Buffalo, here at Northwestern, and at Emory have shown that useful information can be derived from evaluations based upon use of such rating systems. Also, several manufacturers have used these systems to evaluate new products.

Maybe I should add that evaluation sys-

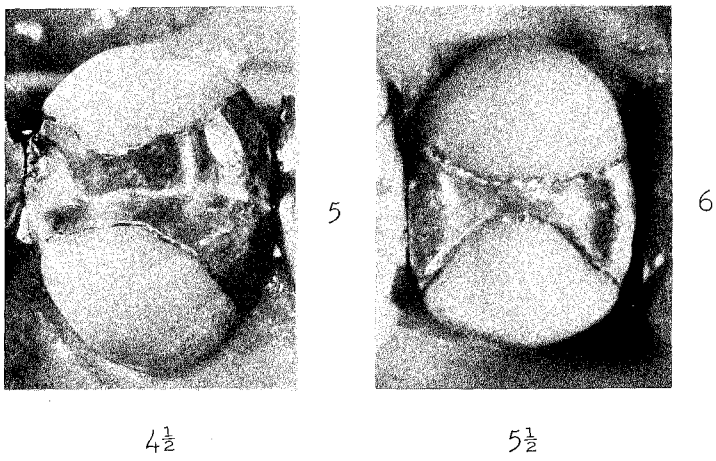


FIG. 3. Categorized reference photographs employed in evaluation system developed by David B. Mahler, University of Oregon Dental School.

tems with many categories may provide greater sensitivity—even to the point of showing differences that are of statistical significance but of limited clinical significance. Again, the choice of evaluation system should be made on the basis of the type of information that is sought.

Perhaps the most important point to be made regarding development of clinical testing is the fact that these various systems have been developed and are being used so that finally we are gathering meaningful information about the clinical usefulness of restorative dental materials, old and new.

In recent years, as dental insurance has become an important factor in the delivery of dental care and as consumerism has gained momentum, the interest in quality control has steadily increased. This interest has turned to concern after the enactment of legislation in 1973 mandating Professional Standards Review Organizations.

It is indeed interesting to note that today strong interest in meaningful clinical evaluation is shared—although maybe for different reasons—by dental educators; by dental research workers; by dental manufacturers; by the regulatory agencies such as the Federal

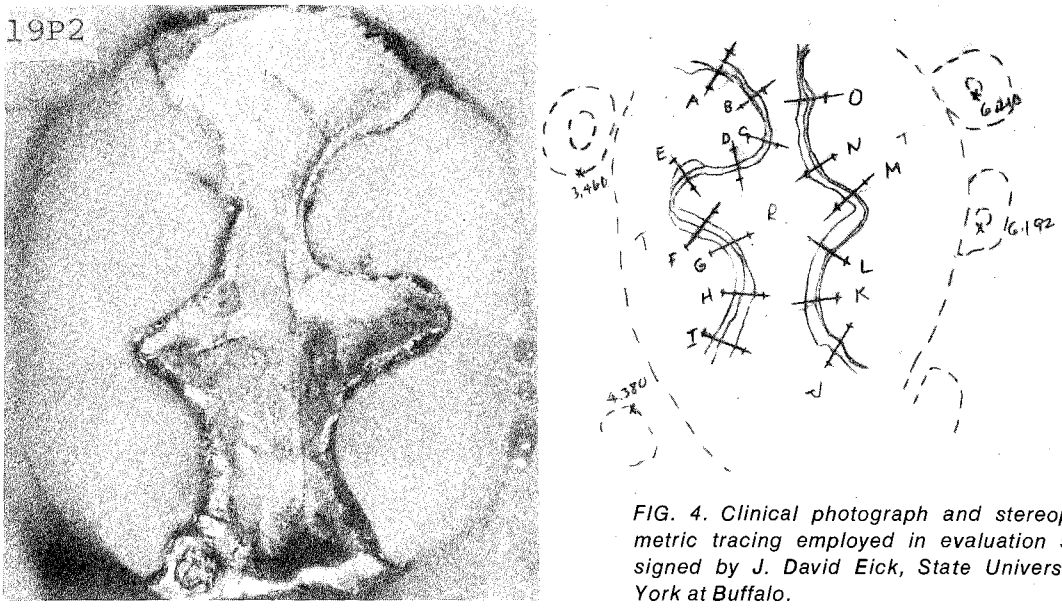


FIG. 4. Clinical photograph and stereophotogrammetric tracing employed in evaluation system designed by J. David Eick, State University of New York at Buffalo.

CHARACTERISTICS

	RATING	CODE	SURFACE AND COLOR	CODE	ANATOMIC FORM	CODE	MARGIN INTEGRITY
SATISFACTORY	R Romeo		Surface of restoration is smooth. No irritation of adjacent tissue. No mismatch in color shade and/or translucency between restoration and adjacent tooth structure.*		Restoration's contour is continuous with existing anatomical form: restores contours, cusps, planes, grooves, marginal ridges, and functional contact points.		No visible evidence of ditching along the margin. No discoloration on the margin between the restoration and tooth structure.*
	S Sierra	RO SMM	Surface of restoration is slightly *rough* or pitted; can be refinished. *Mismatch* between restoration and tooth structure within the normal range of tooth color, shade, and/or translucency.*	SUCO OC OH MR CS FA LI PS SOCO	Restoration is slightly under-contoured: *Occlusal contour* not continuous with that of cusps and planes, OR *Occlusal height* reduced locally (not in toto), OR *Marginal ridges* slightly under-contoured (low), OR *Contact* slightly open (may be self-correcting), OR *Facial* flattening, OR *Lingual* flattening, OR *Interproximal* cervical area slightly under-contoured, OR Restoration is *slightly over-contoured,* but excess material could be removed.	CR DIS	Visible evidence of ditching along the margin not extending to the DE junction. *Discoloration* on the margin between the restoration and the tooth structure.
NOT ACCEPTABLE	T Tango	PIT MM	Surface deeply *pitted;* irregular grooves (not related to anatomy); cannot be refinished. *Mismatch* between restoration and tooth structure outside the normal range of tooth color, shade and/or translucency.*	UCO DE or BA OCC CT PT OCO OV	Restoration is under-contoured: *Dentin* or *base* is exposed, OR *Occlusion* is affected, OR *Contact* is faulty (self-correction is unlikely), OR *Interproximal* cervical area under-contoured, tissue damage likely. Restoration is *over-contoured:* Contour cannot be adjusted properly, OR There is marginal *overhang*	MD MB PEN	*Dentin* or *base* is exposed. Discoloration has *penetrated* along the margin of the restorative material in a pulpal direction.*
	V Victor	SF FL UN	Surface is *fractured* or *flaking* *Esthetically displeasing* color, shade and/or translucency.*	MIS TO PN	Restoration is *missing,* OR *Traumatic occlusion,* OR Restoration causes *pain* in tooth or adjacent tissue.	MOB RF CAR TF	Restoration is mobile OR fractured OR *Caries* contiguous with the margin of restoration, OR *Tooth* structure *fractured.*
TABLE		*Criteria apply to anterior restorations.					

THE ASSESSMENT OF CLINICAL QUALITY
AND PROFESSIONAL PERFORMANCE

Rating System for Quality Evaluation
OPERATIVE DENTISTRY

	RATING	OPERATIONAL EXPLANATION
SATISFACTORY	Meets Standards of Excellence Code: R Call: Romeo	The restoration is of acceptable quality and is expected to protect the tooth and the surrounding tissue.
	OR	OR
	Meets Standards of Acceptability Code: S Call: Sierra	The restoration is of satisfactory quality, but exhibits one or more features which deviate from ideal conditions.
NOT ACCEPTABLE	Replace for Prevention Code: T Call: Tango	The restoration is not of acceptable quality. Future damage to the tooth and/or its surrounding tissues is likely to occur.
	OR	OR
	Replace Statim Code: V Call: Victor	The restoration is not of acceptable quality. Damage to the tooth and/or its surrounding tissues is now occurring.

Drug Administration, the American Dental Association Councils on Dental Materials and Devices, and on Dental Therapeutics; by dental examiners; by insurance companies; by patients (I still prefer to use the term patients rather than calling them 'consumers'); and by practicing dentists and their peer review committees.

In California, the dental profession has been particularly responsive to these trends, and in 1973 the House of Delegates of the California Dental Association established a Task Force on Quality Evaluation under the chairmanship of Dr Dan Gordon.

A planning committee was appointed and it was decided to develop guidelines for assessing clinical quality and professional performance and, also, to establish guidelines for evaluating the quality of dental care programs. Dr Dale F. Redig, the dean of my school, was a member of the original planning committee, and, maybe because he knew of my interest in evaluation, I became chairman of Committee 1, with the charge to establish guidelines for the assessment of clinical quality and professional performance.

This work is now completed and the 1975 House of Delegates of the California Dental

Association adopted the proposed system of evaluation as a basis for peer review. The system has been field tested and the field testing version has just been published by the California Dental Association (1975).

I should like to point out that the rating system and the criteria that we have developed are intended for peer review and may not be directly applicable to dental materials research. However, I submit that the basic philosophy of using rating systems and criteria, spelled out for each of the rating categories, has merit and that the methodology can be very useful for better defining and communicating important aspects of clinical quality. For this reason, I include a brief description of the system.

Committee 1 of the California Dental Association Task Force basically adopted a format, published by Ryge and Snyder (1973), that is applicable to evaluation of all aspects of clinical dentistry. The system is simple and is directly related to the types of decision that every dentist makes every day in private practice.

Each time you examine a new patient or one who comes in for recall you really evaluate quality. You decide whether a given piece of work—be it an amalgam restoration or a complete denture—is satisfactory or whether it is not acceptable. Also, you most likely decide for yourself whether those restorations or appliances that you decide to leave alone are excellent or just acceptable. Similarly, you decide to replace a restoration or appliance—or to carry out a certain procedure, endodontic, periodontic, or whatever—either for preventive reasons, or because damage is now occurring.

We call this the Rating System. It has four ratings: R, S, T, V, representing the code words Romeo, Sierra, Tango, and Victor, which designate the categories described (see chart, page 37).

To get at the more common reasons for categorizing a dental service, in this instance a restoration, in this system, we consider various characteristics. In operative dentistry, we look at surface and color, anatomic form, and margin integrity (see page 36). In diagnosis we look at charting and reports and at diagnostic aids; in treatment plan we look at documentation and sequence.

For each characteristic we try to spell out features that enable us to discriminate between the four ratings R, S, T, V.

Rules: Lowest rating "counts"—this is the rating that determines the operational decision, dictates the treatment to be instituted, and in the case of peer review tells us whether a given dental service meets the criteria for Satisfactory Quality compared with being Not Acceptable.

Once you have experience with the system, you'll find it to be very easy to use, and for this reason it is easy to train dentists to use the system in a consistent manner. We recommend that two dentists evaluate each rating. If the two results are identical, this is the final rating; if not, both examiners reexamine and arrive at a joint final decision. This whole procedure goes very fast because the criteria provide a basis for quick communication. We have also used the system at school and the students who have used it have found it very helpful particularly because it provides a good basis for communication.

It is my hope that this brief review has stimulated your interest in clinical evaluation in general and that some of you will become actively engaged in this very fascinating field, a field which was identified by Eugene W. Skinner as a significant source of information several years before the methodologies and systems that I have mentioned here today had been developed—once again, an indication of the unusual perceptiveness of Dr Skinner.

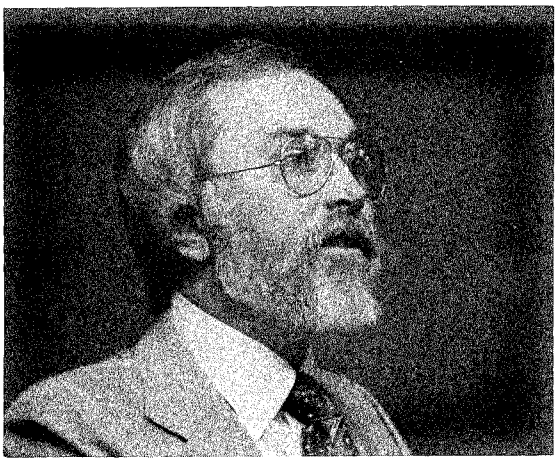
References

CALIFORNIA DENTAL ASSOCIATION (1975) *Quality Evaluation for Dental Care.* Los Angeles: California Dental Association.

RYGE, G. & SNYDER, M. (1973) Evaluating the clinical quality of restorations. *Journal of the American Dental Association,* **87,** 369-377.

SHELL, J. S. (1938) *Hogden-Shell Dental Materials.* P. 268. St. Louis: C. V. Mosby.

POINT OF VIEW



The Gamble

DAVID A. GRAINGER

Las Vegas is some town for a dental meeting—if you like entertainment, no sleep and, of course, gambling. As they say, that's where the action is, in the casinos around the tables and by the machines.

But in the Fall of '76 it wasn't quite the same. The pace was different. You could feel it, smell it, yes, even taste it. It was almost a gambling "slow down." Oh, there were winners and there were losers but the style was missing, the flair for wagering big and taking a chance had evaporated, so it seemed, leaving you and me just drifting through those smoke-filled lobbies at all hours of the day or night.

Now I'll not judge behavior and some of you will scoff, but it seems to me that your Standard American Conventioneer isn't the gambler he used to be. Good, you say! And I'll agree with you, it isn't a healthy habit, but is that all there is to the story? I don't think so.

There's nothing rational about linking gambling for money with gambling for other things in life, but a few days along the Strip in November might have given you a feeling for the change that seemed to be there and food for thought as to the consequences. Perhaps it's a sign that people are preparing themselves for other things. A period of consolidation so that energies can be expended in other ways very soon. If so, a good sign. One we need so desperately in Operative Dentistry today.

Leadership takes many forms. It can draw you out, way out, deliver the best from you, sometimes even lift you beyond yourself giving you a deep-rooted sense of satisfaction with achievement. But other kinds of leadership can also hold you down, dull your senses, and take you down the road to hell to the distant sound of the piper. That's what gambling is all about. Not for money, that's just an aberrant form, but gambling, real gambling is the strength of real leadership. And, when it's functioning, you see it, feel it, all around you . . . and when it's not, you can sense that too.

David A. Grainger, B.D.S., D.D.S., University of Florida, College of Dentistry, Box J 415, J. Hillis Miller Health Center, Gainesville, FL 32610, U.S.A.

Dr. Grainger is professor and chairman of the Department of Operative Dentistry. He is secretary-treasurer of the American Academy of Gold Foil Operators, a past president of the Central Florida Gold Foil Study Group, and consultant to the National Board of Dental Examiners.

I don't know if I'm right but I can certainly take a look at my profession and my discipline and make some observations that you should make as well.

Patrick Moynihan laid it on the line. Socialized dentistry is coming. It's definite, it will arrive, and we have been asked to participate in its planning. Like it or hate it, we must not fail to make it work. It is your future, my future, our future, and it makes me think.

You know you can't buy a separator any more, and you may not be able to purchase a Suter hand instrument in a few years. At one o'clock in the morning, in a delightful French restaurant on the Strip, I listened to a plea for help to save the production of gold foil. Yes, gold foil. Oh, you say it'll never happen . . . or, so what, who needs gold foil? Well, dammit, that's just the point! I do, and maybe you do, but even if it is only me that needs it, isn't this America, the source of liberty and freedom? Perhaps the only country that gives all of us the inalienable right to be different, to have at least a chance of finding and having that one, single, different opportunity? That's what made this country what it is today . . . or was, only yesterday.

Is that a pessimistic attitude? Are things already sliding? I believe they are, and probably too fast for comfort. Is your affluent state taking the punch out of you? Is it just too much trouble to fight for some of the things that matter? What is it going to take to hold the line and stop it?

Well, I don't have the answers but I do have the will, the spirit to gamble, even to lose again and again if that is what it takes to see it right. You must help and that means active help. What does it take to move us? All power has a point of contact but it can't be realized without action. A real act on your part and on mine. It is a cry I hear from so many, and yet the crushing of individualism continues, it seems, from every large organization around us. Yet *we* make up the organizations and create more and bigger ones to solve the problems generated by the first. Solutions from groups have never been very good at solving anything. It's like statistics, it's true for the mean or the median but it sure isn't quite right for each individual that is part of it. The Spirit of '76 needs men and women like us to hold the line, to speak out in public, not only in private, to be part of change, to be seen making it, to lead not follow. When they call for volunteers, do you go? Or is it too easy to leave it up to another?

Success is not necessarily the ability to place an excellent Class III direct filling gold on the distal of a maxillary canine any more than it is the ability to adjust an occlusion to a stable centric position. Success is an environment in which you can do what you want to do as well as you can. Where you can learn to be better. Where you can know, without question, that your friends across the street or in an office in the next town are practicing dentistry in ways that match their needs and those of their patients.

Freedom, that's what it is. Freedom to be good, to excel, to have pride; freedom to manufacture anything that is needed, to buy and to sell; freedom to be different, to lead and to follow. It will only arrive with participation. Participation in anything, in everything, with beliefs to speak up for. There it is, that's the gamble. Good leaders will appear automatically. Will we take that gamble? They did in 1776.

DEPARTMENTS

Press Digest

A four-year evaluation of a fissure sealant in a public health setting. Leake, J. L. & Martinello, B. P. (1976) *Journal of the Canadian Dental Association* (42), 409-415.

In each of 518 school children, age 5-7, two first permanent molar teeth free of caries were treated with a pit-and-fissure sealant (Nuva-Seal). Portable equipment was used to carry out the treatment at the schools. The children were divided into two groups, one of which was treated by a dentist, the other by a hygienist. Of the 420 children examined at the end of four years the sealant had remained in 20.1% of the sealed teeth. The dentist's proportion of successes was substantially higher than that of the hygienist, 29.1% compared with 9.0%. This discrepancy emphasizes the importance of good technique in achieving a successful result. Occlusal caries was reduced 21.6%. An interesting and important feature of this study is the cost-benefit analysis of the program. The cost of sealing the teeth was compared with the cost of treating with amalgam the lesions that would have developed had the sealant not been applied. The analysis disclosed that the program required $3.91 to deliver care that could have been purchased for $1.00. The authors conclude that under the circumstances the program does not appear to be worthwhile.

Microstructure of amalgam surfaces. Chan, K. C., Edie, J. W., & Boyer, D. B. (1976) *Journal of Prosthetic Dentistry* (36), 644-648.

A scanning electron microscope was used to examine the surfaces of amalgam restorations finished in three ways, namely, burnished, carved, and polished with sandpaper discs and chalk 24 hours after condensing. Polished surfaces were the smoothest and carved surfaces the roughest. Numerous small elevations or granules were found on burnished surfaces. These granules contained tin-mercury alloy. The authors conclude that there is no substitute for polishing.

An evaluation of techniques for finishing margins of gold inlays. Metzler, J. C. & Chandler, H. H. (1976) *Journal of Prosthetic Dentistry* (36), 523-531.

The results of several methods of finishing the margins of Class II inlays of type II gold on extracted molar teeth have been examined with the help of the scanning electron microscope. The buccal and lingual walls of the proximal portion of the cavity were prepared in two ways so that either 90° or 30-40° of metal resulted at the margins. The authors conclude that: instruments should be rotated perpendicularly to the margin and from gold to tooth; green stones produce rough surfaces that are difficult to smooth; hand burnishers and rubber points are not effective in gross closure of margins; the best instruments for finishing occlusal margins are round steel burs, finishing burs, and white finishing stones; the finish is better where the marginal angle of the gold is small; castings made from patterns that are slightly overwaxed tend to give better margins than castings made from patterns waxed exactly to the margins.

Exposure of subgingival margins by nonsurgical gingival displacement. Reiman, M. B. (1976) *Journal of Prosthetic Dentistry* (36), 649-654.

This method of preparing the gingival sulcus entails reducing the tooth where necessary to the gingival crest and then tucking a cord of medium size, saturated with 8% racemic epinephrine and dried, into the sulcus. The displacement of the gingiva allows the cervical margin to be established in the sulcus without scarifying the epithelium. It is safe to use epinephrine at this stage because the epithelium is still intact. When the preparation has been completed the cord is removed, a bevel placed if required, and a fine cord of untreated cotton (button thread) placed in the depth of the sulcus, the ends of the cord abutting in the midbuccal region. Over this is placed a cord treated with aluminum chloride. This cord is left in place for five minutes at which time it is removed and the impression taken.

Book Reviews

Rarely do two good books appear at one time about the same subject. Fixed prosthodontics can be a vast topic and it has been difficult, indeed, to find one good text for the dental student that also provides good, useful information for the general practitioner. Texts are usually too extensive, too complicated or too disjointed. *Operative Dentistry* has decided to review two excellent texts in this field at one time to give the reader an opportunity to make comparisons and choose. Such a choice may not be an easy task and will depend upon one's attitudes towards the style of illustrations, presentation, and price.

ATLAS OF FIXED PARTIAL PROSTHESIS

By David E. Beaudreau, D.D.S., M.D.S., with contributing authors from the Medical College of Georgia, School of Dentistry

Published by Charles C Thomas, Springfield, IL, 1974. 570 pages, extensively illustrated. $17.50

A text like this has been needed for many years in fixed prosthodontics. It is part of a series entitled *The American Lectures in Dentistry* and this series, as explained by Alvin Gardner in the foreword, attempts to combat obsolescence and correlate the biologic principles of clinical problems. The text is designed for both an undergraduate education and for continuing education by members of the profession.

Operative dentists cannot really be distinguished from restorative dentists and fixed prosthodontics can be practiced at either a minimal or extensive level. For those who practice the discipline as general dentists, finding the isolated pieces of relatively simple material on fixed prosthodontics in the published literature with a view to piecing it together to make some sense of a diverse and complex field has proved a difficult task. The *Atlas of Fixed Partial Prosthesis* changes that situation. The teacher and the practitioner will find the book quite useful, students more so, and this reviewer will describe it as he sees it. First, the book is basic only, both its strength and weakness. The book is truly an atlas and no attempt is made to disguise this fact. The clinical photographs and radiographs are not good, but this does not affect the content; and though a bibliography is listed with each chapter there are no references cited in the text itself.

The early chapters dealing with the loss of integrity of the arch and the provision of periodontal and orthodontic care are minimal and could be improved by specific indications of the need for each. The section on equilibration is neat, concise, and to the point but does not *teach* the equilibration or selective grinding of natural teeth sufficiently. It does indicate those tooth surfaces most likely to cause problems but does not explain the precise procedures associated with adjustment of a natural or restored occlusion. Other supportive information will be needed to achieve that end.

Excellent material is presented on tooth form, contour, shape, and size; the importance of axial contours; contact relationships and buccolingual widths of occlusal tables; and esthetic aspects of design. A minor criticism of this chapter would be that the written text makes reference to figures which are many pages away. This could be improved by placing text and photographs together.

The chapter, "Preparing the Abutments," is as complete as one could wish. It offers the advantages of line drawings in addition to photographs. Sequential steps in design of tooth preparation make it easy to follow and it discusses the principles of stapling, the direction of retentive grooves to maintain incisal edge and buccal wall integrity, and all the features designed to provide stable partial veneer castings. Since many of the preparations are illustrated on teeth which are an integral part of an arch, it does not limit tooth preparation to abutments but to all situations. A complete selection of different tooth preparations is presented where one important plus is the use of burs to measure groove length, tooth height, and other dimensions so that the operator might know with greater accuracy when a groove of a sufficient dimension has been prepared.

Tooth temporization is broad, from intracoronal reinforced zinc oxide and eugenol to celluloid crowns containing autopolymerizing resin to anodized aluminum shells. The authors

prefer a preoperative wax impression rather than alginate for resin temporaries for short-span fixed prostheses. The use of pins and the use of zephyr bands covered with acrylic for more permanent provisional splints is well explained, as is the use of thermal plastic shells and a vacuum former to fabricate temporaries. Building a temporary from a block of acrylic is well done, but one questions its practical use. Most, if not all, impression techniques are described from hydrocolloid through silicone and rubber base to copper tube impressions, even to the use of a copper tube technique to salvage an isolated incorrect abutment impression. Metalizing with silver plating, the use of dowel pins, die trimming, and die locations is well illustrated and simple to follow. The section on face-bow registration and interocclusal records is, perhaps, too brief and limited to one type of arcon articulator. There is not sufficient information that deals with the waxing of abutment teeth and one must be ready to go to other sources for additional information.

Pontics are very well presented and leave little to the imagination. A description of all forms of pontic design is presented and describes the Harmony pin facing, the Trupontic, the flatback facing, the long pin facing, and the reverse pin facing in excellent detail. The placement of the pontic in relationship to the abutment teeth is well described. Spruing, investing, and casting is adequately covered but one wonders why the authors limit themselves to hygroscopic techniques and the use of a split-arm casting machine with a blow torch. It is a pleasure to see a procedure described for lifting the abutment castings and pontic from the mouth with an acrylic resin key for subsequent soldering. Preparation and finishing is thorough, as is the assembly of the prosthesis and adjustment of a satisfactory occlusion prior to cementation. The authors are too brief with cementation and suggest the use of rubber dam but the photographs belie the words, for unexplained reasons.

The book has been divided into three broad parts: BEFORE, DURING, and AFTER. The latter section is most useful, dealing with a vast number of problems that can arise for patients who wear fixed prostheses. This section of the book makes an effort to provide solutions for problems such as: methods to correct recurrent caries; fractured facings; the removal of loose bridges; two-phase castings for an overlay; the use of pins for repairs, and others. Examples are given to indicate why bridges fail. For the practicing dentist and perhaps even the student, this section is excellent for those times when you must solve a problem without an entire remake.

As an atlas the text is very good and would be excellent with improved picture quality. The obvious omission is that area dealing with porcelain fused to metal restorations. The two major criticisms are that the text layout and continuity fall short of the desired result—this always seems to be a problem with multiple contributors. And, second, the authors in too many sections fail to explain in adequate depth exactly how to do things. The chapters on tooth preparation and pontics are exceptions and don't make that mistake. For these two sections alone, the practicing dentist would enjoy the book. It is a most valuable adjunct to the predoctoral teaching of fixed prosthodontics and most dental students would welcome this book as an aid to fabricating a short-span fixed prosthesis.

FUNDAMENTALS OF FIXED PROSTHODONTICS

By H. T. Shillingburg, S. Hobo, and L. D. Whitsett

Publisher: Quintessence Publishing Co., Inc., Chicago, 1976. 339 pages, illustrated. Available from Anatomy Illustrated Ltd. (U.S. distributor), 236 Fifth Ave., New York, NY 10001.

This reviewer considers this small text to be one of the most excellent to appear in a long time on any topic whatsoever. To qualify writing styles and suggest the superiority of one over another is, perhaps, too personal, but for both predoctoral and graduate students as well as the practicing dentist this concise and easy flowing book succeeds in telling its story with great continuity, citing references for additional information. The authors are to be congratulated on an exceptionally fine book which is most easily reviewed chapter by chapter. One criticism is that line drawings have been used throughout where photographs might have been of more value in some in-

stances. It is, however, a pleasure to note the decisive manner, for clearly defined reasons, that the authors take in presenting their points of view throughout the text.

The book begins with diagnosis and treatment planning and provides a great deal of information in a few short pages. The importance of crown:root ratios, root configurations, periodontal surface areas, and comparisons of the root surface areas of abutment teeth with the root surface areas of the teeth to be replaced is lucidly explained. A discussion on the proportional degrees of deflection of long versus short spans, the problems associated with double abutments, the effect of pontics that lie outside the interabutment axis, the use of nonrigid connectors to satisfy the demands of pier abutments, and special problems associated with tipped teeth is superb. This chapter should provide information to the practicing dentist that has been needed for years and will solve many problems which confront all of us.

Too few people read the preface of a book with sufficient care; since this one refers the reader to two excellent texts on occlusion, the preface should be read. These texts enhance the brief information presented in Chapter 2 on occlusion. The authors are deliberate in making it clear that their discussion on occlusion will be brief and they indicate the problems that may occur and that must be avoided. Perhaps additional figures to illustrate working and nonworking directions of movement in the horizontal plane on the occlusal surfaces would have helped since too many students, and dentists alike, conceive of equilibrating teeth in two planes only without consideration for the third. The discussion on articulators is brief but well to the point, explaining why one needs at least semiadjustable arcon articulators and face-bow transfers to meet the demands of adequate fixed prosthodontics.

Chapter 3 on the principles of tooth preparation for cast restorations is a condensation of an earlier text by Drs Shillingburg, Hobo, and Fisher, which was more explanatory. Nevertheless, these principles, so often overlooked by students and dentists, are completely sufficient in all aspects. An effective illustration or two gives the learner an opportunity, by closing one eye, to determine methods for deciding whether or not a preparation has a path of withdrawal.

Concise and sequential descriptions for all types of tooth preparations for partial veneer crowns and pinledges are presented and excellently illustrated. The discussion on preparations for full veneer crowns describes the value of a reduction index and supports the reason for a shoulder and bevel finish line when porcelain fused to metal is to be used because of margin distortion during porcelain firing. Porcelain jacket crowns are also included as are preparations for intracoronal restorations, including the Class II and V inlays and the MOD onlay. Illustrations are by line drawings and there is a complete armamentarium list in the written text. With the basics covered, the authors introduce preparations for extensively damaged teeth and provide the reader with an opportunity for deciding on definitive pin placement for either pins in the casting or pins as components of composite or amalgam foundations. Such information is vital to the successful restoration of extensively damaged teeth. The restoration of endodontically treated teeth is completely covered for all dowel cast cores and includes the Parapost, Kurer Crown Anchor, and an intraoral acrylic direct pattern dowel for anterior and posterior teeth.

Chapter 8 concerns temporary restorations and explains a variety of techniques. The authors choose to use a prepreparation alginate since this is probably the one chosen by most dentists, but they suggest fabrication of the temporary crown or bridge out of the mouth on a quick-setting plaster model of the tooth preparation. This technique is being recommended more and more as further information is published concerning the effect of acrylic monomers on the pulp via cut dentinal tubules. All forms of temporaries such as polycarbonate and metal crowns are discussed in addition to the resin temporary.

In the chapter on impressions there is an excellent description of gingival management with retraction cord but virtually nothing on electrosurgical techniques. That omission seems unnecessary. The comparison of types of impression material is excellent, offering precise reasons for making a choice and describes the fundamentals of hydrocolloid, polysulfide and silicone rubbers, and polyether materials and problems associated with impressions of pin retention.

Both dowel pins and Di-Lok systems are described in detail in the chapter on die fabrication and working casts. The authors stress the importance of full arch casts as the most accurate method for providing an adequate reproduction of tooth structure involving the occlusal surfaces or pontics. This leads to the chapter on the articulation of casts, which is covered in great detail for the user of a Whip-Mix arcon articulator. An excellent description of interocclusal registration at the retruded contact position (centric relation) is provided utilizing an anterior jig or programmer and wax template. The use of lateral wax check bites for setting the posterior determinants on this articulator and a means of providing anterior guidance is described.

A thorough description of the development of wax patterns is presented for axial contours and for both a cusp/fossae and cusp/marginal ridge occlusion. The authors stress the importance of knowing the positions of cusp/fossae and cusp/marginal ridge relationships if one is to create good occlusions in wax and subsequently in gold.

Investing and casting procedures are covered to satisfy the novice as well as refresh the memory of the practicing dentist by reviewing sprue placement or position and size, investing techniques, casting, and finishing. Casting is only described for the broken arm casting machine and the blow torch which is a seemingly unnecessary gap in the information. Phosphate bonded investments are described for the fabrication of porcelain fused to metal restorations. Finishing and cementation is well covered, providing sufficient information for the astute operator to develop a technique for occlusal and proximal adjustment, and margin finishing as well as ways to test for sufficient occlusal contact on both the casting and adjacent teeth. Reasonably detailed information is provided on dental luting agents: zinc phosphate; polycarboxylate; EBA; and zinc oxide and eugenol cements. All in all, a more than adequate coverage to select the appropriate methods for finishing and cementing is presented.

An excellent review of pontics describes their design and the importance of occlusogingival thickness so they will not flex. Trupontics, interchangeable facings, sanitary pontics, pin facings, modified pin facings, reverse pin facings, and the Harmony facing are all described. Methods of placing the pontic in relationship to the abutment teeth is well covered and the adjustment of porcelain pontics is well detailed. The chapter on soldered joints and other connectors is excellent. It explains quite clearly the general importance of soldering, types of soldering techniques, antifluxing, and includes the soldering of proximal contacts for simple single castings. Post soldering for porcelain fused to metal restorations to other cast golds and soldering nonrigid connectors is well described.

Although mention of porcelain fused to metal restorations is contained throughout the text, the final chapter introduces aluminous porcelain, the porcelain jacket crown, and completes information on the design of porcelain fused to metal restoration.

The soft cover of this text is easy to use in the laboratory or at the chairside. It is completely coherent in its language; items of interest to the student or practitioner are readily followed. This is a text that is a must for anyone wishing to have a concise volume of information concerning fixed prosthodontics.

David A. Grainger

Letter

Dear Sir:

I am a lecturer in dental materials. When I first saw the advertisement for your journal my initial reaction was just another journal to add to the plethora of journals.

I have since seen the reprint of the article by Eames and MacNamara on the new dental amalgams. If this is representative of the quality of your other articles, I certainly want to be a subscriber.

Sincerely yours,
Brian F. Pollack, D.D.S.
Chief of Dental Research
Mt. Sinai Hospital, New York

Announcements

NOTICE OF MEETINGS

American Academy of Gold Foil Operators
Annual Meeting: October 6 and 7, 1977
University of Florida
Gainesville and Disneyworld, Florida

Academy of Operative Dentistry
Annual Meeting: February 16 and 17, 1978
Hyatt Regency Hotel
Chicago, Illinois

NEWS OF STUDY CLUBS

Gold Foil Course

The Associated Ferrier Study Clubs announce a two-week course to be given July 11 to July 22, 1977, in Seattle, Washington. This will be a course of class participation in which the dentist-auxiliary teams operate clinically. Anyone interested may secure details by writing to Dr Harold L. Sondheim, Secretary, Associated Ferrier Study Clubs, 1532 Medical & Dental Building, Seattle, WA 98101.

Minneapolis and Winnipeg

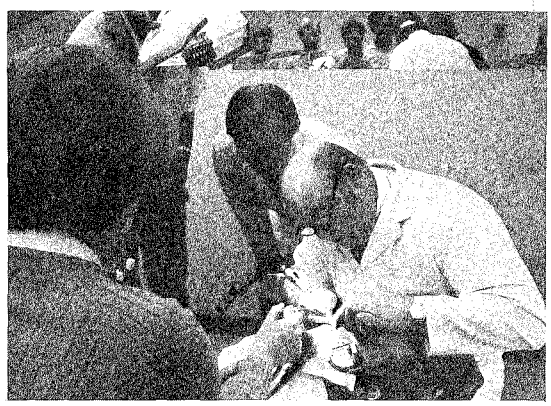
Early this year a singular meeting brought together the oldest active study club of its kind, the G. V. Black Gold Foil Study Club, established in 1897, and the newest gold foil study club, the Winnipeg Ferrier Society, formed in June 1976. The two groups met for a one-day session at the University of Minnesota, School of Dentistry in Minneapolis on January 21, 1977.

Twenty-six members and guests observed nine gold foil operations performed in the morning session under the instruction of Bruce B. Smith from Seattle, Washington. Following the luncheon Dr. Smith critiqued each operation and discussed Ferrier's concepts of cavity preparation and condensation of a Class III gold foil.

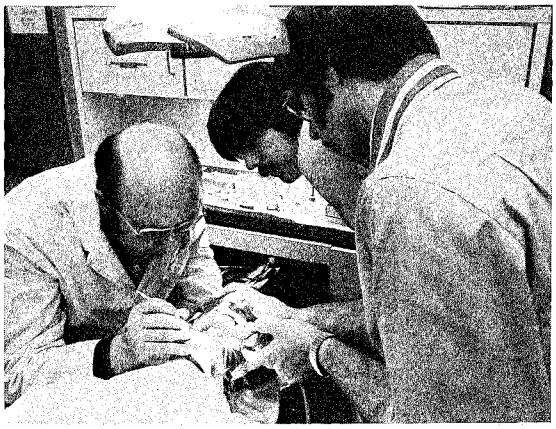
Although philosophies may differ, the sharing of ideas and the friendships which follow such exchanges are more important to enrichment of the members of a study club than the differences. The two study clubs plan to hold more combination meetings in the future. The experience and heritage of the G. V. Black club added to the interest and enthusiasm of the Winnipeg Ferrier Society promises many rewarding meetings in the years ahead for the members of these two unique groups.

Operators at the January 21st meeting were: Allan Osborn, president of the Winnipeg Ferrier Society, George Brass, André LaChance, Len Kahane, Louis Green, George Lister, Tony Romano, Thomas D. Larson, and Jim Guptill.

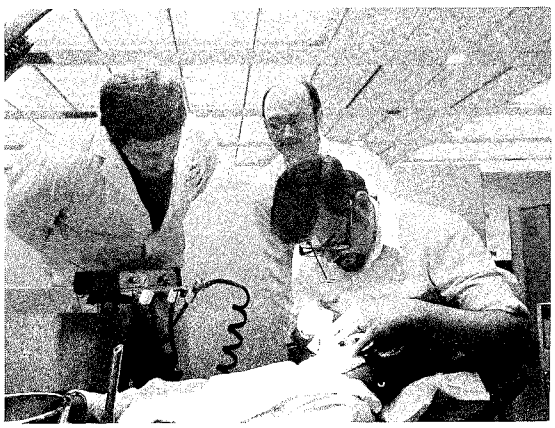
Study club presidents Allan Osborn (operating) and Perry Dungey. Dental student Karen Harrisberger assists.



Tony Romano performs a Class III gold foil operation. Joyce Vetse assists, Doug Streed looks on.



Jim Guptill prepares a Class V gold foil; students assisting.



George Lister performs a Class V. Gary Hill, left, and Warren Zenk look on.

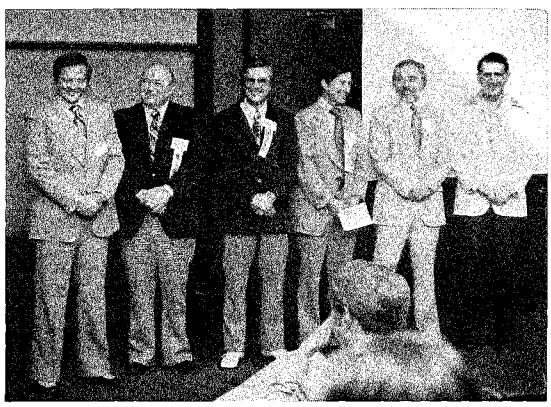
Bruce Smith gives instruction to André LaChance (center), Mrs. LaChance assists. Ed Grainer looks on.

NEWS OF THE ACADEMIES

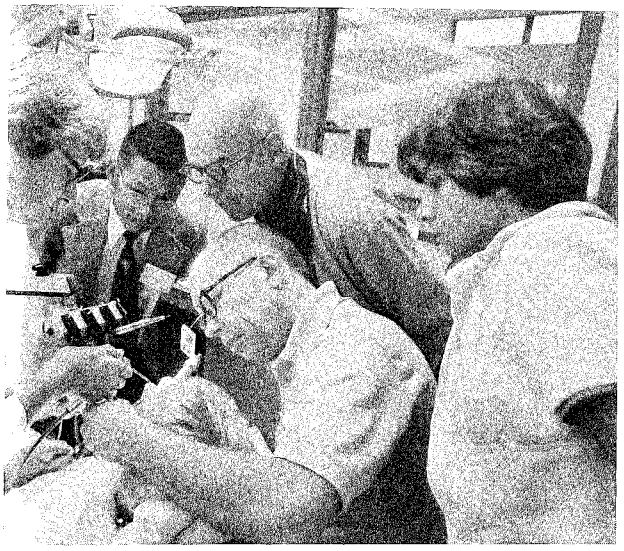
American Academy of Gold Foil Operators

The 26th annual meeting was held November 11 and 12, 1976, at Loma Linda University School of Dentistry. Essays were presented during the morning of November 11. In the evening the president's banquet was held at the top of Mount San Jacinto. Clinical operations were demonstrated during the morning of November 12.

President Brinker addresses the meeting.



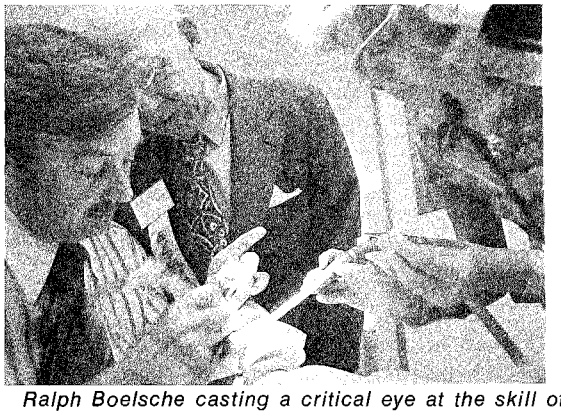
ABOVE: *Officers of the Academy, from left: Hunter A. Brinker, president; Anthony D. Romano, president-elect; Harold E. Schnepper, councillor; Melvin R. Lund, councillor; David A. Grainger, secretary-treasurer; and Chester J. Gibson, vice-president. Not in picture, Lloyd Baum, councillor.*



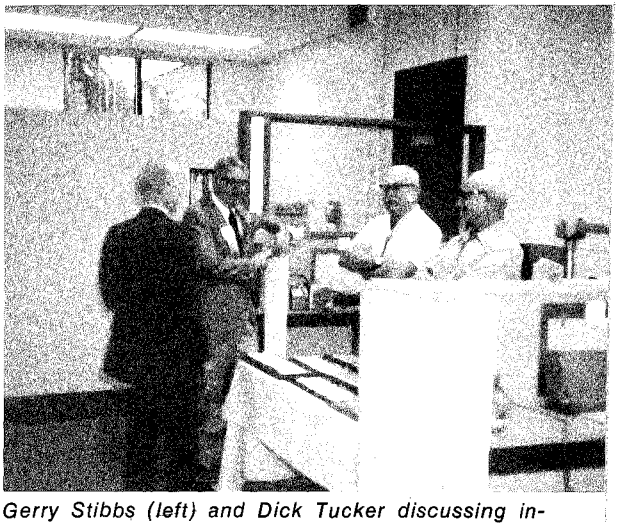
Lyle Ostlund preparing a Class V cavity with Mrs. Smiley's help.

Harold Schnepper (left) and Ralph Plummer inspect a Class III gold foil restoration placed by Douglas Schnepper.

Norm Ferguson and Sue Ferguson condensing foil into a cavity in the distal of a canine.



Ralph Boelsche casting a critical eye at the skill of Larry Schwartz.



Gerry Stibbs (left) and Dick Tucker discussing instruments with Bo Suter (right) and Harold Gravelle.

INSTRUCTIONS TO CONTRIBUTORS

Correspondence

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

Exclusive Publication

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,* 3rd ed., 1966, and *Nomina Histologica,* 1975; 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 by the name and address of the source or manufacturer, in parentheses. The Editor reserves the right to make literary corrections.

Tables

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

Illustrations

Submit two copies of each illustration. Line drawings should be in india ink or its equivalent on heavy white paper, card, or tracing vellum; any labeling should be on an extra copy or on an overleaf of tracing paper securely attached to the illustration, not on the illustration itself. Type legends on separate sheets. Photographs should be on glossy paper and should be cropped to remove redundant areas. For best reproduction a print should be one-third larger than its reproduced size. Maximum figure size is 15x20 cm (6 x 8 inches). The cost of color plates must be met in full by the author. On the back of each illustration, near the edge, indicate lightly in pencil the top, the author's name, and the figure number. Type legends on a separate sheet. Where relevant, state staining techniques and the magnification of prints. Obtain written consent from copyright holders 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 *et al.,* 1975). Four or more authors should always be cited thus: (Jones *et al.,* 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. Book titles should be followed by the name of the place of publication and the name of the publisher.

Reprints

Reprints can be supplied of any article, report, or letter. Requests should be submitted at the time of manuscript acceptance.

OPERATIVE DENTISTRY

WINTER 1977 • VOLUME 2 • NUMBER 1 • 1-48

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