ASDC AMERICAN SOCIETY OF DENTISTRY FOR CHILDREN

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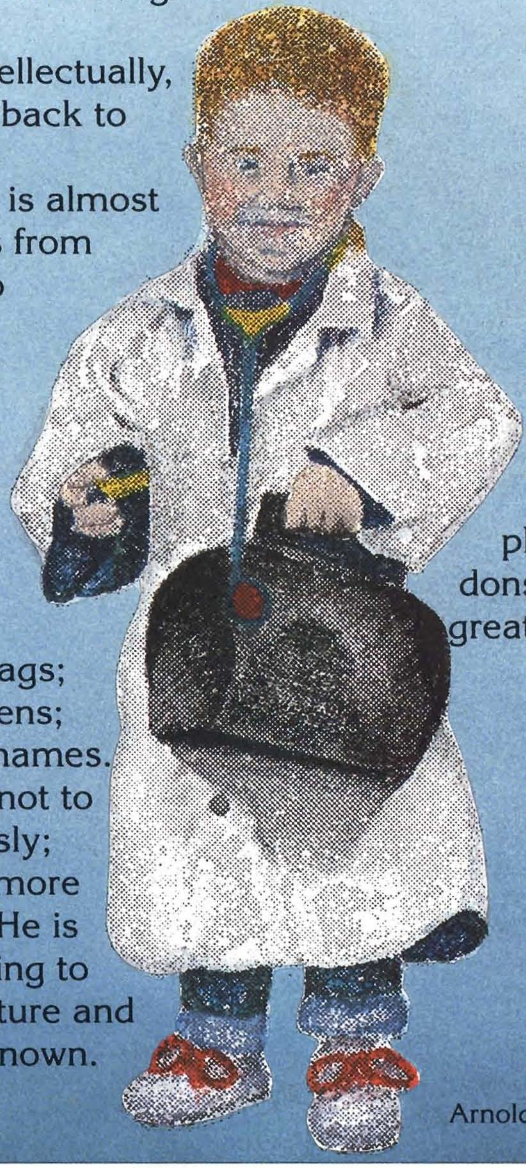
The four-year-old is assertive and expansive. He bursts with motor activity. He bubbles with mental activity, manifested in an abandoned use of words and in flights of fable and fancy. Emotionally and intellectually, however, he comes back to home base. His mental imagery is almost mercurial. It moves from one configuration to another with great agility.



In his dramatic play he doffs and dons his roles with the greatest of ease. He tells tall tales; he brags; he tattles; he threatens; he alibies; he calls names. But this bravado is not to be taken too seriously; his attractive traits more than compensate. He is fundamentally striving to identify with his culture and to penetrate its unknown.

Arnold Gesell—1946

RATIONALISM IS AN ADVENTURE IN THE CLARIFICATION OF THOUGHT.
—Alfred North Whitehead

DIFFERENTIATION MULTIPLICATION MOVEMENT

ASDC AMERICAN SOCIETY OF DENTISTRY FOR CHILDREN

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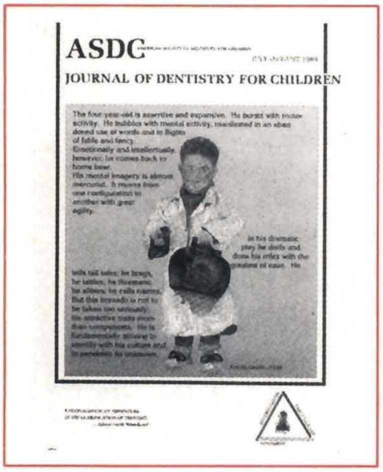

Although the four-year-old tends to go out of bounds, notably in his speech and imaginative antics, he does not get too detached from his moorings. Art and design by Sharlene Nowak-Stellmach.

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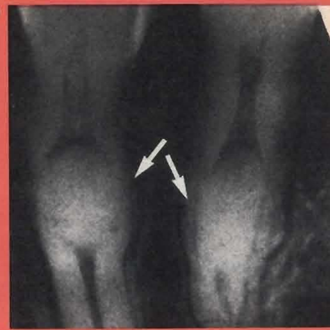

For the busy reader

Would you believe, decreases in dental caries and increases in the demand for dental care?—page 257

Between 1979-80 and 1986-87, there was a continuing decline in the prevalence of caries in primary and permanent teeth for all ages of school children. During this period, an increasing percent of children of all ages received dental services.

Requests for reprints should be directed to Dr. H. Barry Waldman, Professor and Chairman, Department of Dental Health, School of Dental Medicine, State University of New York at Stony Brook, Stony Brook, NY 11794-8715.

Improving conditions for pediatric dental practice are part of the changing environment for dentistry—page 262

The dental profession has recorded two major accomplishments during the 1980s: taking control of the production of the number of dentists and assuring the financial viability of practice. Practice patterns have changed with developments of contractual working arrangements with other practitioners and third parties.

Requests for reprints should be directed to Dr. H. Barry Waldman, Professor and Chairman, Department of Dental Health, School of Dental Medicine, State University of New York at Stony Brook, Stony Brook, NY 11794-8715.

***In vitro* acid production from starch and sucrose in saliva—page 267**

Wheat, corn and potato starches; two wheat flours, with and without phosphates; and an assortment of baked goods were the food items tested in this study. The results presented here leave no doubt that a variety of starches and starch- containing foods can be degraded *in vitro* by saliva to produce acid; in addition, some combinations of sugar and starch produce more acid than either alone.

Requests for reprints should be directed to Dr. Basil G. Bibby, Eastman Dental Center, Department of Oral Biology, 625 Elmwood Avenue, Rochester, NY 14620.

A clinical evaluation of the relative cariostatic effect of dentifrices containing sodium fluoride or sodium monofluorophosphate—page 270

A panel of 3,290 Indiana boys and girls were examined in this study at baseline and after two and three years. The NaF dentifrice showed significantly greater cariostatic activity than the Na_2PO_3F dentifrice in the more caries-prone of these subjects, a difference that must be attributed to a biological difference in the two fluoride compounds.

Requests for reprints should be directed to Dr. Bradley B. Beiswanger, Oral Health Research Institute, 415 Lansing Street, Indianapolis, IN 46202.

Marginal leakage of class II glass-ionomer-silver restorations, with and without posterior composite coverage: an *in vitro* study—page 277

The aims of this laboratory study were (A) to assess marginal leakage around three types of class II restorations (using conventional composite resin with a glass ionomer lining and glass ionomer cermet with and without composite resin coverage); and (B) to study the effect of thermocycling on marginal defects, by means of radiographs and SEM micrographs of the margins.

Requests for reprints should be directed to Dr. Marcio Guelmann, The Hebrew University, Hadassah Faculty of Dental Medicine, P.O.B. 1172, Jerusalem, Israel.

The glass ionomer rest-a-seal—page 283

The purpose of this paper is to describe an indication for use of glass ionomer cements with a clinical technique that minimizes chair time, while overcoming manipulation difficulties associated with their use.

Requests for reprints should be directed to Dr. Robert J. Henry, Assistant Professor of Pediatric Dentistry, Department of Pediatric Dentistry, University of Florida College of Dentistry, Box J-426, J. Hillis Miller Health Center, Gainesville, FL 32610.

Conservative treatment for malaligned permanent mandibular incisors in the early mixed dentition—page 288

This article points out that extraction of the mandibular primary incisors during the early mixed dentition can prevent this area from reaching maximum intercanine dimensional growth. Dentists should reassure the anxious parent that the primary incisor crowded by an erupted corresponding permanent incisor on its lingual side should exfoliate by the child's eighth birthday. Only after that time would such a tooth be considered overretained.

Requests for reprints should be directed to Dr. Milton E. Gellin, University of Kentucky, College of Dentistry, Department of Oral Health Practice, Section of Pediatric Dentistry, Lexington, KY 40536-0084.

Management of the difficult child: A survey of pediatric dentists' use of restraints, sedation and general anesthesia—page 293

In addition to pediatric dentists' experiences, utilization, selection criteria, and preferences for various aversive and pharmacologic management strategies for treatment of the difficult child, this report also examines the impact of variables, which include liability costs, practice location, caries prevalence, training and relative comfort level, preparedness for emergencies, and selection and utilization of specific techniques.

Requests for reprints should be directed to Dr. John E. Nathan, 800 Enterprise Drive, Oak Brook, IL 60521.

Report of project USAP: The use of sedative agents in pediatric dentistry—page 302

Sedation use varies widely around the country. Project USAP was performed to examine the use of sedation in pediatric dentistry in the United States and Canada; 1,105 practitioners responded. Questions concerned their use of nitrous oxide and other sedative agents; frequency of their use; percentages of their patients who were normal or handicapped; ages of patients receiving sedation; methods for monitoring patients; usual drugs, dosage, effects, and side effects; and emergency equipment and drugs available in the office.

Requests for reprints should be directed to Dr. Milton Houpt, Professor and Chairman, Department of Pediatric Dentistry, UMDNJ-New Jersey Dental School, 110 Bergen Street, Newark, NJ 07103-2425.

Dentin dysplasia type II: report of case—page 310

Dentin dysplasia type II is a rare, inherited disorder of dentin. The disorder is inherited as an autosomal dominant trait and affects both the primary and permanent dentitions. This is the only reported case of a patient with dentin dysplasia type II, known to the author, to have undergone orthodontic treatment successfully, despite the unusual root morphology.

Requests for reprints should be directed to Dr. Olwyn Diamond, 6666 Security Blvd., Baltimore, MD 21207

Demographic changes

Would you believe, decreases in dental caries and increases in the demand for dental care?

H. Barry Waldman, BA, DDS, MPH, PhD

A continuing decrease in the prevalence of dental caries in U.S. school children: that is the conclusion of the most recent National Institute of Dental Research (NIDR) report on the 1986-87 national study of almost 40,000 children.[1] "Almost half of U.S. children aged five through seventeen are completely caries-free in their permanent dentition. Almost two thirds of caries lesions involve occlusal surfaces. Interproximal caries is approaching eradication."[2] But at the same time, there are reports that children are increasing their use of dental services.

DECREASE IN DENTAL CARIES

Between 1979-80 and 1986-87, there was a continuing decline in the prevalence of caries in primary and permanent teeth for all ages of school children, which approximated the rate of decline that was observed during the 1970s.[2-4] During the 1980s, the average overall decayed-filled-surface (dfs) rate for primary teeth for children between five and nine years decreased from 5.31 to 3.91. Similarly, the decayed-missing-filled-surface (DMFS) rate for permanent teeth for children between five and seventeen years decreased from 4.77 to 3.07 (Tables 1 and 2).

In addition, during this period, in each age between five and seventeen years, the percent of children who

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were caries-free increased. Overall, the percent of all school age children who were caries-free increased from 36.6 percent to 49.9 percent (Table 3). Other findings included:

☐ While the decay (D) and missing (M) components of the DMFS decreased, the filled (F) component increased (Table 4).

☐ In all age-categories, female children had higher rates of dental caries than their male counterparts.

☐ While the decline in DMFS occurred in all geographic regions of the nation, by 1986-87, the Northeast and the Pacific states had the highest DMFS rates and the Southwest had the lowest rates (3.6 and 3.4 vs 2.4).[2]

USE OF SERVICES

Despite the continuing decrease in the prevalence of dental caries between 1979-80 and 1986-87, during this same period, an increasing percent of children of all ages was receiving dental services.*

☐ Source of information on the use of dental services

The National Health Interview Survey is a continuous cross- sectional nationwide survey conducted by household interview. Each week a probability sample of households is interviewed by personnel of the U.S. Bureau of the Census to obtain information on the health and other characteristics of each member of the household. Available information from various national studies on overall dental use patterns permits a review over a period of time. Information available from the 1986 survey of the civilian noninstitutionalized population represents data from 61,522 interviewees. (There was approximately a one-percent nonresponse rate for dental data.)[6]

☐ Percent of the population with a dental visit

Throughout the 1980s, there has been a progressive increase in the percent of children with reported visits to dentists. By 1986, almost a third of children between two and four years of age and 70 percent of children between five and seventeen years of age had visited a dentist in the previous year (Table 5).

Similarly, between 1978 and 1986, there was an increase in the percent of all children with reported visits to dentists in the previous two years and a decrease in the percent of all children who had never visited a dentist (Table 6).

*Some of the data for the 1983 and 1986 period, on the increasing use of dental services by children, were presented previously by this writer in an article in the *Journal of Dentistry for Children*.

Table 1 ☐ Prevalence of caries in primary teeth by age: 1979-80 and 1986-87.[2,3]

Age	Mean Decayed Filled Surfaces 1979-80	1986-87
5	4.03	3.40
6	4.76	3.73
7	5.52	4.20
8	6.11	4.24
9	5.95	3.89
Totals	5.31	3.91

Table 2 ☐ Prevalence of caries in permanent teeth by age: 1979-80 and 1986-87.[2,3]

Age	Mean Decayed Missing Filled Surfaces 1979-80	1986-87
5	0.11	0.07
6	0.20	0.13
7	0.58	0.41
8	1.25	0.71
9	1.90	1.14
10	2.60	1.69
11	3.00	2.33
12	4.18	2.66
13	5.41	3.76
14	6.53	4.68
15	8.07	5.71
16	9.58	6.68
17	11.04	8.04
Totals	4.77	3.07

Table 3 ☐ Percent of caries free children by age: 1979-80 and 1986-87.[2,3]

Age	1979-80	1986-87
5	95.4%	97.3
6	89.7	94.4
7	76.5	84.2
8	58.6	75.0
9	50.6	65.5
10	37.9	55.7
11	33.7	45.0
12	26.9	41.7
13	21.1	34.0
14	19.6	27.7
15	14.9	21.8
16	11.8	20.0
17	10.7	15.6
Totals	36.6	49.9

Table 4 ☐ Percent of DMFS due to Decayed, Missing and Filled Surfaces: 1979-80 and 1986-1987.[2,3]

	1979-80	1986-87
Decayed	16.8%	13.4%
Filled	76.1	82.3
Missing	7.1	4.3

Table 5 ☐ Percent of children with a dental visit within the past year: 1978-79, 1981, 1983, 1986.[7-10]

Age	1978-79	1981	1983	1986
2-4 yrs.		28.4%	28.4%	31.3%
< 5 yrs.	14.3%	14.9		18.7
< 6 yrs	21.2	21.7	23.1	
5-11 yrs.			67.2	70.7
5-14 yrs.	64.1	64.6		70.7
6-16 yrs.	64.2	64.7	66.1	
12-17 yrs.			66.7	69.9

Table 6 ☐ Percent of children by age and the time since last dental visit: 1978, 1981, 1983, 1986.[6-8]

	Younger than 6 years of age			6 to 17 years of age		
Last dental visit	1978	1981	1983	1978	1981	1983
Younger than 1 year	21.2%	21.7%	23.1%	64.2%	64.7%	66.1%
1-2 years	3.6	3.5	5.4	15.5	14.5	14.8
Subtotal	24.8	25.2	28.5	79.5	79.2	80.9
2 + years	0.9	1.0	1.0	11.2	11.6	11.3
Never	74.3	73.4	70.5	9.1	8.1	7.8

	2 - 4 years of age		5 - 17 years of age	
Last dental visit	1983	1986	1983	1986
Younger than 1 year	28.4%	33.5%	67.0%	71.5%
1-2 years	2.8	2.7	11.7	8.5
Subtotal	31.2	36.2	78.7	80.0
2-5 years	1.0	0.9	8.9	10.1
5 + years	—	—	2.1	2.2
Never	64.2	62.9	8.9	7.7

The increase in the percent of children with a dental visit was for a wide variety of demographic groups, by age, gender, race and family income groups. There were differences, however, within the various demographic groupings. For example, by 1986, in each age-category, a greater percentage of female children, than their male counterparts, had reported dental visits (Table 7).

☐ Number of dental visits

Between 1978-79 and 1986, the number of dental visits per child, for the most part, changed marginally. In the early years (younger than five years) there were limited changes. In the age-range of five to seventeen years, there were increases in some ages and decreases in others (Table 8).**

In addition, between 1983 and 1986, for children, two to four years of age, there was an increase in the percent of children with reported visits in each of the annual visit categories (i.e. 1,2,3, to 4 and 5 + annual visits). For older children, there was an increase in the percent reporting one or two visits and a decrease in the percent reporting three or more visits (reflecting decreasing service needs) (Table 9).

Overall, between 1983 and 1986, the increasing population of children between two and four years of age was reported to have increased their total number of dental visits. During the same period, despite an increase in number of older children, there were decreases in the total number of dental visits (Table 10).

**Because of the continuing changes in the survey reporting age-cohorts throughout the period covered in the dental disease prevalence studies, direct comparisons of dental service use data between 1978-79 and 1986-87 cannot be made for all age-groups. To some degree, therefore, changing dental use patterns will include separate reviews of early 1980s data and some middle 1980s data that were reported previously.

Table 7 ☐ Percent of children with a dental visit in the past year by age and gender: 1983, 1986.[6,8]

	1983		1986	
Age	Male	Female	Male	Female
2-4 yrs.	29.1%	27.8%	31.2%	31.3%
5-11 yrs.	67.6	66.9	69.4	72.0
12-17 yrs.	64.6	68.9	68.1	71.8

Table 8 ☐ Number of visits per child: 1978-79, 1981, 1983, 1986.[7-10]

Age	1978-79	1981	1983	1986
2-4 yrs.		0.7	0.7	0.7
< 5 yrs.	0.4	0.5		0.4
< 6 yrs.	0.6	0.6	0.5	
5-11 yrs.			2.1	2.0
5-14 yrs.	2.0	2.0		2.3
6-16 yrs.	2.1	2.2	2.6	
12-17 yrs.			2.9	2.8

Table 9 ☐ Percent distribution of all children by the number of dental visits in the past year: 1983, 1986.[6,8]

Age and number of visits	1983	1986
2-4 years		
None	71.3%	67.8%
1	17.7	20.9
2	7.2	8.2
3-4	1.4	2.2
5+	0.8	0.9
5-17 years		
None	32.7%	29.1%
1	27.0	29.4
2	20.6	24.5
3-4	9.7	7.9
5+	9.3	9.0

OVERVIEW

Davies, Bailit and Holtby, reporting the relationship between oral health status and the use of dental services, concluded that, "Intuition suggests that healthier people will demand less dental care. We have little definitive evidence, however, to support this hypothesis."[11] Their review indicates a number of factors may affect the relationship between oral health and demand for or utilization of services. They note that dental insurance and perceived need for care have substantial effects on utilization. What remains unresolved is the relative contribution of oral health status and other factors in explaining the use (or nonuse) of dental treatment and the nature of the relationship between these factors. They further conclude that, "...it is premature to predict that the current improvement in oral health necessarily will reduce consumer demand for dental care." An intriguing hypothesis presented is that, "...improved oral health might lead to a greater demand for dental services."[11]

This hypothesis is considered in terms of the fact that better educated and higher income groups enjoy better oral health; but, at the same time, they use more services than the less socioeconomically advantaged. More education and income may lead people to demand a higher standard of oral health and enable them to obtain it. It could follow that, as a population becomes better educated and more affluent, on average, the demand for dental care could increase despite improvements in oral health. In considering this hypothesis, it is significant to note that the level of education of the many segments of our society is increasing.[12]

□ Third-party coverage

In addition, insurance coverage of dental services increasingly is removing the economic barriers to dental services. For example, between 1981 and 1986, the percent of employees in medium and large firms with dental insurance increased from 61 to 71 percent. And further, increasingly, 100 percent of the usual, customary, and reasonable costs for the various categories of dental services are covered by dental insurance programs.[13] But most important, for children, "...dental insurance attenuates differences in demand for dental care between low-income and high-income families..."[14]

In 1986, over 40 percent of almost fifty-six million children in the United States between two and seventeen years of age (23.7 million) were covered by some form of private dental insurance. Insurance coverage for children of all ages increased during the 1980s. By 1986, a greater percentage of children between five and seventeen had dental insurance coverage than the overall population. Only the adult population between thirty-five and fifty-four years of age had a higher rate of dental insurance coverage.[10,15]†

Table 10 □ Population and total number of dental visits by age: 1983, 1986.[6,8]

	Population		Visits	
	1983	1986	1983	1986
	(In thousands)			
2-4 yrs.	8,710	10,861	7,166	8,109
5-11 yrs.	18,630	23,503	47,268	46,934
12-17 yrs.	18,196	21,455	63,362	59,452

While there have been increases in private dental insurance coverage, between federal fiscal years (FYs) 1981 and 1987, there was a 19 percent national decrease in constant dollar Medicaid expenditures (eliminating the effects of inflation) per dental recipient. And further:

□ Twenty-two states and the District of Columbia decreased current dollar expenditures per Medicaid dentistry recipient.

□ Forty-one states and the District of Columbia decreased constant dollar expenditures per Medicaid dentistry recipient.

□ Some states reported large increases in the number of children receiving Medicaid dental services. Twenty-one of the thirty- three states (for which FYs 1981 and 1987 data are available from the American Dental Association) reported decreases, however, in the number of children receiving Medicaid dental services.[17,18]‡

□ Knowledge

The results from the 1979-80 and 1986-87 studies indicated that during the 1970s and 1980s, demand for dental services by children between five years and seventeen years (as measured in terms of filled teeth) did not decline.[2,20] Rather, the ratio of filled teeth to total caries experience increased and there is less untreated dental caries in children. The general public is getting the message. In response to a 1985 national study on health promotion and disease prevention, more than 95 percent of the respondents in all age-cohorts over seventeen years reported that it was important to see a dentist on a

†For a more detailed review of dental insurance for children, see an earlier presentation by this writer.[16]

‡For a more detailed review of the changing dimensions of Medicaid dentistry, see an earlier presentation by this writer.[19]

regular basis; 98 percent recognized the importance of brushing and flossing of teeth; and 96 percent recognized the primary causes of the loss of teeth in children.[21] In general, "The general decline or leveling off in the use of services may reflect several factors, including a decreasing need for treatment in the population; and a general decrease in demand for services, because of economic factors."[22] (1983, reflecting on developments through the 1970s and the economic recession of the early 1980s). This should be compared to a 1987 reflection on developments through the mid-1980s, "Providing dental services for the younger population has changed indeed; but available information continues to document a continuing and growing demand for services by this segment of our community."[23]

There have been many developments in the delivery of dental services and the general economics of the profession during the four intervening years when this writer wrote the above statements. These changes continue into the second half of the 1980s with increasing evidence documenting a continuing and favorable environment for the provision of pediatric dental services.

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Improving conditions for pediatric dental practice are part of the changing environment for dentistry

H. Barry Waldman, BA, DDS, MPH, PhD

Results from National Health Interview Surveys in the 1980s document the increase in the use of dental services by the general population and by children of all ages, males and females, whites and blacks and in all family income groups."[1]

By 1986, a third of children between two and four years of age and over 71 percent of children between five and seventeen years of age had visited a dentist in the previous year (Table 1). Throughout the 1980s, evidence has been building that children increasingly are using the services of dental practitioners, parents are aware of the dental needs of their children, and the future prospects of dentistry have improved dramatically.[3-9]

The improvements in pediatric dental practice during the 1980s, are part of the changing and improving set of conditions and general environment for the practice of dentistry. The following presentation will provide a general review of many of these developments and consider the general potential for pediatric dental practice in the future.

NUMBER OF DENTISTS

Starting in 1988, the American Association of Dental Schools, working in cooperation with a commercial corporation that developed a manpower projection model, issued two reports on dental manpower projections through the year 2000 and beyond. The model displays a host of demographic characteristics (including age, gender, specialty, state location, dental school and years of experience) as well as considerations of economic developments and anticipated population changes (e.g. the decreases, between 1989 and 1993, in the size of the twenty-one to twenty-four-year-old age-cohort and its effect on the applicant pool during the period). Annual projection data are now available for dental school enrollment, number of graduates, number of active dentists, and dentists per population.[10] The combination of available past information from the American Dental Association and the manpower projection data provides an opportunity to review the marked changes in dental personnel numbers that will occur as a result of the dramatic contraction in entering dental school sizes. For example:

- ☐ Between 1978 (the year with the greatest number of first year entering dental students) and 1988, the sizes of the entering classes decreased by a third.
- ☐ Overall, by 1995, entering class sizes will decrease by approximately a half (47.3 percent) (Table 2).
- ☐ By 1988, the number of entering places per million population reached the lowest level in forty years, and it will continue to decrease in the 1990s (Table 3).
- ☐ In 1989, there are 138,749 active civilian dentists with a ratio of 56.5 dentists per 100,000 population. The number of dentists will increase to a maximum of 143,039 in 1996. Reflecting the increase in the general population, by 1996, however, the dentist-to-population ratio will decrease to 54.7 per 100,000.

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Table 1 ☐ Percent of children by age with a reported dental visit in the past year and who have never visited a dentist: 1983, 1986.[2]

	2-4 years of age		5-17 years of age	
Dental visits	1983	1986	1983	1986
Within past year	28.4%	33.5%	67.0%	71.5%
Never	64.2	62.9	8.9	7.7

Table 2 ☐ First year dental school enrollments, dental school graduates, number of active dentists and dentists per 100,000 population: selected years 1978-2010.[10, 11]

Year	First year enrollment	Graduates	Number of active dentists	Active dentists per 100,000 population
1978	6,301	5,324	120,620	53.9
1988	4,198	4,473	138,749	56.5
Projected				
1990	3,896	4,038	140,699	56.3
1995	3,321	3,327	142,867	55.0
2000	3,369	2,955	142,379	53.0
2010	3,916	3,509	137,197	48.4

Table 3 ☐ Dental school entering places and places per million population: selected years 1950-1996.[10-12]

Year	Number entering places	Entering places per million population
1950	3,226	20.3
1960	3,616	19.0
1974*	5,617	25.1
1978**	6,301	26.8
1980	6,030	26.6
1988	4,198	17.1
Projected		
1990	3,896	15.6
1995	3,321	12.8

* Year of the most applicants to schools of dentistry (14,970)
** Year of the most entering places in schools of dentistry

Table 4 ☐ Number of employees in dental establishments and percent change: 1980-1986.[13]

	Number of dental establishments		
Number of employees	1980	1986	Percent change
1-4	58,666	60,037	2.3%
5-9	21,877	31,270	42.9
10-19	4,000	7,603	70.8
20-49	548	985	79.7
50+	59	96	62.7
Totals	85,691	99,991	16.7%

☐ From 1997 through the year 2000 and beyond, there will be a continuing decrease in the number of dentists and the dentist-to- population ratio. By the year 2000, the dentist-to-population ratio will decrease to 53.0 per 100,000; and 48.4 per 100,000 in the year 2010, the lowest it has been since 1920 (Table 2).

☐ There will be marked decreases in the number of male dentists: about 30 percent in the next thirty-three years.

☐ There will be marked increases in the number of female dentists during the same period: about 350 percent.

☐ In 1987, 56 percent of active dentists were younger than forty-five years of age; 30 percent were between forty-five and sixty. Over the next twenty years, the percent of active dentists who are younger than forty-five years of age will decrease to 36 percent, and those between forty-five and sixty will increase by 50 percent.[10]

THE CHANGING PATTERN OF DENTAL PRACTICE

Throughout the 1980s (except for 1982, during the last economic recession) there was an overall annual increase in employment in dental offices. Between 1980 and 1986, there was a 16.7 percent increase in the total number of dental establishments* in the United States.

In 1986, dental establishments that employed fewer than five individuals still represented 60 percent of all dental establishments. Between 1980 and 1986, however, there was only a 2.3 percent growth in these smaller facilities. (Between 1985 and 1986, there was an actual numeric decrease of the smaller establishments from 60,444 to 60,037 establishments.) But during the same period, establishments with greater numbers of employees increased as much as 80 percent. By 1985 and 1986, one dental establishment had more than 250 employees (Table 4). In 1986, 96 percent of independent dentists† employed some full or part-time staff; 43.8 percent had one to three employees; 52.2 percent employed four or more staff members.[14]

In addition to the marked increases in the number of larger dental establishments, there have been significant developments in practice ownership arrangements. Between 1975 and 1986, there was a small decrease (3.4 percent) in the number of sole proprietorships. During the same period, however, there was a 175 percent increase in the number of professional corporations and a 264 percent increase in the number of partnerships. The actual number of partners per partnership remained relatively constant (Table 5). In addition, franchise arrangements, preferred provider organizations, health maintenance organizations, dental offices in department stores and just about any other location that can be imagined, have changed dramatically the landscape of dental practice.

*An establishment is a single physical location at which business is conducted. It is not necessarily identical with a firm, which may consist of one or more establishments.

†An independent dentist can either be a solo practitioner in an unincorporated dental practice, a partner in a complete or limited partnership, or a shareholder in an incorporated practice.

THE ECONOMICS OF DENTISTRY

Any effort to describe the developments in dental economics is complicated by complex business accounting procedures.

"The dental profession has learned some valuable lessons from corporate America. The name of the game is get money *into* (sic) the overhead of practice—health benefits, vacations, the company car, tax shelters, IRAs, Keogh Plans. Dentists have learned to place these items into overhead and make it tax deductible."[19]

However, Internal Revenue Service reports on dental practice, Health Care Financing Administration (HCFA) overall national expenditure data, and survey reports on business receipts that appear in professional and proprietary publications do permit a review of the evolving economics of practice. Yet one must consider the reality that business receipts may be under-reported or over-reported in some reports. For example, in 1986, the following business receipts per sole owner were reported:

☐ Internal Revenue Service, $114,623.[18]
☐ Dental Management, $186,797.[20]
☐ American Dental Association, $198,490.[14]
☐ Health Care Financing Administration (national expenditures, per dental practitioner), $206,660.[21]

In an attempt to overcome these difficulties, data from the different studies were considered separately, The assumption was made that the rate of under-reporting and/or over-reporting in a particular report did not vary significantly from one year to another.

Throughout the 1970s and 1980s, the average annual percent increase in national dental expenditures was greater than the overall Consumer Price Index (at times more than six times the rate). In addition, throughout the 1980s, the percent increase in national dental expenditures consistently has been greater than the percent increase for overall personal health expenditures and hospital care expenses. Between 1984 and 1985, the percent increase in dental expenditures was the highest for all components of medical care services (Table 6).

Despite the increase in the number of dentists, between 1980 and 1987, current and constant dollar (i.e. removing the effects of inflation) national expenditures per dentist increased annually. The single exception was the decrease that occurred in constant dollar expenditures per dentist in 1981, the period of the last economic recession (Table 7).

But it is the increasing cost of delivering dental services (essentially the difference between gross and net income) that raises significant concerns. The days are gone, when professional expenses averaged less than half of practice gross receipts. For example, in 1970, overhead expenses represented 48.1 percent of gross income for independent dentists.[14] By 1986, overhead expenses increased to almost two-thirds (64.7 percent) of gross receipts. Nevertheless, based upon Health Care Financing Administration national expenditure data per practitioner and ADA Survey of Dental Practice gross receipt data, constant dollar dental practitioner net income increased throughout the 1980s (Table 8).

Table 5 ☐ Dental practice ownership arrangements: selected years 1975-1986.[15-18]

Year	Number			
	Sole proprietorships	Partnerships	Partners	Corporations
1975	82,735	2,241	4,863	15,029
1980	82,265	3,609	8,722	32,179
1986	79,904	8,158	19,234	41,411*

* Fiscal year, July 1985-June 1986

Unfortunately, since 1981, the American Dental Association no longer reports individual specialty income data in the Survey of Dental Practice. All income information is supplied in the composite "specialist" category. The proprietary publication, "Dental Management," however, does provide gross income data by the individual clinical specialties. During the 1980s, pediatric dentists consistently have reported gross income data that are greater than reports by general practitioners and Health Care Financing Administration reports for national expenditures per active dentist (Table 9).‡

OVERVIEW AND COMMENTARY

It is most important to realize that the ongoing improvement in general and pediatric dental practice during the 1980s occurred despite a continuing decline in the prevalence of caries in primary and permanent teeth of all ages of school-age children, a decline that approximated the rate of decline that was observed during the 1970s.[28-30] During this period, the traditional "bread and butter of dental practice that paid for the rent", (i.e. the continuous placement and replacement of amalgam restorations) increasingly has given way to broader conservative and prevention-oriented practices.

The public and third parties have learned that prevention works, and practitioners are able to develop and

‡Note: Gross and net income survey data that are developed by, and presented in, the publication, "Dental Economics," were not considered as valid because of the consistently low annual response rate of 2.5 percent or less.[24]

Table 6 ☐ Average annual percent change in national health expenditures: 1970-1987.[21-23]

	Average annual percent change from previous shown year					
	1970	1980	1984	1985	1986	1987
Consumer Price Index	—	11.2%	6.1%	3.5%	1.5%	3.6%
Overall personal health expenditures	—	12.9	11.7	8.6	8.8	9.3
Hospital care	—	13.8	11.4	7.0	7.4	9.5
Physician services	—	12.6	12.6	9.8	11.1	11.5
Dentist services	—	12.5	12.4	9.9	9.5	10.8

Table 7 ☐ Number of dentists and current and constant dollar national dental expenditures per active dentists: selected years 1980-1990.[21-24]

Year	Number of dentists*	Total dental expenditures**	Current dollar expenditures per dentist	Constant dollar expenditures per dentist
1980	126,240	$15.4	$121,989	$49,428
1981	129,180	17.3	133,921	49,163
1982	132,010	19.5	147,716	51,095
1984	137,950	24.6	178,325	57,320
1986	143,230	29.6	206,660	62,929
1987	137,809	32.8	238,010	69,920
Projections				
1990	140,699	41.1	292,112	72,773

* Includes dentists in the federal service
** In billions
*** Note decrease during the period of the economic recession
Note: Number of dentists (1982 to 1986) is based on the ADA 1982 survey and projections. Number of dentists (1987 and beyond) is based on an updated 1987 ADA survey and projections, as well as the AADS manpower committee report. The updated 1987 data indicate a greater retirement rate than anticipated in the 1982 report.[10]

Table 8 ☐ ADA net income figure as a percent of gross receipts, and constant dollar net income based on national expenditures per practitioner and ADA gross receipt data: selected years 1981-1986.[14,21,22]

		Constant Dollar Net Income	
Year	(ADA) (Solo Pract.) Net income as a percent of gross receipts	(HCFA) expenditures per dentist	(ADA) Gross receipt data
1981	43.0%	$19,728	$20,046
1983	37.4	20,295	19,770
1985	36.1	21,569	20,149
1986	35.3	23,099	21,345

Table 9 ☐ General practitioner and pediatric dentist gross income, and national dental expenditures per active dentist: 1982, 1984, 1986, 1987.[20,21,24,26,27]

	1982	1984	1986	1987
Pediatric dentists	$182,856	$181,428	$194,912	$241,187
General practitioners	146,269	153,346	179,580	206,559
(HCFA) Expenditures per active dentist	147,716	178,325	206,660	225,507

maintain financially rewarding practices, while meeting the demands of an ever enlarging segment of the population.

The dental profession has recorded two major accomplishments during the 1980s: taking control of the production of the number of dentists and assuring the financial viability of practice. But during this same period, the patterns of dental practice have changed dramatically. Increasingly, the traditional pediatric arrangement (often a single practitioner operating independently on a referral basis) has and will (must?) develop a series of contractual working arrangements with other practitioners and third parties that reflect the developments throughout the profession. While there will probably always remain the opportunities for traditional specialty practice arrangements, pediatric dental practices (with their increasing emphasis on special pediatric populations, including developmentally disabled and medically compromised children) will be drawn into the world of HMOs, IPAs, PPOs and the rest of the regulated alphabet soup.

While these changes may seem formidable (and indeed for many they will be), the reality is that pediatric dentistry and the dental profession in general have survived some very difficult times and the future will be different. But it appears that it will be bright!

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In vitro acid production from starch and sucrose in saliva

Prevention

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W.D. Miller's conclusion that starch in bread or potatoes was more cariogenic than sugar was based on his tests that showed that after twenty-four or forty-eight hours of incubation in saliva, more titratable acid was formed from starches than from sugar.[1] This was an understandable over-interpretation of his findings because at the time the work was done, it was not realized that during the fermentation by saliva, the acid buffering capacity of the starches delayed the early development of a pH that was low enough to inhibit the continuing acid formation from sugar.[2] Unfortunately, few other laboratories have used similar test procedures and the possible contribution of starch foods to caries causation has been almost ignored.

The possibility that bacterial acid production from food starches, or from mixtures of such starches with sugar, plays a part in caries causation is suggested by some epidemiological studies that have associated consumption of wheat flour or starchy snack foods with caries activity in man.[3-5] That starches may be more important in this respect than is generally believed is indicated by the finding that heated wheat flour was fermented by S. *mutans*, and that the amylose and amylopectin components of starch were fermented by seventeen freshly isolated strains of oral streptococci.[6,7] In addition, starch seems to stimulate sucrose fermentation by saliva or by streptococci and increase sucrose-

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associated rat caries.[8-10] Of greater relevance to human caries are demonstrations that cooked starches depress the pH of dental plaques to about the same level as does sucrose.[11,12] Additionally, the fermentation of starch in unsweetened food has been shown to demineralize enamel.[13] Because the dental literature contains little information on acid production from starch and starch-sugar mixtures by oral bacteria, we are reporting here some tests bearing on that subject.

From our previous work, we reasoned that tests that ran for no more than four hours would largely eliminate the confusing effect of continuing bacterial acid production from the test foods and at the same time be relevant to what we know about the duration of acid production and food clearance from the mouth.[2]

MATERIALS AND METHODS

The food items tested were: wheat starch, corn starch, and potato starch, two wheat flours, one containing phosphate (Pillsbury) and one with no added phosphate (Gold Metal), and an assortment of baked goods. This included "special wheat" bread (containing whole meal, honey and molasses), soft white (Wonder) bread, Italian bread, pumpernickel bread, plain bagel, plain English muffin, and yellow cake. The pure starches were obtained from chemical supply houses and the flours and baked goods from a local food store.

For some tests, the flour (40 percent) and sucrose (25 percent) were mixed with water (35 percent) and baked at 120°C to form "laboratory cakes". These were mixed with appropriate quantities of water to give, after the addition of equal quantities of saliva, test substrates with desired levels of sucrose or starch. The starches were heated either dry or suspended in deionized water. The breads and other baked foods were tested after mixing one part (w/w) with nine parts of 50 percent saliva in water. Scrapings from a freshly cut raw potato, or from one boiled without salt until table ready were used for the tests on potato.

All tests were run in mixtures made to contain a 50 percent final concentration of whole human saliva. The saliva, mainly from one donor, was collected without stimulation in a chilled beaker for about one hour before breakfast and for a similar period beginning one hour after eating. The aliquots of saliva needed for the tests were withdrawn from the previously sonicated saliva pool while it was being stirred. The tubes containing the fermentation mixtures were incubated in the dark in a rocking water bath for four hours at 37.5°C. In the early runs, a sufficient number of fermentation tubes were prepared to permit making pH measurements and acid titrations after one, two, three and four hours; but in most of the later runs these were made only after four hours. Titrations were made to pH 7.0 using 0.1 mol/L NaOH.

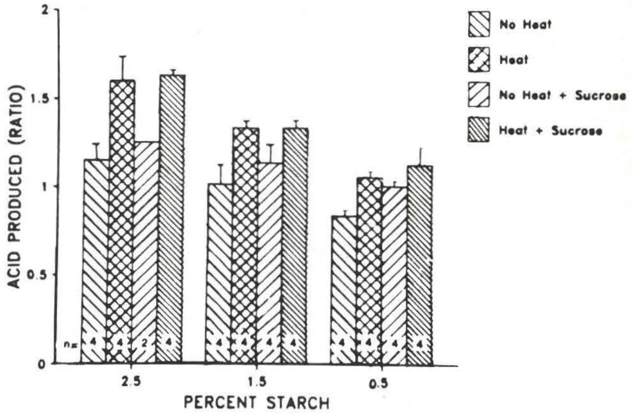

Figure. Effect of heating on acid formation from wheat starch incubated in saliva and effect of sucrose addition to acid production from both unheated and heated starch. (Error bars show standard deviations).

Because of the day-to-day variations in the fermentative power of saliva, the results of tests made with salivas collected on different days cannot be compared directly. To make this possible, a method we have used previously was followed. Two or three aliquots of the saliva collected each day were taken to make control runs of acid production in 2 percent sucrose. The mean value obtained from these runs was assigned a value of one ($C<1$) and the amounts of acid found in all other tests done with that day's saliva were recorded as ratios of the control value. These ratio figures were then used for comparisons with different samples of saliva and the findings subjected to statistical evaluation using ANOVA or Newman-Keuls methods.

RESULTS

The early tests in which the pH of the fermentation mixtures were measured each hour and acid titrations made after two, three and four hours of incubation seldom gave evidence of acid production before the two-hour point.

Incubation of the mixtures of wheat flour and sucrose produced more acid ($p<0.004$) than did sucrose alone (Table). The findings on acid production from different concentrations of heated and unheated wheat starch are shown in Figure. Of the three starch concentrations

Table □ Acid produced from sucrose alone and wheat flour plus sucrose in saliva.

				Acid produced (ratios*)				
	Donor	Percent sucrose	n	Sucrose only Mean (SD)	n	Sucrose and flour Mean (SD)	p	Percent flour
Saliva	A	5	6	1.00 (0.09)	6	1.85 (0.29)	0.0004	8
		10	14	0.96 (0.11)	9	1.65 (0.26)	0.0001	16
Saliva	B	5	2	1.18	6	2.51 (0.20)		8
		10	2	1.04				

*As compared with daily 2 percent sucrose controls (C = 1)

tested (2.5, 1.5 and 0.5 percent), fermentation of the heated starch produced significantly more acid ($p<0.0001$, $p<0.002$ and $p<0.0002$, respectively) than unheated samples.

Duplicate tests on acid production from several starches showed that both unheated and heated potato starch gave more acid (1.53 and 1.66) than corn starch (1.00 and 1.33) or wheat starch (0.88 and 1.20).

There was a wide spread in the amounts of acid given by the assorted starch foods that were tested. Listed in descending order, with statistically different Newman-Keuls groupings separated by /, the amounts of acid formed were: boiled potato (2.50 ± 0.10), "special wheat" bread (2.24 ± 0.68), English muffin (2.19 ± 0.00), raw potato (2.13 ± 0.03), yellow cake (2.02 ± 0.08), /plain wheat flour (1.83 ± 0.03), phosphate-enriched wheat flour (1.83 ± 0.03), bagel (1.67 ± 0.05), / soft white bread (1.39 ± 0.05), Italian bread (1.35 ± 0.08), pumpernickel bread (1.26 ± 0.03).

DISCUSSION

Our results leave no doubt that a variety of starches and starch-containing foods can be degraded *in vitro* by saliva to produce acid and that some combinations of sugar and starch produce more acid than either alone. The finding in our tests with saliva that so much acid is produced from starch makes it unnecessary to assume, as has been suggested for streptococcal fermentation, that starch has a synergistic effect on sucrose fermentation.[9]

The small series of tests on some assorted starch foods brought out a few points of interest, namely, that in the test system we used, the fermentation of boiled potato produced more acid than did that of the other test items, that the "special" wheat bread produced more acid than the muffin, cake, and other breads. The higher acid yield from the "special bread" than from the other breads can be attributed to its content of molasses and honey, but this cannot account for it being more acidogenic than the muffin or cake that, judging by taste and what we know of their contents, have higher contents of sugar. A possible explanation is that the "special bread" contains whole wheat and molasses, both of which produce more acid than their refined counterparts.[8] It is also worth noting that the phosphate content of wheat flour did not, as was expected, increase the yield of acid.

Obviously, what we have reported here needs to be greatly expanded before findings of the sort we have presented could be used as a guide for selecting foods for caries control. Their value at this time is mainly that they draw attention to some characteristics of food that could influence their cariogenicity, particularly the part that the contents of different types of starches could play in determining their acid production in the mouth.

In view of the established practice of cooking foods to make them more digestible and the well known effect of salivary amylase on cooked starch, it is surprising that the effect of heat and industrial processing of starchy foods has not received more attention in caries research. The whole question of the role that nonsugar carbohydrates play in caries causation deserves further investigation than it so far has been given.

We thank Mr. Bill Murphy for carrying out the statistical analyses.

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Clinic

A clinical evaluation of the relative cariostatic effect of dentifrices containing sodium fluoride or sodium monofluorophosphate

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The results of numerous clinical trials conducted during the past three decades have clearly demonstrated the cariostatic impact of fluoride-containing dentifrices.[1,2] With but few exceptions, the home use of dentifrices containing fluoride in combination with a compatible abrasive system has been found to reduce the incidence of dental caries by 25 to 40 percent. In fact, several reports have suggested that the widespread use of communal fluoridation and effective fluoride dentifrices has been primarily responsible for the decline in dental caries repeatedly observed in the more developed countries of the world during the past decade.[3-6]

Beginning with the acceptance of the first effective fluoride dentifrice, a SnF_2 formulation, in 1964, major research efforts have been directed toward the identification of more efficacious fluoride dentifrices. In 1969, the first dentifrice containing Na_2PO_3F was accepted by the American Dental Association, and the results of six clinical trials indicated that the efficacy of this dentifrice was not significantly different from the original SnF_2 product.[2] The first reports of an improvement in efficacy

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occurred in 1981 when the use of a NaF dentifrice, formulated with a highly compatible silica abrasive system was observed to be significantly more effective than the original SnF_2 formulation.[7,8] This finding ultimately resulted in the present situation in the United States in which nearly all ADA-accepted fluoride dentifrices contain either NaF or Na_2PO_3F.

This, of course, has led to the inevitable question regarding the cariostatic comparability of dentifrices containing either of these two fluoride compounds. The results of nine clinical trials comparing NaF and Na_2PO_3F have been reported. In 1972, Gerdin compared NaF and Na_2PO_3F dentifrices (1000 ppm F) provided to children who were 11.5-12.5 years of age at the beginning of the study; after two years the NaF dentifrice was observed to be significantly more effective than the Na_2PO_3F formulation with the magnitude of the difference being 14 percent.[9] The same year Zacherl reported a trial testing the clinical efficacy of dentifrice containing 1000 ppm fluoride as either stannous fluoride, neutral sodium fluoride, sodium monofluorophosphate or an acidulated fluoride phosphate.[10] All the dentifrices employed a moderately compatible calcium pyrophosphate abrasive system. After twenty months, the group using NaF had 7 percent fewer new DMF surfaces than the Na_2PO_3F group, but this difference was not significant at $\alpha = 0.05$. A subsequent study by Edlund and Koch similarly compared NaF and Na_2PO_3F dentifrices (1000 ppm F).[11] After three years of supervised use, eleven-year old children using the NaF dentifrice had significantly fewer new carious surfaces (by 23 percent) than those using the Na_2PO_3F dentifrice and similar differences were observed in all children (nine through eleven years of age) during both the second (21 percent) and third (16 percent) years of the study.

Three additional studies compared the efficacy of these fluoride compounds in children who were also using fluoride rinses; although the differences in the caries rates were not statistically significant, numerically greater levels of caries protection were observed with the NaF dentifrice in two instances while the reverse was observed in one study.[12-14] More recently, Koch *et al* similarly observed a numerically greater (7 percent) efficacy of a NaF dentifrice as compared to that of a commercially-available Na_2PO_3F formulation.[14,15]

Two recent reports have compared the clinical efficacy of these two fluoride compounds, using elevated concentrations of fluoride in dentifrices. Blinkhorn and Kay observed no difference between dentifrices containing 1450 ppm F as NaF or Na_2PO_3F; however, their results may have been confounded by the use of an examination procedure (FOTI) subsequently shown to produce inaccurate diagnoses.[16,17] On the other hand, Lu and coworkers recently reported that significantly greater cariostatic activity was observed with a NaF dentifrice, as compared to a Na_2PO_3F dentifrice, when the concentration of fluoride was increased to 2800 ppm.[18] Further, a dentifrice with Na_2PO_3F at 2800 ppm fluoride was not significantly different in anticaries efficacy from a NaF dentifrice with 1100 ppm fluoride. Thus, eight of the nine published reports of clinical comparisons of dentifrices containing these compounds (Figure) indicate numerically, and in some cases significantly, greater cariostatic activity of NaF.

It should be noted that when this trial was begun, the usual practice was to employ samples of children with relatively broad age-ranges. The advantage to this broad base may be that it permits more generalized inferences; however, since the incidence of caries began to decline over a decade ago, many investigators have recognized the improved efficiency to be gained from studying samples comprised of high caries risk individuals, i.e. children approximately age eleven to twelve. In fact, of the nine trials cited above, only two employed broad age-ranges; Lu used children seven to fifteen years of age and Zacherl employed children seven to fourteen years of age.[10,18] The remaining seven studies all employed children in a very narrow age-range (in most, the subjects were all the same age), and this age was generally eleven years or greater. The initial ages of subjects in these trials were: Gerdin, twelve; Forsman, eleven; Edlund and Koch, nine to eleven; (but eleven-year-olds were analyzed separately); Edward and Torell, twelve; Koch *et al*, twelve to thirteen; Blinkhorn and Kay, eleven to twelve; Koch *et al*, eleven to twelve.[9,11-16] Further, the American Dental Association has sanctioned the use of such high-risk samples.[22] Consequently, this report presents data for children in a

Figure □ Clinical comparisons of sodium fluoride and sodium monofluorophosphate dentifrices.

Study	Percent difference*	Significance**
Gerdin (1972)	-13	SIG.
Zacherl (1972)	- 7	N.S.
Forsman (1974)	-10	N.S.
Edlund (1977)	-23	SIG.
Edward (1978)	- 8	N.S.
	-26	N.S.
Koch (1982)	+7	N.S.
LU (1987)	-11	SIG.
Blinkhorn, (1988)	- 1	N.S.
Koch (1988)	- 7	N.S.
Beiswanger (1989)	-11	SIG.

* Difference = the relative reduction in DMFS (or DFS) for NaF compared to Na_2PO_3F.
** Significance = the difference is significant (SIG.) or not significant (N.S.) at $\alpha = 0.05$.

broad age-range and for those children who were eleven years or older at the baseline.

The purpose of this study was to test the hypothesis that a NaF dentifrice* is more effective than a Na_2PO_3F dentifrice when both contain 1100 ppm fluoride and the same highly compatible silica abrasive. Since the trial was being conducted, for efficiency, two experimental formulations were also included. These formulations are not relevant, however, to the primary comparison intended and the results are not presented here.

MATERIALS AND METHODS

A panel of 3290 male and female grade-school children, ages six to sixteen, from communities in Indiana was recruited for this study. Of this total panel, 847 children were in the age-range, eleven through sixteen. These subjects, eleven years of age or greater, are considered as a separate subgroup due to their higher caries risk. The drinking water of these communities contained approximately 0.5 ppm F from natural sources. Written informed consent was obtained from the parent or guardian of each subject recruited. Children wearing orthodontic appliances or with an unsuitable medical history, as determined by the investigator, were not included in the study. Participation was voluntary, with the understanding that each subject was free to withdraw from the study at any time for any reason.

All of the subjects were examined at baseline and after two years and three years with artificial light, mouth mirrors, compressed air and dental explorers; examinations were performed by an experienced senior examiner (BBB) and independently by a second, less-experienced examiner (MEM) for use in the event the senior examiner should be unable to complete the examinations. The criteria established by Radike were employed for clinically diagnosing carious lesions.[19] Each examination consisted of a visual-tactile caries examination supplemented by a bitewing radiographic series. The number of bitewing films varied from zero to four per subject, depending upon the number of permanent teeth and accessibility of the interproximal surfaces. Duplicate sets of films were made available for each subject's dentist. The radiographs were interpreted by the examiner and used to supplement the visual-tactile examination. All clinical examinations and radiographic interpretations were made independently of previous examination records.

*Crest. The Procter & Gamble Company, Cincinnati, OH.

The dentifrices compared in this study contained 1100 ppm fluoride provided as either NaF or Na_2PO_3F. Both dentifrices were formulated using the same highly compatible, hydrated silica abrasive system and were essentially identical with regard to common excipients (i.e. color, flavor, detergent, etc.) The products were made fresh each six months. Analyses indicated that the average total fluoride in the two products was 1031 ppm F for the NaF product and 1138 ppm F for the Na_2PO_3F product.

Following the baseline examinations, the subjects were separated by sex and intervals of age, and were stratified by intervals of decayed, missing and filled surfaces (DMFS), as diagnosed by visual-tactile examination. Within each stratum, the subjects were randomly assigned to one of the two dentifrice groups. Care was exercised to ensure that siblings were assigned to the same treatment group to avoid having different dentifrices in the same household.

Supplemental supplies of toothbrushes and assigned dentifrices were provided every six months. The dentifrice was packaged in plain white, 4.6- ounce tubes labeled with each subject's name and unique identification number. The effective ages of the dentifrices were similar at the time of distribution to the subjects. The dentifrices were distributed to subjects' schools, but the usage was *ad libitum* at home. Subjects were instructed to "brush as they normally would" and were advised to brush "at least once each day." The subjects were encouraged to continue regular visits to their family dentists. At no time during the course of the study did the subjects or the examiner know to which dentifrice group any subject was assigned.

RESULTS

For purposes of interpretation, the data from this trial were analyzed for all subjects available and for caries prone subjects aged eleven years or greater at the outset. In the analysis of the data, the statements of significance for the observed DMFS increments are based on the normal deviate test and are supplemented by an analysis of covariance using the method and covariates as described by Grainger.[20,21] A one-tailed test of significance was used. In this paper, only the results for the senior examiner are presented for the sake of brevity. The results for the secondary examiner, however, were very similar, e.g. nearly identical percent differences in observed caries increments, etc.

Table 1 shows the initial allocation of all subjects to the two dentifrice groups in terms of sex and age. Table 2 presents the same initial information on sex and age by

Table 1 ☐ Characteristics of study participants: all participants.

Time period	Dentifrice	N	Sex		Age	
			M	F	Mean	Range
Initial	1100 NaF	1646	815	831	9.02	6-14
	1100 Na_2PO_3F	1644	803	841	9.07	6-16
2 Year	1100 NaF	1077	550	527	8.94	6-14
	1100 Na_2PO_3F	1016	497	519	8.97	6-16
3 Year	1100 NaF	1151	584	567	8.88	6-14
	1100 Na_2PO_3F	1122	566	566	8.95	6-14

Table 2 ☐ Characteristics of study participants: only participants' initial age eleven or greater.

Time period	Dentifrice	N	Sex		Age	
			M	F	Mean	Range
Initial	1100 NaF	418	216	202	11.40	11-14
	1100 Na_2PO_3F	429	218	211	11.41	11-16
2 Year	1100 NaF	258	139	119	11.39	11-14
	1100 Na_2PO_3F	259	128	131	11.41	11-16
3 Year	1100 NaF	257	136	121	11.34	11-14
	1100 Na_2PO_3F	262	140	122	11.38	11-14

Table 3 ☐ Initial DMFS values for study participants: all participants.

Time Period	Dentifrice	Mean	SEM
Initial	1100 NaF	1.87	0.072
	1100 Na_2PO_3F	1.93	0.075
2 Year	1100 NaF	1.75	0.083
	1100 Na_2PO_3F	1.94	0.096
3 Year	1100 NaF	1.70	0.078
	1100 Na_2PO_3F	1.82	0.086

Table 4 ☐ Initial DMFS values for study participants: only participants initial age eleven or greater.

Time period	Dentifrice	Mean	SEM
Initial	1100 NaF	3.56	0.204
	1100 Na_2PO_3F	3.73	0.213
2 Year	1100 NaF	3.23	0.241
	1100 Na_2PO_3F	3.91	0.275
3 Year	1100 NaF	3.23	0.229
	1100 Na_2PO_3F	3.55	0.264

dentifrice group for only those subjects eleven years or more of age at the baseline.

Table 3 summarizes the mean number of DMF surfaces for all subjects starting the study and those subjects completing two years and three years, while Table 4 similarly presents this information for only those subjects aged eleven or older. A slight difference between the groups in the baseline DMFS values was noted for all subjects and for only subjects eleven or older when beginning the study. This differential was numerically increased by the withdrawal of subjects during the study period; but in no instance was the difference in baseline scores statistically significant.

Tables 5 and 6 summarize the DMFS increments after

Table 5 ☐ Summary of dental caries increments: all participants.

Dentifrice	Observed DMFS N	Mean	SEM	Percent diff.	Prob.	Covariance adjusted Mean	Percent diff.	Prob.
			2 Years					
1100 NaF	1077	1.86	0.065	---	---	1.93	---	---
1100 Na_2PO_3F	1016	2.09	0.082	+12%	0.01	2.02	+5%	0.17
			3 Years					
1100 NaF	1151	2.82	0.090	---	---	2.87	----	---
1100 Na_2PO_3F	1122	3.01	0.099	+ 7%	0.08	2.96	+3%	0.23

Table 6 ☐ Summary of dental caries increments: only participants initial age eleven or greater.

Dentifrice	Observed DMFS N	Mean	SEM	Percent diff.	Prob.	Covariance adjusted Mean	Percent diff.	Prob.
			2 Years					
1100 NaF	259	2.57	0.160	---	---	2.74	---	---
1100 Na_2PO_3F	258	3.34	0.218	+30%	0.002	3.16	+15%	0.04
			3 Years					
1100 NaF	257	3.95	0.234	---	---	4.03	----	---
1100 Na_2PO_3F	262	4.58	0.261	+16%	0.04	4.53	+12%	0.05

two and three years for all subjects and the more caries prone subset, eleven years or older. From Table 5 it may be seen that the observed data showed the subjects using the Na_2PO_3F dentifrice had 12 percent and 7 percent more caries, after two and three years respectively, than the subjects using the NaF formulation. This difference was significant at $p=0.01$ after two years, but not significant ($p=0.08$) after three years. Furthermore, the effect of the covariance adjustment was to lessen the intergroup differences and the adjusted results showed no significant difference between the treatments. Table 6 summarizes the incremental findings for those panelists eleven years or older, at the baseline. After two years of product usage, the observed findings showed significantly ($p=0.002$) more new DMF surfaces in the subjects provided the Na_2PO_3F dentifrice as compared to subjects provided the NaF dentifrice. The group using the Na_2PO_3 formulation developed 30 percent more DMF surfaces than the group using the NaF dentifrice (3.34 vs 2.57 DMFS, respectively). After three years, significantly ($p=0.04$) more new DMF surfaces were observed in the subjects provided the Na_2PO_3F dentifrice as compared to the values observed in the subjects provided the NaF dentifrice. The group using the Na_2PO_3F dentifrice developed 16 percent more DMF surfaces than the group using the NaF dentifrice (4.58 vs 3.95 DMFS, respectively). The adjusted DMFS increments based on the covariance analysis were 2.74 and 3.16, for the NaF dentifrice and the Na_2PO_3F dentifrice, respectively, after usage for two years, and 4.03 and 4.53, respectively, after usage for three years. The covariance-adjusted difference is also statistically significant at two years ($p=0.04$) and at three years ($p=0.05$). The adjusted DMFS increments showed 15 percent (two years) and 12 percent (three years) more carious surfaces in the group using the Na_2PO_3F dentifrice as compared to those using the NaF formulation.

The mean number of reversals per subject after three years (i.e. surfaces diagnosed as either D, M or F at the baseline and as sound at three years) was (0.07) for the NaF group and (0.05) for the Na_2PO_3F group. These values are obviously quite similar and relatively low reversal rates. The mean number of sealed occlusal surfaces per subject observed in this study was 0.44 for the NaF group and 0.45 for the Na_2PO_3F group. Sealed surfaces were not included in the data analysis.

DISCUSSION

In this trial, the results for the older subjects were much more discriminating between the two dentifrices tested than were the results for all subjects. To a large degree, the reason for this difference between all subjects and the older subjects is attributable to the higher caries rate of the older subjects. From Tables 5 and 6, it may be seen that the entire panel (ages six to sixteen) experienced 2.8-3.0 new lesions during three years, but the older subjects (ages eleven to sixteen) experienced nearly 50 percent more new lesions, with increments of 4.0 through 4.6 during three years.

The precedents for improving the efficiency and discriminating ability (power) for clinical caries trials through employing high-risk samples are numerous. The Council on Dental Therapeutics has accepted that "caries clinical trials could be aimed at populations at caries-risk higher than usual."[22] According to Carlos, one difficulty encountered in conducting clinical caries trials in an environment where caries is declining, is that the control group caries-rate may be so low as to make it "virtually impossible statistically to demonstrate a treatment advantage no matter how effective that treatment actually is."[23] The solution is to employ only those subjects likely to have the highest caries rates. Two different methods have been proposed to accomplish this; either to preselect subjects and delete those with no or little caries experience, or to employ age-ranges with the highest expected increments.[23-25] With regard to the latter approach, Downer and Mitropoulous have shown that the initial age of subjects can have an important impact on the efficiency of a trial, and state that subjects eleven to twelve years of age are usually chosen, because they are in a period of eruption of many teeth and high caries activity.[24] Darvell has shown through mathematical modeling that the rate of progression of proximal caries is maximized at about eleven to thirteen years.[26]

As evidence of the impact of age upon efficiency and ability to discriminate differences in product effects, Lind *et al* analyzed separately data for eight-year-olds and eleven-year-olds from a trial testing a Na_2PO_3F dentifrice versus a placebo. While data from both sets of children showed a significant treatment effect after three years, the data from the older children permitted detection of this effect after only two years. Thus, by using older children with high caries rates, greater efficiency in separating differences between treatments was achieved.

The present study was designed to test the hypothesis that NaF has greater cariostatic effect than Na_2PO_3F, when both are employed in dentifrices that had been prepared with identical concentrations of total fluoride in highly compatible, hydrated silica abrasive systems. In this situation, it was thought that any observed differential in cariostatic activity could only be attributed to a difference in the biological efficiencies of the fluoride compounds. As noted earlier, the NaF dentifrice exhibited significantly greater cariostatic activity than the Na_2PO_3F dentifrice in caries-active panelists, and this difference must be attributed to a biological difference in the two fluoride compounds.

The differential in the cariostatic efficiency of NaF and Na_2PO_3F is most likely due to the difference in the mechanisms of action of these two compounds. Current evidence indicates that the cariostatic activity associated with the use of fluoride dentifrices is attributable primarily to the ability of the fluoride ion to enhance the remineralization of incipient carious lesions. For fluoride provided as Na_2PO_3F to participate in this process, the monofluorophosphate ion must be hydrolyzed to provide free fluoride ions, a process that is thought to be accomplished by phosphatases present in the oral environment, particularly in plaque. The fact that this precursory degradation must occur before Na_2PO_3F can participate in the cariostatic process, whereas NaF readily dissociates in water to provide fluoride ions (and is in the ionized state in highly compatible dentifrice formulations), may well explain the greater cariostatic efficiency of NaF as compared to Na_2PO_3F.

The findings of the present study are consistent with the previous studies conducted by Gerdin, Edlund and Koch, and Lu and coworkers.[9,10,17] It is also worthy to note that the scientific literature contains no reports of clinical trials in which the use of Na_2PO_3F dentifrices resulted in significantly greater cariostatic activity than formulations containing comparable amounts of fluoride as NaF. In fact, as shown in the Figure (*page 271*), of the ten reported trials comparing NaF and Na_2PO_3F formulations, nine of those trials have found a numerical advantage for the NaF formulation and one found a numerical advantage for Na_2PO_3F formulation. If one tests the hypothesis that there is no difference between NaF and Na_2PO_3F by applying a Sign Test for the directional results of these ten studies, the probability of a 9-1 split is 0.011.[28] From these collective results one would conclude, therefore, that it is unlikely that NaF and Na_2PO_3F dentifrices are equivalent. Thus, the conclusions from the present study, coupled with similar results observed by other investigators, demonstrate that NaF has greater cariostatic activity than Na_2PO_3F, when employed in dentifrice formulations with highly compatible abrasive systems.

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SPOILED CHILD SYNDROME

The spoiled child syndrome is characterized by excessive self-centered and immature behavior, resulting from the failure of parents to enforce consistent, age-appropriate limits. Spoiled children display a lack of consideration for others, demand to have their own way, have difficulty delaying gratification, and are prone to temper outbursts. Their behavior is intrusive, obstructive, and manipulative. They are difficult to satisfy and do not remain satisfied long. They are unpleasant to be around, even for those who love them, and one often gets the impression that they do not enjoy being with themselves.

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Marginal leakage of class II glass-ionomer-silver restorations, with and without posterior composite coverage: an *in vitro* study

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Glass ionomer cements are commonly used as cavity bases and liners. Certain types of glass ionomers have also been recommended as filling materials.[1-6] The glass ionomer cements are fast setting and radiopaque. They can be acid- etched for retention to composite resins.[7-11] It is also reported that they seal dentinal tubules.[8,11] No pulp protection may be required, therefore, when using these cements in shallow preparations.[11] In areas where the thickness of the remaining dentin is less than 1.5 mm, however, the application of a calcium hydroxide liner has been advocated.[11]

Recently glass ionomer-silver cermet (cer = ceramic; met = metal) restorations have been introduced as an alternative for amalgam restorations in primary teeth, in several pediatric dental practices.[1,6] These materials do not contain mercury, a feature that may be desirable for dentists, patients, and parents alike.[1] Like other glass ionomers, the silver-cermet materials bond to tooth structure and release fluoride ions, to which cariostatic properties are attributed.[1,2,8-10] The silver-cermets have a lower strength, however, than both amalgam and posterior composite resins, and are esthetically inferior to the latter. Two clinical investigations reported fair results of silver-cermet restorations after six and eighteen months.[1,6] In these studies, however, radiographic examinations were not carried out to estimate recurrent decay.

Composite resins have excellent esthetic properties, but their coefficient of thermal expansion is up to five times greater than that of tooth structure.[9-11] Both incremental and bulk filling techniques were found to give rise to leakage around resin restorations, in particular at the gingival margins of primary teeth.[13,14] Recently a "sandwich technique" has been proposed, combining the adhesive properties of glass ionomers with the esthetic appeal of composite resins.[2,9,15,16] It has been suggested that the gingival part of the box of class II composite restorations be prepared from glass ionomers, in order to prevent secondary caries in this sensitive region, by improvement of the marginal seal and the occurrence of fluoride release.[9]

The aims of the present laboratory study were:

- □ To assess marginal leakage around three types of class II restorations, using:
- □ Conventional composite resin with a glass ionomer lining;
- □ Glass ionomer cermet with composite resin coverage;
- □ Glass ionomer cermet without composite resin coverage.
- □ To study the effect of thermocycling on marginal defects, by means of:
- □ Radiographs
- □ SEM micrographs of the margins.[17]

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MATERIALS AND METHODS

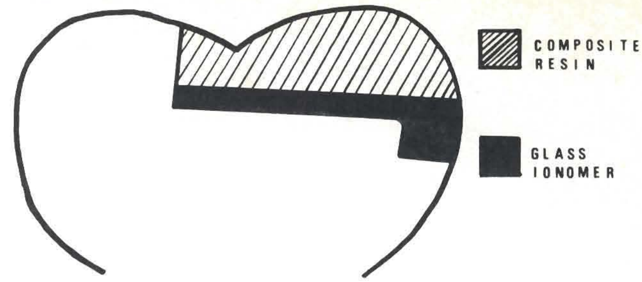

Figure 1. Diagram of a "sandwich restoration" showing the intermediate layer of glass ionomer cermet. The cermet was placed in a thick layer in the box to reduce the bulk and hence the shrinkage of the overlying composite.

Fifty-eight class II cavities were prepared in extracted or exfoliated primary molars. The collected teeth were stored in water and were intact, or had either small carious lesions or amalgam restorations that were removed during cavity preparation. The cavities were prepared with a 330 bur using water as coolant. The width of the isthmuses was wider than conventional for amalgam and composites. This was recommended by the manufacturer of the restorative glass ionomer cermet Ketac Silver*, in order to reduce the incidence of bulk fracture of the restorations.[12,15] Bevels of 1.0 to 1.5 mm length were prepared at an angle of approximately 45° with the tooth surface at all cavosurface margins. The teeth were randomly assigned to one of three groups according to the type of restoration, as shown in Table 1.

In group A, Ketac Bond* was placed on the pulpal and axial walls of the cavities. Five minutes after starting the mix, the beveled enamel margins and the Ketac Bond were acid etched for one minute. After rinsing, VLC Scotchbond** was applied over the etched areas and cured for twenty seconds. Celluloid matrices*** were adapted to the teeth with a Tofflemire matrix holder. The cavities were filled with the resin P-30** in a two step, gingivoclusal incremental filling technique. The first layer was cured for twenty seconds and the second one for forty seconds.[13]

In group B after adaptation of a transparent matrix as in group A, a modified "sandwich" restoration was prepared. Ketac Silver was applied in a thick layer at the proximal box up to the level of the pulpal wall. The rationale of this modification was to reduce the bulk of composite resin in order to keep the concurring setting and thermal dimensional changes to a minimum. After five minutes, the enamel margins and the Ketac Silver were acid-etched for one minute. The resin P-30 was placed in one increment, condensed with a large ball burnisher and cured for one minute (Figure 1).

In group C, metal bands were adapted to the teeth using a Tofflemire matrix holder. Ketac Silver was injected to fill the entire cavity. The restorations were then covered with Varnish*, according to the manufacturer's instructions.

All restorations were ground off flush to the tooth surface. Composhape† superfine diamond finishing burs were used for finishing and Sof-lex** aluminum-oxide disks of decreasing roughnesses were employed for polishing.

The restored teeth were kept at room temperature and at 100 percent humidity for two weeks to prevent dehydration. Silicone impressions (Provil P + L)†† were taken of eight teeth of each group that were randomly selected and dried with a single air blast.

All the restored teeth were subsequently thermocycled for 1000 cycles between 4 ± 2 °C and 60 ± 2 °C with dwell times of one minute in each bath, and one-minute intervals between the baths in ambient atmosphere. A second set of impressions was then taken from the same teeth of each group. Epoxy replicas of the tooth surfaces were prepared in the impressions. The micromorphology of the margins was evaluated with a SEM at a magnification of 100X, before and after thermocycling.

Defects at the interfaces of tooth and restoration were assessed at the cervical and proximal (buccal and lingual) margins and were classified according to the fraction of margin length showing gaps wider than 10 μm, as follows:

a: No gaps present at the tooth-restoration margin.
b: Gaps present at less than 1/3 of the margin.
c: Gaps at up to 2/3 of the margin.
d: Gaps present along the entire margin. The morphology of the margins was studied before and after thermocycling.

Radiographs were taken of the same teeth that were investigated by SEM and the presence of defective margins was evaluated according to the following criteria:
I. Good adaptation.
II. The presence of an underfilled margin.
III. The presence of an overfilled margin. In the teeth of group B, the interface between Ketac Silver and P-30 was also assessed according to these criteria.

Since the roots of most teeth had been resorbed, the pulp chambers or remnants of roots were sealed with IRM.‡ All teeth were coated with utility wax and nail

*ESPE, Seefeld/Oberbay, W. Germany.
**3M, Dental Products, St. Paul, MN.
***Hawe Neos, CH-6925, Gentilino, Switzerland.
†Densco, Teledyne, Denver, CO.
††Bayer, Leverkussen, W. Germany.
‡LD Caulk, Milford, DE.
‡‡Olympus, Tokyo, Japan.

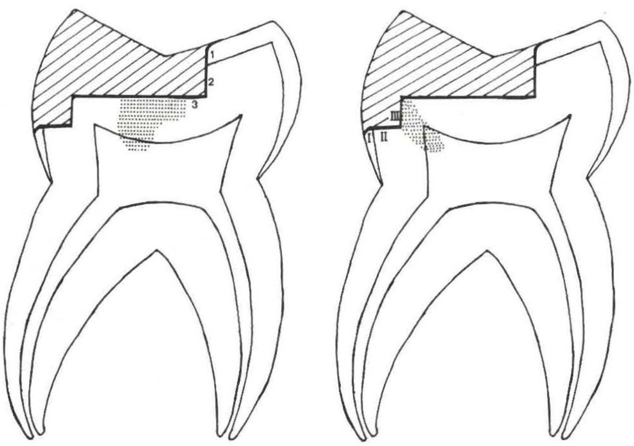

Figure 2. Numerical evaluation of the depth of dye penetration at the occlusal (Arabic numerals) and cervical (Roman numerals) margins.

polish, immersed in a 2 percent solution of basic fuchsin for twenty-four hours, washed in water and embedded in acrylic resin as described previously.[13,14] Mesiodistal sections were obtained by grinding off the embedded teeth parallel to their axes. The sections were polished with abrasive papers up to 800 grit under running water and examined under a binocular microscope‡‡ at magnifications of X6-X40. Occlusal and cervical margins were assessed for the degree of dye penetration on four or five tooth sections that were obtained by sequential grinding. Four degrees of marginal leakage were distinguished and represented by Arabic and Roman numerals, respectively (Figure 2):

Degree 0: no penetration of the dye.

Degree 1 or I: penetration of the dye along the occlusal or gingival wall of the filling adjacent to the enamel only.

Degree 2 or II: penetration of the dye along the entire length of the occlusal or gingival wall of the filling, but not along the pulpal wall.

Degree 3 or III: penetration of the dye along the entire length of the occlusal or gingival wall of the filling, including the pulpal wall.

The most severe degree of dye penetration observed on any section of each tooth was recorded. Statistical differences were evaluated by means of the X^2 test.

RESULTS

Dye penetration

Sections through the teeth with different restorations are shown in Figures 3-5. The results for dye penetration are given in Table 2. Similar degrees of leakage were obtained at the occlusal margins for groups A and B (Figures 3,4). For these two groups the occlusal margins were prepared from the resin P-30. No or minimal penetration of the dye (degrees 0 and 1) was observed at 47.5 percent of these margins for the group A teeth and 31.5 percent of the group B teeth. Only 5 percent of the occlusal cermet margins, however, showed no dye penetration, and leakage at the group C (Figure 5) occlusal margins was significantly greater than for the A and B

Table 1 □ Experimental design.

Group	Distribution of the restored teeth No. of teeth	Type of restoration
A	19	Ketac Bond + P-30
B	19	Ketac Silver + P-30
C	20	Ketac Silver only

Table 2 □ Assessment of marginal leakage by depth of dye penetration.

Degree of dye penetration	Group A Ketac Bond + P-30		Group B Ketac Silver + P-30		Group C Ketac Silver	
Occlusal margin	N	Percent	N	Percent	N	Percent
0	7	37.0	6	31.5	1	5.0
1	2	10.5	—	—	—	—
2	2	10.5	1	5.0	3	15.0
3	8	42.0	12	63.0	16	80.0
Cervical margin						
0	1	5.0	2	10.5	—	—
I	2	10.5	—	—	1	5.0
II	1	5.0	—	—	—	—
III	15	79.0	17	89.5	19	95.0

N = Number of teeth

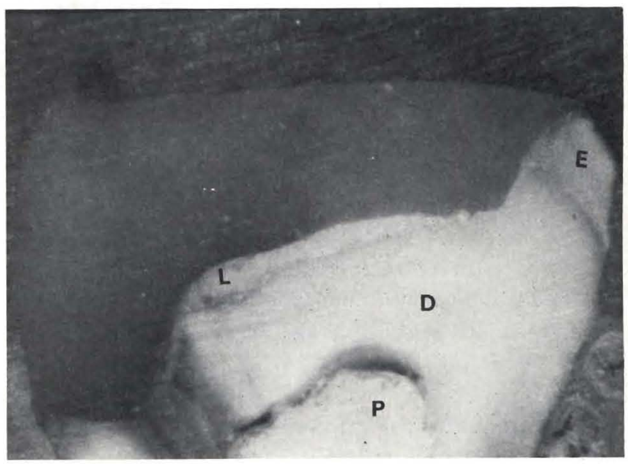

Figure 3. Longitudinal section of a class II composite restoration prepared with P-30 over Ketac Bond Lining. No leakage is observed at the occlusal margin, while penetration of the dye is reaching the pulp chamber (degree III) at the cervical margin. L = Lining; D = Dentin; P = Pulp; E = Enamel.

groups. Although both the cervical and occlusal margins of the teeth in group A were prepared with P-30, the incidence of the two higher degrees of leakage at the cervical resin margins was higher (84 percent) than at the occlusal margins (52.5 percent). The higher degrees of dye penetration were observed almost exclusively (84-95 percent) for all types of margins prepared with Ketac Silver. Differences between the Ketac Silver groups were not significant.

Table 3 ☐ Radiographic evaluation of the adaptation of the restorations after thermocycling.

Group		Margin quality	
	Good	Underfilled	Overfilled
A- Ketac Bond + P-30	6	2	0
B- Ketac Silver + P-30	8	0	0
B- Interface	3	5	0
C- Ketac Silver	7	1	0

Radiographic evaluation

On the radiographs, the adaptation of Ketac Silver to the sixteen cervical margins of groups B and C appeared excellent in almost all cases (94 percent). One margin showed evidence for underfilling (Table 3). For P-30, six out of eight cases (75 percent), showed good adaptation. Overfilling was not observed on any sample.

On five samples, the interface between Ketac Silver and P-30 showed a step at the contour of the restoration with protruding Ketac Silver. On the remaining three cases, the transition between the two materials was not noticeable on the radiographs (Figure 6).

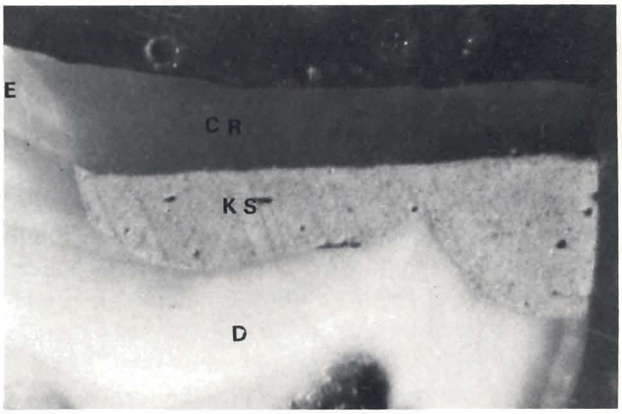

Figure 4. Section of a modified sandwich restoration (Ketac Silver + P-30). This sample did not exhibit leakage at the occlusal or the cervical margin. E = Enamel; CR = Composite resin; KS = Ketac Silver; D = Dentin.

Figure 5. Longitudinal section of a restoration prepared with the glass ionomer cermet Ketac Silver. Severe leakage is present at the occlusal (degree 2) and cervical (degree III) margins. E = Enamel; D = Dentin; P = Pulp.

Micromorphology of margins

The evaluation of the SEM study of the micromorphology of the margins for the three types of restorations, is presented in Table 4. Deterioration of margins due to thermocycling was observed for all groups of restored teeth. Part A of Table 4 shows that before thermocycling, adaptation for group A was good at fifteen of the sixteen buccal and lingual margins (94 percent), but at only six of the eight cervical margins (75 percent).

Buccal, lingual as well as cervical margins showed no defects in 75 percent of the group B (sandwich) restorations before thermocycling. At the interface, defects were present in three of the eight restorations (38 percent) before thermocycling.

Part C of Table 4 shows that poor results were obtained for the proximal and cervical margins of most of the cermet restorations of group C. Defects were observed before thermocycling in eleven of the sixteen proximal margins examined (69 percent) and in two of the eight cervical margins (75 percent).

DISCUSSION

Previous studies on permanent teeth, showed relatively little leakage at cervical margins, when the composite was placed in increments.[18,19] A slightly higher incidence of leakage at the cervical composite margin was found in a study on primary teeth.[13] We have no explanation for the fact that in the present study, leakage at the

Table 4 ☐ SEM evaluation of the margin micromorphology of the restorations before and after thermocycling; presence and extent of defective margins.

Margins evaluated	No defect		Defective: Up to 1/3		Defective: Up to 2/3		Defective: Total length		Total Number margins	
	Before	After	Before	After	Before	After	Before	After	Before	After
A: Ketac Bond + P-30 Buccal + lingual	15	8	—	5	—	2	1	1	16	16
Cervical	6	3	2	4	—	—	—	1	8	8
B: Ketac Silver + P-30 Buccal + lingual	12	10	1	2	—	1	3	3	16	16
Interface	5	3	—	2	1	2	2	1	8	8
Cervical	6	5	1	1	—	1	1	1	8	8
C: Ketac Silver Buccal + lingual	5	4	7	5	—	3	4	4	16	16
Cervical	2	1	2	1	2	4	2	2	8	8

cervical composite margin was much greater than in the latter one.[13] The restorations in this study differed, however, from the ones in the latter study in the clinician who prepared them, the type of liner used, and the ten times greater number of thermal cycles.[13]

Although severe leakage at the cervical margin was found for all materials, significant leakage at the occlusal margin was only found for fillings with Ketac Silver at this margin. It does appear that the marginal seal created with the glass cermet at margins with thick occlusal enamel is inferior to the one created at these margins with etching, bonding, and composite resin. Similar results were obtained by Crim and Shay comparing the sealing by Scotchbond/Silux with that by the glass ionomer Ketac Bond.[20] Extensive leakage around class V and tunnel preparations made of Ketac Silver, has also been reported by Robbins and Cooley.[21]

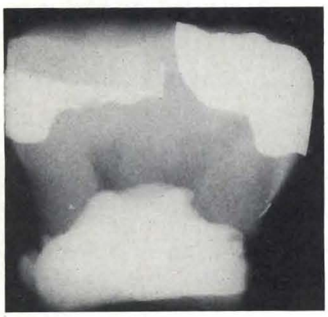

Figure 6. Radiograph of a retrieved primary molar with an amalgam filling (right), in which a sandwich restoration (left) that was placed in vitro. *IRM was used to seal the cervical end of the root canals. The Ketac Silver shows good adaptation to cavity walls on radiographs.*

Figure 7. SEM micrograph of adaptation of Ketac Silver to the gingival floor, showing different gap widths along the margin. Top: Ketac Silver; Bottom: enamel.

Gwinnet demonstrated that in the cervical aspects of the teeth, where the enamel prisms do not extend to the surface, etch patterns are characterized by surface loss without exposing underlying prisms.[22] He found more and deeper etch pits on surfaces perpendicular to the prism direction than on surfaces parallel to the prisms. Hence, the greater leakage found for the primary teeth could possibly be attributed to differences in the prism direction at the cervical margin between the two types of teeth.[18,19] In addition, the greater enamel thickness that is frequently left at the cervical margin of restorations in permanent teeth could also lead to less leakage than is observed for primary ones.

The clinical significance of testing microleakage by penetration of dyes may be questioned. One should not infer from data regarding only the penetration of dye that bacteria will necessarily penetrate the interface between filling and tooth. The diameter of a bacterium is more than ten thousand times larger than that of a dye molecule. It is possible, therefore, that bacteria cannot enter into gaps that show dye penetration. Penetration of dye in specific regions shows, however, that gaps are present and that no bond exists between the restorative material and the tooth in these regions. The possibility exists, furthermore, that gaps will become wider with time, due to changes in the glass ionomers, resulting from alterations in moisture content and flow. On the other hand, it is also possible that the bactericidal activity of fluoride leached from the cement may negate the effect of bactericidal penetration in case it does take place.

In agreement with the results for leakage, the SEM micrographs showed many more gaps at the glass ionomer-tooth margins than at the P-30 tooth margins. The severity of marginal defects was also greater for cervical margins than for buccal and lingual ones, and greater after thermocycling than before thermocycling. The apparent effect of thermocycling may be attributed to detachment of the restorative materials from the tooth tissue, deterioration of the restorative material, as well as enhanced washout of debris from gaps.

The defects observed on the micrographs and on the sectioned samples with penetration of dye were not evident on the radiographs. The latter are not sensitive enough to show small gaps.

CONCLUSIONS

Ketac Silver with and without composite coverage did not prevent leakage, when utilized in class II restorations *in vitro*. Severe penetration of the dye was observed at the cervical margins in all the groups, with no statistically significant differences between Ketac Silver and composite.

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REMOVAL OF PLAQUE

Unfortunately, there is no simple way to remove bacterial plaque other than to scrub, rub it off with bristles of a brush; with fibers of floss, tape, yarn, or gauze; or with toothpick or other interdental cleansing devices. As yet, no agent is available that will totally prevent plaque formation or totally remove bacterial colonies once they have formed.

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The glass ionomer rest-a-seal

Robert J. Henry, DDS, MS
Roy G. Jerrell, DDS

Historically, there has been considerable research conducted in search of the so-called ideal dental restorative material.[1-3] From such research during the 1970s came the discovery and development of glass ionomer cements and microfilled composite resins.[4-6] With continued improvements of these newer materials an alternative to silver amalgam is now available which offers a more conservative approach when restoring decayed areas of selected teeth. The traditional amalgam alloy restoration has, however, withstood the test of time and has served the profession well. These materials will likely continue to have widespread application for the foreseeable future. Silver alloys do have undesirable properties, though, foremost of which is the amount of tooth preparation required for proper retention and strength, even for teeth with minimal decay.

The preventive resin restoration is a technique developed as an alternative to the conventional amalgam alloy preparation and is used primarily on the occlusal surfaces of posterior teeth.[7,8] The obvious advantage of this technique is conservation of tooth structure. Tooth preparation to include "extension for prevention" is eliminated with this approach.[9] These materials do, however, have disadvantages associated with their use, including polymerization shrinkage, pulpal irritation, thermal expansion, and microleakage.[10-12] In addition, a meticulous and a more time consuming placement technique is required.

Recently, glass ionomer cements have become popular and offer advantages over the preventive resin restoration. These materials are a hybrid of polycarboxylate cement and silicate cement and possess some of the desirable properties composite resin systems enjoy.[13] Four basic types of glass ionomer cements exist: lining cements, luting cements, restorative cements and core ionomer cements. All types pose the following desirable properties: form a chemical bond with enamel, dentin and cementum; provide a constant release of fluoride to surrounding tooth structure; are biocompatible; pose minimal setting shrinkage; and have a coefficient of thermal expansion similar to tooth structure, as well as providing a surface to which composite resin will bond.[14,15] The glass ionomer cements are similar to the composite systems in that they are technique sensitive and have other inherent properties as well that make their wide-spread utilization as the ideal restorative material unlikely. The glass ionomer cements would seem ideal though, for use in the restoration of incipient to moderate Class I decay.

The purpose of this paper is to describe an indication for use of glass ionomer cements with a clinical technique that minimizes chair time, while overcoming manipulation difficulties inherent to these materials.

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Figure 1. Tooth selection: This seven-year-old female presented with occlusal decay involving dentin on the mandibular left permanent first molar.

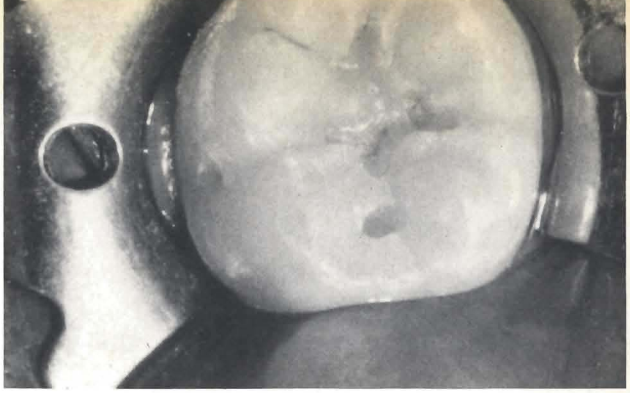

Figure 2. Cavity preparation completed: After local anesthesia and under rubber dam isolation conservative occlusal preparation is accomplished using a 330 bur at high speeds with water irrigation. Only enough tooth structure is removed to allow access and visibility for removal of carious dentin.

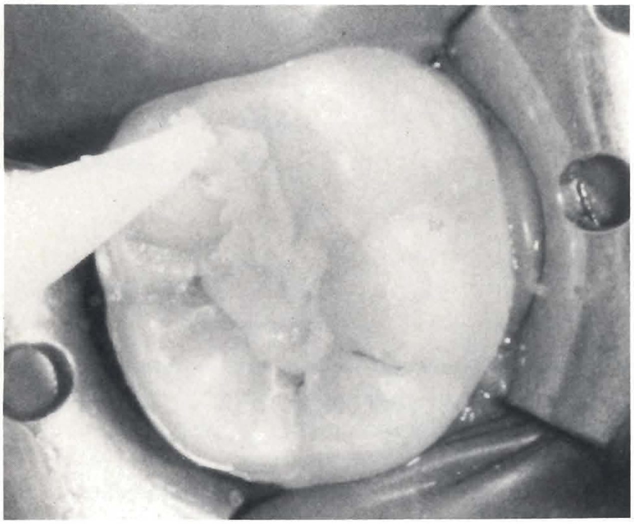

Figure 5. Condensation of the glass ionomer cement: A plastic instrument is used to condense the glass ionomer cement and to remove the initial excess of material. Due to the tacky nature of the glass ionomer cement, the plastic instrument should be either wiped with alcohol or dipped in an unfilled resin bonding agent before condensation, in order to prevent the material from sticking to the instrument.

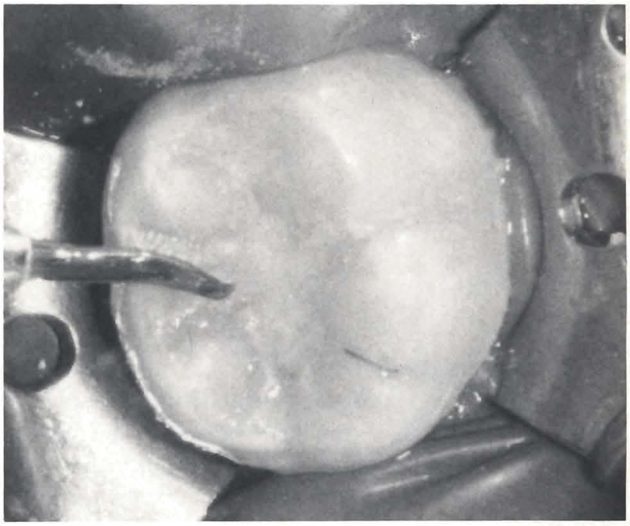

Figure 6. Application of composite bonding agent: Due to the susceptibility of glass ionomer cement to moisture and dehydration, a visible light-cured bonding agent is applied to the surface of the glass ionomer cement and activated with visible light for twenty seconds. Care must be taken to cover only the cement and not enamel, beyond the cavosurface.

CLINICAL TECHNIQUE

Tooth selection

Select teeth that present with mild to moderate pit-and-fissure caries in which dentin is involved (Figure 1) and that are free from proximal decay both clinically and radiographically. Careful visual examination should be performed with a dry occlusal surface, using a sharp explorer.

Tooth preparation

After obtaining local anesthesia, isolate the tooth with a rubber dam. Remove the occlusal decay with a suitable water-cooled, high-speed bur (330) to the depth of the lesion. Minimal tooth structure is removed with only carious areas requiring preparation. Extension for prevention and undercut placement are not performed with this technique (Figure 2). If necessary, remove remaining caries with a small, round bur at slow speed. A calcium hydroxide base is not required unless caries extends to within approximately 2 mm of the dental pulp.[13,16]

Restoration placement

Wash, dry, and reexamine the cavity preparation. Once all decay has been removed, condition the cavity preparation with a ten-second application of 25 percent poly-

Figure 3. Smear layer removal: Polyacrylic acid (25 percent) is placed in and brushed over the cavity preparation for ten seconds and then thoroughly rinsed with water. This procedure removes the smear layer created during cavity preparation and enhances the bond of the glass ionomer cement with tooth structure.

Figure 4. Glass ionomer cement placement: A capsulated restorative glass ionomer cement (Ketac-Fil; Premier/ESPE, Norristown, PA) is used. It is activated and mixed with a high-speed amalgamator according to the maufacturer's instructions. The material is then injected directly into the cavity preparation.

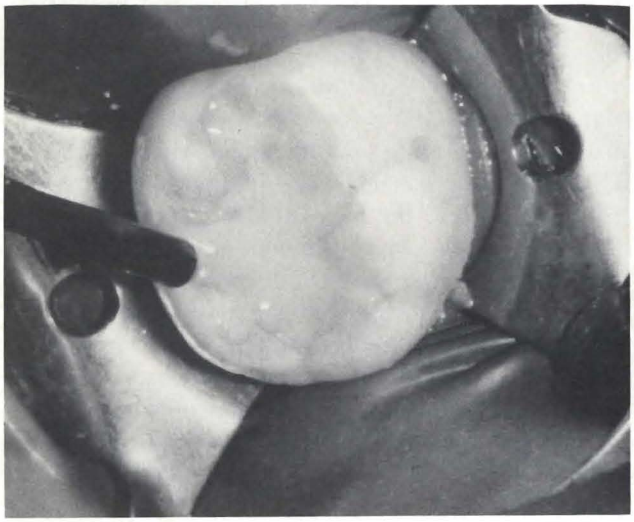

Figure 7. Sealant application: A 37 percent phosphoric acid gel is applied for forty-five to sixty seconds and thoroughly rinsed for twenty seconds. A conservative amount of unfilled visible light-cured sealant material (Delton; Johnson & Johnson Products Co., East Windsor, NJ) is applied to the entire occlusal surface as well as the buccal pit area. The sealant is then exposed to visible light for twenty seconds.

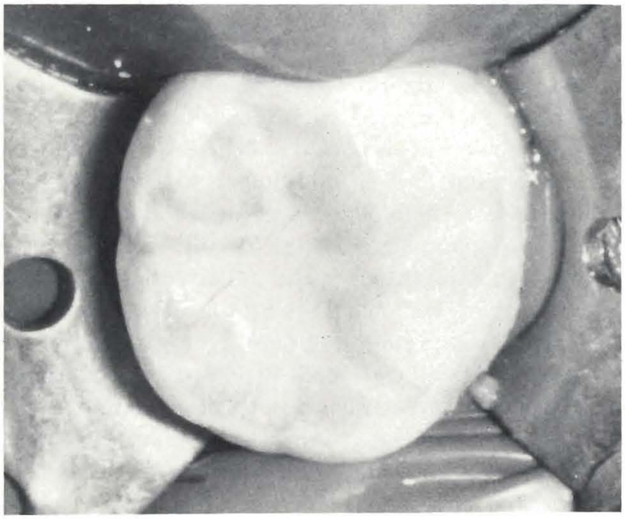

Figure 8. Completed "Glass Ionomer Rest-A-Seal": A conservative restorative approach is utilized with materials that bond to tooth structure and have the added anticariogenic benefit of fluoride ion release.

acrylic acid (Figure 3). This removes the smear layer created during tooth preparation and enhances the bond to tooth structure. Rinse for approximately twenty seconds and dry the tooth without causing desiccation. Mix a prefilled capsule of restorative glass ionomer cement according to the manufacture's instruction and inject it into the cavity preparation (Figure 4). A plastic instrument wiped with alcohol, or dipped in unfilled resin bonding agent, is used to condense the material and remove the initial excess (Figure 5). Carve any remaining excess material with a sharp cleoid-discoid or similar instrument. Next place a thin layer of light-cured bonding agent over the glass ionomer (Figure 6) and cure with a viable light curing unit for twenty seconds. Care must be taken to cover only the glass ionomer cement with unfilled resin and not enamel beyond the cavosurface margin. This procedure protects the glass ionomer from dehydration as well as moisture contamination, but will allow enamel to be properly conditioned before the sealant is applied. Next etch the entire occlusal surface with 37 percent phosphoric acid for forty-five to sixty seconds. Rinse the tooth for twenty seconds, dry, and examine the crown for a proper conditioning of the enamel surface. Apply a conservative amount of light-cured sealant to the entire occlusal surface (Figure 7) and cure with visible light for twenty seconds. After examining the sealant (Figure 8), remove the rubber dam and check the occlusion with articulating paper. Adjust for any excess and reapply sealant to protect the glass ionomer.

DISCUSSION

Glass ionomer cements are used with increasing popularity today. Continued research and clinical study in this area will provide material improvements, increasing the potential for greater application and utilization of glass ionomer cements. The following review is designed to update clinicians regarding the glass ionomer cements, their physical properties, and handling considerations.

Glass ionomer cements first became popular for use as an esthetic Class V restoration in the 1970s. The major advantages of this material are its adhesive nature, bonding to enamel, dentin and cementum, and its anticariogenic properties.[17] Fluoride released from glass ionomer cements is reported to be greater than the old silicate cements.[18,19] In addition to its anticariogenic action, the glass ionomer cements are also kind to pulpal tissue with cytotoxicity noted in only deep caries or direct pulp exposures.[5,16] The adhesive nature of the glass ionomer cements allows for conservation of tooth structure during removal of decay. In order to achieve the chemical bond with tooth structure, the particulate debris (smear layer) that results after routine cavity preparation, must be removed. Phosphoric-acid etch typically used with composite resin materials is contraindicated for removal of the smear layer, due to pulpal irritation this would produce. Rather, conditioning the cavity preparation with 25 percent polyacrylic acid for ten seconds is the recommended procedure.[20] Duralon liquid (Premier Dental Products/ESPE, Norristown, PA) is a 40 percent polyacrylic acid that can be substituted for removal of the smear layer, but should be applied for a shorter period of time. Polyacrylic acid cleans the surface without opening the dentinal tubules and enhances the glass ionomer chemical bond to tooth structure. With this mild conditioning procedure a dycal base is required for pulpal protection only in teeth with deep decay.[14] In most situations, though, a base is not recommended, as this would block the fluoride uptake to the surrounding tooth structure. In addition the glass ionomer cements may themselves be used as a base material to which composite resin restorations will bond and provide added retention with reduced microleakage for the restoration.[21]

The glass ionomer cements do, however, have negative qualities one must consider. Two major property limitations are associated with the glass ionomer cements: their brittleness and susceptibility to acid attack, particularly the lactic acid produced in dental plaque.[17,22] By placing a sealant over the glass ionomer, as described in this paper, one eliminates the influence of acid attack and thus maintains material strength. Of more concern is the lower relative strength of the glass ionomer cements. Their fracture strength is less than either composite resin or silver amalgam.[23] Due to their weak tensile strength the glass ionomer cements are not frequently used in proximal stress bearing areas as a final restoration. Glass ionomer cements are strong in compressive strength, however, and have their best application for use in smaller Class I and Class V restorations.[11] In these applications, the glass ionomer will bond tooth structure and provide cusp reinforcement, assurance that these teeth are stronger than teeth restored with silver amalgam.[24,25] In addition to these property limitations, glass ionomer cements have handling properties that often make their use difficult and time consuming. Glass ionomer cements undergo a two-phase setting reaction. Initially the material is susceptible to hydration and needs to be protected from moisture contamination. During the second reaction, the material is susceptible to dehydration. Care must be taken to prevent dehydration either by use of the air water syringe or by polishing without sufficient water irrigation. In addition, the final finishing of some glass ionomer restorations is not recommended until twenty four hours after placement.[11,14,26] Material advancements are rapidly occurring and may eliminate technique difficulties; but, with current material limitations, proper tooth selection and clinical technique are critical in order to achieve success with glass ionomer cements.

The use of a lining type glass ionomer cement as a restoration beneath a sealant has been previously presented.[27] The technique presented in this paper provides an update and two technique modifications. First, the manufacturer's specifications suggest that the compressive strength and surface hardness of current lining ionomer cements is such that its application in anything but incipient lesions may not be appropriate. Ketac-fill (Premier Dental Products/ESPE, Norristown, PA), or a similar restorative ionomer cement, presented in this paper, supply increased compressive strength and surface hardness to the restoration and would provide for broader clinical application. Material advancements are likely to produce glass ionomer cements with even greater strength for more widespread clinical use, in the future. Second, the phosphoric acid etching of the glass ionomer surface without protection is not recommended. A recent study found that etching the surface longer than fifteen seconds, would significantly dehydrate, weaken, and promote crack formation on the surface of a glass ionomer cement.[26] Placement of unfilled bonding agent or a glass ionomer varnish is required to prevent moisture contamination, as well as dehydration. The glass ionomer varnish should not be confused with the copal varnish one typically uses when restoring teeth with silver alloy. In addition, the use of a light-cured bonding agent will not only seal and protect the glass ionomer surface but will also provide a bondable surface to which the sealant will adhere.[21]

The "glass ionomer rest-a-seal" takes advantage of several desirable properties of this material. Most importantly is the adhesive nature of glass ionomer cements that allows for a conservative cavity preparation, when using this approach. Also, placement of glass ionomer in nonstress bearing Class I areas takes advantage of its relatively high compressive strength (25,000 psi). This material chemically bonds to both dentin and enamel, which strengthens the crown while minimizing microleakage. In addition, the anticariogenic action, with the constant fluoride ion release, would presumably reduce or eliminate future pit-and-fissure decay for teeth restored in such a manner.

The clinical success of pit-and-fissure sealants is proven, particularly when performed in conjunction with mechanical tooth preparation.[28] The preventive resin restoration is widely used and accepted and also enjoys proven clinical success.[29] This history of clinical success combined with continuing material advancements make a conservative approach to tooth preparation the state of the art in operative dentistry. The adhesive nature and fluoride release of glass ionomer cements provide a material that would seem superior. Its indication would be particularly appropriate in teeth presenting with Class I decay in which dentin is involved.

The "glass ionomer rest-a-seal" has been presented as an alternative treatment approach possessing desirable properties and should be considered for use in selected cases.

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Conservative treatment for malaligned permanent mandibular incisors in the early mixed dentition

Milton E. Gellin, DDS

Parents often consult their dentists about the eruption patterns of their children's mandibular permanent incisors. They are most often concerned when they see

- □ The mandibular permanent incisors initially erupted lingual to the corresponding primary incisors (Figure 1).
- □ The mandibular permanent central incisor(s) first erupted crooked or rotated (Figure 2).
- □ Although not always noticed by the parent, there is a lack of space for the unerupted mandibular lateral incisor after the permanent central incisors have erupted (Figure 3).

The parent believes that the problem is related to the overretained primary teeth. The dentist, because of parental pressure, extracts the primary teeth to allow the permanent replacements to assume their positions in the arch. The extraction(s) is performed many times without consideration for the future development of the intercanine width and the subsequent development of the alveolar bone in this area.

The purpose of this article is to point out that extraction of the mandibular primary incisors during the early mixed dentition can prevent this area from reaching maximum intercanine dimensional growth. This article deals only with the early extractions of the mandibular primary incisors (primary canines are excluded).

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LITERATURE REVIEW

Lingual eruption

In managing the cases of mandibular primary incisors where their permanent successors erupt lingually, Gellin observed forty-four children who had fifty- seven lingually erupted permanent mandibular incisors.[1] In all cases, labial migration and acceptable alignment occurred without the need to extract a primary incisor. If labial migration has not occurred by 8.2 years for the lingually positioned permanent central(s) incisors and the data suggest 8.4 years for the permanent central(s), removal of the retained primary incisor(s) should then be considered.

Crowding and rotations

During the exchange of the mandibular primary incisors for the permanent incisors, some degree of crowding is anticipated. Baume and Moorrees and Chada provide data from serial diagnostic casts to support that the initial crowding is transitory and can be improved by normal developmental processes.[2,3] Baume demonstrated that the proper alignment occurs with the transverse widening of the mandibular anterior arch, when the permanent incisors begin their eruption.[2] The strongest impulse for lateral growth of the mandibular alveolar process occurs with the eruption of the lateral incisor. Moorrees and Chada corroborated this observation.[3] After making serial analyses of dental casts they

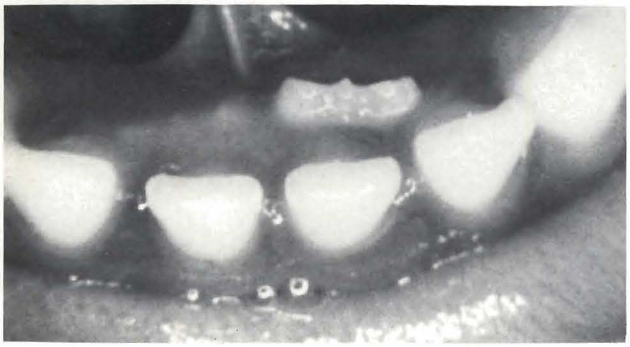

Figure 1. The permanent left central incisor is partially erupted while the permanent right central incisor is not yet clinically visible. This condition causes parental anxiety prompting an emergency call to the dentist.

Figure 2. Rotated permanent right central incisor. The permanent left central incisor is rotated and lingually positioned causing the primary lateral incisor to loosen prematurely. This situation does not predict future crowding.

reported that the incisor segments developed an excellent tooth alignment in the permanent dentition. During the mandibular incisor exchange, a normal degree of crowding can be expected, amounting to 1.6 mm in males and 1.8 mm in females. This 1.6-1.8 mm temporary crowding is relieved, when the crowns of the lateral incisors are fully erupted. Only with the full eruption of the lateral incisor is the intercanine width completed.

Other authors confirm that lingual positioning and crowding of the mandibular incisors can be self-correcting by the combination of some or all of the following events:

- □ Mandibular permanent incisors are normally positioned and developed lingual to the primary incisors.
- □ Variations occur in the mesiodistal width dimensions of the mandibular permanent incisors.
- □ Mandibular permanent incisors are more labially positioned after eruption.
- □ Distal movement of the primary canines into primate space, when the permanent lateral incisors erupt.
- □ Increase of the mandibular intercanine width.
- □ Increase in the growth of the mandibular anterior alveolar process.
- □ Presence of the mandibular leeway space.
- □ Mandibular permanent canines can move distally into the leeway space, allowing for relief of incisor crowding.[4-14]

Van der Linden reports an additional cause. The primary incisors and canines must remain until normal exfoliation, to insure that the expected increase in the intercanine width will occur.[15] "As such these deciduous teeth are involved in an active process to create more space for the erupting permanent incisors." Van der

Figure 3. Apparent lack of space for the unerupted permanent right lateral incisor. This situation does not always predict future crowding.

Linden continues to forewarn that no data exist to indicate that the first rotations of permanent mandibular incisors are signs of crowding and can spontaneously take corrective action.

Leighton suggests yet another cause.[16] He compared longitudinal mandibular diagnostic casts from three years of age to fifteen years of age of thirty-six cases with and without primary molar extractions. The factors examined were the mesiodistal diameters of each primary tooth and its successor, peripheral arch-length at three to four years and again at fourteen to fifteen years of age, interdental spaces at three to four years of age, sum of the primary molar diameters, and the sum of the premolar diameters. The best predictor of spacing or crowding in the mandibular permanent dentition is the sum of the spaces between the primary teeth at three to four years of age.

Lee confirms van der Linden's concepts with dra-

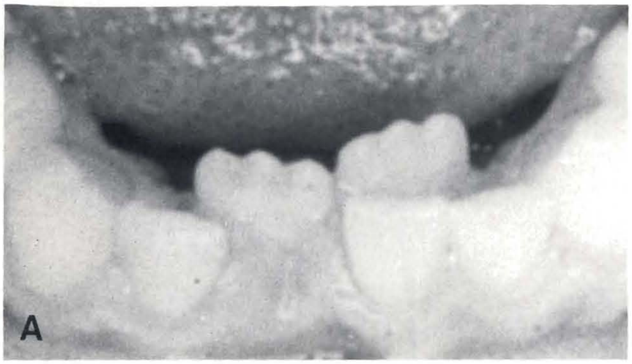

Figure 4. A: Permanent central incisors lingually positioned at six years, six months of age.

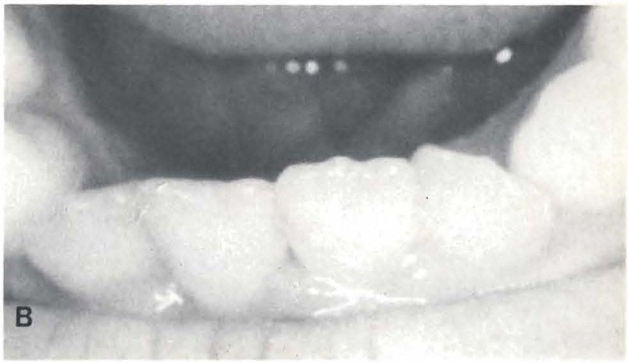

Figure 4. B: Self correction by labial migration of the permanent central incisors into an acceptable alignment at eight years, one month of age.

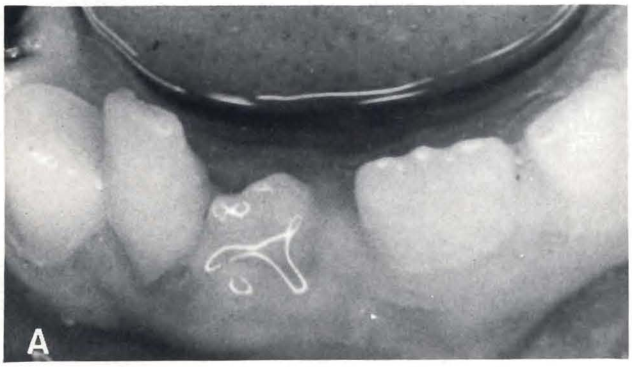

Figure 5. A: The permanent right central incisor is rotated and lingually positioned. The primary right lateral incisor is prematurely loosened. Wait for the full eruption of permanent right lateral incisor.

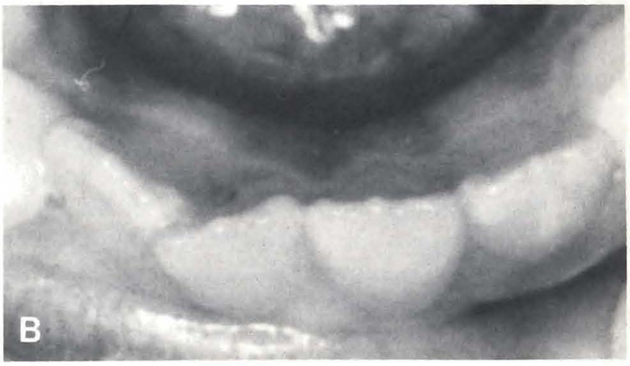

Figure 5. B: The right lateral incisor has erupted into an acceptable alignment, with slight rotation of the right central incisor.

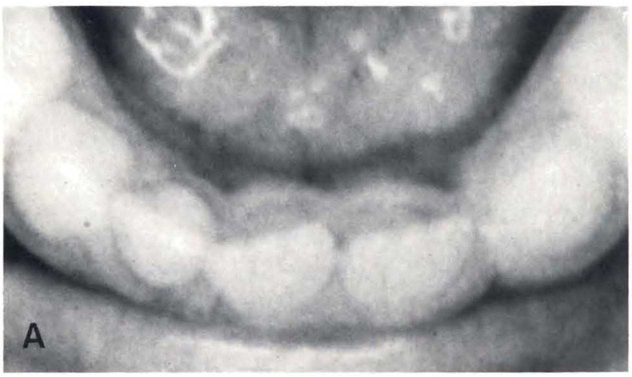

Figure 6. A: Apparent lack of space for the unerupted permanent left lateral incisor.

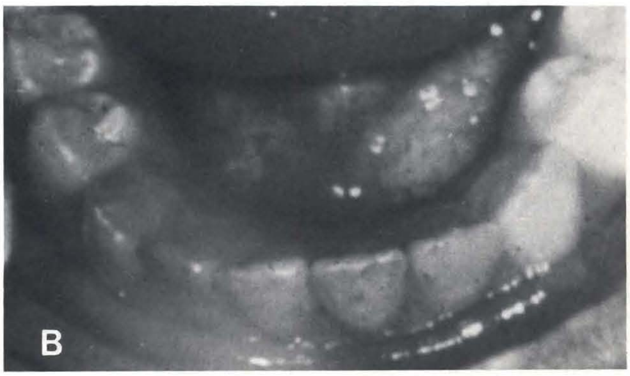

Figure 6. B: Mandibular permanent incisors have assumed an acceptable alignment in the permanent dentition without any previous extraction of primary incisors or orthodontic intervention.

Figure 7. A: Apparent lack of space for the unerupted permanent left lateral incisor.

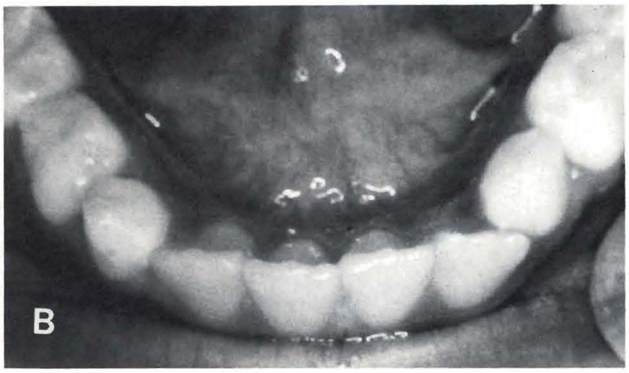

Figure 7. B: Both permanent lateral incisors now fully erupted without extraction of primary incisors.

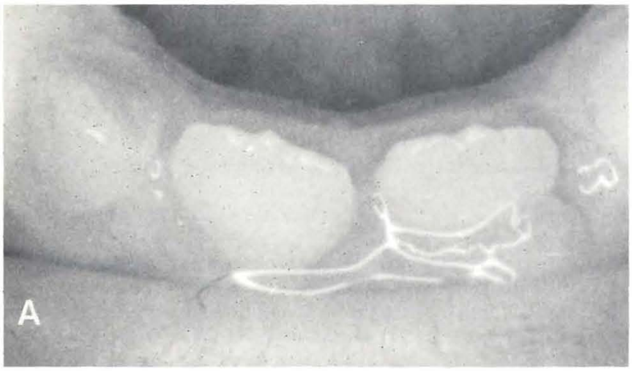

Figure 8. A: Apparent lack of space for the unerupted permanent left lateral incisor.

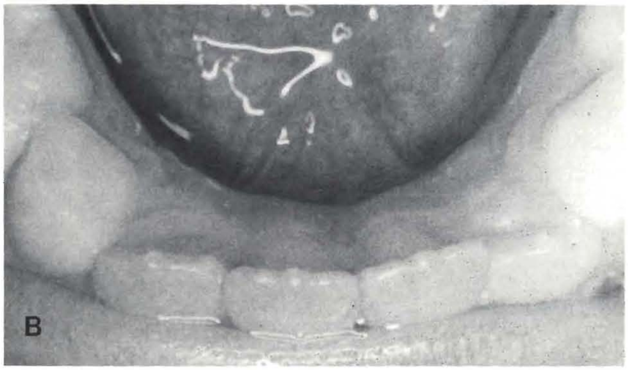

Figure 8. B: With the full eruption of the permanent left lateral incisor there is not adequate space.

matic serial intraoral photographs of seven cases that illustrate how the initial crowding of the mandibular permanent incisors eventually assumed an acceptable alignment without any extractions of the primary incisors or canines or any other orthodontic intervention.[17] He also contends that it is not possible to predict, at a very early age, the growth potential of the alveolar process especially the intercanine width. Lee further supports van der Linden in that the presence of the primary incisors and canines contribute to the optimal development of the mandibular intercanine width sufficient enough to accommodate the initial crowding of the mandibular permanent incisors.

Dewell acknowledges that spectacular growth can occur without any orthodontic intervention.[18] Preconceived concepts on the limitations of expected growth in the early developing occlusion can lead to false predictions at an early age.

REPORT OF CASES

When a mandibular permanent incisor has erupted to the lingual of a primary incisor, the dentist should reassure the parent that the primary incisor should exfoliate by eight years of age (Figure 4). If after eight years of age the primary incisor still remains firm and a periapical radiograph confirms the root of the primary incisor has not resorbed, it should be considered overretained and extraction is indicated. When this conservative approach is used early, however, extraction is seldom necessary.

When the mandibular permanent incisors first erupt, some degree of crowding occurs. The alleviation of this crowding is brought about by the increase of intercanine width, as well as the growth of the alveolar process. The continued presence of the mandibular primary incisors and canines insures that these increases do occur (Figures 5-9).

Figure 9. A: The right permanent lateral incisor partially erupted, rotated, and lingually positioned.

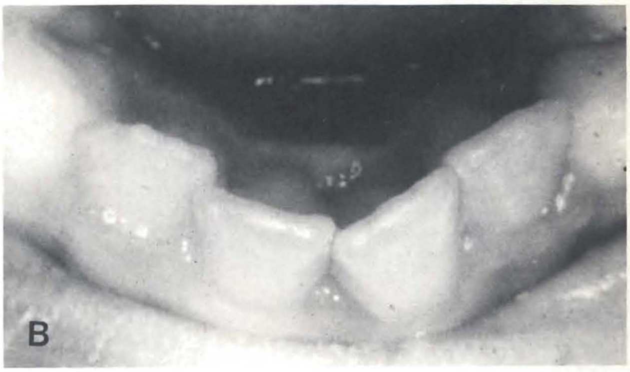

Figure 9. B: Wait for the full eruption of right permanent lateral incisor to allow for the maximum intercanine dimensional changes to occur.

Other causes further contribute to the eventual relief of the initial crowding. The permanent incisors are more labially positioned. Below average mesiodistal widths of the mandibular permanent incisors will need less space within the arch. Creation of the leeway space with the exchange of the primary canine and molars for the permanent canine and premolars allows the permanent canine to move distally, allowing for relief of incisor crowding.[19]

SUMMARY

When mandibular permanent incisors erupt lingually to the corresponding primary tooth, the lingually erupted permanent incisor should be allowed to correct itself. This self correction will usually occur by eight years of age. If the primary incisor is still present at eight years of age, it should be considered overretained. Extraction is indicated.

No primary mandibular central incisors are indicated for extraction, when the mandibular permanent central incisors initially erupt malaligned. In addition, if there is an apparent lack of space for the unerupted mandibular lateral incisor after the permanent central incisors have erupted, wait for the permanent lateral incisor to erupt fully. This waiting period allows for maximum intercanine width to occur. Other factors can allow for further improvement of the malaligned mandibular permanent incisors.

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Management of the difficult child: A survey of pediatric dentists' use of restraints, sedation and general anesthesia

Behavior

John E. Nathan, DDS, MDS

Fearful children demand considerable time, dedication, and expertise from the dental team. While the vast majority of young children can readily accept dental care without the use of sedative drugs or unconscious techniques, there are many for whom nonpharmacologic approaches may prove inadequate or even inappropriate. While several surveys have been reported on practitioner utilization of various behavior management strategies in pediatric dentistry, little information is available relevant to management of the very fearful and difficult child patient.[1-3]

This survey explores pediatric dentists' experiences, utilization, selection criteria, and preferences for various aversive and pharmacologic management strategies for treatment of the difficult child. The impact of variables, which include liability costs, practice location, caries prevalence, training and relative comfort level, preparedness for emergencies, and on selection and utilization of specific techniques is also examined.

The need for a wide and diverse repertoire for management of the challenging pediatric patient is obvious. This project has, therefore, several objectives. Its findings are expected to (1) Identify areas of general agreement as well as controversy, with respect to the criteria to be used in the selection of a management strategy in a specific situation; (2) Identify new areas for investiga-

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tion, with focus on those techniques that have been reported to be clinically successful, but lack evidence of a controlled study; (3) Explore the impact of escalating liability insurance costs and of the recent guidelines on the use of sedation and general anesthesia on clinical practice, published by the Academy of Pediatric Dentistry. It is not the intent of this project to be judgmental of an individual's selection or application of a given strategy or management approach. Significant departures from the norm may, however, serve as indications for reassessment.

MATERIALS AND METHODS

One thousand surveys were mailed to a random selection of diplomates and nondiplomates (American Board of Pediatric Dentistry). Of the 616 usable surveys returned, 166 were diplomates. Forty-eight states were represented with distribution commensurate with per capita populations. Twenty percent of the respondents indicated a predominant activity in academics.

All respondents were asked to identify their institution/practice location (urban, rural, or suburban) and describe the caries prevalence (high, low, or variable) of their patient populations. Data were sought with respect to years experience, state regulatory requirements and limitations for the use of parenteral sedation, current limits and cost of liability coverage, factors which potentially influence the selection and use of a technique.

In addition to sections which examine philosophies and use of aversive measures, parents' presence, sedation, and general anesthesia, practitioners were asked to indicate their preference for management of five case scenarios, each representing a different age and degree of difficulty in terms of extensiveness of treatment and duration of cooperation needed. A final section enabled identification of cases involving morbidity and mortality.

RESULTS

No statistically significant differences were found between diplomates, nondiplomates, academicians, and clinicians across any of the tabulated questions discussed below. As such, percentages are cited to denote the extent to which responses varied to given questions, in an effort to provide insight that may be masked by mean scores.

DISCUSSION

Use of aversive techniques

□ Physical restraint devices

The need for some form of physical restraint in pediatric dental practice is essentially low (4 percent). This includes a tendency to limit the application of actual restraining devices (pedi-wrap, papoose board) to either a handicapped or sedated patient for the purpose of preventing potentially harmful reflex movements. As such, their primary intent is to permit an acceptable quality of care under circumstances where the patient is lacking in cooperative ability, and not as a punitive device for a potentially cooperative child whose behavior might simply be obstinate.

When asked, however, for their preference in selecting either a sedative technique or restraint to complete a single restoration on a neurologically normal but resistant three-year-old child, the majority of pediatric dentists preferred to avoid the use of a pharmacologic adjunct. On the other hand, despite the majority opinion, 38 percent chose to avoid resorting to restraint.

Perhaps more important than how pediatric dentists perceive the relative appropriateness of restraint devices and the criteria for selecting one is the issue of informed consent and dialogue occurring between practitioner and parent before use. The issue will be addressed in greater detail (Figure 1).

□ Hand-over-mouth (H.O.M.) and voice control

While controlled data are lacking to either support or condemn its use, this technique has become controversial; it has been regarded as an acceptable technique, when used appropriately by a compassionate and controlled operator to secure the attention of a hysterical child and to terminate potentially harmful behaviors.

The findings of this study were presented at the National Conference and Workshops on Child Behavior Management, sponsored by the American Academy of Pediatric Dentistry, Iowa City, Iowa, September 29-October 2, 1988. A draft of this paper will appear in a proceedings of that conference (to appear in May, 1989). Permission to submit this paper to the Journal of Dentistry for Children for publication has been obtained from the American Academy of Pediatric Dentistry.

The author expresses appreciation to all respondents who took time to complete the survey and for their candid thoughts and constructive comments.

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Figure 1 ☐ Respondents' answers to the survey items regarding the use of restraints and aversive techniques, the presence of a parent, and the use of sedative and unconscious techniques.

Respondents were asked to characterize their use of the following techniques using the following key:

SA = strongly agree = 1
A = generally agree = 2
N = neutral feelings = 3
D = generally disagree = 4
SD = strongly disagree = 5

A. Use of restraints and aversive techniques

	SA 1	A 2	N 3	D 4	SD 5	Mean score
1. I would prefer to use a sedative technique (other than nitrous) than to restrain a (normal) 3 y.o. for a simple restoration.	24%	14%	9%	25%	28%	3.1
2. I limit the use of a pediwrap or papoose bd to either a handicapped or sedated pt.	30%	24%	10%	18%	18%	2.7
3. I do not find parents objecting to: a. H.O.M. (Hand-over-mouth)	4%	36%	22%	23%	15%	3.1
b. H.O.M.A.R. (airway restricted)	2%	7%	20%	10%	61%	4.0
4. I generally attempt to secure informed consent before using H.O.M.	17%	21%	19%	27%	16%	3.0
5. Effective use of Voice Control should almost eliminate the need for H.O.M.	17%	37%	10%	25%	11%	2.8
6. The longer I practice, the less I use or need: a. aversive techniques	37%	37%	14%	8%	4%	2.2
b. sedative techniques	30%	28%	21%	14%	7%	2.4

B. Parent presence

	SA 1	A 2	N 3	D 4	SD 5	Mean score
1. I do not allow parents in the operatory during: a. Initial examinations	11%	17%	12%	23%	37%	3.5
b. Treatment with or without nitrous oxide	27%	24%	15%	17%	17%	2.7
c. Sedation visits	41%	19%	14%	13%	13%	2.4

C. Use of sedative and unconscious techniques

	SA 1	A 2	N 3	D 4	SD 5	Mean score
1. Effective use of oral or rectal agents (with or without nitrous) almost eliminates the need for parenteral techniques	21%	26%	14%	26%	13%	2.8
2. I recommend general anesthesia (G.A.) if it seems unlikely all tx can be accomplished on very difficult pts in no more than 2 sedation visits	31%	31%	10%	18%	10%	2.4
3. I would select G.A. rather than use an agent like alphaprodine in the office	49%	23%	12%	5%	11%	2.0
4. A pedodontist practicing in a suburban, low-caries area who does ⟩ 150 G.A. cases/yr (who uses no nitrous or sedation) is grossly overusing G.A.	57%	23%	17%	2%	1%	1.3
5. I generally prefer to attempt tx using a sedative regimen before resorting to G.A.	37%	31%	10%	15%	7%	2.2
6. Effective use of conscious or deep sedation has significantly reduced the frequency with which I would otherwise need G.A.	30%	29%	19%	12%	10%	2.4
7. Due to the ramifications of the AAPD-AAP sedation guidelines I find I select G.A. more now and in-office sedation less.	18%	16%	31%	25%	10%	2.9
8. I (do not) (will not) use parenteral sedation in my office because: a. of prohibitive liability costs	34%	23%	28%	8%	7%	2.3
b. insufficient cases to justify cost or increased risk	37%	25%	23%	9%	6%	2.2
c. I prefer the hospital for G.A.	52%	22%	14%	6%	6%	2.0
9. I would prefer to use alphaprodine instead of oral chloral hydrate for very difficult young pts	7%	7%	11%	18%	57%	4.0
10. I have no difficulty complying with AAPD-AAP sedation guidelines for: a. consciousa sedation	27%	37%	20%	10%	6%	2.4
b. deep sedation	15%	25%	33%	19%	8%	3.0

Even when used in the manner described by Craig (1971) and Levitas (1974), however, some consider the technique objectionable and have challenged dentists employing the technique on the basis of perceived harshness or lack of informed consent.[4,5] Judgments for the latter reason are particularly troubling to dentists who believe the technique is appropriate and effective on the basis of the spontaneity with which it is applied. Objections are understandable where the practitioner resorts to the technique without reasonable effort to exhaust alternate means of communication; or worse, applies the technique harshly or punitively. The variation of hand-over-mouth in which the practitioner restricts the child's airway in any form is such an example. Sixty-six percent of the respondents in this survey indicated they use hand-over-mouth and need it on less than 2 percent of their patients. Eighty percent of the respondents indicated they would never restrict the airway. Almost unanimously, participants at the AAPD conference condemned any degree of restriction.

A growing number of pediatric dentists and allied health professionals, however, currently discourage the use of hand-over-mouth in any form. Weinstein and Nathan (1988), hypothesize that given an opportunity to witness its application many if not most parents would reject the use of hand-over- mouth.[6] They believe this technique and other restraints are often used prematurely, that children do not show tantrum behavior in the dental chair without warning. They show numerous signs of fear and upset, which are often ignored or attended to by superficial reassurance. Not allowing adequate time to establish rapport or to assess more carefully the child's tolerance of stress frequently results in premature application of hand-over-mouth and other restraints for the purpose of completing a procedure. These authors point out that despite their intentions, these techniques of last resort are not readily employed without emotion. The scenario of a screaming, flailing child is emotionally charged. Children can sense anger and inadequacy of the clinician and should not be expected to respond positively in such situations.

As an alternate to hand-over-mouth, Troutman (1988) advocates a "time-out", to permit an emotionally charged situation to attenuate, while opening lines of communication with the parent to gain input and support for subsequent efforts to manage the child.[7]

While overall neutral responses were reported on whether pediatric dentists believed parents object to hand-over-mouth, a consistent pattern of parental disapproval of restriction of the airway was seen. Overall, the majority of respondents felt that effective use of the voice might reduce or eliminate the need for hand-over-mouth. Those using the technique more often, however, tended to respond to the contrary, while nonusers tended to favor the use of voice control.

Informed consent

In our litigious society, increased attention has been given by health professionals to the issue of informed consent. The request "do whatever you think is best doctor" is perhaps more the exception than the rule today. Hence, decisions to use control techniques that carry the potential for misuse, misinterpretation, or adverse responses (e.g. hard restraints, hand-over-mouth, sedation, and general anesthesia) require the practitioner to obtain the informed consent of the child's legal guardian and to be able to produce evidence of it.

The findings of this survey indicate the majority of pediatric dentists continue to regard hand-over-mouth as a spontaneous technique for which consent is not warranted. Isolated cases have occurred where assault charges have been brought against pediatric dentists for using it. In perspective, however, the use of hand-over-mouth appears acceptable to parents whether consent has or has not been obtained. In the final analysis, the relative appropriateness of hand- over-mouth will be judged by parents and/or the justice system, not by pediatric dentists. If applied in the manner described by Craig and Levitas, with parental informed consent, (for hand-over-mouth or any other nonmainstream behavior management technique) perception of assault or misuse seems unlikely.

Parental presence during examinations and treatment

While there is no general consensus among pediatric dentists whether a parent should be permitted in the operatory, trends revealed in this survey include increased parental presence and involvement in decision-making and provision of care.

While a number of nondental studies advocate the positive influence of parental presence in increasing the security and coping ability of the child in an unfamiliar environment, research conducted in dentistry is limited and inconclusive. In pediatric medical practice, except under emergency conditions (trauma, surgery) parents are excluded only rarely. Many dentists arbitrarily exclude parents; some dentists view the parent as a hindrance to the completion of a procedure, while other are uncomfortable with a parent witnessing their treatment methods or use of various control techniques. Other reasons for parent exclusion include size of operatory, persistent parental interference (competition in establishing attention and child rapport), and both subtle and overt displays of parental anxiety. While the latter are clearly instances for which parent presence can prove counterproductive, exclusion according to Troutman and others should not be routine.[6-9] Parent's presence should be agreed upon mutually, with the child's best interests in mind. The need to spend time to eliminate parent's fears and provide counsel with respect to parent's role and expectations are essential to the overall management plan for child and parent alike.

Advocates of parental presence find it illuminating for the "skeptic" parent to observe the behavior with which one must contend and to witness how patient, gentle, systematic, confident, and skillful one is in difficult and in favorable circumstances. Their presence facilitates dialogue and immediate feedback about available options, and selection of a mutually acceptable management plant. This seems particularly useful for the parent and child who have had several unsuccessful visits to other offices.

Figure 2 □ Respondents' answers on use of oral sedation.

Oral sedations (annually)					
	N	Percent	Total Cases	Avg/user	Avg/all pediatric dentists
Diplomates	117	70	15,679	134	94
Nondiplomates	351	78	40,084	114	89

Oral sedations (annually)		
Cases per year	Diplomates	Nondiplomates
0	49 (30%)	99 (22%)
1-10	31 (19%)	77 (17%)
11-50	34 (20%)	131 (29%)
51-100	14 (8%)	61 (13%)
101-200	19 (11%)	40 (9%)
201-500	12 (7%)	26 (6%)
501-1,000	5 (3%)	11 (2%)
〉 1,000	2 (1%)	5 (1%)

Figure 3 □ Use of parenteral sedation.

Annual use of parenteral sedations (IM, IV, SubQ, Submucosal)				
	Number using	Percent	Cases per year	Average per doctor
Diplomates	31/166	19	2,231	72
Nondiplomates	80/450	18	6,477	81

Use of sedation and general anesthesia

An accepted caution of pediatric dental practice is that pharmacologic approaches should never be employed as substitutes for reasonable efforts to manage fearful and difficult children by nonpharmacologic techniques. As such, pediatric dentists believe they treat the vast majority of all children without drugs. For the small percentage of children who have a limited ability to cooperate or lack it entirely, nonpharmacologic approaches, however, may prove either inadequate or inappropriate.

As seen in the results section, wide variation exists amongst practitioners in their selection and use of pharmacologic and nonpharmacologic methods for controlling the patient. In the case scenario section, wide ranges are seen with respect to the selection of drug, route of administration, and method for cases involving essentially minor treatment needs. While some select conservative and nonpharmacologic approaches, others choose general anesthesia. Rather than attempt to characterize any one approach as acceptable and another an unacceptable, readers are encouraged to draw personal conclusions as to what constitutes the most viable approach for their patients and practice (Figs. 2-6).

□ Use of nitrous oxide

Overall, 85 percent of the pediatric dentists reported using nitrous oxide (in 35 percent of their patients). Of these, 12 percent report using nitrous oxide on between 90-100 percent of their patients who are to receive restorative or surgical care; 25 percent of those surveyed use nitrous oxide on 60-100 percent of their patients. There was no apparent correlation between the frequency with which practitioners use nitrous oxide and the number of general anesthetic cases they perform annually. While many heavy users of nitrous oxide performed high numbers of general anesthetic cases, other heavy users performed less than 20 general anesthetic cases per year. In contrast to earlier reports, nitrous oxide is now used by more practitioners and with higher frequencies. The extent to which its greater usage violates the caution about nonpharmacologic management stated above is unclear. Recognized for its weak potency by practitioners and liability carriers alike, it would appear that those making frequent use of it may regard it as similar to local anesthesia: namely as a behavior management tool. Those holding to the caution are inclined to argue that nitrous oxide is overused, while heavy users might argue that nitrous oxide serves as a "preventive medication" management strategy, an extrapolation of a concept described by Musselman and McClure (1975).[10] Resolution of this hypothetical debate seems unlikely.

□ Oral and parenteral sedation and general anesthesia

Despite many recognized limitations, the oral route of administration is generally preferred over parenteral agents for the difficult pediatric patient. Consistent with reports by Duncan *et al* and Houpt, chloral hydrate, alone or as a comedication with hydroxyzine or promethazine, is the most frequently used oral agent (frequently combined with nitrous oxide).[3,11] Base of administration, relative safety, and significantly less liability are major factors that appear to account for continued popularity over more predictable yet more potent parenteral agents. With the removal of alphaprodine, the use of meperidine appears to have increased, particularly in its oral form.

With respect to a relationship between the number of sedations and general anesthetic cases, those performing 50-150 oral sedations per year were found to utilize the hospital operating room significantly fewer times than those performing little or no in-office sedation. Documentation of the effectiveness and safety of oral and parenteral sedation, consistent with the findings of Wright *et al* seems apparent.[12]

Concerns related to increased state regulation over the use of in-office parenteral sedation and spiralling liability costs associated with its use clearly limit the pediatric dentist's selection of injectable sedative techniques in difficult young children as well as in resistive older handicapped children and adolescents. While the recent Academy guidelines for the elective use of conscious and deep sedation mandate strict compliance in terms of patient monitoring and personnel requirements, pediatric dentists as a group, however, do not express difficulty with these provisions. Given the availability of hospital facilities, and prohibitive liability costs, it is not surprising to see a strong preference for general anesthesia over parenteral sedation in the private office.

Some additional factors which potentially influence selection of method are discussed below.

Figure 4 □ Summations of the use of general anesthesia by diplomates and nondiplomates.

Annual use of general anesthesia

	Number using	Total cases	Average per user
Diplomates	113 (68%)	3,052	27
Nondiplomates	285 (63%)	8,360	29

Average annual use of general anesthesia (N = 616)

	Cases per year
Diplomates	18.4
Nondiplomates	18.6

General anesthesia cases

Cases per year	Diplomates	Nondiplomates
0 - 25	76 %	79 %
0 - 50	90 %	92 %

General anesthesia cases annually

Cases per year	Diplomates	Nondiplomates
0	53 (32%)	156 (37%)
1-12	52 (31%)	140 (31%)
13-25	21 (13%)	48 (11%)
26-50	24 (14%)	59 (13%)
51-100	12 (7%)	27 (6%)
101-150	1 (0.6%)	4 (0.8%)
151-200	2 (1%)	2 (0.4%)
201-250	0	0
⟩ 250	1 (0.6%)	4 (0.8%)

The effect of experience on selection and use of aversive, sedative, or unconscious techniques

Consistent with earlier surveys, there is a general belief that as our experience increases, we have less need for aversive and pharmacologic techniques. While an explanation of this widespread belief is somewhat obscure and complex, it strongly suggests improved communication skills and persuasive abilities offset the need for more invasive and high-risk techniques. This simplistic notion, however, does not take into account a number of important variables that may influence the method to be used. Variables among operators (such as training experience, relative success with given methods and hence individual preferences, practice locations, caries prevalence, and average age and type of patients seen in one's practice) as well as increasing liability and treatment costs associated with the use of oral and parenteral sedation and general anesthesia no doubt are determinants in the selection of a method (Figure 7).

For example, do those who do not use sedation employ general anesthesia more often than those who successfully utilize sedation? Similarly, do practitioners who do not use sedation or general anesthesia utilize aversive measures with greater frequency? Or conversely, are those who do not need pharmacologic approaches measurably more proficient in their application of nonpharmacologic communication strategies? Are practitioners who use no form of sedation or general anesthesia able to consistently provide quality care for very difficult young children? Why are some practitioners performing more than a hundred general anesthesia cases annually (some, over 300 per year) when the

Figure 5 ☐ For each of the following case scenarios, respondents were asked to indicate their first preference for patient management, with the assumption that behavior is difficult to the extent that significant physical restraint would be minimally necessary.

	Case scenario	Management strategies selected*	
1.	A 4 y.o., 20 kg, profoundly retarded child with pulpally involved (restorable) primary first molars	chloral hydrate combinations	40%
		general anesthesia	31%
		nitrous oxide + local	9%
		restraint + local	9%
		nisentil	1%
2.	A 3 y.o., 15 kg neurologically normal, with pulpally involved yet restorable maxillary incisors	chloral hydrate combinations	32%
		demerol + phenergan	16%
		nitrous oxide + local	15%
		restraint + local	10%
		local only	10%
		general anesthesia	6%
		nisentil	4%
		diazepam	2%
		midazolam	1%
3.	Same patient as in (2) but only needs extraction of #D-G.	local only	25%
		restraint + local	24%
		nitrous + local	23%
		chloral hydrate combinations	15%
		hydroxyzine or promethazine	4%
		referral to OMFS	2%
		nisentil	1%
		morphine	1%
		diazepam	1%
4.	4 y.o. requiring extensive restorative tx . . . but you are not able to consider general anesthesia	chloral hydrate combinations	28%
		nitrous + local	15%
		restraints + local	12%
		local only	10%
		meperidine + promethazine	9%
		diazepam	9%
		nisentil	2%
		meperidine + diazepam	1%
		general anesthesia	1%
5.	A 15 y.o., 60 kg, Down syndrome with extensive caries . . . but you are not able to consider general anesthesia	hospital O.R. for IV sedation	37%
		nitrous + local	13%
		restraints + local	9%
		referral to university, OMFS, or to another pediatric dentist	8%
		meperidine + promethazine or diazepam	8%
		chloral hydrate combination	5%
		ketamine (in-office)	1%
		diazepam + morphine	1%
		general anesthesia	4%

* Detailed analysis and breakdown of various drug regimens, dosages, and success expectations were considered beyond the scope of this paper. These data will appear in subsequent manuscripts.

Figure 6 ☐ Data regarding permission and cost for use of parenteral sedation in specific states.

States requiring a special permit to administer parenteral sedation in their offices	PDs in possession of parenteral sedation permits for in-office use	PDs not aware permit is needed to administer parenteral agents in their offices
23 states	8/166 diplomates 27/450 non-diplomates	15%

	Low	Range of Limits of liability coverage (occurrence/aggregate) Mode	High	Range of annual Premium costs*,**	Average annual premium (mode)
U.S.A. +					
CA	500/1M	1M/3M	1.5M/4.5M	$4,000-7,000	$5,000
CT	1M/1M	1M/3M	–	$4,000-6,000	5,000
FL	300/1M	1M/1M	2M/3M	900-9,000	6,000
PA	200/600	1M/1M	1M/3M	850-5,000	4,500
NJ	200/600	1M/3M	3M/5M	2,500-6,000	4,000
IN	100/300	300/1M	1M/3M	385-1,200	900
CANADA	100/300	1M/2.5M	2M/5M	300- 600	500

* does not reflect effects of carrier changes to "claims-made" policies.
** data not yet available of premiums on a breakdown of the use of various conscious and unconscious techniques.
+ states requiring special permits for in-office parenteral conscious sedation.

Figure 7 ☐ Select examples of annual utilization of sedation and general anesthesia.

ID#	Caries level	N_2O	P.O.	IM IV	General Anesthesia cases	Liability limits	Yrs. experience	Monitoring devices
196	high	90%	700	500	300	100/300	1	1
261	variable	25%	200	0	350	iM/3M	12	0
314	variable	90%	50	125	400	1M/3M	7	1-4
D149	low	0	0	0	300	1M/3M	20	0
D5	low	70%	0	0	200	100/300	24	0
D47+	variable	0	1000	0	0	100/300	20	2,3
D98	high	100%	2000	200	100	1M/1M	14	3
D120*	variable	97%	0	0	0	1M/3M	20	0
D101‡	high	33%	2000	75	100	1M/3M	12	2,3
D140	high	90%	500	300	0	1M/3M	13	0
39	variable	90%	2000	1200	30	100/300	12	0
388	variable	100%	400	400	0	2M/2M	9	0

+ most frequently uses meperidine (1-2 mg/kg) with hydroxyzine 1.5 mg/kg
* experienced case resulting in mortality (alphaprodine)
+ + academic setting
Key for monitoring devices: 0 = none; 1 = BP; 2 = precord stethoscope; 3 = pulse oximeter; 4 = ECG monitor

national average is less than twenty per year? Are the patient populations so different among practices, or are practitioners overusing (or underusing) sedation and general anesthesia? In this survey, more than 90 percent of the respondents perform fifty or fewer general anesthesia cases annually, and approximately 80 percent perform 100 in-office sedations or fewer per year.

While it is somewhat inconclusive and inappropriate to be highly critical of heavy users of either restraints, sedation, or general anesthesia, there are several examples for which caution and reassessment appear warranted. Practitioners performing more than 100 general anesthetic cases per year, for example, while using minimal or no other forms of office sedation, raises serious ethical questions: are alternative options, including referral to a colleague proficient in the use of sedation, being adequately explored or presented to parents?

Other examples are illustrated below.

Preparedness and comfort levels for the management of medical emergencies

Commensurate with the responsibilities associated with the use of in-office sedation, the pediatric dentist must be proficient and adequately equipped for early recognition and management of medical emergencies. While not necessarily a conclusive measure of the relative preparedness for management of emergencies, factors used in assessing preparedness include the knowledge of the operator and staff, availability of specific and appropriate emergency equipment and supplies, and the dental team's ability to respond to the emergency and use the equipment proficiently (Figures 8, 9).

Ninety-six percent of the respondents indicated they were equipped with standard or customized pediatric emergency kits; of these, 32 percent felt comfortable with their use, and 43 percent reported them to be adequate. Twenty- five percent indicated they were less than adequately trained or comfortable. There were no differences between the number of oral and parenteral sedations performed by those who reported adequate vs inadequate comfort levels in emergency management. This finding raises obvious concerns.

Ninety-eight percent reported having basic life support certification, while 10 percent and 17 percent of the diplomates and nondiplomates, respectively, have advanced cardiac life-support certification (ACLS). Of those with ACLS certification, few reported using parenteral sedations. An interesting finding was that 41 percent of respondents believed ACLS training should be mandatory in pediatric dental training programs.

With regard to office resuscitation and emergency equipment, 27 percent reported having laryngoscopes, tubes and airways; 28 percent, intravenous armamentaria; 4 percent, ECG monitors; and 1 percent, defibrillators in their facilities. The actual on-site ability to recognize, address, and rectify a developing medical emergency, pending arrival of support teams, suggests, therefore, most offices are not sufficiently prepared, particularly those performing sedation with agents other than simply nitrous oxide or single sedative agents.

The benefits and indications for a pulse-oximeter for patient monitoring for all in-office conscious sedation (other than for nitrous oxide) are becoming known and considerations are underway to suggest this adjunct as required equipment. As per the survey, only 9 percent indicated they have and use this device. Eighty-five percent routinely monitor blood pressures, while only 44 percent indicated they use either precordial or pretracheal stethoscopes, during sedation visits.

While the majority of practitioners indicate little or no difficulty complying with the AAPD-AAP guidelines of 1985 regarding monitoring, equipment, and personnel requirements, it seems likely that compliance in actuality falls seriously short of optimal. Study seems warranted to determine mechanisms by which further training and proficiency in this area can be evaluated and enhanced.

Cases involving morbidity and mortality in pediatric dental management

Practitioners were asked in the final section of the survey to identify any untoward reactions or occurrences they

Figure 8 ☐ Adverse patient reactions from the use of sedation or general anesthesia.

Pt age/wt	ASA classif	Agents used	Adverse reactions	Outcome
28 mos	I	alphaprodine ? mg	resp. arrest	mortality
36 mos	I	alphaprodine 0.4 mg/kg	resp. arrest	mortality
30 mos	I	alphaprodine 0.4 mg/kg + chloral hydrate 50 mg/kg + hydroxyzine 25 mg	resp. arrest	mortality
22 lb	I	IM Demerol 22 mg + IM Phenergan 25 mg + IM Thorazine 25 mg	—	brain damage
39 mos	I	chloral hydrate 750 mg + hydroxyzine 50 mg + nitrous 40%	lethargic for 4 days	
5 y.o.	I	chloral hydrate 1500 mg	resp. arrest	Full Recovery
5 y.o.	I	chloral hydrate 75 mg/kg	resp. depress.	Full Recovery
4 y.o.	II	IM meperidine 35 mg + IM promethazine 25 mg	resp. depress.	Full Recovery
3 y.o.	I	alphaprodine 0.4 mg/kg	reversed in office; stable at time of discharge; resp. arrst at home 2 hrs. later	Fatality
19 mos	I	G.A. Ethrane-diazepam		Fatality
24 mos	I	G.A. post-extubation aspiration		Fatality
37 mos	I	G.A. post-extubation aspiration		Fatality
4 y.o.	I	G.A. cardiac arrythmia/arrest		Fatality
4 y.o.	I	Non-pharmacologic mgmt	extremely disruptive, uncontrollable behavior . . . aspiration/ laryngospasm	Fatality

have experienced with sedation or general anesthesia. They are listed as follows:

SUMMARY AND IMPLICATIONS FOR FUTURE STUDY

This survey project explored the experience and philosophies of pediatric dentists toward their use of various behavior-management strategies for the challenging pediatric dental patient. With the exception of definitive views toward the overuse of general anesthesia in certain instances, and the inappropriateness of an airway-restricted variation of hand-over-mouth, there are few areas in which general agreement exists for managing difficult children.

The data are presented to permit readers to make personal conclusions as to what constitutes appropriate and acceptable management choices. What is appropriate or successful for one practitioner may not be for another. A task that remains is for pediatric dentists to begin to define the range of acceptable approaches and strategies for the young dental patient. Another goal is to identify areas in need of further study. Controlled data are needed to clarify the short and long-range effects of the various management strategies we endorse today. In some situations, we must take a hard look at our own capabilities and objectively assess our limitations. Our competence and proficiency as both individuals and as a group in the area of medical emergency management is another area in need of attention.

Figure 9 ☐ Selected comments from respondents.

"I use chloral hydrate at 100 mg/kg + nitrous oxide and experience 100 percent success with no need for general anesthesia."

"For difficult children, I use two grams chloral hydrate + 50 mg hydroxyzine + nitrous oxide and only need general anesthesia for ten cases per year."

"With the withdrawal of alphaprodine, I do many more general anesthesia cases than before."

"I have done more than 7000 cases using alphaprodine or meperidine and promethazine with only one mild reaction."

"I do no sedations. . . it's nitrous oxide, restraint, or general anesthesia."

"No need for sedation or general anesthesia. . . I use only a papoose board, and it hasn't killed anyone yet."

"There is little need for sedation. . . too much risk."

Fertile areas for investigation include systematic and controlled study of several premedication regimens (new and old) for which many report considerable clinical success and safety. Needed are improved research designs that begin with well-defined criteria for selection of patients upon whom to assess or compare the efficacy of selected agents or techniques.

Lastly, as the process of reassessment and restructuring of our thinking occurs in this area, it should be acknowledged that we have not been unsuccessful in the past. As suggested by Troutman, "Contemporary dental care for children must include empathy rather than indifference, structure rather than diffuseness, and flexible direction rather than rigid control."[7] No other group is more concerned or dedicated to the well-being and dental health of fearful and anxious children.

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Report of project USAP: The use of sedative agents in pediatric dentistry

Milton Houpt, DDS, PhD

Children who present with behavioral problems in the dental operatory usually are managed with nonpharmacologic methods. These techniques include the tell-show-do method and voice control, and they are usually sufficient to manage patients with whom one can communicate. Individuals who cannot communicate adequately, such as infants or severely retarded persons, who manifest severe behavioral problems usually require sedation or general anesthesia in order to receive dental treatment.

Sedation use varies widely around the country. Project USAP was performed to examine the use of sedation in pediatric dentistry in the United States and Canada. The project was conducted in two parts: part I studied the use of sedative agents by practicing pediatric dentists, and part II examined the use of sedation in postgraduate teaching programs.

PART I: USE OF SEDATIVE AGENTS BY PRACTITIONERS

Methods

Members of the American Academy of Pediatric Dentistry participated in a national survey that was conducted during the summer of 1985. All 2,040 members of the Academy were sent questionnaires regarding the frequency of their use of sedation and the types of agents used. Eleven hundred five (1,105) practitioners responded and these represented all geographic areas of the United States and Canada, hospital and university-based training programs, and various lengths of time in practice from recent graduate to long-time practitioner (Table 1).

The practitioners were questioned concerning their use of nitrous oxide, their use of other sedative agents, the frequency of their use of sedative agents, the percentage of their patients who were normal as compared to handicapped, the ages of their patients receiving sedation, the methods for monitoring patients during treatment, the usual drugs used together with the typical dosage and the typical effect of sedation, any undesirable side effects observed by the practitioner, and the emergency equipment and drugs available in the office of the practitioner (Figure 1).

Results

The results of Part I of the study appear in Tables 1 to 9. Table 1 describes all participants in the study. Nonparticipants included retired or semiretired individuals, and those who could not be contacted as they had moved with no forwarding addresses. Eleven hundred and five (1,105) practitioners participated in the survey, and of these, 801 indicated that they used sedative drugs other than nitrous oxide in their practices. One hundred and thirty eight (138) indicated that they used such drugs more than sixty times in a typical three-month period (greater than once/day) and sixty-four individuals used

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Table 1 □ Participants in project USAP: The use of sedative agents by pediatric dentists, shown in percent.

	Total sample N = 1105	Sample using sedation N = 802	Sedation use > 1/day N = 138	Sadation use > 2/day N = 64
Diplomate status				
Diplomate	19	17	17	14
Nondiplomate	81	83	83	86
Type of teaching				
Grandfathered	9	5	6	8
University based	47	47	43	36
Hospital based	31	35	36	30
Combined	13	12	16	27
Area of practice				
Northeast	25	26	20	19
South/Southeast	27	29	41	38
Midwest	25	24	12	16
West	21	20	27	28
Canada	2	2	0	0
Years of Practice				
1-5	18	20	24	26
6-10	30	34	35	30
11-15	23	24	22	22
16-20	10	8	7	9
20+	19	14	12	13

Table 2 □ Frequency of use of sedative agents, shown in percent.

	Total	Sample using sedative drugs Other than N_2O		
Percent of patients sedated only with nitrous oxide	sample N = 1105	> 1/3 mos. N = 801	> 1/day N = 138	> 2/day N = 64
0	19	11	8	11
1-5	24	25	14	11
6-10	12	16	14	13
11-25	12	13	16	17
26-50	11	12	21	20
> 50	22	23	27	28
Percent of all patients sedated with other sedative agents				
0	23	2	1	0
1-5	52	67	20	6
6-10	14	18	28	25
11-25	7	8	31	33
26-50	4	4	14	25
> 50	1	1	6	11
Total number of patients sedated (other than N_2O) in 3 months	33,465	33,465	21,670	14,802
Average number of patients sedated (other than N_2O) by each practitioner in 3 months	30	42	157	231
Percent of sedated patients (other than N_2O) who were handicapped	--	14	9	8
Percent of all patients sedated (other than N_2O) who were ages				
0-2 Yrs.	--	41	26	23
3 Yrs.		34	35	33
4-5 Yrs.		16	24	25
6-10 Yrs.		6	11	14
> 10 Yrs.		3	4	5

sedation more than 120 times in a similar time period (greater than twice/day). Respondents were fairly evenly distributed across the four geographic areas of the country; frequent users of sedation (greater than 1/day), however, were located more in the south/southeast (41 percent) and west (27 percent) areas of the country compared with the northeast (20 percent) or midwest (12 percent) areas. Respondents from university-based programs who used sedative drugs other than nitrous oxide were similar in number to those who attended hospital-based or combined programs, although heavy users tended to be more from the hospital based or combined programs (57 percent) than from university based programs (36 percent). More practitioners who had been in specialty practice for six to ten years used sedation than those with other years in practice.

The relative frequency of use of sedative agents by the respondents is described in Table 2. In regard to the use of nitrous oxide alone, 55 percent of the total sample used nitrous oxide less than 10 percent of the time, and two thirds indicated that they used nitrous oxide less than 25 percent of the time. In regard to other types of sedative agents, most practitioners used little, if any, sedation. Eighty-nine percent of practitioners used se-

Figure 1 ☐ Project USAP: The use of sedative agents by pedodontists. A national survey of members of the American Academy of Pediatric Dentists coordinated by the New Jersey Dental School.

1. In which geographic area do you practice? Northeast ( ) South/Southeast ( ) Midwest ( ) West ( )

2. What was your specialty training? Grandfathered ( ) University Based ( ) Hospital Based ( )

3. How many years have you been in specialty practice? 1-5 ( ) 6-10 ( ) 11-15 ( ) 16-20 ( ) 20+ ( )

4. What approximate percentage of your total patients receive sedation with only nitrous oxide (N_2O)? 0% ( ) 1-5% ( ) 6-10% ( ) 11-25% ( ) 26-50% ( ) 50%+ ( )

5. What approximate percentage of your total patients receive other sedative agents? 0% ( ) 1-5% ( ) 6-10% ( ) 11-25% ( ) 26-50% ( ) 50%+ ( )

   (IF ANSWER IS 0%, SKIP TO QUESTION 14)

6. Approximately how many of your patients receive sedative agents (excluding N_2O) in a typical *3 month* period? (_____)

7. Of those patients who received sedation other than nitrous oxide, what percentage were normal and what percentage were handicapped? _____% Normal _____% Handicapped

8. Of those patients who received sedation, what percentage were the following ages? 0-2 yrs.___% 3 yrs.___% 4-5 yrs.___% 6-10 yrs.___% 10+ yrs.___%

9. If you use oral agents, where are these usually administered? ( ) In the office ( ) In the patient's home

10. For how long do you restrict food and fluid intake prior to sedation with agents other than N_2O? Hours: 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6( )

11. Indicate which method(s) you use to monitor your patient during treatment.
    Evaluate color (skin, mucosa or nails)? ( ) Yes ( ) No Monitor pulse rate? ( ) Yes ( ) No
    Use a precordial stethescope? ( ) Yes ( ) No Monitor respiration rate? ( ) Yes ( ) No
    Take blood pressure readings? ( ) Yes ( ) No
    Who monitors your patients? ( ) You ( ) An Auxiliary ( ) Another professional (describe)__________

12. Of those patients who received sedation, approximately what percentage received various agents below? What typical dosage regimen was used? What maximum dose would you use? What typical effect would you expect?

	% Time Used	Typical Dosage Level	Max. Safe Dose Used	Typical effect: Excellent	Good	Fair	Poor
a. hydroxyzine (Atarax or Vistaril) alone	___	___	___	___	___	___	___
b. hydroxyzine and N_2O	___	___ ___	___ ___	___	___	___	___
c. chloral hydrate (Noctec) alone	___	___	___	___	___	___	___
d. chloral hydrate and N_2O	___	___ ___	___ ___	___	___	___	___
e. chloral hydrate and promethazine (Phenergan) alone	___	___ ___	___ ___	___	___	___	___
f. chloral hydrate, promethazine and N_2O	___	___ ___ ___	___ ___ ___	___	___	___	___
g. chloral hydrate and hydroxyzine alone	___	___ ___	___ ___	___	___	___	___
h. chloral hydrate, hydroxyzine and N_2O	___	___ ___ ___	___ ___ ___	___	___	___	___
i. alphaprodine (Nisentil) alone	___	___	___	___	___	___	___
j. alphaprodine and promethazine alone	___	___ ___	___ ___	___	___	___	___
k. alphaprodine, promethazine and N_2O	___	___ ___ ___	___ ___ ___	___	___	___	___
l. meperidine (Demerol) alone (Oral___; IM___)	___	___	___	___	___	___	___
m. meperidine with N_2O (Oral___; IM___)	___	___ ___	___ ___	___	___	___	___
n. meperidine and promethazine (Oral___; IM___)	___	___ ___	___ ___	___	___	___	___
o. meperidine, promethazine & N_2O (Oral___; IM___)	___	___ ___ ___	___ ___ ___	___	___	___	___
p. Other: __________	___	___	___	___	___	___	___
__________	___	___	___	___	___	___	___
	100%						

13. What undesirable side effects have you experienced? How frequently? With which drug? __________

14. What emergency equipment and drugs should be available in the office of a practitioner who uses sedation?

Identifying your name and address is *not* necessary; however, if you would wish to participate in a national study of sedative agents, please fill in your name and you will be contacted in the future.

Name (Please print) __________

Address: __________

Telephone Number: _____/________

Table 3 ☐ Percent frequency of use of various dosages of hydroxyzine (mg) when used alone or together with nitrous oxide and or chloral hydrate.

		mg hydroxyzine								
Comedicant	N	15	25	40	50	65	100	.5/lb	1/lb	
None	106	3	23	19	28	8	12	1	6	= 100%
Nitrous oxide	116	3	21	12	26	6	14	3	15	= 100%
Chloral hydrate	92	7	41	10	23	5	2	10	2	= 100%
Chloral hydrate and nitrous oxide	189	6	47	8	20	6	2	6	5	= 100%
Mean percent use		5	33	12	24	6	8	5	7	= 100%

N = Number of practitioners using particular drug combination. Most used more than one drug combination.

Table 4 ☐ Percent use of chloral hydrate (mg) when used alone or together with nitrous oxide and/or hydroxyzine or promethazine.

		mg chloral hydrate								
Comedicant	N	25/kg	50/kg	60/kg	80/kg	500	750	1000	1250	
None	100	8	28	5	15	11	22	10	1	= 100%
Nitrous oxide	130	5	21	6	16	16	27	8	1	= 100%
Promethazine	26	8	38	4	4	8	15	23	0	= 100%
Promethazine & nitrous oxide	48	4	34	6	8	13	12	21	2	= 100%
Hydroxyzine	92	7	16	4	2	15	25	30	1	= 100%
Hydroxyzine & nitrous oxide	189	3	23	5	8	15	23	23	1	= 100%
Mean percent use		6	27	5	9	13	20	19	1	= 100%

N = Number of practitioners using particular drug combination. Most used more than one drug combination.

dation for less than 10 percent of their patients, whereas only 12 percent used sedation for more than 10 percent of their patients. In comparison, only 31 percent of heavy users sedated less than 10 percent of their patients, and 69 percent used sedation more than 10 percent of the time.

In a typical three-month period, a total of 33,465 drug administrations were reported by the 1,105 respondents. Almost half (14,802 or 44 percent of the total) were administered by only sixty-four practitioners; that is, approximately 6 percent of the practitioners used sedative agents other than nitrous oxide twice a day, each day, during a three-month period and administered almost as many sedations as the remaining 94 percent of practitioners. Two thirds of the sedations (21,670 or 65 percent of the total) were administered by 12 percent of the practitioners (138) who used sedation on the average of greater than once each day. The average number of patients sedated in a three- month period by each practitioner in the total sample was thirty, compared with an average of 231 patients sedated by heavy users of sedation. The heavier use of sedation by some practitioners was not related to the percentage of their sedated patients who were handicapped, in that there was a rather low percentage for both the total sample (14 percent of patients) and heavy users of sedation (8 percent). Forty-four percent of patients sedated by heavy users were more than three years of age, compared with 25 percent of sedated patients for the total sample.

Sedation was usually administered in the office by 50 percent of respondents, in the home by 44 percent, and in both locations by 6 percent, before sedation with agents other than nitrous oxide, practitioners restricted food and fluid intake most frequently between four (28 percent of respondents) and six (40 percent of respondents) hours.

Practitioners who use sedation indicated that they monitored their patients by a variety of methods. Whereas most evaluated color of their patients, only a third used a precordial stethoscope and less than a quarter took blood pressure readings. Pulse rate was monitored by approximately half of the practitioners and respiration by approximately three quarters. In more than half the time, patients were monitored by the operator; and in a third of the time, another professional was used to monitor patients.

Side effects were reported by approximately 74 percent of practitioners. Approximately 42 percent reported that at some time, some of their patients had experienced some nausea or vomiting; and 8 percent reported observing some type of respiratory depression, following the use of sedation.

Table 5 ☐ Percent frequency of use of various dosages of meperidine (mg) when used alone or together with nitrous oxide and/or promethazine.

		mg meperidine						
Comedicant	N	50 mg oral	75 mg oral	.25/lb IM	.5/lb IM	.75/lb IM	1/lb IM	
None	15	14	0	14	7	0	65	= 100%
Nitrous oxide	19	33	6	6	6	11	38	= 100%
Promethazine	54	21	2	17	7	4	49	= 100%
Promethazine & nitrous oxide	82	19	5	3	4	6	63	= 100%
Mean percent use		22	3	10	6	5	54	= 100%

N = Number of practitioners using particular drug combination. Most used more than one drug combination.

Table 6 ☐ Percent frequency of use of various dosages of alphaprodine (mg) when used alone or with nitrous oxide and/or promethazine.

		mg alphaprodine				
Comedicant	N	.5/k	.6/k	.7/k	1/k	
None	43	43	24	14	19	= 100%
Promethazine	13	10	40	40	10	= 100%
Promethazine & nitrous oxide	38	37	33	27	3	= 100%
Mean percent use		30	32	27	11	

N = Number of practitioners using particular drug combination. Most used more than one drug combination.

Table 7 ☐ Percent frequency of use of various concentrations of nitrous oxide as a comedicant with different drug combinations.

		Percent nitrous oxide				
Comedicant	N	30%	40%	50%	60%	
Hydroxyzine	116	35	17	43	5	= 100%
Chloral hydrate alone	130	29	18	48	5	= 100%
Chloral hydrate & promethazine	48	32	21	47	0	= 100%
Chloral hydrate & hydroxyzine	189	35	24	37	4	= 100%
Alpharodine & promethazine	38	29	18	35	18	= 100%
Meperidine alone	19	20	60	20	0	= 100%
Meperidine & promethazine	82	29	25	42	4	= 100%
Mean percent use		30	26	39	5	= 100%

N = Number of practitioners using particular drug combination. Most used more than one combination.

Specific dosages for drugs were quite variable among practitioners (Tables 3 to 8). Table 3 displays the percent frequency of use of various dosages of hydroxyzine when used alone or together with nitrous oxide and/or chloral hydrate. The most frequent use of hydroxyzine was together with chloral hydrate and nitrous oxide. Dosages ranged from fixed doses of 15 to 100 mg or doses calculated as 0.5 to 1 mg per pound of body weight, with 25 mg as the most frequent dose used. Table 4 shows the percent frequency of use of various dosages of chloral hydrate when used alone or together with nitrous oxide and/or hydroxyzine or promethazine. The most frequent use of chloral hydrate was with hydroxyzine and nitrous oxide. Dosages of chloral hydrate ranged from 25 to 80 mg/kg of body weight with the standard dose of 50 mg/kg being used most frequently. Fixed doses of 500 to 1250 mg were used by 53 percent of the practitioners. Table 5 lists the percent frequency of use of various dosages of meperidine when used alone or together with nitrous oxide and/or promethazine. Dosages were either 50 or 75 mg administered orally, or 0.25 to 1 mg/lb of body weight administered by intramuscular injection. More

Table 8 ☐ Percent frequency of use of various dosages of promethazine (mg) when used together with other drugs.

		mg promethazine						
Comedicant	N	12	25	50	.5/lb	1/lb	2/lb	
Chloral hydrate	26	5	75	5	0	10	5	= 100%
Chloral hydrate & nitrous oxide	48	17	62	6	2	4	9	= 100%
Meperidine	54	16	32	0	16	16	20	= 100%
Meperidine & nitrous oxide	82	7	28	6	17	28	14	= 100%
Alphaprodine	13	0	80	0	0	20	0	= 100%
Alphaprodine & nitrous oxide	38	14	44	9	9	10	14	= 100%
Mean percent use		10	54	4	7	15	10	= 100%

N = Number of practitioners using particular drug combination. Most used more than one combination.

Table 9 ☐ Percent of practitioners reporting a particular drug effect (sum of values of all effects equals 100 percent for each drug combination).

Drug	N	Excellent	Good	Fair	Poor
Hydroxyzine alone	106	9	57	34	0
Hydroxyzine with nitrous oxide	116	22	59	18	0
Average effect		16	58	26	0
Chloral hydrate alone	100	7	58	35	0
Chloral hydrate with nitrous oxide	130	12	61	26	0
Chloral hydrate with promethazine	26	12	50	38	0
Chloral hydrate with promethazine & nitrous oxide	48	17	63	20	0
Chloral hydrate with hydroxyzine	92	11	70	19	0
Chloral hydrate with hydroxyzine & nitrous oxide	189	24	59	16	0
Average effect		14	60	26	
Meperidine alone	15	0	80	20	0
Meperidine with nitrous oxide	19	21	63	16	0
Meperidine with promethazine	54	22	63	15	0
Meperidine with promethazine & nitrous oxide	82	32	57	11	0
Average effect		19	66	15	0
Alphaprodine alone	43	26	58	16	0
Alphaprodine with promethazine	13	31	69	0	0
Alphaprodine with promethazine & nitrous oxide	38	50	47	3	0
Average effect		36	58	6	0

N = Number of practitioners using particular drug combinations. Most used more than one drug combination.

than half of the practitioners used a dose of 1 mg/lb either alone or together with promethazine and nitrous oxide. Table 6 shows the use of various dosages of alphaprodine when used alone or together with nitrous oxide and/or promethazine. Dosages ranged from 0.5 to 1 mg/kg with the drug used most frequently alone, at a dose of 0.5/mg. The percent frequency of use of various concentrations of nitrous oxide used as a comedicant with different drug combinations is shown in Table 7. Nitrous oxide was used most frequently as a comedicant with chloral hydrate and hydroxyzine at a concentration of 50 percent. Finally, Table 8 illustrates the percent frequency of use of various dosages of promethazine when used together with other drugs. The most common dose was a fixed dose of 25 mg, with other doses ranging from 12 to 50 mg or 0.5 to 2 mg/lb of body weight. Promethazine was used more frequently with nitrous oxide when it was a comedicant with chloral hydrate, meperidine and alphaprodine.

As would be expected, pediatric dentists use drugs that produce a desired effect. Table 9 demonstrates that more than 90 percent of sedations were rated as either excellent or good. Alphaprodine received the best ratings, followed by meperidine, chloral hydrate, and hydroxyzine. No drug was rated as poor.

PART II: THE USE OF SEDATIVE AGENTS IN POSTGRADUATE TRAINING PROGRAMS

A survey was conducted of all training programs in the United States as a separate part of Project USAP. The survey was performed in order to examine the relationship of the use of various sedative agents by private practitioners with the use in training programs. Of the fifty-nine programs, eighteen were hospital-based and forty-one were university-based. In addition, there were approximately 160 students in each of the two years of training. The program directors were asked what experiences their students had with the following agents: hydroxyzine, chloral hydrate, alphaprodine, meperidine, and other drugs.

Results

The use of sedative agents by postgraduate students in pediatric dentistry programs is described in Figures 2 to 5. Figure 2 reports the percent of use of various drugs used as the sole agent. Frequently, these drugs are used together and the percents would vary, if the values were adjusted for the combined use of the various drugs.

Figure 3 illustrates the frequency of use of sedative agents by postgraduate students in all programs. For each drug, the range, the median and the arithmetic mean are indicated. There are relatively wide discrepancies between the means and medians, because of the extremely large range of use. For example, in regard to the use of chloral hydrate, the median number of administrations in each program for first-year and second-year students was thirty-five; because in one school the total number of experiences for chloral hydrate was 375, however, the arithmetic mean for all programs was forty-four. Similar discrepancies appear with the other drugs listed. There was a number of programs that reported no experiences for some of the drugs, and Figure 4 shows adjusted figures for only those programs using the specific agent. The most notable difference between Figures 3 and 4 is for the use of alphaprodine, in which the mean jumps from sixteen to forty-six. Most programs did not use alphaprodine, but some of those that did provided their students with extensive experiences with the drug.

Figure 5 illustrates the percent use of sedative agents by all students in forty-one university-based programs compared with eighteen hospital-based programs. The most notable difference was with the use of hydroxyzine, which was used more frequently in the hospital-based programs.

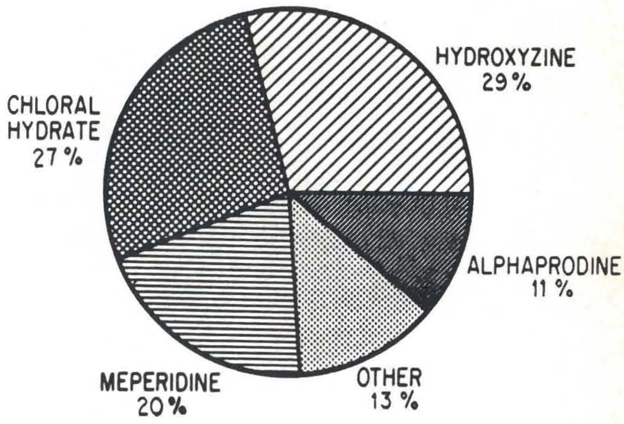

Figure 2. Use of sedative agents by all postgraduate students in pediatric dentistry.

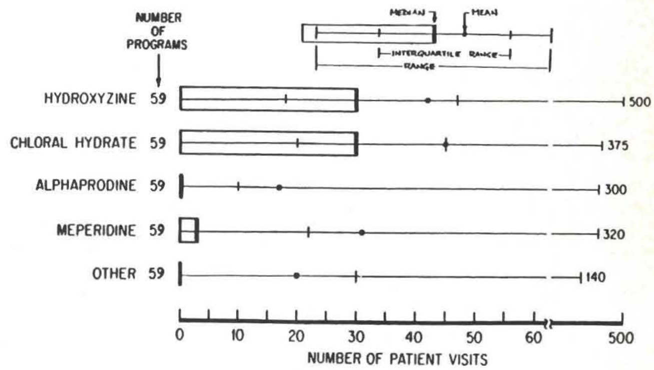

Figure 3. Use of sedative agents by postgraduate students in pediatric dentistry for all programs.

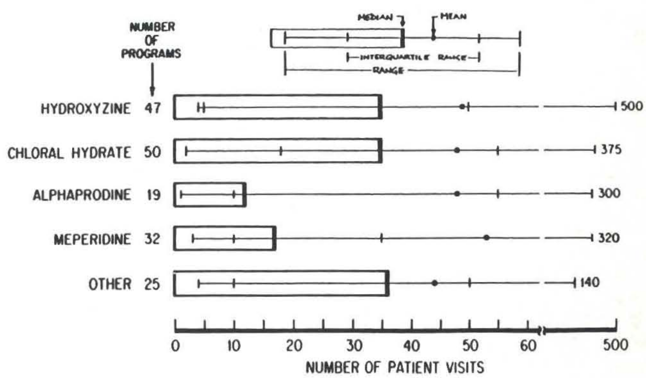

Figure 4. Use of sedative agents by postgraduate students in pediatric dentistry for those programs using agent.

Discussion

These surveys demonstrate wide differences in the experiences postgraduate students have with sedative drugs and wide differences in the use of these drugs by

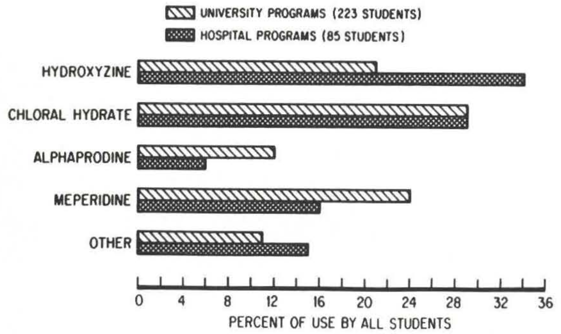

Figure 5. Use of sedative agents by all postgraduate students in pediatric dentistry.

pediatric dentists. Insofar as the types of patients treated by most practitioners or in most training programs are fairly similar, the differences in the uses of drugs probably reflect the biases of individual practitioners. It is quite likely that when a healthy child receives a sedative agent for dental treatment, the type of drug depends more on the experiences of the practitioner than on the requirements of the patient. These findings suggest a need for clinical research on drug dosage and drug effect in children. Additional research is also required to identify those children who require sedation for dental treatment and those who do not.

Other surveys have examined the use of sedative agents in pediatric dentistry.[1-4] Those surveys did not report data concerning frequency of use of sedation and, consequently, it is not possible to make comparisons with the results of Project USAP concerning frequency of use by practitioners. Project USAP was performed in 1985 before the widespread implementation of the American Academy of Pediatric Dentistry *Guidelines for the Use of Sedation*, and it is likely that sedation practices will have changed because of many factors.[5] Recently unpublished data indicate a 28 percent decrease in use of sedation by practitioners.[6]

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SPECULATION AND RELEVANCE

From a practical standpoint, it is important for physicians and other health professionals who are caring for adolescents to evaluate eating attitudes and practices as well as to identify the medical complications that may be associated with the types of inappropriate eating behaviors described by adolescent girls in this study. With careful assessment of height and weight progression, those children who are not gaining in weight and growing appropriately will be clearly identified. The pediatrician should also keep in mind that underweight adolescents may be dieting and have a distorted perception of what their ideal body weight for height should be. Adolescents, regardless of their body weight, may frequently engage in inappropriate eating behaviors such as bingeing and vomiting to combat their fears of becoming obese. To allow for adequate nutritional intakes, the adolescents' concerns regarding obesity must be addressed.

Moses, Nancy *et al*: Fear of obesity among adolescent girls.
Pediatr, 83:393-398, March, 1989.

Case reports

Dentin dysplasia type II: report of case

Olwyn Diamond, DDS

Dentin dysplasia type II is a rare, inherited disorder of dentin first described in 1973 by Shields, Bixler and El-Kafrawy.[1] The disorder is inherited as an autosomal dominant trait and affects both the primary and permanent dentitions. The involvement of the two dentitions is, however, different with respect to clinical presentation, radiographic appearance and histopathologic findings.[2]

The primary teeth, clinically, resemble those seen in dentinogenesis imperfecta.[1,2,3] The shape and size are within normal limits, and the crowns have an amber, translucent coloration. Radiographically, the primary teeth show varying degrees of pulpal obliteration.

The permanent teeth, clinically, appear essentially normal.[1,2,3] The characteristic feature is the radiographic appearance of abnormal pulp morphology most evident in single rooted teeth.[2] The pulp chambers appear abnormally large coronally with some extension into the radicular dentin. Within the abnormally large coronal pulps are varying numbers of radiopaque foci resembling free pulp stones. These calcifications, in rare situations, may cause deformities and abnormalities of the roots of the teeth. The degree of deformity is dependent on the degree and extent of the calcification.

The term "dentin dysplasia" was originally used in a case reported by Rushton.[4] Dentin dysplasia type I is a rare hereditary disturbance of dentin formation characterized by apparently normal enamel formation, with

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short tapering roots, and obliteration of the pulp chambers before eruption. There is a predisposition to multiple apical radiolucencies, in noncarious teeth, which are essentially pathognomonic of this disorder.[4]

It is debatable whether dentin dysplasia types I and II are variants of a single clinical entity, different stages of single disease, or two separate pathologic conditions. Peterson described a case with features of both dentin dysplasia types I and II, supporting Elzay and Robinson's hypothesis that the anomalies are variants of a single disease entity.[5,6]

CASE REPORT

A fifteen-year-old white female orthodontic patient transferred to my office. The report from the transferring orthodontist stated that the patient:

- □ Had been in active orthodontic treatment for 2.0 years and it was estimated that she would be in treatment at least another year.
- □ Was slow in developing her permanent teeth.
- □ Had had her upper first and lower second premolars extracted to facilitate the orthodontics.

No further information was provided, and no unusual radiographic findings were reported. The patient did bring along, at the time of transfer, a panorex taken before orthodontic treatment was begun.

Clinically, the patient presented as an attractive, healthy and mature-looking female. Her dental and periodontal condition appeared as normal as one would expect from a patient in braces 2.0 years. The crowns of her teeth were normal in size, color, and shape.

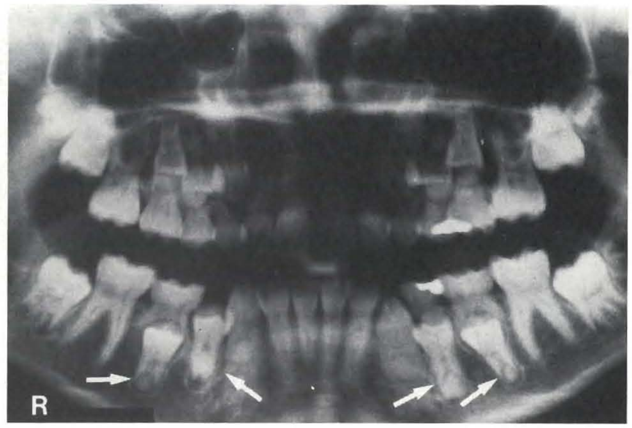

Figure 1. Initial panorex exhibiting masses forming during permanent root development.

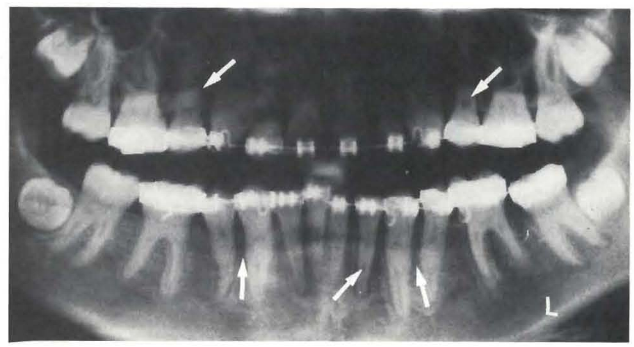

Figure 2. Panorex taken at time of transfer revealing homogenous radiopaque masses within root canals of incisors, canines and premolars.

Radiographic findings

The initial panorex (Figure 1) was taken during the mixed dentition stage. The amount and pattern of root resorption appeared normal in response to the developing permanent teeth. The primary teeth radiographically revealed varying degrees of pulpal obliteration. Teeth whose roots were still in a state of development revealed masses forming while the roots were still developing. These masses were situated at approximately the same level in all the teeth. The root canals of all the premolars, canines and incisors revealed homogenous, radiopaque, oval or round masses of the same density as dentin (Figure 2). Each mass appeared to be free and not attached to the pulpal walls. Radiolucent lines depicting pulpal spaces were continuous around the masses and separated them from the dentin. Around these bodies the roots appeared thickened but tapered off apically (Figure 3). The apical portions of the

Figure 3. Periapical film of the lower left premolar area.

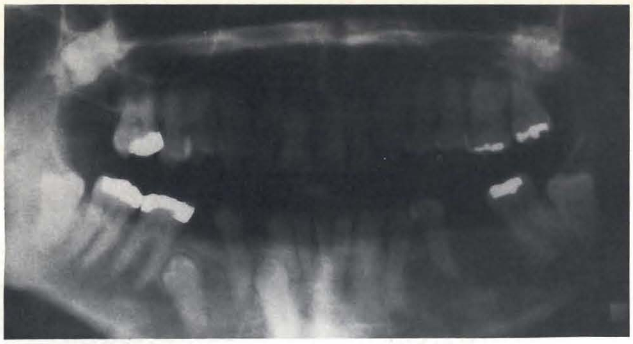

Figure 4. Panorex of mother.

Figure 5. Anterior view on completion of treatment.

roots appeared normal in size and shape and contained a normal root canal that terminated at the apex. No periapical morbidity was evident. The periodontal membrane space and surrounding bone had a normal radiographic appearance.

Histopathologic examination was not feasible, since there was no further indication for extraction of any teeth. Unfortunately, the dentist who performed the orthodontic extractions was no longer in practice and could not be reached. Further, the patient and her parents were insistent that no previous dentist had ever mentioned that there was anything unusual about her teeth. It was presumed, therefore, that histopathologic examination was not considered at the time of the orthodontic extractions.

Because of the inherited nature of dentin dysplasia type II, it was decided to study the patient's immediate family. A panorex of her brother revealed a normal dentition, while one of her mother showed similar, but less characteristic, pulpal morphology with intrapulpal radiopacities (Figure 4).

Treatment

The patient was treated orthodontically, with fixed edgewise appliances. Treatment was completed uneventfully, in spite of the unusual root morphology (Figure 5).

DISCUSSION

This case appears to be an example of dentin dysplasia type II as described by Shields and others.[1] The characteristic radiographic appearance, with clinically normal permanent teeth, supports this diagnosis. This is the only reported case of a patient with dentin dysplasia type II, known by the author, to have undergone orthodontic treatment.

The cause of the calcification of the dentinal papilla is unknown in these cases. Dental abnormalities similar to these have, however, been reported in calcinosis and the Ehlers-Danlos syndrome.[7-10]

Calcinosis is a rare genetic disorder characterized by the presence of periarticular cystic and solid tumorous calcifications, in association with hyperphosphatemia and an elevated serum 1,25-dihydroxyvitamin D level.[8] The dental lesion, which is specific for this disorder, and serves as a phenotypic marker, consists of enamel of normal color with bulbous roots, pulp stones and almost total obliteration of pulp cavities.

The Ehlers-Danlos syndrome is a hereditary connective tissue disorder closely related to Marfan's syndrome, osteogenesis imperfecta and pseudoxanthoma elasticum.[11] The main diagnostic features are hyperelasticity of the skin, hyperextensibility of the joints, including the temporomandibular joint, and fragility of the skin and blood vessels. Barabos and Barabos found that all oral tissues, membranes, gingivae and teeth, were excessively fragile.[12] The dentition may show malformed, hypoplastic changes of the enamel, stunted roots, large pulp stones, and calcification of the pulp.

Patients with dentin dysplasia type II do not appear to require special dental management. Normal retention of the permanent teeth is expected, as opposed to dentin dysplasia type I, where periapical radiolucencies occur.[13] Routine preventive and restorative care is important, however, since the calcification makes endodontic treatment difficult, if not impossible.

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ABSTRACTS

Waldman, H. Barry: Would you believe, decreases in dental caries and increases in the demand for dental care? J Dent Child, 56:257-261, July-August, 1989.
A review is provided of the continuing reports of decreases in the dental decay rates in school children and the concurrent increasing general use of dental services. An NIDR report on the 1986-87 national study of nearly 40,000 children provides data supporting such a conclusion. National Health Survey data from 61,522 interviewees show increases in the percentage of children with visits to a dentist in the previous year; there was a decrease in the percentage of all children who had never visited a dentist.
Delivery of dental services; Pedodontics; Caries incidence

Waldman, H. Barry: Improving conditions for pediatric dental practice are part of the changing environment for dentistry. J Dent Child, 56:262-266, July-August, 1989.
A review is provided of the changing and general improving environment for pediatric and general dental practice. Emphasis is placed on developments in manpower, changing delivery patterns and the economics of practice.
Pediatric dentistry; Dental economics

Renz, Cheryl L. and Bibby, Basil G.: *In vitro* acid production from starch and sucrose in saliva. J Dent Child, 56:267-269, July-August, 1989.
There was a wide range in the amounts of acid given by the assorted starch foods that were tested. In descending order, the amounts of acid formed were: boiled potato (2.50 ± 0.10), "special wheat" bread (2.24 ± 0.68), English muffin (2.19 ± 0.00), raw potato (2.13 ± 0.03), yellow cake (2.02 ± 0.08), plain wheat flour (1.83 ± 0.03), phosphate-enriched wheat flour (1.83 ± 0.03), bagel (1.67 ± 0.05), soft white bread (1.39 ± 0.05), Italian bread (1.35 ± 0.08), and pumpernickel bread (1.26 ± 0.03).

Caries incidence; Acid production; Food choices; Streptococcal fermentation

Beiswanger, Bradley B.; Lehnhoff, Robert W.; Mallatt, Mark E.; Mau, Melissa S.; Stookey, George K.: A clinical evaluation of the relative cariostatic effect of dentifrices containing sodium fluoride or sodium monofluorophosphate. J Dent Child, 56:270-276, July-August, 1989.
A three-year clinical trial was conducted to determine whether a sodium fluoride (NaF) dentifrice had greater cariostatic effects than a sodium monofluorophosphate (Na_2PO_3F) dentifrice. Both dentifrices contained 1100 ppm fluoride and silica abrasive systems. A panel of 3,290 children, age 6-16, received one of the two dentifrices for ad libitum home use. The subjects were examined for caries at the baseline and after 2 and 3 years. Results were analyzed both for all children and for those children age 11 years or older at the baseline. The older children were found to have about 50 percent higher new caries increments than did the entire panel of children. In the older, caries- prone children, the subjects using the NaF product experienced significantly (15 percent and 12 percent) fewer new lesions than did the subjects using the Na_2PO_3F product after 2 and 3 years respectively. In the panel of all children, subjects using the NaF product had numerically, but not significantly, fewer new lesions. The results for this study, showing significantly greater cariostatic benefits in caries-prone children for a sodium fluoride dentifrice with a highly compatible system, are consistent with findings of other investigators.
Dentifrice fluoride; NaF; Na_2PO_3F; Caries incidence

Guelmann, Marcio; Fuks, Anna B.; Holan, Gideon; Grajower, R.: Marginal leakage of class II glass-ionomer-silver restorations, with and without posterior composite coverage: an *in vitro* study. J Dent Child, 56:277-282, July-August, 1989.
The aims of this *in vitro* investigation were: 1) to assess marginal leakage around three types of class II restorations, using: a) a composite resin with a glass ionomer lining; b) a glass ionomer cermet with composite resin coverage; c) a glass ionomer cermet without composite resin coverage and 2) to study the effect of thermocycling on marginal defects, by means of radiographs and SEM micrographs of the margins. Fifty-eight class II cavities were prepared in extracted primary molars. The teeth were divided into three groups and restored as follows: Group A—Ketac Bond (liner) and P-30; Group B—Ketac Silver and P-30 (sandwich); Group C—Ketac Silver only. The restored teeth were thermocycled and marginal leakage was assessed from the degree of dye penetration on the sections. Dye penetration at the occlusal margins increased in the sequence A<B<C. The differences between group C and Groups A and B were statistically significant. Severe penetration of the dye was observed at the cervical margins with no statistical differences between the groups. Deterioration of margins due to thermocycling was observed for all groups, but these defects were not evident on the radiographs. Ketac Sil-

ver with and without composite coverage did not prevent marginal leakage when utilized in class II restorations *in vitro*.

Restorations, class II; Marginal leakage; Evaluation, radiographic

Henry, Robert J. and Jerrell, Roy G.: The glass ionomer rest-a-seal. J Dent Child, 56:283-288, July-August, 1989.

The "glass ionomer rest-a-seal" described is a restorative technique that minimizes removal of tooth structure and protects the glass ionomer from inherent property weaknesses. This technique would seem to have added benefits over the preventive resin restoration where pit-and-fissure decay involves dentin. Glass ionomer cements have become popular as materials with many desirable properties, including an adhesive nature and an ability to release fluoride to adjacent tooth structure. These materials are, however, technique-sensitive and proper application is critical for long-term success. Conservative treatment of pit- and-fissure decay is often indicated. By utilization of the preventive resin restoration and now the glass ionomer rest-a-seal, practitioners can improve the long-term dental health of their patients.

Cement, glass ionomer; Sealants; Restorations, composite

Gellin, Milton E.: Conservative treatment for malaligned permanent mandibular incisors in the early mixed dentition. J Dent Child, 56:288-292, July-August, 1989.

The purpose of this article is to review the literature that discourages the extraction of retained mandibular primary incisors during the early mixed dentition when the permanent incisors often erupt malaligned. Early extraction of primary incisors can limit the growth potential of the alveolar process as reflected in the increase of the intercanine width. *This report deals only with the extractions of the primary incisors; primary canines are excluded.* Case reports illustrate that when the mandibular incisors erupt lingually to the corresponding retained primary incisor, the lingually erupted incisor will usually self correct by the child's eighth birthday. Other cases illustrate that when the mandibular permanent central incisors erupt malaligned, an apparent lack of space may also exist for the unerupted lateral incisors. The dentist should wait until the full eruption of the unerupted lateral incisor for the maximum intercanine dimensional changes to occur.

Dentition, mixed; Extraction; Treatment, conservative; Incisors, retained

Nathan, John E.: Management of the difficult child: A survey of pediatric dentists use of restraints, sedation and general anesthesia. J Dent Child, 56:293-301, July-August, 1989.

The findings of a 1988 survey of 616 pediatric dentists' attitudes and utilization of non-pharmacologic and pharmacologic strategies for treating the difficult pediatric patient are described. Wide variations appear to exist with regard to the use of restraints and aversive techniques, parent presence in the operatory, use of sedation, and general anesthesia. Variables including practice location, caries prevalence, patient populations, individual training experiences and skills, and liability costs clearly have an impact on pediatric dentists perception of the appropriateness of various modalities and their choice of application. There appear to be more concerns regarding the issue of informed consent, the appropriateness of hand-over-mouth, particularly HOMAR, and the use and overuse of sedation and general anesthesia. In the area of risk management, although many report high proficiency and comfort levels in their ability to recognize and manage in-office medical emergencies, others using various forms of in-office sedation, however, report having minimal emergency and monitoring equipment or training.

Sedation; Attitudes; Pedodontics; Patient management

Houpt, Milton E.: Report of project USAP: The use of sedative agents in pediatric dentistry. J Dent Child, 56:302-309, July-August, 1989.

Project USAP was performed to examine the use of sedation in pedodontics; part one studied the use of sedative agents by pediatric dentists, and part two examined the use of sedation in postgraduate teaching programs. In part I all 2,040 members of the American Academy of Pediatric Dentistry were sent questionnaires in 1985 concerning their use of sedation, and 1,105 responded. In regard to their use of nitrous oxide alone, 55 percent of practitioners responded that they used nitrous oxide less than 10 percent of the time. In regard to other types of sedative agents, most practitioners used little, if any sedation; 88 percent of practitioners used sedation for less than 10 percent of their patients. In a typical three-month period, the 1,105 respondents performed 33,465 sedations. Of that number, almost half (14,802) were administered by only 64 practitioners. Compared with other geographic areas, there appeared to be greater use of sedation in the south/southeast and west regions of the United States. The heavier use of sedation by some practitioners was not related to the percentage of their handicapped patients who received sedation. In part II, all 59 postgraduate programs in pediatric dentistry were surveyed during 1985 to examine the use of sedation by postgraduate students. There were wide differences in frequency and type of experience of students with different drugs. It is concluded that when a healthy child receives a sedative agent for dental treatment, the type of drug and drug dosage depend more on the biases of the individual practitioner, than on the requirements of the patient.

Sedation; Attitudes; Pedodontists; Patient management

Diamond, Olwyn: Dentin dysplasia type II: report of case. J Dent Child, 56:310-312, July-August, 1989.

Intrapulpal calcifications, in rare situations, may cause deformities and abnormalities of the roots of the teeth. Dentin Dysplasia Type II is a rare heritable dentin defect, of radiopaque foci resembling free pulp stones. This report describes the clinical and radiographic features of Dentin Dysplasia Type II in a fifteen-year-old girl.

Dysplasia, dentin, types I and II; Orthodontics; Radiography