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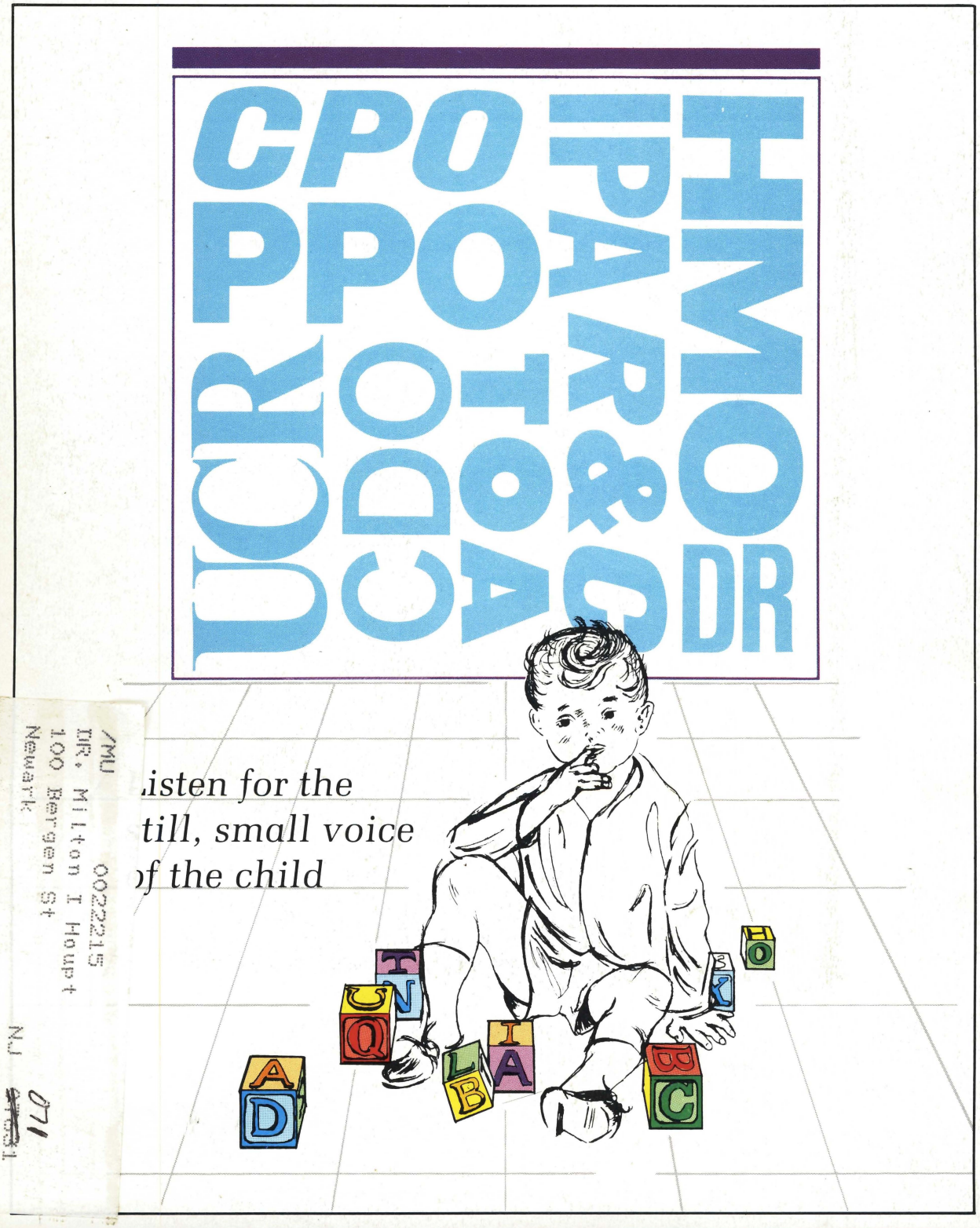

THE CHILD—THE NEGLECTED PERSON IN PAYMENT PLANS

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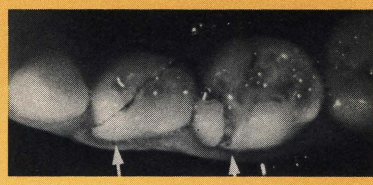

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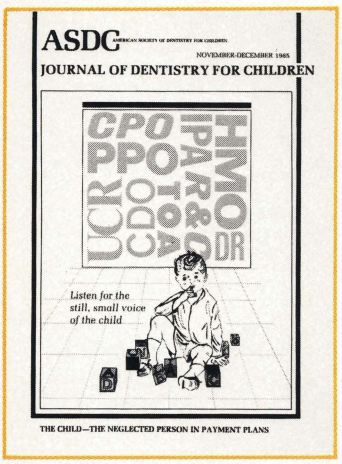

The cover depicts a child surrounded by a tangle of acronyms representing a network of dental payment plans, one of which will probably pay for his dental care. Designed by Sharlene Nowak. Illustration by Jim Bradshaw.

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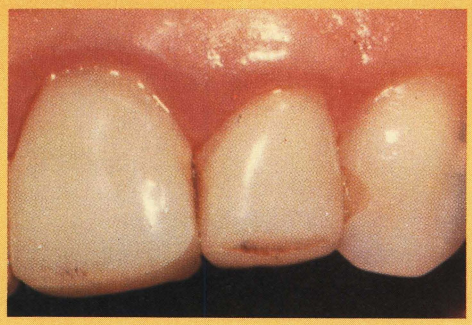

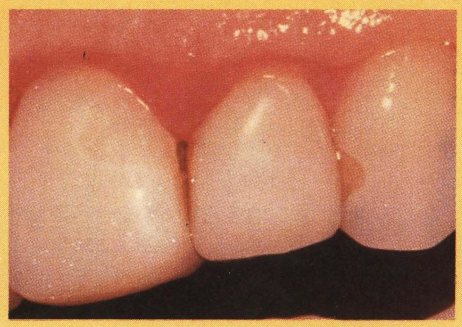

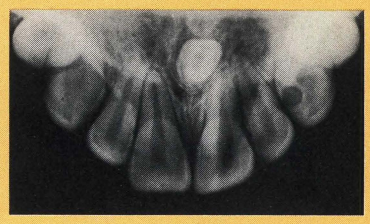

FLUORIDE

CASE REPORTS

The measured effect of phenytoin withdrawal on gingival hyperplasia in children

Clinic

Michael Brunsvold, DDS, MS
Jerry Tomasovic, MD
Dale Ruemping, DDS, MSD

Gingival hyperplasia secondary to phenytoin usage remains a major problem in the dental management of epileptic patients. Of the estimated two million persons in the United States presently receiving phenytoin, from 30 - 90 percent of such individuals manifest some degree of gingival hyperplasia.[1] Severe hyperplasia requires surgical intervention in about 30 percent of affected patients. This condition often causes significant social, psychological and medical problems for the individual. The cosmetic changes have a negative impact on interpersonal social relations, often leading to noncompliance with prescriptions for medication and to additional complications from recurring seizures. Gingival hyperplasia not only can interfere with mastication, but frequently invites secondary inflammatory changes.

Bacterial plaque, gingival inflammation and direct effects from the drug have been implicated in the production of gingival hyperplasia. Despite extensive investigation, however, the relative contribution of these conditions to the development of gingival hyperplasia remains vague. Choices of therapy for gingival hyperplasia have included dental hygiene to eliminate

The authors were formerly assigned to Wilford Hall USAF Medical Center, Lackland AFB, Texas, where the work was done.

Dr. Brunsvold is Assistant Professor, Department of Periodontics, The University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78284.

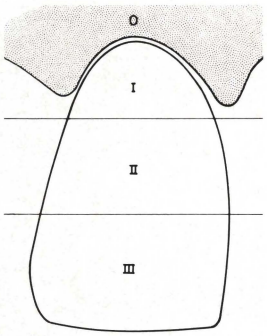

Figure 1. Diagram to illustrate grades of gingival hyperplasia.

plaque, reduction or elimination of the phenytoin, and surgical resection. [1-5] Because of significant recurrence within a relatively short period of time, resection of hyperplastic gingival tissue is not a permanent solution to this problem.

Dentists require a description of both the extent and timing of regression of gingival hyperplasia, following withdrawal of phenytoin, upon which to select appropriate therapy. Present knowledge concerning this issue is based primarily on clinical observation. In a primate animal model, gingival enlargement produced by phenytoin was completely reversible within twenty-six weeks after discontinuation of the drug.[2] Similar control studies have not been performed on human subjects. In the past, ethical consideration and limited choices of major anticonvulsants have dictated continuation of phenytoin, despite this significant side effect. Recently new anticonvulsants have emerged as effective substitutes for phenytoin for the treatment of both focal and generalized seizures in children, as well as in adults.[6-10] Several reports have confirmed that carbamazepine is equal in its anticonvulsant protection to that of diphenylhydantoin and phenobarbital.[6,8] Sodium valproate has also been used successfully in the treatment of generalized major and minor seizures.[9,10] With such medical options available, we elected to measure the dimensional changes in phenytoin gingival hyperplasia, produced when phenytoin was discontinued in children.

MATERIALS AND METHODS

Twelve experimental subjects were selected for the study from twenty epileptic patients referred by a child neurologist for dental screening examination. The main purpose of the examination was to determine whether gingival hyperplasia complicated phenytoin therapy. Discontinuation of phenytoin was ordered by the neurologist either to improve control of seizure activity or diminish side effects of the drug. Clinically detectable gingival hyperplasia was identified in twelve of the patients. One subject was later eliminated from the study because of poorly controlled seizures, while another moved from the state. Ten subjects completed the study, aged three to sixteen years, with an average age of eleven. Six subjects were girls and four were boys. Nine children were treated for their epilepsy as outpatients and one was institutionalized, because of severe mental retardation. Four control subjects receiving phenytoin were age-matched with the test subjects.

Children in both groups received phenytoin for one to ten years. The average phenytoin serum level in the ten subjects was 13.4 μg/ml (range 8-20) prior to discontinuation and 13.75 μg/ml (range 10-18) in the control group.

Severity of gingival enlargement was graded from stone dental casts obtained from test subjects before phenytoin was discontinued, and eighteen months later. The eighteen-month duration of this study was based on clinical observations that regression of gingival hyperplasia may take twelve months or longer, if it is severe when phenytoin is discontinued.[1] In seven test subjects and the four controls, casts were obtained at one, six, twelve and eighteen months. Impressions were obtained with alginate, according to the technique of Rudd *et al.*[11] The degree of gingival hyperplasia was graded using the following index (Figure 1):

Grade 0 = Normal gingiva, gingival margin at or near the cementoenamel junction with no evidence of abnormal gingival thickness. If the gingival margin extended onto the cervical third of the anatomic crown but without thickening, it was graded as 0.

Grade I = Slight hyperplasia with abnormally thickened gingiva extending into the cervical third of the anatomic crown.

Grade II = Moderate hyperplasia with abnormally thickened gingiva extending to the middle third of the anatomic crown.

Grade III = Severe hyperplasia with abnormally thickened gingiva extending to the incisal or occlusal third of the anatomic crown.

Cases were graded for degree of gingival hyperplasia by one investigator (M.B.) who was unaware of either patient identity or the time acquired. The grade was assigned from the region of most severe enlargement. Only completely erupted teeth were graded. Some of the teeth were permanent and some were primary (depending on the subject's age). Primary teeth that were exfoliated during the study were excluded. Erupting teeth were not used because they show a great variation

Table 1 ☐ Gingival hyperplasia grades of test subjects.

Subject	While taking phenytoin	Eighteen months after discontinuing phenytoin
M.B.	II	I
M.B.	II	I
S.G.	II	I
M.V.	II	I
R.C.	II	I
L.K.	II	I
E.T.	III	II
K.H.	III	I
W.G.	II	I
C.S.	II	I

Table 2 ☐ Gingival hyperplasia grades of controls.

Subject	While taking phenytoin	Eighteen months later on phenytoin
D.C.	I	I
M.P.	I	I
M.S.	I	I
J.V.	I	I

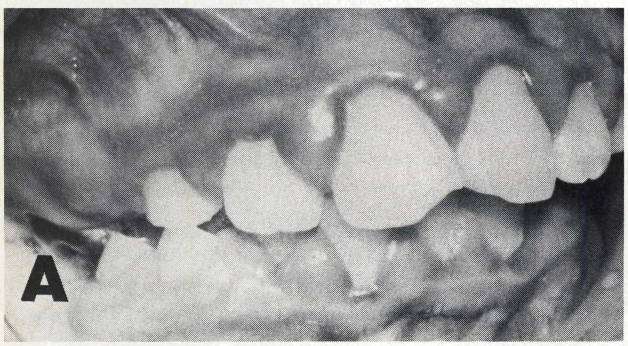

Figure 2, A. An eleven year old subject with gingival hyperplasia at the time Dilantin was discontinued.

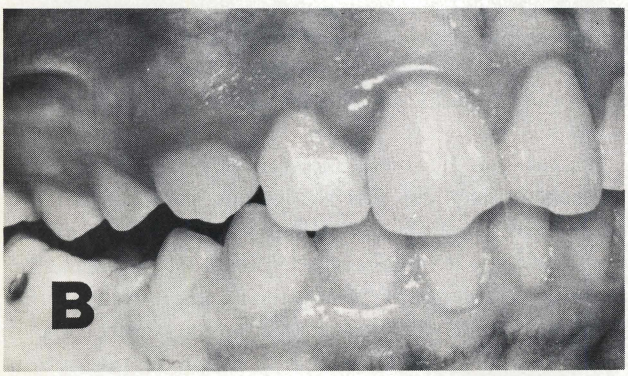

Figure 2, B. Same subject as in A, eighteen months after Dilantin therapy was stopped. Note the reduction in the amount of gingival hyperplasia.

in the amount of anatomic crown exposed, depending on the stage of eruption.

Grading of casts was repeated two weeks after the original evaluation, to determine reproducibility of the index. Grades of twenty-seven of twenty-eight casts were identical at both evaluations. Gingival Index, Plaque Index, and pocket measurements obtained from subjects at the beginning of the study and at six-month intervals were determined from selected teeth used in the Periodontal Disease Index. [12,13] Pocket depths and scores for both the Gingival Index and the Plaque Index are reported as averages. The subjects received no instructions to alter plaque control during the study.

RESULTS

Seizure control

Phenytoin was successfully withdrawn in three of the ten children without replacement therapy, because of prolonged seizure control. The additional test subjects received carbamazepine as a substitute. Seizure control was sustained without significant side effects.

Gingival hyperplasia

Prior to discontinuation of phenytoin, eight test subjects demonstrated Grade II gingival hyperplasia, while two subjects exhibited Grade III severity. Grade I gingival hyperplasia was determined in the control subjects. Eighteen months after discontinuing phenytoin, all test subjects showed a measurable decrease in gingival hyperplasia (Table 1), although none obtained complete regression of the gingival hyperplasia. A typical reduction in gingival hyperplasia can be seen in Figure 2. All but one subject improved from a Grade II/III to a Grade I. That exception revealed a Grade III change to a Grade II. In all subjects, the most severe gingival hyperplasia was identified in the anterior segments. Controls demonstrated no change in the grade of gingival hyperplasia throughout the study (Table 2).

Casts obtained in seven subjects at six-month intervals revealed that the major decrease in the severity of the gingival hyperplasia occurred between six and twelve months. Four of these seven subjects, however, displayed continued improvement during the twelve to eighteen months of the study.

Plaque index

The average plaque index of the test subjects remained stable with 0.8 at the beginning of the study and 0.7 at

Table 3 ☐ Average plaque index, gingival index, and pocket depths.

	Plaque index		Gingival index		Pocket depths	
	Day 1	18 months	Day 1	18 months	Day 1	18 months
Test	0.8	0.7	1.2	0.6	2.9	2.7
Controls	0.6	0.6	1.1	0.4	2.5	2.2

the end of eighteen months (Table 3). In the test subjects, individual measurements revealed a decrease in five, increase in three and no change in a single subject. Control subjects demonstrated no change in the average plaque index.

Gingival index

Despite our lack of effort to improve their oral hygiene, the gingival index decreased in eight of ten subjects and three of four controls. The average gingival index of test subjects was 1.2 at the beginning of the study with a 0.6 at its completion (Table 3). One test subject remained uncooperative for measurements of all the indices and one subject demonstrated a slight increase in the gingival index. The average gingival index of controls decreased from 1.1 at the beginning to 0.4 at the end of the eighteen-month study.

Pocket depths

Pocket depths of test subjects upon initiation of the study averaged 2.9 mm (Table 3). After eighteen months, pocket depths averaged 2.7 mm. Five test subjects displayed a decrease in pocket depth while three revealed an increase. Control subject pocket depths averaged 2.5 mm at the beginning and eighteen months later, 2.2 mm. Two controls demonstrated an increase in pocket depth, while two showed a decrease.

DISCUSSION

Livingston and Livingston observed that moderate hyperplasia disappears spontaneously within three to six months, following complete withdrawal of phenytoin.[1] They suggested that severe gingival hyperplasia might require a year or longer to regress. No specific measurements have been obtained in man, however, to verify these claims. Our study clearly demonstrated a measurable decrease in gingival hyperplasia in all ten test subjects following discontinuation of phenytoin. Although each child demonstrated a reduction in severity, none of the test subjects demonstrated complete regression of gingival hyperplasia. Surgery was avoided, however, in those cases in which moderate severity was reduced to mild. Several authors argue that severe prolonged hyperplasia develops excessive fibrosis, thereby reducing the significance of regression following phenytoin removal.[5]

The question of length of observation following phenytoin removal for maximum reduction in severity is partially answered in this study. Gross comparison of interval casts obtained from seven test subjects indicates that the greatest decrease occurs between six and twelve months. Additional reductions continued, however, in four of seven subjects during the twelve-to eighteen-month interval. The findings on our limited number of patients suggests that follow-up should persist for eighteen months prior to consideration for surgical resection. We noted also that the most severe gingival hyperplasia appeared in the anterior segments, an observation that is in agreement with other clinical observations.[14,15]

Studies by Kapur and Little have argued that the severity of gingival hyperplasia appears to be proportional to both dosage and serum level.[16] They suggest direct action by the medication upon the gingiva. We noted that the controls demonstrated blood levels similar to those of the test subject group, yet revealed only a mild degree of hyperplasia when compared to the test group's moderate (Grade II) severity. The numbers in these cases are clearly inadequate to draw a major conclusion from this observation, but failed to confirm a relationship between severity and drug level.

The average plaque index for all subjects remained unchanged throughout the study. This was not surprising in view of the lack of attempt to alter individual oral hygiene habits. Because the plaque index state remained unchanged throughout the study, it appeared the plaque did not provide a significant role in the regression of gingival hyperplasia.

Despite the lack of change in the average plaque index, we noted a decrease in the average gingival index scores for both test and control groups. No explanation for this finding was evident. It suggested that the change in drug therapy was related in some fashion to changes in the gingival index observed.

Pocket depth averages at the beginning and end of the study also remained unchanged. The slight average decrease in pocket depths of both test and control subjects may have been related to pocket depth changes that occur in the developing dentition.[4] Pocket depths did not appear to influence the decrease in gingival hyperplasia observed.

Because of the small number of test subjects and controls utilized for this study, one must regard the findings as preliminary. Although only four controls were studied, it is widely accepted that patients who develop gingival hyperplasia during phenytoin administration do not experience spontaneous regression of gingival hyperplasia for the duration of phenytoin therapy. A large number of control patients was not required, therefore, to validate the observed reductions in the test subjects.

Greater reduction might have accompanied discontinuation of phenytoin, if more individuals with severe

(Grade III) gingival hyperplasia had been selected. Additionally, the findings from this study were obtained in a younger population, and they might not apply to adults with gingival hyperplasia.

Ethical issues have been raised concerning the safety of withdrawal of phenytoin, but the majority of these studies appeared before significant use of newer major anticonvulsants such as carbamazepine and sodium valproate. Phenytoin was successfully withdrawn in three test subjects and those who received carbamazepine as a substitute experienced neither a change in seizure frequency nor undesirable side effects. As mentioned earlier, these medications have emerged as potential substitutes for phenytoin and barbiturates in the treatment of both focal and generalized seizures in children. In a double-blind, cross-over study performed at the University of Washington in Seattle, carbamazepine was noted to have equal qualities of seizure control with phenytoin, but offered fewer side effects.[17] No significant toxic effects were noted in that study, although we have observed a reduction in total white blood cell count to levels of 3500 to 4500 in such children. This has failed to require elimination of the medication in most subjects. Dr. Richard Shain at University of California at Los Angeles reported the successful treatment of major motor and psychomotor seizures in 200 children with carbamazepine without significant side effects.[6] These reports suggest that carbamazepine is a major anticonvulsant equal in potency to that of diphenylhydantoin and phenobarbital.

During recent years sodium valproate has also been successfully utilized in the treatment of generalized major and minor motor seizures. Despite relatively few side effects of sodium valproate, Hassel *et al* recommended caution in dental patients requiring surgery, because of its association with defective clotting.[18]

Several authors in the past have suggested that phenytoin should not be discontinued on the basis of either moderate or severe gingival hyperplasia.[4,5] We recommend that the dentist encourage improved oral hygiene which may eliminate secondary inflammatory responses contributing to increased severity of gingival hyperplasia. If moderate to severe hyperplasia persists, we would suggest consultation with a child neurologist to consider substitution for phenytoin of either a barbiturate, carbamazepine or sodium valproate, if continued anticonvulsant therapy is indicated. Following withdrawal of phenytoin, one should monitor the patient for at least eighteen months. The persistence of significant hyperplasia (Grades II, III) with its accompanying psychosocial problems should then prompt surgical excision, but recurrence will be avoided through discontinuation of this medication.

Future studies of the changes in gingival hyperplasia should include more test and control subjects with an increase in the age-range. Also patients with more severe gingival hyperplasia should be studied. These studies should extend over a longer period to include changes noted after twelve to eighteen months. Laser technology could measure gingival hyperplasia in three dimensions.[19]

Our results documented a measured decrease in gingival hyperplasia following discontinuation of phenytoin. Because surgical resection of gingival hyperplasia is limited to its effectiveness through postoperative recurrence, these results may encourage increased use of alternate antiseizure drugs, thus decreasing the prevalence of phenytoin-induced gingival hyperplasia.

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The influence of tooth preparation and crown manipulation on the mechanical retention of stainless steel crowns

Jeffrey A. Rector, DDS
Richard J. Mitchell, PhD
Robert H. Spedding, DDS, MSD

Some clinicians have suggested that dental cement alone is responsible for retention of stainless steel crowns on primary molars.[1,2] Others believe that the significant retentive feature is the close adaptation of the metal crown margin to the tooth surfaces in the undercut areas of the prepared teeth.[3-5] No studies support the belief that mechanical retention alone can adequately retain well-fitted, contoured stainless steel crows on different crown preparations.

The purpose of this study was to determine whether significant crown retention could be produced in the absence of cement when the stainless steel crowns were trimmed to length, contoured and crimped so that their margins were closely adapted to the undercut surfaces on five different preparations on epoxy resin dies, prepared from primary molar typodont teeth.

LITERATURE REVIEW

The influences of tooth preparation on stainless steel crown retention

Many tooth preparations have been proposed to improve retention of stainless steel crowns. Humphrey (1950) advocated leaving as much tooth structure as possible, when preparing a tooth to be crowned, to aid retention.[6] Full *et al* (1974) hypothesized that retention is attained by elastically deforming the crown into the undercut areas of the primary tooth. They recommended conservative preparation of the tooth's cervical perimeters to retain undercut tooth surfaces.[4] Myers (1976) suggested a preparation that retains the general morphology of the tooth. He argued that the cervical portion of the tooth be retained so that the metal crown will "snap" into place.[7] Henderson (1977) noted that it is frequently impossible to obtain sufficient retention without placing the margin of the crown subgingivally.[3] Savide *et al* (1981) assessed the role of different tooth preparations on primary molar typodont teeth. They found that the most retentive preparations had the least amount of buccal and lingual tooth structure removed.[2]

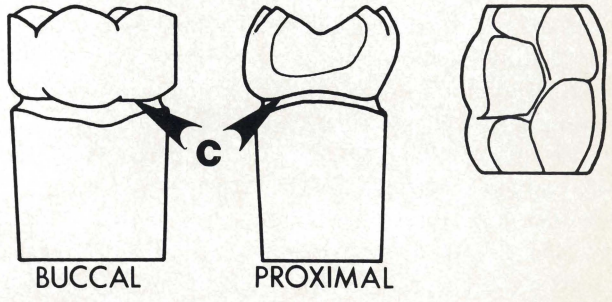

Figure 1. The master die (mandibular second primary molar). C - cementoenamel junction (CEJ) circumscribed on the die.

The authors are with the Departments of Pediatric and Restorative Dentistry, University of Kentucky College of Dentistry, Lexington, KY 40536.

Figure 2. The five preparations tested. In all preparations (I-V) a hole was drilled through the root in a buccolingual direction and clearance was made for the head of a one-inch nail in the central pit of the occlusal surface except for preparation IV. Preparation I-V shows buccal, proximal and occlusal views respectively. The reduced areas on the preparation are stippled.

Myers *et al* (1981) assessed the influence of tooth preparations on crown retention. Although crowns placed on teeth with ideal preparations (minimal tooth structure removed) were not significantly more retentive than those on teeth with extensive caries lesions, there was a trend toward greater retention when less tooth structure was lost. Nevertheless, they concluded that if the cervical enamel is intact, the remaining occlusal portion of the tooth has little influence on stainless steel crown retention.[8].

The influence of crown manipulation on stainless steel crown retention

According to More and Pink (1973) retention is primarily created by contouring the crown and adapting its margins to the tooth. They viewed the role of cement as that of a space-filler. They said that if cement was relied upon for retention that the crown would most likely be lost.[5] Mathewson *et al* (1974) used five different dental cements to retain stainless steel crowns on extracted primary molars. They found little or no mechanical retention unless a cement was used. They concluded that retention is attributed to the adhesiveness of the cements.[1]

The specific aims of this study are,

- ☐ To compare the effects of five different tooth preparations, made on epoxy resin dies, on the subsequent mechanical retention of stainless steel crowns.
- ☐ To compare the mechanical retention of trimmed, contoured and circumferentially adapted stainless steel crowns to that of contoured crowns that have neither been trimmed nor adapted circumferentially to the different preparations on the dies.

MATERIALS AND METHODS

Preparation of the five epoxy resin dies

A mandibular right second primary molar typodont tooth made of epoxy resin was prepared in the following manner (Figure 1): The occlusal surface and the occlusal thirds of the buccal and lingual surfaces were reduced uniformly approximately 1 mm with a number 69L bur. The convex mesial and distal surfaces (contact areas) were flattened with fine sandpaper and made parallel to each other. The proximal undercuts were retained. The position of the cementoenamel junction was marked along the entire circumference of the tooth with a 0.25 round bur. This tooth was then commercially replicated to produce five epoxy resin dies.* These five dies were modified to yield five master dies each with a different tooth preparation.

Preparation I (Figure 2-I). No further reductions were made on this master die.

Preparation II (Figure 2-II). All supragingival undercuts two millimeters above the cementoenamel junction

*Viade, 354 Dawson, P.O. Box 911, Camarillo, Ca 93010.

were removed on the buccal and lingual surfaces with a number 330 bur.

Preparation III (Figure 2-III). All supragingival and subgingival undercuts 1 mm above the cementoenamel junction were removed on the buccal and lingual surfaces with a number 330 bur.

Preparation IV (Figure 2-IV). All supragingival tooth structure 2 mm above the cementoenamel junction was removed circumferentially with a number 330 bur.

Preparation V (Figure 2-V). All line angles were rounded with a number 69L bur; no other crown reduction was made.

A round diamond stone was used to make clearance for the head of a one-inch number 16 wire nail in the central pit area of the occlusal surface of each master die (except for Preparation IV). Most of the crown had already been removed on this latter die.

Twenty epoxy resin replicas were produced commercially from each of the five master dies.* The five preparations tested differed mainly in the amount of buccal and lingual tooth structure removed, except for Preparation IV, which represented a tooth that had almost the entire crown destroyed by dental caries.

Preparation of the control and experimental stainless steel crowns

Only one brand of commercially available stainless steel crowns was used in this study.** These crowns were called standard by the manufacturer and were noted to have all surfaces but the occlusal parallel to each other. The size used was identified as LR4. These crowns were further modified by only one of the authors (JAR).

Control crowns

Fifty stainless steel crowns were modified to serve as controls.

- ☐ These crowns were not reduced (trimmed) in height to fit the dies.
- ☐ A number 137 (Gordon) pliers was used to crimp about 2 mm of only the buccal and lingual gingival margins.

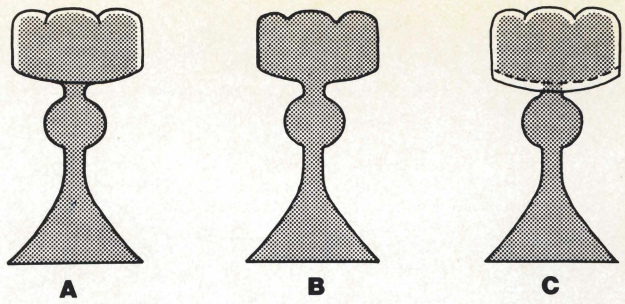

Figure 3. Fabrication and and use of the metal template: (A) Trimmed crown filled with wax and sprue attached; (B) Metal template; (C) Untrimmed metal crown on the template. The crown's margin was trimmed evenly with the gingival extent of the template (to dotted line).

- ☐ Pliers were not used on the proximal surfaces.
- ☐ Holes approximately 1 mm in diameter were drilled through the central pits of the occlusal surfaces of the crowns with a number 557 bur in an ultrahigh-speed handpiece.
- ☐ A one-inch number 16 wire nail was inserted through the hole from the underside of the occlusal surface. The undersurface of the head of the nail was flush with the underside of the metal occlusal surface.

Experimental crowns

The margins of fifty crowns were trimmed with a heatless wheel† in a low-speed handpiece so that each crown margin was located 1 mm above the cementoenamel junction. All marginal flash of metal was removed with a number 69L bur. A method was developed that enabled the investigator to trim the crowns to the same length uniformly. The method is described as follows:

- ☐ One stainless steel crown was trimmed and reduced in height as described in the preceding paragraph.
- ☐ The crown was filled with melted dental casting wax and a sprue was attached. Thus a template was made (Figure 3-A).
- ☐ This wax template was separated from the metal crown. It was invested, burned out and cast with a nonprecious alloy†† (Figure 3-B).
- ☐ Each experimental stainless steel crown was placed on this template and trimmed to length. The crown margins were trimmed evenly with the gingival extent of the template to yield uniform crown lengths (Figure 3-C).

Resistance of the stainless steel crowns to removal from the dies (Figure 4)

Retention of the experimental and control crowns was determined in the following manner:

- ☐ The end of the nail protruding through the occlusal surface of each metal crown was gripped by the top jaw of the Instron Universal Testing Machine.†††

**Unitek Corp., 2724 Peck Road, Monrovia, Ca 91016.
†Mizzy, Inc. , Clifton Forge, VA
††Rexillium III, Rx Jeneric Gold Co., Jeneric Industries, 125 No. Plain Industrial Road, Wallingford, CT.
†††Instron Universal Testing Machine, Model TTC, Instron Corp., Canton, MA.

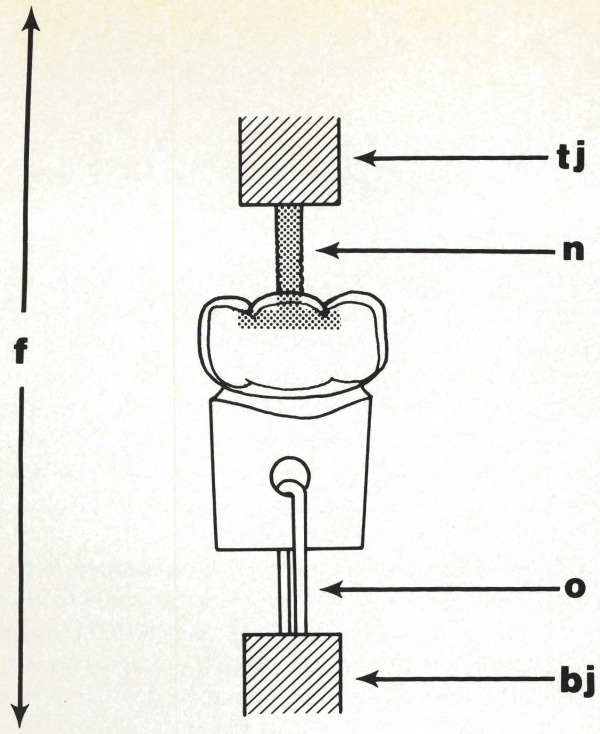

Figure 4. Assembly for determining the forces required to remove crowns from the dies: (f) Direction of forces; (tj) Top jaw of the testing machine; (bj) Bottom jaw of the testing machine; (n) Number 16 one-inch wire nail; the end held fast by the top jaw; (o) An .030 round orthodontic wire bent into a U-shape; its arms gripped by the bottom jaw.

- ☐ A three-inch piece (approximately) of .030 round orthodontic wire was bent in a U-shape figure with equal length arms. One arm of the wire was placed through the hole in the root of the die until the two equal arms were hanging from the die.
- ☐ Both arms of the U-shaped wire were gripped by the bottom jaw of the testing machine.
- ☐ The top jaw of the testing machine contained a universal joint. This joint coupled with the arms of the wire gripped by the bottom jaw ensured that the steel crown would be pulled in an axial direction.
- ☐ The upper and lower jaws then separated the crowns from the dies at a cross-head speed of 0.05 inches per minute. The maximum force in pounds required for separation was recorded for each crown.

Statistical examination of data

A Student t-test was used to test for significant differences in retention between experimental and control crowns. The null hypothesis was rejected for $P > 0.05$. For each set of tests, a one-factor analysis of variance was used to determine whether preparation type had a significant influence on retention. Where there was a significant effect, the Tukey HSD multiple comparison test was used to identify sets of preparations whose members were not significantly different from one another.

RESULTS

Effect of the various preparations of the resin dies

The one-factor analysis of variance showed no significant difference between preparations in the experimental groups. A similar analysis of the control group, however, indicated a significant effect ($P = 0.05$) of the type of preparation on the retentive forces; Preparation II offered significantly more retention than the other types.

Effect of stainless steel crown manipulation

The forces required to remove the experimental crowns and the control crowns from the prepared dies are shown in Figure 5. For each of the five pairs, the experimental group was found to be significantly more retentive than the control group.

DISCUSSION

Effect of the various preparations of the resin dies

The different die preparations played no significant role in the retention of the metal crowns. This finding was

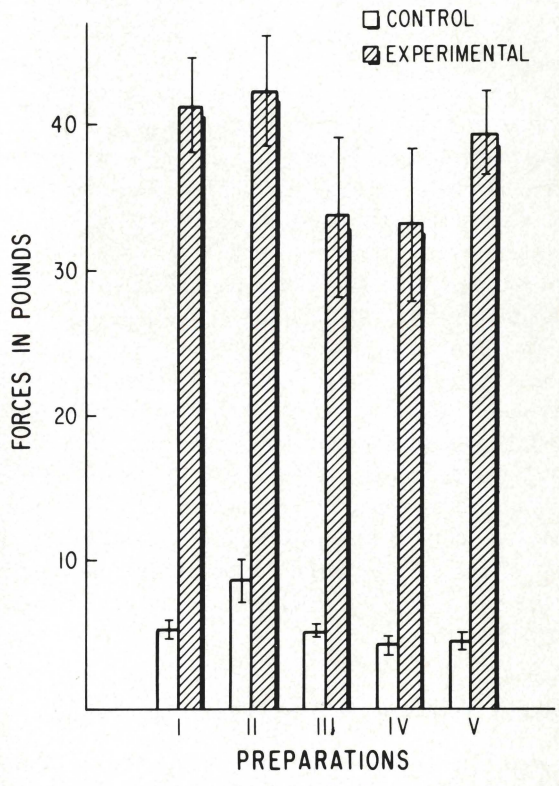

Figure 5. Forces required to remove experimental and control crowns. Comparative mean forces (± the standard error) to remove experimental and control crowns from the five different preparations.

not unexpected, since all five preparations had identical circumferential undercuts available for adaptation of the crown margin.

The finding that the die preparation does not affect retention of uncemented crowns agrees with the findings of a previous investigation. Myers *et al* found that if cervical tooth structures were intact, the amount of the remaining occlusal portions of the teeth had little influence on stainless steel crown retention. On the other hand, the Savide group found evidence of an effect of preparation on crown retention. Using epoxy resin dies they were able to demonstrate higher retentive forces, when buccal and lingual tooth structures were preserved. In the present study, the combination of Preparation I and the control crowns were those most like the crowns tested by Savide *et al.* It is not presently understoody why an increase in retention similar to that reported by Savide *et al* was not found for this preparation.

The only significant effect of tooth preparation on crown retention was found for control crowns adapted to Preparation II. This preparation contained no undercuts on the clinical crown (supragingival undercuts). As a result, stainless steel crowns could be adapted more closely to tooth surfaces in the subgingival undercut areas. When crowns were seated over the prepared teeth, they would not have to be deformed to the same extent as crowns that were placed on prepared teeth containing retained buccal and lingual supragingival bulges. Thus the crimped circumferential margins remained more closely adapted to the teeth and the retentive forces were greater.

Since the preparations on the resin dies were found to have no influence on mechanical retention, a conservative clinical preparation that minimizes the possibility of damage to the dental pulp should be used. Further, our results suggest that it is desirable to prepare the tooth so that the crown is readily seated, correctly oriented and well adapted to the tooth. For example, the presence of rounded line angles also may enable the clinician to obtain close adaptation of the crown margins to undercut areas at the line angles. Preparation V (Figure 2-V) is an example of such a preparation.

Effects of stainless steel crown manipulation

The results of our study indicate that when a stainless steel crown is trimmed to length and adapted intimately to undercut surfaces of an expoxy resin die, significant retention is attained. When the retention findings measured by other investigators are compared with our results, there is apparent disagreement. Two groups of investigators (Savide *et al* and Myers *et al*) reported retention forces for crowns held only by mechanical means to be much lower than for the experimental crowns reported in our study.[2,8] The focus of their investigations was on the effects of various cements, types of crowns, and tooth preparations on retention. They say little about how their crowns were trimmed and adapted. Myers *et al* are the only ones who indicate that their crowns were trimmed. No description of the trimming procedure, however, was given. Savide *et al* are the only ones who explicitly describe their metal crown adaptation procedures. Like the control crowns of our study, their crowns were contoured and crimped only on the buccal and lingual surfaces. It is interesting to note that the retentive forces found by Savide *et al* agree with those for the control crowns of our investigation. Myers *et al* also found retentive forces that agree with those of the controls in our study. This agreement suggests that their crowns may also have been adapted similarly to our control crowns.

From the preceding discussion it should be clear that the reason our experimental crowns were retained better than those uncemented crowns in previous investigations was because of better circumferential margin adaptation.

Two procedures are thought to be critical for obtaining good retention:

- ☐ Precise trimming of the crown with respect to the gingival undercut.
- ☐ Adapting and crimping the crown along its entire gingival margin.

Failure to trim the crown precisely makes it difficult to take advantage of the maximum undercuts available while still being able either to remove the crown easily from the prepared tooth or to put it on the tooth. When a crown is reduced in height (trimmed) and its margins shaped by the method Spedding advocated in a previous publication, the margins were thought to be located 1.0 mm above the cementoenamel junction and 1.0 mm below the height of gingival contour at all points on the tooth.[10] The margins of the crowns manipulated according to his technical principles were said to be intimately adapted to the prepared teeth.

Once the crown is trimmed so that it can be circumferentially crimped into the deepest undercuts available, our results suggest that it can and should be crimped along its entire marginal circumference to contact the tooth. The force to dislodge the crown will be proportional to the energy needed to pull the crimped crown away from the tooth surfaces and from the under-

cuts. More energy will be needed to pull the crown from all of the circumferential undercuts than from just the buccal and lingual ones (the only ones used by Savide *et al*).

When the crowns were trimmed and adapted as described in the preceding paragraphs, the forces required to remove the experimental crowns were approximately 50 percent of the forces reported by Savide *et al* for their cemented crowns. The retentive strengths of our uncemented experimental crowns, however, were similar to those of the cemented crowns in the studies of Myers *et al* and Mathewson *et al*. Use of epoxy resin dies rather than human teeth may have inflated the retention figures reported by Savide *et al*. Cement may adhere better to resin dies than to enamel. Use of epoxy resin teeth should not have affected the results in our study, since adhesion was not a factor.

It is not our purpose to downgrade the role of cement in the retention of stainless steel crowns. We do believe that cement improves the overall retention of crowns in opposition to the dislodgment forces of mastication. We also believe, however, this study shows that when crowns are reduced in height, contoured, and crimped so that the metal margins can be adapted circumferentially to the tooth surface undercuts, significant additional retention is attained and this feature should not be overlooked by clinicians.

CONCLUSIONS

The type of epoxy resin die pareparation used had no significant effect on the retention of stainless steel crowns in the experimental group in the study. It was found, however, that when a stainless steel crown's gingival margin was trimmed so that it was located approximately 1 mm above the cementoenamel junction and was closely adapted to the surfaces in the undercut areas on five different preparations on epoxy resin dies prepared from primary molar typodont teeth, significant retention was obtained.

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MEDICINE VERSUS ECONOMICS

The federal government has a budget deficit of $200 billion plus. It spends more than $100 billion on health care. If it is to reduce its budget deficit by cutting expenditures, it must cut health care spending. The federal government used to view health care as a social problem. Today it views it almost solely as a budget-deficit problem. The shift in perspectives is important. Social problems can be left to fester; budget-deficit problems require more immediate solution.

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Changing positions of supernumerary teeth in the premaxilla: a radiographic study

Eva M. Stermer Beyer-Olsen, Lic Odont
Bjørn Hurlen, Dr Odont
Diderich Humerfelt, Cand Odont

Supernumerary teeth have attracted the interest of many authors, representing several dental specialties.[1-4] Because supernumerary teeth usually remain unerupted, they can be studied only radiographically. The techniques described in the literature seem to focus, however, on the mere detection rather than on an exact localization of the supernumerary tooth. To our knowledge longitudinal studies describing change of position of supernumerary teeth have not been reported in the literature. The aim of the present study was to describe patterns of migration of inverted, supernumerary teeth in the premaxilla.

REVIEW OF THE LITERATURE

The material consisted of thirty-one patients, twenty-seven boys and four girls, each with one inverted supernumerary tooth in the premaxilla, the crown pointing in a cranial direction. The patients were selected from a total population of 393 patients with 432 inverted supernumerary teech (Table 1). Usually, supernumerary teeth are subject to immediate removal. The thirty-one patients mentioned above were among those who did not lose their supernumerary teeth and were observed clinically and radiographically for some period of time. Intervals between examinations varied from one year to 8.75 years. Age range at the first examination was 1.25 to 8.50 years and at the close of the study was 6.9 to 15 years. Radiographic examinations for determination of position were done, using stereoscopic views with intraoral films, and profile and axial views with occlusal films. For most patients a panoramic view was also included.

A General Electric GE 100* X-ray machine was used for the standard films, Kodak** Morlite Ultraspeed DR 55, or DR 57, DF 34; and a Palomex Siemens*** OP 3 or OP 5 was used for the panorama views with Dupont **** Cronex 4 films. All films were developed under standardized conditions.

All radiographs were examined on an illuminated glass table. A transparent ruler showing a rectangular coordinate system with 2 mm graduations (Figure 1) was superimposed on the radiographs to be evaluated.

In the frontal plane (Figure 1, left) the vertical midline of the diagram coincided with the radiographic image of sutura palatina mediana. In the sagittal plane (Figure 1, right) the vertical midline coincided with the axis of the adjacent, permanent central incisor. The levels of the nasal floor and the alveolar crest, respectively, were depicted as dotted lines at the first examination, and as

Dr. Stermer Beyer-Olsen and Dr. Humerfelt are with the Department of Oral Radiology and Dr. Hurlen is with the Department of Oral Surgery and Oral Medicine, Dental Faculty, University of Oslo, Norway.

* General Electric Company, Milwaukee, Wis.
** Eastman Kodak Company, Rochester, N.Y.
*** Siemens Aktiengesellschaft, Bensheim
**** Dupont de Nemours, Frankfurt am Main

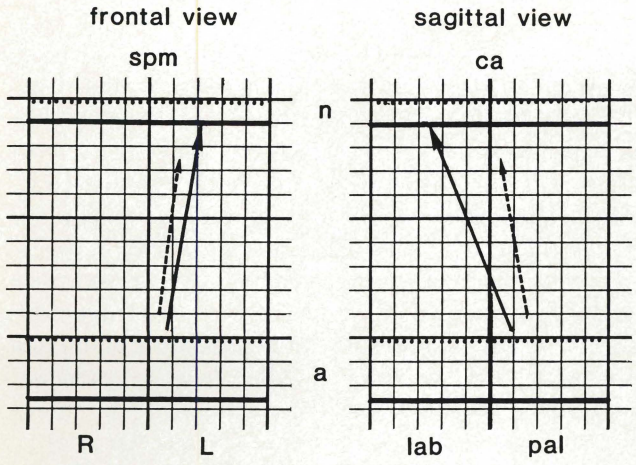

Figure 1. Relative positions of inverted, supernumerary teeth (arrows). Dotted lines and arrows represent the first examination, the solid ones represent the last examination. Upper lines = nasal floor; lower lines = alveolar crest; arrows = tooth lengths.

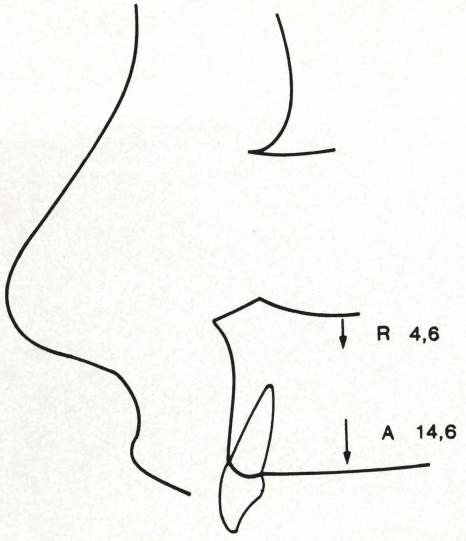

Figure 2. Mean growth changes in nine boys in a sixteen-year period. R = resorptive lowering of the nasal floor. A = appositional increase in height of the alveolar process.[5]

Table 1 ☐ Unerupted, inverted supernumerary teeth in the premaxilla.

	Basic material		
	m	f	Total
Patients	255	138	393
Teeth	285	147	432
	Selected materials		
	m	f	Total
Patients/teeth	27	4	31

Table 2 ☐ Distribution by sex of patients/teeth with changed position of inverted, supernumerary teeth.

	Longitudinal observation		
	m	f	Total
Patients/teeth	27	4	31
Changed position	14	2	16
Pathologic process	1		1
	13	2	15

Table 3 ☐ Direction of movement of inverted supernumerary teeth.

Direction	m	f	Total
Labial	3		3
Cranial	6	2	8
Dorsal	4		4
	13	2	15

solid lines at the last. Allowance for the dimensional changes due to maxillary growth was made according to Björk and Skieller.[5] The incisal edges and root apices of the supernumerary teeth were recorded as the points and butts of the arrows respectively, all relative to the nasal floor and alveolar crest. The axial view served as a control or supplement. The dotted arrows represented the supernumerary tooth at the first examination, the solid arrow represented it at the last examination. All details of the information were plotted on the diagrams. With due regard to the morphologic evolution of the maxilla, any change of position consisting of a minimum limit of 2 mm of displacement per year of the supernumerary tooth was evaluated.

RESULTS

At the first examination, all thirty-one teeth had a palatal position. In fourteen of the cases, an alteration in position could be registered (Table 2). Three had moved in a labial direction, eight cranially and four in a dorsal direction (Table 3). One case was excluded based on the occurrence of a dentigerous cyst.

DISCUSSION

Radiographs made from various projectiles are necessary to determine the relationship of intrabony objects to their neighboring structures.

As to supernumerary teeth in the premaxilla, Figure 3 shows the position of an inverted supernumerary tooth in a patient at approximately six years of age and again at approximately twelve years of age. Accordingly, changes of the position in the frontal plane could be easily recorded on intraoral radiographs. For this reason intraoral radiographs with a labiopalatinal beam direction, as well as a profile view (not shown here), were used and analyzed, using the transparent ruler.

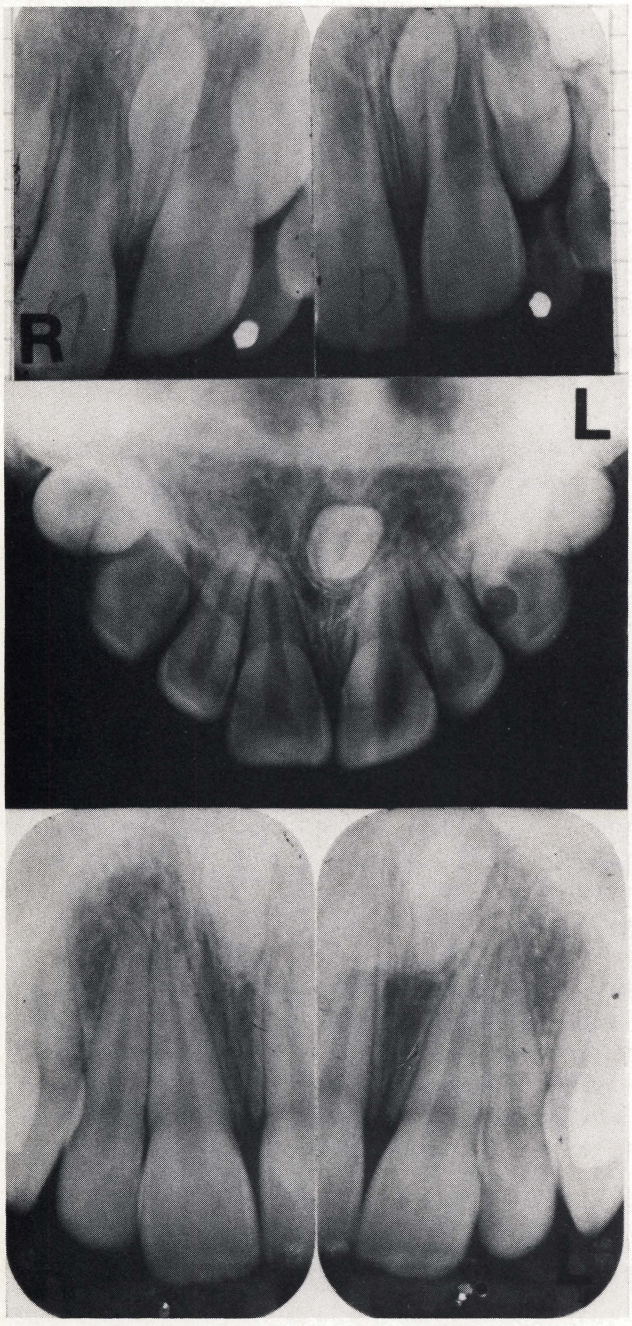

Figure 3. Position of an inverted supernumerary tooth at 5 10/13 years (top) and at 12.25 years (center and bottom).

The growth and development of the maxilla will influence the position of supernumerary teeth. The impact of these factors has been considered in the present investigation, based on the findings of Björk and Skieller (1976)[5]. In a longitudinal study of patients, four to twenty years of age, Björk and Skieller found that the floor of the nasal cavity was lowered by resorption on an average of 4.6 mm (range 1.5-7.5 mm) during the observation period. At the same time, the height of the alveolar crest increased by 14.6 mm (range 9.5-21 mm) (Figure 2), by virtue of the apposition of bone tissue. Most of the patients in the present study were in the age range of four to twenty years. We found it appropriate, therefore, to estimate the average values of resorption and apposition according to Björk and Skieller. This means an annual lowering of the nasal floor of 0.3 mm and an apposition of 0.9 mm to the alveolar crest in our subjects, or an increase of 0.6 mm annually in the distance between the nasal floor and the alveolar crest.

The measurements made on the present profile pictures showed a high degree of agreement with these findings. Deviations found were less than 0.5 mm, in spite of the fact that both apposition and resorption were expected to vary. All evaluations were based on the diagrams traced from the films, using the transparent ruler. At the last examination (Figure 1, right and left) the levels of the nasal cavity and alveolar crest were marked by solid lines, determined as described above.

Supernumerary teeth are usually removed surgically. In some cases removal is required to permit the proper eruption of the normal dentition and to prevent malposition. Early diagnosis, therefore, is important.

The position of a supernumerary tooth can frequently be made at an early age, often as early as one year of age. It has been reported that supernumerary teeth in inverted positions have a greater tendency to migrate than those in an upright position.[2] Inverted supernumerary teeth with their crowns pointing in a cranial direction may present a difficult surgical problem because of their proximity to developing teeth. Damage to the root papilla and blood supply of the permanent tooth could result. Benefit might result from postponing their removal, and allowing the supernumerary teeth to migrate to more favorable positions.

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Assessment of the systemic distribution and toxicity of formaldehyde following pulpotomy treatment: part one

Don M. Ranly, DDS, PhD

The systemic distribution of formaldehyde following the application of formocresol to a pulpotomized tooth was recently demonstrated.[1,2] Because formaldehyde has mutagenic and carcinogenic properties, its continued use in dentistry has been questioned.[3] Although systemic levels attained following single or multiple pulpotomies are probably inadequate to incite mutagenic or carcinogenic changes, liver and kidney morbidity was demonstrated in a dog following sixteen concurrent formocresol pulpotomies.[2,4] While the large number of pulpotomies required to demonstrate systemic damage experimentally is perhaps never duplicated in clinical practice, the oral rehabilitation of children under general anesthesia often involves numerous pulp procedures. Consequently, in some situations, there is potential to cause at least transient systemic morbidity as a result of the use of formocresol. Because this possible side-effect has not been adequately investigated, a two-part study was initiated to quantitate the systemic distribution of formaldehyde from a pulpotomy site and to compare this level to doses which elicit overt morbidity in vital organs.

MATERIAL AND METHODS

Pulpotomy procedure

Twelve Sprague-Dawley rats, each weighing 150 gm, were anesthetized with Nembutal and positioned on an operating table as described by Maurice and Schour.[5] Penetration of the pulp chamber of the maxillary left first molar was made with 0.5 round bur using a slow speed handpiece. The pulp was amputated by a hand-manipulated 0.5 round bur under a binocular scope, and bleeding was controlled with endodontic paper points. A 0.2 µl aliguot of 19 percent formaldehyde containing 1.6 µCi of ^{14}C labeled formaldehyde (^{14}C-formaldehyde, 52.5 mCi/mmol, New England Nuclear) was deposited in the pulp chamber with the aid of a one µl syringe (Unimetrics). After a timed five-minute interval, the chamber was blotted dry with a paper point and filled with zinc oxide-eugenol cement. Two hours later the rats were bled and then sacrificed. Samples of lung, liver, kidney, and muscle tissue were harvested for counting of incorporated ^{14}C-formaldehyde.

Intravenous administration of formaldehyde

Four groups of 150 gm Sprague-Dawley rats (4 rats/group) were anesthetized with Nembutal prior to surgical exposure of the neck region. Labeled formaldehyde diluted with saline was then infused into the jugular vein. The dose levels administered to the rats in this manner represented 10 percent, 20 percent, 30 percent, or 50 percent of the amount of formaldehyde that was delivered to the pulpotomy site. These percentages were used to determine an intravenously administered dose, which effected a systemic incorporation of labeled formaldehyde comparable to that following a

Dr. Ranly is with the University of Texas Health Science Center at San Antonio, Department of Pediatric Dentistry, 7703 Floyd Curl Drive, San Antonio, TX 78284. This study was supported by a grant from ASDC Foundation and by NIH grant DEO 6446.

Table 1 ☐ Systemic distribution of ^{14}C-formaldehyde two hours following administration.

Tissue	Pulpotomy[A]	50% dose[B]	30% dose[C]	20% dose[D]	10% dose[E]
Lung	4447 ± 398* (1.5)©	2521 ± 340 (.86)	2262 ± 481 (.77)	2382 ± 280 (.83)	881 ± 131 (.31)
Liver	6083 ± 618[1] (2.1)	8597 ± 447 (3.0)	7292 ± 851[1] (2.6)	3555 ± 388 (1.2)	1272 ± 26 (.45)
Kidney	6358 ± 526[2] (2.2)	6540 ± 505 (2.2)	4853 ± 630[2] (1.7)	4424 ± 520 (1.5)	1669 ± 171 (.58)
Muscle	2395 ± 159 (.84)	1703 ± 105 (.58)	1511 ± 162 (.50)	1584 ± 114 (.55)	619 ± 111 (.22)
Plasma	2051 ± 692[3] (.70)	2600 ± 546 (.88)	2050 ± 154[3] (.70)	1450 ± 106 (.50)	6251 ± 78 (.22)

A 1.26 μmoles (1.66 μCi) formaldehyde applied to pulpotomy site.
B 0.63 μmoles (.833 μCi) formaldehyde infused.
C 0.38 μmoles (.498 μCi) formaldehyde infused.
D 0.26 μmoles (.332 μCi) formaldehyde infused.
E 0.13 μmoles (.166 μCi) formaldehyde infused.
* Reported as dpm/gm wet wt tissue or ml or plasma. All values are reported as mean ± S.E.M.
© Values in parenthesis represent total formaldehyde in picomoles calculated from specific activity.
1,2,3, — Differences not statistically significant.

pulpotomy. Two hours following the infusion, the animals were sacrificed and their tissues harvested in the manner described above.

Metabolic studies

Two groups of rats, each consisting of three animals, were injected intraperitoneally with .38 μmoles of formaldehyde (.498 μCi) diluted in saline. The animals were immediately placed in a glass metabolic cage, which had outlets for the capture of expired gases and a separate receptacle for urine. Air was drawn from the cage by a vacuum and was bubbled through two vessels containing 3 N NaOH. This solution trapped the expired $^{14}CO_2$ which was a metabolic by-product of the administered formaldehyde. No attempt was made to capture unmetabolized molecules, since previous studies had been unable to demonstrate expired formaldehyde.[6]

The urine receptacle was cooled by ice to reduce volatilization of labeled waste products. After two or twenty-four hours, the animals were removed and handled in the manner previously discussed. Samples of urine and the NaOH solutions were retained for counting by liquid scintillation spectroscopy. An additional group of three rats was injected intraperitoneally with a higher dose of formaldehyde (4.98 μmoles, .498 μCi) and placed in the metabolic cage for two hours. At that time they were sacrificed and their tissues and waste products harvested in the same manner.

Radioisotope determination

Tissue samples were solubilized for three days at room temperature in a tissue solubilizer (Beckman BTS-450) and counted using a multipurpose scintillation cocktail (Beckman Ready-Solv MP). All vials were counted for five minutes, and quenching effects were corrected by internal standards. Radioactivity is reported as dpm/ml of plasma or dpm/gm of tissue.

RESULTS

The radioactivity present in five systemic tissues two hours following the application of labeled formaldehyde to a pulpotomy site is listed in Table 1. Both the raw counts from the isotope and the picomole equivalents of unlabeled as well as labeled formaldehyde are listed. The picomoles were calculated from the specific activity of the 30 percent ^{14}C-formaldehyde solutions. The tissue/plasma ratios of 3 for the liver, 3 for the kidney and 2 for the lung demonstrate the incorporation of ^{14}C-formaldehyde above a level that can be explained by the distribution of body water. These ratios are similar to those reported by Pashley *et al.*[1]

The distribution of four doses of labeled formaldehyde following intravenous infusions is also shown in Table 1. The lesser concentrations (10 percent and 20 percent of the amount deposited into the pulp chamber) did not achieve a level of isotopic incorporation comparable to the systemic distribution following pulpotomy. The values for the 30 percent dose most closely approximated the pulpotomy values. The plasma counts were very similar, and while the incorporation following infusion was greater in the liver and less in the kidney, the differences were not statistically significant. The uptake of ^{14}C-formaldehyde into the lung following any of the infusions never reached a level observed in the pulpotomized animals.

Table 2 compares the distribution and metabolism of isotope at two and twenty-four hours. A half of the injected ^{14}C-formaldehyde was converted to CO_2 within two hours; a much lesser amount was excreted in the urine. Approximately 10 percent was additionally expired during the last twenty-two hours.

Table 3 compares the distribution and metabolism of two doses (0.38 μmoles and 4.9 μmoles) of formaldehyde when injected intraperitoneally. The incorporation is reported as a percent of the total administered/gm of tissue. The excreted or expired formaldehyde is also reported as a percent of the amount injected. While

Table 2 □ Systemic distribution and metabolism of ^{14}C-formaldehyde* comparison after two and twenty-four hours.

	Two hours	Twenty-four hours
Lung	2771 ± 415	1769 ± 226
Liver	4824 ± 353	2759 ± 451
Kidney	5442 ± 940	3323 ± 653
Muscle	1712 ± 343	1126 ± 218
Serum	1650 ± 132	900 ± 208
Urine	24,660 ± 1648†	39,000 ± 8014
CO_2	550,666 ± 20,990	653,000 ± 29,000
% as CO_2	50	59

*0.38 μmoles of formaldehyde (.498 μCi - 1,105,560 dpm) injected intraperitoneally at time zero. Mean ± S.E.M. (N = 3)
† Mean of two animals

there is a suggestion that the larger load of formaldehyde causes a greater incorporation into the kidney and liver and less conversion to CO_2, none of the difference is statistically meaningful. Thus at these two doses, there is no significant difference in the proportion of formaldehyde incorporated or metabolized.

DISCUSSION

The intent of this study was to quantify the systemic distribution of formaldehyde from a pulpotomy site so that a similar dose, and multiples of that dose, could be evaluated for toxicity. The method selected for this determination was indirect. It involved a determination of the radioactivity incorporated in systemic tissues following pulpotomy as compared to the uptake following the infusion of labeled formaldehyde. This approach was taken because the accurate determination of ^{14}C-formaldehyde everywhere in the rat along with the weight of all the tissues would be virtually impossible. The indirect method of infusing graded doses of formaldehyde, although not precisely duplicating the incorporation seen in the pulpotomized animals, therefore, provided a reasonable reference dose for future toxicity experiments.

Comparison of the pulpally applied and infused doses suggests that approximately 30 percent of the formaldehyde pipetted into the pulp chamber was distributed systemically in five minutes. This figure was derived from a comparison of plasma, liver, and kidney values. The lower lung and muscle counts in the infusion groups suggests that the intravenous administration is less protracted; thereby permitting the more rapid metabolism of formaldehyde and expiration of labeled CO_2.

The 30 percent figure is higher than that reported for monkeys and dogs.[1,7] These differences could be explained in several ways. First, the architecture of the root canals varies; second, the application of formaldehyde with a pipette rather than a cotton pellet could be a factor; third, the solution applied to the pulp stumps contained no cresol, a caustic agent that could conceivably cauterize the tissue and diminish the systemic distribution; and fourth, the increased uptake might parallel the generally more active metabolic state of a rodent.

With respect to the first and fourth points, we recognized that the rat model has limitations for dental studies, compared to dogs and primates. We felt, however, that the variability of the systemic uptake from a pulpotomy site necessitated a sample size that could not be practically attained with the larger animals. In addition, future toxicity studies involving the infusion of graded doses of formaldehyde will require a considerable number of animals to test various dose levels and post-administration sacrifice intervals adequately. In light of these considerations, therefore, the use of the rat model seemed justified.

With respect to the second difference cited, the practical limitations of pulp chamber size precluded the use of cotton pellets. We also felt confident about the consistency of the volume of formaldehyde delivered to the chamber with the ultra-micro pipette.

With respect to the testing of formaldehyde rather than formocresol, cresol was viewed as a confounding constituent which would hinder the evaluation of the active component, formaldehyde. The elimination of cresol was not viewed as a deficiency in the experimental design for future testing of toxicity, since the very low solubility of cresol in aqueous solutions probably prevents significant absorption during the five-minute application period. Most of the concern about the possible toxicity, mutagenicity, and carcinogenicity of formocresol has focused on formaldehyde.[4] While cresol has locally destructive properties and no doubt is responsible for considerable morbidity seen following the

Table 3 ☐ Effect of dose level on formaldehyde distribution and metabolism (two hours).

Sample	Low dose (.38 μmoles)	High dose (5.0 μmoles)
	(% Dose incorporated/gm tissue)	
Lung	.25	.23
Liver	.43	.51
Kidney	.49	.64
Muscle	.14	.14
Serum	.15	.17
	% of total dose	
% in urine	2.2	2.5
% as CO_2	50	45

bolus injection of formocresol, we view its potential for systemic toxicity via a dental route as negligible.[8,9]

Comparison of the radioactivity remaining in tissues of animals sacrificed at two hours and twenty-four hours following the administration of the 30 percent dose reveals that much of the incorporated formaldehyde is retained during the intervening twenty-two hours. The loss of radioactivity from the tissues, in some cases approaching 50 percent, is not matched by the increase in expired $^{14}CO_2$. This might be explained by the excretion of isotope into the bile and subsequently the feces (not measured) or the redistribution of label into tissues not analyzed in this study.

Presumably, most of the tissue counts represent the ^{14}C from the formaldehyde which was shunted through the one-carbon pool for the synthesis of larger molecules. The metabolic studies suggest that the metabolism of formaldehyde is very rapid and that the majority of the conversion occurs within two hours. Further clearance of the remaining radioactivity must be prolonged, therefore, dependent upon the metabolic breakdown and excretion of the large labeled molecules.

Metabolic conversion represents the "detoxification" of formaldehyde in a sense; only formic acid production might be considered an unproductive activity. Unmetabolized formaldehyde, in contrast, has the potential to bind enzymes and structural proteins; thereby jeopardizing cell viability.

The data in Table 3, the comparison of the distribution and metabolism of formaldehyde at two distinct doses, indicate that there was substantial tolerance to the exogenous compound. If the higher dose of formaldehyde were toxic, the impairment of metabolic pathways would then be expected. Accordingly, the conversion of formaldehyde to CO_2 would be diminished and the tissue load would rise. The findings do not support this scenario. Instead, the constant proportions of formaldehyde that were present in the blood, incorporated into the cells, or expired as CO_2 suggest that the metabolic systems were not damaged or overloaded. By selecting the low dose to be comparable to the amount of formaldehyde that escapes from one pulpotomized tooth, and the high dose to be thirteen times as much, the metabolic response to the equivalent of multiple pulpotomies was tested. The findings suggest that, in the range of formaldehyde load that might be introduced by multiple pulpotomies, there was no significant difference in its distribution or metabolism. These metabolic data should not be overinterpreted, however, and a correlative study of formaldehyde levels and somatic pathology is needed.

Accordingly, beginning with the reference level of systemically distributed formaldehyde established in this study, incremental doses will be administered to rats until perceptible histological or biochemical damage is produced. This value will then be equated to the number of concurrent pulpotomies which would be required to achieve the same level of systemic formaldehyde.

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Proximoclusal composite restorations in primary molars: a six-year follow-up

Mirja Varpio, DDS

Ninety-one class II composite restorations were placed in primary molars, during the period of autumn 1977 to spring 1978. An evaluation of their performance after two years was presented earlier.[1] Although there were many unsuccessful restorations, it was concluded that under favorable conditions, composite resin is an excellent restorative material. It was, however, decided to follow up the restorations until the shedding of the teeth, for further assessment of the suitability of composite resin for filling proximoclusal cavities in primary molars. All teeth treated have now exfoliated, except for one second lower molar in a twelve-year-old boy. The condition of the restorations during six years *in situ* will be described. Since a third of the filled teeth could be collected after shedding, a description of the restorations *ex situ* will also be given.

STUDY POPULATION, MATERIAL AND PROCEDURE

Because the study population, material and procedure are presented in the two-year evaluation, only the main features will be repeated here.

Most of the children were six years old at the start of the study; the mean age was 7.4 years. The distribution of the ninety-one restorations among different tooth surfaces was recorded. Adjacent proximal surfaces, distally in the first and mesially in the second molars, were filled in fifteen patients.

The teeth had small proximal cavities, but intact occlusal surfaces. The preparation occlusally was restricted to the enamel of the main fissures, which were opened and bevelled. The proximal box was extended buccolingually to self-cleaning surfaces, the enamel of the lateral walls bevelled, and the gingival seat was prepared level. The isthmus area was about 2 mm wide and reached into the dentin. A rubber dam was placed and stabilized with a modified Ivory 8 matrix system for primary molars.[2] The dentin was isolated with a liner*, and the enamel etched for two minutes with 37 percent phosphoric acid, which was rinsed off for thirty seconds.[3]

The composite resin† was inserted immediately without intermediate bonding resin. After five minutes, the restoration was contoured to occlusion. Final finishing was usually performed at a later appointment.

The clinical performance of the restorations was evaluated according to the guidelines presented by the California Dental Association.[4] From the third year on, the evaluation was made by the author. The clinical status corresponds to four categories (Romeo, Sierra, Tango, and Victor).

Statistical methods

The findings at the follow-up examinations are presented in life-table form. The four categories of evalua-

Dr. Varpio, formerly with the Department of Pedodontics, Faculty of Odontology, Göteborg, Sweden is now with Specialist Clinic of Pedodontics, Sociala Huset, S-411 17 Göteborg, Sweden.

*Fluoritec^{R}, Dental therapeutics AB, Nacka, Sweden
† Concise Cap-C-Rynge, 3M Co, St. Paul, Minnesota, USA

tion were regrouped into two: Romeo and Sierra were called successful restorations, and Tango and Victor, failures. The withdrawals comprise, firstly, successful restorations in children that moved out of the district, during the follow-up; and, secondly, successful restorations in teeth that were shed, during the study.

The standard error of the cumulative survival and the test of significance are calculated as suggested by Colton.[5]

RESULTS

Follow-up *in situ*

The cumulative proportion of successful restorations decreased from 86 percent after the first year to 72 percent after the second year, and to 56 percent after the third year. From the fourth through the sixth year, the percentage of successful restorations was 38 percent (Table 1). The results for the material as a whole as well as for the different tooth surfaces are presented as survival curves in Figure 1. Data concerning the success of the restorations on the treated surfaces are presented in Tables 2 and 3.

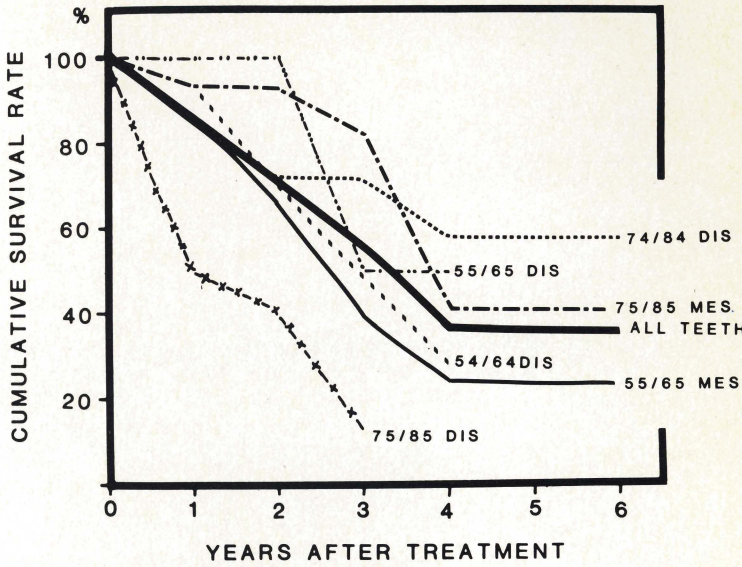

Figure 1. Cumulative survival rate for ninety-one proximoclusal composite restorations as a whole and on different tooth surfaces.

Table 1 ☐ Six-year success rate of 91 proximoclusal composite restorations in primary molars.

Years	Successful restorations at start	Failures during interval	Patient moved during interval N teeth	Teeth shed during interval	Teeth exposed to risk of failure $(0-\frac{W1+w2}{2})$	Rate of failure during interval (d:E)	Rate of success during interval (1-q)	Cumulative success rate	Standard error of cumulative success rate
x	0	d	w1	w2	E	q	p	P	SE(P)
0 - 1	91	12	3	3	88	0.1364	0.8636	0.8636	0.0366
1 - 2	73	11	5	12	64.5	0.1705	0.8295	0.7163	0.0505
2 - 3	45	9	1	4	42.5	0.2118	0.7882	0.5646	0.0600
3 - 4	31	8	2	12	24	0.3333	0.6667	0.3764	0.0675
4 - 5	9	-	-	5	6.5	0	1	0.3764	0.0675
5 - 6	4	-	-	1	3.5	0	1	0.3764	0.0675
6 -	3								

Table 2 ☐ The six-year success rate of the 38 proximoclusal composite restorations in the maxillary primary molars. (Letter designations, cf. Table 1).

X	o	d	w_1	W_2	E	q	p	P	SE(P)
56/64 DIS									
0 - 1	16	1	1	-	15.5	0.0645	0.9355	0.9355	0.0624
1 - 2	14	3	-	4	12	0.2500	0.7500	0.7016	0.1260
2 - 3	7	2	-	1	6.5	0.3077	0.6923	0.4857	0.1541
3 - 4	4	1	-	3	2.5	0.4000	0.6000	0.2914	0.1766
55/65 MES									
0 - 1	19	2	1	-	18.5	0.1081	0.8919	0.8919	0.0722
1 - 2	16	4	1	-	15.5	0.2581	0.7419	0.6617	0.1127
2 - 3	11	4	1	-	10.5	0.3810	0.6190	0.4096	0.1212
3 - 4	6	2	-	2	5	0.4000	0.6000	0.2458	0.1155
4 - 5	2	-	-	1	1.5	0	1	0.2458	0.1155
5 - 6	1	-	-	-	1	0	1	0.2458	0.1155
6 -	1								
55/65 DIS									
0 - 1	3	-	-	1	2.5	0	1	1	0
1 - 2	2	-	-	-	2	0	1	1	0
2 - 3	2	1	-	-	2	0.5000	0.5000	0.5000	0.3536
3 - 4	1	-	-	1	0.5	0	1	0.5000	0.3536

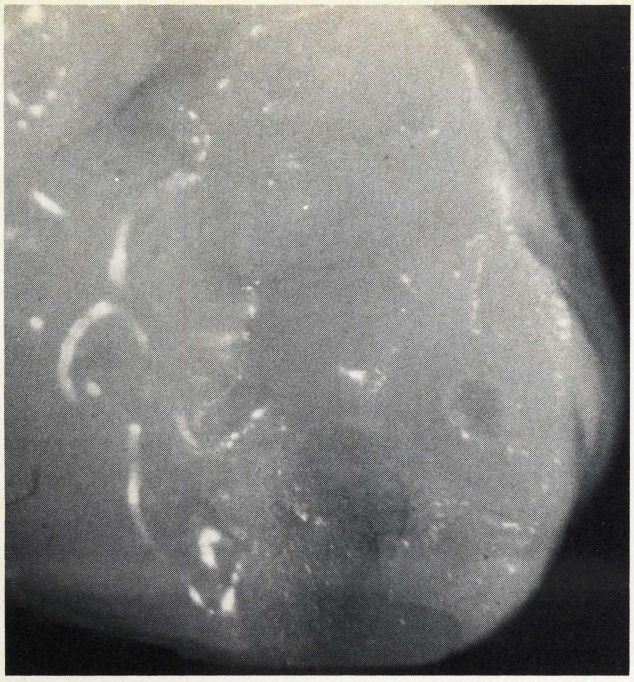

Figure 2a. Occlusal aspect of the maxillary left second primary molar. Category Romeo. Period of clinical function, six years.

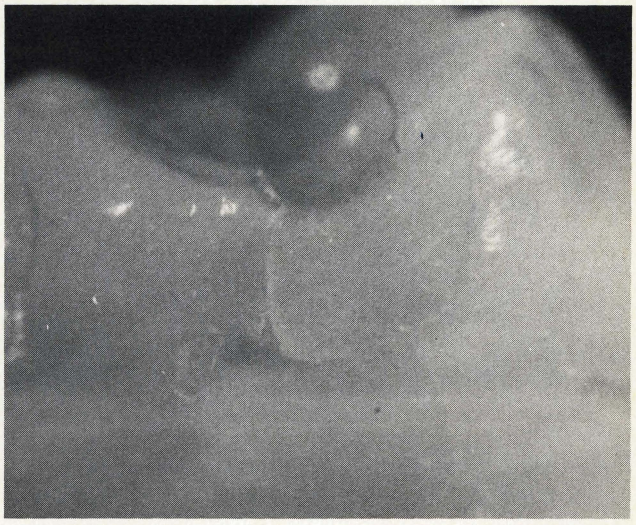

Figure 2b. Mesial aspect of the maxillary left second primary molar.

As the restorations in the mandibular teeth seem to have been more successful than those in the maxillary teeth, a test of the significance of the difference was performed. Because the distal surfaces of the second molars received very few restorations—three in the maxillary and nine in the mandibular—they will be excluded from the calculations. The results from the fourth year on are also excluded, because the number of fillings is already too low for statistical analysis. When the success rates of the restorations distoclusally in the first molars and mesioclusally in the second molars, in the maxillary and in the mandibular, respectively, are compared, there is no statistically significant difference in their performance, during the first and second years; but during the third year the restorations in the mandibular teeth performed significantly better, $P<0.01$, than those in the maxillary teeth (Table 4).

On the final examination, eighty-three restorations were rated as Tango or Victor, i.e. as failures (46 percent). Fractures were found early (eight of the sixteen fractures occurred during the first year) whereas recurrent caries could be detected, beginning in the second year. Features rated as Tango, i.e. reduced occlusal height and color mismatch, were diagnosed late, after the third and fourth years.

Owing to the failures, composite resin was replaced

Table 3 ☐ The six-year success rate of the 53 proximoclusal composite restorations in the lower primary molars. (Letter designations, cf. Table 1).

x	o	d	w_1	w_2	E	q	p	p	SE(P)
74/84 DIS									
0 - 1	29	4	1	1	28	0.1429	0.8571	0.8571	0.0661
1 - 2	23	3	1	5	20	0.1500	0.8500	0.7286	0.0886
2 - 3	14	-	-	2	13	0	1	0.7286	0.0886
3 - 4	12	2	1	3	10	0.2000	0.8000	0.5829	0.1162
4 - 5	6	-	-	4	4	0	1	0.5829	0.1162
5 - 6	2	-	-	1	1.5	0	1	0.5829	0.1162
6 -	1								
75/85 MES									
0 - 1	15	1	-	1	14.5	0.0690	0.9310	0.9310	0.0665
1 - 2	13	-	3	1	11	0	1	0.9310	0.0665
2 - 3	9	1	-	-	9	0.1111	0.8889	0.8276	0.1140
3 - 4	8	3	1	3	6	0.5000	0.5000	0.4138	0.1783
4 - 5	1	-	-	-	1	0	1	0.4138	0.1783
5 - 6	1	-	-	-	1	0	1	0.4138	0.1783
6 -	1								
75/85 DIS									
0 - 1	9	4	-	-	9	0.4444	0.5556	0.5556	0.1656
1 - 2	5	1	-	2	4	0.2500	0.7500	0.4167	0.1729
2 - 3	2	1	-	1	1.5	0.6667	0.3333	0.1389	0.1704

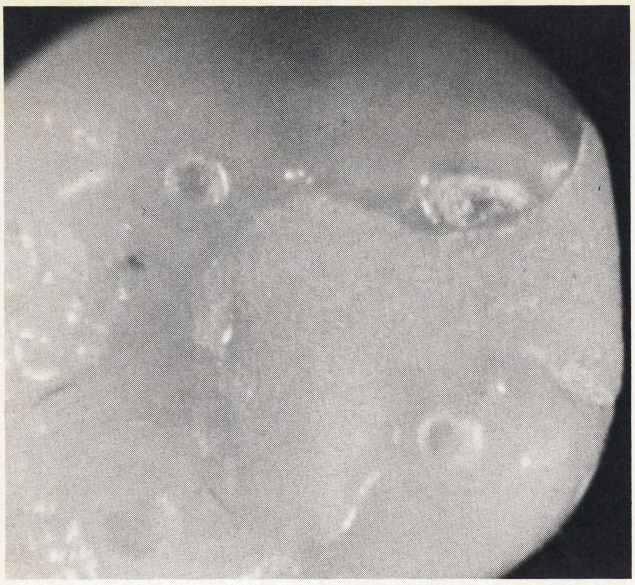

Figure 3a. Occlusal aspect of the mandibular left second primary molar. Category Sierra. Period of clinical function, 3.5 years.

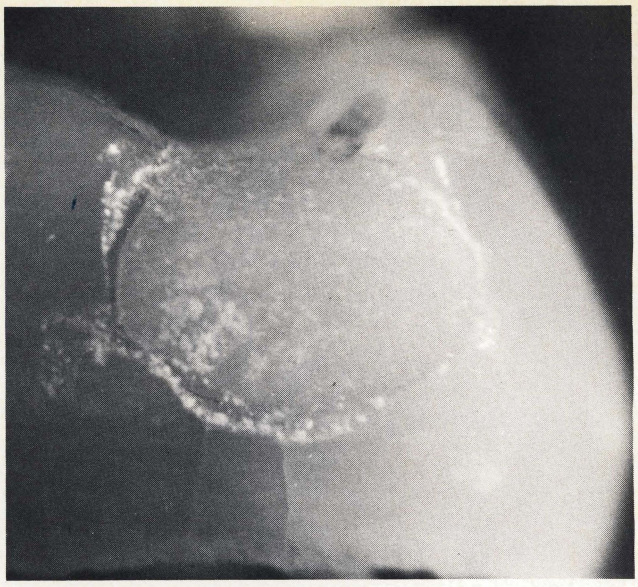

Figure 3b. Mesial aspect of the mandibular left second primary molar. Visible crevice.

by silver amalgam in twenty-six teeth. Because the composite resin was not radiopaque, except in the last twenty-eight restorations, some of the replacements may have been made on the grounds of radiographic diagnosis only, which was verified in one case of an excellent restoration.

Evaluation of the proximoclusal composite restorations *ex situ*

Visual inspection of the thirty-one restorations in teeth that could be collected after exfoliation revealed several defects along the cavosurface margins of the proximal box, now accessible for examination. Thus, only ten restorations without defects were now found, while five restorations, rated as excellent in the *in-situ* follow-up, had to be placed in the Sierra category, since four of them showed marginal discoloration and one was undercontoured cervically. In general, defects on the proximal surfaces of the restorations outnumber other deficiences by two to one (Table 5). Different clinical conditions of the restorations are also presented in Figures 2-6. The results of the *in-situ* follow-up must, therefore, be considered in relation to the surfaces accessible for visual examination.

Table 4 ☐ Comparison of the success rate of the composite restorations during the first three years in the maxillary and mandibular teeth, respectively.

Critical ratio $z = \frac{P - P'}{[SE(P)]^2 + [SE(P')]^2}$

YEARS	74/84 DIS 75/85 MES P	SE(P)	54/64 DIS 55/65 MES P'	SE(P')	Z	
0-1	0.8824	0.0494	0.9118	0.0486	0.4242	N.S.
1-2	0.7970	0.0645	0.6797	0.0838	1.1092	N.S.
2-3	0.7607	0.0712	0.4398	0.0956	2.692	$P < 0.01$

Table 5 ☐ Clincial condition of the 31 restorations collected after shedding. Mean time of function: three and a half years, range one to six years.

Tooth, restored surface	Romeo		Sierra				Tango		Victor		Total no. of observations
	N	Excellent	Marginal discoloration Prox Occl	Visible crevice Prox Occl	Undercontoured Prox Occl	Overcontoured Prox Occl	Occlusal height reduced	Color mismatch	Marginal caries	Fracture	
DIS 55/65	1		1 1			1					3
MES	4	2	1 1	1	1			1		1	8
DIS 54/64	7	2	2	2	1			1			8
DIS 74/84	9	3	5 1		1				1	1	12
DIS 75/85	5	1	2	1	1				1	1	7
MES	5	2	2				2				6
Total	31	10	13 3	4	3 1	1	2	2	2	3	44

Seven restorations showed two defects; one showed three; and one, five defects.

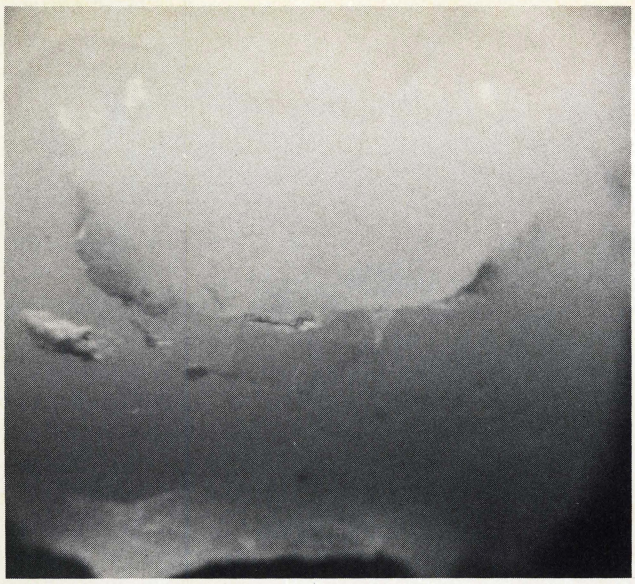

Figure 4. Distal aspect of the maxillary left second primary molar. Category Sierra, marginal discoloration and visible crevice. Period of clinical function, three years.

DISCUSSION

The percentage of failures in this study, 46 percent, is higher than in a comparable population that was treated with conventional proximal silver amalgam restorations, and observed periodically from the age of three. The proximoclusal silver amalgam restorations had failed in 27 percent of cases by the age of eight, calculated as the number of extractions and the number of replacements on the surfaces as in this study.[6]

The causes of failure were discussed in the two-year report.[1] After six years, it still seems that the main cause lies in the handling of the material, rather than in the material as such or in the cavity form, since there are restorations that were observed in excellent condition until the exfoliation of the tooth, with an average of three years of functional time.

The major difficulties in the handling of the material were the size of the dispenser, which was too big for children's mouths, and the tendency of the capsule to glide off the dispenser. Both these factors delayed the insertion of the composite resin, which after activation was increasing in viscosity while the etched enamel was decreasing in reactiveness. The stickiness of the material prevented any attempt to apply pressure during application. On the contrary, any effort to model the restoration or to remove excess material probably resulted in voids in the restoration.

When the study was started, the procedure of filling with composite resin was felt to be time-consuming, compared to the conventional silver amalgam therapy. The long etching time of two minutes has later been shown to be unnecesary, since well-defined tags in the enamel of the buccal and lingual surfaces of primary teeth could be achieved by etching for sixty, or even for fifteen seconds.[7]

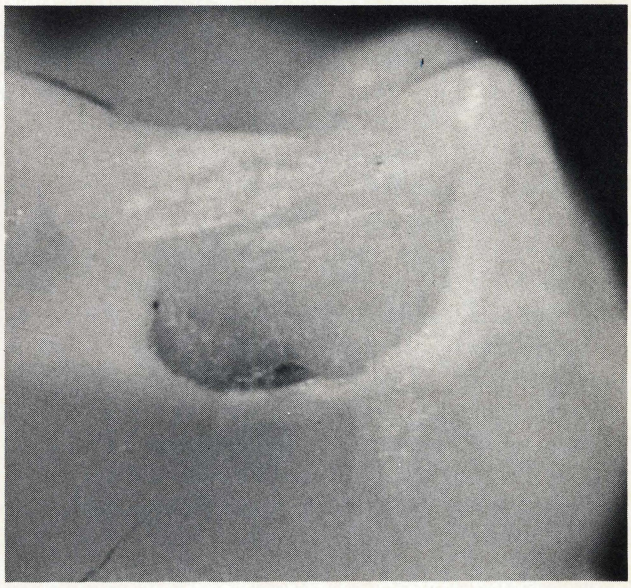

Figure 5. Distal aspect of the mandibular right second primary molar. Category Victor, visible crevice and marginal caries. Period of clinical function, two years.

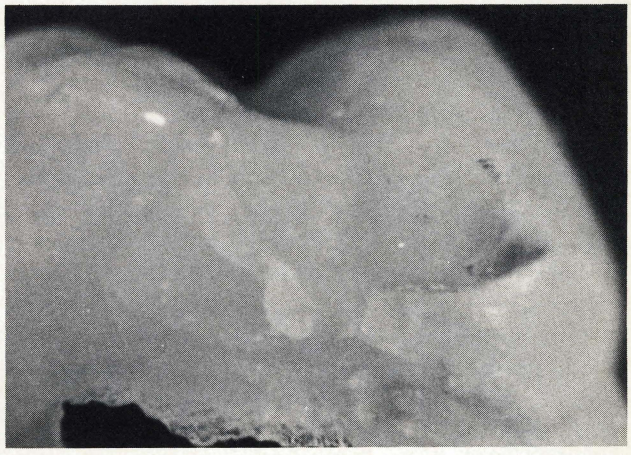

Figure 6. Distal aspect of the maxillary right first primary molar. Category Victor, marginal caries. Period of clinical function, three years.

To compensate for the long etching time, the intermediate layer of bonding resin was omitted. Later tests *in vitro* on permanent enamel showed that there is no difference in the tag formation between Concise composite resin and Concise Enamel Bond.[8] Under clinical conditions, too, the omission of the intermediate bonding resin does not appear to influence the success rate of proximoclusal composite restorations in primary molars, when the one-year results of this study are com-

pared with those of a later study, using autopolymerized composite resin of the same particle size in modified cavities with bevelled enamel margins, two minutes of etching time, and an intermediate layer of bonding resin. The rate of failure in both studies after one year was about 16 percent.[1,9] In terms of manipulation, however, the application of bonding resin is the quickest way to ensure the reactiveness of the etched enamel.

With the matrix sytem used, firm proximal contacts could be established. On the other hand, the highly curved matrix band led to overcontouring, especially in the upper first molars. In the fifteen pairs of fillings on adjacent proximal surfaces, one would expect to find wear on adjacent surfaces with shortening of the dental arch as a consequence. Changes in the anatomic form, however, were not registered by measurements on models or other refined methods; furthermore, ocular inspection did not reveal wear as a salient feature. The difference in the success rates between maxillary and mandibular restorations may reflect difficulties in the handling of the material. With conventional silver amalgam therapy, failures were, on the contrary, more frequent in the mandibular teeth.[6]

Most defects were found in the proximal box. These defects may have been caused by voids between the restorative material and the cavity wall, macroscopic gaps soon leading to fracture while microscopic voids initiated the later failures: color mismatch, marginal discoloration, recurrent caries, and, as its consequence, fracture. The gaps along the cavity wall may be caused by the high viscosity of the material or the contraction of the resin during polymerization. The condensable composites seem to resist the formation of contraction gaps better than the resin that has been used in this study.[10] Another problem connected with the class II restoration is the quality and thickness of the cervical enamel, which in permanent teeth shows more microleakage in class V cavities than the incisal enamel when tested *in vitro*.[11] In this study, the proximal aspect of the restorations shows that a good margin of enamel has been left between the cervical boundary of the cavity and the cementoenamel junction.

In conclusion, the modified proximoclusal composite restoration in primary molars seems to function excellently, when all the prerequisites of the material are fulfilled. The material appeared, however, to be too sensitive to variations in clinical management to replace silver amalgam. Since all restored surfaces become accessible for investigation after exfoliation of the tooth, the use of primary molars as a study model for restorative materials appears useful. A follow-up period of six to eight years can be achieved for a preliminary test of a material. A study of the adaptation of the composite resin to the cavity walls and the penetration of microorganisms in the teeth collected after shedding will be performed.

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Troubleshooting for the laminate veneer restoration

Mark L. Helpin, DMD

The laminate veneer restoration is a well described and well-accepted technique for treating a number of esthetic problems.[1-5] Experience has shown that proper patient care and regular follow-up, including smoothing, cleaning, and resealing will minimize marginal breakdown and marginal staining. Occasionally, despite the patient's and doctor's best efforts, marginal staining may still occur. Most often this is associated with frequent exposure to coffee or tea and is located only at the incisal edge. When staining occurs and the rest of the veneer and its margins are intact, the dentist is faced with a problem: must the veneer be removed or its integrity compromised in order to restore the esthetics which is desired? This difficulty may frequently be solved by bleaching the veneer margin.

Bleaching of vital teeth has been described in many articles.[6-16] Basically the procedure uses a heating source which is applied to a bleaching medium on the tooth. This paper describes the details of this technique as it applies to the laminate veneer and presents a case in which the procedure was successfully employed.

TECHNIQUE

- ☐ Warm the Indiana bleaching tool* prior to the patient's arrival. The flat spatula tip should be used in the heating handle. Generally, initial setting can be made at 110 degrees. It is important to remember that this might require adjustment later (Figure 1).
- ☐ Apply petroleum jelly liberally to the buccal and lingual gingiva.
- ☐ Place two sheets of extra heavy rubber dam together and punch the smallest hole possible for each tooth to be bleached. Place the holes far enough apart to insure that gingival tissue will be adequately covered, protected, and retracted.
- ☐ Place both sheets of the dam, invert, and ligate

Dr. Helpin is Associate Professor, Department of Pediatric Dentistry, University of Mississippi, School of Dentistry.

* Union Broach Co. Long Island City, New York 11101.

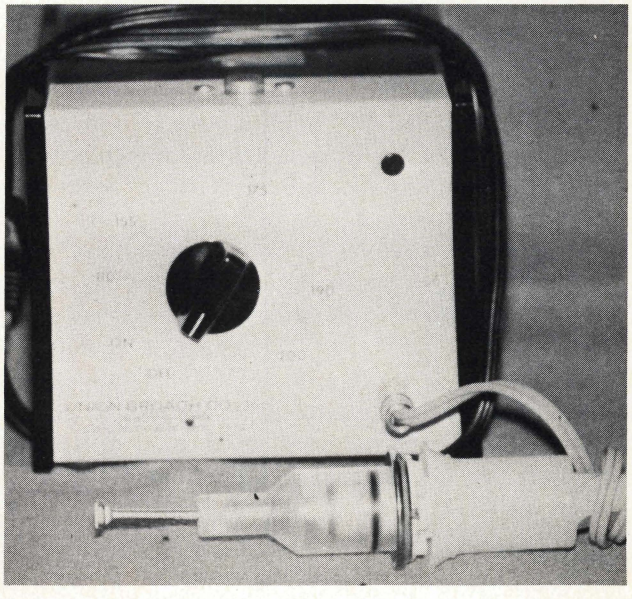

Figure 1.

securely with floss. Rubber dam clamps are not routinely used because they present a danger of leakage. Advise the patient that he should indicate if he feels any burning sensation on the gingiva, as this would indicate a leak in the dam. If the ligatures are long and extend beyond the limits of the rubber dam, they should be cut; this prevents any danger to the skin should the ligatures become saturated with the bleaching liquid.

- ☐ Use a firm slurry of flour of pumice to clean the stained margin. A slightly more abrasive stain-removing abrasive agent such as Prophy Prep† may also be used. The tooth should then be thoroughly rinsed.
- ☐ Because the bleaching medium is so irritating, the patient should be well-covered with a plastic drape or a heavy towel. Protective glasses should also be provided for the patient. Doctor and assistant should wear surgical gloves and safety glasses to protect themselves. Large cotton pellets should be soaked in the bleaching medium Superoxol†† (35 percent H_2O_2).
- ☐ A large, soaked pellet should be carried to the tooth with great care. Make certain that it is not passed across the patient's face. It is held in place with cotton pliers (Figure 2).
- ☐ When the pellet is pressed to place on the tooth, excess Superoxol is expressed. In order to avoid splattering the Superoxol, care should be taken not to vacuum the dam material itself, a procedure which is extremely difficult to do when a regular high-speed evacuation tip is utilized; we recommend, therefore, using a small surgical suction tip.
- ☐ The tip of the heating instrument is placed firmly on the cotton pellet and suction is repeated, if necessary. This pellet is held in place until it appears to be dry. The dry pellet should be replaced with a fresh Superoxol pellet; this usually is needed after one to two minutes.
- ☐ The patient is instructed to indicate whether he feels any heat on the tooth. If heat is noted, the thermostat on the bleaching tool should be lowered ten degrees at a time until the patient is comfortable.
- ☐ The application of heat to soaked pellets is continued up to thirty minutes. Evaluation of stain removal can be made periodically and the procedure stopped at any point. When bleaching is complete, the tooth and rubber dam should be irrigated copiously with water. The surgical suction is used initially; then the regular tip can be employed.
- ☐ The veneer is sealed as would normally be done after its initial placement.
- ☐ The rubber dam is removed.
- ☐ If only partial stain dissolution is achieved, the patient can be given an additional appointment for another bleaching session. If no improvement is noted, consideration must be given to a technique which is more destructive of the laminate.

Figure 2.

CASE REPORT

The patient is a forty-seven-year-old white female who was treated with laminate veneers in July, 1981. Over the following 3.5 years, she maintained them in excellent condition through a conscientious program of home care and regular follow-up visits with the dentist. Over a period of several months, she noted a stain developing at the incisal edge of the maxillary left lateral incisor. Home use of dilute hydrogen peroxide (3 percent) was unsuccessful in resolving the problem. On examination, the patient asked whether we could remove the stain, but without harming the veneer. It was suggested that bleaching might remove the stain and the procedure was explained to her. As seen in before and after photographs (Figures 3, 4), a single bleaching procedure was completely successful.

† The Louric Corporation, St. Louis, MO 63134.

†† Sultan Chemists, Inc., Englewood, N.J. 08631.

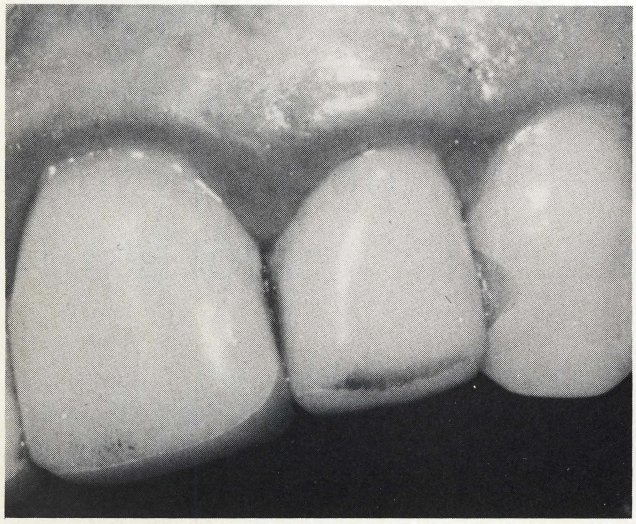

Figure 3. Reproduced in color on page 403.

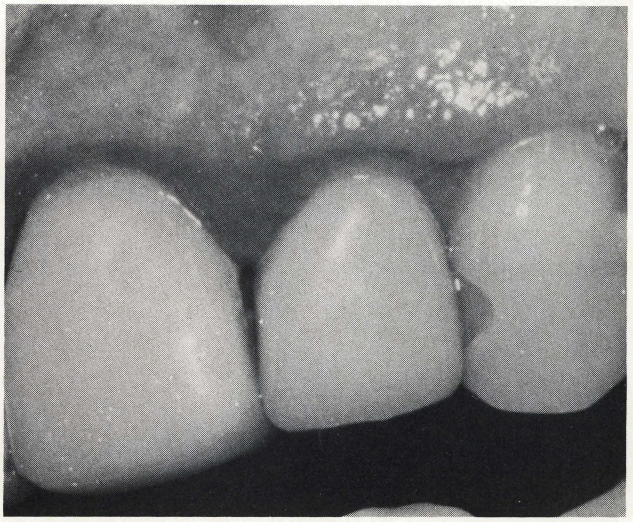

Figure 4. Reproduced in color on page 403.

CONCLUSION

A technique to remove stain from the margin of the laminate without compromising the veneer's integrity is described. This procedure is a simple way to maintain the esthetics which the patient and doctor desire.

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Fluoride

In vitro dissolution of human enamel after application of a mixture of stannous fluoride and amine fluoride 297: a pilot study

Fred Barbakow, BDS, HDD, MSc, (Med)
Felix Lutz, MD, DMD, PhD
Beatrice Sener, Snr Lab Assoc

Stannous fluoride (SnF_2) is frequently used clinically. Its ability to reduce caries incidence, growth of plaque and bacteria, and enamel dissolution rate has been well documented in clinical studies, in animal experiments and in laboratory tests.[1-4] One disadvantage of aqueous SnF_2 solutions is their instability, but SnF_2 can be stabilized by mixing with anhydrous glycerine at 150°C.[5] Aqueous amine fluoride 297 (AmF 297; N' -Octadecyltrimethyldiamine - N,N,N' - tris - (2-ethanol) -dihydrofluoride) also has excellent anticariogenic properties.[6-8] Recently, laboratory tests indicated that aged aqueous mixtures of SnF_2 and AmF 297 do not precipitate. In clinical studies, significant reductions of plaque growth, sulcus bleeding index and amount of sulcus fluid were reported.[9-11] The purpose of this *in vitro* pilot study was to determine the dissolution of enamel (measured by loss of phosphorus), the fluoride concentration, and the depth of etch, after the immersion of enamel specimens in an equimolar SnF_2/AmF 297 mixture containing 250 ppm F^-

MATERIALS AND METHODS

In this study, eighty enamel specimens were prepraed from twenty extracted human unerupted or partially

The authors are with the Dept. of Cariology, Periodontology and Preventive Dentistry, Dental Institute, Univesity of Zürich, 11 Plattenstrasse, CH-8028 Zürich, Switzerland. The authors thank their assistants, Misses. N. Rosenberger, L. Brandenberger, and U. Kuhn for their participation.

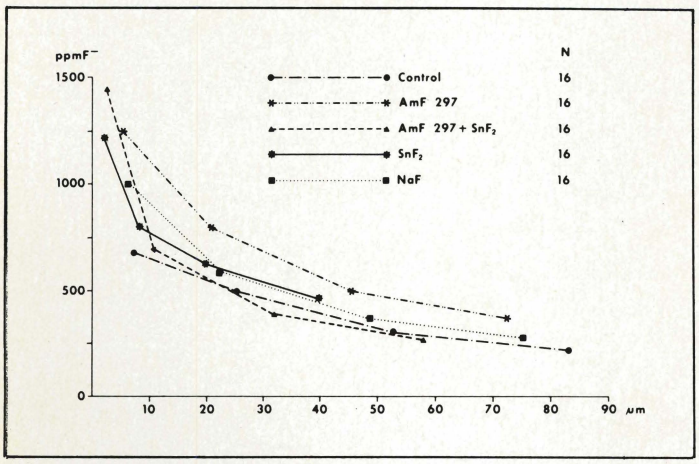

Figure. Profiles of enamel fluoride concentrations (ppm) to depths of etch (µm) for the five groups tested.

erupted third molar teeth. The teeth had been stored in a 0.1 percent thymol solution at 4°C before use. The enamel specimens were cleaned, using a rotating brush and an aqueous slurry of flour of pumice, washed with distilled water and stored in humid conditions (0.1 percent thymol), during the entire experiment. The enamel specimens were divided at random into five groups and immersed in 30 ml of the alloted test solutions (listed in Table 1), twice daily, for 2 min each time for ten days, at room temperature. After each immersion in the test solution, the enamel specimens were washed for 10 sec, using distilled water to remove any residual solution and unreacted fluoride, and stored in humid conditions. Only the aqueous SnF_2 solutions were freshly prepared immediately before use. The other fluoride-containing test solutions were aged, having been freshly mixed several weeks before use. After the ten-day immersion period, areas of enamel were selected by applying round adhesive scotch tape disks* with an inner window of 3 mm diameter onto the enamel, avoiding macroscopic cracks or hypoplastic areas. The rest of the specimen was covered with sticky wax† and the exposed window of enamel of each specimen was etched four times for 5, 10, 15, and 15 sec, respectively (total 45 sec) in four separate polyethylene tubes, each with 5 ml 2N HCL††. During the acid-etching, the enamel specimens were regularly agitated.

Fluoride concentrations were determined using the specific fluoride ion electrode.† The corresponding phosphate concentrations were determined colorimetrically‡‡ .[12,13] With these results, the amounts of phosphorous after the first 5 sec etch as well as the cumulative amounts of phosphorus in the three subsequent etches were calculated. Also the initial depth of etch and fluoride concentration after the 5 sec etch and the subsequent cumulative depths of etch and their fluoride concentrations for the three additional etches were calculated, using the following formula:

$$\text{Biopsy depth } (\mu m) = \frac{\text{Mass of dissolved enamel } (\mu g)}{\text{Density of enamel x etched area } (mm^2)}$$

A constant density of enamel of 3 g/ml, a calcium content of 38 percent and a phosphorus content of 18 percent throughout the etched areas were assumed.[14] The results were statistically analyzed during the One-Way Analysis of Variance Test accepting $P<0.01$ as being statistically significant.[15]

RESULTS

The amount of phosphorus in the first etched enamel layer and the cumulative amounts of phosphorus in the three subsequently etched layers, in each of the five groups, are shown in Table 2. The fluoride concentration of the first etched enamel layer and the cumulative fluoride concentrations of the three subsequently etched layers are listed in Table 3. Corresponding depths of etch for these fluoride concentrations are listed in Table 4. Statistical evaluations of the amounts of phosphorus, the fluoride concentrations and the depths of etch are listed in Tables 2, 3 and 4, respectively. Profiles of the enamel fluoride concentrations and depths of etch for the five groups tested are shown in the Figure.

* 3M Co., No. 471, St. Paul, MN, USA.
† Ruscher, Zurich, Switzerland.
†† Merck, Darmstadt, West Germany
‡ Orion Co., 906900, Cambridge, MA, USA.
‡‡ Hitachi 100-80, Boehringer - Mannheim, Zürich, Switzerland.

Table I ☐ List of solutions tested with their pH's and fluoride ion concentrations for 10 percent aqueous solutions (means of twenty samples).

	pH	ppm F^-
Control (distilled H_2O)	6.80	—
Amine fluoride 297	3.73	253
Amine fluoride 297 + SnF_2 (1:1)	3.98	239
SnF_2	3.38	259
NaF	4.13	255

Table 2 ☐ Mean (± SD) amount of phosphorus (μg) of the five groups dissolved from the first etched layer and the cumulative amounts from the second, third and fourth etched layers.

	N	Acid-etch 1	1+2*	1+2+3*	1+2+3+4*
Control	16	29.1 (2.7)	100.9 (6.7)	210.2 (14.3)	328.0 (22.0)
Amine fluoride 297	16	21.3 (4.1)	81.2 (13.0)	178.4 (21.0)	284.3 (28.3)
Amine fluoride 297 + SnF_2 (1:1)	16	9.3 (4.7)	42.0 (15.3)	124.6 (28.7)	228.1 (36.2)
SnF_2	16	8.0 (5.9)	30.4 (17.6)	77.3 (48.3)	152.0 (80.0)
NaF	16	24.6 (3.4)	88.0 (6.6)	188.0 (13.4)	295.8 (23.7)
$S_{\bar{x}}$		1.07	3.17	7.05	10.92
F		76.29	93.26	58.46	40.12
p		<0.001	<0.001	<0.001	<0.001
LDS* *	< 0.05	3.02	8.94	19.87	30.77
	< 0.01	4.01	11.86	26.36	40.83
	<0.001	5.19	15.37	34.17	52.91

* Cumulative
* *Least significant difference between two means

The cumulative amounts of phosphorus dissolved in the four layers of the specimens treated with the SnF_2/AmF 297 mixture or with SnF_2 alone were significantly less ($P<0.001$) than that of the other three groups. In the four layers, there were no differences in the amounts of phosphorus dissolved from the specimens treated with NaF and with AmF 297.

In the first etched layer, the enamel fluoride concentration with significantly higher ($P<0.01$) only for the group treated with the SnF_2/AmF 297 mixture compared to the control, with no differences in the enamel fluoride concentration between the other four groups. In the second, third, and fourth etched layers only the specimens treated with SnF_2 and AmF 297 alone had statistically increased enamel fluoride concentrations, compared to the other three groups.

In all four etched layers, the SnF_2/AmF 297 and the SnF_2 groups were significantly less ($P<0.001$) etched than the three other groups, with no differences in the etched depths of the first two layers between the specimens treated with the SnF_2/AmF 297 mixture or with SnF_2 alone. The depths of etch in the third and fourth layers were, however, significantly less ($P<0.001$) for the SnF_2-treated group, compared to the SnF_2/AmF 297-treated group. Depths of etch of the four layers were similar between the control groups and the NaF groups, and between the AmF 297 groups and NaF groups.

DISCUSSION

Clinically SnF_2 is frequently used as a topical gel or solution and as a mouthrinse. Aqueous solutions of SnF_2 are not stable and should ideally be freshly mixed before use. SnF_2 can, however, be stabilized by mixing with anhydrous glycerine.[16] Another method to prevent a precipitate from forming in an aqueous SnF_2 solution, is to mix SnF_2 with AmF 297.[9,10] Mixing the two solutions is a simple procedure and does not require heating or any other special techniques. In this pilot study, aged solutions of the SnF_2/AmF 297 mixture were applied to the enamel specimens. Unerupted or newly erupted third molars were used because they had only minimal or no exposure to topical fluorides. We are aware that washing with artificial saliva, water or KOH for 24 h or longer is required to remove all the CaF_2 and other products from the surface of fluoride-treated enamel. The short washing period used in this pilot study was intended to provide the most ideal basis to test initially the influence of the SnF_2/AmF 297 mixture on intact enamel, *in vitro*. The effects of SnF_2 on enamel solubility are well documented; but the possible effect that the AmF 297 might have on the SnF_2, when applied to enamel, are presently unknown.[3] In addition, because the fluoride concentration used was low (250 ppm; 0.025 percent F^-), a prolonged washing period might have masked any possible changes.

Distinct differences in the amount of phosphorus and in the depth of etch were found in the enamel specimens

Table 3 ☐ Mean (± SD) enamel fluoride concentration (ppm F^-) of the five groups in the first etched layer and the cumulative fluoride concentrations in the second, third and fourth etched layers.

	N		1	Acid-Etch 1+2*	1+2+3*	1+2+3+4*
Control	16		676 (302)	427 (191)	303 (164)	213 (97)
Amine fluoride 297	16		1268 (266)	792 (196)	498 (98)	367 (69)
Amine fluoride 297 + SnF_2 (1:1)	16		1447 (1215)	698 (368)	390 (173)	263 (118)
SnF_2	16		1211 (745)	802 (531)	622 (429)	457 (313)
NaF	16		1024 (357)	590 (192)	371 (126)	272 (100)
$S_{\bar{x}}$			170.30	81.29	57.62	41.23
F			2.96	3.71	4.71	5.60
P			<0.05	<0.01	<0.01	<0.001
LSD* *		< 0.05	480	229	162	116
		< 0.01	637	304	215	154
		<0.001	824	394	279	200

* Cumulative
* * Least significant difference between two means

Table 4 ☐ Mean (± SD) depth of etch (μm) of the five groups in the first etched layer and the cumulative depths of etch of the second, third and fourth etched layers.

	N		1	Acid-Etch 1+2*	1+2+3*	1+2+3+4*
Control	16		7.2 (0.8)	25.4 (1.8)	53.0 (3.4)	83.2 (5.4)
Amine fluoride 297	16		5.4 (1.1)	20.7 (3.3)	45.4 (5.4)	72.4 (7.2)
Amine fluoride 297 + SnF_2 (1:1)	16		2.6 (1.6)	10.7 (3.9)	31.7 (7.4)	58.1 (9.3)
SnF_2	16		2.2 (1.4)	7.9 (4.4)	19.9 (12.2)	39.5 (19.9)
NaF	16		6.3 (0.9)	22.4 (1.7)	47.8 (3.4)	75.3 (6.0)
$S_{\bar{x}}$			0.29	0.81	1.78	2.74
F			58.87	90.03	57.54	39.56
P			<0.001	<0.001	<0.001	<0.001
LSD* *		<0.05	0.82	2.28	5.03	7.72
		<0.01	1.09	3.02	6.67	10.24
		<0.001	1.41	3.91	8.65	13.27

* Cumulative
* * Least significant difference between two means

treated with SnF_2 alone or mixed with AmF 297, compared to the three other groups. Under the conditions of this study, it appears as though the SnF_2/AmF 297 mixture produced a similar effect on the surface of the enamel as did the SnF_2 alone, indicating that the enamel appears to react with the stannous ions of the SnF_2 before it does with the AmF 297. After etching the surface, however, the acid dissolved more enamel from the specimens treated with the SnF_2/AmF 297 mixture than from those treated with SnF_2 alone, at the same time intervals.

When evaluating the enamel fluoride concentrations after the various topical applications, particular note must be taken of the variations in the depths of etch. The differences in the enamel fluoride concentrations in this study were strictly dependent on the depths of etch. Profiles of the enamel fluoride concentration to depths of etch (Figure 1) show that the enamel specimens topically treated with SnF_2/AmF 297 and with SnF_2 alone were less etched than the three other groups. One could then speculate that the enamel fluoride concentration in the specimens treated with the SnF_2/AmF 297 mixture or with SnF_2 alone were not significantly increased compared to that of the controls at similar depths of etch. Previous *in vitro* and *in vivo* studies have shown that AmF 297 induced higher enamel fluoride concentrations than the inorganic fluoride salts following topical application when using various fluoride concentrations.[8,19,20] Other authors, on the other hand, have reported that the enamel fluoride concentration was not increased after SnF_2 application; but some have reported variable enamel fluoride concentrations after applying APF and SnF_2 sequentially or mixed, and found that the enamel fluoride uptake was dependent on the concentration of the SnF_2.[6,17,21-26] The latter is an interesting finding and is not quite in agreement with the findings of the present study, in which a single SnF_2 concentration was used, and which was lower than that used by Crall *et al* (1982) and by Crall and Bjerga (1984).[25,26] Further studies are required to clarify the differences.

The enamel fluoride concentrations of the specimens treated with AmF 297 alone and with NaF were similar, probably because of the similar low fluoride concentrations and the similar pH values of the test solutions, and because of the short water-washing period. With longer washing periods, differences in enamel fluoride concentrations between these two groups might have been shown. Studies are in progress to evaluate *in vitro* changes on enamel treated with the SnF_2/AmF 297 mixture after longer washing periods and after brushing. As it is known that various types of tin-fluoro-phosphate complexes form on enamel treated with SnF_2, it would be interesting to examine the products formed on enamel treated with the SnF_2/AmF 297 mixture, and to assess the surface morphology and chemical composition of the surface reaction products after the SnF_2/AmF 297 application.[27,28]

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TMJ AND ADULT ORTHODONTICS

More and more orthodontists are entering the field of adult orthodontics. At present, more than 20% of orthodontic patients in the United States are adults (Bohannan, 1982). Temporomandibular orthopedics is basic to all occlusal therapy, especially as it affects the emerging standards of adult orthodontics. In this multiprofessional effort, orthodontists have the opportunity to contribute much to an area currently dominated by a prosthetic bias.

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Lea & Febiger, 1985, p 149.

The effect of a fluoride dentifrice containing an anticalculus agent on dental caries in children

K.H. Lu, PhD
D.J. C. Yen, DDS
W.A. Zacherl, DDS
C.D. Ruhlman, DDS
O.P. Sturzenberger, DDS
R.W. Lehnhoff, BS

In the literature, only limited information is available on the rate of caries attack in Taiwanese children over the span of the last decade. Two reports on field dental surveys were issued in 1979. One of these was conducted as a comparison of a fluoridated water area with a nonfluoride area.[1] While the six-year fluoridation was considered of benefit, it was concluded that the caries rates had increased, in spite of fluoridation. At that time, however, the Decayed, Missing, Filled (DMF) rate in Chinese children was considered lower than in Caucasians. The other report is from a National Dental Survey in a large population sample from three main cities and villages. Here it was concluded that the "prevalence of dental caries was markedly low."[2] In addition, fillings in permanent teeth were uncommon. As for oral hygiene, it was stated that there was a relatively small portion of people with good oral hygiene. In a later survey by Lan the status of carious teeth was listed as 1.89 - 3.74 Decayed, Missing and Filled Teeth (DMFT) for grade schools and as 3.71 - 5.03 DMFT for high schools.[3] In 1983, our own cursory inspection of approximately 100 children in six Taiwanese public schools confirmed that caries was relatively frequent in children, eight to thirteen years old. It appeared similar to the caries rates found in the USA, twenty-five to thirty years ago. According to our observations, the consumption of sugar in food and beverages is very high. This agrees with a statement by Hsieh who related the sugar consumption to the rising level of the economy in Taiwan.[1]

There is no general water fluoridation in the metropolitan area of Taipei. Although dentifrices are available, our pretrial observations of the intended population sample made it clear that toothbrushing with a dentifrice was infrequent at best.

The purpose of this study was to evaluate clinically the anticaries effect of a sodium fluoride dentifrice with 1100 ppm fluoride.* Since it also contained a mixture of soluble pyrophosphates (crystal-growth inhibitors, that provide an anticalculus benefit) a simultaneous testing against dental calculus was of interest in a population that appears equally suitable for caries and calculus investigations.[4] The calculus investigation will be the subject of a separate report.

Dr. Lu is Professor of Biostatistics, Oregon Health Sciences University, Portland, OR 97201. Dr. Yen was Associate Professor, Taipei Medical College, Taiwan, R.O.C. He is now a consultant to the V.A. Hospital, Taipei. Dr. Zacherl is Professor of Dentistry, Ohio State University, Columbus, OH 43210. Dr. Ruhlman is Professor of Research, Oregon Health Sciences University, Portland, OR 97201. Dr. Sturzenberger is Senior Dentist, Procter & Gamble Co., Cincinnati, OH 45241. Mr. Lehnhoff is Section Head Clinical Operations and Biometrics, Procter & Gamble Co., Cincinnati, OH 45241.

*Crest Tarter Control Formula, Procter & Gamble Company, Cincinnati, Ohio.

MATERIALS AND METHODS

Nearly 1500 children in an age-range of eight to fifteen years were recruited from two public schools in Taipei, Taiwan, ROC, as subjects for a one-year caries and calculus study. The necessary parental consent forms and the permission from authorities were obtained. Since toothbrushing was not commonly practiced in this population, arrangements were made with the school administrations to permit supervised toothbrushing twice per school day from Monday through Friday, and once on Saturday.

Under field conditions, subjects were examined for dental caries at baseline and again after one year of dentifrice use according to the criteria described by Radike.[5] This was done by two experienced clinical examiners (W.A.Z. and C.D.R.) who saw each subject. They used fiber optic illumination, mouth mirrors and new dental explorers of their choice. Subjects were requested to brush with a nonfluoride dentifrice prior to the caries examination to present a clean field to the examiners. Compressed air was available to dry the teeth. A seven-film bitewing radiographic series was taken for each child. To make a set of radiographs available to the child's dentist, if desired, double film packets of Kodak E film were used. The radiographic diagnosis was added later to the visual-tactile caries scores.

Although the test dentifrice was tested in adults without any adverse effects, it was important to determine that this product is equally well tolerated by children.[6] A methodical examination of the peri-oral area and the oral cavity, therefore, was conducted at baseline and again after six and twelve months, by an oral pathologist. Of special interest were soft-tissue lesions, e.g. desquamation, erythema, edema and ulceration, that could possibly be associated with a treatment-related tissue irritation.

The caries scoring was recorded on forms that are suitable for computer processing. The location and severity of soft-tissue lesions were recorded on other forms.

Following the baseline examination, the subjects were separated by sex, intervals of age, and stratified by intervals of visual-tactile caries scores as diagnosed by examiner 1. Within strata, subjects were assigned to dentifrice groups by random permutations of two. Siblings were assigned to the same dentifrice. The examiners were not aware of the identity of the dentifrices assigned to any given subject nor were the subjects. The study, therefore, was of double-blind design.

Following the initial assignment of subjects to treatment groups, the investigator was provided with a file of sealed envelopes, one for each subject, so that he could determine, if necessary, the treatment assigned to an individual subject during the study without breaking the double-blind nature of the study for the remainder of the subjects. This file also served the investigator in verifying the treatment assignments at the completion of the study.

Assignment procedures were handled by representatives of the investigator, site personnel and the sponsor of the study.

On school days the subjects were provided with their assigned dentifrices in the classrooms. Classroom teachers provided supervision of the application of the toothpaste to the brushes and the brushings for one minute each. The quantity of the toothpaste used for each brushing was a ribbon equal to the length of the brush head. At the initiation of the study the students were instructed in efficient toothbrushing. Adequate quantities of the assigned dentifrice and soft toothbrushes were given to each subject for use at home, over weekends and holidays. Twice-per-day toothbrushing with the dentifrice was emphasized by oral instructions and the instructions were also printed on the tube labels. Supplies were monitored and replenished as needed.

The toothpaste was packed in plain white 5 oz.-tubes that were uniquely numbered. After assignment, the student's name was affixed to the tube, in the English and Chinese languages. The test and control dentifrices were identical in taste and appearance. Both dentifrices

Table 1 ☐ Balance of subject groups.

		Examiner 1						
					Sex	Age	Initial DMFS*	
		N	M	F	$\bar{\chi}$	Range	$\bar{\chi}$	S.E.M.**
Subjects starting study	Control	727	346	381	10.42	8-15	16.16	0.44
	Test	712	352	360	10.40	8-15	15.74	0.45
Subjects completing 1 year	Control	573	256	317	10.13	8-15	15.25	0.48
	Test	587	276	311	10.14	8-14	14.88	0.48
		Examiner 2						
					Sex	Age	Initial DMFS*	
		N	M	F	$\bar{\chi}$	Range	$\bar{\chi}$	S.E.M.**
Subjects starting study	Control	723	342	381	10.42	8-15	13.20	0.41
	Test	708	351	357	10.39	8-15	12.75	0.39
Subjects completing 1 year	Control	571	255	316	10.11	8-15	12.60	0.44
	Test	585	278	307	10.14	8-14	12.03	0.40

**Standard errors of the means.
*Decayed, Missing and Filled Surfaces.

Table 2 ☐ One-year DMFS* results.

	Examiner 1				
	N	$\bar{\chi}$	S.E.M.**	%Red.	Prob.
Control	573	3.78	0.24	—	—
Test	587	2.80	0.24	25.9%	0.0020
	Examiner 2				
	N	$\bar{\chi}$	S.E.M.**	%Red	Prob.
Control	571	1.22	0.15	—	—
Test	585	0.59	0.16	51.6%	0.0022

**Standard errors of the means
*Decayed, Missing and Filled Surfaces

were formulated with silica abrasive. The test formula contained 0.243 percent fluoride (1100 ppm F^-), an agent effective against dental caries, and soluble pyrophosphates, agents effective against calculus formation. The control dentifrice contained neither of these ingredients.

In the analyses of the data, statements of significance for caries are based on the normal deviate test and are corroborated by analyses of covariance as described by Grainger *et al.*[7] A one-tailed test of significance was applied to the results.

RESULTS AND DISCUSSION

After one year of dentifrice use, 1160 children were available for caries examination by the two examiners. The initial and one-year group balances are shown in Table 1. The table shows that the baseline assignment of subjects to treatments resulted in comparably balanced groups with reference to numbers of subjects, their age, ratio of males to females, and mean initial Decayed, Missing and Filled Surfaces (DMFS).

The loss of 279 subjects during the study occurred because of the transfer of children to other schools, unavailability for the final examination, and failure to comply with the treatment regimen.

Table 2 is a summary of the one-year caries results for both experienced examiners. Both examiners examined independently and used the same standard criteria. Their approach and their interpretation of the findings, however, may have varied, which is not unusual.[8,9] The differences in mean DMFS increments for examiner 1 represent a caries reduction of 26 percent over one year of treatment with the fluoride dentifrice. For examiner 2, the reduction was 52 percent. The differences between groups for both examiners are statistically significant (α 0.05). The average reduction in new carious surfaces for the two examiners was 39 percent.

In regard to the results of the soft-tissue examinations, there were no significant differences in the total numbers of pathoses or the kind of pathoses observed in the test or control groups. This indicates that both dentifrices were equally well tolerated on the oral mucosae. As a matter of fact, across both groups there was a general improvement of oral soft-tissue health. At the final examination, a larger proportion of all subjects was without soft-tissue pathoses as compared to the baseline status. Thus, nearly 90 percent of the test population was considered "clinically normal", which is attributed to a better oral hygiene through supervised brushing.

In conclusion, it can be stated that the sodium fluoride dentifrice containing an anticalculus agent produced a notable benefit in this caries-prone population. The test dentifrice was as well tolerated as the control dentifrice.

This investigation was supported by a grant from the Procter & Gamble Company, Cincinnati, Ohio. The authors express their appreciation for the assistance of Mr. B.W. Bollmer of The Procter & Gamble Company in the design of the study and analyses of the data. We are grateful for the assessment of oral morbidity by Dr. C.F. Huang, Taipai Medical College, Taiwan, ROC, and the diligent cooperators of that institution.

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Case reports

Chin trauma as a cause of primary molar fracture: report of case

Sabine C. Maréchaux, DDS

According to Andreasen, traumatic injuries to the primary maxillary incisors account for 86.5 percent of the accidents occurring in preschool children, while only 0.5 percent of injuries occur with primary molars.[1] Case reports of multiple accidental fractures of primary molars have been reported by Suher *et al* and Needleman *et al.*[2,3] Both authors state that the child had fallen on his chin and that the chin wound was the first to be treated. Only subsequently, because of the symptoms of pain with mastication, did the parents consult a dentist. Kennedy described the case of a mandibular second primary molar which, as a result of injury, seven months prior to consultation, caused lateral facial swelling and formation of a fistula, due to a nonvital pulp with interradicular periodontitis.[4]

CASE REPORT

In October 1984, the Geneva Pediatric Hospital referred a boy aged 8.5 years to the Pedodontic Clinic of the University of Geneva Dental School. The patient had fallen on his chin, while climbing a wall that morning. During the treatment of the injury to his chin, he complained of "painful teeth". Family and medical history were noncontributory and clinical examination revealed only a deep gash on his chin, which had been sutured. Oral examination showed an Angle class I occlusal relationship in the first stage of the caries-free

Dr. Maréchaux is Head of the Pedodontie Clinic, University of Geneva Dental School, Switzerland.

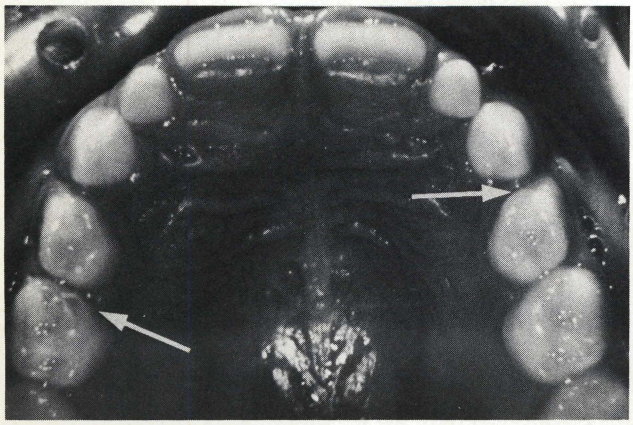

Figure 1. Maxillary occlusal view indicating the mesial enamel fracture of the maxillary right second primary molar and the maxillary left first primary molar (arrows).

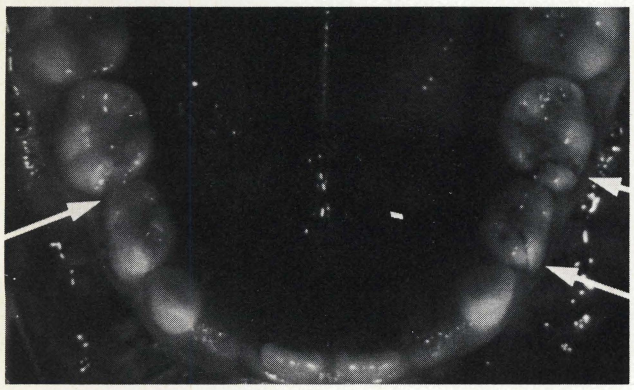

Figure 2. Mandibular occlusal view with arrows indicating the fractures of the mandibular left first primary molar, the mandibular left second primary molar, and the mandibular right second primary molar.

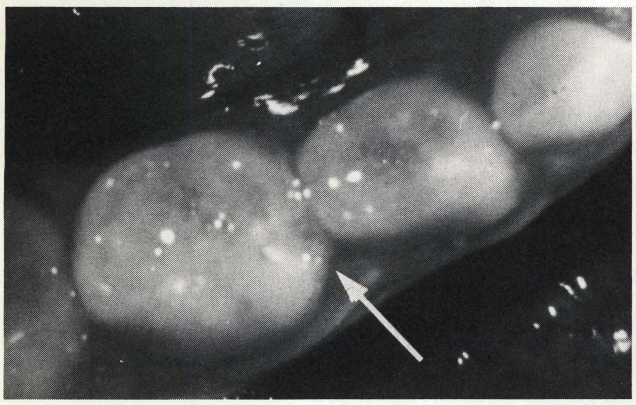

Figure 3. A close-up view of the mesial enamel fracture of the mandibular right second molar (arrow).

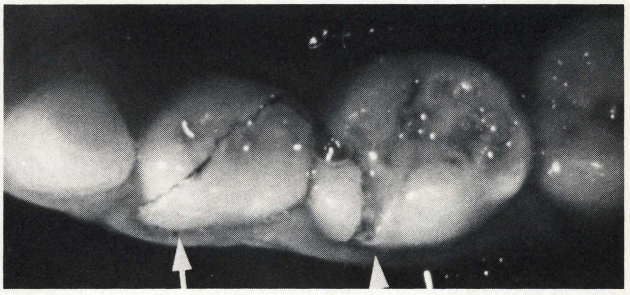

Figure 4. A close-up view of the buccolingual fracture of the mandibular left first primary molar and mesial enamel-dentin fracture of the mandibular left second primary molar (arrows).

mixed dentition. Fracture of the enamel only was noted on the mesial of the maxillary right second molar, the maxillary left first primary molar (Figure 1) and the mandibular left second primary molar (Figures 2, 3). The mandibular left second primary molar showed a mesiobuccal fracture of enamel and dentin and the mandibular left first primary molar, a buccolingual transversal fracture exposing the pulp (Figures 2, 4). Bitewing radiographs (Figure 5) and one apical film were taken of the mandibular left first primary molar and the man-

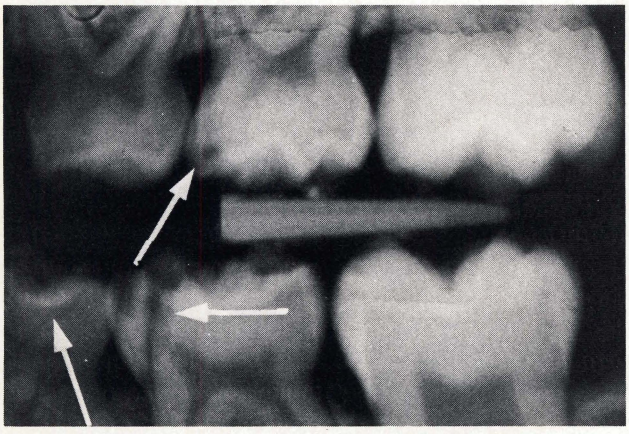

Figure 5. Left bitewing radiographs with arrows indicating the fracture lines of the maxillary left second primary molar, the mandibular left first primary molar and the mandibular left second primary molar.

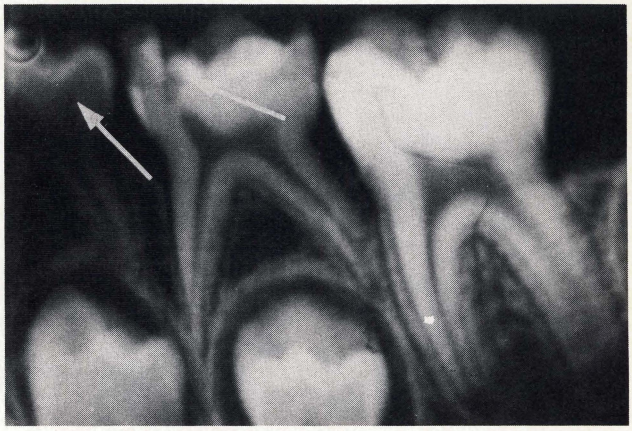

Figure 6. An apical radiograph of the mandibular left first primary molar and the mandibular left secondary primary molar indicating crown fracture lines only.

dibular left second primary molar (Figure 6).

Under local anesthesia, pulpotomy was performed on the mandibular left second primary molar; and the manduiblar left first primary molar was extracted, because of its extensive fracture. The maxillary right second primary molar, the maxillary left first primary molar and the mandibular right second primary molar were treated with a topical fluoride varnish.

The patient chose to return to his family dentist for the follow-up treatment.

CONCLUSIONS

While the maxillary incisors are most prone to accidental injury, it should be noted that the primary molars can also fracture, if a severe blow is received on the chin. Sometimes the fracture remains undiagnosed and the only symptoms are pain on mastication, especially in lateral excursions. Needleman states that one can use a disclosing solution to disclose the fracture line; and thus facilitate the determination of the extent of the injury to the teeth and the nature of the treatment.

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ANTIFLUORIDATION STRATEGY

The anti-fluoridation activists have a clear strategy. They are not concerned with drawing conclusions from data, but use data to create an aura of scientific controversy. Simply refuting the anti-fluoridationist's arguments plays into their hands by highlighting the "debate". It is important, instead, to emphasize the positive, to stress the fact that this is not an area of unsettled controversy but rather a matter that has been well studied and in which conclusions regarding safety and efficacy are clear. Moreover, it is important to emphasize that *failure* to fluoridate carries a certainty of increased dental caries such that the caution factor works in both directions.

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Am J Pub Health, 75:888-891, August, 1985.

Autogenous third molar transplantation: report of case

Mario E. Saravia, DDS, MEd
Louis G. Mercuri, DDS, MS
Arthur P. Mourino, DDS, MSD

The autogenous transplantation of teeth has proven to be effective, especially for the purpose of replacing severely decayed first molars by third molars. The proper timing of transplantation is essential for success. The guidelines established three decades ago for a successful prognosis still hold true. The third molar tooth bud should be developed at least to the bifurcation, with three to eight millimeters of root length radiographically evident.[1,2] Meticulous oral hygiene in the area of transplantation is essential to promote and maintain proper healing. The absence of chronic periapical morbidity at the recipient site is a strict requirement for success.

Although some authors report the use of adjunctive antibiotic therapy either previous to, in conjunction with, or following the surgical procedure, the use of antibiotics to minimize postoperative infection has not been firmly established.[3,4] Likewise, the method and the amount of time required for the stabilization of the transplanted tooth are controversial. Ligature wires, acrylic splints, silk sutures, periodontal packs and acid-etch techniques have all been used or recommended.[3-5] Recommendations for splinting time range from one to eight weeks.[1,5]

Postoperative complications related to the transplanted tooth vary. Some authors report devitalization, periapical morbidity, external root resorption, internal resorption, ankylosis, cessation of root development, and calcific metamorphosis.[3,5-9] The length of time a transplanted tooth will remain as a functional component of the dentition is also variable, with some being retained for as long as twenty years.

This report describes the autogenous transplantation of a developing third molar tooth into a first molar extraction (recipient) site, including a twenty-one month follow-up period.

REPORT OF CASE

A fifteen-year-old white female was seen at the Pediatric Dental Clinic of the Virginia Commonwealth University School of Dentistry, in August of 1982, with a complaint of "discolored teeth". The patient had received minimal previous dental treatment and the medical history was noncontributory. Clinical examination revealed a full complement of erupted permanent teeth, with the exception of all third molars (Figure 1). There was slight to moderate carious involvement of all posterior teeth, excepting the lower left first molar which was severely decayed (Figure 2). The only anomaly of note was some mild enamel hypoplasia of the upper anterior teeth, which was the patient's chief complaint. No soft tissue abnormalities or morbidity were noted.

Since the patient had to travel a great distance (three

Drs. Saravia and Mourino are with the Department of Pediatric Dentistry and Dr. Mercuri is with the Department of Oral Surgery, Medical College of Virginia, Virginia Commonwealth University, School of Dentistry.

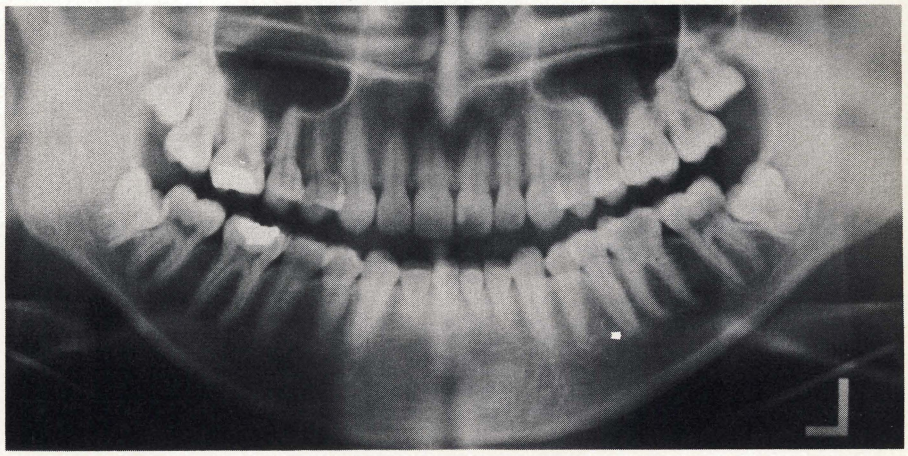

Figure 1. Panoramic radiograph of patient at initial visit.

hours in each direction), it was decided to perform all the restorative work in two appointments. All the posterior teeth were treated with amalgam restorations, with the exception of the lower left first molar. This tooth was treated by indirect pulp therapy using a calcium hydroxide base (Dycal) followed by placement of a temporary intermediate restoration (IRM).

Twenty-four hours after the indirect pulp therapy procedure, the patient presented with severe pain in the area of the lower left first molar. The pain kept her awake all night. The indirect pulp therapy procedure proved unsuccessful, and the pulp was subsequently extirpated. All further treatment options were explained to the patient and her mother, including the option of extraction of this molar and replacement with the sound third molar tooth. Patient and mother opted for the transplant procedure, and an appointment was made to perform the transplant a week later. Preoperative radiographs were used to determine the feasibility of the operation. Mesiodistal measurements of the tooth bud and first molar were made and compared; the root length of the donor tooth was also determined. There was no radiographic evidence of periapical morbidity at the donor site.

The patient was sedated with 10 mg of Diazepam given intravenously and 40 percent nitrous oxide. Inferior alveolar and lingual nerve anesthesia and buccal infiltration were accomplished with 3cc of 2 percent xylocaine with 1:100,000 epinephrine. The first molar was initially luxated and elevated within the socket, without removing it completely. A mucoperiosteal flap was reflected adjacent to the donor third molar site, the area irrigated, and the tooth exposed to view. A small overhanging shelf of bone covering the distal aspect of the tooth was removed with a surgical bur and handpiece. This allowed complete accessibility to the tooth and thus making its removal as atraumatic as possible. Using a straight elevator, the third molar was gently loosened within its socket. The first molar was then carefully extracted from its socket and the alveolar bone was kept intact. The third molar was gently removed from its socket and immediately placed into the recipient site.

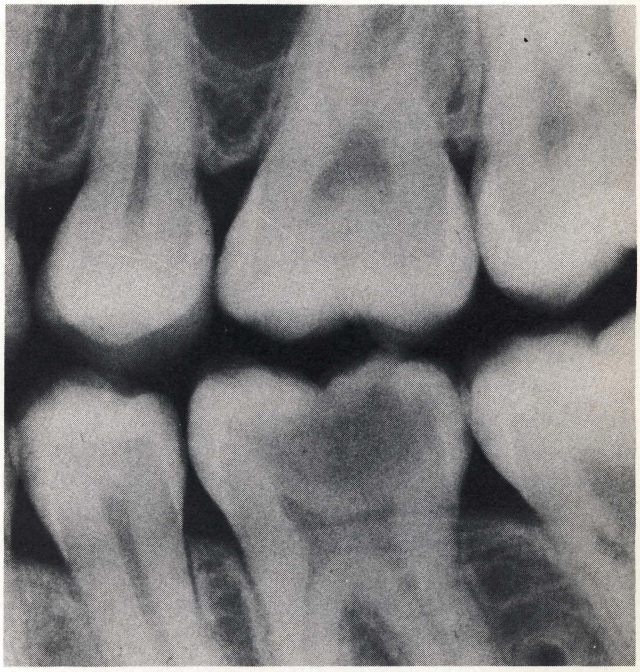

Figure 2. Severely decayed left mandibular first molar.

Since the mesiodistal widths of the first and third molars were compatible, no alterations of the proximal surfaces of either of the adjacent teeth or of the donor

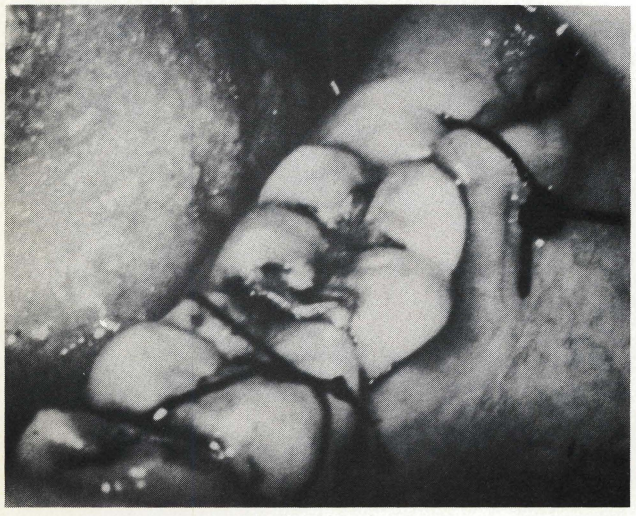

Figure 3. Transplanted tooth immediately postsurgery, sutured in place.

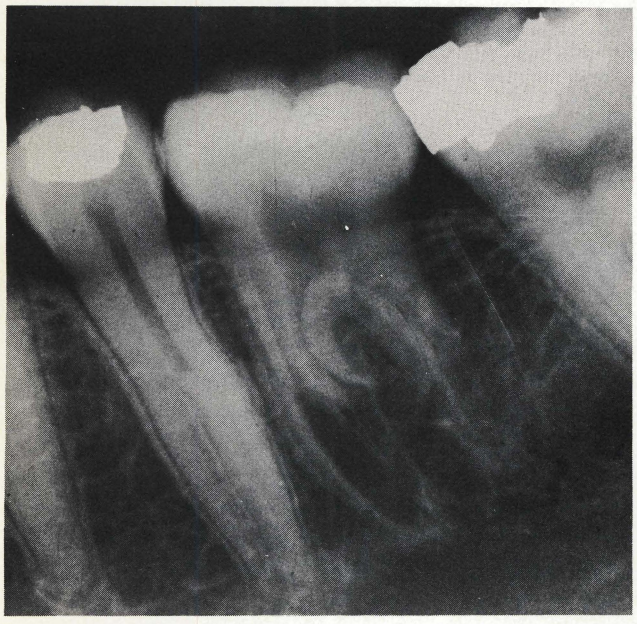

Figure 4. Periapical radiograph of transplanted tooth, immediate postoperative.

were necessary. The third molar was placed in the socket and kept out of occlusion in order to minimize traumatic occlusal stresses. The donor site was closed with 3-0 silk sutures. The necessity for stabilization was minimal because of the tight contact with the adjacent teeth. Stabilization was accomplished by interproximal contact and 3-0 silk sutures placed over the occlusal surface of the donor tooth (Figure 3).

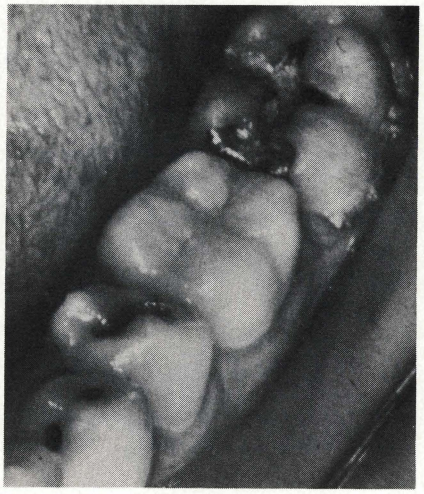

Figure 5. Transplanted tooth, twenty-one months postsurgery.

A periapical radiograph was taken to assure proper placement of the donor tooth (Figure 4). Standard postoperative instructions were given to the patient. The patient was placed on a soft diet, and instructed to chew on the opposite side of the mouth. Oral hygiene was stressed, especially at the surgical site.

RESULTS

The patient returned one week postoperatively for suture removal. Healing was normal and uneventful. The transplanted tooth was slightly mobile and it was not in occlusion. A periapical radiograph revealed the donor tooth to be in good position within the recipient socket.

The patient was recalled every three months for a year. During the follow-up visits the occlusion was adjusted as the tooth erupted, so that it was maintained with minimal occlusal trauma. The tooth was tested for vitality (positive vitality noted) and the mobility checked. At the second recall (six months) the root formation had progressed to an acceptable length and the tooth was allowed to come into occlusion.

Twenty-one months postsurgery, the tooth was found to be in good occlusion with slight physiologic mobility (Figure 5). Pulp-testing indicated that the tooth was still vital. A radiograph showed continued growth with apical closure of the mesial root and further growth of the

distal root (Figure 6). There was also some decrease in the size of the pulp chamber.

SUMMARY

This case reports the surgical autogenous transplant of a third molar into a first molar recipient site. No antiobiotic therapy was prescribed. Mechanical stabilization was minimal, because most of the splinting was provided by the adjacent teeth. Twenty-one months postoperatively, the tooth exhibited normal growth and absence of morbidity. The only abnormality was a decrease in the size of the pulp chamber.

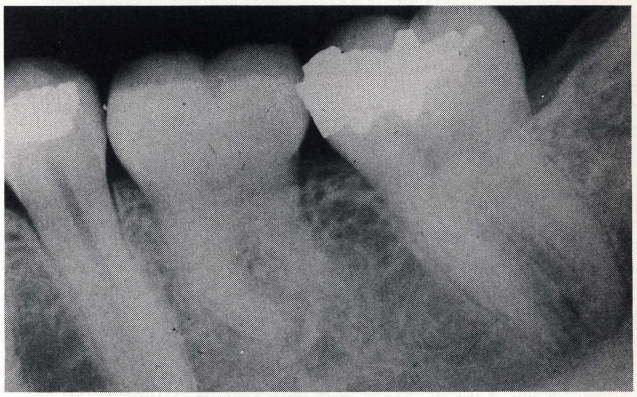

Figure 6. Periapical radiograph, twenty-one months postsurgery.

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TMJ SYMPTOMS IN CHILDREN AND ADOLESCENTS

The results of a variety of well-designed epidemiologic studies on children with TMJ symptoms recently were published. Egermark-Eriksson and colleagues (1981) found nearly as many subjective complaints in children 7, 11, and 15 years old as in young adults (Solberg, Woo, and Houston, 1979). Similar levels of subjective symptoms in children were found by Nilner (1981a, b).

As with adults, the most common signs were TMJ sounds and muscle tenderness. Recurrent headache appears to be as common with children as with adults and is most prevalent in 15-year-old girls (Egermark-Eriksson, Carlsson, and Ingervall, 1981). When clinical signs were graded by the clinical dysfunction index (Helkimo, 1974a, b), severe dysfunction was attributed to children only occasionally, but mild and moderate dysfunction were common. All grades of dysfunction increased significantly with age (Egermark-Eriksson, Carlsson, and Ingervall, 1981). Correlations between oral parafunctions and the dysfunction index (Egermark-Eriksson, et al., 1981), and, specifically, tenderness (Nilner, 1981a, b) suggest that children who brux are at greater risk of developing symptoms.

Johnston, Jr. L.E.: New vistas in orthodontics. Philadelphia: Lea & Febiger, 1985, p 151.

Fused primary teeth: a documented familial report of case

F. Thomas Hagman, DDS

Fused teeth are seen more often in the primary dentition than in the permanent dentition.[1-5] To date, only Levitas has reported cases of fusion in the primary dentition, where the term "fused teeth"was clearly defined.[6] Most reports of surveys of fused teeth have combined them with geminated teeth, sometimes using the term "double formation"; in other reports, the term "fused teeth" has been used, but not defined.

Fusion is defined as two teeth with a union between the dentin and/or enamel of two or more separate developing teeth.[4] Geminated teeth develop from a single dental sac which attempts to replicate itself.[4,6] Fusion, or synodontia, may be differentiated from gemination by simply accounting for the number of teeth. Where fusion is suspected there should be less teeth than normally expected for a given dental age, because the bifid crown is counted as one tooth. Fusion with a supernumerary tooth would be, of course, an exception to this rule. We should be reminded that hyperdontia has a predilection for the maxillary dentition and fusion occurs most frequently in the anterior segment of the mandible.[2,7,8]

Heredity seems to be a factor in fused teeth. Moody

Dr. Hagman is Assistant Professor Pediatric Dentistry, College of Dentistry, The Ohio State University.

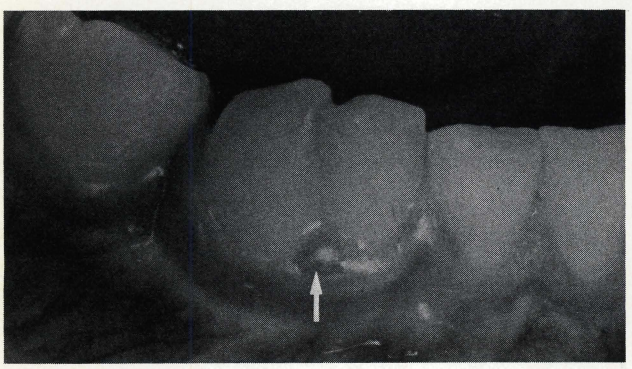


Figure 1. Fusion of the lower right primary canine and lateral incisor (P.J., male).

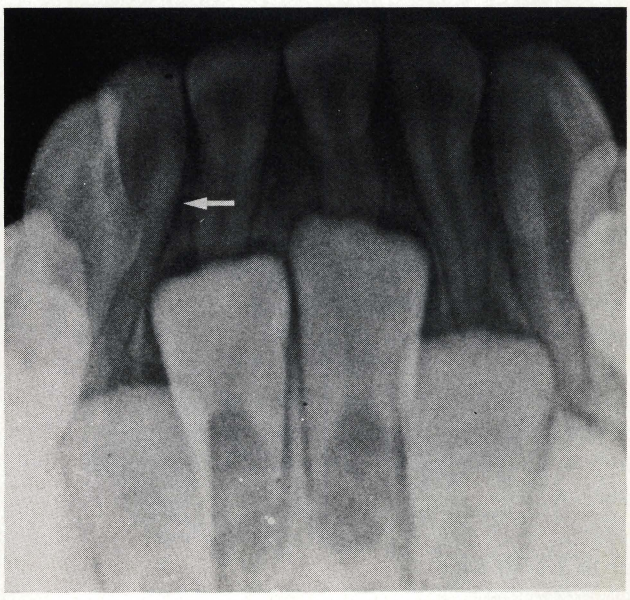
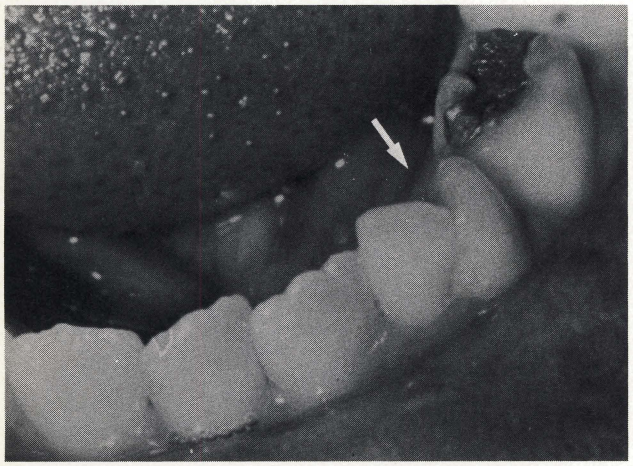


Figure 2. Showing presence of the lower right permanent lateral incisor (P.J., male).

Figure 3. Showing fusion of the lower left primary canine and lateral incisor (M.G., female).



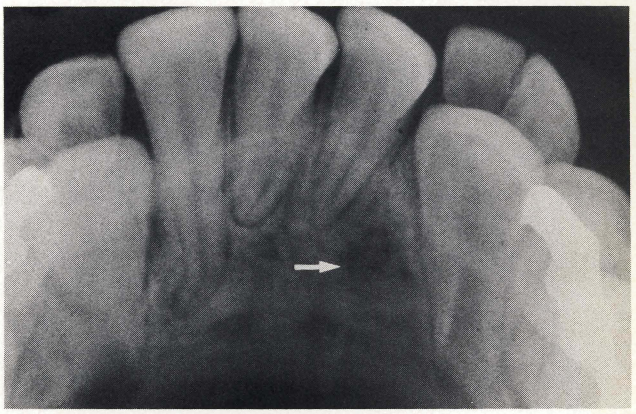


Figure 4. Showing aplasia of the lower left permanent lateral incisor (M.G., female).

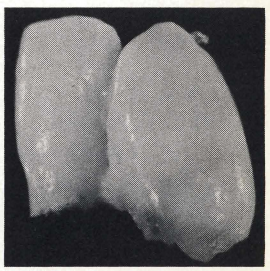


Figure 5. Showing exfoliated lower left primary canine and lateral incisor (M.G., female).

and Montgomery demonstrated familial disposition in three pedigrees in which the affected individuals were all females.[9] Grahnen and Granath demonstrated three of eight siblings (two female and one male) with double formations.[2] Niswander and Sujaku reported a high incidence of fusion (2.5 percent) among Japanese children in the primary dentition.[10] About a half of these children were offspring of biologically related parents. Levitas reported two sisters with dental fusions.[6]

CASE REPORT

Two of five children in this family have fused teeth: P.J. (male) age four with fusion of the lower right primary lateral incisor and canine (Figures 1, 2) and M.G. (female) age seven with fusion of the lower left primary lateral incisor and canine (Figures 3, 4, 5). Aplasia of the permanent lateral incisor is evident in the case of M.G. (female) from radiographic examination; P.G. (male) shows no evidence of aplasia radiographically. Nothing in the medical and dental histories of these two children appears to be significantly related to the dental anomaly.

DISCUSSION

To date, only one case of fused teeth, as defined, in siblings has been reported.[6] It would be of great benefit, if future studies or reports would be more specific in terms of location, teeth involved, sex, aplasia of succedaneous teeth, familial relation, and definition of terms, when describing "bifid" crowns.

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Papillon-Lefevre syndrome: report of case

Hemant Narendra Joshi, BDS
Promod Kumar Dayal, MDS
Parimal Jinabhai Kansagra

Papillon and Lefevre in 1924 reported a syndrome consisting of hyperkeratosis palmoplantaris and periodontoclasia.[1] The main manifestations of the Papillon-Lefevre syndrome are the hyperkeratosis of palms and soles, usually appearing during childhood between one and four years of age, and, simultaneously, a periodontal involvement of the primary teeth. This syndrome is a rare disorder and is estimated to have an incidence of one case per million population.[2] By 1969, fifty-five cases were reported. Naik *et al*, in 1968, reported the first case from India and since then, approximately ten cases have been reported.[3-8]

CASE REPORT

An eleven-year-old girl visited the Government Dental College and Hospital, Ahmedabad, with a complaint of tooth mobility and exfoliation, since the age of four years. She related that her primary teeth first became loose and then exfoliated. Prior to exfoliation the gum would swell with pain and redness. After exfoliation, the gum tissues became normal. Simultaneously, she felt roughness on the skin of the palms of her hands and the soles of her feet. After some time crustations and fissuring appeared on them. In addition, the skin of her elbow and knee joints showed signs of suppuration. The skin trouble did not subside, showing regression during the summer and progression in the winter. Although her parents took her to medical practitioners for the skin problem, they were unaware of her dental problem. When her permanent teeth became involved, they consulted a private dentist, who ultimately referred her to our hospital. The family history was noncontributory.

On clinical examination, some of the teeth were already exfoliated and the remaining ones were mobile. The gingivae were swollen and inflamed with deep periodontal pockets (Figure 1). The alveolar mucosa covering the edentulous regions, however, was normal. The skin over the palms and soles was diffusely hyperkeratotic and erythematous (Figure 2). Abscesses and scaly areas were seen over the skin of the elbows, knees and thighs (Figure 3). The skin elsewhere was normal. Hair and nails were also normal.

Routine laboratory tests for the blood and urine were within normal limits. A special blood examination, im-

Dr. Joshi is Tutor in Oral Diagnosis and Dental Radiology Department, Government Dental College and Hospital, Ahmedabad—380016, India.

Dr. Kansagra is Clinical Assistant in Oral and Maxillofacial and Plastic Surgery Department, Government Dental College and Hospital, Ahmedabad—380016, India.

Dr Dayal is Assistant Professor in Oral Diagnosis and Dental Radiology Department, Government Dental College and Hospital, Ahmedabad—380016, India.

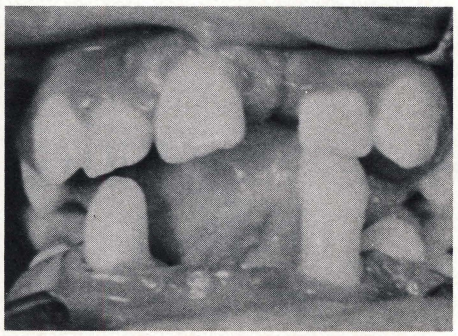

Figure 1. (Left) Inflamed and swollen gingivae around the remaining teeth; and normal mucosa in edentulous region.

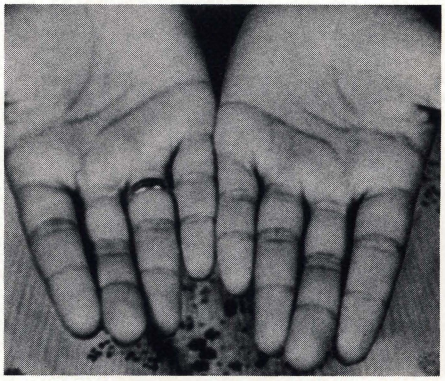

Figure 2. Palms showing diffused hyperkeratosis of the skin. Similar conditions occurred on the soles of the feet, with fissures and crustations.

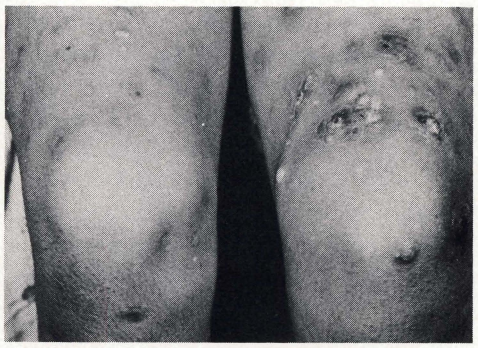

Figure 3. Abscesses and scaly areas over the skin of knees and thighs. The elbows were afflicted with a similar condition.

munoelectrophoresis using polyvalent sera, for IgG, IgA and IgM was carried out, which revealed that there was no significant deficiency of these substances.

Radiographs (Posterior and lateral views of the jaws and intraoral periapical radiographs) showed severe bone loss around most of the teeth.

A punch biopsy from the gingivae showed proliferation of stratified squamous epithelium, fibrous tissue, and blood vessels and the presence of chronic inflammatory cells. The histopathologic report was not significant.

A diagnosis of Papillon-Lefevre syndrome was made.

DISCUSSION

Other diseases such as acrodynia, histiocytosis X, hypophosphatasia and leukemia are often characterized by the premature loss of teeth; the Papillon-Lefevre syndrome is differentiated from them, however, by two important diagnostic signs, palmoplantaris hyperkeratosis and periodontoclasia. In the present case both the features were conspicuous. The syndrome could be

associated with eczema in other regions of the body, such as the facial, gluteal and sacral.[9] In our patient, abscesses of the skin had formed over the elbows, knees and thighs. Keratotic lesions in Papillon-Lefevre syndrome can also occur on the skin of the thighs, eyelids, cheeks, and lips.[9] In our patient, however, these areas were not affected. A characteristic fluctuation of the skin lesions during summer and winter seasons, was also observed in our case.[10] Some of the rarer manifestations of the Papillon-Lefevre syndrome, such as calcification of the dura, attachment of the tentorium and choroid, thumb nail dystrophy, and hypohidrosis that appeared in some reports, were absent in our case.[5,11]

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EFFECT OF ANTISEPTICS ON PLAQUE AND CARIES

Microorganisms in dental plaque are the primary cause of diseases of the periodontium [*Löe* et al., 1965; *Linde* et al., 1973; *van Palenstein-Helderman*, 1981] and the teeth [*von der Fehr*, 1970]. Consequently, much effort has been devoted to the search for chemical agents capable of preventing or controlling plaque formation. Several agents have been found effective including chlorhexidine and SnF_2. A variety of mechanisms appear responsible for the benefits attributed to various antiplaque agents [*Keyes and Shern*, 1971; *Opperman and Rölla*, 1980; *Winter* et al., 1980]. *Löe* and co-workers documented the chemical approach as a safe and effective method of promoting oral health. Their short-term studies demonstrated that daily mouthrinses of chlorhexidine digluconate in the absence of mechanical oral hygiene resulted in plaque inhibition and decrease of gingivitis [*Löe*, 1973]. These benefits were also apparent when chlorhexidine was used as an adjunct to customary oral hygiene procedures in a 2-year study [*Löe* et al., 1976]. Furthermore, chlorhexidine appeared to restrict the development of dental caries [*Dolles and Gjermo*, 1980]. These benefits were sometimes accompanied by dental staining, which could be readily removed by a conventional dental prophylaxis.

Shern, R.J. *et al*: Effect of two recently developed antiseptics on dental plaque and caries in rats. Caries Res, 19:458-465, 1985

Abstracts

Brunsvold, M; Tomasovic, J.; Ruempling, D.: The measured effect of phenytoin withdrawal on gingival hyperplasia in children. J Dent Child, 52:417-421, November-December, 1985

Gingival enlargement was studied and measured in ten patients before, and for 18 months after discontinuation of phenytoin therapy. A clinically evident decrease in gingival hyperplasia occurred after discontinuing phenytoin in all subjects; all subjects, however, had mild hyperplasia after 18 months. These results may encourage increased use of alternative antiseizure drugs.

Gingival hyperplasia, Phenytoin therapy

Rector, J.A.; Mitchell, R.J.; Spedding, R.H.: The influence of tooth preparation and crown manipulation on the mechanical retention of stainless steel crowns. J Dent Child, 52:422-427, November-December, 1985.

The belief that close adaptation of the metal margins to tooth surfaces in the undercut areas is the most important retentive feature, was borne out in this study. The type of preparation did not affect the retention of stainless steel crowns.

Retention, Stainless steel crowns

Stermer Beyer-Olsen, E.M.: Changing positions of supernumerary teeth in the premaxilla: a radiographic study. J Dent Child, 52:428-430, November-December, 1985.

To evaluate possible change of position of unerupted supernumerary teeth in the premaxilla, thirty-one patients were followed clinically and radiographically. Alteration in position could be observed in fourteen cases. Occasionally, migration of supernumerary teeth may occur if surgical intervention is postponed, resulting in a more accessible position.

Supernumerary teeth, Premaxilla, Tooth migration

Ranly, D.M.: Assessment of the systemic distribution and toxicity of formaldehyde following pulpotomy treatments: part one. J Dent Child, 52:431-434, November-December, 1985.

This report, the first of a two-part study, was undertaken to quantitate the systemic distribution of formaldehyde from a pulpotomy site, and to compare this level to doses that elicit overt systemic pathology. Maxillary first molars of rats were pulpotomized and treated with ^{14}C-labeled formaldehyde, for 5 minutes. Additionally, four groups of rats were infused with 10,20,30, or 50 percent of the first quantity applied to the site. The data show that approximately 30 percent of the ^{14}C-formaldehyde placed in the pulp chamber was distributed systemically; 50 percent to 59 percent was expired as CO_2; and 2 percent was excreted.

Formaldehyde, Pulpotomy, Pathology

Varpio, M.: Proximoclusal composite restorations in primary molars: a six-year follow-up. J Dent Child, 52:435-440, November-December, 1985.

Composite resin was tested in shallow, class II cavities in 91 primary molars. The proportion of successful restorations decreased from 86 percent after the first year to 38 percent from the fourth to the sixth year. Altogether, 46 percent were failures; significantly more failures occurred in the upper molars. The composite resin (concise Cap-C-Rynze) proved to be too sensitive to variations in clinical management.

Composite resin, Class II restorations

Helpin, M.L.: Troubleshooting for the laminate veneer restoration. J Dent Child, 52:441-443, November-December 1985.
The laminate veneer restoration may present problems for the practitioner when stain lines occur at the incisal edge, after a period of use. This paper describes a successful conservative technique that avoids compromising the veneer by applying a heating source to a bleaching medium on the tooth.

Veneer margins, Tooth bleaching

Barbakow, F.: Lutz, F.: Sener, B: *In vitro* dissolution of human enamel after application of a mixture of stannous fluoride and amine fluoride 297: a pilot study. J Dent Child, 52: 444-448, November-December, 1985.
Human enamel specimens were topically treated *in vitro*, using either a clear, aged aqueous mixture consisting of SnF_2 and amine fluoride 297, or SnF_2 alone, amine fluoride 297 alone, NaF, or water (as the negative control). The fluoride concentrations used were 250 ppm $F^{1/n}$. The topically treated enamel specimens were then acid-etched for 5, 10, 15, and 15 seconds, respectively, in 2NHCl. The amount of phosphorous dissolved from the enamel and the depth of etch were both significantly less for the groups treated with SnF_2/AmF297 and SnF_2 alone, which indicated better protection against acid dissolution than the other three groups.

Enamel, Acid etching, Stannous fluoride

Lu, K.H.; Yen, D.J.C.; Zacherl, W.A. *et al*: The effect of a fluoride dentifrice containing an anticalculus agent on dental caries in children. J Dent Child, 52:449-451, November-December, 1985.
In this double-blind caries study, 1160 Taiwanese children (ages 8-15) completed a program using a test dentifrice containing 1.243 percent sodium fluoride and soluble pyrophosphates, or a control dentifrice without these agents. The average reduction of new carious tooth surfaces was 39 percent with the sodium fluoride dentifrice.

Fluoride dentifrice, Caries, Anticalculus agent

Marechaux, S.C.: Chin trauma as a cause of primary molar fracture: report of case. J Dent Child, 52:452-454, November-December, 1985.
Primary molars can fracture if a severe blow is received on the chin; the fracture can remain undiagnosed, with pain on mastication the only symptom. A case report is described in which an 8½-year-old boy sustained chin trauma and fractures of primary molars.

Tooth fracture, Chin trauma

Saravia, M.E.; Mercuri, L.G.; Mourino, A.P.: Autogenous third molar transplantation: report of case. J Dent Child, 52:455-458, November-December, 1985.
In this case report, a decayed mandibular first molar was replaced with a transplanted third molar. Stabilization was minimal; no antibiotics were prescribed. Twenty-one months after the procedure, the transplanted tooth is still in good condition.

Autogenous transplantation, Third molars

Hagman, F.T.: Fused primary teeth: a documented familial report of case. J Dent Child, 52:459-460, November-December, 1985.
A case report of fused teeth in two of five siblings is described. Both siblings had fusion of contralateral lower primary canines and lateral incisors. One had aplasia of one of the succedaneous lateral incisors.

Fused teeth

Mellberg, J.R. *et al:* The relationship between dental caries and tooth enamel fluoride. Caries Res, 19:385-389, 1985.
Four thin layers of enamel totaling approximately 8 μm were removed from each of two premolars in 215 subjects, age 14-24 years, and analyzed for fluoride. The concentration of fluoride in the outer layers decreased significantly with subjects' ages. A small but statistically significant correlation between enamel fluoride and DMFS of individual subjects was found. Correlations were somewhat stronger in the outer enamel layers and in subjects from nonfluoridated areas.

Caries; Enamel, fluoride content; Fluoride; Fluoride-caries relationship

Purdell-Lewis, D.J. *et al:* Plasma fluoride levels in 9 children with acute lymphatic leukaemia using daily self-applied fluoride gels. Caries Res, 19:475-480, 1985.
Many patients with acute lymphatic leukaemia apply 1 percent NaF gel daily. Plasma fluoride levels and urinary excretion of 9 children using this regimen were followed in this study. Patients with a high daily fluoride intake showed high baseline plasma fluoride levels. There was a direct relationship between the amount of fluoride excreted, the amount of urine produced, peak plasma fluoride levels and mg fluoride ingested per kg body weight. It was found that with the fluoride level used (1 percent NaF equivalent to 0.45 percent F^-) the plasma fluoride levels remained well below those which cause polyuria.

Fluoride, topical application; Fluoride toxicity; Leukaemia; Plasma fluoride