ASDC AMERICAN SOCIETY OF DENTISTRY FOR CHILDREN

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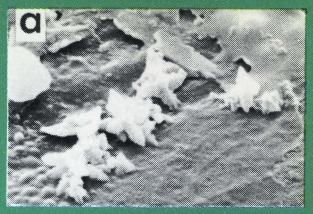
FLUORIDES IMPROVE THE QUALITY OF LIFE FOR THE ENTIRE FAMILY.



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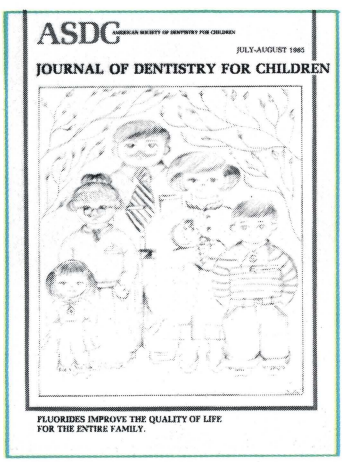
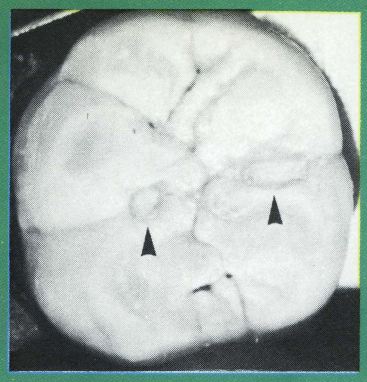


The cover depicts a family whose members represent three generations, all of whom can benefit from the ingestion of fluoride. Research has established the beneficial efficacy of fluoride for adults as well as for children. Knowledge about the phenomenal effects of fluoride continues to be acquired.

SYMPOSIUM

FLUORIDE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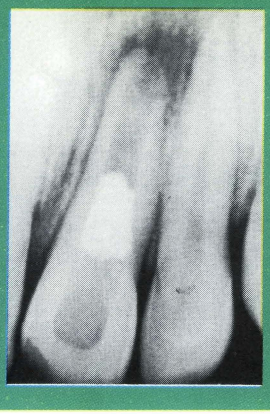
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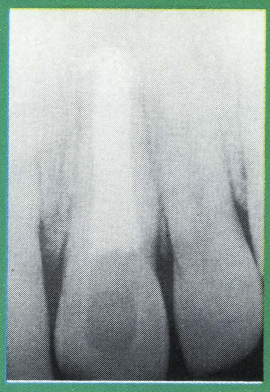
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1. Introductory comments

Herschel S. Horowitz, DDS, MPH

Dietary fluoride supplements, drops, tablets and lozenges, have been commercially available for many years. Their use provides a good source of systemic fluoride for the development of teeth that are highly resistant to dental caries and of topical fluoride after teeth erupt into the mouth. They are designed for use in fluoride-deficient areas without central water supplies or as a temporary caries-preventive method in areas that have central water supplies, but have not begun to fluoridate them.

There are some advantages to the use of fluoride supplements compared with other methods of providing systemic fluoride. One is that they provide a precise dosage of fluoride to an individual. With community water fluoridation, children consume different amounts of water and, therefore, may benefit from the procedure to different degrees. As long as the dosage schedule for dietary fluoride supplements is followed, the precise amount of fluoride delivered should result in low variability among individuals in their level of protection.

One of the main disadvantages of dietary fluoride supplements is that their use, as recommended, requires a high degree of motivation on the part of professionals who must prescribe the supplements; by parents, who must give the supplements to their young children; and by the children themselves as they get older, who must remember to take them, and not rebel at the nagging of their parents to continue doing so. A commitment to the use of dietary fluoride supplements entails a rigorous regimen of taking them daily for at least thirteen years in order to provide maximum benefits. For that reason, one cannot equate the use of fluoride supplements to community water fluoridation as a public health measure. With community fluoridation, benefits accrue automatically, simply because children often drink water when they are thirsty and eat foods that are prepared with the fluoridated water when they are hungry.

The cariostatic effects of dietary fluoride supplements have been proved unequivocally. In fact, caries protection has been profound when the dosage schedule has been followed precisely. There are still some questions that remain concerning the best use of dietary fluoride supplements. For example, what additional caries-protection is provided children whose mothers took dietary fluoride supplements during pregnancy? There is also some controversy on whether fluoride supplementation should begin at birth, a few weeks after birth or a few months after birth.

Unless the scientific knowledge that we do have about the value of dietary fluoride supplements is learned and applied by health care providers and unless the public is informed about their value, then the knowledge is solely academic. It is very important, therefore, to educate the public and the professions about their value. In order to educate these groups intelligently, we must know their current level of knowledge and ascertain their attitudes toward fluorides in general and, particularly, toward supplements.

Today we have assembled a distinguished panel of experts on the use of dietary fluoride supplements to review the scientific basis for their use, to discuss efforts that have been made to educate the public and the professions about them and to report on dentists' and physicians' attitudes, knowledge and practices with respect to dietary fluoride supplements.

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2. What we know and don't know about dietary fluoride supplements—the research basis

William S. Driscoll, DDS, MPH

EFFECTIVENESS AND INDICATIONS FOR USE

Although the degree of protection has varied considerably among studies, the administration of dietary fluoride supplements has been shown unequivocally to be an effective procedure for preventing dental caries. In what was probably the most comprehensive review of the subject in the past decade, a panel of scientists at the International Workshop on Fluorides and Dental Caries Reductions, held in Baltimore in 1974, concluded that conscientious use of fluoride supplements can provide protection against dental caries in the primary and permanent teeth that approaches the protection derived from consuming optimally fluoridated drinking water over a similar period of time.[1] A few studies, in fact, have reported benefits even greater than those generally expected from the consumption of fluoridated water.[2,3] It should not be inferred from these findings, however, that fluoride supplementation is an unqualified substitute for community water fluoridation, because the latter is far more economical and feasible for benefiting large numbers of children.

Prescribing fluoride supplements is facilitated if the concentration of natural fluoride in a child's drinking water is negligible. However, the procedure is still recommended for children who consume water with significant but suboptimal concentrations of natural fluoride, although appropriate downward adjustments in the dosage of the supplement must be made. If water fluoridation is implemented in a community, supplementation should be promptly discontinued for children who consume the water, to avoid the possibility of causing dental fluorosis in the developing teeth. Indirect evidence from studies conducted in optimally fluoridated areas suggests that additional caries-preventive benefits may accrue to children who receive professionally-administered topical fluoride treatments or who use fluoride mouthrinses in conjunction with fluoride supplements.[4-7] However, because there is no direct evidence demonstrating additive effects, and because of the increased cost, it may be best to limit this combined therapy to those children who are highly susceptible to caries attack despite the use of supplements.

Studies have shown that the concentration of fluoride in breast milk is very low, even when a mother consumes fluoridated drinking water.[8-10] Consequently, infants in fluoridated communities who are solely breast-fed should be provided fluoride supplements during that period. The prescribed dosage should be the same as that recommended for use by infants in areas having negligible amounts of fluoride in the water supply. Before prescribing dietary fluoride, however, it is important to establish clearly that the mother is not giving supplementary bottle feedings prepared with the fluoridated water, and that she is not giving drinking water to the infant between feedings. Determining whether these conditions exist is difficult when supplements are dispensed in public health programs, because close contact with the mother is frequently not maintained. Thus, it is probably unwise to recommend, in public health settings with fluoridated drinking water, that nursing mothers give fluoride supplements to their infants. In contrast, there is minimal risk in private practice, because physicians usually have good rapport with the mothers of newborns and can ascertain their breast feeding practices.

Fluoride supplements are commercially available in the form of drops, solutions, lozenges and tablets. Because clinical studies have not been published on the

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relative efficacy of these vehicles, selection of a particular form of supplement must be based primarily on the personal preferences of the practitioner and patient, taking into consideration the child's age and the relative costs of the various preparations. Drops are particularly convenient for use by infants because the fluoride can be dispensed directly into the child's mouth with a medicine dropper or drip bottle, or it can be added to certain foods, such as cereals and juices. A tablet or lozenge can also be used for infants, but they must be crushed in foods or dissolved in water, formula or juice, which is more time consuming for the parent. For older children, whose primary teeth have erupted, fluoride tablets are most commonly prescribed.

The type of preparation used is probably less critical than the manner in which it is used. In the past, fluoride supplements were frequently regarded primarily as systemic agents that imparted their protection prior to the eruption of the teeth. Thus, instructions were often given for the patient simply to swallow the supplement directly. That belief has been disproven by evidence from several studies which clearly showed that erupted teeth can derive a significant topical benefit from fluoride supplements, if the supplement is kept in contact with the teeth for a period of time before it is swallowed.[3,11-14] Accordingly, tablets and lozenges should be chewed, dissolved or sucked in the mouth and efforts should be made to swish the resulting salivary fluoride solution forcefully between the teeth before swallowing. Similarly, if a solution is used by children with erupted teeth, it should be swished thoroughly in the mouth before it is swallowed.

Dietary fluoride preparations may also be obtained as either neutral sodium fluoride or acidulated phosphate-fluoride. Although both of these agents can effectively prevent dental caries, only one study has been reported in which they have been directly compared.[13] In that study, the two supplements were administered as solutions and produced similar reductions in the incidence of dental decay. At the present time, the choice between neutral and acidulated preparations should be based upon their relative costs and taste preferences.

Dietary fluoride supplements are also available combined with vitamins. On the basis of several clinical studies, there is little question that fluoride-vitamin supplements are effective in reducing dental caries.[2,15-19] Their degree of effectiveness is similar to that produced by regular use of fluoride supplements without vitamins.[17] The determining factor in deciding whether a fluoride-vitamin combination should be prescribed is whether a clear need exists for a vitamin supplement. If vitamins are indicated, it is more convenient for the parent to give a combined supplement. Also, some parents may be highly motivated to give vitamins to children, and thus, combinations of fluoride with vitamins may enhance compliance. It should be kept in mind, however, that the need for fluoride usually continues well beyond the age at which vitamin supplementation is discontinued. This prolonged need for systemic fluorides should be emphasized to parents so that children are not deprived the benefits of long-term exposure to fluoride. Other factors to consider in prescribing fluoride-vitamin supplements are their added cost and the possibility that they may not be made in fluoride dosages required for different ages and levels of natural fluoride in drinking water.

DOSAGE FOR FLUORIDE SUPPLEMENTATION

The Council on Dental Therapeutics of the American Dental Association (ADA) recommends the following dosage schedule for fluoride supplementation:[20]

Age in Years	Concentration of Fluoride in Drinking Water (ppm)		
	Less than 0.3	0.3 to 0.7	Greater than 0.7
Birth to 2	0.25*	0	0
2 to 3	0.50	0.25	0
3 to 13	1.00	0.50	0

*mg F per day

The ADA schedule is easy to follow and accommodates both drops and 0.25, 0.5 and 1.0 mg fluoride tablets, all of which are available commercially. The schedule provides for convenient downward adjustments in dosage for children residing in areas that have significant, but suboptimal, concentrations of natural fluorides in their water supply (from 0.3 to 0.7 parts per million). Supplementation is not recommended, if the natural fluoride content of the water supply exceeds 0.7 ppm. Before a fluoride supplement is prescribed, it is essential to know the fluoride concentration of a child's drinking water supply, to avoid exposing the child to excessive amounts of fluoride that might lead to fluorosis in the developing dentition. It is usually possible to obtain this information by contacting the local water company or health department. If a child consumes water from a private well, it may be necessary to send a sample of the water to a laboratory at the local or state health department to have the fluoride concentration determined.

A dosage schedule almost identical to that of the ADA was adopted in 1979 by the American Academy of Pediatrics.[21] The only difference between the two schedules is that the Academy's schedule requires that supplementation be continued until age sixteen. The schedule endorsed by the Academy prior to 1979 specified a daily dosage of 0.5 mg of fluoride from birth to three years of age and 1 mg thereafter, for children residing in a community that had less than 0.5 ppm fluoride in its water supply.[22] That schedule was also frequently recommended by the manufacturers of fluoride supplements. Findings of dental fluorosis in a long-term clinical trial in which that dosage schedule was used, were a major factor in the Academy's decision to adopt the more conservative schedule endorsed by the ADA.[2] In that study, it was found that 67 percent of the participants who had consumed supplements daily from birth experienced dental fluorosis. Although the fluorosis was mainly very mild or mild, which is of little or no esthetic concern, a few of the children had unattractive, moderate fluorosis. The investigators felt that the amount of fluoride given particularly during the first two years of life was of borderline tolerance in terms of its potential for causing fluorosis. It should not be overlooked, however, that the study participants showed striking reductions in dental caries of about 80 percent at the end of the treatment period in both their primary and permanent dentitions.

The findings of several studies conducted in the mid-to-late 1970s indicated that many commercially available infant foods and formulas contained more than trace amounts of fluoride.[9,23-26] The amount of fluoride found in the products varied considerably, depending in most instances on the fluoride concentration of the water used by the manufacturers during processing. The findings prompted one group of investigators to recommend that fluoride supplements should not be given to formula-fed infants until six months of age, because they believed the amount of fluoride ingested from formula and supplements would be sufficient in many children to produce dental fluorosis.[25] Although their recommendation was controversial and not widely followed, their concerns could not be easily dismissed. Fortunately, the issue was largely resolved when the major manufacturers of infant formulas in the United States began to use water containing negligible concentrations of fluoride in the processing of those products.[27]

OPTIMAL PERIOD OF ADMINISTRATION

An important factor to consider in determining the best time to begin fluoride supplementation to achieve maximum caries protection is how fluoride exerts its cariostatic effect. As I mentioned earlier, fluoride supplements were previously thought of as being essentially systemic agents that imparted their protection prior to the eruption of teeth by converting enamel hydroxyapatite crystals to fluorapatite, which is more resistant to acid dissolution. Although this mechanism of action is still considered by many to be important, it is no longer recognized as the only way in which fluoride acts. It is currently believed that fluoride also acts posteruptively by eliciting a variety of antibacterial effects on caries-causing microorganisms, and by facilitating remineralization of incipient enamel lesions.[28]

The latter mechanism, remineralization of early demineralized areas, is currently considered to be a primary, if not the primary, means by which fluoride exerts its cariostatic effect. Demineralization occurs when an area of tooth enamel begins to lose minerals to the oral environment following exposure to bacterial acids. These early demineralized areas appear as white spots on the enamel. Remineralization takes place when calcium and phosphate ions present in the saliva become redeposited in the affected areas. This reparative process is greatly enhanced by the presence of fluoride. The newly-formed fluoride-containing crystals are thought to be more resistant to caries attack than the original enamel.

Because at least two of the mechanisms by which fluoride acts are entirely posteruptive phenomena, it is not surprising that some clinical studies have demonstrated significant caries-preventive benefits from only posteruptive exposure to fluoride supplements. The importance of fluoride exposure prior to tooth eruption, however, is less clear because it is difficult to separate benefits derived preeruptively from those derived from subsequent posteruptive exposure. There is also disagreement among researchers on specifically when during the preeruptive period fluoride should be introduced to impart maximum caries protection. Findings of some studies suggest that maximum benefits can be obtained if teeth are exposed to systemic fluoride only during the last stages of their development, that is, during preeruptive maturation.[29-31] However, other investigators believe that initial fluoride exposure during the late stages of tooth development can maximally benefit only the smooth surfaces of teeth, and that very early exposure is necessary to provide protection to pit and fissure surfaces.[32,33] This position is of particular interest because a number of investigators have maintained that the grooves and fossae in occlusal surfaces of teeth exposed regularly to systemic fluoride early in their development are shallower and

less sharply defined than they are in teeth deprived of early exposure to fluoride. An anatomic alteration of that nature clearly might render occlusal tooth surfaces less vulnerable to caries attack.

If exposure to fluoride from an early stage of tooth mineralization is necessary for maximum caries protection, then prenatal fluoride administration would likely be important for protecting the primary teeth of children, which have been shown to undergo significant mineralization during the prenatal period.[34] Conversely, if exposure is needed only during the later stages of mineralization for maximum protection, then prenatal fluoride administration might contribute little or nothing to the benefit achieved by starting supplementation at birth. Because mineralization of the permanent teeth before birth is limited to the cusp tips of first molars, there is little likelihood that they could benefit from prenatal exposure to fluoride.[35,36]

A mandate issued by the U.S. Food and Drug Administration (FDA) in 1966 prohibited manufacturers of fluoride supplements from making claims of efficacy for prenatal use of their products.[37] The FDA ruling was based solely on a lack of sufficient clinical data to demonstrate a beneficial effect; in no way did it question the safety of the procedure. Additional laboratory and clinical studies concerned with prenatal exposure to fluorides have been published subsequent to the FDA ruling, and the existing data on prenatal fluoride supplementation were discussed in detail at a symposium held in 1980 during the annual session of the American Dental Association. The proceedings of that symposium were published, and serve as an excellent reference on the subject.[38]

Taken collectively, the available data clearly suggest a possible prenatal effect in primary teeth. However, it is my belief that further proof of clinical effectiveness is needed before prenatal fluoride administration can be recommended as a sound caries-preventive measure. I hope such proof will be forthcoming because the procedure clearly would offer a simple and relatively inexpensive means of providing caries protection. Also, it would provide a unique opportunity to create in expectant mothers an early awareness of the importance of dental health. The need to clarify the role of prenatal fluoride administration is accentuated by the fact that the FDA ruling did not prohibit physicians and dentists from prescribing supplements for pregnant women. The resurgence of interest in prenatal fluoride supplementation in recent years has led many practitioners to prescribe supplements for prenatal use.

Numerous clinical studies have demonstrated that definite protection against caries can be attained when fluoride supplementation is begun at school-age and is given only on days of school attendance.[1,3,14] Caries reductions for permanent teeth in most of these studies have tended to range between 20 and 35 percent, after two or more years of fluoride administration. Although the level of protection is lower than that which occurs with full-time use from birth, the administration of fluoride supplements in school overcomes some of the practical disadvantages of home use. The degree of success with home use depends upon the level of cooperation that can be obtained from parents and children in following the consistent and continuous regimen required. Although individual families may be motivated to comply in a private practice setting, the demands of the home regimen tend to restrict its usefulness as a wide-scale measure for caries prevention. In contrast, a school-based program provides an organized setting in which the use of fluoride tablets can be supervised and controlled by classroom teachers. School fluoride tablet programs are simple to implement, take little time and are relatively inexpensive. Even this method of administration, however, faces increasing compliance problems as students become older and exert more independence.

Just as there is uncertainty about the optimal time to initiate fluoride supplementation, the length of time supplementation should be continued to assure optimal results is unclear. For example, the American Dental Association and the American Academy of Pediatrics differ in their recommendation on when supplementation should stop. Information on the retained benefits following the use of supplements for various periods would be helpful in answering the question. Some studies have addressed that issue, but their findings are equivocal: some provide evidence that most of the cariostatic benefit persists after long-term use of supplements, whereas others indicate that accrued benefits gradually diminish after supplementation is stopped.[39-44] Until more definitive information is available, consideration should be given to continuing fluoride supplementation beyond age thirteen or giving periodic topical applications of fluoride to children who seem to be caries-prone. A decision on when to stop supplementation for an individual child after age thirteen should be based on the professional judgment of a child's dentist.

SAFETY ASPECTS OF FLUORIDE SUPPLEMENTATION

Dosage schedules for fluoride supplementation were initially derived from estimates of the amount of fluoride ingested each day by children who lived in optimally fluoridated communities. Fluoride supplements differ from water fluoridation, however, because their use produces less frequent but higher plasma fluoride peaks. Consequently, it is uncertain whether fluoride supplementation and water fluoridation have the same propensity for causing dental fluorosis. Although a few studies have examined the relation between plasma fluoride concentration and fluorosis, more definitive information is needed to resolve the question.[45-48] Nevertheless, there have not been reports of dental fluorosis that can be attributed solely to the dosages currently recommended by the ADA and the American Academy of Pediatrics.

Fluoride supplementation will result in obvious dental fluorosis only if the procedure is misused. It is clearly contraindicated in communities with greater than 0.7ppm fluoride in their water supplies. Nevertheless, a nation-wide survey conducted in 1980 by Margolis and co-workers showed that 46.3 percent of physicians who treated children in large fluoridated cities and 70.7 percent of those in smaller fluoridated communities prescribed fluoride supplements.[49] The study focused on physicians rather than dentists because only a small percentage of U.S. children visit a dentist during the early years of tooth development. These disturbing findings strongly suggest a need to educate health professionals, particularly physicians, about appropriately prescribing fluoride supplements. Before any fluoride supplement is prescribed, it is absolutely essential to verify the fluoride concentration of a child's drinking water supply to determine whether supplements should be given at all, or whether the dosage should be adjusted downward. Anyone who prescribes fluoride supplements, of course, must be familiar with the currently recommended dosage schedule.

Although instances of accidental ingestion of toxic amounts of fluoride supplements are rare, precautions should always be taken to guard against such occurrences. No more than 120 mg of fluoride (264 mg of sodium fluoride), as recommended by the American Dental Association, should be dispensed at a time for home use. They should be dispensed in child-proof containers and stored in a safe place out of the reach of small children. The labels of containers should include appropriate cautionary statements and instructions for use should be easy to read and written in language that can be understood by parents.

The ADA recommendation on total amounts of fluoride for distribution at one time should also serve as a guide for limiting the amount of fluoride that is dispensed to classroom teachers in school programs, because many classrooms do not have provisions for locked storage. One hundred and twenty one-milligram tablets provide a week's supply for a classroom of twenty-four participating students. Teachers should be able to obtain additional tablets conveniently, as needed, from a central, secure storage area in the school. Administrators of school programs should make certain that participating children are not also receiving daily fluoride supplements from their private dentist or pediatrician. All local health practitioners and pharmacists should be informed of ongoing school programs.

Shortcomings on the use of dietary fluoride supplements should not discourage practitioners from prescribing them for their patients, when indicated. Patients have a right to expect that practitioners are knowledgeable and exercise due care when prescribing any medication, agent or procedure, and fluoride supplements are no exception. Used properly, dietary fluoride supplementation is a patently safe and highly effective measure for the prevention of dental caries.

REFERENCES

1. International workshop on fluorides and dental caries reductions, eds Forrester, D.J. and Schulz, E.M., Jr. Baltimore, Maryland: University of Maryland, 1974, p 99.
2. Aasenden, R. and Peebles, T.C.: Effects of fluoride supplementation from birth on human deciduous and permanent teeth. Arch Oral Biol, 19:321–326, April, 1974.
3. Stephen, K.W. and Campbell, D.: Caries reduction and cost benefit after 3 years of sucking fluoride tablets daily at school. Brit Dent J, 144:202–206, April, 1978.
4. Muhler, J.C.: The effectiveness of stannous fluoride on children residing in an optimal communal fluoride area. J Dent Child, 27:51–54, 1st Quar, 1960.
5. Horowitz, H.S. and Heifetz, S.B.: Evaluation of topical application of stannous fluoride to teeth of children born and reared in a fluoridated community: final report. J Dent Child, 36:65–71, September-October, 1969.
6. Radike, A.W. *et al.*: Clinical evaluation of stannous fluoride as an anticaries mouthrinse. JADA, 86:404–408, February, 1973.
7. Driscoll, W.S. *et al.*: Caries-preventive effects of daily and weekly fluoride mouthrinsing in a fluoridated community: final results after 30 months. JADA, 105:1010–1013, December, 1982.
8. Ericsson, Y.: Fluoride excretion in human saliva and milk. Caries Res, 3:159–166, 1969.
9. Tinanoff, N. and Mueller, B.: Fluoride content in milk and formula for infants. J Dent Child, 45:53–55, January-February, 1978.
10. Spak, C.J.; Hardell, L.I.; and DeChateau, P.: Fluoride in human milk. Acta Paediatr Scand, 72:699–701, September, 1983.
11. DePaola, P.F. and Lax, M.: The caries-inhibiting effect of acidulated phosphate-fluoride chewable tablets: A two-year double-blind study. JADA, 76:554–557, March, 1968.

12. Marthaler, T.M.: Caries-inhibiting effect of fluoride tablets. Helv Odont Acta, 13:1–13, April, 1969.
13. Aasenden, R.; DePaola, P.F.; and Brudevold, F.: Effects of daily rinsing and ingestion of fluoride solutions upon dental caries and enamel fluoride. Arch Oral Biol, 17:1705–1714, December, 1972.
14. Driscoll, W.S.; Heifetz, S.B.; and Korts, D.C.: Effect of chewable fluoride tablets on dental caries in school children: Results after six years of use. JADA, 97:820–824, November, 1978.
15. Hennon, D.K.; Stookey, G.K.; and Muhler, J.C.: The clinical anticariogenic effectiveness of supplementary fluoride-vitamin preparations. Results at the end of five and a half years. J Phar Ther Dent, 1:1–6, October, 1970.
16. Hamberg, L: Controlled trial of fluoride in vitamin drops for prevention of caries in children. Lancet, 1:441–442, February 27, 1971.
17. Hennon, D.K.; Stookey, G.K.; and Muhler, J.C.: Prophylaxis of dental caries: Relative effectiveness of chewable fluoride preparations with and without added vitamins. J Pediatrics, 80:1018–1021, June, 1972.,
18. Margolis, F.J. *et al.*: Fluoride: Ten-year prospective study of deciduous and permanent dentition. Amer J Dis Child, 129:794–800, July, 1975.
19. Hennon, D.K.; Stookey, G.K.; and Beiswanger, B.B.: Fluoride-vitamin supplements: effects on dental caries and fluorosis when used in areas with suboptimum fluoride in the water supply. JADA, 95:965–971, November, 1977.
20. Council on Dental Therapeutics: Fluoride compounds. In Accepted Dental Therapeutics, Chicago: Amer Dent Assoc, 1984, 40th ed, pp 395–420.
21. Committee on Nutrition, American Academy of Pediatrics: Fluoride supplementation: revised dosage schedule. Pediatrics, 63:150–152, January, 1979.
22. Committee on Nutrition, American Academy of Pediatrics: Fluoride as a nutrient. Pediatrics, 49:456–460, 1972.
23. Wiatrowski, E. *et al*: Dietary fluoride intake of infants. Pediatrics, 55:517–522, April, 1975.
24. Stamm, J.W. and Kuo, H.C.: Fluoride concentration in prepared infant foods. Presentation, Annual General Session, Amer Assoc Dent Res, Las Vegas, Nev., June 23–26, 1977.
25. Adair, S.M. and Wei, S.H.Y.: Supplemental fluoride recommendations for infants based on dietary fluoride intake. Caries Res, 12:76–82, 1978.
26. Singer, L. and Ophaug, R.: Total fluoride intake of infants. Pediatrics, 63:460–466, 1979.
27. Tinanoff, N.; Pinkerton, R.; and Ramanan, C.: Connecticut physician's role in preventing dental caries. Conn Med, 45:141–143, 1981.
28. Wefel, J.S.: Mechanisms of action of fluoride, in Pediatric Dentistry, eds Stewart, R.E. *et al*: St. Louis: C.V. Mosby Co., 1982, pp 772–779.
29. Grainger, R.M. and Coburn, C.I.: Dental caries of the first molars and the age of children when first consuming naturally fluoridated water. Canad J Pub Health, 46:347–354, September, 1955.
30. Klein, H.: Dental caries (DMF) experience in relocated children exposed to water containing fluorine. II. JADA, 33:1136–1141, September 1946.
31. Weaver, R.: Fluorine and dental caries. Further investigations on Tyneside and in Sunderland. Brit Dent J, 77:185–193, October 6, 1944.
32. Backer Dirks, O.; Houwink, B.; and Kwant, G.: Some special features of the caries preventive effect of water-fluoridation. Arch Oral Biol, 4(special supp.):187–192, August, 1961.
33. Marthaler, T.M.: Fluoride supplements for systemic effects in caries protection, in Continuing evaluation on the use of fluorides, eds Johansen, E. *et al.* Boulder: Westview Press, 1979, pp 33–59.
34. Kraus, B.S.: Calcification of the human deciduous teeth. JADA, 59:1128–1136, December, 1959.
35. Boller, R.J.: Fetal morphogenesis of the human dentition. J Dent Child, 31:67–97, 1964.
36. Christensen, G.J. and Kraus, B.S.: Initial calcification of the human permanent first molar. J Dent Res, 44:1338–1342, November-December, 1965.
37. Food and Drug Administration: Statements of general policy or interpretation, oral prenatal drugs containing fluorides for human use. Federal Register, October 20, 1966.
38. Proceedings of Symposium: Perspectives on the use of prenatal fluorides. J Dent Child, 48:101–133, March-April, 1981.
39. Driscoll, W.S.; Heifetz, S.B.; and Brunelle, J.A.: Caries-preventive effects of fluoride tablets in schoolchildren four years after discontinuation of treatment. JADA, 103:878–881, December, 1981.
40. Aasenden, R. and Peebles, T.C.: Effects of fluoride supplementation from birth on dental caries and fluorosis in teenage children. Arch Oral Biol, 23:111–115, 1978.
41. Binder, K.: Results of the fluorine tablet campaign in Vienna. Mitt Ost Sanit-Verwalt. 65:253–255, 1964. (Fluoride Abstracts 1963-1965, Vol. I, Sec 9B. Cincinnati, Ohio: Kettering Laboratory, Abstr No 75, p 9.)
42. Berner, L.; Fernex, E.; and Held, A.J.: Study of the anticarious effect of sodium fluoride tablets (Zymafluor). Results recorded in the course of 13 years of observation. Schweiz Mschr Zahnheilk, 77:528–539, June, 1967.
43. Girardi-Vogt, J.: Results of fluoridation in Darmstadt. Dissertation, Johann Wolfgang Goethe University, Frankfurt, Germany, 1968, 127 pp (Fluoride Abstracts 1966-1968, Vol I, Sec 9B. Cincinnati, Ohio: Kettering Laboratory, Abstr No 269, p 51).
44. Stolte, G.: Results of three years of caries prophylaxis by oral fluoride application in Solingen kindergartens. Zahnaerztl Mitt, 58:380–382, April, 1968.
45. Suttie, J.W.; Carlson, J.R.; and Faltin, E.C.: Effects of alternating periods of high and low fluoride ingestion on dairy cattle. J Dairy Science, 55:790–804, 1972.
46. Angmar-Mansson, B.; Ericsson, Y.; and Ekberg, O.: Plasma fluoride and enamel fluorosis. Calcif Tiss Res, 22:77–84, 1976.
47. Angmar-Mansson, B. and Whitford, G.M.: Plasma fluoride levels and enamel fluorosis in the rat. Caries Res, 16:334–339, 1982.
48. Angmar-Mansson, B. and Whitford, G.M.: Enamel fluorosis related to plasma F levels in the rat. Caries Res, 18:25–32, 1984.
49. Margolis, F.J. *et al*: Fluoride supplements for children. Am J Dis Child, 134:865–868, September, 1980.

3. Attitudes of dentists and physicians toward the use of dietary fluoride supplements

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Advances in caries prevention methods, over the past several decades, have been significant. Leverett, in a recent review of the changing prevalence of dental caries in this country, attributed the 32 percent decline over the past decade among children from age five to seventeen to communal water fluoridation and use of these waters in food processing.[1] There is little disagreement with these observations. Following community water fluoridation and dentifrices with fluoride, developments in other topical and systemic fluorides have ensured that adequate fluoride can be available irrespective of modality.

The value of the fluoride therapies, in conjunction with the other caries prevention measures has been demonstrated by studies conducted during the past two decades. The acceptance and use of these procedures in the health delivery system, however, have not been uniform.[2-5] Dietary fluoride supplements as a caries prevention method are available to patients by prescription from dentists and physicians, being recommended almost exclusively when the patient is not receiving adequate systemic fluoride from other sources. The primary foci of dietary fluoride supplements are in areas without community water fluoride for children up to at least age thirteen—when the third molar has calcified—and children without exposure to community water fluoride as infants—breast fed. Thus, to be appropriately prescribed, the physician or dentist must have a clear understanding of when to use dietary fluorides and must know the exposures of the patient to other fluoride. Because of the emphasis on infants (an age when few go to a dentist), this caries prevention method, more than others, is a responsibility of physicians as well as dentists.

Fluoride, to be appropriately prescribed, must be understood with respect to age-dosage relationships and content of other dietary sources such as drinking water and foodstuffs. Some questions arise as to the vigor of both physicians and dentists in providing supplementation as required in nonfluoridated locales. Accordingly, this paper reveals the results of a survey among dentists and physicians, nationwide, regarding knowledge of and attitudes toward dietary fluorides. Also, the prescription-writing patterns and self-perceived roles in use of dietary fluorides in caries prevention of each profession are examined.

RESEARCH DESIGN

Questionnaires were mailed to 4,000 dentists selected as a subsample of the entire population of dentists as listed with the American Dental Association, and 2,000 physicians who treat children. The analysis was based on a response rate of 75 percent among dentists, and 49 percent among physicians. The questionnaire mailed to dentists covered all caries preventive procedures used in dentistry, while that sent to physicians focused on dietary fluoride supplements, diet and nutrition counseling and oral health education. The methodology

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consisted of an initial mailing followed by a second mailing and a telephone call to nonrespondents.

RESULTS

Preventive orientation

Physicians and dentists have similar general attitudes toward caries prevention, eighty-eight percent of the dentists and 94 percent of the physicians agree that most caries lesions can be prevented using available techniques (Table 1). Over four-fifths (81 percent) of both professions believe that the public is not sufficiently aware of available methods of caries prevention. It is not clear whether they blame the public for any caries they have or whether they are pointing to the need of the professions to improve their education of the public.

Physicians and dentists vary somewhat in the effectiveness they perceive for specific procedures in this country: primarily reflecting their own involvement in the procedures. As seen in Table 2, the largest differences in perceived effectiveness (as measured by those indicating *very effective*) is for dietary fluorides and topical fluorides. Dentists give them similar levels of effectiveness (24 percent and 26 percent, respectively), while physicians are far more likely to consider dietary fluorides as very effective (37 percent vs 14 percent).

Another factor that may predispose a health professional's orientation toward dietary fluoride supplements is adequacy of community water fluoridation. As can be seen in Table 3, 75 percent-85 percent of both professions report that at least some of their child patients drink an adequate amount of fluoride. Thus, we are comparing two groups who are positive toward caries prevention and who provide care to at least some children who get fluoride through drinking water.

Prescription Patterns

More physicians prescribe dietary fluorides than do dentists, as seen in Table 4 (79 percent *vs* 60 percent). This very possibly reflects the larger number of children under age two in these physicians' practices. There are no practice characteristics of dentists associated with prescription. The only variable related to prescription by physicians is type of practice: pediatricians prescribe more than family practitioners.

Both professions were asked to indicate which of a list of criteria were used to evaluate a child's need for dietary fluoride supplements. As seen in Table 5, both

Table 1 ☐ Attitudes toward caries prevention.

	Percent agree	
	Dentists	Physicians
Using available techniques, it is possible to prevent the formation of most caries lesions.	88	94
The public is not sufficiently aware of available methods of caries prevention.	81	81

Table 2 ☐ Currently, what do you think is the effectiveness of each of the following procedures in preventing caries in children in this country?

	Percent *very effective*	
	Dentists	Physicians
Community water fluoridation	77	66
School water fluoridation	29	19
Topical fluorides	26	14
Dietary fluoride supplements	24	37
Fluoride dentifrices	16	10
Fluoride rinses	12	5

Table 3 ☐ How many of your child patients drink water with an adequate amount (approximately 1 ppm) of fluoride?

	Dentists	Physicians
All	20.2%	15.4%
Most	42.7%	37.9%
Some	19.9%	21.1%
None	12.5%	16.1%
Don't know	4.7%	9.5%
	100.0%	100.0%
	(2,583)	(924)

Table 4 ☐ Do you prescribe dietary fluoride supplements to your child patients?

	Dentists	Physicians
Yes	60.1%	79.4%
No	39.9%	20.6%
	100.0%	100.0%
	(2,564)	(934)

Table 5 ☐ Criteria considered when prescribing systemic fluorides.

	Percent Prescribing	
	Dentists	Physicians
Age of the child	96	96
Amount of fluoridated water consumed	93	91
Likely compliance of the patients and parents	74	61
Susceptibility of other family members to decay	72	36
Adequacy of the child's diet	59	47
Whether or not a child is breast-fed	--	55

Table 6 ☐ When do you think is the best time to start taking a dietary fluoride supplement?

	Percent	
	Dentists	Physicians
During the mother's pregnancy	46	23
At birth	26	48
1 to 5 months old	1	7
At 6 months old	22	20
1 to 3 years old	2	1
As needed	2	1
Never	2	1

Table 7 ☐ During what age-range do you usually discontinue prescribing dietary fluoride supplements?

	Dentists	Physicians
Newborn to 3 years	1.8%	12.7%
4 to 8 years	9.8%	22.2%
9 to 11 years	24.8%	28.9%
12 to 14 years	37.6%	25.4%
15 years or over	25.9%	10.8%
	100.0%	100.0%
	(1,435)	(693)

Table 8 ☐ If you do not prescribe dietary fluoride supplements to child patients, are any of the following reasons why?

	Dentists	Physicians
Other fluoride therapies are being used	82.3%	52.8%
Problems with patient compliance	36.4%	28.1%
Community water is fluoridated	91.6%	91.5%
Don't believe they are effective	12.9%	*

* Not applicable to physician questionnaire.

Table 9 ☐ Do you consider caries prevention activities, such as the prescription of dietary fluoride supplements, a primary concern of physicians, dentists or both for the following patients?

	Shown in percent							
	Dentists				Physicians			
	Physician	Dentist	Both	Neither	Physician	Dentist	Both	Neither
Pregnant women	34	7	47	12	36	8	45	12
Children under 2 years	25	19	52	4	53	4	42	1
Children 2 to 6 years	2	51	44	3	10	12	78	1
Children 7 to 18 years	1	69	24	6	4	30	62	3

physicians and dentists emphasize age of child and exposure to fluoridated water, while dentists place relatively more emphasis on genetics and compliance.

As seen in Table 6, when asked when they think is the best time to start taking a dietary fluoride supplement, physicians, more than dentists, indicate at birth (48 percent *vs* 26 percent) In contrast, dentists are more likely to indicate that during the mother's pregnancy is the best time (46 percent *vs* 23 percent). These results reflect two different schools of thought, with the more up-to-date point of view being represented by the physician.

Similarly, dentists, more than physicians, are likely to continue the use of dietary fluorides past the optimal age of effectiveness (calcification of the third molar). As seen in Table 7, 26 percent of the dentists indicate a discontinuation age of fifteen years or older, as compared to 11 percent of the physicians. Overall, the results indicate that too many of both professions are discontinuing the supplements too early or too late, if the prescription was appropriate initially.

Characteristics of dentists' practices are not associated with these prescription practices. In contrast, pediatricians, more recent graduates and physicians with more child patients indicate the appropriate prescription patterns more often than others, reflecting a greater awareness of recent research literature.

Both professions indicate that the primary reason for not prescribing dietary fluoride supplements is because the community water is fluoridated (92 percent). As seen in Table 8, dentists more than physicians indicate that they do not use supplements because they use other fluoride therapies (82 percent *vs* 53 percent). This would be expected, since dentists have other fluoride therapies available while physicians may not be generalizing to what the child is getting from the dentist. In fact, 81 percent of the dentists report that most of their child patients receive topical fluoride. The 13 percent of dentists who do not think dietary fluorides are effective might be noted.

Who is considered responsible for dietary fluoride supplements provides an interesting perspective on professional roles. As seen in Table 9, neither profession gives the other predominant responsibility. Rather, when they recognize the need for the other profession, they indicate that both should share responsibility. Thus, more dentists indicate that both physicians and dentists share responsibility for the pregnant women and the infant (whom they do not see) (47 percent and 52 percent, respectively), while indicating the dentist has primary responsibility for older children (51 percent and 69 percent). Similarly, more physicians take primary responsibility for the infant (53 percent), but indicate a shared responsibility for pregnant women (45 percent) and older children (78 percent and 63 percent).

SUMMARY AND CONCLUSIONS

One of the major goals of the reported research was to determine how consistent health practitioners' knowledge, attitudes and practices are with the consensus of the public health and research communities regarding caries prevention. Both professions are aware of current caries preventive methods, but have very mixed reactions toward their relative effectiveness in the United States, today.

Dentists and physicians see a great deal of value in community water fluoridation and see some effectiveness from fluoridating school water supplies. They regard the prescription of dietary fluoride supplements as an effective caries prevention measure, but to a much lesser extent, and base their use of these prescriptions on the age of the child and the level of fluoride in the community's water system. Topical fluoride applications and fluoride dentifrices, as well, are thought to be very effective preventive measures by only a small

proportion of dentists and physicians, as are fluoride mouth rinses.

Dentists and physicians rate systemic fluorides as effective more often than they do other selected methods, as would the research community; but they are not as solidly behind these, as evidence would suggest they should be. Both community water fluoridation and dietary fluoride supplements are known to be very effective caries prevention measures, yet only 66 percent of the physicians think community water fluoridation is very effective and only 37 percent think dietary fluoride supplements are very effective. Similarly, 77 percent of the dentists believe community water fluoridation and 24 percent of the dentists believe dietary supplements are very effective. It is possible, however, that these professionals are considering the extent of patient compliance with an available regimen when commenting on overall effectiveness. The physicians, as well as the dentists, tend to underrate fluoride therapies and overrate the contribution of other oral health procedures, e.g. brushing and flossing, for preventing caries, when considered against the consensus of the research and public health communities.

Approximately one-half (47 percent) of the physicians are in agreement with American Dental Association/American Medical Association recommendations regarding when to start dietary fluoride supplements. As is recommended, most physicians consider the age of the child and the level of fluoride in community water when prescribing fluorides. Seventy-five percent begin prescribing between birth and six months. They are less systematic in discontinuing the regimen. Over one-half of the physicians discontinue prescription between ages four and eleven based on these contingencies, which is not within the recommendations. Eleven percent of the physicians prescribe beyond the age of calcification of the third molar (age fourteen) which is probably of little value to the child.

In contrast, dentists have a broader orientation to fluorides, which appears to diminish their appreciation of dietary supplements. The most frequently used fluoride therapy is topical (80 percent), and 60 percent of the dentists reported prescribing dietary fluorides. The survey results show some inconsistencies between the use of dietary fluorides and the recommendations of the Association's Council on Dental Therapeutics. While research is inconclusive on the effect of prenatal fluoride therapies, 46 percent of the dentists think dietary fluorides should be started during a mother's pregnancy. Research suggests that dietary fluoride is beneficial at least until the third molar is calcified (approximately thirteen years) in areas where there is no community water fluoridation, yet 36 percent of the dentists reported that the appropriate time to discontinue fluoride supplements is before the age of twelve. Dentists in general, however, are sensitive to the fact that the age of the child and the level of community water fluoridation determine the need for dietary fluoride supplements.

Dentists are aware that the physician should participate in providing dietary fluoride supplements to children with unerupted teeth, with approximately 50 percent indicating that providing fluoride therapies for patients up to age two should be a shared responsibility between the dentist and physician. After teeth erupt at age two, however, the respondents think that a dentist should assume full responsibility.

Physicians consider themselves to be primarily responsible for the oral health of children with unerupted teeth and think they should share responsibility with the dentists for other age-groups. This appears to represent a realistic appreciation of how children enter the health care system.

In conclusion, it is clear that both professions can serve a distinct role in providing dietary fluoride supplements as a caries prevention method given current health care patterns of the public. It is also evident that more education needs to be directed toward both professions, to ensure appropriate provision of these supplements. Also, both of the professions need to be encouraged to understand and complement each other's role in this process, to ensure the best care for the child.

REFERENCES

1. Leverett, D.: Fluorides and the changing prevalence of dental caries. Science, 217:26–30, 1982.
2. Margolis, F.J. *et al*: Fluorides: Ten-year prospective study of deciduous and permanent dentition. Am J Dis Child, 129:794–800, 1975.
3. Driscoll, W.S.: Review of clinical research on prenatal fluorides. Perspectives on the use of prenatal fluorides: a symposium, 1980.
4. Tinanoff, N. *et al*: A protocol for fluoride therapy for Connecticut residents. J Conn State Dent Assoc, 52:14–17, 1978.
5. Siegel, C. and Gutgesell, M.E.: Fluoride supplementation in Harris County, Texas Am J Dis Child, 136:61–63, 1982.

4. Ways to improve/increase appropriate use of dietary fluorides

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When prescribed appropriately, dietary fluoride supplements are safe and effective in preventing dental caries, but they are not now being prescribed appropriately by health care providers.[1-11] Unfortunately, the American public still remains ill-informed about the importance of fluorides for oral health.[12-15] These factors have important implications for all children in the United States—both for those who live in communities without optimally-fluoridated water, who should receive caries protection in the form of fluoride drops or tablets, and for those who live in optimally fluoridated communities, who should not receive fluoride supplements because of the risk of fluorosis.

The failure of many health care providers to use fluoride supplements is an example of the slow rate of acceptance of an effective caries preventive regimen that has been available for decades. The inappropriate prescription of these supplements demonstrates continuing confusion on the part of prescribers. However, these problems are unique neither to prescribing dietary fluorides, nor to dentistry. This paper is a review of the efforts, to date, to educate and inform health care providers and the public about fluoride supplements; to discuss some of the barriers inhibiting their use; and to suggest strategies for enhancing their acceptance and appropriate usage.

CONTEMPORARY EFFORTS TO EDUCATE AND INFORM HEALTH CARE PROVIDERS AND THE PUBLIC

Industry

Dietary fluoride supplements have been available for nearly a quarter of a century, and they were first accepted by the Council on Dental Therapeutics, in 1958. Industry has contributed extensively to efforts which attempted to inform prescribers about fluoride supplements. Ever since these products have been available, manufacturers have placed advertisements about fluoride supplements in medical and dental journals; used detail persons to convey the message directly to the practitioner; provided product information cards and prescription blanks; and exhibited their products at scientific meetings. In addition, several industry-supported monographs on fluorides have included sections on supplements.[16-17] And, more recently, two films to educate the public about fluorides were produced.

Associations and foundations

For many years, the American Dental Association (ADA), through the Council on Dental Therapeutics, has published in *Accepted Dental Therapeutics* an overview of the pertinent scientific literature, appropriate fluoride dosage schedules, examples of correct prescriptions for fluoride supplements, and a list of products accepted by the Council.[18] In addition, the ADA has produced a leaflet for the public on fluoride that includes fluoride supplements and has published a variety of reports in their Journal. Moreover, the ADA has sponsored several scientific sessions on the subject.

The American Academy of Pediatrics, through their Committee on Nutrition, published their revised recommended dosage schedule and several related articles.[19-20]

The American Academy of Pediatric Dentistry endorses the ADA's dosage schedule of dietary fluoride supplements and has sponsored sessions on the subject

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at their scientific meetings and collaborated with industry to produce monographs that contain sections on fluoride supplements. [16-17]

The American Association for Dental Research (AADR) passed and published a policy statement recommending the use of dietary fluoride supplements in hopes of promoting its use.[21] In addition, the AADR has organized several symposia at their annual session that have included information on these supplements.

The National Foundation of Dentistry for the Handicapped published "A Guide to the Use of Fluorides" that contains comprehensive coverage of fluoride supplements. This publication was developed by a committee headed by Dr. Louis W. Ripa and was funded by the Robert Wood Johnson Foundation and the American Dental Association.[22]

Several years ago, Margolis and co-workers undertook a major educational endeavor directed at physicians that was supported by the W.K. Kellogg Foundation. This educational program consists of an audiotape for physicians containing information from nine experts; a film that parallels the tape for use in medical institutions and in medical meetings; a portfolio with slides and a variety of written information, as well as an exhibit which is sent to various professional meetings. The objective of the Margolis *et al* multiphasic approach is to make every physician dealing with children understand his or her role in prescribing fluoride supplements and to motivate them to promote the use of fluoride, just as they promote routine immunization for children.

Complementing these efforts, the National Institute of Dental Research (NIDR) staff have initiated a variety of activities to educate health care providers on the use of fluoride supplements and developing educational materials for providers to use in educating the public. In 1979, a film "Prescribing fluoride supplements in medical and dental practice" was produced to help teach health care providers the value of fluoride supplements; to give the correct dosage schedule; and to encourage the practice. Dosage schedules have been printed and are available for distribution when the film is shown. Posters and leaflets also are available for health care providers which can reinforce the message to the public. Two new films, developed to educate the public about fluorides, are available for the use of health care providers in their efforts to reach the public. The NIDR funded surveys of dentists' and physicians' attitudes and practices concerning fluoride supplements, which were conducted by the ADA in 1982.[5-6] In addition, the NIDR has supported several conferences on caries prevention, the content of which included the use of fluoride supplements. Despite the efforts of many organizations and individuals, problems with respect to the use of fluoride supplements still persist.

BARRIERS TO THE APPROPRIATE USE OF FLUORIDE SUPPLEMENTS

Before a discussion is presented, therefore, of additional ways to inform and educate health care providers and the public about the appropriate use of fluoride supplements, a brief consideration of some of the barriers associated with this problem may be in order.

Complexity of the dosage schedule

The recommended dosage schedule of dietary fluoride supplements depends upon the age of the child; the concentration of fluoride in the local drinking water; and, in the case of an infant, whether it is solely breast-fed or formula-fed; and if the latter, what kind of formula—ready to use, concentrated or powdered, and whether it is milk or soy-based.

Determining the concentration of fluoride in the drinking water of a patient may be as simple as calling the local water department or it may require obtaining an analysis of a water sample, if the water is from an independent source. Further, some communities use multiple sources of water, and, therefore, the concentration of fluoride may fluctuate greatly from day to day. These situations deter busy practitioners from prescribing dietary fluoride supplements, particularly practitioners who do not place high priority on this activity.

Although the American Academy of Pediatric's revised dosage schedule was published in January 1979, confusion about this change on the part of some prescribers, especially physicians, is likely. Moreover, at least two firms sell a vitamin-fluoride product that yields .5 mg fluoride. According to the recommended dosage schedule, these products should be used only in non-fluoridated communities for children between two and three years of age. These factors probably have contributed to inappropriate prescribing practices.

In contrast, some practitioners still believe that infant formulas contain enough fluoride and, therefore, do not prescribe supplements, despite the fact that manufacturers for several years have kept the fluoride content in formulas at trace levels.

Priority of preventive regimens in educational institutions

Little information is available about what schools of dentistry, medicine, dental hygiene, nursing, or pharmacy teach about the appropriate use of fluoride supplements. Probably, it is safe to state that they place little emphasis on this subject.

The relative lack of emphasis on preventing any disease rather than treating it, undoubtedly prevails in both dental and medical schools and may carry over into practice. In dental schools, the disproportionate amount of time allocated to restorative dentistry and prosthetics versus that time spent on preventing the need for these procedures is well known. The amount of time medical schools spend on preventing dental caries is undoubtedly even less. Thus, one barrier may be lack of emphasis placed on the appropriate use of fluorides by faculty teaching in undergraduate and graduate schools.

Economic factors

Prescribing fluoride supplements and educating parents and patients to understand the need for their use not only take time, but, generally, do not involve financial compensation. It may be unrealistic, furthermore, to expect that dental practitioners will try to reduce further the caries rates among their patients, if they perceive that there are or will be few lesions to restore.

Lack of public knowledge

Little is known about the public's knowledge of dietary fluoride supplements. Several studies, however, have shown that the public does not understand that fluorides effectively prevent caries, even though they benefit from their use. For example:

- ☐ In 1977, only 49 percent of a national sample of adults correctly identified the purpose of water fluoridation.[12]
- ☐ In three surveys of Minneapolis elementary school teachers between 1973 and 1981, "drinking fluoridated community water" was ranked in sixth place in 1973 and in seventh place in 1980 and 1981, out of eleven dental caries preventive methods listed.[13]
- ☐ In a 1981 survey of adults in Portland, Oregon, three forms of fluoride use—professional applications, water fluoridation, and fluoride supplements—were rated as least effective for preventing dental caries in a list of seven measures presented.[14]
- ☐ A 1983 survey of dental researchers, dental practitioners, and the general public found that dental researchers consider fluoride the most important factor in preventing caries, but that dental practitioners and the public rank oral hygiene above the specific use of fluoride.[15]

These studies illustrate the lack of public knowledge about fluorides—clearly, a barrier to their acceptance and appropriate use in the form of fluoride supplements. This factor is especially important because dentists and physicians report that the likely compliance by the patient (and parents) is part of the criteria considered, when prescribing fluoride drops or tablets.[11,21]

NEW AND EXTENDED STRATEGIES TO EDUCATE HEALTH CARE PROVIDERS

Several strategies for improving the prescription patterns of fluoride supplements are suggested, as follows. Although educational activities are emphasized, that emphasis can be directed not only to dental students and dentists, but to all relevant health care providers—physicians, dental hygienists, nurses, and pharmacists.

Health care providers in dental schools

Dental school faculty are the gatekeepers of information.[23] They are in a position to influence significantly the appropriate use of caries preventive measures, including dietary fluoride supplements. Dental school faculty have a responsibility, to both their students and the general public, to provide appropriate information about dietary fluoride supplements, as well as opportunities to practice prescription writing and ways of educating patients to use the supplements. Ideally, each dental school should have the equipment to test the fluoride content of water samples and should provide patients with the containers for the water samples. Dental students could then be taught how to obtain water samples and where they can be analyzed in their state. This information might be provided to the dental student during his or her first year of dental school so that the information can be applied throughout the four-year period (for both personal and patient use), and this information could be reinforced at appropriate intervals, such as during lectures in departments of pedodontics and community or preventive dentistry. Finally, curricula could emphasize this important topic by providing opportunities to practice the skills with

patients and their parents. For example, all pediatric patients could have a fluoride history taken as a routine part of their health history. Through this process, the dental student can determine the child's need for fluoride supplements, obtain the water sample when appropriate, educate the parent and older patient about the importance of fluoride in preventing tooth decay, and also can identify those children taking fluoride supplements who should not. These kinds of activities may encourage dental students to establish them, later, as routine and necessary procedures in their practices.

Moreover, because the information collected from the NIDR-ADA survey indicates that dentists consider the likelihood of compliance by patients and parents when prescribing fluoride supplements, emphasis should be placed on educating dental students on how to achieve compliance. Health providers should learn that compliance is not the sole responsibility of the patient, but that the prescriber plays a critical role in the process.[5-6]

Further, gravid women—whether they are mothers of patients in the children's clinic or patients in an adult clinic—should be informed of the need for fluoride supplements for the forthcoming infants.

Dental schools with departments of dental hygiene could provide similar educational experiences for those students. Although dental hygienists cannot prescribe fluoride supplements, they can help the dental practitioner identify patients who should receive supplements, as well as those that are receiving them but should not. Because dental hygienists play a significant role in educating the public about preventive measures, they should know the correct dosage schedule, as well as how to obtain compliance in its use. All dental hygiene students have this need, whether or not they receive their education in a dental school.

Dental school faculty may also have an opportunity to educate medical, pharmacy, and nursing students regarding fluoride supplements. For those schools which have access to other health care professional students, it is important for such dental faculty to make an effort to reach them with relevant information. Such opportunities for outreach activities should not be missed, particularly in the pediatric and obstetric departments of each school. Special attention might be focused on pediatric nurse practitioners.

Dental school administrators also can help institutionalize graduate programs which place appropriate emphasis on fluoride supplements and to make information on dietary fluoride supplements available, periodically, through continuing education courses.

Health care providers in pharmacy schools

Faculty in schools of pharmacy also could and should play gatekeeper roles by emphasizing the appropriate use of fluorides. Moreover, pharmacy schools could include the appropriateness of a fluoride prescription in their computer drug cross-checking program. Such computer programs can help, as well, to monitor patient compliance with the procedure. Pharmacies that have computer drug cross-checking programs should consider including dietary fluoride supplements. Dentistry can help to stimulate this activity among the practicing community of pharmacists through this and other relevant ways.

Licensure of health care providers

Licensure for all health care providers—dentists, physicians, dental hygienists, nurses, and pharmacists should include questions on prescribing fluoride supplements. Likewise, dental specialty board examinations of pedodontics and dental public health and medical specialties of pediatrics and primary care physicians should contain questions on the subject, as well. Without this emphasis, the unstated message is clear: "The subject is not important."

Industry

Industry might play an even stronger role than they now play in encouraging the appropriate use of fluoride supplements by educating their detail men and women in greater depth on the recommended dosage schedule and, also, by providing even clearer patient inserts. Detail persons could be very helpful, if they would advise a prescriber where in each state water samples can be analyzed. Moreover, industry also might consider supporting lectures on the appropriate use of fluoride supplements for faculty and students of schools of nursing and dental hygiene that are not a part of a medical/dental complex. Fluoride supplement advertisements might be placed, periodically, in journals of public health, such as the *Journal of the American Public Health Association* and the *Journal of Public Health Dentistry*, as well as in *Pediatric Nurse* and *American Dental Hygiene Association Journal*. Most of these advertisements are now confined to journals read by health care providers in private practice. Yet many patients who would benefit most live in rural areas, and many of these receive health care in public clinics from providers of public health care.

If industry advertised dietary fluoride supplements along with the correct dosage schedule in lay magazines, more parents might become aware of the need for fluoride supplements and ask their health care provider about them, thus, providing a "patient push." Further, those in the formula industry should consider placing the fluoride content on each container, with appropriate caveats about fluoride supplementation. Patient inserts for all fluoride supplements should contain similar information about formula.

Government

Working with the private sector, the NIDR is promoting its films and other educational aids, and hopes to reach schools of dentistry, medicine, pharmacy, nursing, and dental hygiene, as well as the general public.

Working within each state, it is possible to map the fluoride concentration of independent water sources, thus, making it more convenient for prescribers and patients to use supplements wisely. Such an activity might be jointly sponsored by State and Federal Governments.

All Federal agencies, in cooperation with state health departments, might join ranks to promote the appropriate use of fluoride supplements in Federally-sponsored care programs, such as the Indian Health Service; National Health Service Corps; Women, Infants, and Childrens' Food Supplement Program; Head Start; and migrant programs, as well as care programs of the Department of Defense and the Department of State. This educational effort could include both health care providers and the recipients of care.

Educating the public

According to a recent survey, the public's major source of oral health information is the dentist.[15] In another recent survey, 99 percent of the dentists reported that they educate their patients about oral health. Eighty-two percent of the respondents of this latter study indicated that they included information on fluorides.[11] Clearly, all types of health care providers must be well-informed, if they are to supply correct information.

Because many persons do not seek routine medical and dental care, other channels for informing them about fluoride supplements must be used. For example, health columns in magazines and newspapers, as well as radio (especially in rural areas) and television are but a few media examples that might effectively provide correct information on fluoride supplements.

Knowing how to prevent oral (or any other) disease is useless unless both providers of health care and the general public apply the information. Everyone should know what fluoride is; how it works; the methods of application, including dietary fluoride supplements; and their appropriate use. The appropriate use of dietary fluoride supplements is an excellent primary preventive measure, well-documented by research. Because education must be the foundation of any effort to prevent disease and promote health, the challenge is clear: we must educate all relevant groups. Obviously, dentists should be the experts in advocating dietary fluoride supplements. This need is greater than ever before, because of the public's growing interest in promoting health through disease prevention.

REFERENCES

1. Driscoll, W.S.: What We Know and Don't Know About Dietary Fluoride Supplements—The Research Basis. J Dent Child, 52:259–264, July-August, 1985.
2. Driscoll, W.S.: Dietary Fluoride Supplements. In: Pediatric Dental Medicine, eds. Forrester, D.J.; Wagner, M.L.; and Fleming, J. Philadelphia: Lea & Febiger, 1981, pp 312–319.
3. Aasenden, R. and Peebles, T.C.: Effects of fluoride supplementation from birth on human deciduous and permanent teeth. Arch Oral Biol, 19:321–326, 1974.
4. Margolis, F.J. *et al*: Fluoride: Ten-year prospective study of deciduous and permanent dentition. Am J Dis Child, 129:794–800, 1975.
5. Gift, H.C. and Hoerman, K.C.: Dentists' and physicians' attitudes toward and use of dietary fluoride supplements. J Dent Child, 52:265–268, July-August, 1985.
6. Gift, H.C.; Milton, B; and Walsh, V.: Physicians and caries prevention. JAMA, 252:1447–1448, 1984.
7. Margolis, F.J. *et al*: Fluoride supplements for children: A survey of physicians' prescription practices. Am J Dis Child, 134:865–868, 1980.
8. Siegel, C. and Gutgesell, M.: Fluoride supplementation in Harris County, Texas. Am J Dis Child, 136:61–63, 1982.
9. Pinkerton, R.E. *et al*: Resident physician performance in a continuing education format. JAMA, 244:2183–2185, 1980.
10. Levy, S.M. *et al*: Fluoride analyses of patient water supplies requested by North Carolina Health Professionals. Am J Pub Health, 74:1412–1414, 1984.
11. American Dental Association Health Foundation: Prevention in the dental office: results of a preventive dentistry survey. JADA, 108:809–817, 1984.
12. United States General Accounting Office: Reducing tooth decay—more emphasis on fluoridation needed. Pub. No. HRD-79-3. Washington, D.C. GPO, 1979.
13. Loupe, M.J. and Frazier, P.J.: Knowledge and attitudes of school teachers toward oral health programs and preventive dentistry. JADA, 107:229–234, 1983.
14. Isman, R.: Public views on fluoridation and other preventive dental practices. Comm Dent Oral Epidemiol, 11:217–223, 1983.
15. Opinion Research Corporation: Dental care: What people know. Surveying the "Knowledge Gap." Study conducted for the Mars Corp. 1983.
16. Moss, S.J. and Wei, S.H.Y. eds: Fluorides: An update for dental practice. New York: Medcom, Inc., 1976.
17. Wei, S.H.Y. ed: Pediatric dental care: An update for the dentist and for the pediatrician. New York: Medcom, Inc., 1978.

18. American Dental Association: Prescribed fluoride supplements. In: Accepted Dental Therapeutics, 40 ed. Chicago: Am Dent Assoc, 1984, pp 399–402.
19. Committee on Nutrition. American Academy of Pediatrics: Fluoride supplementation: Revised dosage schedule. Pediatrics, 63:150–152, 1979.
20. American Academy of Pediatrics: Pediatric nutrition handbook. Evanston: Am Acad Pediatr, 1979, pp 369–375.
21. American Association for Dental Research: Policy statement of the American Association for Dental Research—Dietary fluoride supplements. J Dent Res, 60:898, 1982.
22. National Fluorides Task Force of National Foundation of Dentistry for the Handicapped: A guide to the use of fluorides for the prevention of dental caries with alternative recommendations for patients with handicaps. Funded by the Robert Wood Johnson Foundation and the American Dental Association. Denver: National Foundation of Dentistry for the Handicapped, 1981.
23. Frazier, P.J.: Public health education and promotion for caries prevention: The role of dental schools. J Pub Health Dent, 43:28–42, Winter, 1983.

Observations of SnF_2-treated human enamel using scanning electron microscope

Fluoride

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Decreases in caries incidence following the use of stannous fluoride (SnF_2) as a component in dentifrices, in mouth rinses and as a concentrated topical agent have been documented.[1-4] At the present time, SnF_2 is seldom incorporated in dentifrices; but it is a frequently used topical agent for children and adults generally, and is also prescribed for dental prophylaxis in persons requiring or having had head and neck radiation therapy.

The surface morphology of both natural and preetched enamel has been studied after applying SnF_2, using the scanning electron microscope.[5-9] The products formed on enamel after topical SnF_2-applications have been characterized by using infrared internal reflection spectroscopy, ion probe analyses and x-ray photoelectron spectroscopy.[10-12] In the studies cited, the application times varied from 30 sec to one week, the concentrations of the SnF_2 solutions varied from 4 to 10 percent and they were applied to the enamel at either room temperature or at 37°C.[8-12] In addition, after the topical SnF_2 applications, the enamel specimens were washed in various solutions for various times, before analyzing the changes on the enamel surfaces. The step-by-step changes that occur on topically treated enamel are important, however, because the greatest

This study was done in the Department of Cariology, Periodontology and Preventive Dentistry and Department of Oral Structural Biology, Dental Institute, University of Zürich, Plattenstrasse 11, CH - 8028 Zürich, Switzerland.

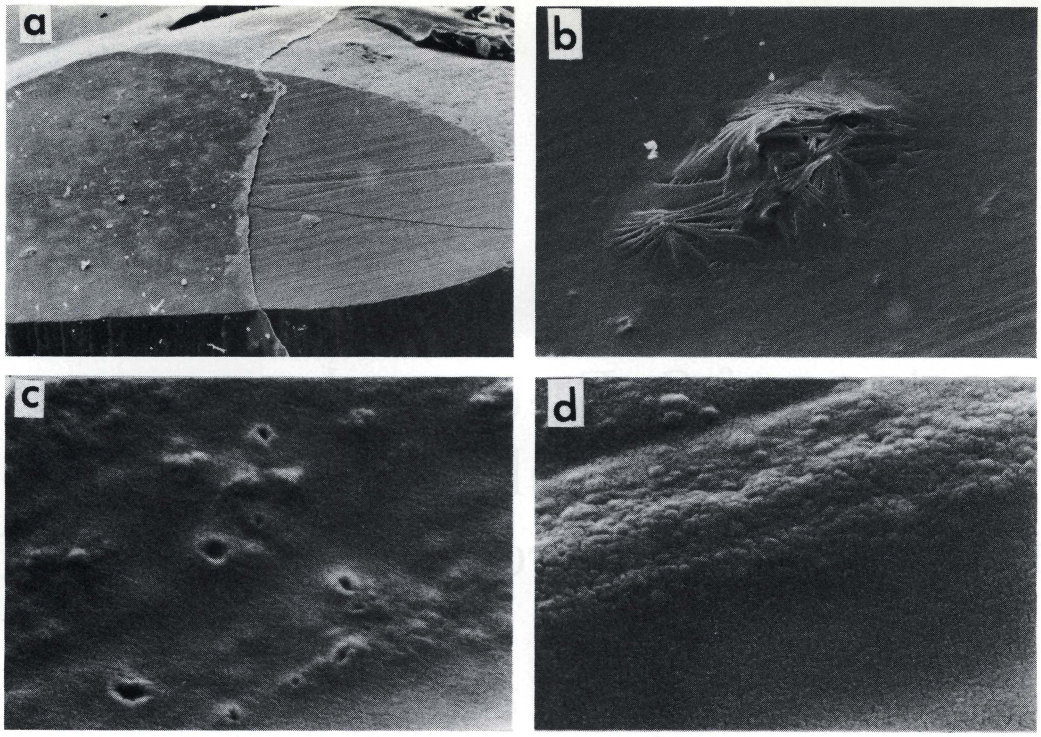

Figure 1. Appearance of flat, ground enamel specimens treated for 4 min in 8 percent aqueous SnF_2.
a) A distinct border is present between the treated surface to the left (covered by a precipitate) and the control surface to the right (with deep scratch). A distinct border was also present on the natural unground enamel (Mag. 30 × 0.54).
b) A group of crystalline structures within the predominantly amorphous appearing precipitate after immersion in the SnF_2 solution (pH 3.8) (Mag. 500× 0.54).
c) Detail of the amorphous nature and crazed appearance of the precipitate on the enamel surface treated with SnF_2 (pH 3.8). Volcano-like artifacts were probably due to vacuum conditions (Mag. 30,000 × 0.54).
d) Detail of the precipitate on enamel treated with SnF_2 (pH 2.3) showing accumulation of round globular structures within the crazed amorphous precipitate (Mag. 30,000 × 0.54).

loss of acquired fluoride (fluoride "on the enamel" as opposed to "in the enamel") takes place within the first twenty-four hours. Practitioners should be aware, therefore, of the possible morphological changes on the enamel surface, because these changes could influence the enamel clinically. This type of study is conveniently conducted, using extracted teeth.

The purpose of this study was to examine the changes of the micromorphology of flat ground human enamel surfaces after a 4 min application of an 8 percent aqueous SnF_2 solution. Subsequent changes of the surface morphology of the SnF_2-treated enamel surfaces were recorded after various washing periods in water.

MATERIALS AND METHODS

Flat enamel surfaces were prepared by grinding the crowns of extracted human third molar teeth with silicon carbide* discs (1'000 grit) in a water-cooled Buehler Automat 1900 AB*. The extracted teeth, collected from different sources in the USA, were stored in 0.1 percent thymol solution and were divided into buccal and lingual halves before use. Twenty extracted teeth were used, providing forty halved surfaces. After the grinding, any loose particles on the enamel surfaces were washed away using air and water under pressure. The specimens were then left to dry at room temperature. Part of the flat ground enamel surface on each specimen was covered with rubber cement**; and when dry, the specimens were chosen at random and immersed in groups of four for 4 min in freshly mixed 8 percent SnF_2 ≠ solutions (unagitated and nonbuffered) at room temperature. After immersion in the SnF_2 solution, the specimens were either a) air-dried without any washing or b) immersed in distilled water for either 5 sec, 5 min, 60 min or 24 h and then air-dried. There were eight specimens within each group and the immersion was carried out on two separate occasions: four specimens per group per day. The fluoride concentration of the topical solution used was 880 ppm F^- and the pH values of the solutions were 2.3 on the first occasion and 3.8 on the second, respectively. After drying, the rubber cement was removed to expose the control surfaces and the enamel specimens were gold coated (200 – 500A°) at 15 mA in a Balzer BA 109 ≠ ≠ shadow caster and examined in a Cambridge Stereo-

* Buehler Ltd, Evanston, IL, USA
** Sanford Corp., Bellwood, IL, USA
≠ Merck Labs, Darmstadt, West Germany
≠ ≠ Balzers, Liechtenstein
≠ ≠ ≠ Cambridge Instruments, Cambridge, U.K.

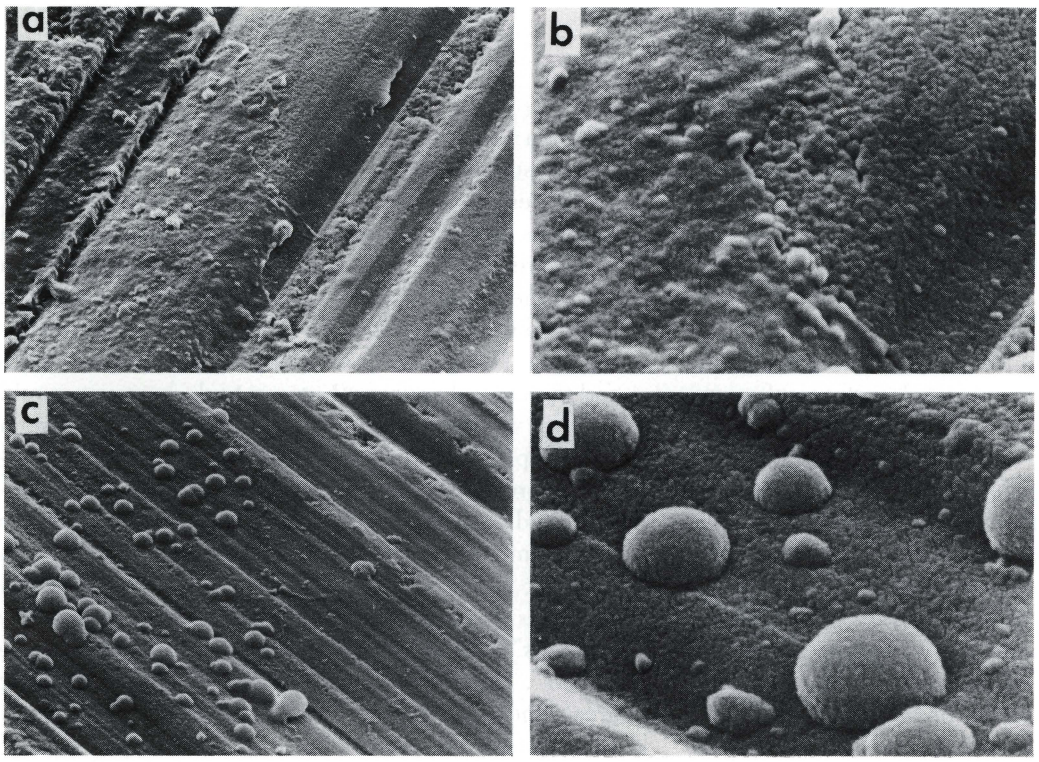

Figure 2. Appearance of flat, ground enamel specimens treated for 4 min in 8 percent aqueous SnF_2 and immersed for 5 sec in water.
a) A distinct border is present between the treated- (left) and control (right) surfaces after immersion in SnF_2 (pH 3.8). Round globular structures are present on and under the amorphous-appearing precipitate. Crystalline structures are also present on the precipitate. The control surface is finely granular, with distinct grooves (Mag. 10,000 × 0.54).
b) Detail of the crazed appearance of the amorphous precipitate (SnF_2, pH 3.8), either covering round structures or with these structures on the surface of the precipitate. The appearance of the ground enamel rods is seen on the control surface (Right; Mag. 30,000 × 0.54).
c) Indistinct border is seen between the enamel treated with SnF_2 (pH 2.3) to the left and the control surface to the right. On the treated surface, the approximate relationship between the numbers of round globular and the crystalline structures is seen. The finely granular control surface has deep grooves showing areas, particularly on the crests, where enamel was "ripped out" (Mag. 10,000 × 0.54).
d) Details of the variable-sized round globular structures at times indented in the treated enamel surface (Mag. 30,000 × 0.54).

scan 180$^{\perp\perp\perp}$ operating at 30 KV at magnifications between 30 and 30,000 ×. Photomicrographs were taken of unselected areas of the treated and control surfaces, making minor adjustments for photographic reasons only.

RESULTS

The resulting photomicrographs (Figures 1 - 5), represent the changes on the enamel surface. They were taken at original magnifications varying between 30 and 30,000 ×, and are here reduced by 0.54.

Specimens treated with SnF_2: not water-washed

All the specimens immersed in the SnF_2 solutions (Figure 1a) had precipitates on the ground surfaces, and a distinct border was present between the treated and control sides. The treated, unground, natural enamel surfaces also presented with precipitates and with distinct borders between the treated and control sides. At higher magnifications, groups of long finger-like crystalline structures (Figure 1b) were seen in the precipitate in isolated areas. Generally the precipitate had a crazed appearance at still higher magnification (Figure 1c), in which densely packed globular structures (Figures 1c, d) were seen. These were particularly noted in the specimens immersed in the SnF_2 solution at pH 2.3. Fewer numbers of globular structures appeared to be present on the enamel specimens that were immersed in the SnF_2 solution at pH 3.8. The volcano-

like vents (Figure 1c) were artifacts, probably caused during the vacuum conditions prevailing while coating the specimens with gold.

Washed specimens

Immersing the SnF_2-treated enamel specimens in distilled water produced a milky discoloration of the water.

The appearances of the enamel surfaces after immersion for 5 sec in water following the SnF_2-treatment are shown in Figures 2a - d. Precipitates were seen on the enamel specimens immersed in the SnF_2 solution at pH 3.8 and there were distinct borders between the treated and control surfaces (Figures 2a,b). The thickness of the precipitate on the treated surface appeared to be similar to that seen on the unwashed specimens. The precipitate had a crazed, amorphous appearance and covered round structures, giving a raised appearance to the precipitate, or round globular structures on the surface of the precipitate. In contrast, the enamel immersed in the SnF_2 solution at pH 2.3 had a precipitate that appeared different, consisting of round globular structures (Figures 2c,d) of various sizes, present either singularly or in groups. The border delineating the control and treated surfaces in this group was less distinct (Figure 2c). Isolated and grouped crystalline structures were present on all the enamel surfaces immersed in the SnF_2 solutions, but in fewer numbers numbers than the globular structures. The globular structures were indented in the surface enamel (Figure 2d). The control surfaces had a fine granular appearance with distinct grooves produced during the grinding process (Figures 2a,c); and at higher magnification (Figures. 2b,d), the enamel rods had either rounded or flattened ends. "Traumatized" areas are seen, particularly on the crests on the control surface (right, Figure 2c) where the enamel had been "ripped out" during the grinding.

The results of the specimens treated with SnF_2 at pH 3.8 and 2.3 and subsequently immersed for 5 min in water are shown in Figures 3a-d. Generally the surface appeared to be similar to those specimens that were immersed in water for 5 sec only. The longer exposure to the water appeared, however, to cause the crystalline (Figure 3a) and globular structures (Figure 3c) to cluster. The crystalline structures were present on the precipitate (Figure 3a) but when the precipitate was missing, the structures contacted the enamel or were indented in it (Figure 3b). The round, globular structures were also indented in the surface enamel and it was difficult in some specimens to differentiate between the abraded enamel rods of the treated and control surfaces (Figure 3d).

The results of the specimens treated with the SnF_2 solutions and immersed for 60 min in water are shown in Figures 4 a-f. There was no obvious precipitate on any of the treated enamel surfaces and distinct margins between the treated and the control surfaces were thus not seen. Differences between the treated (Figures 4a,b) and the control surfaces (Figures 4c,d), however, could be seen in several places. The enamel immersed in SnF_2 at pH 3.8 had a rough granular appearance, probably representing the enamel rods from which the isolated and coalesced globular and crystalline structures were removed (Figures 4a,b). The control surface, in contrast, had more distinct "grooves", produced by the abrasives (Figure 3c). The abraded enamel rods in the "troughs" had a flattened appearance; while on the "crests", the enamel rods had rounded ends showing areas where the enamel was damaged or "ripped out". Remnants of the enamel that had been ripped out appeared as smaller round globular structures on the surface (Figures 4a-d). The numbers of crystalline and globular structures seen on the treated surfaces were less on these specimens than on those washed for 5 min (Figure 3c). The "crests and troughs" were less obvious on the treated surfaces (Figure 4a) than on the control surfaces (Figure 4c). The enamel immersed in SnF_2 at pH 2.3 appeared to have more of the crystalline structures present on the treated surfaces than those specimens immersed in the SnF_2 at pH 3.8, although the numbers were reduced when compared to the specimens that were washed for 5 min (Figures 4e,f). The crystalline structures were composed of triangular-shaped parts grouped to form star-shaped clusters. Some of these star-shaped clusters were indented on the surface enamel (Figures 4e,f).

The results of the specimens treated with the SnF_2 solutions and immersed for 24 hours in water are shown in Figures 5a-f. There was no obvious precipitate on any of these enamel specimens. Consequently, distinct margins were not seen between the treated and the control surfaces; but differences between these surfaces were noted. The treated surface (SnF_2, pH 3.8 and 2.3) (Figure 5a) had a rough granular appearance compared to the less granular control surface (Figure 5c). The round globular and crystalline structures were rarely found on the treated surface. The roughened crests produced by the "ripping" out of the enamel during the grinding was less distinct on the treated surface (Figure 5a) compared to the control surface (Figure 5b). The "troughs" of the treated surface (Fig-

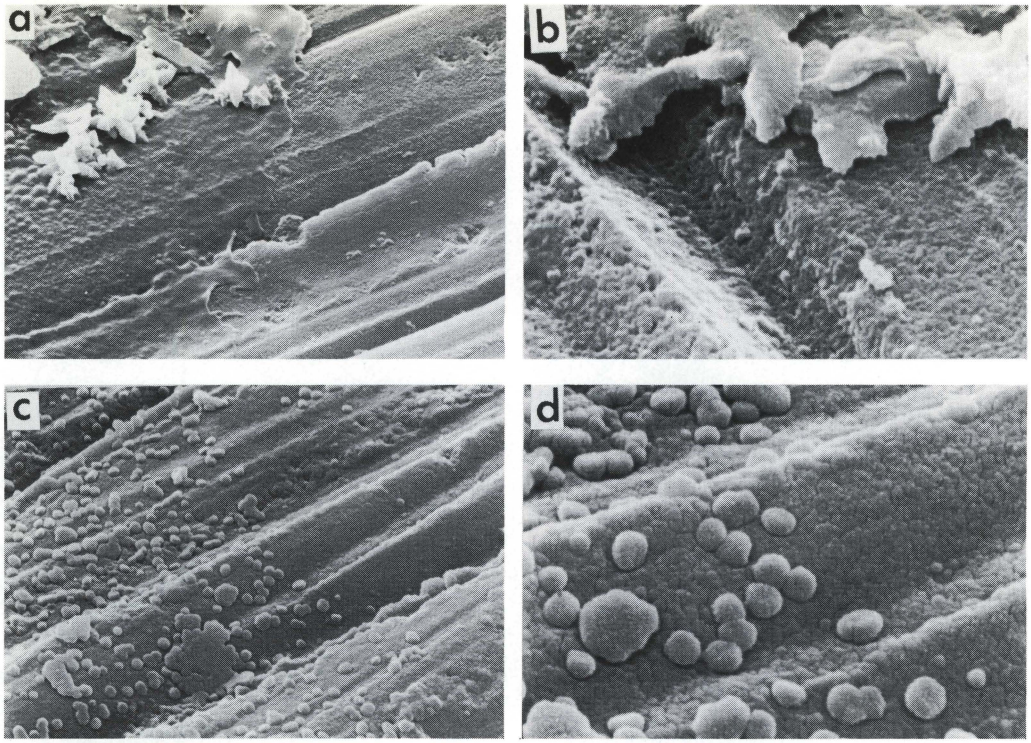

Figure 3. Appearance of a flat, ground enamel specimen treated for 4 min in 8 percent aqueous SnF_2 and immersed for 5 min in water.
a) A distinct border is present between the treated (left) and control surfaces (right) after immersion in SnF_2 (pH 3.8). Groups of crystalline structures were present on the precipitate; the latter covered the round, globular structures (Mag. 10,000 × 0.54).
b) Detail of the crystalline structure, adjacent to the border between the precipitate and the control surface of a specimen treated with SnF_2 (pH 3.8) (Mag. 30,000 × 0.54).
c) Detail of the border between enamel immersed in SnF_2 (pH 2.3) to the left and the control surface to the right showing single- and clustered round globular structures (Mag. 10,000 × 0.54).
d) Detail of the varying-sized round, globular structures on the enamel treated with SnF_2 (pH 2.3). The globular structures were either isolated or coalesced and were at times indented in the enamel. The flat abraded enamel rods of the control surface are seen and difficult to differentiate from those on the treated surface. (Mag. 30,000 × 0.54).

ure 5b) had rounded rod ends compared to the flattened rod ends of the control surface (Figure 5d). The enamel surfaces immersed in the SnF_2 at pH 2.3 were characterized by a granular surface with rounded enamel rod ends with varying degrees of granularity (Figures 5e,f). Isolated crystalline structures present on the treated surface are shown in Figures 5e and f.

DISCUSSION

In this study, the enamel specimens were not immersed in the same SnF_2 solution, but in two freshly mixed solutions, prepared on different days, several months apart. Variations in pH values of 4 percent SnF_2 solutions have previously been reported and vary from 1.8 to 3.2[9] The difference in pH values of the two SnF_2 solutions used in this study (pH 2.3 and 3.8) was an unintentional variable and possibly produced some interesting findings. Under the conditions of this study, globular, crystalline, and amorphous material was present on the ground enamel surfaces after the 4-min immersion in SnF_2. This is in agreement with the findings of Wei and Forbes (1974) who reported that $Sn_3F_3PO_4$ and CaF_2 formed on enamel after an initial enamel surface dissolution, because of the acidic pH of the SnF_2 solution. The chemical nature of the substances producing the milky appearance in the distilled water after immersion of the SnF_2-treated enamel specimens has not yet been elucidated and will be studied in the future.

Earlier SEM studies have reported that SnF_2 solutions (pH 3 to 7) produced no detectable deposit or precipitate on the surface enamel after a 5-min application.[13] Subsequently, Wei showed that the quantity of the reaction products on enamel increased with increasing exposure time.[8] After the 4-min application of SnF_2 only a roughened enamel surface was produced; but amorphous and crystalline structures were present after exposures to SnF_2, lasting for up to seven days. The crystalline material has been characterized and consisted mainly of $Sn_3F_3PO_4$, and it increased in amount with increased contact time of the enamel to SnF_2.[16] On acid-etched enamel surfaces, in contrast, refractile crystals were observed after 4- and 8-min ap-

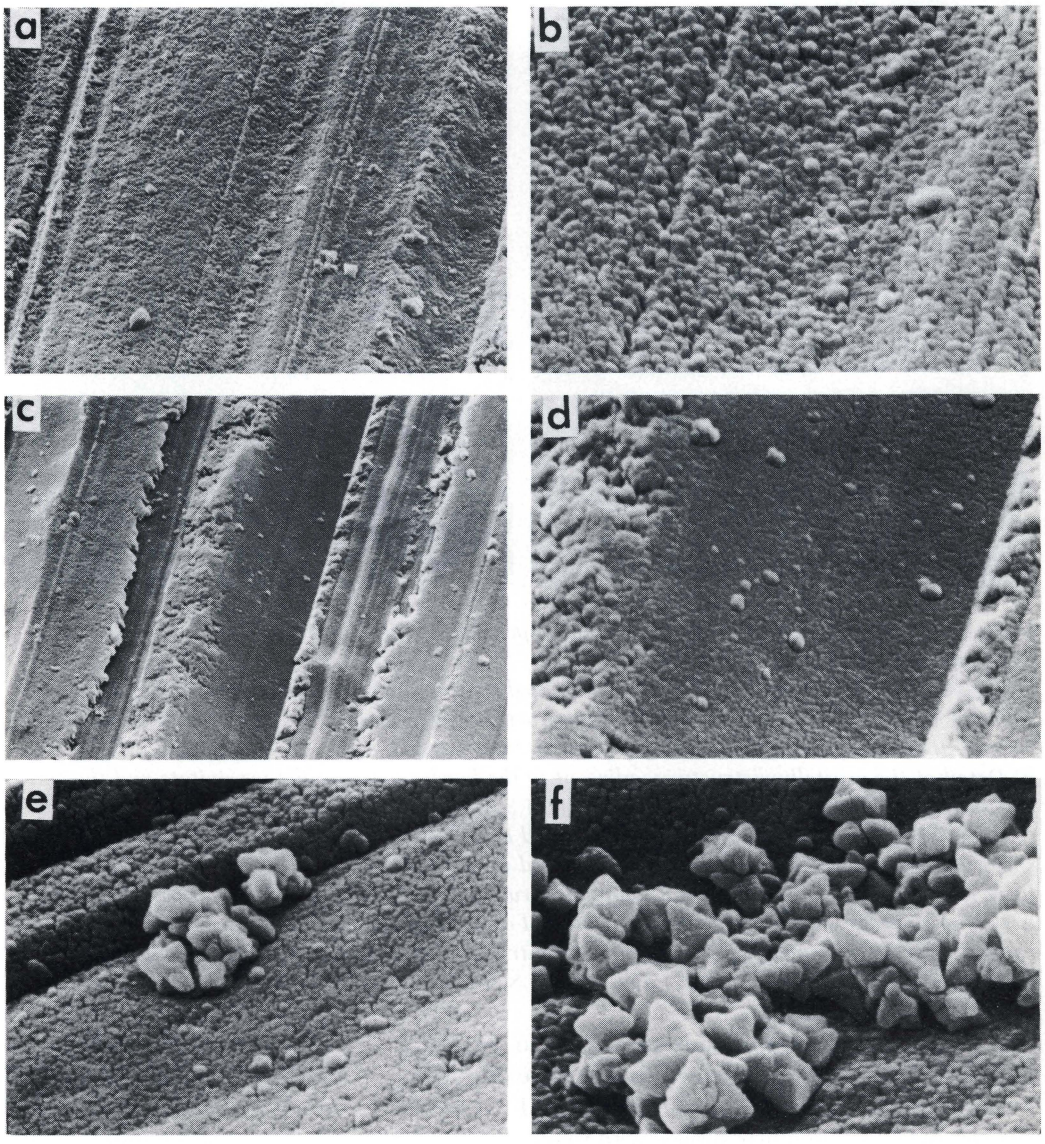

Figure 4. Appearance of flat, ground enamel specimen treated for 4 min in 8 percent aqueous SnF_2 and immersed for 60 min in water. Borders between the treated- and control surfaces were not clearly defined in the specimens treated with SnF_2 at either pH value.
a) The roughened granular appearance of the treated surface (SnF_2, pH 3.8) is shown and is practically devoid of the typical round globular and crystalline structures although some are seen. Troughs and crests produced by the grinding are less clearly defined than on the control surface (Figure 4c). (Mag. 10,000× 0.54).
b) Detail of the treated enamel surface shown in Figure 4a indicating rounded enamel rods of the granular surface (Mag. 30,000 × 0.54).
c) Control surface (corresponding to Figure 4a) showing the flattened, less granular surfaces of the troughs of the grooves produced by the grinding and the irregular crests from which the enamel has been "ripped out". The round structures on the surface are remnants of the enamel "ripped" out during the grinding (Mag. 10,000 × 0.54).
d) Detail of the control surface (corresponding to Fig. 4b) showing a less granular texture than that of the treated surface (Figure 4a). The enamel rods have a flattened appearance (Mag. 30,000 × 0.54).
e) Detail of an isolated group of crystalline structures composed of many triangular shaped crystals after immersion in SnF_2 (pH 2.3) (Mag. 30,000 × 0.54).
f) Detail of several groups of crystalline structures composed of many triangular shaped crystals after immersion in SnF_2 (pH 2.3) (Mag. 30,000 × 0.54).

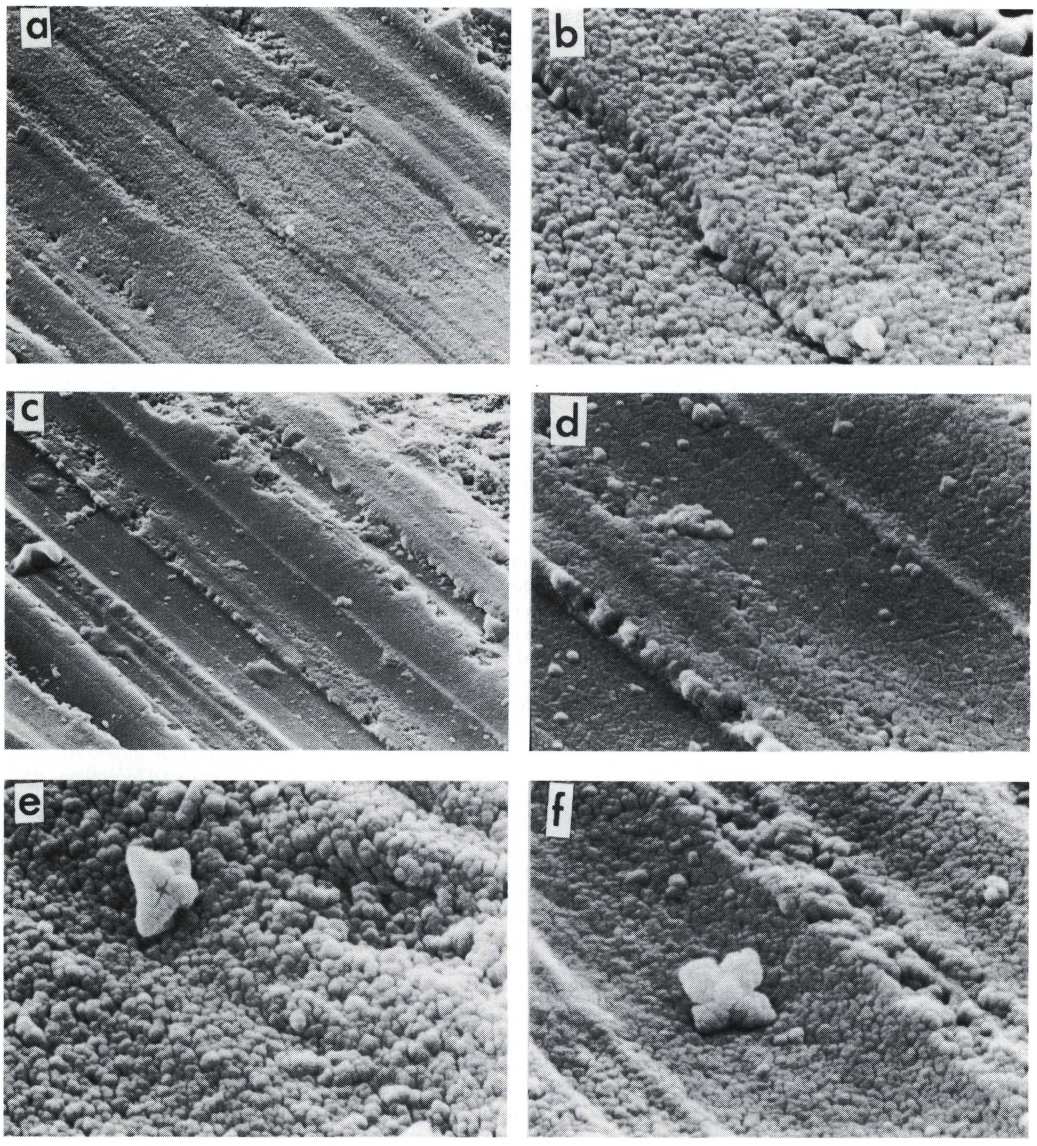

Figure 5. Appearance of flat, ground enamel specimens treated for 4 min in 8 percent SnF_2 and immersed for 24 h in water. Borders between the treated and control surfaces were not clearly defined in the specimens treated with the SnF_2 at either pH value.
a) The roughened granular appearance of the treated surface (SnF_2, pH 3.8) is shown and is practically devoid of the typical round, globular, and crystalline structures, although some are seen. Troughs and crests produced by the grinding are less clearly defined than on the control surface (Figure 5c). (Mag. 10,000 × 0.54).
b) Detail of the treated enamel surface shown in Figure 5a indicating rounded enamel rods of the granular surface. The typical rounded, globular and crystalline structures were practically absent (Mag. 30,000 × 0.54).
c) Control surface (corresponding to Figure 4a) showing the flattened, less granular surfaces of the troughs of the grooves produced by the grinding and the irregular crests from which the enamel has been "ripped" out. The round structures on the surface are remnants of the enamel "ripped" out during the grinding (Mag. 10,000 × 0.54).
d) Detail of a control surface (corresponding to Figure 5b) showing a less granular structure and the flattened enamel prisms compared to the treated surface (Figure 5b) (Mag. 30,000 × 0.54).
e) Detail of an isolated crystalline structure composed of triangular-shaped crystals after immersion in SnF_2 (pH 2.3) (Mag. 30,000 × 0.54).
f) Enamel surface treated with SnF_2 (pH 2.6) with a less densely packed granular structure than in Figure 5e and some crystalline material indented in the surface (Mag. 30,000 × 0.54).

plications of 10 percent SnF_2.[14] Wei (1975) also reported the presence of an amorphous material, which was difficult to resolve under high power, on pre-etched enamel after applying 10 percent SnF_2 for 4 min.[17] No surface changes, however, were seen in that study after a 2-min SnF_2 application on the pre-etched enamel. Dijkman *et al* (1983) described the presence of a thin layer of globular-shaped products on the enamel after a 5-min application of 4 percent SnF_2 (pH 2-6) and subsequent washing for 30 sec.[9] A thicker layer, however, was present when the application time was extended for 30 min. SnF_2 topically applied to enamel following an APF application produced a thicker precipitate on the enamel than when the APF was applied alone, and this precipitate was not removed during a 24 hour washing.[15]

One could speculate that in this study the ground enamel surface was more reactive to the acidic SnF_2 solutions than the natural enamel surface, but less reactive than a previously acid-etched enamel surface. Further, one could speculate that the crystalline and globular structures were primarily $Sn_3F_3PO_4$ and CaF_2, respectively. The indentation of the crystalline and the globular structures in the enamel surface suggests that these products were formed from components dissolved from the ground enamel surface. The nature of the amorphous material, present before the water-washing, also remains unresolved, but could have been composed of densely packed CaF_2 globular structures. The amorphous material was, however, no longer present after washing the treated specimens in water for 5 min and longer, but the globular and crystalline material remained on the treated abraded surfaces after washing for up to 60 min. After twenty-four hours of washing, all the above structures were removed from the enamel surfaces, but the treated surface differed in morphology from the corresponding control surfaces. These changes could be the result of the acid solution and the subsequent products which were deposited on the abraded enamel rods. Further, at low and high magnification, differences between the treated and control surfaces were seen. The former was more granular than the control surface. This was true because the enamel rods of the treated surface were probably changed morphologically, first by the grinding and then by the acidic SnF_2 solutions. On the control surfaces, the enamel rods were only changed by the grinding.

The importance of the various structures present on enamel, after immersion in SnF_2, on the caries process is not clear. Because these products can be removed by immersion in water, patients should be instructed not to rinse or eat for at least 30-60 min after a SnF_2 topical application, as is the case following other topical fluoridation agents. SnF_2 does reduce the solubility rate of enamel and these products could be, at least partially, involved in that process. A more detailed analysis with many more specimens is required to show the differences between the SnF_2 solutions at pH 2.3 and 3.8 on ground human enamel.

REFERENCES

1. Muhler, J.C. and Van Huysen, G.: Solubility of enamel protected by sodium fluoride and other compounds. J Dent Res, 26:119–127, April, 1947.
2. Volpe, R.A.: Dentifrices and mouthrinses. In: A Textbook of Preventive Dentistry, Stallard, R.E. 2nd ed., Philadelphia: W.B. Saunders Co. 1982, pp 170–216.
3. Shannon, I.L.: Water-free solutions of stannous fluoride and their incorporation into a gel for topical application. Caries Res, 3:339–347, May-June, 1969.
4. Dyer, J.R. and Shannon, I.L.: MFP versus stannous fluoride mouthrinses for prevention of decalcification in orthodontic patients. J Dent Child, 49:January-February, 1982.
5. Cooley, W.E.: Reactions of tin (II) and fluoride ions with etched enamel. J Dent Res, 40:1199–1210, November-December, 1961.
6. Gwinnett, A.J.; Buonocore, M.G.; and Sheykholeslam, Z.: Effect of fluoride on etched human and bovine tooth enamel surfaces as demonstrated by scanning electron microscopy. Arch Oral Biol, 17:271–278, February, 1972.
7. Wei, S.H.Y.: Effect of topical fluoride solutions on the enamel surface as studied by scanning electron microscopy. Caries Res, 9:445–458, November-December, 1975.
8. Wei, S.H.Y.: Scanning electron microscope study of stannous fluoride-treated enamel surfaces. J Dent Res, 53:57–63, January-February, 1974.
9. Dijkman, A.G.; Tak, J.; Smith, M.L. *et al*: Fluoride deposited by topical applications with stannous fluoride in human enamel. J Biol Buccale, 10:63–71, March, 1982.
10. Krutchkoff, D.J.; Jordan, T.H.; Wei, S.H.Y. *et al*: Surface characterization of the stannous fluoride- enamel interaction, Arch Oral Biol, 17:923–930, June, 1972.
11. Wei, S.H.Y. and Forbes, W.C.: Electron microprobe investigation of stannous fluoride reactions with dental enamel. J Dent Res, 53:51–56, January-February, 1974.
12. Hercules, D.M. and Craig, N.L.: Fluorine and tin uptake by enamel studied by X-ray photoelectron spectroscopy (ESCA). J Dent Res, 57:296–305, February, 1978.
13. Gray, J.A.; Schweizer, H.C.; Rosevear, F.B. *et al*: Electron microscopic observations of the differences in the effects of stannous fluoride and sodium fluoride on dental enamel. J Dent Res, 37:638–648, 1958.
14. Nordquist, W.D.; Krutchkoff, D.J.; and Wei, S.H.Y.: Influence of variable SnF_2 exposure time on in vitro $Sn_3F_3PO_4$ formation. Caries Res, 11:39–45, January-February, 1977.
15. Crall, J.J.; Silverstone, L.M.; Clarkson, B.H. *et al*: Fluoride uptake and in vitro caries-like lesion formation in enamel after two-step topical fluoride applications. Caries Res, 16:162–169, March-April, 1982.
16. Berndt, A.F.: Reaction of stannous fluoride with hydroxyapatite: the crystal structure of $Sn_3F_3PO_4$. J Dent Res, 51:53–57, January-February, 1972.
17. Wei, S.H.Y.: Effect of topical fluoride solutions on the enamel surface as studied by scanning electron microscopy. Caries Res, 9:445–458, November-December, 1975.

Effect of motivation on the oral health of French schoolchildren

Behavior

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Marie-Thérèse Le Cabellec
Bertrand Kerebel, DDS, DSc
Guy Daculsi

School-based plaque control programs have become a focus of the National Caries Program in Scandinavia and of the National Caries Program in the United States, in the past ten years.

Such programs have not yet been conducted in France. Moreover, except in Strasbourg (eastern France), where a school dental service was created at the beginning of the century, the oral health status of French schoolchildren is not regularly controlled; and the oral hygiene level is low, despite the efforts of local oral hygiene committees, which visit a number of schools annually, and provide oral hygiene instruction.[1,2]

In the fall of 1980, at the beginning of the school year, a controlled prevention program was started in two schools in the suburbs of Nantes (western France). The aim of the three-year investigation was to establish whether it would be possible to motivate a group of French schoolchildren to improve their oral hygiene, and to study the effect of improved oral hygiene in conjunction with the use of fluorides on the incidence of dental caries.[3] The purpose of this paper is to answer the first question and to emphasize the impact of motivation.

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MATERIALS AND METHODS

The study involved 244 children, aged eight years at baseline. Four co-educational elementary schools, located in the same geographical district Nantes, a provincial town in western France and with pupils of similar socio-economic backgrounds, were selected for the study. Two were used as experimental schools and two as control schools, in order to avoid a spillover effect on the control group.

The prevention program consisted of:

- ☐ One daily toothbrushing at school under the supervision of a dental student.
- ☐ Prophylactic treatment every two months.
- ☐ The use of high fluoride contents in the toothpaste (180 mg F^-) and in the gel applied to the teeth every two months (2 percent F^-).
- ☐ Reinforced motivation.

Before the start of the program, the parents of the children in the experimental schools received printed information on the dental health education program. They were also invited to a meeting in order to discuss the purpose of the trial. A series of color slides was used to demonstrate the role of microorganisms in the caries process, with special emphasis on the preclinical stage of carious tooth destruction.

The meeting was focused on the importance of oral hygiene, emphasizing the role of continuous parental support. The children also were invited to this meeting, where the members of the dental team presented themselves as friends willing to help and convince, not to force.

The dental team consisted of eight persons: two in charge of the general organization and motivation; two dentists who had complied with interrater and intrarater reliability tests; two chairside assistants; and two dental students acting as dental hygienists, a profession not yet recognized in France.

Just before the start of the program, the children in the experimental schools were given detailed instruction in toothbrushing. The children in the control schools did not receive instruction and no attempt was made to change their oral hygiene habits. Nor was an attempt made to change the dietary habits of either group.

A dental truck, equipped with two dental chairs, two seats for the chairside assistants, water supply and artificial light, was used for the study.

The dental truck visited the control schools only twice a year, at the beginning and at the end of the school year, to record the presence of plaque and caries. In the experimental schools, five oral hygiene sessions were performed during the school year.

Criteria for using the Silness-Loe plaque index and the def and DMF surface indices for recording dental caries, including incipient lesions, were those developed by Mühlemann.[4]

Oral hygiene sessions

The children, called in small groups, received a blue or a green ticket indicating the dentist who would examine them. They entered the truck two at a time. Since the intrarater and interrater reliability tests had proved to be satisfactory, the children at baseline were assigned randomly to one of the two examiners. Each child, however, was always examined by the same dentist, in order to ensure a motivational follow-up. The dentists, using dental mirrors, sharp explorers and artificial light, recorded the plaque index and, after cleaning and polishing the teeth with a fluoride paste, recorded the caries index. Each child received two toothbrushes and two tubes of toothpaste, one for home and one for school. After they left the truck, a 2 percent fluoride gel was applied for four minutes to all of their teeth.

Motivation

Reinforcement procedures were conducted on a continual basis.

- ☐ At school, every day, during the toothbrushing sessions, the dental student supervising toothbrushing gave repeated instruction on oral hygiene, on an individual basis. From time to time, dental plaque was demonstrated, using disclosing tablets. In addition, the children were advised to brush their teeth at home, mornings and evenings. No dietary counseling was given, but the children were repeatedly reminded that they should not eat anything in the evening, after the last toothbrushing.
- ☐ In the truck, during the oral hygiene sessions, the two dentists checked whether the caries lesions recorded in the course of the preceding session had been treated. They insisted that the children visit their private dentists for prompt treatment. The plaque score for each child was recorded by the dentist on the toothpaste box. From the score, as the children left the truck, the two persons in charge of gel application and motivation judged the degree of compliance and proceeded to reinforce the motivation of the children with high plaque index scores.

- ☐ Competition was encouraged throughout the year between the two experimental schools; and within each experimental school, between two teams (Blues and Greens), each supported by one of the two dentists. Competition was encouraged also on an individual basis. Children who obtained a low plaque index score, or at least a lower score compared with the preceding session, were given "good marks" and were warmly congratulated. Those who obtained high or higher plaque index scores were questioned to learn the reasons for their failure.
- ☐ Before every holiday, personal letters were sent to the children to remind them of their oral hygiene instruction. "Holiday for you, not for your toothbrush" was used as a slogan. Also, the children received memory ticklers to be pinned on their clothes when they undressed at night, so that it would be seen when they dressed in the morning. In the letters, the children were given their personal plaque index score and the results of the competitions between schools and teams. They were also reminded of the caries lesions recorded during the last oral hygiene session and of the need to have them treated by their personal dentist as soon as possible. Letters and drawings in answer to the dental team letters were not unusual.
- ☐ At the end of each school year, the parents were invited to an information meeting and were told how the prevention program was operating, the results already obtained and the results expected.

Statistical study

The statistical study was performed using an Apple IIe computer. The t-test was applied and, when necessary, adjustment of data was made to correct for the imbalance.

RESULTS

Table 1 shows age and sex distributions within the two groups. Table 2 shows tooth eruption rates. It is clear from those tables that although the control children were a little older, the respective proportions of primary and permanent teeth were similar at the start of the trial. At the end of the trial, however, a slight delay in tooth eruption was recorded in the experimental group.

Plaque index data

At the beginning of the study, the oral hygiene status of the children was poor. In the control group, the mean plaque index score was 1.17. Grades 2 (visible plaque) and 3 (thick deposits often extending far up the crown) were often recorded. In the experimental groups, the mean plaque index score was 0.93. Grades 2 and 3 were not unusual.

If we consider the general evolution curve of plaque index score, in both groups during the three-year trial, obtained by linear adjustment (Figure), it is clear that no change occurred in the control group with respect to oral hygiene habits: The mean score recorded at the last examination was practically the same as the one recorded at baseline, with similar results in grades 2 and 3. The inclination of the curve before linear adjustment points out, however, the influence of a long summer vacation on dental care. Obviously, a holiday for children meant a holiday for their toothbrushes also.

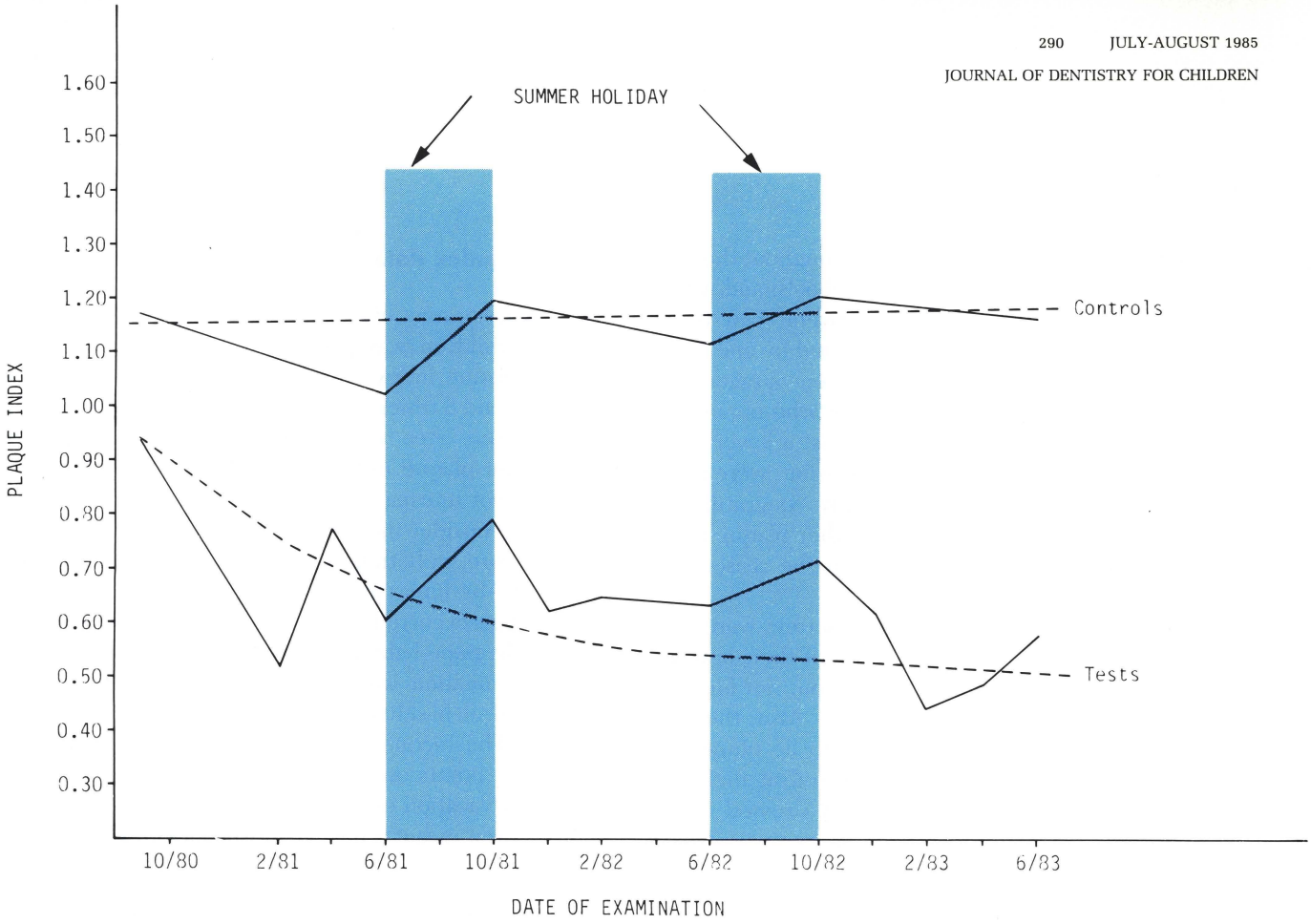
The evolution curve of the plaque index in the experimental group, obtained by linear adjustment, shows a statistically significant decrease, from 0.93 at baseline to 0.57 at the last examination. Again, the influence of the summer holiday is clear. Due to reinforcement of motivation beforehand, however, the improvement obtained in oral hygiene habits was never questioned and the variations of plaque index score during the three-year experiment are relative to an already decreased value obtained immediately following the start of the study. A final significant 52 percent plaque reduction

Table 1 ☐ Distribution of study population by age and sex.

Age		
	Control	Experimental
	96.3 ± 7.5	94.7 ± 8.2
Sex		
	Control	Experimental
Boys	61%	53.1%
Girls	39%	46.9%

Table 2 ☐ Tooth-eruption rate.

Primary teeth			
	Control	Experimental	Difference (Exp./Control)
10/80	55.2	56.6	+ 3% p> 20%
06/83	24.0	30.0	+25% p> 3%
Permanent teeth			
	Control	Experimental	Difference (Exp./Control)
10/80	43.7	42.4	− 3% p> 20%
06/83	59.2	53.8	− 9% p> 20%
Nonerupted teeth			
	Control	Experimental	Difference (Exp./Control)
10/80	26.1	25.2	− 3% p> 20%
06/83	19.3	19.0	− 2% p> 20%



was obtained at the end of the three-year trial. Table 3 shows plaque index distribution according to sex. In both groups the girls' scores were always better than the boys'.

Care index

In our study, care index—the ratio of F to DMF, expressed as a percentage—was a useful measure of the success of motivation. At the close of the experiment, this ratio was 44 percent ($p<0.01$ percent) higher in the experimental group compared with the control group with respect to primary teeth, and 31 percent ($p< 1$ percent) higher with respect to permanent teeth.

DMFS and defs indices

Table 4 shows the evolution of the caries index during the three-year trial, taking into account incipient lesions.

DISCUSSION

The present study is unique in France with respect to the combination of preventive measures and reinforced motivation. Although attempts were made to obtain support from the parents during the trial, their low level of interest was revealed by the difficulty in getting them to attend the information meetings. Koch, in his most interesting trial conducted among schoolchildren in Malmo, was faced with the same problem.[5] It was clear from the beginning, therefore, that the success of the experiment would depend upon the relationship

Table 3 ☐ Plaque index according to sex.

	Total		Boys		Girls	
	Control	Experimental	Control	Experimental	Control	Experimental
10/80	1.17	0.93	1.28	1.02	1.06	0.84
06/81	1.03	0.61	1.14	0.73	0.92	0.49
10/81	1.20	0.78	1.32	0.85	1.08	0.73
06/82	1.12	0.63	1.15	0.78	1.12	0.48
10/82	1.20	0.71	1.29	0.95	1.14	0.47
06/83	1.16	0.57	1.20	0.70	1.12	0.44

Table 4 ☐ DMF and defs.

		Control	Experimental
Primary teeth	10/80	9.28 ± 7.08	7.12 ± 6.14
	06/83	6.93 ± 7.04	5.00 ± 4.94
Permanent teeth (all included)	10/80	5.39 ± 3.38	4.94 ± 3.26
	06/83	9.72 ± 5.28	6.37 ± 3.31
Permanent teeth (new teeth excluded)	10/80	6.72 ± 3.72	5.65 ± 3.55
	06/83	8.43 ± 4.46	6.07 ± 3.33
New teeth (teeth erupted during the trial)	10/80	0.13 ± 0.54	0.01 ± 0.30
	06/83	1.30 ± 1.85	0.29 ± 0.92

between the dental team and the children. The role played by the enthusiasm of the dental personnel in the success of prevention programs, such as the Karlstadt program, has been emphasized.[6,7]

At the start of the trial, the oral hygiene status of the children was very low. Plaque index was around 1, which indicates that toothbrushing was not regularly or correctly performed.

The unexpected difference recorded at baseline examination between the control and the experimental groups could be accounted for later:

- ☐ It appeared that, following the annual visit of the local Oral Hygiene Committee, the headmasters of the two experimental schools had tried to keep the children concerned with their dental health, the importance of which was discussed at school regularly. No information at all had been offered in the two control schools.
- ☐ Since the backbone of the study was the daily supervised toothbrushing at school, only day boarders were selected for the study. It so happened that the children in the control group were a little older, which explained their somewhat advanced tooth-eruption rate, compared with the experimental group. Also, the numbers of boys and girls were not equal, which explained the correlated imbalance in the initial oral hygiene status. It is well known that girls are more concerned with their appearance than boys, and therefore brush their teeth significantly more often.[8,9] In our study, the fact that the number of girls was higher in the experimental group made the motivation process easier.

The results of a number of instructional-motivational programs for caries prevention have been often disappointing.[10-13] In a summary of the methods and means of motivation, Bay emphasized the necessity of active participation by the children in the program.[14] It is difficult to maintain a child's interest in an activity for sustained periods. In the present study, there were two major difficulties:

- ☐ To keep the children motivated throughout the year. During the long summer holiday, there was always an increase in plaque index scores, both in the control and the experimental groups. Horowitz *et al*, who obtained a similar significant plaque reduction in their experimental group, reported that it was not maintained during summer vacation.[15,16]
- ☐ To alleviate the boredom likely to develop in the course of the three-year trial. Koch noticed that the children's oral hygiene had worsened during the last part of the experimental year.[5] Thanks to the efforts of the dental team and to the intimate relationships established with the children by means of individual letters and personal motivation, the plaque reduction obtained at the end of the trial was similar to that reported in Scandinavian studies.[6,17] The project may be considered notably successful, considering the poor oral hygiene status and the lack of motivation at the start of the trial. The increase in the care index, furthermore, provides the best token of dental awareness obtained through motivation.

The degree of caries reduction can be measured by referring to an evaluation of the dental health status of schoolchildren, aged six to fourteen years, conducted in the East of France.[18] At the beginning of the trial, the children in our study had a caries index a little higher than the age-matched children in Dimbert's study, which can be explained by the fact that incipient lesions were counted in our study. The caries index obtained at the end of our trial, however, was almost decreased by half compared with that of the age-matched children in the reference study.

In conclusion, the results of the present study emphasized the essential role played by reinforced individual motivation in the success of dental prevention programs.

REFERENCES

1. Cahen, P.M.; Balleroy, J.L.; Nanopoulos, F. *et al*: Etude épidémiologique de la carie dentaire dans la population scolaire de Strasbourg. J Biol Buccale, 2:133–151, 1975.
2. Jung, M.T.; Cahen, P.M.; and Frank, R. M.: Etude épidémilogique de la carie dentaire chez les enfants d'âge préscolaire de Strasbourg. J Biol Buccale, 3:95–106, 1975.
3. Kerebel, L. M.; Le Cabellec, M.T.; Daculsi, G.*et al*: Report on caries reduction in French schoolchildren 3 years after the introduction of a preventive program. Community Dent Oral Epidemiol (in press).
4. Mühlemann, H. R.: Introduction to oral preventive medicine. Berlin: Buch-und Zeitschriften-Verlag "Die Quintessenz", 1976, pp 75–83.
5. Koch, G.: Effect of sodium fluoride in dentifrice and mouthwash on incidence of dental caries in schoolchildren. Odontol Revy, 18:7–125, 1967.
6. Axelsson, P. and Lindhe, J.: The effect of a preventive program on dental plaque, gingivitis and caries in schoolchildren. Results after one and two years. J Clin Periodontol, 1:126–132, 1974.
7. Badersten, A.; Egelberg, J.; Koch, G.: Effect of monthly prophylaxis on caries and gingivitis in schoolchildren. Commun Dent Oral Epidemiol, 3:1–4, 1975.

8. Ainamo, J. and Parviainen, K.: Occurrence of plaque, gingivitis and caries as related to self-reported frequency of toothbrushing in fluoride areas in Finland. Community Dent Oral Epidemiol, 7:142–145, 1979.
9. Honkala, E.; Rajala, M.; and Rimpel, M.: Oral hygiene habits among adolescents in Finland. Community Dent Oral Epidemiol, 9:61–68, 1981.
10. Albino, J.E.; Juliano, D.B.; and Slakter, M.J.: Effects of an instructional-motivational program on plaque and gingivitis in adolescents. J Public Health Dent, 37:280–289, 1977.
11. McKee, D.P.; Faine, R.; and Murphy, R.F.: The effectiveness of a dental health education program in a nonfluoridated community. J Public Health Dent, 37:290–299, 1977.
12. Heloe, L.A. and Konig, K.G.: Oral hygiene and educational programs for caries prevention. Caries Res, 12:83–93, 1978.
13. Truin, G. J.; Plasschaert, A.J.M.; Konig, K.G. *et al*: Dental caries in 5-, 7-, 9- and 11-year-old schoolchildren during a 9-year dental health campaign in The Hague. Community Dent Oral Epidemiol, 9:55–60, 1981.
14. Bay, I.: Methods and means in motivation. In: Frandsen: Oral Hygiene. Copenhagen: Munksgaard, 1972, pp 89–103.
15. Horowitz, A.M.; Suomi, J.D.; Peterson, J.K. *et al*: Effects of supervised daily dental plaque removal by children: 24 months' results. J Public Health Dent, 37:180–188, 1977.
16. Horowitz, A.M; Suomi, J.D.; Peterson, J.K. *et al*: Effects of supervised daily dental plaque removal by children: results after third and final year. J Dent Res, 56A:85, 1977.
17. Hamp, S.E.; Lindhe, J.; Fornell, J. *et al*: Effect of a field program based on systematic plaque control on caries and gingivitis in schoolchildren after 3 years. Community Dent Oral Epidemiol, 6:17–23, 1978.
18. Dimbert, B.: Enquête épidémiologique de santé bucco-dentaire en milieu scolaire dans le territoire de Belfort. Rev Odontostomatol,8:115–126, 1979.

USE OF SILENCE

Silence is an extremely effective listening tool. People usually find silence during an interaction to be somewhat unpleasant and will often begin speaking to avoid an "awkward" period of silence. By permitting silence to continue, patients can often be encouraged to provide more information. The practitioner should be certain to give the patient adequate time to formulate his thoughts and avoid the common tendency to jump in quickly and fill silences with additional questions or comments of his or her own. Interviewers, themselves uncomfortable with silence, will sometimes ask another question before the first one is answered completely, thus losing important information they might have gained had they allowed the silence to continue for a short period of time.

Geboy, M.J.: Communication and behavior management in dentistry.
Baltimore: Williams and Wilkins, 1985, p 31.

Hand-over-mouth behavior management technique in a solo pedodontic practice: A study

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The hand-over-mouth technique (HOM) is widely accepted as an effective and positive method of managing difficult behavior problems in children. Approximately 90 percent of pedodontic diplomates surveyed indicated use of HOM in selected cases, that is, for children exhibiting temper tantrums, aggression, resistance or hysteria, and especially for younger children (age two to six years).[1] Almost 90 percent of postdoctoral educational programs surveyed included the teaching of the technique. Alternative methods of child management include physical restraint, and the use of sedative drugs and general anesthesia. The major therapeutic objective of HOM is to prevent avoidance responses to the dental situation so that the child learns the disruptive avoidance response will not succeed, is inappropriate, and that the anxiety provoking stimuli are actually far less noxious than imagined.[2] This paper described the frequency of the use of HOM in a modern one-dentist pedodontic practice and its relationship to the patient's age, sex, previous dental experience and history of a significant medical experience.

The relationship between chronologic age and the acceptance of dental treatment has been reported. Gotthardson *et al* found that three-year-old children refused treatment three to four times more than four- and five-year-old children.[3] Klorman *et al* found that, in general, dental anxiety and disruptiveness were negatively related to the child's age.[4] Green *et al* studied children ranging in age from two to six years of age and found older children were significantly more cooperative than younger ones.[5] Taylor *et al* reported a trend that younger children, aged three to six years, demonstrated a wider range of behavior during the initial appointment. More extremely uncooperative behavior and more extremely cooperative behavior occurred in younger age-groups. Older children behaved better during injections. There were no significant differences between three-to-six-year-old children and the seven-to-nine-year-old children during operative procedures.[6] Herbett and Innes found, however, that in a group of children five to eleven years old, uncooperative behavior was at a maximum in ages eight and nine years.[7]

Published research generally confirms clinical observations that the sex of the child does not have a significant effect on cooperative behavior in younger children. In the study by Taylor *et al*, however, males exhibited less negative behavior than females in the seven-to-nine-year and the ten-to-thirteen-year groups.[6]

Medical experiences can be a significant source of uncooperative behavior in the dental setting. The num-

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ber or frequency of prior experiences does not appear as critical as their emotional quality.[8] Children with a history of positive medical experiences were found to be more likely to behave in a positive manner than those who had unpleasant medical experiences, including trauma or physical pain, or who have a history of surgical significance.[9-12]

Once a child has experienced the first dental visit, many preappointment predictors of dental behavior lose their significance.[13] On the other hand, if the previous experience was unfavorable, it may have considerable significance.[14,15] Lautch reported a study of thirty-four adults with dental phobia; that is, a special kind of fear out of proportion to the demands of the situation, which would not respond to reason and resulted in avoidance of necessary dental treatment. All thirty-four members of the phobic group had suffered what they considered a traumatic experience at the hands of the dentist on at least one occasion during childhood. Ten of the thirty-four in the control group had a similar experience. Four of the thirty-four in the phobic group avoided dentists until adulthood. Of the remaining thirty, all had a second traumatic dental experience. Twenty-one in the phobic group with a first traumatic experience were between the ages of six and ten.[16]

PROCEDURES

The subjects of the study consisted of all patients seen in a modern one-dentist pedodontic practice during a fifty-eight month period. Clientele in the practice consisted mainly of white middle-class children. A total of 1773 patients consisted of 1009 (57 percent) males and 764 (43 percent) females. The age range of the population was one to nineteen years; the mean was 7.64 years. Patients were seen for a total of 10,576 appointments.

Patient records were examined to determine the number of children who received HOM. The medical/dental histories were examined to determine the number who had had a dental experience, a bad dental experience, or a significant medical experience. The child was considered to have had a significant medical experience if the parent checked "yes" to the question "Has your child ever been hospitalized?" or provided additional information that would indicate an unpleasant experience. Examples include the placement of sutures, injections for allergies and treatment of broken limbs.

The records of the patients who had received HOM were further examined to determine how old the child was when HOM was received, the number of appointments when HOM was used and whether management medication or general anesthesia was utilized. These records were also examined to determine at which appointment HOM was used and the number of appointments without HOM, following the HOM experience.

The purpose and technique of HOM were similar to that advocated by Levitas.[17] Its purpose was "to gain the attention of the (hysterical) child so that he can listen to what is being said and receive the dental care he needs."

Every effort short of HOM was attempted before its administration. It was used only on normal children who were thought to be sufficiently mature and able to express themselves orally. It was never used in anger.

The technique involved placing the hand over the mouth and speaking softly in the ear, giving instructions that, first, the hands must be placed in the lap. Experience has show that when children take this first step, they become cooperative more quickly. Also, if they become hysterical again, reminding them to keep the hands in the lap is often all that is necessary to regain cooperation. Secondly, the child is told that when the crying stops, the hand will be removed. As the crying stops, the hand is removed and the child is praised for his good behavior. On some occasions, the procedure was repeated until a desired response was achieved. The objective was to stop the hysterical crying, establish communication, gain cooperation, continue the dental procedure and help the child gain confidence in his ability to deal with the dental situation.

RESULTS

The number of patients who were treated with HOM was 172 or 9.7 percent of the population while the total number of HOM episodes was 193, less than 2 percent of the total number of appointments.

Age and sex

As can be seen from Table 1, patients from thirty-six to forty-seven months old most commonly received HOM. They accounted for 57 percent of all cases of HOM. They were, however, only 8.1 percent of the population studied. Eighty-seven percent of the patients receiving HOM were four years old or younger.

Table 1 also shows that female patients (55 percent) received HOM more frequently than males (45 percent). This is particularly revealing, since the ratio of

males to females in the total population was 57 percent male and 43 percent female.

Previous experience

The records were examined further to determine whether the child had experienced previous dental treatment, had had a bad dental experience, or had had a previous significant medical experience. These results for the total population and the HOM group are shown in Table 2.

A test for differences between two proportions was applied to the data in Table 2 and no significant differences were found between non-HOM and HOM groups.

HOM experience

Of the group who received HOM, the majority (153 or 89 percent) received it on a single occasion. Of these 153, thirteen received HOM at their last appointment and consequently did not have the opportunity to receive HOM again. Seventeen children (10 percent) received HOM on two occasions and two children (1 percent) received HOM on three occasions.

Subsequent appointments

Of the patients who received HOM on only a single occasion, twenty-nine had one positive appointment after receiving HOM and 111 had two or more positive appointments following the HOM experience.

Twelve of the nineteen patients who had multiple HOM episodes had two or more positive appointments following their last HOM experience while four of the nineteen had one positive appointment following HOM.

Type of appointment

One hundred and eight (63 percent) of the children who received HOM had it administered at an examination appointment. Of these children, sixty-nine (40 percent)received HOM at the initial examination and only on that occasion. Fifty-eight (34 percent) children received HOM at treatment appointments and the remaining six (3 percent) children received HOM at examination and treatment appointments.

Of the children who received treatment appointments, approximately 50 percent were treated with pharmacotherapeutic agents (nitrous oxide/oxygen and/or chloral hydrate) or general anesthesia. This is in contrast to approximately 20 percent of the non-HOM population.

Table 1 ☐ Total number of males and females receiving HOM by age.

Age in months	Male N(%)	Female N(%)	M&F (total by age-group) N(%)
23-35	5 (3)	12 (7)	17 (10)
36-47	41 (24)	56 (33)	97 (57)
48-59	19 (11)	16 (9)	35 (20)
60-71	7 (4)	5 (3)	12 (7)
72+	6 (3)	5 (3)	11 (6)
Total	78 (45)	94 (55)	172 (100)

Table 2 ☐ Number of subjects with prior experiences by HOM or non-HOM-patient population.

	non-HOM		HOM group	
	N	%	N	%
Previous dental experience	872	54.5	90	52.3
Previous bad dental experience	151	9.4	22	12.8
Previous significant medical experience	542	33.8	49	28.5

DISCUSSION

Although approximately 90 percent of pedodontic diplomates use HOM in selected cases it has not been reported how often the procedure is used.[1] The authors' search of the literature found no reports relative to this issue. In this study of a single-dentist modern pedodontic practice, HOM was used for almost 10 percent of the population studied. It was used in less than 2 percent of the total number of dental appointments.

The results of this study confirm previously published reports and indicate that younger children exhibit more uncooperative behavior; it appears inversely proportional to age. This is especially true for the three-year-old children. Although they comprised only 8.1 percent of the population studied, they accounted for 57 percent of all cases receiving HOM.

Although published research generally confirms clinical observations that the sex of the child does not have a significant effect on the cooperative behavior of younger children, the results of this study indicate that female patients, especially those who are three years old, are more uncooperative. This is similar to the findings of Taylor *et al* who reported males demonstrated less negative behavior than females in the seven-to-nine-year and ten-to-thirteen-year age-groups.[6]

Nothing significant was found relating the use of HOM to previous experiences, bad dental experiences or significant medical experiences. The history form used in

the study, however, did not provide information regarding the emotional quality of the experiences.

It is noteworthy that in the majority of cases (89 percent), HOM was used on a single occasion and that the incident was followed by appointments of a positive nature. It is also noteworthy that 63 percent of the HOM cases received HOM at examination appointments and nearly two thirds of these children received HOM at the initial examination appointment and only on that occasion.

Conclusions drawn from this study must be considered in light of the following factors:

- ☐ The current study was limited to a single dentist and should be replicated using multiple offices as the data source.
- ☐ The patient population in this case consisted of middle-to-upper-middle-class children and should be replicated in other socioeconomic groups.

This study does confirm, however, the use of HOM as a safe and effective method of controlling highly uncooperative children. Negative consequences do not occur from its application and it helps to establish positive communication between the child and dentist. Finally, the initially disruptive patient receives the long-term benefit of having pleasant dental treatment rather than continued problems leading to dental phobic reactions.

REFERENCES

1. Association of Pedodontic Diplomates: Survey of attitudes and practices in behavior management. Pediatric Dent, 3:246–250, March, 1981.
2. Davis, M.J. and Rombom, H.M.: Survey of the utilization of and rationale for hand-over-the-mouth (HOM) and restraint in postdoctoral pedodontic education. Pediatric Dent, 1:87–90, June, 1979.
3. Gotthardsson, E.; Holmquist, H.; Holmquist, K. *et al*: Behandling av forkskolebarn. Sverig Tandlak-Forb Tidn, 62:221–229, 1970.
4. Klorman, R.; Michael, R.; Hilpert, P. *et al:* A further assessment of predictors of the child's behavior in dental treatment. J Dent Res, 58:2338–2342, December, 1979.
5. Green, R.V.; Meilman, P.; Routh, D.K. *et al*: Preparing the preschool child for a visit to the dentist. J Dent, 5:231–236, 1977.
6. Taylor, M.H.; Moyer, I.N.; and Peterson, D.S.: Effect of appointment time, age, and gender on children's behavior in a dental setting. J Dent Child, 50:107–110, March-April, 1983.
7. Herbertt, R.M. and Innes, J.M.: Familiarization and preparatory information in the reduction of anxiety in child dental patients. J Dent Child, 46:319–323, July-August, 1979.
8. Wright, G.Z.: Behavior management in dentistry for children. Philadelphia: W.B. Saunders Co., 1975.
9. Wright, G.Z. and Alpern, G.D.: Variables influencing children's cooperative behavior at the first dental visit. J Dent Child, 38:124–128, March-April, 1971.
10. Wright, G.Z.; Alpern, G.D.; and Leake, J.L.: A cross-validation of the variables affecting children's cooperative behavior. J Canad Dent Assoc, 39:268–273, April, 1973.
11. Bailey, P.M.; Talbot, M.; and Taylor, P.P.: A comparison of maternal anxiety with anxiety levels manifested in the child patient. J Dent Child, 40:277–284, July-August, 1973.
12. Martin, R.B.; Shaw, M.A.; and Taylor, R.P.: The influence of prior surgical experience on the child's behavior at the initial dental visit. J Dent Child, 44:443–447, November-December, 1977.
13. Koenigsberg, S.R. and Johnson, R.: Child behavior during sequential dental visits. JADA, 85:128–132, July, 1972.
14. Berggren, U. and Megnert, G.: Dental fear and avoidance: causes, symptoms, and consequences. JADA, 109:247–251, August, 1984.
15. Forgione, A.G. and Clark, R.E.: Comments on an empirical study of the courses of dental fear. J Dent Res, 53:496, March-April, 1974.
16. Lautch, H.: Dental phobia. Brit J Psychiat, 119:151–158, August, 1971.
17. Levitas, T.C.: HOME—Hand Over Mouth Exercise. J Dent Child, 41:178–182, May-June, 1974.

ANXIETY AND FEAR

Anxiety may be defined as apprehension from a source which is largely unknown or unrecognized. Fear, on the other hand, is an anxiety reaction which stems from a recognized source.

Braham, R.L. and Morris, M.E.: Textbook of pediatric dentistry 2nd ed. Baltimore: Williams & Wilkins, 1985, p 369.

Comparison of dental crown height in bite impressions

James F. Kane, DMD, MS
Audrey Stack, DDS
James Dickerson, DMD
Susan Schmidt, RDH

REVIEW OF LITERATURE

The uniqueness of the human dentition is well established. This can be attributed to such factors as size, shape, wear rotations, diastemata, versions, restorations, and accidental occurrences, such as occlusal trauma, which are different in each individual.[1-4] Beckstead *et al* believe that in addition to these characteristics, each individual's dental configuration is unique.[5]

Sognnaes *et al* studied bite mark patterns of monozygotic twins to determine whether bite marks are unique to the individual.[4] The study was limited to the anterior portion of the dentition and the bite mark patterns made by those teeth. Illustrations of computerized comparisons of the dental casts demonstrated the uniqueness of the dentition in terms of the dental arch and of the positioning of the teeth. Regardless of the similar developmental morphology of individual teeth, significant variations occurred to indicate that even

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Herb Kayne, PhD, made the statistical analysis of the data.

identical twins were not dentally identical. Forensic dentists, arguing that the human dentition is unique, have demonstrated to the courts that a bite mark is totally consistent with a particular dentition and should be considered useful as evidence in a court of law.[2]

Wax is frequently described as a useful medium for obtaining an occlusal record of the dentition.[6-9] Millstein and Clark studied the effects of initial heating, intraoral withdrawal, storage environments, storage times, and seating forces of laminated and nonlaminated wax inter-occlusal wafers, half of which contained 0.05-mm thick aluminum laminate.[6] Results of the study indicate that accuracy and dimensional stability were sensitive to treatment and handling techniques. Laminated and metalized interocclusal wax wafers were found to be the most accurate and stable.

In another study, Powers and Craig examined the material's penetration and thermal stability.[9] Bite waxes which are commonly used for registering the occlusal surfaces of teeth demonstrated low flow properties. Penetration at 98.6°F ranged from 2.5 percent to 22 percent.

METHODS AND MATERIALS

Ten patients, three to eight years of age, were selected from the Pediatric Dental Clinic at the New England Medical Center. The subjects, six male and four female, were either in the primary or mixed dentition stage of occlusal development.

Four wax bite impressions were taken on each patient using four different types of wax wafers.* Each wafer was softened in warm (100°F) water, and inserted into the child's mouth. The procedure was similar to making a bite registration. The wafer was removed and chilled with cold water (40°F - 50°F) and the impression poured up in dental stone. The resulting maxillary and mandibular casts were then trimmed and labeled.

All of the dental crown heights of each cast were measured with a Boley gauge on a line parallel to the long axis of the tooth.

The resulting data were analyzed by analysis of variance for a block design. The four groups were the four different wax wafers. The blocks were the patients (N = 10); so the effect is to compare the four wax wafers within each child. Three analyses were made: the average for the anterior teeth (canine, lateral incisors and central incisors) (Figure 1), the average for the posterior teeth (molars) (Figure 2), and the average for all the teeth (Figure 3). The analysis of variance was followed by Bonferroni t-tests for multiple comparisons. This compares each wax wafer with every other wax wafer (six comparisons among means).

Figure 1. Anterior (1,2,A,B,C) average.

		BL	P	BR	TP	Σ
RS	C1	2.8	1.1	2.2	3.3	9.4
JF	C2	1.4	1.7	2.6	4.5	10.2
RM	C3	2.5	1.8	2.6	2.2	9.1
KF	C4	1.3	1.5	1.7	3.7	8.2
KOS	C5	2.2	1.5	1.9	2.9	8.5
CW	C6	3.0	.8	2.2	3.4	9.4
MW	C7	2.0	1.5	1.6	3.2	8.3
JK	C8	2.9	2.3	2.5	3.6	11.3
CG	C9	2.4	1.6	3.0	3.9	10.9
JD	C10	1.1	1.0	1.0	2.5	5.6
Sum	Σ	21.6	14.8	21.3	33.2	90.9
Mean	$\bar{x}$	2.2	1.5	2.1	3.3	

Figure 2. Posterior (D,E,6) average.

		BL	P	BR	TP	Σ
RS	C1	4.2	2.6	4.1	4.9	15.8
JF	C2	2.9	1.9	3.7	3.3	11.8
RM	C3	3.2	2.4	3.2	2.0	10.8
KF	C4	2.1	2.8	3.2	3.7	11.8
KOS	C5	4.0	2.6	4.0	4.6	15.2
CW	C6	4.7	1.6	4.2	5.2	15.7
MW	C7	1.6	1.0	1.5	2.4	6.5
JK	C8	3.2	3.2	2.8	3.6	12.8
CG	C9	4.4	2.2	3.7	3.6	13.9
JD	C10	1.3	1.2	1.3	1.6	5.4
	Σ	31.6	21.5	31.7	34.9	119.7
	$\bar{x}$	3.2	2.2	3.2	3.5	

Figure 3. Average of all teeth.

		BL	P	BR	TP	Σ
RS	C1	3.4	1.8	2.9	4.2	12.3
JF	C2	2.0	1.8	3.0	4.0	10.8
RM	C3	2.8	2.1	2.8	2.1	9.8
KF	C4	1.7	2.1	2.4	3.7	9.9
KOS	C5	3.1	2.1	3.0	3.7	11.9
CW	C6	3.8	1.2	3.2	4.3	12.5
MW	C7	1.8	1.2	1.6	2.7	7.3
JK	C8	3.1	2.8	2.7	3.6	12.2
CG	C9	3.2	1.8	3.4	3.7	12.1
JD	C10	1.2	1.1	1.2	1.8	5.3
	Σ	26.1	18.0	26.2	33.8	104.1
	$\bar{x}$	2.6	1.8	2.6	3.4	

RESULTS

There was a significant difference on each of the three analyses. The differences were most pronounced on the anterior teeth (Figure 1). Here, there was a statistically significant difference among the four wax wafers. TP was significantly greater than the other three and P was significantly less than BL or BR ($df = 3$; $S = 17.582$; $MS = 5.861$; $F = 21.6$; $P < .001$).

*BL Bite Wafer-Hygienic Wax Company®
P Wax Wafer-Artus Company®
BR Corpwax Bite Wafer-Surgident Division of Columbus Dental Company®
TP Toothprints™ Contoured Bite Impression Wafer-Toothprints®

The posterior teeth showed less of a difference among the wafers tested. There were no significant differences among BL, BR and TP ($df = 3$; $SS = 12.488$; $MS = 4.168$; $F = 15.30$; $P < .001$) (Figure 2).

DISCUSSION

Few social issues have received as much local and national media attention as the issue of missing and abused children has recently. Because of this, not just forensic dentists, but also private practitioners have become involved in dental identification programs.

> "Although chartings have been instrumental in making an identification in many cases, children's dental records have not been able to provide adequate descriptive characteristics in the absence of caries and restorations...
>
> "When done properly, a wax bite impression can serve as a verifiable record of the child's dental characteristics....clearly, in noncarious children without noteworthy dental characteristics, the wax bite impression would be essential if dental identification is to be made."[10]

Furthermore, wax bite impressions, repeated four or more times during the mixed dentition stage, provide a simple means of recording the child's dentition in a nonfrightening way. The odds against identical mouths occurring are computed to be 2.5 billion to one.[11]

Clinically, the difference observed among the wax wafers in this study are not important, if the wafers are being used to establish an interocclusal relationship between working casts to be mounted on an articulator. If, however, the wax wafers are being used in a bite impression technique for identification purposes, the differences become important; particularly because the anterior teeth are the teeth most often used in bitemark analysis.

Since all the wafers studied were bilaminated with a sheet of foil between the two layers of wax, the main differences among them were the thickness and contour of the wafer. BR (impregnated with copper powder) and BL were approximately the same thickness ($\approx$ 4 mm); P was the thinnest ($\approx$ 3 mm). TP was the only contoured wafer studied, being thicker anteriorly ($\approx$ 7 mm) and tapering to $\approx$ 4 mm posteriorly. This design probably accounts for the statistical differences observed in the anterior teeth of the subjects.

One patient had a lingually locked mandibular lateral incisor that showed a 3 mm crown height in the TP impression, but did not register in the others.

Since the overall lateral and anteroposterior dimensions of the TP wafer were less than the others, less alteration of the wafer was needed prior to insertion in the mouth.

CONCLUSION

Dental crown height in bite impressions generated from noncontoured and contoured wax wafers were compared. The contoured wafer produced significantly greater crown heights in the casts which were fabricated from it. The differences were most pronounced in the anterior teeth. The differences were in the same direction in the posterior teeth; therefore, the differences also held for all the teeth.

Further studies are needed to determine the relative accuracy of the wax bite impression as a function of dental sophistication and to ascertain the best method of storing, collating and retrieving the dental information stored in these wax impressions, when needed to identify a missing child.

REFERENCES

1. Mertz, C.: Dental identification. Dent Clin North Am, 21:47–67, 1977.
2. Levine, L.J.: Bite mark evidence. Dent Clin North Am, 21:145–158, 1977.
3. Schmidt, J.S. and Fulton, P.R.: Using dentistry and computers to identify missing persons and unidentified dead. J Mich Dent Assoc, 64:251–252, June, 1982.
4. Sognnaes, R.F. *et al:* Computer comparison of bitemark patterns in identical twins. JADA, 105:449–451, September, 1982.
5. Beckstead, J.; Rawson, R.; Giles, W.S.: Review of bite mark evidence. JADA, 99:69–74, July 1979.
6. Millstein, P.L.; Clark, E.R.: Determination of the accuracy of laminated wax interocclusal wafers. J Prosthet Dent, 50:327–331, 1983.
7. Millstein, P.L.; Kronman, J.H.; Clark, R.E. Determination of the accuracy of wax interocclusal registrations. J Prosthet Dent, 25:189, 1971.
8. Millstein, P.L. and Kronman, J.H.: Determination of the accuracy of wax interocclusal registrations. Part II. J Prosthet Dent, 29:40, 1973.
9. Powers, J.M. and Craig, R.G.: Thermal analysis of dental impression waxes. J Dent Res, 57:37–41, 1978.
10. Tesini, D.; O'Malley, K.; Swartz, S.: Development of a bite impression technique for use in identification of missing and unknown children. J Mass Dent Society, Spring, 1985.
11. Berndt, T.: Bite mark science. Florida Dent J, 53:22–43, 1982.
12. Furness, J.: A general review of bite-mark evidence. Am J Foren Med Path, 2:49–52, March, 1981.

Clinic

The sealed composite resin restoration

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We are often required to decide whether to make an extensive cavity preparation in a deeply grooved tooth with questionable caries activity. When the decision concerns a young permanent tooth, the use of a composite restoration-sealant combination, the "sealed composite resin restoration" known under various names should be considered.[1] The alternative choice has been to observe, and later to restore with amalgam. Amalgam was our material of choice, prior to the development of the resin systems available to us today. This is not to suggest that amalgam is obsolete, whereas composites are the materials of the present and future. Silver amalgam is still an important restorative material; we would find it difficult to fulfill our clinical responsibilities without it.

This paper addresses the need to consider an alternative to traditional restorative dentistry. From a philosophical point of view, it may still be difficult to consider the possibility of a resin material for posterior teeth. The literature documents the fact that resins, primarily the first generation of these materials, have had a serious problem with anatomic wear.[2-4] The small pit restorations (the areas with minimal occlusal loading), however, are not likely to exhibit the anticipated anatomic wear. Besides, the more recent small particle, microfill or hybrid materials, used in non-stress bearing

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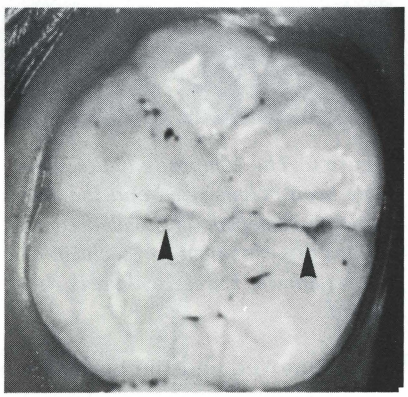

Figure 1. Susceptible occlusal surface of a first permanent molar with early dental caries in the pits. The points of occlusal contact are marked with articulating paper before treatment.

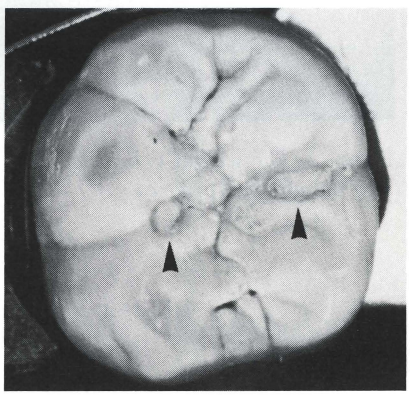

Figure 2. Conservative cavities prepared and lined with a quick-setting calcium hydroxide material under rubber dam isolation. The tooth is etched, washed and dried.

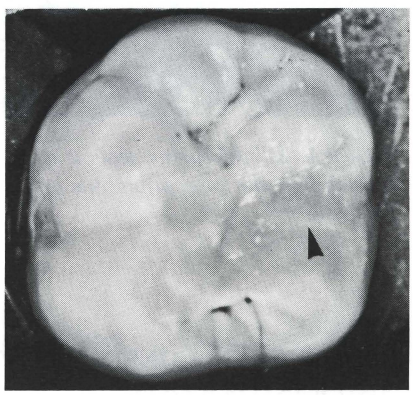

Figure 3. The cavities are filled with a light-curing composite which may or may not be cured at this stage.

areas of posterior teeth, exhibit less anatomic wear.[5-7] In order to test the technique, several teeth with small occlusal caries lesions were restored with a composite. Moisture was eliminated by isolating the tooth with rubber dam. Then the entire occlusal surface was sealed. These teeth were carefully evaluated at each recall visit and no detectable change was found in the sealed composite resin restoration.

Studies have shown that placing a sealant over a small caries lesion will arrest the caries process.[8,9] Conscientious and conservative practitioners, however, will not knowingly place a sealant over a caries lesion. A number of pits and fissures with bacterial activity, nevertheless, have been sealed when the pit appeared to be noncarious. The sealing of a carious tooth as a conservative procedure appears somewhat less acceptable than the technique calling for the removal of the active caries, placing a lining when necessary, etching and restoring the tooth with a composite sealant.

The primary challenge is selection, followed by the placing of the calcium hydroxide base. The frustration of carrying the material to the base of a small cavity has been experienced by most dentists. Do not expect this technique to save time; the meticulous technique usually requires more time. Resins are extremely sensitive to technique. Success depends primarily upon attention to detail and the elimination of moisture from the operating field. Tooth structure is saved, however, due to a conservative pit and fissure preparation.

Composite resins and pit and fissure sealant materials are generally BisGMA or urethane-based products. Both types of systems are acceptable and, within systems from the same manufacturer, composite and sealant are expected to bond to each other without any problems. The degree of bonding between various brands, however, warrants investigation. Combinations of urethane-based composites and BisGMA-based pit and fissure sealants, and vice versa, are less likely to bond to each other; these combinations should be avoided.

INDICATIONS

The composite restoration-sealant combination should be considered in shallow lesions, in which the caries process has penetrated beyond the dentinoenamel junction; but is not endangering the pulp. This conservative approach is particularly useful in young patients with recently erupted teeth with deep pits and fissures.

Pits and fissures in teeth are congenital in origin. A thin film of organic substance lines the deep pit or fissure as the enamel lobes unite during the mineralization process. Bacterial and enzymatic activity in the oral environment can dissolve this organic film and produce a channel for the caries process to progress to the nearby dentin layer. When this has occurred, the occlusal surface can no longer be sealed as a preventive measure. This carious enamel and dentin should be removed mechanically and the small pit preparation restored with an appropriate restorative material.

Careful selection of the case and a meticulous technique can lead to a successful restoration.

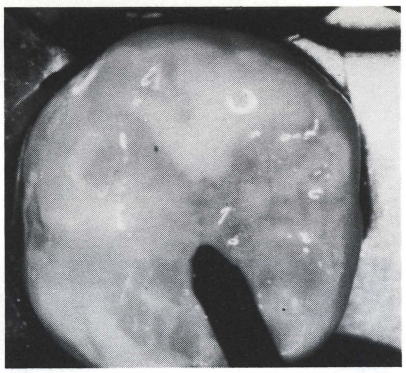

Figure 4. A light-curing sealant is placed over the susceptible pits and fissures.

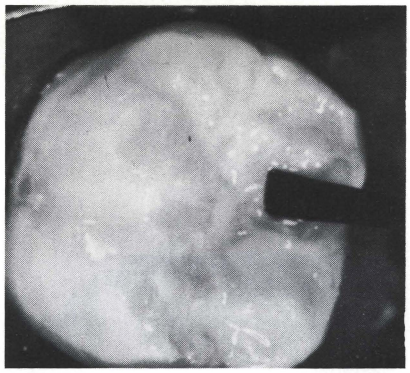

Figure 5. The sealant is brushed into the pits and grooves.

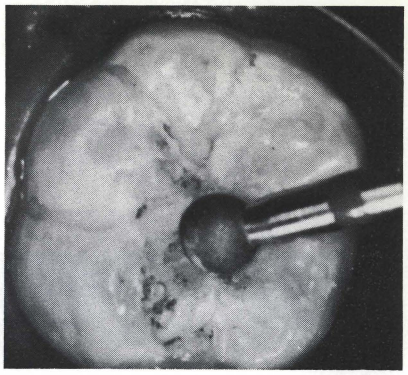

Figure 6. The composite and sealant have been polymerized and the rubber dam removed. The sealed composites are examined for occlusal discrepancies. Excess sealant is removed.

SEQUENCE OF CONSERVATIVE PREPARATION AND RESTORATION

- ☐ Identify the tooth with the minimal pit and fissure cavity. This is accomplished by careful visual examination of a dry occlusal surface, using a sharp explorer and a reflecting mirror and light. The points of occlusal contact should be marked with articulating paper (Figure 1).
- ☐ Anesthetize the tooth (not always necessary).
- ☐ Isolate the tooth with rubber dam.
- ☐ Reexamine the isolated tooth to determine the extent of the caries process.
- ☐ With a number 329 pear-shaped, high-speed bur, gain access to the depth of the lesion.
- ☐ A number 1/2 round, slow-speed bur is used to remove the remaining caries.
- ☐ Wash, dry, and reexamine the preparation.
- ☐ Place a quick-setting calcium hydroxide material over the exposed dentin.
- ☐ Etch the enamel margins of the cavity and the remaining occlusal surface (in mandibular molars where the sealant will be carried over the buccal groove areas, and in maxillary molars where the sealant will be carried over the lingual groove area, the approximating enamel is also etched). Wash the tooth for at least 20 seconds and dry (Figure 2).
- ☐ A composite, preferably light-curing, is carefully placed in the small preparation without entrapping air. This may be accomplished by using a syringe. In general the newer composites designated for posterior restorations are more wear resistant (Figure 3).
- ☐ A pit and fissure sealant is placed over the entire susceptible pit and fissure area. (Figure 4). A light-activated sealant allows more working time for brushing into the grooves (Figure 5).
- ☐ If a light-activated composite and sealant have been used, the composite and sealant may be polymerized simultaneously with a visible light system at this time.
- ☐ The rubber dam is removed and the occlusion is checked with articulating paper. Any occlusal discrepancies are adjusted to reduce postoperative sensitivity. Particular attention should be paid to removal of excess filled sealant, because this will not wear as quickly as the unfilled sealant (Figure 6).

SUMMARY

This composite restoration-sealant combination is only to be considered for the small pit and fissure caries lesion. Bitewing radiographs should indicate no smooth surface interproximal caries in the teeth to be restored in this manner. All teeth treated with the composite restoration-sealant combination should be carefully evaluated at periodic recall visits. There is no single perfect conservative restoration for the young patient. Each of us must decide, on an individual basis, the appropriate type of procedure we elect to use. The sealed composite resin restoration can be very effective in carefully selected cases.

REFERENCES

1. Simonsen, R.J.: Clinical application of the acid etch technique. Chicago: Quintessence Pub. Co., 1978.
2. Phillips, R.W.; Avery, D.R.; Mehra, R. *et al*: Observations on a composite resin for Class II restorations: Three-year report. J Prosthetic Dent, 30:891–897, 1973.
3. Eames, W.B.; Strain, S.D.; Weitman, R.T. *et al*: Clinical comparison of composite, amalgam and silicate restorative materials. JADA, 89:1111–1117, 1974.
4. Leinfelder, K.F.; Sluder, T.B.; Stockwell, C.L. *et al*: Clinical evaluation of composite resins as anterior and posterior restorative materials. J Prosthetic Dent, 33:407–416, 1975.
5. Moffa, J.P. and Jenkins, W.A.: Three year clinical evaluation of three experimental composite resins. IADR Abstr, 206, 1978.
6. Lutz, F.; Setcos, J.C.; Phillips, R.W. *et al*: Dental restorative resins, types and characteristics. Dent Clin N Am, 27:697–711 October, 1983.
7. Lutz, F.; Phillips, R.W.; Roulet, J.F. *et al*: *In vivo* and *in vitro* wear of potential posterior composites. J Dent Res, 63:914–920, 1984.
8. Leverett, D.H.; Handelman, S.L.; Brenner, C.M. *et al*: Use of sealants in the prevention and early treatment of carious lesions: Cost analysis. JADA, 106:39–42, 1983.
9. Handelman, S.L.; Washburn, F.; and Wopperer, P.: Two year report of sealant effect on bacteria in dental caries. JADA, 93:967–970, 1976.

Periapical healing after apicocurettage during apexification

Henry L. Harbert, DMD

Calcium hydroxide apexification treatment is well documented and frequently performed.[1-3] Difficulties may occur, however, during the long course of treatment: bacterial invasion because of leakage around the occlusal seal, occurrence of a root fracture, or apical non-healing for unknown reasons. In addition, there may be a problem with the retention of a temporary restoration because of a large endodontic access opening. It may be difficult to schedule office recall visits over a long period of time and cost factors may restrict extended treatment.

Shortening the treatment time with apicocurettage could mitigate this combination of problems and make treatment more convenient for some patients. The use of apicocurettage in association with an apexification procedure has already been described by Verniecks.[4]

This report deals with a case in which periapical curettage was done in association with an apexification procedure that appeared to have failed. Apexification continued then, after the surgery, to form a new organic stop. Subsequently, a gutta-percha root canal filling was placed via the coronal access.[5,6] This resulted in an abbreviated and successful culmination of the apexification procedure.

CASE REPORT

In 1974, a twelve-year-old male presented with a nonvital maxillary left central incisor which was mildly sensitive to occlusal percussion (Figure 1). The periodontium and the pulps of the adjacent teeth were normal. The medical history was noncontributory.

During two visits over the next month the root canal of the left central incisor was cleaned and filled with CaOH-CMCP paste. A double seal of zinc oxide and eugenol and composite was placed. Five weeks later the patient returned with moderate pain and swelling labial to the apex of the central incisor. Codeine and a seven-day course of penicillin were prescribed. Two weeks later an apicocurettage was done (Figure 2). A biopsy of the periapical tissue was diagnosed as a reactive periapical granuloma.

The patient remained asymptomatic and was next seen eleven months later (Figure 3). At that time a dry hard stop was present at the apex and a root canal filling was placed (Figure 4). The patient remained symptom-free over the following ten years. A ten-year posttreatment radiograph showed normal periapical morphology (Figure 5).

DISCUSSION

In this case apicocurettage was performed to resolve an acute exacerbation of a chronic lesion and to expedite healing. The exacerbation occurred five weeks after placing the CaOH-CMCP paste. If there was an overfill of paste it may be that it was poorly tolerated in a chronic lesion that tended to become acute.

The apicocurettage consisted of removing the periapical lesion and only enough dentin to smooth uneven

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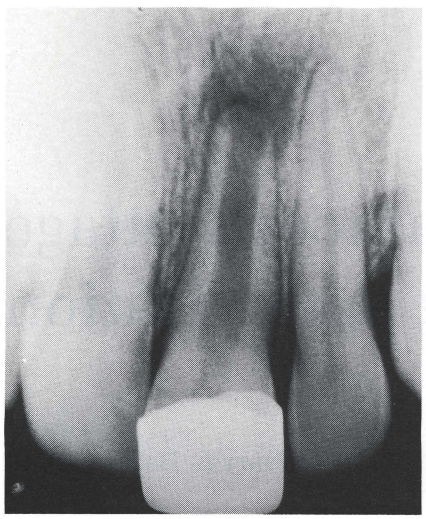

Figure 1. Radiograph of nonvital permanent central incisor before endodontic treatment.

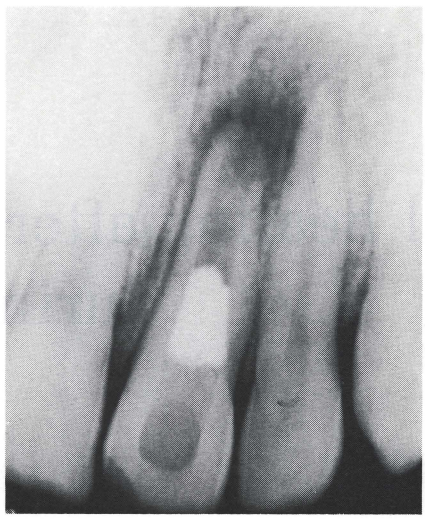

Figure 2. Radiograph of central incisor immediately after apicocurettage.

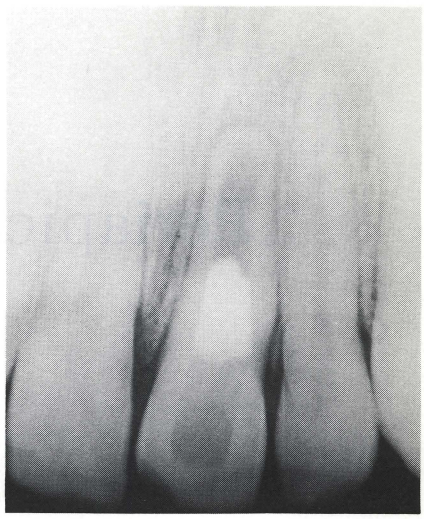

Figure 3. Radiograph eleven months post-apicocurettage, showing periapical healing and apical stop formation.

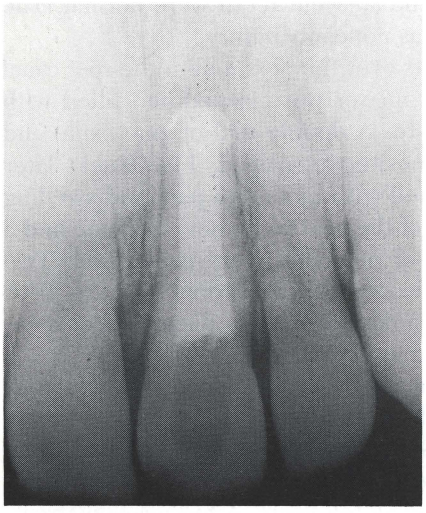

Figure 4. Radiograph at time of endodontic filling.

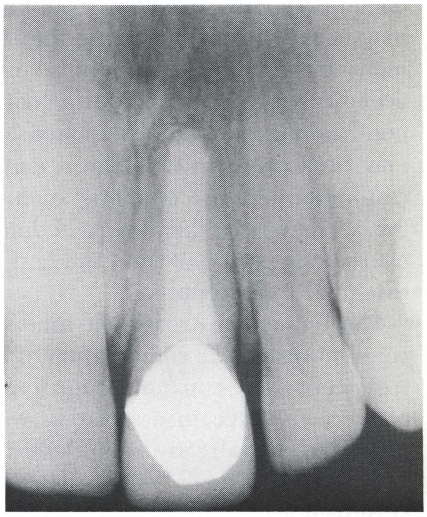

Figure 5. Radiograph at ten years post-filling, showing normal periapical tissue.

edges of the foramen. The effect was to reduce the perimeter of the foramen and save as much root length as possible. The surgery allowed direct view of the apex and, therefore, thorough inspection for root fractures, bone sequestra, and the adequacy of the paste filling in the root canal. Furthermore, the biopsy identified the nonhealing lesion as nonneoplastic.

There are some features of an alloy retrofilling which may make it less desirable, in some circumstances, than performing an apicocurettage. It may be difficult to place reliable retention into thin dentin walls deep in the canal. A deep alloy occupies canal space which may be needed later for a dowel post for a permanent restoration. An apical bevel to provide access reduces root length and elongates the alloy margin. Controlling bleeding during placement of an alloy may be difficult. Condensing alloy incisally into a short mobile root introduces bleeding from the periodontal ligament as a factor to control. Moisture contamination can cause irregular expansion of the alloy, marginal leakage, and root fracture. Compared to an apicocurettage, a retrofilling requires additional surgical time for hemostasis, preparation of a cavity, condensation, and a removal of excess alloy.

Apical formation was observed radiographically, eleven months after the surgery. That time compared favorably with a frequently quoted time-range of six to twenty-four months, or longer, for non-surgically assisted apexification.

No antibiotics were administered during or after the apicocurettage procedure. One might presume that during the surgery, bacteria would contaminate the root canal via the large apical foramen and porous paste filling. After surgery, the periapical tissue could become reinfected from the root canal. The gradual leaching of the calcium hydroxide paste creates a hollow space in the canal which could become a haven for new bacterial growth. None of these considerations, however, seemed to have a detrimental effect on either bone healing or apical stop formation in this case. Calcium hydroxide by itself lacks a discernible bacteriocidal effect.[7,8] On the other hand, when calcium hydroxide is mixed with CMCP, it has a demonstrable bacteriocidal effect.[8,9] If that effect could last for months, it may have been a significant factor in the success of this case.

REFERENCES

1. Oswald, R.J. and Van Hassel, H.J.: Calcium hydroxide root closure. In: Techniques in Clinical Endodontics, ed. Gerstein, H. Philadelphia: Saunders, 1983, pp 162–171.
2. Webber, R.T.: Traumatic injuries and the expanded endodontic role of calcium hydroxide. In: Techniques in Clinical Endodontics, ed. Gerstein, H. Philadelphia: Saunders, 1983, pp 172–258.
3. Weine, F.S. Endodontic therapy, 3rd ed. St. Louis: C.V. Mosby Company, 1982, pp 570–584.
4. Verniecks, A.A. and Messer, L.B.: Calcium hydroxide induced healing of periapical lesions: a study of 78 non-vital teeth. J Brit Endod Soc, 11:61–69, July, 1978.
5. Simpson, T.H. and Natkin, E.: Gutta percha techniques for filling young permanent teeth after induction of apical formation. J Brit Endod Soc, 6:35–39, Summer, 1972.
6. Schilder, H.: Filling root canals in three dimensions. Dent Clin North Am, November, 1967, pp 732–739.
7. Cvek, M.; Hollander, L.,; Nord, E.: Treatment of non-vital permanent incisors with calcium hydroxide. Odontol Revy, 27:93–108, April, 1976.
8. DiFiore, P.M.; Peters, D.D.; Stetterstrom, J.A. *et al*: The antibacterial effects of calcium hydroxide apexification pastes on streptococcus sanguis. Oral Surg, 55:91–94, January, 1983.
9. Stevens, R.H. and Grossman, L.I.: Evaluation of the antimicrobial potential of calcium hydroxide as an intracanal medicament. J Endod, 9:372–374, September, 1983.

APEXIFICATION

Objective. Pulpal and periapical disease, associated with immature roots and divergent canals, presents several problems. First, the larger apical versus smaller coronal canal diameter makes debridement very difficult. Second, lack of an apical stop, such as the apical constricture of mature root, makes obturation impossible in all dimensions with current techniques. Third, the thin root canal walls become prone to fracture.

Surgical techniques have been used in the past to fill the canals by a retrosurgical approach, but the following problem, pointed out by Frank, made surgery unpopular. Retrofilling apices of immature teeth often means packing silver amalgam into preparations with paper-thin walls. Condensing pressure or expansion of the amalgam may lead to root fracture. Further, such procedures most often involve young children, who view surgical intervention with great anxiety.

A more desirable method of treatment induces apical repair as a hard tissue barrier across the open apex. This cementum-like barrier provides a stop against which root canal filling material may be condensed and confined to the root canal space. This procedure, referred to as apexification, has received much attention in the literature.

Ingle, J.I. and Taintor, J.F.:
Endodontics, 3rd ed. Philadelphia:
Lea & Febiger, 1985, p 754.

Management of Ludwig's angina in a patient with severe hemophilia A with factor VIII inhibitors: Report of case

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Joel Elfman, DDS
Alan Cohen, MD

The management of impending airway obstruction because of dental infection in a medically compromised patient requires cooperation from many medical services. This report describes the management of Ludwig's angina, a potentially fatal complication of infection, in a patient with hemophilia, with a high titer of inhibitors to factor VIII.

Ludwig's angina is defined as an aggressive infection bilaterally involving the submandibular, sublingual, and submental fascial spaces. In a recent review of Ludwig's angina, a dental etiology was determined in 70 percent of the cases.[1] The causes included infections of the pulp, periodontium, or postextraction sockets of mandibular molars. Other causes of infection were compound fractures of the mandible, lacerations of the floor of the mouth, and obstructions of salivary gland ducts. Nondental causes ranged from peritonsillar abcess, otitis media, osteomyelitis, and other abscesses occurring under the thyrohyoid membrane.

Tschiassny (1943) emphasized the anatomic relationships between the site of infection and the development of Ludwig's angina. Infections involving the mandibular second or third molars may perforate the buccal or lingual cortical plate below the mylohyoid and buccinator attachments, spreading into the submandibular spaces. In children, these muscle attachments are located superiorly so that the roots of all permanent mandibular molars project below these important muscle attachments.[2] The mylohyoid muscle forms the superior boundary of the submandibular space and the inferior boundary of the sublingual space (Figure 1).[3] An invasive organism can spread the infection into the contiguous fascial spaces resulting in bilateral submandibular, sublingual,and submental swelling.

The complications associated with Ludwig's angina are severe. Involvement of the sublingual space displaces the tongue upward and backward, resulting in a rapid airway obstruction. This condition is aggravated in the supine position,potentially leading to asphyxiation.

Infection and edema may track farther along the fascial planes to involve the pharynx, retropharynx, and mediastinum, leading to further airway obstruction and/or erosion of vital structures such as the carotid vessels. The spread of the infection is related to the extent and speed of the suppurative process. Metastatic sepsis, aspiration pneumonia, emphysema, and lung abscesses represent additional complications. In the pre-antibiotic era, the mortality rate was 54 percent; following

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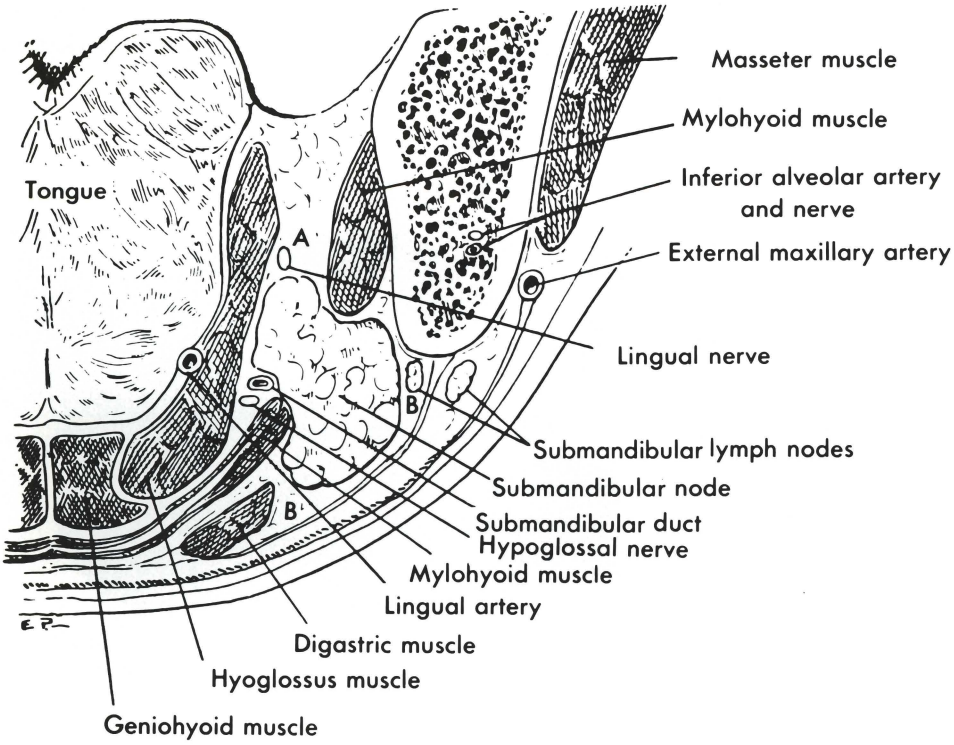

Figure 1. Vertical section through the sublingual space (A) and submandibular space (B).[3]

the discovery of penicillin, the mortality rate decreased to 4 percent.[1,4]

Of the major types of hemophilia, hemophilia A (classical hemophilia) is the most common, affecting 80 percent of all hemophiliacs, and is characterized by decreased amounts of circulating factor VIII, also known as antihemophilic factor or globulin.[5] There are three categories of hemophilia A (mild, moderate, and severe) depending upon the amount of circulating factor in the patient's blood.

Severe hemophilia A patients have less than 1 percent of the level of normal circulating factor VIII, and may suffer from spontaneous hemorrhage into the skin, mucosa, joints, or viscera. Repeated hemorrhage into the joints and muscles of the extremities can produce destruction and subsequent crippling.

Hemorrhage control in patients with classical hemophilia may require replacement therapy with exogenous factor VIII. Five to ten percent of the patients who received exogenous factor VIII, however, develop antibodies to the replacement factor.[5] If the level of inhibitors is high, effective replacement therapy with factor VIII preparations may be prevented, making hemorrhagic episodes potentially life-threatening.

CASE REPORT

B.B., an eighteen-year-old black male with severe factor VIII deficiency and a high titer of inhibitors presented to the emergency room at the Children's Hospital of Philadelphia with a chief complaint of "jaw and neck pain." The history revealed a toothache of several weeks duration localized in the mandibular left posterior quadrant, for which no treatment had been sought. A sore throat developed the evening before, and at admission, B.B. complained of difficulty in breathing and of changes in his voice. There was no history of recent trauma.

The medical history was remarkable for severe (less than 1 percent) factor VIII deficient hemophilia, diagnosed at age eighteen months, when bleeding from a mouse bite could not be controlled with usual measures. Inhibitors to factor VIII were detected at age eight. Bleeding incidents since that time have been successfully controlled with factor IX concentrates, which have proven useful in the treatment of hemorrhage in patients with inhibitors to factor VIII. Since the initial diagnosis, there have been sixteen admissions to the Children's Hospital of Philadelphia for spontaneous or traumatic bleeding episodes. Physical growth and maturation of B.B. have occurred normally. He presently takes ferrous sulfate, 300 mg t.i.d., for a persistent iron deficiency anemia.

B.B. initially presented to the dental center of the Children's Hospital of Philadelphia, one year prior to this admission. The treatment plan included deep periodontal scaling, amalgam restorations,and extractions of impacted third molars. Dental care had to be limited, however, to simple restorations which could be accomplished without local anesthesia. This limited treatment was a consequence of a hematology consultation report which emphasized the unpredictability of B.B.'s response to factor VIII and factor XI replacements, and hemorrhage control.

At this admission the physical examination revealed an alert, cooperative and afebrile black male with a bilateral swelling of the submandibular, submental and sublingual regions, which was especially prominent on the left side (Figure 2). The warm, tender, and indurated swelling extended down the left lateral aspect of the neck. Bilateral anterior cervical and submandibular lymphadenopathy was present. There was a physical deviation of the trachea to the patient's right side. Breathing difficulty was marked by prolonged inspirations and expirations without retractions, stridor, or cyanosis. The voice was "hot potato" in character.

The admitting laboratory values are presented in Table 1. The urinalysis was within normal limits.

An infusion of 4800 units of Proplex^{R}*, a prothrombin complex containing activated factor IX, was given in the emergency room and the patient referred to the dental department for evaluation. The oral examination revealed a subcutaneous oozing of blood along the floor of the mouth, extending across the midline (Figure 3). This collection of blood along with the sublingual edema was severe enough to cause a 1 cm elevation of the tongue posteriorly and superiorly. Trismus was present with maximum opening of about 1 cm. The permanent dentition with multiple restorations was intact, without evidence of caries or defective restorations. Oral hygiene was generally poor, with accumulations of plaque and calculus causing generalized gingival inflammation. No fistulous tracts were observed. The mandibular left first molar, which had an occlusal amalgam restoration, was slightly mobile and tender to percussion.

Dental radiographs (Figure 4), including panorex tomogram, revealed an intraradicular radiolucency of the left mandibular first molar, extending apically along the mesial and distal root surfaces to the periapical regions. The left mandibular third molar was noted to be horizontally impacted. In addition, a probable condensing osteitis of the mesial root apex of the mandibular right first molar was apparent. The periapical radiograph taken in the operating room revealed a 10 mm periodontal defect associated with the mandibular permanent left first molar.

The infectious disease service was consulted and a joint decision was made to administer 3,000,000 units of aqueous penicillin G intravenously every four hours,and to admit the patient to the intensive care unit to be monitored for airway patency. If airway compromise occurred, a soft nasal airway would be at-

*Hyland Laboratories, Costa Mesa, CA.

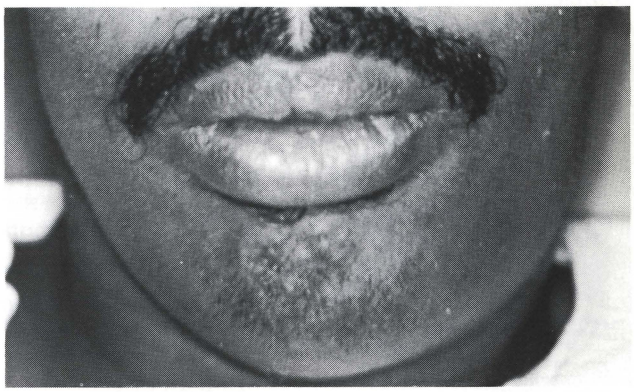

Figure 2. Extra-oral view demonstrating bilateral swelling of the submandibular, sublingual and submental fascial spaces especially prominent on the left side.

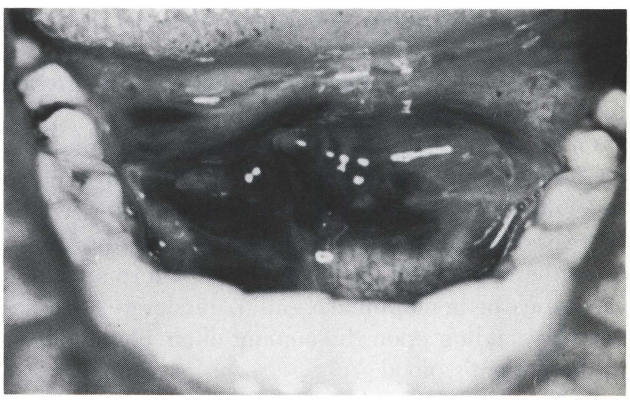

Figure 3. Intra-oral view demonstrating edema and subcutaneous oozing of blood along the floor of the mouth bilaterally, causing an elevation of the tongue posteriorly and superiorly.

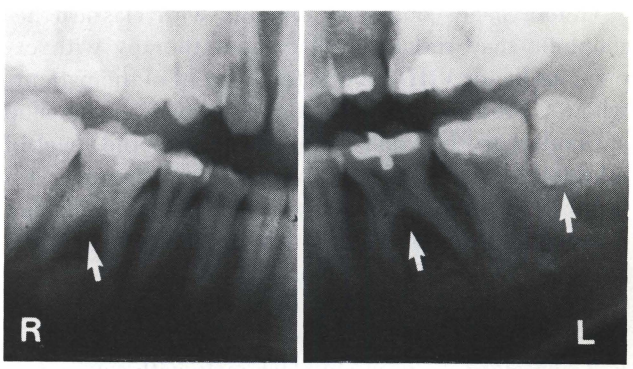

Figure 4. Panorex tomogram revealing intraradicular radiolucency of the left mandibular first molar. Horizontal impaction of the left mandibular third molar and a probable condensing osteitis of the right mandibular first molar are noted.

tempted, or if necessary, a tracheostomy under local anesthesia would be performed. The antibiotic regimen would be reevaluated pending the patient's response.

Since the patient was not responding to the Proplex[R] as shown by the continuation of subcutaneous oozing of blood, and in the anticipation of surgical intervention, factor VIII concentrate was infused. An initial bolus of 4,000 units was delivered to provide a 170 percent correction level. This was followed by a continual infusion of 2,400 units every four hours to maintain a 100 percent correction. After the initial bolus, clotting time was recorded at eight minutes (normal is five to ten minutes by the Lee-White method), and the PTT was measured at 26 sec, which was also within normal limits. Factor VIII levels were determined periodically and are presented in Table 2. The subcutaneous bleeding and general discomfort were markedly reduced within several hours. Five grams of the antifibrinolysin Amicar[R**] were administered every six hours.

During the next twelve hours, the edema and ecchymosis of the floor of the mouth and the submental region diminished considerably. The indurated nature of the swelling, however, remained.

With assurance of acceptable factor VIII levels and adequate hemostasis, oral surgery was now possible. General anesthesia was contraindicated in this patient due to the deviation of the trachea and the potential of uncontrollable hemorrhage following intubation.

Conscious sedation using intravenous fentanyl (1 mg) and diazepam (5 mg) was achieved, and vital signs were monitored by members of the Department of Anesthesia. Local anesthesia was accomplished by a mandibular block using 3.6 cc of 2 percent lidocaine with epinephrine 1:100,000 with careful aspiration prior to injection. The left mandibular first molar was extracted without complications, and aerobic and anaerobic culture specimens from the socket were obtained. One 4-0 chromic gut suture was tied over the socket. Avitene[R***], a topical microfibrillar collagen hemostatic agent, was applied to aid hemostasis.

The postsurgical course preceeded well, with the patient resting comfortably and hemostasis occurring at the extraction site. The tongue descended significantly within four hours and the sublingual hematoma continued to diminish in size. Appetite returned and general malaise subsided. The patient remained afebrile, and the voice returned to normal, twenty-four hours postoperatively. The edema of the lateral aspect of the neck and of the left submandibular space gradually decreased in size and induration.

Factor VIII concentrate, to maintain a 50 percent correction level, and Amicar[R] were administered for three days following surgery. The clot remained stable. The antibiotics were switched to phenoxymethyl penicillin, 500 mg q 6 h, for convenience. PTT values remained normal.

Five days following admission, with the facial swellings well resolved, the patient was discharged. Factor VIII infusions were discontinued twelve hours before discharge, and no further bleeding was observed. Discharge orders included Amicar[R], 5 gm q 6 h for 24 hr, phenoxymethyl penicillin 500 mg q 6 h for five days (to complete a ten-day course), and ferrous sulfate, 300 mg t.i.d. B.B. was instructed to rinse with warm saline rinses t.i.d. with gentle expectoration.

Two weeks following discharge, B.B. was evaluated by the dental and hematology departments and appeared to be in his usual state of health.

DISCUSSION

Effective treatment of Ludwig's angina involves airway maintenance, antimicrobial therapy, and surgical incision and drainage, if required.

☐ Airway management.

This poses a difficult problem, because endotracheal intubation can rupture a lateral pharyngeal

**Lederle Laboratories, Pearl River, NY.

***Avicon, Inc., Fort Worth, TX.

Table 1 ☐ Laboratory values at time of admissions to the hospital.

	B.B.	Normal
WBC	12.1 × 10^3/mm^3	5.0-10.0 × 10^3/mm^3
RBC	3.89 × 10^6/mm^3	4.6-6.2 × 10^6/mm^3
Hgb	10.1 g/dl.	14-18 g/dl.
Hct	29.8%	40-54%
Plt.	443 × 10^3/mm^3	200-500 × 10^3/mm^3
PTT	36.0 sec.	21.9-28.3 sec.
Factor VIII level	1%	100%
Inh.	7.2 B.U.	O B.U.

Table 2 ☐ Factor VIII levels during a constant infusion.

Infusion time	Factor VIII levels (Percent)
Pre-infusion	1
1 hr.	60
2 hr.	74
4½ hr.	62
8 hr.	70
13 hr.	144

abscess with subsequent aspiration of purulent material. A tracheostomy or cricothyroidotomy may need to be performed. Schwartz and others describe a technique for endotracheal intubation, so general anesthesia can be induced without a preliminary tracheostomy.[6]

☐ Antibiotics.

The selection of antibiotics should be based upon the type of causative organisms. In Hought's review, streptococci were the predominant organism, but other organisms, alone or in combinations, were cultured.[1] Gross *et al* stressed that since the use of penicillin began, there has been an increase in the incidence of mixed infections including penicillin-resistant anaerobes and staphylococci.[7]

Most authors recommend penicillin as the antibiotic of choice, pending results of culture and sensitivity tests, because of its effectiveness against oral flora. Other antibiotics, such as clindamycin or chloramphenicol, however, may be used alone or in combination with penicillin, based upon the clinical course of the disease as well as on sensitivity tests. The dosage of the antibiotic is usually determined by the surgeon's judgment, with consideration for the undesirable side effects of the medications, and the aggressive nature of this condition.

☐ Surgical incision and drainage.

This is the third component of management. If the infection remains brawny and indurated, the decision for surgical intervention is based upon clinical progress and the surgeon's discretion. Hall (1950) and Murray and Fischer (1946) suggested that early surgical intervention even without fluctuance may prevent tissue necrosis and extension of the infection into the mediastinal spaces.[8,9] Other authors argue that effective antibiotic therapy may obviate the need for surgical incision and drainage. If the infection becomes purulent, however, most surgeons agree that adequate drainage is necessary, which can be best accomplished with long incisions, and the placement of drains.

In emergency situations, very large doses of concentrated factor VIII may be administered in an attempt to neutralize a mild level of inhibitors and allow clot formation to occur before deactivation of the exogenous factor. Infusion of factor VIII into a patient with inhibitors may stimulate a great increase in the antibody titer, making future transfusions more difficult or impossible. Sometimes hemorrhage may be controlled with infusions of prothrombin complexes, containing several activated factors. A sufficient amount of this complex will apparently override the factor VIII portion of the intrinsic pathway and initiate clotting.[10] The complications of using these prothrombin complexes, such as Konyne^{R} and Proplex^{R}, include thrombosis and disseminated intravascular coagulation.[11]

In addition to factor replacement, Amicar^{R} (epsilon aminocaproic acid) has proven to be a valuable adjunct. This agent blocks the conversion of plasminogen to plasmin, thus preserving the clot which is so critical in cases of decreased factor VIII. The drug competitively inhibits the activation of plasminogen by streptokinase, urokinase, and other tissue activators.[12]

Other hemostatic measures such as pressure, ice, and topical thrombin are available. Croll *et al* fabricated a stent to apply pressure and prevent mechanical disruption of the clot.[13] Immunosuppressants, such as corticosteroids, are sometimes employed to interfere with the production of inhibitors.

In B.B.'s case, classic treatment considerations for Ludwig's angina were not initially possible, due to the severe hemophilia A. Surgical incision and drainage, and culture and sensitivity tests were contraindicated until hemostasis could be assured. Intravenous aqueous penicillin G was chosen as the antibiotic of choice, in light of its effectiveness against the organisms associated with most odontogenic infections. In retrospect, due to the life-threatening nature of this infection and the increased incidence of penicillin resistant organisms, additional antibiotic coverage may have been indicated. Fortunately, B.B. displayed a rapid favorable response to the penicillin, and no additional antibiotics were necessary. The results of the microbial culture specimens revealed nonspecific gram-positive anaerobic organisms, which are normally present in the oral flora. These results must be interpreted, however, realizing the probability of contamination and that the specimen sample was obtained following a twenty-four-hour course of intravenous penicillin.

The horizontally impacted third molar was not the offending tooth due to the lack of clinical signs. This tooth was not extracted during this admission because of the potential of additional postsurgical complications.

Mandibular block injections in hemophiliacs are controversial, because of the possibility of a dissecting hematoma. In this case, however, block anesthesia was preferred to general anesthesia from a hematologic standpoint.

Postsurgical local hemostasis control included use of

a resorbable suture and Avitene[R], a purified bovine collagen matrix. Ice, stents, topical thrombin and corticosteroids were not used. Analgesics were limited to acetaminophen with codeine sulphate, keeping in mind that aspirin-containing medications were contraindicated, due to their alteration of platelet function. Pressure was applied with gauze packs for twenty-four hours. Amicar[R] was initiated preoperatively, and continued for six days to stabilize the clot.

This report illustrates the need for close cooperation among hospital services to manage a life-threatening situation of dental origin in a medically compromised patient. Treatment considerations of severe classical hemophilia with inhibitors to factor VIII and of Ludwig's angina were discussed. Traditional management of Ludwig's angina was not feasible until adequate hemostasis could be achieved. Once clotting was assured, successful treatment of the Ludwig's angina was accomplished.

REFERENCES

1. Hought, R.T.; Fitzgerald, B.F.; Latta, J.E. *et al:* Ludwig's angina: report of two cases and review of the literature from 1945 to January, 1979. J Oral Surg, 38:849–855, November, 1980.
2. Tschiassny, K.: Ludwig's angina: An anatomic study of the role of the lower molar teeth in its pathogenesis. Arch Otolaryngol, 38:485, November, 1943.
3. Darling, A.I.: Periapical inflammation of the teeth. In Gorlin, R.J., and Goldman, H.M., editors: Thoma's Oral Pathology. ed. 6, St. Louis: The C.V. Mosby Co., 1979, p 348.
4. Williams, A.C.: Ludwig's angina. Surg Gynecol Obstet, 70:140–149, February 1940.
5. Nelson, W.E.: Textbook of pediatrics. Philadelphia: W.B. Saunders Publishing Co., 1979, pp 1410–1412.
6. Schwartz, *et al*: Ludwig's angina: Use of a fiberoptic laryngoscope to avoid tracheostomy. J Oral Surg, 32:608–611, August, 1979.
7. Gross, B.D. *et al:* Ludwig's angina due to bacteroides. J Oral Surg, 34:456–460, May 1976.
8. Hall, C.: Suprahyoid neck infections. Laryngoscope, 60:779–793, August, 1950.
9. Murray, C. and Fisher, G.: The modern treatment of Ludwig's angina. Miss Doctor, 23:580–584, March, 1946.
10. Berlocher, W.C. and King, D.L.: Considerations in the dental management of the factor VIII deficient child with inhibitors. Pediatr Dent 1:188–191, 1979.
11. Blatt, P. *et al*: Thrombogenic materials in prothrombin complex concentrates. Ann Int Med, 81:766–770, December, 1974.
12. Alkjaersig, N.; Fletcher, A.P.; and Sherry, S.: Epsilon aminocaproic acid: An inhibitor of plasminogen activity. J Biol Chem, 234:832–837, April, 1959.
13. Croll, T. *et al*: Dental management for a hemophilia A patient with circulating antibodies to factor VIII. J Pedodont, 2:344–352, Summer, 1978.

LUDWIG'S ANGINA

The serious complication of Ludwig's angina usually develops from a massive infection of the submandibular space that eventually involves the pharyngeal space. Clinically the patient develops a large, firm swelling in the submandibular space. The floor of the mouth is elevated, and eating, swallowing, and respiration may be impaired. Treatment includes antibiotics and possible intubation by tracheostomy.

Ingle, J.I. and Taintor, J.F.:
Endodontics, 3rd ed. Philadelphia:
Lea & Febiger, 1985, p 560.

Nutrition

Dietary iron—chemistry and bioavailability

Fergus M. Clydesdale, PhD

Difficulties in food iron absorption may be quantitative and/or qualitative in nature, depending upon the type of food consumed, state of iron nutriture, amount of food consumed, and other mediating factors. However, if iron is required and food intake is adequate, the problem is probably related to the type of iron in the diet, which is ultimately dependent upon the type of food consumed and the physicochemical environment provided by that food.[1]

Iron is the fourth most abundant element in the earth's crust; only oxygen, silicon and aluminum are more common.[2] Iron ranks 26th in the periodic table and has an atomic weight of 55.85. It has several oxidation states varying from Fe^{+6} to Fe^{-2} depending upon its chemical environment. The ferric form, Fe^{+3}, and the ferrous form, Fe^{+2}, are the only states that are stable in an aqueous environment and thus are the only states that occur naturally in food. Elemental iron, Fe^{o}, is rarely found in biological environments but it is a common food iron fortificant with reasonable bioavailability.[3]

FUNCTION

The major function of iron is to transport oxygen in the body via two transport molecules, hemoglobin in the red blood cells and myoglobin in the muscle. Hemo-

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globin is formed from the combination of four heme groups with one molecule of globin, while myoglobin has only one-quarter the iron of hemoglobin. Hemoglobin is responsible for oxygen transport through the entire body, while myoglobin serves as an oxygen reserve in muscle metabolism. Iron is also a component of cytochromes, enzymes (catalase, xanthine oxidase) and is involved as a cofactor of other enzyme systems, such as aconitase.

Red blood cells, the major repository for iron, die approximately every 120 days but their iron is recycled very efficiently so that little iron is excreted; losses through the urine, endogenous fecal, and dermal iron loss are 0.6-1.0 mg/day. The average menstrual loss is 0.5 mg/day.

The Recommended Dietary Allowances (RDA) established by the Food and Nutrition Board in 1980 is 10 and 18 mg/day for men and women, respectively, decreasing to 10 mg for postmenopausal women.[4]

These calculations assume an average loss of 1 mg/day in women of child-bearing age. They also assume an average absorption of 10 percent from the diet. This figure is higher when extra demands are placed upon the body, such as those occurring during growth, pregnancy and lactation.

It is difficult to estimate accurately the exact amount of iron absorbed from the diet. Monsen *et al* have suggested a figure of 6 mg of iron per 1000 kcal of food in the average American diet, but this estimate does not consider the increased emphasis on dietary fiber, which is occurring in the eighties.[6] The dramatic effect of meal constituents may be seen in a later study that categorizes iron availability into low, medium and high, depending upon the amount of meat, poultry, fish, ascorbic acid, total iron, heme iron and non-heme iron in the meal.[6]

Nevertheless, applying the estimate of 6 mg/1000 kcal, it becomes obvious that men would be able to meet their RDA quite easily, while women would have great difficulty because they would have to consume approximately 3000 kcal/day. The relationship between food intake and iron status is especially critical for certain segments of the population if few iron-enriched or iron-fortified foods are consumed or if iron supplements are not used.

FOOD CONTENT AND BIOAVAILABILITY

In general, meats provide the greatest amount of iron in its most available form as heme iron. Non-meat sources contain non-heme iron, which is not nearly as readily absorbed due to the presence of inhibitors, such as fibers, polyphenolics, phosphates, proteins and organic acids.[6,7] However, these generalizations must be made with care since environmental factors in the food, such as pH, reduction potential and ligands as in organic acids and amino acids, can form soluble complexes with iron and act as enhancers of iron absorption.[1]

The best known and most widely accepted enhancer of non-heme iron is ascorbic acid, but the presence of small amounts of meat in the diet will also act as an enhancer. Concern about reported inhibition of iron caused by soy products prompted the International Nutritional Anemia Consultative Group (INACG) to issue a monograph on the effects of cereals and legumes on iron availability.[8] Their general conclusions indicated that although iron is poorly absorbed from cereals and legumes, such absorption may be increased by the inclusion of meat and/or ascorbic acid in the diet as well as by certain types of processing. Further, recent work has shown that any inhibition of iron absorption, when soy protein is substituted in beef, is partially offset by improved availability of the remaining heme iron and an increase of non-heme iron.[9] However, conclusions concerning cereals, legumes and soy-substituted meat products must consider added requirements for infants, children and women during the reproductive years.[8]

HEALTH IMPLICATIONS AND STATUS

According to dietary intake studies in the U.S., many young women are not consuming adequate amounts of iron in their diets. Half of the women, 19-50 years old, consume less than 66 percent of the RDA for iron; and 93 percent consume less than 100 percent of the RDA. With their lower RDA, adult men and women over fifty years old have less difficulty meeting their recommended daily intakes. A substantial proportion of children and teenagers (especially females) also are not consuming the recommended amounts of iron.[10]

Biochemical studies determining the extent of iron-deficiency anemia in the population demonstrate the effect of the low dietary intake. Researchers estimated the prevalence of anemia in the U.S. from the results of the Second National Health and Nutrition Examination Survey (NHANES II, 1976-1980) and found the prevalence of anemia (measured as those with hemoglobin values below the 95 percent reference range for age and sex) to be highest in teenage girls (5.9 percent), young women (5.8 percent), infants (5.7 percent), and elderly men (4.4 percent).[11]

There are some important health implications involved with anemia and iron deficiency. INACG has listed such problems as decreased work performance, increased risk of maternal and fetal morbidity and mortality, increased risk of infection and immunological disorders, decreased gastric juice secretion, reduced activity of intestinal cell enzymes, subcellular structural abnormalities and possible decreased growth rate.[12]

Also, iron deficiency in the absence of anemia has been found to create problems. Four groups of nonanemic, iron-deficient infants nine to twelve months of age who had hemoglobin greater than 11.0 g/dl were studied.[13] Iron sufficiency or deficiency was based on cellular and/or biochemical evidence. Subjects in each group were tested before and after iron therapy with the Boyley Mental Development Index. Those with nonanemic iron deficiency showed a significant score increase while those with iron sufficiency or only iron depletion did not. Thus anemia is not necessarily the only criterion for biochemical alterations.

In rare cases of excess iron accumulation, the body does not excrete and/or absorb iron normally, thus resulting in a build-up in the soft tissues that may cause cell destruction and death. Hemosiderosis is the resulting condition and is called hemochromatosis when it reaches an advanced stage. Thalassemia and sickle cell anemia are also diseases in which patients suffer from excessive iron storage.

Thus we have a situation where an optimum iron dosage must be the aim, but with the clear recognition that dangers from iron overload do exist. This is also complicated by the fact that diagnosis of anemia and iron deficiency is difficult and can be compounded by problems of variations in laboratory tests.[14]

MEASUREMENT OF IRON BIOAVAILABILITY

Available techniques for measuring the efficiency of iron absorption from oral ingestion of individual foods or ingredients have been reviewed.[15] These include 1)nonisotopic *in vivo* techniques, such as chemical balance, serum iron concentration and hemoglobin repletion; 2)radioisotopic *in vivo* methods, including extrinsic and intrinsic labeling, whole blood or hemoglobin incorporation, whole body counting, plasma labeling and isotope dilution and radioisotope balance; 3)stable isotopes; 4)*in vitro* methods.

Each of these has advantages and disadvantages and, in general, their results are not directly interchangeable. Smith has reviewed the problems presented by the environment in which the iron exists and other scientists have provided a critique of the extrinsic tag methodology.[16,17] INACG has also discussed the applicability of certain of these methods.[8]

The *in vitro* techniques all depend on solubility and/or dialysis and often use pH specifications to simulate physiological conditions. However, it may be concluded that *in vitro* methods do not quantitatively represent *in vivo* experiments; but often agree in a qualitative manner.

All methods suffer from the fact that iron absorption is a function of the total meal eaten and, therefore, it is difficult to predict bioavailability of a particular type of iron from meal to meal.

FORTIFICATION

Clearly, fortification is one of the best answers to iron deficiency and iron deficiency anemia. In fact, Cook and Reusser have stated that "iron fortification is the optimal approach to reducing the high prevalence of iron deficiency in developing countries."[18]

In developed countries, there are also examples of the efficacy of fortification. For example, studies of the prevalence of anemia among women in Sweden describe a marked decline from 30 percent in 1965 to 7 percent ten years later.[19] They estimated that 7 percent to 8 percent of this decline was attributable to fortification and the rest to a combination of iron supplements, ascorbic acid intake and possibly oral contraceptives.

INACG (1977) has reviewed and recommended various fortification sources and vehicles for use in developing countries and others have reviewed those fortificants which are available in the U.S.[3,12]

The choice of an iron fortification source depends upon several factors, including bioavailability, functionality in food, reactivity (type of food to be used in) and its potential chemical environment, presence of enhancers and inhibitors, type of processing and storage life.[6,7,20]

The use of a very available, but reactive source, such as ferrous sulfate, does not often make sense. This is due to the fact that its reactivity will not only change the quality of the food but, in so doing, will be changed itself to a less reactive and perhaps less available compound, such as an insoluble hydroxide. In such a case, it would be much better to use a stable iron source, such as elemental iron, that would not react with the food, but would solubilize at the low pH environment of the stomach to become available.[21]

The levels used will depend upon the product and,

of course, the legal limits. The latter is controlled by federal law in foods, such as flour and bread, as described in the *Federal Register.*[22]

In addition to the previous factors, there are a number of other questions that should be answered when considering fortification: 1) Is there a need for a bioavailability standard? 2) If such a standard is developed, should it refer to the fortificant alone or as used in the processed food or in the stored processed food? 3) Should there be requirements for upper and lower amounts of absorbable iron? 4) What techniques for the measurement of bioavailability are most appropriate and cost effective?[23]

It is obvious that iron nutriture is extremely important, yet not fully understood. There are, and will be, controversies in the fortification and labeling of iron in foods. Many of these problems are not technically solvable at our present level of knowledge and will depend upon cooperation between marketers, researchers and regulatory agencies.

REFERENCES

1. Clydesdale, F.M.: Physiocochemical determinants of iron bioavailability. Food Technol, 37:133, 1983.
2. National Research Council: Iron. Baltimore, MD: University Park Press, 1979.
3. Lee, K. and Clydesdale, F.M.: Iron sources used in food fortification and their exchanges due to food processing. Critical Reviews in Food Science Nutrition, 11:117. West Palm Beach, FL: CRC Press, 1979.
4. Food and Nutrition Board Committee on Dietary Allowances, National Research Council: Recommended Dietary Allowances. National Washington, D.C.: Academy of Sciences, 1980.
5. Monsen, E.R.; Kuhn, I.N.; and Finch, L.: Iron status of menstruating women. Am J Clin Nutr, 20:842, 1967.
6. Monsen, E.R. *et al*: Estimation of available dietary iron, Am J Clin Nutr, 31:134, 1978.
7. Clydesdale, F.M.: The effects of physiochemical properties of food on the chemical status of iron. In: Nutritional Bioavailability of Iron. Edited by C. Kies. Washington, D.C.: American Chemical Society Symposium Series 203, 1982.
8. International Nutritional Anemia Consultative Group: The effects of cereals and legumes on iron availability. Washington, D.C.: The Nutrition Foundation, 1982.
9. Lynch, S.R.; Dassenko, S.A.; Morck, T.A.; Beard, J.L. *et al*: Soy protein products and heme iron absorption in humans. Am J Clin Nutr, 41:13, 1985.
10. General Mills, Inc.: Dietary intake of Americans, 1980-82. Minneapolis, MN, 1982 (unpublished).
11. Dallman, P.R.; Ypi, R.; and Johnson, C.: Prevalence and causes of anemia in the United States, 1976-1980. Am J Clin Nutr, 39:437, 1984.
12. International Nutritional Anemia Consultative Group: Guidelines for the eradication of iron deficiency anemia. Washington, D.C.: The Nutrition Foundation, 1977.
13. Oski, F.A. *et al*: Effect of iron therapy on behavior performance in nonanemic, iron-deficient infants. Pediatrics, 71:877, 1983.
14. Dallman, P.R.: Diagnosis of anemia and iron deficiency: cerrolytic and biological variations of laboratory tests. Am J Clin Nutr, 39:937, 1984.
15. Van Campen, D.: Iron bioavailability techniques: an overview. Food Technol, 37:127, 1983.
16. Smith, K.T.: Effects of chemical environment on iron bioavailability measurements. Food Technol, 37:115, 1983.
17. Consaul, J.R. and Lee, K.: Extrinsic tagging in iron bioavailability research: a critical review. J Agric Food Chem, 61:332, 1984.
18. Cook, J.D. and Reusser, M.E.: Iron fortification: an update. Am J Clin Nutr, 38:648, 1983.
19. Hallberg, L. *et al*: An analysis of factors leading to a reduction in iron deficiency in Swedish women. Bull WHO, 57:947, 1979.
20. Cook, J.D.: Determinant of non-heme iron absorption in man. Food Technol, 37:124, 1983.
21. Clydesdale, F.M. and Nadeau, D.B.: Solubilization of iron in cereals by milk and milk fractions. Cereal Chem, 61:332, 1984.
22. Superintendent of Documents, FR Do. 77-33062. Washington, D.C.: Fed Register, 1977.
23. Yetley, E.A. and Glinsmann, W.H.: Regulatory issues regarding iron bioavailability. Food Technol, 37:121, 1983.

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PLUMMER-VINSON SYNDROME

In this syndrome (also known as the Patterson-Brown-Kelly syndrome), there is an association between iron deficiency anaemia and dysphagia, often associated with the presence of an oesophageal web. There is often atrophy of the lingual papillae and, as in this case, there may be areas of leukoplakia present on the tongue. These leukoplakias have a sinister reputation for malignant transformation.

Tyldesley, W.R.: Oral Medicine.
Chicago: Year Book Medical Publishers, Inc.,
1978, p 75.

Abstracts

Proceedings of a Symposium Presented at the 125th Annual Session of the American Dental Association (10/22/84) Atlanta, GA.

Horowitz, H.S.: Introductory comments. J Dent Child, 52:258, July-August, 1985. There are advantages in using fluoride supplements compared with other methods of providing systemic fluoride. When the dosage schedule is followed, the precise amount of fluoride delivered should provide nearly uniform protection to children. Because children consume different amounts of water, they may receive the automatic benefits of community water fluoridation to varying degrees.

A primary disadvantage of dietary fluoride supplements is the degree of motivation required by all parties involved: practitioners, parents, and children. A rigorous regimen of taking the supplements daily for at least 13 years is required to obtain maximum benefits. Cariostatic effects have been proven unequivocally.

It is very important to educate the public and the professions about the value of dietary fluoride supplements. A distinguished panel of experts on their use has been assembled, to discuss such educational efforts and to report on dentists' and physicians' attitudes, knowledge, and practices with respect to these supplements.

Driscoll, W. S. What we know and don't know about dietary fluoride supplements—the research basis. J Dent Child, 52: 259-264, July-August, 1985.

The administration of dietary fluoride supplements has been shown unequivocally to be an effective procedure for preventing dental caries, approaching and sometimes exceeding the benefits generally expected from the consumption of fluoridated water. The latter, however, is far more economical and feasible for benefiting large numbers of children. Prescribing supplements is still recommended for children drinking water with suboptimal amounts of natural fluoride.

There is a need to clarify the role of prenatal fluoride administration. As there is uncertainty about the optimal time to initiate fluoride supplementation, the period during which such supplementation should be continued is also unclear. Some studies have addressed the issue, but their findings are equivocal. The decision on when to stop supplementation should be based on the professional judgment of a child's dentist. Combined therapies should be limited to children who are highly susceptible to caries attack.

Fluoride supplementation will result in obvious dental fluorosis only if the procedure is misused and reliable dosage schedules have not been formulated; if misused, it is clearly contraindicated in communities with greater than 0.7 ppm fluoride in their water supplies. Used properly and when indicated, dietary fluoride supplementation is a patently safe and highly effective measure for the prevention of dental caries.

Gift, H.C. and Hoerman, K.C.: Attitudes of dentists and physicians toward the use of dietary fluoride supplements. J Dent Child, 52:265-268, July-August, 1985.

The value of fluoride therapies, in conjunction with the other caries prevention measures, has been demonstrated by studies conducted during the last two decades. Acceptance, use, and delivery of such therapies, however, have not been uniform.

The primary foci of dental fluoride supplements are in areas without fluoridated water supplies, for children younger than 13 years old, especially for those not exposed to such community water as infants. Because of the emphasis on infants, this preventive method is a responsibility of physicians as well as dentists.

This paper presents results of a nationwide survey of both physicians and dentists regarding knowledge of and attitudes toward dietary fluorides. Prescription-writing patterns and self-perceived roles of each profession are also examined.

More education needs to be directed toward both professions, to ensure appropriate provision of these supplements and the best care for the child.

Horowitz, A.M.: Ways to improve/increase appropriate use of dietary fluorides. J Dent Child, 52:269-274, July-August, 1985.
Dietary fluoride supplements are not now being prescribed appropriately by health care providers, an example of the slow rate of acceptance of an effective caries preventive regimen available for nearly a quarter-century.

Industry, the American Dental Association Council of Dental Therapeutics, the American Academy of Pediatric Dentistry, the American Association for Dental Research, the National Foundation of Dentistry for the Handicapped, the W.K. Kellogg Foundation, and the National Institute of Dental Research have all initiated or supported a variety of activities to educate health care providers on the use of fluoride supplements and developing educational materials for providers to use in educating the public.

Barriers to appropriate use include the following factors: complexity of the dosage schedule; priority of preventive regimens in educational institutions; economic factors; and lack of public knowledge—clearly a barrier to their acceptance, appropriate use, and compliance.

Dental school faculty have a responsibility, to both their students and the general public, to provide appropriate information about dietary fluoride supplements and their use. Emphasis should be placed on educating dental students on the best ways of achieving compliance in their patients. Federal agencies might join the ranks as well, along with the individual dentist, in educating all relevant groups and promoting health through disease prevention.

Barbakow, F.; Scherle, W.; Imfeld, T.: Observations of SnF_2-treated human enamel using the scanning electron microscope. J Dent Child, 52:279–286, July-August, 1985.
Human enamel was ground flat, treated for 4 min with 8 percent SnF_2 and then immersed in water for 5 sec, 5 min, 60 min and 24 h. Products formed on the enamel included round globular and triangular-shaped crystalline structures which were removed after the treated enamel specimens were immersed in water for 24 h. In contrast, the non-water-washed treated enamel specimens had a distinct precipitate.

SnF_2-treated human enamel, Crystalline structures, Electron microscopy

Hartmann, C.; Pruhs, R.J.; Taft, T.B., Jr.: Hand-over-mouth behavior management technique in a solo pedodontic practice: A study. J Dent Child, 52:293–296, July-August, 1985.
The hand-over-the-mouth technique (HOM) was studied in a single-dentist pedodontic practice. The study included the frequency of its use relative to the patient's age, sex, previous dental experience and history of a significant medical experience. Observations were also made of the nature of subsequent appointments.

HOM was used for almost 10 percent of the patients studied in less than 2 percent of the total number of dental appointments. It was used most often for three-year-old patients, especially female. In the majority of cases (89 percent), it was used on a single occasion and that incident was followed by appointments of a positive nature.

Behavior management, Hand-over-mouth technique, Solo practice

Harbert, H.L.: Periapical healing after apicocurettage during apexification. J Dent Child, 52:303–305, July-August, 1985.
A case is presented in which conventional apexification with CaOH-CMCP paste was not successful at first. A minimal apicocurettage was done. Subsequently, the periapical bone healed and a dry, hard apical stop formed at the apical foramen. A gutta percha root canal filling was packed from the coronal access. This procedure offered a surgical alternative to an alloy retrofilling, when the usual apexification process was not successful.

Apicocurettage

Kane, J.F.; Stack, A.; Dickerson, J. *et al*: Comparison of dental crown heights in bite impressions. J Dent Child, 52:297–299, July-August, 1985.
A wax bite impression can serve as a reliable identification of missing and unknown children, particularly in the absence of caries and restorations.

Dental crown heights in bite impressions made from noncontoured and contoured wax wafers were compared in ten patients, ranging in age from three to eight years. The contoured wax wafer produced significantly greater crown heights in the casts which were fabricated from it. The differences were most pronounced in the anterior teeth; but generally true for all the teeth.

Identification, personal; Wax wafer, contoured; Wax wafer, noncontoured

Nelson, L.; Elfman, J.; Cohen, A.: The management of Ludwig's angina in a patient with severe hemophilia A factor VIII inhibitors: Report of case. J Dent Child, 52:306–311, July-August, 1985.
Dental treatment of a patient with classical hemophilia with inhibitors to factor VIII poses a serious management challenge. Ludwig's angina in this patient is truly a dramatic life-threatening complication of infection. Successful treatment requires the cooperation of several hospital services. This report describes the management of Ludwig's angina in a patient with severe classical hemophilia with a high titer of inhibitors to factor VIII.

Ludwig's angina, Hemophilia A, Dental treatment