ASDC
AMERICAN SOCIETY OF DENTISTRY FOR CHILDREN
JOURNAL OF DENTISTRY FOR CHILDREN

JULY—AUGUST 1995

Often children don't want to talk very much; often there are barriers of race and class, of language, which separate doctors (or teachers) like me from those we want to get to know; often, even in the midst of the intimacy of psychiatric and psychoanalytic work with boys and girls, a spell of grim, unyielding silence or suspicion or aloofness takes hold—hence the great alternative and opportunity of drawing, painting, together. Anna Freud on the subject—on a certain kind of psychoanalytic technique: "If the child has a reason to become communicative, we will obviously want to know what the reason is—but if the child persists in being uncommunicative, we don't have much of a chance to find our answer! It is then, especially, that playing with children or asking them to draw or paint, may be of great help. A child's drawing can be a child's fantasy, a child's exploration: an account, really, of what's on his mind, or hers. Naturally, we have to know what to do with the information we get." —Robert Coles

"STAY WITH YOUR PATIENTS LONG ENOUGH,
THROUGH THICK AND THIN, AND YOU'LL LEARN...
A LOT MORE THAN YOU EVER EXPECTED."
—*William Carlos Williams*

Handicaps • STEREOTYPE • Sexism
Children in Crisis

ASDC
AMERICAN SOCIETY OF DENTISTRY FOR CHILDREN
JOURNAL OF DENTISTRY FOR CHILDREN
JULY-AUGUST 1995 VOLUME 62 NUMBER 4

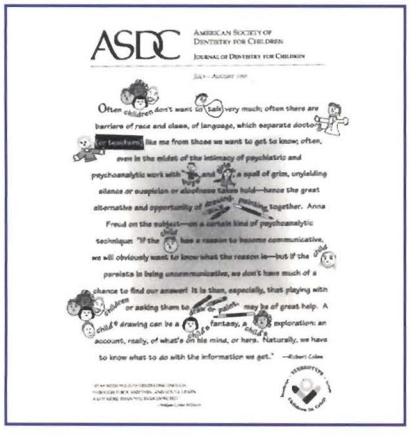
 USPS #279-480. Issued bimonthly—in January-February, March-April, May-June, July-August, September-October, and November-December—John Hancock Center, 875 North Michigan Avenue, Ste 4040, Chicago, IL 60611-1901, (312) 943-1244. Second class postage paid at Chicago, IL and additional mailing office. Subscription prices: within U.S.A., individuals $100.00 per volume, institution $120.00, single copies $35.00; Foreign (including Canada and Mexico) individuals $120.00 per volume, institution $150.00, single copies $40.00. Foreign subscriptions are sent airmail. Ninety dollars ($90.00) of the full membership dues are allocated to the Journal. **Subscriptions to the Journal cannot be sold to anyone eligible for membership in ASDC.** Member—American Association of Dental Editors.

All copy and manuscripts for the journal should be sent directly to the Editorial Office, John Hancock Center, 875 North Michigan Avenue, Ste 4040, Chicago, IL 60611-1901, (312) 943-1244.

Prospective authors should consult "Information for Authors." Reprints of this document may be obtained from the Editorial Office.

POSTMASTER
Change of address, subscriptions, advertising and other business correspondence should be sent to ASDC, Journal of Dentistry for Children, John Hancock Center, 875 North Michigan Avenue, Ste 4040, Chicago, Illinois 60611-1901.

Printed in the U.S.A.



Drawing and painting together by the child and health professional have helped to remove the barrier of poor or negative communication.

Art and design by Sharlene Nowak-Stellmach

CHILD ABUSE

SEALANTS

CLINIC



EPIDEMIOLOGY

DEMOGRAPHICS

Calendar

1995

ASDC Annual Meeting, Palm Springs, CA, October 11-15
Florida ASDC Unit, Gainesville, FL, September 8 & 9
Iowa ASDC Unit, Lake Okoboji, July 27-29

1996

ASDC Annual Meeting, Westin Canal Place, New Orleans, LA, October 23-27

1997

ASDC Annual Meeting, site to be determined, late October

For The Busy Reader

Physical manifestations of child abuse to the head, face and mouth: A hospital survey—page 245

The author analyzed the hospital records of 266 children, newborn to seventeen years of age, who were seen at Texas Children's Hospital during 1993 and 1994, because they were suspected to be victims of physical abuse. Injuries to the face and mouth were found in eighty-three cases; the same number involved head injuries; and ten cases presented with neck injuries.

Requests for reprints to: Dr. Stephen A. Jessee, P.O. Box 20068, Houston, TX 77225.

Sealant use and dental utilization in U.S. children—page 250

One of the U.S. National health objectives in Healthy People 2000 is to increase the appropriate use of dental sealants. the authors describe the reported use of dental sealants and dental visits by U.S. children, with attention given to differences by race and socioeconomic status.

Requests for reprints to: Dr. Gail Cherry-Peppers, National Health Service Corps., 4350 East-West Highway, 8th Floor, Bethesda, Maryland 20814.

Anterior tooth trauma in the primary dentition: Incidence, classification, treatment methods, and sequelae: A review of the literature—page 256

The authors reviewed the literature to present information pertaining to traumatized primary anterior teeth, including incidence, types of classification used, methods of treatment, follow-up, and sequelae. The incidence of traumatized primary anterior teeth remains high.

Requests for reprints to: Dr. Pamela R. Erickson, 6-150 Moos Tower, 515 Delaware Street, S.E., Minneapolis, MN 55455.

Characteristics of premaxillary supernumerary teeth: A survey of 112 cases—262

The author wished to determine the characteristics of premaxillary supernumerary teeth among children in central Taiwan. One hundred and twelve patients were examined and 152 supernumerary teeth were found. The author describes the types and locations of these teeth.

Requests for reprints to: Dr. Jeng-fen Liu, Dental Department, Taichung Veterans General Hospital, Taichung, Taiwan 407.

Cheese molars: A pilot study of the etiology of hypocalcifications in first permanent molars—page 266

Opacities in the enamel of permanent first molars are frequently seen. The authors discuss the numerous causes of hypocalcification and state that there is lack of a clear etiology. They studied the relationship of medical data related to the children from birth to three years of age and the hypocalcifications seen in the permanent teeth.

Requests for reprints to: Dr. W.E. van Amerongen, Department of Pediatric Dentistry, ACTA, Louwesweg 1, 1066 EA Amsterdam, The Netherlands.

Chairside veneering of composite resin to anterior stainless steel crowns: Another look—page 270

The authors discuss improvements made in a technique presented in an earlier paper. They succeeded in improving the facial contours of their restorations and in simplifying their fabrication. The result was a very thin veneer (1-2 mm) with excellent cosmetic results.

Requests for reprints to: Dr. Kenneth R. Wiedenfeld, 937 Tall Pine Road, Mt. Pleasant, SC 29464.

In vitro evaluation of fluoride uptake with application of acidulated phosphate fluoride to interproximal enamel of primary teeth using dental floss—page 274

The authors planned the present study to ascertain the fluoride uptake of interproximal enamel of primary teeth, following application of acidulated phosphate flu-

oride (APF) with dental floss. The floss was saturated with fluoride by immersing it in an APF gel for five minutes. The authors recommended the method as an effective means of reducing to a minimum the number of interproximal surfaces to develop caries lesions, in children and adolescents.

Requests for reprints to: Dr. Zerrin Us, Ataköy 3, Kisim 0-57 Blok, Daire:4, °Istanbul, Turkey.

Plaque removing efficacy of individually modified toothbrushes in cerebral palsy children—page 279

Many children handicapped physically or mentally develop serious periodontal problems because of the inability to use a toothbrush properly. For this study the authors selected ten children suffering from cerebral palsy. The children were twelve to fourteen years of age.

The authors modified standard toothbrushes according to the individual needs of the children. The results showed a marked reduction in plaque levels.

Requests for reprints to: Dr. S.G. Damle, Professor and Head, Department of Pediatric Dentistry, Nair Hospital Dental College, Bombay-8, India.

A study of dental caries and risk factors among Native American infants—page 283

The prevalence of baby bottle tooth decay (BBTD) is very high in Native American populations. In this study the authors observed seventy-seven infants, twelve to thirty-six months of age, and their parents/caregiver, who participated in a WIC program at the Tulasip Health Center, Marysville, Washington. The local water was not fluoridated. All parents/caregivers completed questionnaires that focused on behavioral risk factors for dental diseases.

The authors believe culturally appropriate preventive and early screening efforts, tailored to American Indian caregivers are needed.

Requests for reprints to: Dr. Peter K. Domoto, Department of Pediatric Dentistry, SB-26, School of Dentistry, University of Washington, Seattle, WA 98195.

Immigrant children and pediatric dental practice—page 288

New immigrants present healthcare providers with unique problems, some of which may be unfamiliar to U.S. practitioners. This presentation will provide a general introduction to the numbers and changing backgrounds of immigrant children, as they add their increasing diversity to our communities and the complexities of dental practice.

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

CHILD ABUSE

Physical manifestations of child abuse to the head, face and mouth: A hospital survey

Stephen A. Jessee, DDS

Child maltreatment is a widespread problem that affects all segments of society. Physical abuse, one of four main types of child maltreatment, is defined as the nonaccidental injury or trauma to the body of a child by a parent, guardian, or sibling. While physical abuse is the second leading form of child maltreatment, it is the cause of almost 60 percent of the child-abuse-related fatalities.[1] Holter stated that in children under the age of five who were seen in the emergency room, 10 percent had injuries that were inflicted.[2]

Previous studies found that injuries occurred to the head and neck in over one-half of the suspected or documented cases of child abuse. Becker *et al* in their review of 260 abused children, hospitalized at Boston's Children's Hospital Medical Center during a five-year period, found that 49 percent exhibited facial and intraoral trauma, while an additional 16 percent presented with injuries to the head. An extensive hospital study recently performed by da Fonseca *et al* showed that in cases where children had been physically abused, over 75 percent of the cases involved injuries to the head, face, mouth, or neck.[4] These data suggest that dental professionals may encounter a substantial number of abused children. Further support for this premise is the fact that, while abusive parents usually do not return to the same physician or emergency room when seeking treatment for their child, the same forethought is not applied with regard to dental treatment.[5] Unfortunately, most dentists are either unaware of their legal responsibility to report child abuse or, when abuse is suspected, are reluctant to do so. Reasons given for the inadequate reporting by dentists include lack of knowledge of the subject, fear of legal involvement, reluctance to confront parents, and fear of damage to their practices.[6-9]

The purpose of this study was to determine the extent and degree of physical abuse to the head, face, mouth, and neck of children who, during their treatment at a major metropolitan pediatric hospital, were suspected to have been the victims of child abuse.

MATERIALS AND METHODS

The study consisted of a review of charts of 266 children, newborn to seventeen years of age, seen at Texas Children's Hospital during 1993 and 1994 and who were reported to Children's Protective Services (CPS) as suspected cases of physical abuse. Children who were believed to have been the victims of other types of child maltreatment such as sexual abuse, neglect, or emotional abuse were excluded from the study. The hospital's protocol directs physicians to request a consultation with a

The author wishes to thank Monty Rieger, MS, PhD, for his invaluable assistance with the computer analysis of the data; and Joan E. Shook, MD, for help in getting the project started.

This study was approved by the Committee for the Protection of Human Subjects of the University of Texas Health Science Center at Houston and by the Texas Children's Hospital Pediatric Clinical Investigations Subcommittee of the Baylor College of Medicine Affiliated Review Board.

Dr. Jessee is Assistant Professor, Department of General Dentistry, The University of Texas Health Science Center at Houston—Dental Branch, Houston, TX.

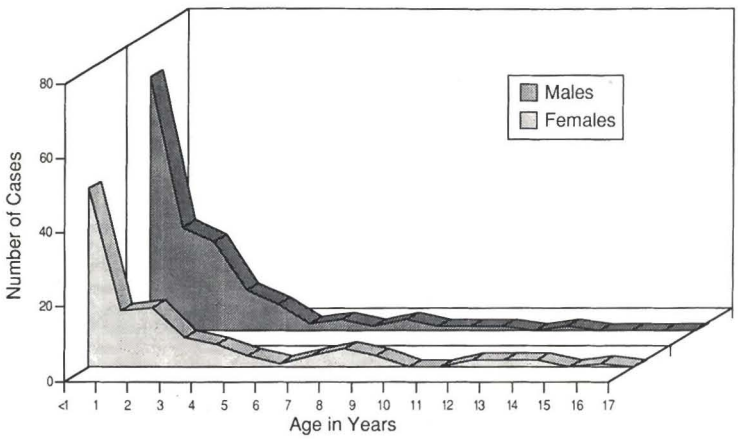


Figure. Distribution of physical abuse by age and gender.

staff social worker if, following an examination, there is reason to believe that a child has been abused. Following an oral report, a caseworker is assigned by CPS. Documentation from the attending physician, nurses, hospital social worker, and CPS are entered into the patient's chart. Texas Children's Hospital is the largest free-standing pediatric institution in the United States.

For the purpose of the study, the data gathered were divided into both demographics and physical findings. Demographic information was further subdivided into categories that included age and gender of the child, parental status, suspected perpetrator(s), place of occurrence of abuse, instrument used to abuse, reoccurrence of the abuse, and the individual who performed the examination. Physical findings included type(s) of injury sustained, locations(s) of injury (head, face, mouth, neck, and body) and any reported deaths. All cases were referenced by hospital chart number and the data were entered into a computer utilizing Microsoft Excel software (Redmond, CA) and analyzed using the *chi square test* to determine significant differences. The author was the only investigator involved in chart reviews and the gathering and interpretation of the data, thereby assuring the standardization of all information presented. The study was approved by both the Committee for the Protection of Human Subjects of the University of Texas Health Science Center at Houston and the Texas Children's Hospital Pediatric Clinical Investigations Subcommittee of the Baylor College of Medicine Affiliated Review Board.

RESULTS

Injuries to the face and mouth were found in eighty-three (31.2 percent) of the 266 suspected cases of physical abuse. The same number of cases (83) involved head injuries of varying severity, while ten cases presented with injuries to the neck. Although the body (anatomically designated as below the neck), as a whole, was injured in the greatest number of cases in this study, injuries to the head, face, mouth, and neck comprised a surprising 66.2 percent of all cases. Many cases involved not only multiple injuries, but injuries to more than one area of a child's anatomy.

Almost three-fourths (74.8 percent) of the children reported in this study were under the age of three (Figure). The overall distribution by gender was 151 males (57 percent) and 115 females (43 percent). There was no significant difference in the incidence of child abuse between male children and female children at any age.

In cases where the parental or supervisory status of the household was known, 55 percent of the cases involved households headed by either divorced, separated, or single parent females. In 37 percent of the cases, the parents of the children were married and residing in the same household. When the perpetrator of the abuse was suspected or known, the biological mother or biological father was responsible in 31 percent and 24 percent of the cases, respectively. Both parents were involved in the physical abuse of their child in only two cases. Stepfathers and mother's boyfriends were responsible for abusing a child in approximately 10 percent of the known cases. In 92 percent of the cases, the abuse was believed or acknowledged to have occurred at home, while only nine of the 266 cases happened in either a school or child-care setting.

When the type of instrument or object used to abuse a child was ascertained, the hand or fist was cited in almost a third of the cases (32.8 percent). Other instruments used, in decreasing order of rank, were hot water or food, a paddle or broom, teeth, and finally, a knife or sharp object. Statistically, no differences were found between the instruments of abuse and the gender of the child.

Physicians were responsible for every examination performed on the 266 children included in this study. In only one instance did a dentist collaborate with the attending physician. With regard to the incidence of recurrence of abuse to a child, 17.9 percent of the boys and 14.8 percent of the girls had signs of having been injured previously. Of those children who had been physically abused on two or more occasions, many had either fractures and/or numerous injuries at multiple locations.

Cases involving fractures were most common, followed in decreasing frequency by cases exhibiting con-

tusions or ecchymosis, burns, abrasions or lacerations, subdural hematomas, ingestion, or unknown trauma. The overall distribution by type of injury is shown in Table 1. The type of injury occurring most often was contusions/ecchymosis which, with 187 injury sites, represented 35.4 percent of all injuries. Other injuries and their respective totals included fractures (134), burns (70), abrasions or lacerations (59), and subdural hematomas (20). Since many children had different types of injuries and multiple injury sites, the totals for these two statistical categories exceeds the total number of cases.

The incidence of injury to various parts of the body is listed in Table 2. As shown, the face was injured most often. Of the ninety-five head injuries, 57.9 percent were skull fractures and 21.1 percent were subdural hematomas. Other injuries to the head included ten cases of unknown trauma, four hematomas, two cases of traumatic alopecia, and one case each of subgaleal hematoma, abrasion/laceration, contusion/ecchymosis, and erythema/petechia. Injuries to the face included sixty-nine contusions or ecchymosis, twenty-five abrasions or lacerations, and eleven burns, which, when combined, accounted for 83.3 percent of all facial trauma. Other facial injuries in decreasing frequency of occurrence were eight retinal hemorrhages, four hematomas, two each of puncture wounds, unknown trauma, bites and erythema/petechia, and one fracture. The cheek was the site of the most facial injury followed by the eyes and periorbital area, forehead, lips, nose, and ears. Intraoral trauma included four tooth fractures, burns to the buccal mucosa, palate and tongue, and lacerations to the buccal mucosa and gingiva. Neither tears or lacerations of the labial or lingual frenums nor mandibular fractures were reported. The ten injuries confined to the neck included five contusions/ecchymosis, four abrasions/lacerations, and one puncture wound. Of the injuries involving the body, 39.3 percent were contusions/ecchymosis, 27.3 percent were fractures, 19.3 percent were burns, and 9.1 percent were abrasions/lacerations. Other visible signs of bodily abuse included bites, erythema, hematomas, and unknown trauma. The thirteen cases of ingestion were not included in the results of this survey because the investigator could not determine whether this type of maltreatment was forced or due to lack of supervision (neglect). During the two-year period of this study, two deaths were attributed to physical abuse.

DISCUSSION

Many of the findings in this study are in agreement with previous hospital surveys regarding the incidence of head, face, intraoral, and neck injuries in suspected or documented cases of child abuse.[3,4] Becker *et al* found head, facial, and intraoral trauma in 65 percent of 260 documented cases of child abuse. da Fonseca and associates reported an even higher percentage of similar trauma (75.5 percent) in their five-year hospital study.[4] In smaller, less random population studies, Cameron found that 50 percent of abusive injuries were located on the head or neck, while Skinner and Castle found that 43.5 percent of such injuries occurred to the facial area.[10,11] The astute, well-informed dentist may use such clinical findings to his or her advantage when viewing suspicious head, facial, intraoral, or neck injuries.

As shown in the Figure, injuries resulting from physical abuse occurred overwhelmingly within the first three years of life, with 43.6 percent happening before the age of one. These findings are consistent with other studies.[3,10,12-15] This high incidence of physical abuse at a very

Table 1 ☐ Distribution of injuries by type.

Type	Number	Percentage
Contusion/Ecchymosis	187	35.4
Fractures	134	25.4
Burns	70	13.3
Abrasion/Laceration	59	11.2
Subdural Hematoma	20	3.8
Unknown Trauma	15	2.8
Hematoma	11	2.1
Erythema/Petechia	9	1.7
Retinal Hemorrhage	8	1.5
Bites	4	0.8
Dental Trauma	4	0.8
Puncture Wound	3	0.6
Traumatic Alopecia	2	0.4
Subgaleal Hematoma	1	0.2
Total	527	100.0

Table 2 ☐ Incidence of bodily injury.

Site	Number	Percentage
Face	126	23.9
Leg/Foot	103	19.6
Head	95	18.0
Arm/Hand	66	12.5
Back	35	6.7
Chest	18	3.4
Shoulder	18	3.4
Buttocks	18	3.4
Mouth	11	2.1
Neck	10	1.9
Genitals	9	1.7
Ribs	8	1.5
Abdomen	8	1.5
Pelvis	2	0.4
Total	527	100.0

early age may be due to the almost constant demands imposed upon the parents of such a child as well as the physical defenselessness of the child. The fact that most children were so young and had not yet developed the needed language or communication skills to describe how their injuries happened, places a further burden on practitioners in their diagnosis of the cause of the clinical signs. This study showed no predilection for physical abuse to either males or females, which supports the findings of other researchers.[4,10] Further support for a lack of gender bias is evidenced in this study's finding that there was no significant difference in the incidence of physical abuse between male and female children by either male or female perpetrators.

It is interesting to note that of the 266 children suspected to have been abused, over half lived in households headed by divorced, separated, or single females. In support of this finding, the U.S. Advisory Board on Child Abuse and Neglect in its 1991 report stated that "young families and families headed by females are increasingly and disproportionately subject to economic and social stresses." Such stress can be a contributing factor in child abuse. In addition to financial stress or poverty, alcohol or drug abuse, and marital difficulties are elements that may promote abusive behavior in an already susceptible adult.[15,16] Kenney and Clark stated that biological mothers and fathers were implicated almost equally in physical abuse cases, but rarely collaborated in such acts.[17] Gallo found that one parent is usually the abuser, while the other parent takes a passive position, thus allowing the abuse to continue.[13] In this study, comparable statistics were found.

Although more cases involved fractures than any other type of injury, contusions or ecchymosis had the highest overall incidence of occurrence. This was true not only for the body, but for the face as well. Considering this evidence and the finding that the hand or fist were the most often reported instrument of abuse may explain why both are so often mentioned in child abuse literature. The fact that it is socially acceptable to discipline a child with physical force (hitting) may also contribute to the high frequency of contusions. Needleman stated that soft tissue injuries, predominantly bruises, are the most common form of injury to the head and face as well as the most frequent injury incurred in cases of physical abuse.[18] Other injuries found in decreasing frequency of occurrence were fractures, burns, abrasions/lacerations and subdural hematomas. Schmitt reported that trauma to the bone is found in 10 percent to 20 percent of all physically abused children.[20] Lenoski and Hunter pointed out that burns are present in approximately 10 percent of physical abuse cases.[21] These findings are similar to those in other studies.[3,12,19] Baetz *et al* commented that the fact that bruises and fractures are seen far more often than burns suggests that most physical abuse is the result of a spontaneous loss of control rather than an act of premeditation.[19]

The majority of injuries to the head were either skull fractures or subdural hematomas. Fractures of the skull were found in over 20 percent of the 266 children in the findings of Lauer *et al*, who reported the percentage of cases with skull fractures as 22.3 percent. Subdural hematomas were found in the absence of skull fractures in 55 percent of the cases. Many times this injury is the result of a child having been violently shaken in an effort to stop his or her crying and may also result in retinal hemorrhaging due to an increase in intracranial pressure. In the two deaths uncovered in this study, both were attributed to some form of intracranial injury.

As stated previously, the face was the most often injured area of the body (Table 2). In the most recent comparative study, da Fonseca *et al* had similar results.[4] With the exception of retinal hemorrhaging in the eyes and abrasions or lacerations of the lips, contusions were the most frequently occurring injury to all other facial structures. A study by Becker and associates reported that facial contusions were the most common type of injury found in children who had been physically abused. Other frequently occurring injuries to the face included abrasions, lacerations and burns. The cheek incurred more trauma than any other facial area and, as a soft tissue that does not cover a bony prominence, any bruising here should be carefully investigated as possible abuse. The finding that the injuries most often afflicted to the lips were abrasions or lacerations may be the result of forced feeding or a blow to the face to silence the child.

There were few injuries found to the oral cavity. Such injuries represented only 2.6 percent of the 266 cases and only 2.1 percent of the total number of injuries. Similar results were obtained in other hospital studies.[3,4] The primary dental injuries found in cases of suspected child abuse include fractures of teeth, bruises, lacerations, fractures of maxilla or mandible, and burns.[6] Surprisingly, this study found no maxillary or mandibular fractures nor were there any reports of labial or lingual frenum tears, which are pathognomonic of more severely abused children. It is inconceivable how, when almost 50 percent of the facial trauma occurred to either the cheek, nose, or lips, structures which directly overlay the mouth, so few intraoral injuries could have resulted. This investigator supports the premise offered by both

Becker *et al* and da Fonseca and associates that because every child in this survey was examined exclusively by a physician, many intraoral injuries that may have been detected by someone more familiar with the oral cavity, such as a dentist, may have gone undetected.[3,4]

Most of the reported soft tissue injuries to the neck were either contusions or abrasions. Such trauma is usually the result of a child being strangled or choked with either a hand or an instrument such as a cord or rope. Any injury to this region of the body should be viewed with skepticism.[20]

Approximately 54 percent of the total injuries in this survey were to the body. The most common injuries were contusions, fractures, burns, and abrasions or lacerations. Exposed areas of a child's body should be carefully examined for signs of unusual or multiple injuries. Such areas should always include the arms and eyes, which, in this study, were found to have been subjected to a high frequency of trauma as a result of physical abuse. Bruises in various stages of healing or bruises that resemble objects that may have been used to inflict the injury should arouse suspicion.[23,24]

There were sixty-four children who, during the two year period of this study, presented with multiple injuries at the time of their admittance to Texas Children's Hospital. This figure represents approximately one out of every four children surveyed. Of the forty-four children who showed signs of previous abuse, twenty were diagnosed with new, multiple injuries—a ratio of almost one out of every two children in the study. These two statements appear to suggest that, in many instances, the severity of abuse is proportionate to the frequency of occurrence.

CONCLUSION

Three significant conclusions that may be drawn are:

- ☐ The head, face, mouth, and neck were sites of physical injury or trauma in 66.2 percent of the suspected cases of child abuse at a large pediatric hospital.
- ☐ The number of reported injuries to the oral cavity (mouth) was extremely low, especially when taking into consideration that the face was the most often injured part of the body.
- ☐ Dentists need to take a more active role in the hospital examinations of those children suspected to have been physically abused.

REFERENCES

1. Fact Sheet, American Humane Association, Children's Division, Child Abuse and Neglect Data, AHA Sheet 1, 1993.
2. Holter, J.C. and Friedman, S.B.: Child abuse early case findings in the emergency department. Pediatrics 42:128-138, July 1968.
3. Becker, D.B.; Needleman, H.L.; Kotelchuck, M.: Child abuse and dentistry: orofacial trauma and its recognition by dentists. JADA 97:24-28, July 1978.
4. da Fonseca, M.A.; Feigal, R.J.; ten Bensel, R.W.: Dental aspects of 1248 cases of child maltreatment on file at a major county hospital. Pediatr Dent, 14:152-157, May-June 1992.
5. Hamilton, J.: Child abuse: the dentists responsibility. CDS Rev, 83:18-23, November 1990.
6. Malecz, R.E.: Child abuse, its relationship to pedodontics: A survey. J Dent Child, 46: 193-194, May-June 1979.
7. Sanger, R.G. and Bross, D.C.: *Clinical management of child abuse and neglect: a guide for the dental professional.* Chicago: Quintessence Publishing Co., 1984, p 47.
8. Davis, J.R.; Domato, P.K.; Levy, R.L.: The dentist's role in child abuse and neglect. J Dent Child, 46:185-192, May-June 1979.
9. Croll, T.P.; Menna, V.J.; Evans, C.A. *et al*: Primary identification of an abused child in a dental office. Pediatr Dent, 3:339-341, December 1981.
10. Cameron, J.M.; Johnson, H.R.M.; Camps, F.E.: The battered child syndrome. Med Sci Law, 6:2-21, January 1966.
11. Skinner, A.E. and Castle, R.L.: *78 battered children: a retrospective study.* London: National Society for Prevention of Cruelty to Children, 1969.
12. O'Neill Jr., J.A.; Meacham, W.F.; Griffin, P.P. *et al*: Patterns of injury in the battered child syndrome. J Trauma, 13:332-339, April 1973.
13. Gallo, L.G.: Child abuse: who is involved? NY State Dent J, 49: 77-78, February 1983.
14. Sperber, N.: The dual responsibility of dentistry in child abuse. Int J Orthod, 19:21-28, September 1981.
15. Fontana, V.J.; Donovan, D.; Wong, R.J.: The "maltreatment syndrome" in children. N Engl J Med, 169:1389-1394, December 26, 1968.
16. Macintyre, D.R.; Jones, G.M.; Pinckney, R.C.: The role of the dental practitioner in the management of non-accidental injury to children. Br Dent J, 161:108-110, August 1986.
17. Kenney, J.P. and Clark, D.H.: Child abuse. In: *Practical Forensic Odontology.* Clark, D.H., Ed. Oxford: Butterworth-Heinemann Ltd, 1992, p 139.
18. Needlemann, H.L.: Child abuse and neglect—recognition and reporting. J Am Coll Dent, 61: 30-37, Spring 1994.
19. Baetz, K.; Sledziewski, W.; Magetts, D. *et al*: Recognition and management of the battered child syndrome. J Dent Assoc S Afr, 32:13-18, January 1977.
20. Schmitt, B.D.: Clinical diagnosis of physical abuse. In: *Clinical management of child abuse and neglect.* Sanger, R.G. and Bross, D.C., Eds. Chicago: Quintessence Publishing Co., 1984, p 31.
21. Lenoski, E.F. and Hunter, K.A.: Specific patterns of inflicted burn injuries. J Trauma, 17:842-846, November 1977.
22. Lauer, B.; ten Broeck, E.; Grossman, M.: Battered child syndrome: review of 130 patients with controls. Pediatrics, 54:67-70, July 1974.
23. Wilson, E.: Estimation of the ages of cutaneous contusions in child abuse. Pediatrics, 60: 751-753, November 1977.
24. Ellerstein, N.: The cutaneous manifestations of the battered child syndrome. Am J Dis Child, 133:906-909, September 1979.

SEALANTS

Sealant use and dental utilization in U.S. children

Gail Cherry-Peppers, DDS, MS
Helen C. Gift, PhD
Janet A. Brunelle, MS
Cecelia B. Snowden, MA

Caries prevalence among US children and youth has declined in the past several decades.[1] Seventy-five percent of dental caries in children is concentrated in 25 percent of the population.[2,3]

The documented decline in dental caries experience among U.S. school-age children is the result of not only the reduction in the number of tooth surfaces attacked, but also the change in the relative distribution (pattern) of caries on different tooth surfaces.[4-6] Pit and fissure caries comprise the majority of the caries increment in both fluoridated and nonfluoridated communities, and the caries increment for proximal surfaces is relatively low.[7] In the 1986-87 National Oral Health Survey of School Age Children, almost 60 percent of the carious or filled surfaces were of the pit and fissure (occlusal) type.[3] By age seventeen, the mean DMFS was greater than eight and only 15.6 percent of seventeen-year-olds were caries-free.[1] In addition, caries risk varied by geographic area and race. For seventeen-year-olds, the highest mean DMFS score, 12.9, was found in nonwhites in Region VII [Pacific]. This score was almost twice that of the group with the lowest level, whites in Region V (Southwest).[6] Other studies show caries differentials by socioeconomic status (Healthy People 2000).[8]

A combination of factors has contributed significantly to the improvement of oral health in children over the past several decades. These include general life style changes and use of preventive measures such as fluorides, dental sealants, and oral hygiene practices.[1,9-11] Dental sealants, a caries preventive method specific for pits and fissures, were introduced more than twenty-five years ago and have become recognized as a significant adjunct to the use of fluorides in the prevention of dental caries.[7,12-17] The combined use of fluorides and the appropriate use of dental sealants offers the potential for still more impressive reductions in caries.[18]

Despite these advantages, the use of dental sealants has remained relatively low in comparison with other proven oral disease preventive therapies.[10,19-21] The 1986-87 National Survey of Dental Caries in U.S. School Children found that only 7.6 percent of the children ages six to seventeen had any sealed teeth.[3,6] As a professionally-provided therapy, application of sealants is dependent on regular visits to a dental care provider. The widespread adoption of the procedure has been hindered by a lack of consumer knowledge of dental sealants, a low level of provider awareness and acceptance, lack of access to professional preventive services, as well as, cost of sealants.[10,11,22-24]

Dr. Cherry-Peppers is a former epidemiology fellow, Epidemiology and Oral Disease Prevention Program, National Institute of Dental Research, NIH, currently, National Health Service Corps, HRSA, USPHS.

Drs. Gift, Brunelle and Snowden are in the Epidemiology and Oral Disease Prevention Program, national Institute of Dental Research, NIH, USPHS.

One of the U.S. national health objectives in Healthy People 2000 is to increase the appropriate use of dental sealants among children. Also, the use of dental sealants has been proposed in the National Health Care Reform package.

The purpose of this paper is to describe the reported use of dental sealants and dental visits by U.S. children, with specific attention given to differences by race and socioeconomic status.

METHODS

The 1989 National Health Interview Survey (NHIS), a continuing nationwide household interview survey conducted each year, has two parts: a basic health and demographic questionnaire, which is the same every year, and several specific health topic questionnaires, which change every year.[25] The 1989 NHIS was based on personal interviews that were conducted in 45,711 households containing 116,929 individuals of all ages.[25] The total non-interview rate was 5.1 percent, with 3.0 percent being the result of respondent refusal and the remainder being primarily the result of failure to locate eligible respondents at home after repeated attempts. The 1989 NHIS had an oral health care supplement that included information on *frequency of dental visits, interval since last dental visit*, and *reported presence or absence of dental sealants*.[26] Demographic and socioeconomic variables included age, race, ethnicity, family income, education, and dental insurance. Race and ethnicity are defined by the respondent's self-perception and are separate variables. Education of responsible adults and family income were categorized to maximize comparisons between blacks and whites. Since both of these variables are lower among blacks, this is reflected in the categories used in cross-tabulations.

The analyses reported are for children ages six to seventeen (n=20,592), which are the ages that children most likely receive sealants, based on common molar eruption patterns.[27,28] The data have been adjusted for unequal probabilities of selection and for clustering introduced during sampling. Sampling weights were included to generalize the estimates to the civilian noninstitutionalized child population, ages six to seventeen, for the entire year of 1989. Estimates for the tables and test statistics were calculated using the statistical software, SUDAAN, to account for clustering introduced by the complex sample design.[29] SUDAAN uses the Taylor series method to estimate parameters. Chi-square has been used to test the interdependence between the row and column variables for each analysis. P-values are based on the F-statistic using the Wald chi-square. Adjustments have been made for multiple comparisons in reporting these statistical analyses.

Using variables found to be significant in the exploratory bivariate analyses, logistic regression was conducted on the presence or absence of dental sealants among children ages six to seventeen. Odds ratios were calculated along with 95 percent confidence intervals.

RESULTS

Bivariate results

SEALANT USE

Fifteen percent of children, ages six to seventeen, were reported to have dental sealants. More white children (17 percent) had dental sealants than black children (5 percent). Those without dental sealants were most likely to be lower SES as measured by family income and education of parents (Table 1).

White children from high income categories were two to three times as likely to have dental sealants than black children of similar SES. Sealant usage among lower SES children was equally low among black and white children (Table 1).

Considering both SES variables simultaneously illustrates the interaction of these variables with race. For example, there was a two-fold difference between white children whose parents had higher incomes and less than twelve years education (10 percent) and black children in a similar SES category (5 percent) (Figure 1). The

Table 1 □ Dental sealant use and interval since last dental visit by race, family income and education of adult for children, ages 6-17.

Race and socioeconomic status	Have sealants	Visits: Past 12 months %	Visits: 1-5 years %	Visits: Never %
Totals	15	73	21	6
White	17	76	19	5
Adult education				
9-11	5	52	32	16
High School	12	71	23	6
1 Year of College +	23	86	12	2
Family income				
< $6,999	5	58	27	15
7-14,999	9	56	32	12
15-34,999	13	72	22	6
35,000 +	24	88	11	1
Black	5	58	33	9
Adult education				
9-11	4	52	36	12
High School	4	54	36	10
1 Year of College +	8	68	26	6
Family income				
< $6,999	3	53	35	12
7-14,999	6	50	41	9
15-34,999	4	57	34	9
35,000 +	11	78	18	4

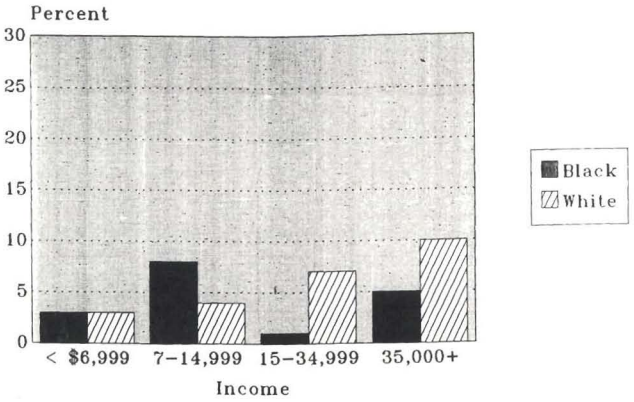


Figure 1. Dental sealant use among children ages six to seventeen, by race and income, among those whose parents have less than twelve years of education.

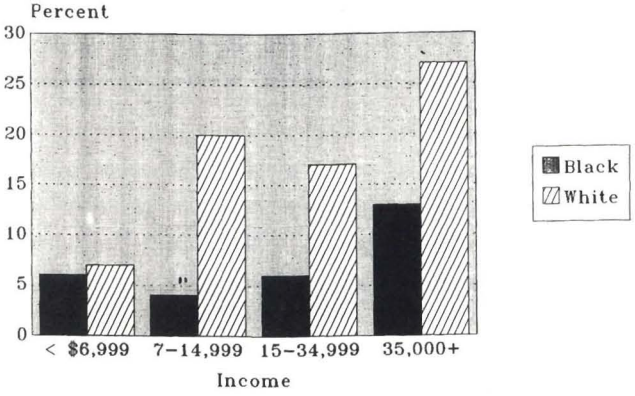


Figure 2. Dental sealant use among children ages six to seventeen, by race and income, among those whose parents have more than twelve years education.

racial differences are even more notable among children whose parents have more than twelve years of education and have mid to upper incomes (Figure 2). Racial differences are not evident among the lower income children in either parental education group.

UTILIZATION OF DENTAL SERVICES

Seventy-three percent of children ages six to seventeen had a dental visit in the past year. More white children (76 percent) had dental visits than black children (58 percent) (Table 1). Adult education and family income were each directly associated with a child dental visit in the past year.

Black and white lower socioeconomic children (family income or adult education) have equally low dental visit rates. In contrast, white upper socioeconomic (family income or adult education) children had a higher dental utilization rate than black children of similar SES. Fifty-two percent of black and white children of parents with nine to eleven years of education visited a dentist during the past twelve months (Table 1). Fifty-four percent of black children and 71 percent of white children from households where the parents had a high school education visited a dentist in the past twelve months. Among children whose parents had at least one year of college, 68 percent black and 86 percent white children visited a dentist during the past twelve months (Table 1).

Fifteen percent of black children and 22 percent white children whose parents had less than eleven years of education and incomes less than $7,000 had never been to the dentist, compared to 26 percent of black and 2 percent of white children whose parents had less than eleven years of education and incomes greater than $35,000 (Figure 3). Among children with better educated parents, black children are more likely than white ones to have never been to a dentist (Figure 4). Two percent of black children and one percent of white children whose parents had at least one year of college and incomes greater than $35,000 have never been to the dentist (Figure not shown).

Multivariate results

Multivariate analyses were conducted to examine the relative contribution of different independent variables in the use of dental sealants. The purpose was to assess

- ☐ Whether racial differences persisted within socioeconomic groups.
- ☐ What factors were significant in each racial group when other variables were controlled.

Models were selected that allowed for assessment of groups and factors that subsequently could be used in planning intervention studies. A sequential process was used in these analyses to establish the final model; variables that were highly correlated and insignificant primary variables were excluded. Additionally, insignificant interaction terms were eliminated sequentially. The logistic regression model was performed for all children ages six to seventeen. The variables in the final model are displayed in Table 2. Since differences by race and socioeconomic characteristics had been observed in descriptive analyses, logistic regressions were performed subsequently on stratified subgroups (Tables 3-5). Since little evidence of differences in age distribution of children within socioeconomic groups was noted in prelim-

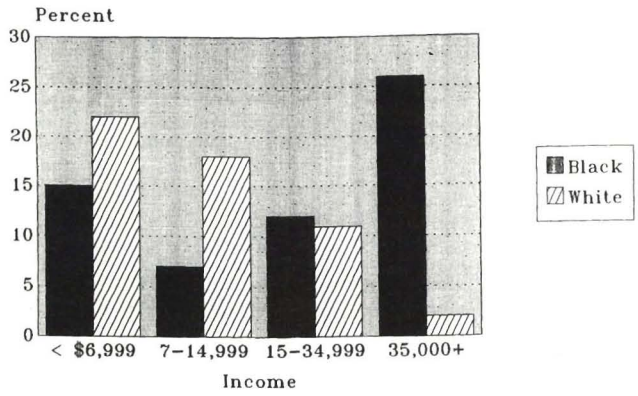


Figure 3. Children ages six to seventeen, who have never visited a dentist, by race and income, among those whose parents have less than twelve years education.

Table 2 ☐ Logistic regression results for presence or absence of dental sealants, ages 6-17.

Variable	Parameter estimate	P	Odds ratio	Confidence interval (5% 95%)
Intercept	−3.33(.20)	.001		
Race		.001		
White	.81(.14)		2.25	(1.32, 3.81)
Black	—			
Education of adult		.001		
< High School	−.82(.17)		.44	(.32, .61)
High School	−.43(.08)		.65	(.55, .76)
> High School	—			
Family income		.001		
< $6,999	−.80(.22)		.45	(.29, .69)
7-14,999	−.27(.13)		.76	(.59, .98)
15-34,999	−.40(.08)		.67	(.57, .78)
35,000 +	—			
Insurance		.001		
Yes	.20(.06)		1.22	(1.09, 1.36)
No	—			
Dental visit		.001		
Never	−2.34(.43)		.10	(.04, .22)
Less than 1 Year	1.48(.11)		4.39	(3.56, 5.40)
More than 1 Year	—			

Table 3 ☐ Logistic regression for presence or absence of dental sealants, ages 6-17, low socioeconomic status (parents with less than a high school education).

Variable	Parameter estimate	P	Odds ratio*	Confidence interval (5% 95%)
Intercept	−3.60(.99)	.001		
Race		N.S.		
White	.11(.57)			
Black	—			
Family income		N.S.		
< $6,999	−.59(.65)			
7-14,999	−.06(.49)			
15-34,999	−.18(.43)			
35,000 +	—			
Insurance		N.S.		
Yes	.76(.41)			
No	—			
Dental visit		.001		
Never	−1.4(.69)		.33	(.06, .95)
Less than 1 Year	1.07(.31)		2.91	(1.60, 5.31)
More than 1 Year	—			

*Only significant odds ratios are shown.

Table 4 ☐ Logistic regression for presence or absence of dental sealants, ages 6-17, middle socioeconomic status (parents with a high school education).

Variable	Parameter estimate	P	Odds ratio*	95% Confidence interval
Intercept	−4.04(.32)	.001		
Race		.001		
White	.92(.20)		2.51	(1.70, 3.70)
Black	—			
Family income		.05		
< $6,999	−.63(.28)		.53	(.31, .91)
7-14,999	−.30(.20)		.74	(.50, 1.09)
15-34,999	−.33(.14)		.71	(.55, .94)
35,000 +	—		—	
Insurance		N.S.		
Yes	.247(.13)			
No	—			
Dental visit		.001		
Never	−3.66(.20)		.02	(.02, .04)
Less than 1 Year	1.61(.20)		5.00	(3.39, 7.38)
More than 1 Year	—			

*Only significant odds ratios are shown.

inary analyses, all ages (six to seventeen) were combined in the model.

Among all children ages six to seventeen, being white, having dental insurance and having a dental visit in the past year were the most significant variables for predicting use of sealants (Table 2). Those children whose parents were in low income strata with limited education were less likely to have dental sealants. Table 2 also shows the odds ratios and the 95 percent confidence intervals for the significant variables based on the logistic model tested. These represent the odds of reporting sealant use with a unit change in the independent variable. For example, a white child is 2.3 times more likely to have dental sealants than a black child. Also, a child who had a dental visit in the past year is 4.4 times more likely to have dental sealants than one whose last visit was more than a year ago. As might be expected, the same pattern as seen in the overall model was observed in white children (table not shown).

The only significant variable in the model for low socioeconomic status children (education of adult less than high school) was a dental visit; those with a recent dental visit were 2.9 times more likely to have dental sealants than those who had not been to the dentist in more than one year (Table 3). Similarly, in the model for only black children the only significant variable was having a recent dental visit (table not shown). Those black children with a dental visit during the past year were 6.4 times more likely to have dental sealants than those whose last visit was more than a year ago.

In both the model for middle and upper socioeconomic status children (adult-high school, more than high

Table 5 ☐ Logistic regression for presence or absence of dental sealants, ages 6-17, upper socioeconomic status (parents with more than a high school education).

Variable	Parameter estimate	P	Odds ratio*	95% Confidence interval
Intercept	−3.36(.24)	.001		
Race		.001		
White	.89(.19)		2.43	(1.68, 3.52)
Black	—			
Family income		.001		
< $6,999	−1.02(.42)		.36	(.16, .82)
7-14,999	−.16(.22)		.85	(.55, 1.31)
15-34,999	−.44(.11)		.64	(.52, .80)
35,000 +	—		—	
Insurance		N.S.		
Yes	.14(.08)			
No	—			
Dental visit		.001		
Never	−2.36(.58)		.09	(.03, .29)
Less than 1 Year	1.47(.16)		4.35	(3.19, 5.93)
More than 1 Year	—			

*Only significant odds ratios are shown.

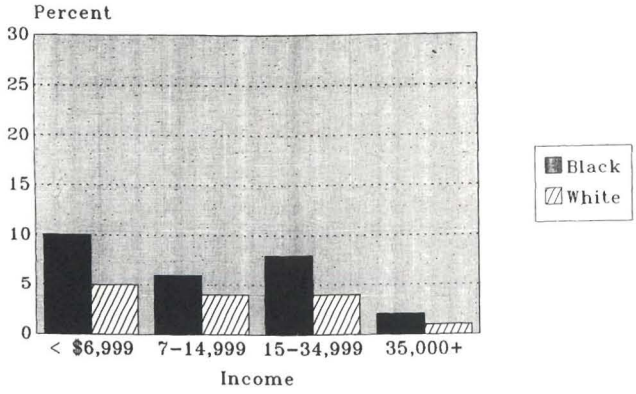


Figure 4. Children ages six to seventeen, who have never visited a dentist by race and income, among those whose parents have more than twelve years education.

school), being white, having greater family income, and having a dental visit during the past year were the most significant variables predicting use of dental sealants (Tables 4 and 5). Among children whose parents had either a high school degree or had attended college for at least a year, those children who were black, had never been to the dentist, and were from low to middle income families were the least likely to have dental sealants. For example, children of parents who had attended college for at least a year but, had incomes less than $7,000, were 0.36 times as likely to have dental sealants as those children from families whose incomes were $35,000 or more (Table 5).

DISCUSSION

Despite improvements in the oral health of children in the past several decades, there is still considerable evidence of untreated oral diseases. It appears that a large proportion of this occurs in lower SES groups. Lack of access to appropriate dental services reduces opportunities to receive preventive and therapeutic care, and appears to be a major barrier to altering disparities. One component of a comprehensive preventive strategy is the use of dental sealants, yet over the past two decades there has been a continued low use of sealants.[9,30,31]

The NHIS provides an opportunity to investigate knowledge and behaviors that could form the basis for altering the receipt of preventive services and treatment, and ultimately the patterns of untreated oral diseases. These data continue to illustrate a low use of sealants and it appears that sealants have not become part of the routine package of preventive services. Overall sealant use is 15 percent, and there was a three-fold difference in white compared to black children (17 percent versus 5 percent).

As a professionally-provided service, increased and appropriate use of dental sealants will be dependent on regular dental visits. The pattern of dental visits was strongly associated with socioeconomic variables (income and education), as was sealant use. In the upper SES groups, white children have more sealants than blacks. The analyses from the National Health Interview Survey suggest that similarly low patterns of dental visits occur in more disadvantaged black and white populations. The apparently lower use of dental services during the past year by children of parents with low education and low income status among blacks and whites is possibly attributed to lack of funds, knowledge, insurance, as well as access to dental services. Unless children in low income and education categories who visit the dentist less than those of higher SES status have improved access to dental services and improved knowledge of oral health behavior, it is unlikely that sealant use will improve. These descriptive analyses indicate that considerably more effort is needed to promote receipt of professional dental services and use of dental sealants, particularly among children of low education parents.

The focus on dental sealants in Healthy People 2000 and Health Care Reform may increase overall use and decrease the disparity which exists for low SES children. The Healthy People 2000 oral health objectives stress the disparities in oral health status of low SES and racial minorities and the need for more preventive services to overcome disadvantages. To meet these needs for the poor and underserved populations, health promotion

strategies need to be directed toward regular dental visits and appropriate application of dental sealants. Particular attention needs to be directed toward racial minorities who seek routine dental care or preventive therapy less often. Such efforts might include:

- ☐ Educational efforts at the community as well as individual level.
- ☐ Improved efforts by practitioners to reach minority populations.
- ☐ Increased environmental and financial efforts of public and private groups to increase sealant use.

Ways to incorporate sealants as an integral component of clinical decision making for children and adolescents in both the private and public sectors are needed. Also, more attention needs to be directed toward the identification of risk factors for dental caries and sealants as an alternative to other treatment.

Beyond efforts to encourage provision of dental sealants to appropriate patients by dental professionals, efforts are needed to increase awareness since the public appears not to understand the added value of sealants for the prevention of occlusal caries.[32] Public education should encourage and facilitate the discussion of appropriate preventive care. These findings create challenges for dental professionals working within their communities world-wide.

REFERENCES

1. Brunelle, J.A.; Carlos, J.P.: Recent trends in dental caries in US children and the effect of water fluoridation. J Dent Res, 69(Spec Iss):723-727, March 1990.
2. White, A.: Toward Improving the Oral Health of Americans. J Public Health Reports, 108:657-681, November-December 1993.
3. National Institute of Dental Research. *The Oral Health of United States Children: The National Survey of Dental Caries in U.S. School Children, 1986-87.* DHHS Pub. No. (NIH) 89-2247. Bethesda, MD: U.S. Department of Health and Human Services, 1989.
4. Bohannan, H.M.: Caries distribution and the case for sealants. J Public Health Dent, 43:200-204, Summer 1983.
5. Stamm. J.W.: Is there a need for dental sealants?: epidemiological indications in the 1980s. J Dent Educ, 4 (suppl):9-17, February 1984.
6. Brunelle, J.: Prevalence of dental sealants in US school children (abstract). J Dent Res, 68:183, March 1989.
7. Ripa, L.W.: A critique of topical fluoride methods (dentifrices, mouthrinses, operator-, and self-applied gels) in an era of decreasing caries and increased fluorosis prevalence. J Public Health Dent, 51:23-41, Winter 1991.
8. *Healthy People 2000, National Health Promotion and Disease Prevention Objectives.* U.S. Department of Health and Human Services, Public Health Service. Washington, DC: U.S. Department of Health and Human Services; DHHS Publication No. (PHS) 91-50212, pp 226-247, 271-293,1991.
9. Nowjack-Raymer, R.E.; Gift, H.C.: Contributing factors to maternal and child oral health. J Pub Health Dent, 50:370-378, June (Special issue) 1990.
10. Gift, H.C.; Frew, R.: Sealants: changing patterns. JADA, 112:391-392, March 1986.
11. Gift, H.C.; Newman, J.F.: Oral health of US children: results of National Health Interview Survey. JADA, 123:96-106, October 1992.
12. Cueto E. and Buonocore M.: Adhesive sealing of pits and fissures for caries prevention. Abst #400. IADR Program and Abstracts of Papers. 43rd General Meeting. J Dent Res, 44:400, July 1995.
13. Cueto, E. and Buonocore, M.: Sealing of pits and fissures with an adhesive resin: its use in caries prevention. JADA, 75:121-128, 1967.
14. Weintraub, J.A.: The effectiveness of pit and fissure sealants. J Public Health Dent, 49:317-330, Spring (Special issue) 1989.
15. Ripa, L.W.: The current status of pit and fissure sealants: a review. Canad Dent Assoc J, 51:367-380, 1985.
16. Mandel, I.D.: Dental caries: another extinct disease? In: Bowen, W.H.; Tabak, L.A., eds. *Cariology for the nineties.* Rochester, NY: University of Rochester Press, pp 1-10, 1993.
17. Proceedings, National Institutes of Health Consensus Development Conference: Dental Sealants in the Prevention of tooth Decay. J Dent Educ (special issue), 48(2), 1984.
18. Ripa, L.W.: Occlusal sealants: An overview of clinical studies. J Public Health, 43:216-225, Summer 1983.
19. Burt, B.A.: Cost-effectiveness of sealants in private practice and standards for use in prepaid dental care. J Am Dent Assoc, 110: 103-107, January 1985.
20. Glasrud, P.H.: Insuring preventive dental care: are sealants included? Am J Public Health, 75:285-286, 1985.
21. Koop, C.E. [Statement on] Dental sealants. J Public Health Dent, 44:126, Summer 1984.
22. Gift, H.C.; Frew, R.; Hefferren, J.J.: Attitudes toward and use of pit and fissure sealants. J Dent Child, 42:460-466, November-December 1975.
23. Weintraub, J.A.; Stearns, S.C.; Burt, B.A. *et al*: A retrospective analysis of the cost-effectiveness of dental sealants in a children's health center. Soc Sci Med, 36:1483-1493, June 1993.
24. Selwitz, R.H.; Colley, B.J.; Rozier, R.G.: Factors associated with parental acceptance of dental sealants. J Public Health Dent , 52: 137-145, Spring 1992.
25. Adams, P.F. and Benson, V.: Current estimates from the national health interview survey, 1989. National Center for Health Statistics, Vital Health Statistics, 10 (176), 1990.
26. Bloom, B.; Gift, H.C.; Jack, S.S.: Dental services and oral health: United States, 1989. National Center for Health Statistics. Washington, D.C.: U.S. Department of Public Health; DHHS (Vital and health statistics, series 10, 183, 1993.
27. Ripa, L.W.: Occlusal sealing: Rationale of the technique and historical review. J Amer Soc Prev Dent, 3:32-39, 1973.
28. Leverett, D.H.; Handelman, S.L.; Brenner, C.M. *et al*: Use of sealants in the prevention and early treatment of carious lesions: cost analysis. JADA, 108:83-87, January 1984.
29. Shah, B.V.; Barnwell, B.G.; Hunt, P.N. *et al*: *Sudaan Users Manual*, Version 5.3 Research Triangle Institute, Research Triangle Park, NC 1991, pp 6-18.
30. Cohen, L.; LaBelle, A.; Romberg, E.: The use of pit and fissure sealants in private practice: a national survey. J Pub Health Dent, 48:26-35, Winter 1988.
31. Horowitz, A.M.: Effective oral health education and promotion programs to prevent dental caries. Internat Dent J, 33:171-181, June 1982.
32. Gift, H.C.; Corbin, S.B.; Nowjack-Raymer, R.E.: J Pub Health Reports, 109:397-404, May-June 1994.

CLINIC

Anterior tooth trauma in the primary dentition: Incidence, classification, treatment methods, and sequelae: A review of the literature

Irwin Fried, DDS, MS
Pamela Erickson, DDS, PhD

Trauma to the primary anterior dentition continues as a frequent dental problem. So long as young children remain active, accidents will occur that require careful and conscientious care. These accidents pose challenges to the dentist, not only in behavior management, but also in determining the proper treatment. With knowledge of the potential prognoses of various treatment modalities, the dentist can make a better assessment and carry out treatment more effectively.

We review the literature to present information pertaining to primary anterior tooth trauma, including its incidence, different types of classifications used, methods of treatment, follow-up, and possible sequelae.

INCIDENCE

Traumatic injury to the primary dentition is a common occurrence. A review of the literature showed that the incidence range is from 4 percent to 30 percent, depending on the location and type of study.[1] Anterior teeth are the most commonly traumatized. Galea found that 71 percent of cases involved the maxillary central incisors.[2] This was three times more frequent than the involvement of the maxillary lateral incisors. Studies have also looked at the sex predilection and found that it varied depending on the age of the child (Table 1).[1-3] Garcia-Godoy *et al* found that males between one and two years and females between one and two and between three and four years showed the highest number of trauma cases.[3] Andreasen and Ravn report that in boys, the highest number of injuries occurred at two to four years and in girls between two to three years of age. Ferguson and Ripa found that both males and females showed the highest number of cases between the ages of four to five years. In either case, Garcia-Godoy *et al* seem to summarize it best when they say, "...more traumatic dental injuries occur to younger children, probably because the children are gaining mobility and independence, yet lack full coordination and judgment."[3]

CLASSIFICATION OF TRAUMA

Traumatic injuries have been classified in various ways.[6,7] An easy and accepted classification is first to subclassify the condition into trauma affecting the tooth, that is fracture; and second, trauma affecting the periodontium. A combination of subclassifications may occur following a traumatic accident. The classification put forth by Ellis

Table 1 ☐ Highest incidence of primary tooth trauma.

Age range (years)		Authors
Male	Female	
1-2	1-2	Garcia-Godoy[3]
2-4	2-3 & 3-4	Andreasen[4]
4-5	4-5	Ferguson[5]

Dr. Fried is a Resident and Dr. Erickson is Assistant Professor, Department of Preventive Sciences, University of Minnesota.

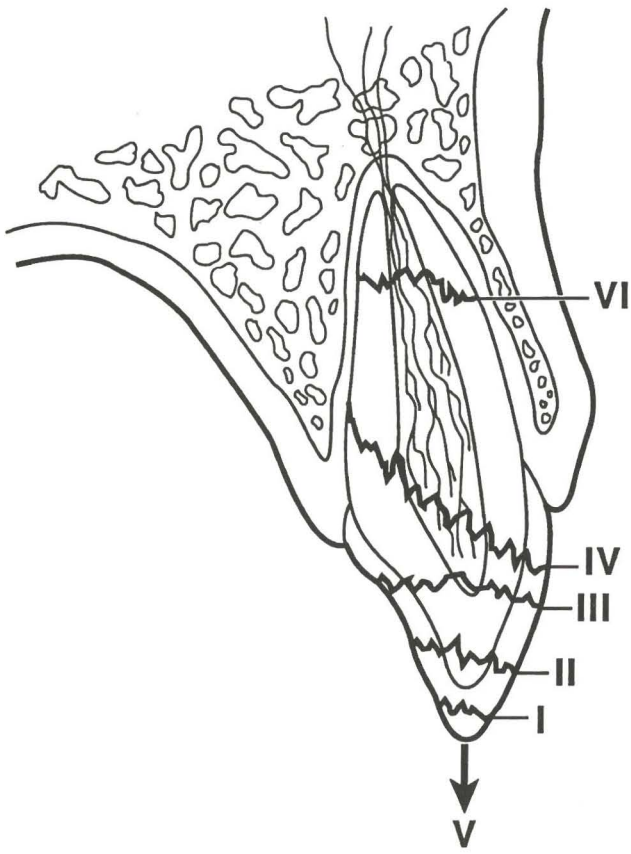


Figure. Classification of Hard Tissue Fractures (A modification of the Ellis Classification). This figure designates the types of hard tissue fractures which may occur following trauma to the orofacial area. As shown above, a class I fracture is a simple fracture of enamel only. A class II fracture includes enamel and dentin. A class III fracture extends farther into the tooth, with a small pulpal exposure. Whereas, a class IV fracture involves a significant amount of pulpal exposure. A class V fracture involves complete loss of the tooth, or avulsion. And, a root fracture is classified as a class VI fracture.

for tooth fractures has been modified, but is still in common use.[7] Fractured primary teeth are often classified in the same way as permanent teeth. For example, a Class I fracture pertains to an enamel fracture only: a Class II fracture refers to enamel and dentin, etc., as displayed in Figure.

The subclassification of tooth trauma affecting the periodontium is more difficult. Many authors use the following definitions, as described in Table 2.[2,3,6,8-11]

- ☐ *Concussion* is defined as sensitivity of the tooth due to trauma without abnormal loosening or mobility.[6,11] The tooth may be sensitive to percussion following the trauma.
- ☐ *Subluxation* is defined as the loosening of the tooth (mobility) without displacement.[9,11]
- ☐ *Luxation* is defined as the displacement of a traumatized tooth.[9,11] It can occur in a variety of directions including labially, palatolingually, mesially, distally, by extrusion, or any combination of two or more. Crushing of the alveolar socket may occur in any case. A complete displacement of the tooth from its socket is termed avulsion.[6,11] In severe trauma, with excessive force, alveolar fracture may be associated with tooth displacement. Refer to Table 3 for the incidence of trauma to the primary dentition by subclassification.

DIAGNOSIS

Careful diagnosis and case documentation is the first step in treatment of any traumatic injury. This procedure can be done rapidly, but should be carried out in a thorough and stepwise manner, as described in Table 4. The importance of this process is often overlooked or ignored by many dentists. Diagnosis and case documentation should include the time elapsed since the accident, what care was given immediately following trauma, the indication for tetanus or other medications, and the determination of the need to transfer the case to another dentist. Well documented records are needed in these cases, because traumatized teeth may become symptomatic years later. The use of photographs, both preoperative and postoperative, is becoming a widespread practice for documentation purposes. All documentation should be maintained for possible insurance and liability claims.

Table 2 ☐ Tooth trauma to the periodontal tissues.

Type of injury	Effect on tooth	Treatment options
Concussion	Sensitivity	No treatment, Relieve occlusion
Sub-Luxation	Mobility	No treatment, Relieve occlusion, Splint, Relieve and splint, Extract
Luxation	Displacement	No treatment, Realignment, Realignment and splint, Extract
Avulsion	Exarticulation	No treatment, Re-implant and Splint

Table 3 ☐ Incidence of injury by classification.

Classification	Author				
	Garcia-Godoy[3]	Andreasen[12]	Galea[2]	Ravn[10]	von Arx[13]
Concussion	34.7%	—	—	—	—
Subluxation	14.4%	12%	27.8%	25%	18%
Luxation (all types)	21.6%	50%	40.7%	50.8%	55%
Avulsion	11.5%	13%	11.7%	19.4%	18%

Table 4 ☐ Diagnostic steps following dental trauma.

Steps
1. Medical and health history
2. Neurologic evaluation
3. Clinical examination of head and neck
4. Oral examination
a. Soft tissues
b. Hard tissues
5. Radiographic examination
6. Photographic documentation

When a patient presents to a dental practitioner following dental trauma, the entire craniofacial complex should be evaluated as part of the initial examination. Because early diagnosis of neurologic injury is crucial to preventing subsequent morbidity, a rapid neurologic evaluation should be performed.[14] Medical attention. if needed, should be sought. The tetanus status of the child should also be determined and the need for antibiotics should be assessed.

An overall clinical examination of the head and neck region should be performed. Extra-oral wounds, such as contusion, lacerations, or abrasions, should be assessed and treated, if necessary. If lacerations are present on facial skin, they are better treated by a plastic surgeon. At this time, jaw movements should be checked for normal range of movements, pain, and presence of deviation. If any of the above are abnormal, jaw fracture must be considered and evaluated radiographically.

An oral examination is commenced with a cursory verification of all soft tissues of the mouth and throat. If bleeding or blood clots interfere with proper vision, the areas should be cleaned with wet gauze. If a soft tissue wound is present, and a piece of tooth is unaccounted for, the wound should be cleaned, palpated, and verified with radiographic supplementation to ensure that the suspected foreign body is not present.

A dental examination begins with the determination of the child's stage of dentition. A mobile tooth may not be traumatized, but exfoliating. The mouth is surveyed for any tooth avulsions. Teeth with fractures are checked next, and their respective fracture classification is noted. Displacement of teeth is then verified, including the direction and distance of the luxation. It must also be assessed as to whether a bony fracture occurred, and whether the alveolar segment was displaced with the tooth. The mouth is then surveyed for any subluxated teeth. noting the degree and distance of mobility. The occlusion is checked, including overbite/overjet relationships, and any intradental interferences. Finally, any noticeable differences or dental abnormalities should be noted, including teeth that are fractured, irregularly shaped, discolored, or previously traumatized.

Radiographs must be taken for initial diagnosis, follow-up records, and insurance and liability documentation.[8] Routine radiographs may include one of the following views or a combination of views: occlusal, lateral, periapical, or soft tissue radiographs.

Following the evaluation of the medical status of the child and the determination of the classification of the trauma sustained, dental treatment can begin. Treatment methods for traumatized teeth vary greatly. Many factors must be considered, such as: the type and severity of trauma; the maturity of the tooth; the length of time since the trauma occurred and whether an alveolar fracture was associated with the trauma. In all cases, parents should be completely informed of treatment options and their respective prognoses.

TREATMENT

Primary teeth suffering from concussion often do not require treatment. These teeth may be sensitive but have not been displaced in the socket. Some authors recommend relieving the occlusion to prevent a hyperocclusion and to decrease the child's discomfort.[15]

Treatment of a subluxated tooth depends on the considerations mentioned previously. Treatment options may include performing no treatment, relieving the occlusion, splinting the tooth for approximately ten days, and/or extraction.[15,16] For example, if the tooth has minimal mobility, no treatment or relief of the occlusion should be considered. If the tooth had a large degree of mobility or was near exfoliation, however, extraction may be the preferred treatment. Individual assessment is necessary, therefore, when evaluating the potential treatment.

Luxation injuries must be evaluated carefully before treatment begins. The direction and severity of the trauma, as well as the maturity of the tooth and the presence or absence of an alveolar bone fracture play important roles in choice of treatment. Intrusive luxations are often left in their intruded position and monitored for re-eruption.[15,16] An exception to this is if the

intruded tooth appears to be in contact with the permanent tooth bud or if the apex of the tooth in question has pierced the labial plate of bone (supported by evidence seen in a lateral radiograph).[16] In these circumstances, extraction should be considered. Treatment of extrusive luxations depends on the amount of extrusion and the maturity level of the tooth. If the tooth is minimally displaced, replacement and splinting for approximately ten days should be considered. If the tooth is extruded to the point where it can almost be considered an avulsion, or the tooth is near exfoliation, extraction is usually the treatment of choice. Displacement of the tooth in the palatal or labial direction is associated with comminution of the alveolar bone. At times, the blow may be severe enough to fracture the alveolar plate. If an alveolar bone fracture has occurred, repositioning and splinting of the tooth is necessary, regardless of the severity of the displacement, to allow for bone healing to occur. Proper healing may take four to six weeks. Under these conditions ankylosis is less of a concern; the tooth should still be monitored, however, for the possibility of ankylosis. If no bone fracture has occurred, treatment options include leaving the tooth as is, providing it does not interfere with occlusion, or realignment of the tooth with or without splinting, or extraction.

Avulsions of primary teeth are usually not reimplanted for fear of future infection, ankylosis, or trauma to the permanent tooth. On occasion, attempts are made to reimplant the tooth. An example of such a case is when parents are very concerned about their child losing a natural body part. If an attempt is going to be made to reimplant the tooth, a light wire should be used as a splint for a short duration (seven to ten days), to avoid ankylosis, which is a serious sequela to this type of treatment.[17] In these cases, the time lapse between avulsion and reimplantation should be minimal. The tooth should be kept in a suitable solution to maintain the viability of the cells on the root, such as a physiologic saline solution or milk.[18] As well, there should be no previous signs or symptoms of pain or trauma associated with the tooth.

Table 5 ☐ Treatment of dental tissues.

Type of injury	Treatment options
Class I	No treatment, Smooth, Resin restoration
Class II	No treatment, Resin restoration, Extract
Class III	Pulp therapy, SSC or resin restoration, Extract
Class IV	Pulp therapy, SSC or resin restoration, Extract
Class V	No treatment
Class VI	No treatment, Extract

Trauma of the dental hard tissues is dependent on the classification of tooth fracture and the child's stage of dental development (Table 5). As well, patient management must be considered in the treatment decisions. If a combination of trauma occurs to the periodontal and hard tissues, careful consideration must be given to both types of trauma before formulating a treatment plan.

A primary tooth that has sustained a Class I fracture often does not require treatment. If necessary, the tooth may be smoothed or polished to eliminate roughness. If a larger fracture was sustained, a composite resin restoration may be placed to restore the tooth to its natural conformation.

Treatment of a Class II fracture consists primarily of covering the fracture with a composite resin restoration. If the fracture is into deeper layers of dentin, steps to protect the pulp should be taken: Such as a glass ionomer base or calcium hydroxide, to decrease the potential for pulpal sensitivity.

Teeth sustaining a Class III dental fracture must be evaluated carefully. The maturity of the tooth and the size of pulp exposure must be considered. Extraction should be considered, if the tooth is nearing exfoliation or behavior management is a concern.[10] If possible, an attempt to save the tooth, however, should be considered. Treatment options include a direct pulp capping, a partial pulpotomy, a pulpotomy, or a pulpectomy, followed by restoration with a stainless steel crown or composite resin restoration. Direct pulp capping of primary teeth often fails.[19] A partial pulpotomy can be attempted; to date, however, there is only one successful case reported in the literature.[20]

Treatment of a Class IV fracture depends on the factors discussed in treating a (Class III fracture, as well as whether the fracture site along the root is negotiable. If restoration is possible, treatment should be accomplished as discussed previously for a Class III fracture. If restoration is not possible, however, extraction is the treatment of choice.

Teeth sustaining root fractures are often extracted. If the coronal section is highly mobile or causing discomfort, it can be extracted, leaving the apical portion to resorb physiologically.[8] If the root fragment can be retrieved with minimal difficulty, however, it should be removed. If an attempt is to be made to save the tooth, the dentist should be aware that calcific healing does not occur. and that the coronal section will maintain a certain amount of mobility.[8]

POSTTRAUMA DENTAL CARE

Careful follow up to a traumatic injury is very important. The sequelae to tooth trauma range from the tooth remaining normal and asymptomatic to the loss of the traumatized tooth. The more severe the injury, the shorter the recall of the patient should be. For example, for a luxated tooth requiring a splint, the patient should be seen at seven to ten days following trauma to remove the splint, and then at three to four weeks, three months, and six months. Future evaluations should be scheduled at six month intervals.

The key reason for the recall examination is to ensure that no problems have arisen that may cause damage to the developing permanent tooth. Permanent teeth often show posttraumatic damage, such as enamel hypoplasias and dilaceration. Von Arx reported that the frequency of malformations of the permanent tooth following primary tooth trauma ranged from 25 percent to 69 percent.[13] To avoid these problems, posttrauma follow-up should assess tooth mobility, symptoms related to the tooth, discoloration, sound and pain on percussion, and signs of infection (clinically and radiographically).

Tooth mobility should be measured at subsequent recall visits. If the tooth remains abnormally mobile, it should be evaluated for hyperocclusion or need for splinting. If hyperocclusion exists, the occlusion should be relieved, and the patient maintained on a soft diet until the mobility returns to normal. If the mobility decreases and then increases, repeated trauma may have occurred or an infection may be present. If an infection is present, as evaluated by clinical or radiographic assessment, an extraction should be performed. If the mobility decreases to zero, no physiologic movement is present and the tooth may have become ankylosed. This can lead to problems with eruption of the permanent successor, and extraction is indicated.

The presence of symptoms reported by the patient or the parent should also be evaluated as possible indications for pulp therapy or tooth extraction. Spontaneous pain, or pain associated with hot and/or cold are indications of pulp degeneration.[21] While traumatized teeth showing symptoms of spontaneous pain should be extracted, symptoms of hot and/or cold sensitivity are often treatable by performing pulp therapy. The tooth should be carefully assessed, however, for other signs of morbidity. If other signs are present, extraction may be the treatment of choice.

Discoloration is a common occurrence following primary tooth trauma.[22] Discoloration can range from yellow or pink to grey or black.[23] The yellowish hue is thought to be due to partial obliteration of the pulp canal. The pink hue may be due to blood pigments entering the dentinal tubules at the time of trauma. The grey or black tooth is generally thought to be due to pulpal death.[22-24] There are differing opinions as to the treatment of discolored teeth. Several authors suggest that grey and/or black teeth are a source of infection and should be extracted.[22-25] Other authors have found, however, that forty-four of fifty-eight grey teeth eventually turned yellow, indicating obliteration of the pulp canal.[25] Another study found that discoloration of the primary teeth was associated with various irreversible pulp changes.[22] Periapical osteitis was found in 82 percent of grey teeth within one month of trauma.[24] Because of these differing opinions, tooth discoloration should be used as an adjunct in diagnosis, but not as the sole criterion in determining the need for extraction. Sonis found that "72 percent of discolored primary teeth failed to develop any radiographic and/or clinical evidence of pathology".[26]

Percussion testing has relative importance at follow-up visits. Its main purpose is to detect the occurrence of ankylosis. This can be determined by hearing a dull thud. Testing for sensitivity upon percussion should be done; the results, however, should be used with caution. Children often fail to understand what the clinician is trying to assess from percussion testing and find all tapping "painful". Vitality testing can be attempted; in children, however, these tests are often unreliable.[8,27] These methods of testing should be used, therefore, only as an adjunct to diagnosis.

A dental radiograph should be taken periodically to monitor tooth development, resorption, and/or signs of infection. Radiographic examination is important in assessing pulp calcification, internal and/or external inflammatory root resorption, replacement resorption (ankylosis). or periapical infection.

Generally any condition which may interfere with the development of the permanent tooth (periapical infection, ankylosis) is an indication for extraction of the traumatized primary tooth. At times, pulp therapy may be attempted, in order to save the tooth from premature loss. If this treatment is attempted, however, the clinician should carefully follow up the patient to ensure that a chronic infection does not persist. Should the infection not resolve itself, the tooth should be extracted, to avoid potential damage to the permanent successor.

DISCUSSION

The literature review discusses injury classifications and diagnostic methods used to assess the type and extent

of trauma. Treatment modalities are presented, with emphasis on the appreciation of the uniqueness of each case. All factors must be considered before definitive treatment can be accomplished. Circumstances that may necessitate alteration of the proposed treatment plan include severe trauma to other craniofacial structures requiring immediate medical attention, behavior management issues, the child's ability to undergo the treatment of choice, and the tooth that does not respond to treatment as expected. In all cases, of ultimate importance is the minimization or alleviation of the child's pain, prevention of further infection, and decrease of potential damage to the permanent succudaneous tooth.

Presently, there is literature available detailing many aspects of primary anterior tooth trauma. One must take into consideration that much of the literature presents retrospective and anecdotal data. Further research is needed in all areas involving primary tooth trauma. With increased case reports of differing diagnostic and clinical findings, dentists will improve their ability to diagnose and treat these traumatic injuries.

CONCLUSION

Based on the reviewed studies, it is obvious that this information is relevant to the practicing dentist. The incidence of traumatic injury to the primary anterior teeth remains high. It can be concluded that careful diagnosis and follow-up are necessary. Treatment will differ depending on various factors; the ultimate goal, however, is to prevent future complications related to the permanent successor.

REFERENCES

1. Andreasen, J.: Challenges in clinical dental traumatology. Endodont Dent Traumatol, 1:45-55, April 1985.
2. Galea, H.: An investigation of dental injuries treated in an acute care general hospital. JADA, 109:434-438, September 1984.
3. Garcia-Godoy, F.; Garcia-Godoy, F.; Garcia-Godoy, F.M.: Primary teeth traumatic injuries at a private pediatric dental center. Endod Dent Traumatol, 3:126-129, June 1987.
4. Andreasen, J. and Ravn, J.: Epidemiology of traumatic dental injuries to primary and permanent teeth in a Danish population sample. Int J Oral Surg, 1(5):235-239, 1972.
5. Ferguson, F. and Ripa, L.: Prevalence and type of traumatic injuries to the anterior teeth of preschool children. J Pedod, 3:3-8, Fall 1979.
6. Johnson, R.: Descriptive classification of traumatic injuries to the teeth and supporting structures. JADA, 102:195-197, February 1981.
7. Ellis, R. and Davey, K.: *The Classification and Treatment of Injuries to the Teeth of Children*, 4th ed. R.G. Ellis, Ed. Chicago: Year Book Publishers, Inc., 1970.
8. Andreasen, J. and Andreasen, F.: *Essentials of Traumatic Injuries of the Teeth*, 2nd ed. J. Andreasen and F. Andreasen, Eds. Copenhagen: Munksgaard International Publishers, 1981.
9. Meadow, D.; Lidner, G.; Needleman, H.: Oral trauma in children. Pediatr Dent, 6:248-251, December 1984.
10. Ravn, J.: Sequelae of acute mechanical traumata in the primary dentition. J Dent Child, 35:281-289, July 1968.
11. Garcia-Godoy, F.: A classification for traumatic injuries to primary and permanent teeth. J Pedod, 5:295-297, Summer 1981.
12. Andreasen, J.: Etiology and pathogenesis of traumatic dental injuries: A clinical study of 1,298 cases. Scand J Dent Res, 78(4): 329-342, 1970.
13. von Arx, T.: Developmental disturbances of permanent teeth following trauma to the primary dentition. Austr Dent J, 38:1-10, February 1993.
14. Croll, T.; Brooks, E.; Schut, L.*et al*: Rapid neurological assessment and initial management of the patient with traumatic dental injuries. JADA, 100:530-534, April 1980.
15. Mackie, I. and Warren, V.: Dental trauma: 1. General aspects of management, and trauma to the primary dentition. Dental Update, 15:155-159, May 1988.
16. Davis, M.: The treatment of traumatic injuries to the teeth of children. NYJ Dent, 54:65-67, February 1984.
17. Croll, T.; Pascon, E.; Langeland, K.: Traumatically injured primary incisors: A clinical and histological study. J Dent Child, 54:401-422, November-December 1987.
18. Courts, F.; Mueller, W.; Tabeling, H.: Milk as an interim storage medium for avulsed teeth. Pediatr Dent, 5:183-186, September 1983.
19. Camp, J.: Pulp Therapy for Primary and Young Permanent Teeth. Dental Clinics of North America, 28:651-668, October 1984.
20. Ram, D. and Holan, G.: Partial pulpotomy in a traumatized primary incisor with pulp exposure: case report. Pediatr Dent, 16:46-48, January/February 1994.
21. McDonald, R. and Avery, D.: Treatment of Deep Caries, Vital Pulp Exposure, and Pulpless Teeth. In: *Dentistry for the Child and Adolescent*, 6th Ed. R.E. McDonald, D.R. Avery, Eds. St. Louis: Mosby-Year Book Inc, 1994, pp 428-454.
22. Soxman, J.; Nazif, M.; Bouquot, J.: Pulpal pathology in relation to discoloration of primary anterior teeth. J Dent Child, 51:282-284, July-August 1984.
23. Bennet, D.: Traumatized anterior teeth. Br Dent J, 116:52-55, January 1964.
24. Schroder, U.; Wennberg, E.; Granath, L.*et al*: Traumatized primary incisors follow-up program based on frequency of periapical osteitis related to tooth color. Swed Dent J, 1(3):95-98, 1977.
25. Jacobsen, I. and Sangnes, G.: Traumatized primary anterior teeth. Prognosis related to calcific reactions in the pulp cavity. Acta Odontol Scand, 36:199-204, June 1978.
26. Sonis, A.: Longitudinal study of discolored primary teeth and effect on succedaneous teeth. J Pedod, 11:247-252, Spring 1987.
27. McTigue, D.: Introduction to dental trauma: Managing traumatic injuries in the primary dentition. In: *Pediatric Dentistry: Infancy Through Adolescence*, 2nd Ed. J.R. Pinkham, Ed. Philadelphia: W.B. Saunders Company, 1988, pp 171-182.

Characteristics of premaxillary supernumerary teeth: A survey of 112 cases

Jeng-fen Liu, DDS, MS

Teeth formed in excess of the normal number are termed supernumerary. Supernumerary teeth occur in 0.3 to 3.8 percent of the population; of these, 90 to 98 percent occur in the maxilla with a particular predilection for the premaxilla.[1,2] The prevalence of the supernumerary teeth may be as high as 28 percent in patients with cleft lip and palate.[3] Supernumerary teeth have been reported in both the primary and permanent dentitions. The incidence is lower in primary dentitions. The majority of the primary supernumerary teeth are of the supplemental type and seldom remain impacted.[4,5] Supernumerary teeth may occur singly, in multiples, unilaterally or bilaterally, and in the maxilla, the mandible or both. Maxillary midline supernumeraries (mesiodens) are the most common type, followed by maxillary lateral incisors, and mandibular third premolars.[6] While there is no significant sex distribution in primary supernumerary teeth, males are affected approximately twice as frequently as females in the permanent dentition.[7] Supernumerary teeth may erupt normally, stay impacted, appear inverted, assume an ectopic position, or follow an abnormal path of eruption. It is found that approximately 25 percent of supernumerary teeth are erupted, while the rest are unerupted.[6] The development of such teeth may precipitate a variety of complications, such as crowding, delayed eruption, diastema, rotations, cystic lesions, and resorption of adjacent teeth.

The etiology of supernumerary teeth is not known, but several theories have been introduced to explain the phenomenon. A theory has been proposed where it is opined that a supernumerary tooth is created as a result of dichotomy of the tooth bud. The supernumerary tooth may develop from the complete splitting of a tooth bud. The dental-lamina hyperactivity theory suggests that supernumeraries are formed as a result of local, independently conditioned hyperactivity of the dental lamina. Most literature on the subject supports the dental lamina hyperactivity theory.[8,9] In addition, heredity may have a role in the occurrence of this anomaly. Stafne in a survey of 200 patients with supernumerary teeth, concluded that in 90 percent of his cases, there was a definite genetic influence.[10]

Detection of supernumerary teeth is best achieved with a thorough clinical examination and routine radiographic surveys. Localization of impacted supernumerary teeth can be achieved with one of the several available techniques of which the most frequently used are the horizontal shift and the vertical shift techniques.

The purpose of this study was to investigate the characteristics of premaxillary supernumerary teeth among children in central Taiwan.

MATERIAL AND METHOD

The study population comprised 112 children (83 boys and 29 girls), with diagnoses of supernumerary teeth in the premaxillary regions and ranging in age from four years, nine months to fourteen years, ten months. The mean age was eight years, five months. All the patients

Dr. Liu is in the Department of Pediatric Dentistry, Taichung Veterans General Hospital, Taiwan.

Figure 1. Conical type supernumerary tooth.

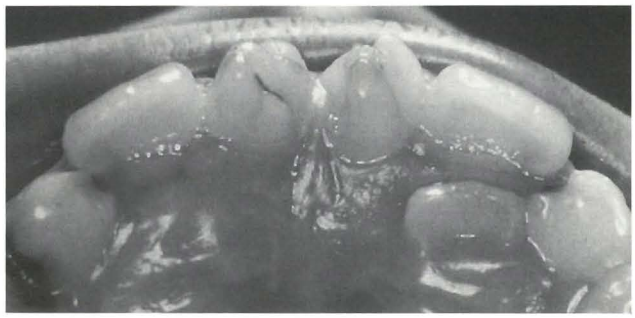


Figure 2. Tuberculate type supernumerary tooth.

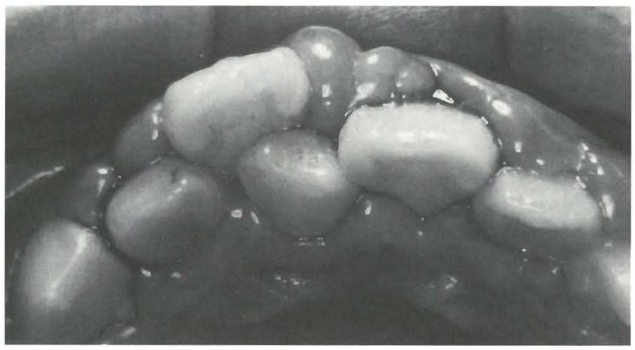


Figure 3. Supplemental type supernumerary tooth.

Figure 4. Inverted and transverse by position supernumerary tooth.

in this study visited Taichung Veterans General Hospital Taiwan between 1988 to 1992. These patients visited Taichung Veteran General Hospital for several reasons, which included caries, malocclusion, routine dental check up, and evaluation of supernumerary teeth. The characteristics of supernumerary teeth were obtained from maxillary occlusal films, periapical radiographs and clinical examinations, and were confirmed by surgical intervention. Two periapical radiographs were taken from different horizontal angulations and Clark's rule was applied to diagnose the sagittal position of the supernumerary tooth. Patients with syndromes known to be predisposed to supernumerary teeth, such as clefts of the lip, and palate, cleidocranial dysplasia, and Gardner syndrome were not included in this study.

RESULTS

In the 112 patients, 83 were boys and 29 were girls ranging in age from four years, nine months to fourteen years, ten months (Table 1).

The total number of supernumerary teeth was 152 among the 112 patients (Table 2). Seventy-two patients (64.3 percent) had one supernumerary tooth. Forty patients (35.7 percent) had two supernumerary teeth, and none had more than two supernumerary teeth (Table 3). The morphology of supernumerary teeth was classified as conical, tuberculate or one of several supplemental types. Of these 152 supernumerary teeth, 103 (67.7 percent) were conical shape, forty-three (28.3 percent) were tuberculate shape, six (4 percent) were of a supplemental type (Table 4).

One hundred and forty-seven (96.7 percent) of the supernumerary teeth were located in the central region, and of these, fifty-seven supernumerary teeth were located in the midline region. Only five (3.3 percent) were in the lateral incisor region. None was in the canine region (Table 5).

Fifty-three supernumerary teeth (34.8 percent) were in the vertical position, 70 (46 percent) were in the inverted position, and only 29 (19 percent) were in the transverse position (Table 6).

One hundred and nineteen supernumerary teeth (78.3 percent) were in the palatal position, three supernumerary teeth (2 percent) were in the labial position, and

Table 1 ☐ Distribution of premaxillary supernumerary teeth by sex.

Sex	Number of patient	Percentage
male	83	74.2
female	29	25.8
total	112	100

Table 2 ☐ Average number of supernumerary teeth per patient.

Sex	Number of ST	Average
Male	114	1.37
Female	38	1.31
Totals	152	1.35

Table 3 ☐ Distribution of supernumerary teeth by sex and number.

Sex	One supernumerary tooth	Two supernumerary teeth	% of 2 supernumerary teeth
Male	52	31	37.3
Female	20	9	31.0
Total	72	40	35.7

Table 4 ☐ Type of supernumerary teeth in the premaxilla.

Type	Number	Percentage
Conical	103	67.7
Tuberculate	43	28.3
Supplemental	6	4
Totals	152	100

Table 5 ☐ Position of supernumerary teeth in the premaxilla.

Position	Number	Percentage
Midline	57	37.5
Central incisors	90	59.2
Lateral incisors	5	3.3
Canines	0	0
Totals	152	100

Table 6 ☐ Orientation of supernumerary teeth in the premaxilla.

Orientation	Number	Percentage
Normal	70	46
Inverted	53	34.8
Transverse	29	19
Totals	152	100

Table 7 ☐ Sagittal position of supernumerary teeth in the premaxilla.

Sagittal position	Number	Percentage
Labial	3	67.7
Palatal	119	28.3
Within arch	30	4
Totals	152	100

Table 8 ☐ Eruption of supernumerary teeth in the premaxilla.

	Number	Percentage
Eruption	52	34.2
Uneruption	100	65.8
Totals	152	100

Table 9 ☐ The relationship between type of supernumerary teeth and eruption rate.

Type	Erupted supernumerary teeth	Totals	Eruption rate
Conical	33	103	32.0
Tuberculate	16	43	37.2
Supplemental	5	6	83.3

Table 10 ☐ The relationship between unerupted supernumerary teeth and its orientation.

Position	Unerupted supernumerary teeth	Totals	Percentage of erupted supernumerary teeth
Normal	11	53	20.7
Inverted	70	70	100
Transverse	29	29	100

thirty supernumerary teeth (19.7 percent) were within the arch (Table 7).

Fifty-two supernumerary teeth (34.2 percent) were erupted, 100 (65.8 percent) were unerupted (Table 8); 37 percent tuberculate shaped supernumerary teeth were erupted, 32 percent of the conical shaped supernumerary teeth were erupted; and 83.3 percent of supplemental type supernumerary teeth were erupted (Table 9). All the inverted and transverse oriented supernumerary teeth were unerupted (Table 10); 20.3 percent of the normally oriented supernumerary teeth were unerupted, and all the erupted supernumerary teeth were normally oriented (Table 10).

DISCUSSION

In the present study the sex ratio was about 2.8:1 in favor of males. This is higher than in other studies, but close to Huang's study.[11-13] In Hulen's study the sex ratio was 2:1 in favor of males; and in Luten's study the sex ratio was 1.3:1 in favor of males.[11-12] In these two studies the study population was Caucasian. In Huang's study the sex ratio was 2.5:1; her study population was of Chinese origin. The difference in the sex ratio may be due,

therefore, to racial differences. A sex ratio has been reported to be as high as 5.5:1 favoring males in Japanese school children.[14]

The finding that 35.7 percent of the supernumerary teeth found in these samples was bilateral falls within the range of 17 percent to 44 percent reported in other studies.[6,8,15] The predominant location of premaxillary supernumerary teeth in the central incisor region has also been established by others.[11,12] In the present study, 34.2 percent of the supernumerary teeth were erupted, which is higher than that in Mckibben's study.[6] It was found that all the erupted supernumerary teeth were of the type expected to be found in the specific position; 65.8 percent of the supernumerary teeth were unerupted. These included eleven normally positioned supernumerary teeth and all those in inverted or transverse positions (Table 10). These eleven unerupted, normally positioned, supernumerary teeth included six conical shaped and five tuberculate shaped teeth.

Foster states that the tuberculate supernumerary tooth is usually unerupted and delays the eruption of a permanent upper central incisor; and the conical supernumerary tooth is frequently erupted and does not usually delay the eruption of a permanent central incisor.[15] But in the present study, sixteen of the forty-three tuberculate supernumerary teeth (37.2 percent) were erupted and thirty-three of the 103 conical supernumerary teeth (32 percent) were erupted. The eruption rates of the tuberculate supernumerary tooth and conical supernumerary tooth are similar (Table 11). Further analyses of the eleven normally positioned, unerupted supernumerary teeth, revealed that six were conical in shape and five were tuberculate in shape. For the thirty-nine normally positioned, conical supernumerary teeth, 15.4 percent were unerupted. For the twenty-one normally positioned, tuberculate supernumerary teeth, 23.8 percent were unerupted. This may be due to a delayed root development in tuberculate supernumerary teeth. Foster further states that a highly significant difference in the degree of root formation of these two types of supernumerary teeth was found.[15] The present study shows that tuberculate supernumerary teeth do erupt, therefore, as conical supernumerary teeth erupt, and the eruption rate is similar to that of the conical supernumerary tooth, although possibly delayed.

This study shows that all the erupted supernumerary teeth were normally positioned. The teeth in transverse or inverted positions never erupted. They should, therefore, be surgically removed. The best time for removal is at approximately eight to nine years of age, or at the time when the upper central incisors are erupting. Also at this age, the behavior of a child is much easier to manage and the type of anesthesia can be less invasive, thereby reducing the trauma of surgery. For the normally positioned, supernumerary tooth, the eruption rate was quite high (about 80 percent). Removal of these supernumerary teeth as soon as they erupt and no later than age eight or nine is recommended. This can reduce the surgical anxiety, surgical trauma, and prevent interference with the eruption of the permanent incisors.

CONCLUSION

Supernumerary teeth occur more frequently in males. The sex ratio was 2.8:1 in this study, which is higher than in other studies. In these samples, conical shaped supernumerary teeth were the most common type and the majority were in the central incisor region. Most of the supernumerary teeth were in the palatal side of the central incisors. The eruption rate of supernumerary teeth was 34 percent, and the eruption rates of conical-shaped and tuberculate-shaped supernumerary teeth were identical.

REFERENCES

1. Nazif, M.M.; Ruffalo, R.C.; Zullo, T.: Impacted supernumerary teeth: a survey of 50 cases. JADA, 106:201-204, February 1983.
2. Primosch, R: Anterior supernumerary teeth-assessment and surgical intervention in children. Pediatric Dent, 3:204-215, July 1981.
3. Millhon, J.A. and Stafne, E.C.: Incidence of supernumerary and congenital missing lateral incisor teeth in 81 cases of harelip and cleft palate. Am J Orthod, 37:599-604, December 1941.
4. Ravn, J.J.: Aplasia supernumerary teeth and fused teeth in the primary dentition—an epidemiologic study. Scand J Dent Res, 79: 1-6, January 1971.
5. Brabant, H: Comparison of the characteristics and anomalies of the deciduous and the permanent dentition. J Dent Res, 46:897-902, Suppl No 5,1967.
6. Mckibben, D.R. and Bearly, L.J.: Radiographic determination of the prevalence of selected dental anomalies in children. J Dent Child, 38:390-398, November-December 1971.
7. Kinirons, M.J.: Unerupted premaxillary supernumerary teeth. Br Dent J, 153:110, August 1982.
8. Di Biase, D.D.: Midline supernumeraries and eruption of the maxillary central incisor. Dent Practit, 20:35-40, September 1969.
9. Levine, N: The clinical management of supernumerary teeth. J Canad Dent Asso, 28:297-303,1961.
10. Stafne, F.C.: Supernumerary teeth. Dent Cosmos, 74:653-659, July 1932.
11. Luten, J.R.: The prevalence of supernumerary teeth in primary and mixed dentition. J Dent Child, 34:346-353, September-October 1967.
12. Hurlen, B. and Hemerfelt, D.: Characteristic of premaxillary hyperdontia—a radiographic study. Acta Odontol Scand, 43:75-81, May 1985.
13. Huang, W.H.×ai, T.P.; Su, H.L.: Mesiodens in the primary dentition stage: A radiographic study. J Dent Child, 59:186-189, May-June 1992.
14. Saito, T.: A genetic study on the degenerative anomalies of deciduous teeth. Japanese J Hum Gen, 4-27-30, January 1959.
15. Foster, T.D. and Taylor, G.S.: Characteristics of supernumerary teeth in the upper central incisor region. Dent Practit Dent Rec, 20:8-12, September 1969.

Cheese molars: A pilot study of the etiology of hypocalcifications in first permanent molars

W.E. van Amerongen, DDS, PhD
C.M. Kreulen, DDS, PhD

Opacities in the enamel show up regularly in clinical check-ups and are almost always caused initially by the caries process, which may have become inactive, or by a developmental disorder. Hypocalcification of the enamel is the most common developmental disorder observed in teeth.[1,2] It may vary in extent from a solitary spot on one of the teeth to a general manifestation, with the entire crown of every single tooth affected.

A frequently detected disorder is an opacity in the enamel of one or more first permanent molars. Because clinically the lesion resembles the color and the consistency of Dutch cheese, these molars in the Netherlands are often referred to as *cheese molars*.

EPIDEMIOLOGY

The prevalence varies greatly: Depending on the location of the study and the definition of the criterion of hypocalcification, percentages may vary from 4 to 80.[1-3] During an extensive study, Koch *et al* found this phenomenon in about 7 percent of a study population of Swedish children.[4] This percentage was based upon the opacities mainly observed on first permanent molars and maxillary central incisors.

Drs. van Amerongen and Kreulen are in the Department of Pediatric Dentistry, Academic Centre for Dentistry Amsterdam, Louwesweg 1, 1066 EA Amsterdam, The Netherlands.

ETIOLOGICAL BACKGROUND

The causes of hypocalcifications are numerous. General manifestation in the dentition indicates a structural developmental disorder, which may be genetic. Well-known examples are amelogenesis imperfecta of the hypocalcification type and all degrees of fluorosis. A traumatized or infected root of a primary tooth might damage the germ of the successor, which can lead, in turn, to a poorly calcified local disorder. Between these two extremes, when there is a question of more than one hypocalcified tooth, but without a general manifestation thereof, there is a lack of a clear etiology. Consequently, the literature uses such descriptions as *idiopathic enamel hypomineralization, idiopathic enamel opacities* and *nonfluoride enamel opacities*[3,4] Koch's definition of *idiopathic enamel hypomineralization* greatly resembles that of the Dutch *cheese molar*.[4]

Clinically, enamel is present in its entirety, but mineralization is disrupted. Moreover, the hypocalcification can only be observed clinically in some teeth and its extent may vary from tooth to tooth. It appears that the mineralization of the enamel has been affected temporarily and at a particular moment. The time of onset of the disorder and its duration seem to determine its location and severity. Evidently, the ameloblasts are able to deposit the entire enamel matrix, but the deposit of calcium phosphates in the matrix is disturbed, due to:

- ☐ A disturbance of the ameloblasts, resulting in an insufficient resorption of matrix proteins and conse-

quently insufficient space for the deposit of calcium phosphates, or

- ☐ Insufficient uptake of calcium phosphates, due to an inadequate supply.

In the first option, the ameloblasts did not function properly. Because these cells are known to be very sensitive to oxygen supply, a shortage would soon cause functional impairment.[5] Oxygen shortages may occur during complications in childbirth, or may result from respiratory diseases involving respiratory depression.[6-10]

In the case of the second option, the insufficient supply of calcium phosphates may be related to problems such as renal defects, diarrhoea, high fever and malnutrition.[10-12] Whether there is a direct relationship between the oxygen shortage, or a calcium phosphate insufficiency, and a functional impairment of the ameloblasts still remains unclear. Given that especially first permanent molars are frequently identified as cheese molars, the disorder must have occurred during the first three years of the child's life.[13] Similar disorders are detected quite frequently on central incisors, the crowns of which develop in the same period.

In their study of the occurrence of *idiopathic enamel hypomineralizations*, Koch *et al* are able to establish little more than that patients with this disorder have a higher rate of illness and use more medication than healthy patients.[4]

The aim of this pilot study is, therefore, to gain a better understanding of possible causes of cheese molars, with an emphasis on postnatal illness.

MATERIALS AND METHOD

Based upon patient records of the Department of Paediatric Dentistry, thirty-five children with cheese molars could be selected. After having acquired parental permission, the medical data from birth to three years of age were requested from their physicians. Ultimately, we were left with a population of twenty-one patients, because not all family doctors were willing to cooperate,

Figure. Parents' questionnaire for obtaining medical information in addition to that held by the GP.

1. Were you seriously ill shortly before the child was born (for example: diabetes mellitus, Rh-problem, hypoxia, vitamin D deficiency, asthma)?
   If so, for how long were you ill?
   How long before the child was born did you become ill?
   Did you receive medication? If so, what medication, and when?
2. Some questions about the delivery.
   a) Was it a long delivery?
   b) Was the child premature?
   c) Did the child spend time in an incubator?
   d) Was the child's weight at birth too high or too low?
   e) Did the child have problems immediately after birth (for example, respiratory problems)?
   f) Did the child look blue or yellow shortly after delivery?
3. What did the child's diet consist of after delivery?
   a) Was the child hypersensitive to milk? If so, was the child given a substitute? For how long did the child take this product? (The child might, for instance, have been able to tolerate other milk products, like yoghurt.)
   b) Did the child take calcium tablets?
   c) Did the child take fluoride tablets? If so, how many a day? At what age did it start to take the tablets?
   d) Did the child have any other hypersensitivities or allergies (for example, allergic reactions to food)? If so, describe them.
4. Did the child have diarrhoea? If so, how long did the diarrhoea last? What was the child's age at the time?
5. Have any other gastrointestinal disorders occurred? If so, how long did these last? What was the child's age?
6. Has the child had any respiratory problems at a later stage (for example, asthma or bronchitis)? If so, for how long did the child suffer from this? Did the problems occur right after birth or later? If later, when?
7. Has the child ever had high fever? If so, for how long and at what age?
8. Are there any members in your family that you know to have a tooth enamel disorder?
9. What children's diseases did your child have in its first 3 years? Were the symptoms serious or not?

or particular medical data were no longer available. In addition, a standard written questionnaire on the children' s medical history was given to the parents to complete (Figure). The location and the extent of the opacity on each patient's most affected cheese molar were registered in order to establish a possible chronology between the disease (if registered) and the location on the crown and the extent of the hypocalcification. In determining this location and extent. the crown was divided into three horizontal segments. An occlusal, a middle and a cervical part, based upon the development of the enamel. Due to the slower mineralization, the fissures are allocated to the middle third. The extent of the hypocalcification was assessed on the basis of the location: a small defect was always allocated to only one of the three layers, whereas larger defects extended over the surfaces of two or three segments. Based on this information, the following classification has been established:

☐ Class 1: Occlusal
☐ Class 2: Middle (and/or fissures)
☐ Class 3: Occlusal + middle (and/or fissures)
☐ Class 4: Occlusal + middle + cervical

Superposing the medical and clinical data, it was possible to compare the given disease with the location and extent of the hypocalcification. The chronological relation between these data could be clear (+), not quite clear (±) or there was no relation at all (−). A "+" indicated that the extent and the location of the hypocalcification corresponded with the duration and the moment of the "disease"; a "±" indicated a less distinct correspondence and indicated, for example, the absence of any records on the patient's diseases or other disorders.

RESULTS

The Table clearly indicates that only two patients in the age-group of 0-3 years were free of medical problems.

In 48 percent of the cases, the medical problems were related to birth (for example premature birth, excessively prolonged duration of delivery, cyanosis), whereas 67 percent of the patients suffered from respiratory diseases (such as bronchitis, asthmatic bronchitis, pneumonia, infections to the upper respiratory organs). Reports of high fever, gastrointestinal disorders, other diseases and the use of medicines were few and far between.

In 57 percent of the patients, the location and extent of the hypocalcification appeared to correspond to the moment and the duration of the disease and/or other disorders.

Table ☐ Overview of the hypocalcifications and diseases/disorders determined during the first three years of life.

class	relation with disease	birth problems	diseases bronchial tubes	high fever or diarrhea	antibiotics	other diseases	healthy	possible familial influence
1	+	X				X		
1	−					X		
1	+	X						X
1	±		X					
2	+	X	X					
2	+	X	X		X			
2	+		X					
2	+			X		X		
3	+	X	X					
3	±		X					
3	−						X	
3	+	X	X	X	X			
3	+	X	X					
3	−						X	
4	±		X					X
4	±	X			X			X
4	+		X		X			
4	+		X			X		
4	±	X	X	X				
4	±	X	X					
4	+		X		X			
21		10	14	3	5	4	2	3

DISCUSSION AND CONCLUSION

According to Koch *et al* the etiology of enamel hypomineralization can be divided into genetic, acquired and idiopathic causes.[4] The main reason for the present study was to encourage a reduction in idiopathic causes, in favor of acquired ones.

Because the criteria for assessment of the disorders were the same and the Swedish child population is probably comparable with the Dutch, it can be expected that from an epidemiological point of view the percentage of children with cheese molars is of a similar magnitude, approximately 7 percent.

During the conduct of the retrospective study, it became clear that restorations in cheese molars can hinder the assessment of position and extent of the hypocalcification. Due to the high sensitivity to caries, these molars can be restored extensively, and consequently more difficult to assess. The unusual form of the restoration often indicates, however, that the usual caries lesion may not have been the only reason for restoration. Despite the effort to collect all medical data, there still is a reasonable doubt whether the obtained data are a complete reflection of the medical history of the patients involved, during the period of 0-3 years of age. The reports from the physicians were often briefly worded and the parents were unable to remember every single disease from which their child had suffered during their first three years. There are most likely gaps in the data, especially regarding diseases of short duration and fevers. This information, combined with the limited number of patients, makes it impossible to trace the exact cause of cheese molars. The results of the study, however, do point us in a certain direction for further investigation. The high percentage of problems at birth and respiratory diseases in 81 percent of all patients concerned, indicates for example that these patients could have suffered oxygen shortage. This shortage can disrupt the resorption of matrix proteins by the ameloblasts, resulting in a hypocalcification.

Still, we cannot exclude a shortage in the supply of calcium phosphates during the mineralization phase as another possible cause. The data showed that only three patients had suffered from diarrhoea or high fever, but this figure may well have been higher. It seems, however, unlikely that the occurrence rate of diarrhoea, high fever, or other diseases of short duration in children without cheese molars would have been different.

This present study does not involve any patients without defects in the enamel of the first permanent molars. Because, in theory, it would be possible that the number of diseases of such a control group would be similar to the number of diseases registered in the study population, the national figures regarding the disorders that might result in a respiratory depression have been used to compare with the data from the study. From the CMR (Continuous Morbidity Registration) it can be calculated that of all Dutch children, ages 0-4, approximately 22 percent suffered from a respiratory disease from which a respiratory depression cannot be excluded. Moreover, roughly 10 percent of all childbirths involve problems that may result in an oxygen shortage.[14] Because these percentages are considerably higher in the study population (67 percent and 48 percent, respectively) it seems likely that an oxygen shortage might influence the mineralization of the enamel matrix. Extensive follow-up study is necessary to confirm these findings.

REFERENCES

1. Murray, J.J. and Shaw, L: Classification and prevalence of enamel opacities in the human deciduous and permanent dentition. Arch Oral Biol, 24:7-13, January 1979.
2. Dummer, P.M.H.; Kingdom, A.; Kingdom, R.: Prevalence and distribution by tooth type and surface of development defects of dental enamel in a group of 15 to 16-year-old children in South Wales. Comm Dent Health, 7:369-377, December 1990.
3. Suckling, G.W. and Pearce, E.I.F.: Developmental defects of enamel in a group of New Zealand children: their prevalence and some associated etiological factors. Comm Dent Oral Epidemiol, 12:177-184, June 1984.
4. Koch *et al*: Epidemiological study of idiopathic enamel hypomineralization in permanent teeth of Swedish children. Comm Dent Oral Epidemiol, 15:279-285, October 1987.
5. Bronckers, A.: Effect of oxygen tension on development of hamster molars in vitro. Thesis, Chapter III, Amsterdam, 1984, pp 47-60.
6. Johnson, D.; Kreji, C.; Hack, M.; et al: Distribution of enamel defects and the association with respiratory distress in very low birth weight infants. J Dent Res, 63:59-64, January 1984.
7. Noren, J.G.: Enamel structure in deciduous teeth from low birth weight infants. Acta Odont Scand, 41:355-362, December 1984.
8. Pimlot, J.F.L.; Nikiforuk, G.; Howly, T.P. *et al*: Enamel defects in prematurely born, low birth weight infants. Pediatr Dent, 7:218-223, September 1985.
9. Seow, W.K.; Brown, J.P.; Tudehope, D.A. *et al*: Dental defects in the deciduous dentition of premature infants with low birth weight and neonatal rickets. Pediatr Dent, 6:88-92, June 1984.
10. Via, W.F. Jr. and Churchill, J.A.: Relationships of enamel hypoplasia to the abnormal events of gestation and birth. JADA, 59: 702-707, October 1959.
11. Pindborg, J.J.: Aetiology of development enamel defects not related to fluorosis. Int Dent J, 32:123-134, April 1982.
12. Smith, D.M.H. and Miller, J.: Gastro-enteritis, coeliac disease and enamel hypoplasia. Brit Dent J, 147:91-95, August 1979.
13. Wöltgens, J.H.M.: Histologie van pré-en posteruptieve tandontwikkeling en de beïnvloeding ervan door nutriënten en hormonen. Syllabus Academisch Centrum Tandheelkunde, Amsterdam 1991.
14. Lisdonk, J. van de: *Continue Morbiditeits Registratie*; Utrecht: Bunge, 1994.

Chairside veneering of composite resin to anterior stainless steel crowns: Another look

Kenneth R. Wiedenfeld, DDS
Robert A. Draughn, DSc
Sheryl E. Goltra, DMD

Restoration of severely damaged primary anterior teeth presents a challenging problem to the clinician.[1-3] As presented in our original article, an esthetic technique was described in which composite resin was veneered to trimmed and fitted stainless steel crowns.[1] The fitted crowns were sandblasted (Microetcher®, Danville Engineering Inc., San Ramon, CA) and veneered chairside, using a composite cement (Panavia OP®, J. Morita USA Inc., Tustin, CA), sealant, and a composite resin.[1] This technique provided very high bond strengths and excellent cosmetic results. Importantly, no loss of bonding or fractures have been reported in over fifty crowns placed during the previous year. The technique described in our original article often resulted in overcontoured facial surfaces and required practice to master the chairside procedures.

Building upon the clinical success of the original technique, the authors began looking at ways to refine and simplify placement of the material and improve the facial contour. This paper describes a modified technique that improves the facial contour and simplifies fabrication, yet maintains the strength and cosmetic values of the original technique.

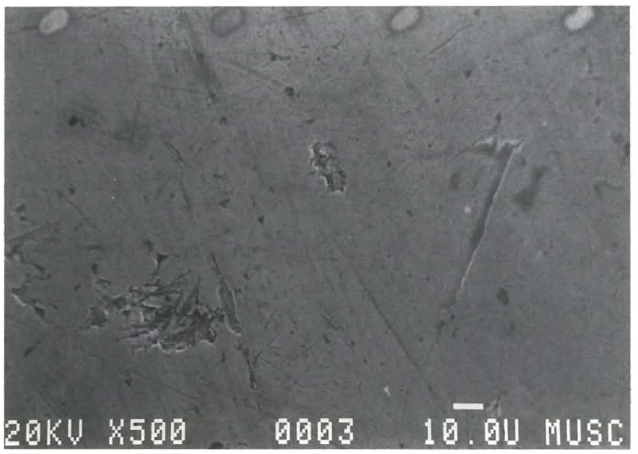
Dr. Wiedenfeld was a Pediatric Dental Resident and is now in private practice in Corpus Christi, Texas; Dr. Draughn is Chairman and Professor of Materials Science; and Dr. Goltra is part-time faculty and private practice in the Department of Pediatric Dentistry, Medical University of South Carolina.

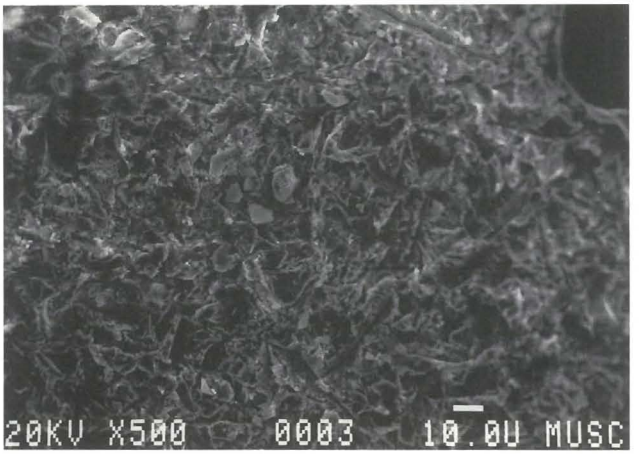
TECHNIQUE

Primary anterior teeth are prepared for stainless steel crowns in the customary manner. After final trimming and crimping, the crowns are secured with locking cotton pliers on their lingual sides. The crowns are sandblasted as described in the original article.[1] Sandblasting of the crowns produces a roughened surface, which significantly enhances bonding to the metal (Figures 1,2). After sandblasting, veneering of the crowns should be completed without a lengthy delay to maximize bond retention.[1,4] The following steps complete the chairside veneering technique:

- ☐ A metal bonding agent is applied to the sandblasted crowns on the surfaces to be veneered. This step has been successfully accomplished, using one of three commercially available metal bonding systems. (Restobond Four®, Lee Pharmaceuticals, South El Monte, CA; All-Bond®2, Bisco Dental Products, Itasca, IL; or Probond®, Caulk/Dentsply, Milford, DE). Specific instructions for application of each metal bonding agent are explained as follows:

When using the Restobond Four system, one drop of adhesive #2 is mixed with one drop of metal activator #2b. This mixture is painted on the surfaces to be bonded in two consecutive coats. The solvent is allowed to evaporate for ten seconds and then the bonded surfaces are dried with an air syringe for three to five sec-





Figures 1, 2. Scanning electron micrographs of the facial surface of a stainless steel crown before (left) and after sandblasting. Bar = 10 microns.

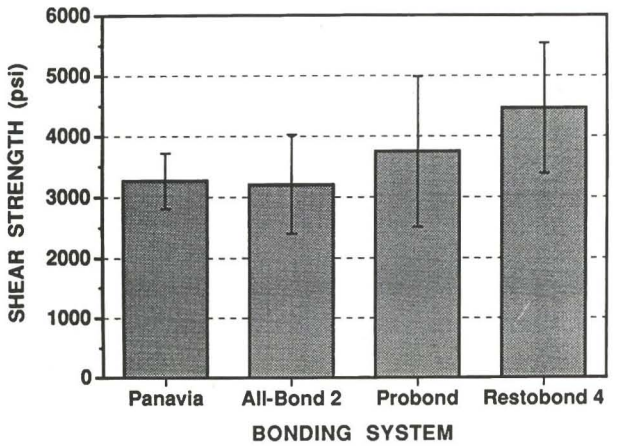


Figure 3. Mean shear bond strengths. Bars indicate standard deviations of the means.

Figure 4. Three-year-old with advanced decay.

onds. As an alternative, the All-Bond 2 system can be utilized by mixing primer A with primer B and applying two coats to the sandblasted metal surfaces. After the application of the primer the crown is dried with an air syringe for five seconds to ensure thorough removal of the solvent.

The Probond system is used by painting on the sandblasted surfaces two coats of Probond primer, waiting twenty seconds between coats and then airdrying the crowns twenty seconds after the last application.

Note: None of these systems requires a nonfilled resin layer or lightcuring after their application.

☐ An opaque shade of a dual cured composite cement (Enforce®, Caulk/Dentsply, Milford, DE) is applied in a thin layer over the sandblasted and primed esthetic surfaces and is thoroughly light cured for thirty to forty seconds. This opaquing step is accomplished by mixing equal parts of the Enforce Opaque base with the catalyst and applying the cement with a disposable paint brush (Bendabrush, Centrix Inc., Shelton, CT). The opaque shade is applied just thick enough to mask the gray hue of the crown. Light curing of all bonded surfaces for thirty to forty seconds is necessary for early strength, and is accomplished, using a quality visible light curing system with a large diameter wand.

☐ An appropriate high strength, nonsticky, composite resin (TPH®, B1 opaque, Dentsply/Caulk, Milford DE) is applied to the esthetic surfaces of the crown in a thin layer, just thick enough to cover esthetically the composite cement. The composite is tapped down and contoured with a plastic instru-

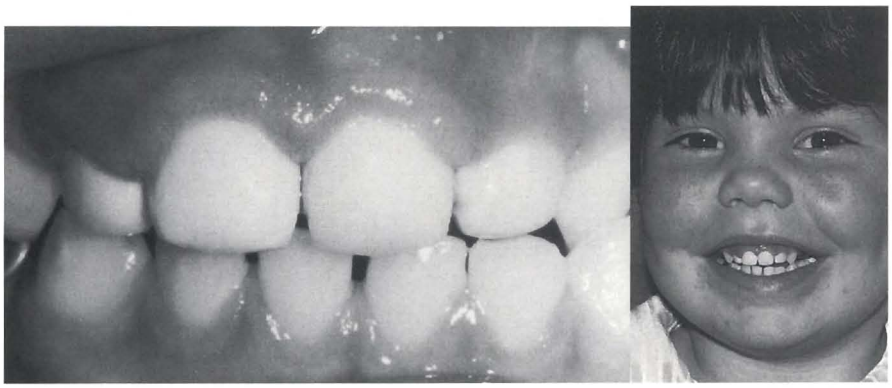


Figure 5, 6. Restoration of the primary maxillary central and lateral incisors with veneered stainless steel crowns.

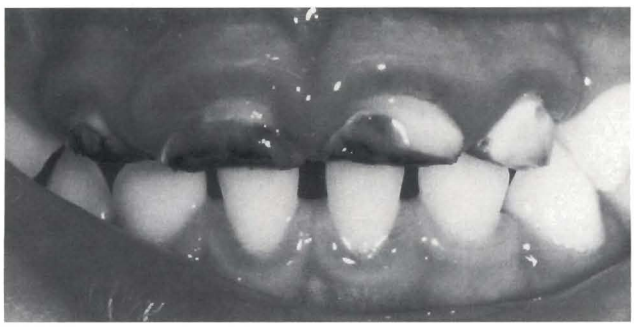


Figure 7. Two-year-old with advanced nursing-bottle caries.

ment to achieve the desired coverage. The contoured composite is then thoroughly light cured.

☐ The crowns are retried in the mouth. If necessary, modification of contour and outline may be refined using a soft abrasive disc (Sof-Lex, 3M Corp, St. Paul MN). The crowns are cemented in the customary manner.

STRENGTH TESTING

The bond strengths of composite beads applied to the facial surfaces of sandblasted crowns were measured by applying shear stresses at a rate of 1 mm/1min, using a mechanical testing system (MTS System 810, MTS Corp., St. Paul, MN). Ten specimens were prepared for each bonding system. The bond strengths using the Restobond Four, All-Bond 2, and Probond systems were compared to those using no bonding system (Enforce alone), and those using Panavia. Results revealed comparable shear bond strengths between Restobond Four (4464 ± 1075 PSI), All-Bond 2 (3210 ± 812), Probond (3749 ± 1240 PSI), and Panavia (3269 ± 453 PSI (Figure 3). All four systems were significantly stronger than applying the Enforce cement alone (1637 ± 357 PSI) without primer. Each of the bonding systems appeared to fail at the metal-primer interface.

In vitro testing suggested that washing and drying the crowns with an air water syringe after sandblasting, but before bonding, tended to decrease bond strengths. A three to five second blast of air to clean the crowns after the crowns have been sandblasted is, therefore, recommended. In addition, even though the Enforce cement is dual cured, a decrease in bond strength and a problem with clinical performance was noted, if the material was not thoroughly light cured.

DISCUSSION

The described technique results in a very thin veneer (1-2 mm) with excellent cosmetic results. Additionally, the new technique is easier and faster to perform clinically than the original one, using Panavia. The application of both the Enforce and the composite is simplified due to minimal problems with the materials sticking to the instruments in the application process. The application process is also improved, due to the fact that the composite cement is light cured instead of anaerobically activated as in the case of Panavia. This technique has proven to be easily taught and mastered by both dentists and auxiliaries. As with all clinical procedures, however, efficiency and quality come with practice. The Restobond Four or the All-Bond 2 systems have become the preferred methods for metal priming, due to their ease of handling as compared to the Probond system. All three systems have been used clinically, however, with equal restorative success. It should also be noted that

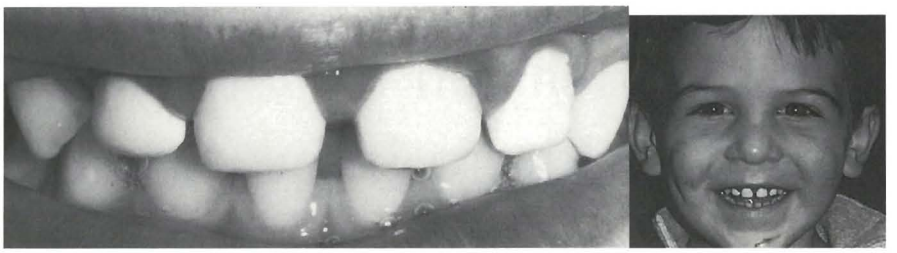


Figure 8,9. Primary maxillary central and lateral incisors, restored chairside with veneered stainless steel crowns.

the best esthetic results are achieved when all four maxillary incisors are crowned at the same time. Single tooth crowns can be veneered but usually produce a slight shade mismatch compared to the natural teeth.

Both the original technique and the updated refinements enable the clinician to avoid many of the shortfalls seen in commercially veneered stainless steel crowns. Crimping and contouring of the stainless steel crowns are accomplished before the veneering process. Commercially veneered crowns can be difficult to adapt to the prepared teeth due to the rigid nature of the esthetic facings. Sterilization problems related to tried in but unused commercially veneered crowns are nonexistent in the described technique since, only the finally selected crowns are veneered.[5] All plain stainless steel crowns contaminated during the crown selection phase can be easily sterilized in the conventional manner. Finally, if there is a fracture of any veneered facing after cementation, the facings can be successfully repaired intraorally with the compatible bonding procedures.

Over the last year approximately eighty crowns have been veneered, using the original and updated techniques described in this paper. Both techniques have been an overwhelming success with parents and patients. Teeth previously considered virtually unrestorable with conventional procedures have been cosmetically restored with durable and well-fitted crowns (Figures 4-9). The principal of taking a fitted stainless steel crown and cosmetically bonding it will surely continue to evolve in simplicity and esthetics. The possible applications of this concept are only limited to the imagination of the clinician.

CONCLUSION

The described technique for the chairside veneering of stainless steel crowns offers very strong bond strengths with excellent cosmetic results. The modified technique uses methods and materials that are easier to master and results in crowns with very natural contours.

REFERENCES

1. Wiedenfeld, K.R.; Draughn, R.A.; Welford, J.B.: An esthetic technique for veneering anterior stainless steel crowns with composite resin. J Dent Child, 61:321-326, September-December 1994.
2. Waggoner, W.F.: Restorative dentistry for the primary dentition. In *Pediatric dentistry infancy through adolescence*, 2nd Ed., Pinkham, J.R., Editor. Philadelphia: W.B. Saunders Company, 1994, pp 318-324.
3. Braham, R.L.: Restorative procedures for primary anterior teeth with proximoincisal caries. In *Textbook of Pediatric Dentistry*, 2nd Ed. Braham, R.L. and Morris, M.E. Baltimore: Williams and Wilkins, 1985, pp 549-551.
4. Aboush, Y.E.: Cast metal resin-bonded dental restorations: Effect on the resin-to-metal bond of storage conditions before cementation. J Prosthet Dent, 67:293-295, March 1992.
5. Waggoner, W.F. and Cohen, H.: Failure strength of four veneered primary stainless steel crowns. Pediatric Dent, 17:36-40, January-February 1995.

In vitro evaluation of fluoride uptake with application of acidulated phosphate fluoride to interproximal enamel of primary teeth using dental floss

Zerrin Us, DDS, PhD
Cemal Ören, MS
Tezer Ulusu, DDS, PhD
Tefik Orbey, PhD

Topically applied fluorides have an important place in preventive dentistry. Numerous studies have been conducted on the method of application and mechanisms of action of various topical fluoride preparations. Studies concerned with the transportation of topical fluoride agents to the areas vulnerable to tooth decay, but hardly accessible, however, have been limited.[7,10,20,22,26]

Caries lesions in primary molars are encountered most frequently on contact areas and can cause exposure of the dental pulp and destruction of the septal bone.

The present study was planned to ascertain the fluoride uptake of the interproximal surfaces, following application of acidulated phosphate fluoride (APF) with dental floss in a medium prepared in vitro by splitting primary molars into two parts.

MATERIALS AND METHODS

A total of thirty-five primary second molars, due for exfoliation, were extracted from children, ten to twelve years of age, who applied to the Department of Pediatric Dentistry, Gazi University. Sixteen were extracted from the mandible and nineteen from the maxilla; and all were caries free. The teeth were cleaned with a brush under running water and were kept in deionized water at 4°C until used.[11,12] The teeth were split in a buccolingual direction, to provide mesial and distal halves.

The window method suggested by McCann was used for the measurement of fluoride in the teeth.[28] Labels, 4 mm in diameter, were affixed to all mesial and distal interproximal surfaces. The unlabeled areas were covered with nail polish and left to dry at room temperature. Labels were removed after drying occurred. Thus an enamel surface of 12.5 sq. mm was exposed for preparing the biopsy. Mesial and distal halves of each tooth were randomly picked to set up a control group. All specimens were embedded in a silicone-based impression material (Fulldent, CH-1261 Arzler/VD-Switzerland), to make contact with the interproximal surface of another healthy tooth.

Unwaxed dental floss was saturated with fluoride by immersing it in an APF gel (Nupragel, Johnson and Johnson) for a period of five minutes. It was applied then to the teeth in the working group for a period of forty seconds (Figure). The treated teeth were washed in distilled running water for twenty seconds. A new dental floss was used for each new tooth. Same procedure was repeated twice a day, morning and evening, for three days, for a total APF gel application time of four minutes.

Dr. Us is Research Assistant, Department of Pediatric Dentistry, Faculty of Dentistry; Dr. Ören is Research Assistant, Department of Analytical Chemistry, Faculty of Pharmacy; Dr. Ulusu is Professor and Chairman, Department of Pediatric Dentistry; Dr. Orbey, Associate Professor and Chairman, Department of Analytical Chemistry, Faculty of Pharmacy, University of Gazi, Turkey.

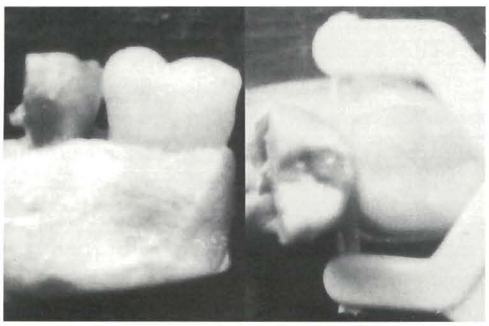


Figure. Application of fluoride-impregnated dental floss to teeth embedded in an impression compound.

Table ☐ Depths of enamel biopsies and the mean fluoride uptake.

Depth	Study group	Control group	Difference
20 μ	M=10584.0000 SD= 7718.3353	M=2160.9333 SD=2376.3739	M=8473.8667 SED=1474.4474
40 μ	M= 2859.1667 SD= 1835.2791	M= 467.2000 SD= 424.8072	M=2391.9667 SED= 343.9336
60 μ	M= 1371.4333 SD= 944.3079	M= 198.8000 SD= 175.9509	M=1172.6333 SED= 175.3735

M=Mean SD=Standard deviation SED=Standard error of difference

All the specimens (working and control) were kept in artificial saliva at 37°C in an autoclave, except for the time required to apply the gel. Twenty ml of saliva were used for each tooth and replaced twice daily. At the end of the third day, all the teeth (working and control) were removed from their bases. To remove unbound fluoride, the teeth were washed for twenty-four hours with 1 mol/lt potassium hydroxide solution as suggested by Caslavska.[9]

In taking biopsies from the specimens, McCann's fluoride ion electrode and fluoride analysis procedure for hard tissues were utilized.[28] Fifty ml of the tubes with tapering tips and screwed caps (LP Italiana SPA, Milan, Italy) were used for each biopsy.

The teeth selected for biopsy were immersed in tubes containing 1 ml 0.5 M perchloric acid by holding them with a plier. The tip of the plier was covered with nail polish, to prevent ionic dissociation from the plier tip and thus upsetting the balance by causing a chemical reaction. The tooth in the acid was agitated with small impulses, as suggested by Soyman, to prevent a return of phosphate and fluoride ions to the enamel after separating from it.[39] After a sixty-second perchloric acid treatment, etched enamel surfaces were washed with 4 ml 0.5 M trisodium citrate buffer. The whole procedure was completed in the same tube and a total of 5 ml biopsy solution was obtained. Three consecutive biopsies were taken from each half-tooth specimen. Fluoride measurements were conducted, using a combined ion selective electrode (Russel Model 96-6099).

Since the average 37-percent-of-enamel-weight represented the calcium, and the average enamel density is 2.95 gr/cm^3, the depth was computed, using the following equation:[1,2,12,25,32]

$$d\ (\text{depth}) = \frac{M\ (\text{mass})}{\text{biopsy area } (\text{cm}^2) \times \text{density } (\text{gr/cm}^3)}$$

In our study, the atomic absorption spectrophotometer (Perkin Elmer, Model 2380) was utilized for calcium analysis from the biopsy specimens.

In order to make a linear comparison between experimental and control groups, depths of biopsy were standardized at 20 μ, 40 μ, and 60 μ in first, second and third biopsies, respectively. For this purpose, taking the fluoride concentration obtained from each half tooth and three biopsy depth values as the base, ppm fluoride values at standard depths were determined with the aid of the equation $y = ax^{-b}$.[38]

In the evaluation of the results, we made use of the t test for the comparison of the averages obtained from two different groups.[42]

CONCLUSION

Average enamel-fluoride values (ppm) obtained during the present study at 20 μ, 40 μ, 60 μ depths both in study and control groups, and the differences between averages are presented in the Table.

As a result of statistical comparisons of average fluoride values at all three depths, the differences between the groups has been found to be significant ($p < 0.001$).

DISCUSSION

Topical fluoride application has been shown to be one of the most successful methods in the reduction of tooth decay, a multi-factor disease caused by bacterial products.[17,18,27,43,46] Use of dental floss is being recommended as an effective method in the reduction to minimum of the interproximal caries lesions frequently encountered in children and adolescents.[10,26,40]

Jorgensen *et al* established in their studies that unwaxed dental floss absorbed fluoride better.[26] For this reason, we used unwaxed dental floss in our study.

The reason for using APF as the topical fluoride agent is that fluoride uptake by the enamel is greater than is possible with neutral agents. It has been shown that the effect is due to the orthophosphoric acid in the composition of the agent.[3,15,19,45]

It was reported that diffusion of APF gels with viscosities between 7,000-20,000 cp into interproximal surfaces and fissure areas was comparatively slower than when in a solution form.[29,35,41,47] Dental floss was used in our study to increase the diffusion properties of APF gel interproximal surfaces.

It has been shown that there were two different stages of reaction in the fluoride uptake of the enamel: that is, superficial absorption through mineral dissolution in the enamel at the beginning and the reattachment of fluoride-rich reaction products on the enamel surface.[19,21,47] It has been reported that this was followed by a spreading of fluoride into interprism areas and subsequent interaction with enamel crystals, and that the basic chemical product of the superficial absorption process was calcium fluoride.[4,6,8,13,16,19]

It was shown during initial experimental studies that calcium fluoride accumulation could be completely eliminated either by washing with water for a period of twenty-four hours or longer, or within twenty-four hours, with the use of 1 M potassium hydroxide.[8] There exists a widely accepted view, however, that calcium fluoride dissociation is slower in human saliva and lasts for several weeks.[3,15,16,36,48] Significant remineralization and reduction of decay has been shown at the end of fluoride applications, where the principal reaction product is calcium fluoride.[3,19,21,36,47,48] To avert the possibility that loosely bound fluoride, such as calcium fluoride, would mask the amount of closely bound fluoride, we washed fluoride-treated teeth for twenty-four hours with 1 M potassium hydroxide, in our study. It has been reported that the apatite structure of the enamel does not undergo dissociation and that only loosely bound fluoride is removed from the surface during the application of potassium hydroxide.[8]

Guo *et al* were able to remove loosely bound fluoride from the treated specimens by washing with 1 mol/lt potassium hydroxide solution after keeping them in synthetic saliva for three days.[22] In none of the in vitro studies, was distinction made in respect to closely bound fluoride formed after application of fluoride from impregnated dental floss.[7,10,26]

It was also reported that keeping enamel specimens in a moist medium after fluoride application increased the ratio of fluoride retained.[32,39] While Bohrer *et al* and Jorgensen *et al* kept enamel specimens in a moist medium for seven days, Guo *et al* kept them in the same medium only for three days, when making measurements. Chaet *et al* carried out measurements, nevertheless, without keeping the teeth in a moist medium.[7,10,22,26] We kept our test specimens in synthetic saliva for three days, to allow loosely bound calcium fluoride in the enamel to enter into reaction, and because the measurements made immediately after fluoride treatment were not clinically important.

It was reported that splitting the crowns of primary molars and using one of two symmetrical parts as the control and the other as the test specimen would permit comparison of the treated enamel with the tooth's intrinsic qualities.[30,31] The fluoride content of enamel in corresponding areas of the study specimens was shown to be approximately the same.[16,30,31] Fluoride uptake by the enamel after topical application could be determined by subtracting the value of the fluoride in the control half from that in the test half.[23,26,30] In our study primary molar teeth were split in a buccolingual direction and one half was taken as the control specimen, the other as the test specimen. Halves of the teeth so obtained were embedded in a silicone based impression material to make contact with the interproximal surface of a sound tooth. In this manner, it was possible to take measurements simultaneously of control and working groups.

It was claimed that APF gel must be applied to the teeth for at least four minutes and that fluoride uptake was significantly reduced if treatment periods were less than four minutes.[29,35,41,47] Although there are reported studies in which the treatment periods were for one minute, such studies were not clinically supported.[29,35,47] Taking this into consideration, we applied fluoride over a three-day period for a total of four minutes, twice a day (morning and evening), for a total of eighty seconds per day. This regimen is realistic and conceivably practical. As a result, we are able to show a significant fluoride uptake in our findings.

Chaet *et al* showed a significant fluoride uptake as a result of two treatments using APF impregnated, unwaxed dental floss at thirty-second intervals, as compared with the treatment using non-impregnated floss.[10] Bohrer *et al* gave thirty-second, 0.4 percent and 1.28 percent amine fluoride and amine chloride treatments, using dental floss over a period of seven days.[7] As a result, it was observed that the greatest fluoride uptake was in the 1.28 percent amine fluoride group. Guo *et al* reported that treatment using APF impregnated dental floss for a total of four minutes twice a day for three days was better than the four-minute tray treatment.[22] Jorgensen *et al* reported, however, that the fluoride up-

take during a treatment period totaling 17.5 minutes, on a schedule of twice a day for seven days was greater in the group using floss impregnated with sodium fluoride than in the immersion group.[26] It was reported in many *in vivo* and *in vitro* studies that fluoride uptake is not affected by the presence of plaque and that clinical effectiveness is not dependent upon the type and degree of dental prophylaxis.[24,33,35,37,44] It has also been proposed that plaque must be removed during fluoride treatment.[37,43] In our study we cleaned the teeth using only a tooth brush before using the impregnated dental floss. In a study where dental floss impregnated with amine chloride and 0.48 percent and 1.02 percent amine fluoride was used *in vitro* on the interproximal surfaces of permanent molars, it was learned that fluoride uptake in the group treated with 1.28 percent amine fluoride was significantly greater.[7] Jorgensen *et al* found that fluoride uptake as a result of using a dental floss saturated with 0.05 percent sodium fluoride solution and a toothpaste containing a fluoride on interproximal surfaces of demineralized primary teeth was 1.5 to three times greater than that obtained with 0.05 percent sodium fluoride solution only.[26] Results obtained in both those studies are lower than ours. No comparison could be made, however, because size of the biopsy area and the number and depths of the biopsies were not indicated.

Guo *et al* found in a study where dicalcium phosphate dihydrate-APF was applied to the surfaces of premolars and molars, using a tray and dental floss, that fluoride uptake was significantly greater in this group than that obtained in a group treated only with APF; and that the use of dental floss, furthermore, was superior to the use of a tray.[22] Results obtained by these researchers show that the fluoride was bound firmly to the enamel, because the teeth were washed with potassium hydroxide after the fluoride was applied, as in our study. In other studies where fluoride was applied with dental floss no distinction was made between loosely bound fluoride and firmly bound fluoride.[7,10,26] Despite this fact, fluoride values obtained by them are smaller than ours. The differences in results may be the result of differences in fluoride agents used and dissimilar depths of the biopsies.

It was reported that an application of dicalcium phosphate dihydrate before APF increased the fluoride uptake significantly.[9,13,14] for this reason, the results obtained by Guo *et al* through application of APF by dental floss only may be comparable to our results.[22] Direct comparison is not possible, however, despite the fact that these two studies were similar in type and length of application time, because the biopsy depths in our study were significantly different from those in the study alluded to above.

We discounted five of thirty-five primary teeth used in the research, because the results yielded by them were inconsistent. We are of the opinion that the inconsistencies may be due to enamel lesions that could not be seen with the naked eye, and to damages to the nail polish that may have occurred during acid treatment. As a result of our observations, we concluded that a minimum of thirty-five to forty teeth should be used in similar biopsy studies, and that the greater the number, the more reliable the results.

In our opinion, either the control group should be standardized or various factors such as the region of residence, the concentration of fluoride in the drinking water, and eating habits should be taken into consideration in the selection of the teeth, if reliable results are to be obtained. It was observed that these requirements were not met in *in vitro* dental-floss studies conducted to date. Since half of each tooth was used in the control group, standardization was achieved to a great extent in our study.

Our research is significant in that the study specimens are in contact with enamel surfaces and were kept in synthetic saliva, under conditions similar to those prevalent in the mouth.

We have reached the conclusion that daily use of fluoride impregnated dental floss provides for significant fluoride uptake in interproximal enamel and that a fluoride reserve may be maintained, despite the rinsing qualities of saliva. In addition, we are of the opinion that high fluoride concentrations at all three of the biopsy depths may have resulted because of the ability of APF to penetrate the enamel, due to its acidic property and phosphate content. Use of fluoride impregnated dental floss is an effective method for increasing the fluoride content of interproximal surfaces that are difficult to access and vulnerable to dental caries. Research is needed to develop less-time-consuming methods of application.

REFERENCES

1. Aasenden, R. and Moreno, C.: Evaluation of biopsy data in human enamel fluoride studies. Arch oral Biol, 16:1413-1426, December 1971.
2. Aasenden, R.; Moreno, C.; Brudevold, F.: Control of sampling areas for human tooth enamel biopsies. Arch Oral Biol, 17:355-358, May 1972.
3. Arends, J. and Christoffersen, J.: Nature and role of loosely bound fluoride in dental caries. J Dent Res, 69 (Spec. Iss.):601-605, 1990.
4. Benediktsson, S.; Retief, D.H.; Beadley, E.L. *et al*: The effect of contact time of acidulated phosphate fluoride on fluoride concentration in human enamel. Arch Oral Biol, 27:567-572, July 1982.
5. Bijella, M.F.T.B.; Bijella, V.T.; Lores, E.S. *et al*: Comparison of dental prophylaxis and tooth brushing prior to topical APF applications. Community Dent Oral Epidemiol, 13:208-211, May 1985.

6. Bodde, H.E.; Nelson, D.G.A.; Koops, P.G. *et al*: Influence of repeated APF applications on long-term remineralization of initial lesions in bovine enamel. J Dent Res, 64:12-18, January 1985.
7. Bohrer, D.; Hirschfield, Z.; Gedalia, I.: Fluoride uptake in vitro by interproximal enamel from dental floss impregnated with amine fluoride gel. J Dent, 11:271-273, March 1983.
8. Caslavska, V.; Moreno, F.C.; Brudevold, F.: Determination of the calcium fluoride formed from in vitro exposure of human enamel to fluoride solution. Arch Oral Biol, 20:333-339, March 1975.
9. Caslavska, V.; Gron, P.; Ahern, J.M.: Fluoride acquisition by enamel from solutions and self-gelling preparations. Caries Res, 21: 333-339, May 1987.
10. Chaet, R. and Wei, S.H.Y.: The effect of fluoride impregnated dental floss on enamel fluoride uptake in vitro and streptococcus mutans colonization in vitro. J Dent Child, 44:122-126, March-April 1977.
11. Chow, L.C. and Brown, W.E.: Formation of $CaHPO_4.2H_2O$ in tooth enamel as an intermediate product in topical fluoride treatments. J Dent Res, 54:65-76, January 1975.
12. Chow, L.C.; Beaudreau, G.M.; Brown, R.E.: Enamel fluoride profile construction from biopsy data. Caries Res, 19:103-112, February 1985.
13. Chow, L.C.: Tooth-bound fluoride and dental caries. J Dent Res, 69 (Spec. Iss.):595-600, 1990.
14. Crall, J.J. and Bjerga, J.M.: Enamel fluoride retention after DCPD and APF application and prolonged exposure to fluoride in vitro. J Dent Res, 65:387-389, March 1986.
15. Dawes, C.: Fluorides: Mechanisms of action and recommendations for use. Can Den Assoc J, 55:721-723, September 1989.
16. Dijkman, A.G.; DeBoer, P.; Arends, J.: In vitro investigation on the fluoride content in and on human enamel after topical application. Caries Res, 17:392-402, May 1983.
17. Duckworth, R.M.; Morgan, S.N.; Murray, A.M.: Fluoride in saliva and plaque following use of fluoride-containing mouthwashes. J Dent Res, 66:1730-1734, December 1987.
18. Ekstrand, J.: Pharmacokinetic aspects of topical fluorides. J Dent Res, 66:1061-1065, May 1987.
19. Ericsson, S.Y.: Cariostatic mechanisms of fluorides: Clinical observations. Caries Res, 11 (Suppl. 1):2-41, 1977.
20. Gillings, B.R.D.: Fluoride uptake of enamel after application of fluoride solutions and fluoride impregnated dental floss: A preliminary report. Abstr J Dent Res, 52:575, May-June 1973.
21. Gron, P.: Chemistry of topical fluorides. Caries Res, 11 (Suppl. 1): 172-204, 1977.
22. Guo, M.M.; Chow, L.C.; Schreirer, G.T. *et al*: Comparison of fluoride uptake produced by tray and flossing methods in vitro. J Dent Res, 68:496-498, March 1989.
23. Heifetz, S.B.; Mellberg, J.R.; Winter, S.J. *et al*: In vivo fluoride uptake by enamel of teeth of human adults from various topical fluoride uptake by enamel of teeth of human adults from various topical fluoride procedures. Arch Oral Biol, 15:1171-1181, October 1970.
24. Hellwig, E.; Klimek, J.; Schmidt, H.F.M. *et al*: Fluoride uptake in plaque-covered enamel after treatment with the fluoride lacquer duraphat. J Dent Res, 64:1080-1083, August 1985.
25. Iijma, Y. and Katayama, T.: Fluoride concentration in deciduous enamel in high- and low-fluoride areas. Caries Res, 19:262-265, March 1985.
26. Jorgensen, J.; Shields, C.P.; Proskin, H.M.: Fluoride uptake into demineralized primary enamel from fluoride impregnated dental floss in vitro. Pediatr Dent, 11:17-20, January 1989.
27. Mathewson, R.J.; Primosch, R.E.; Sanger, R.G. *et al: Fundamentals of dentistry for children.* Chicago: Quintessence Publishing Company, 1982, pp 147-171.
28. McCann, H.G.: Determination of fluoride in mineralized tissues using the fluoride ion electrode. Arch Oral Biol, 13:475-477, April 1968.
29. Mellberg, J.R.: Evaluation of topical fluoride preparations. J Dent Res, 69 (Spec. Iss.):771-779, 1990.
30. Retief, D.H.; Sorvas, P.G.; Bradley, E.L. *et al*: In vitro fluoride uptake, distribution and retention by human enamel after 1- and 24-hour application of various topical fluoride agents. J Dent Res, 59:573-582, March 1980.
31. Retief, D.H.; Bradley, E.L.; Holbrook, M. *et al*: Enamel fluoride uptake, distribution and retention from topical fluoride agents. Caries Res, 17:44-51, January 1983.
32. Richardson, B.: Fixation of topically applied fluoride in enamel. J Dent Res, 46 (Suppl. 1):87-91, January 1967.
33. Ripa, L.W.: Need for prior toothcleaning when performing a professional topical fluoride application. J Am Dent Assoc, 109:281-285, February 1984.
34. Ripa, L.W.; Leske, G.S.; Sposato, A. *et al*: Effect of prior toothcleaning on bi-annual professional APF topical fluoride gel-tray treatments. Caries Res, 18:457-463, May 1984.
35. Ripa, L.W.: An evaluation of the use of professional topical fluorides. j Dent Res, 69 (Spec. Iss.):786-796, 1990.
36. Saxegaard, E. and Rolla, G.: Kinetics of acquisition and loss of calcium fluoride by enamel in vivo. Caries Res, 23:406-411, May 1989.
37. Seppa, L.: Effect of dental plaque on fluoride uptake by enamel from a sodium fluoride varnish in vivo. Caries Res, 17:71-75, January 1983.
38. Shida, N.; Matsushima, K.; Wada, M.: A new method for analyzing the distribution of fluoride in human dental enamel. J Nihon Univ Sch Dent, 28:61-66, March 1986.
39. Soyman, M.; Sirin, S.; Akinci, T.: Diş minesiacözülmesinin matematiksel yönden incelenmesi ve bundan yararlanilarak minedeki fluoride miktarinin saptanmasi. M Ü Dişhek Fak Derg, 1:17-27, May 1984.
40. Stewart, R.E.; Barber, T.K.; Troutman, K.C. *et al: Pediatric dentistry.* St. Louis: Mosby Company, 1982, pp 652-659.
41. Stookey, G.K.: Critical evaluation of the composition and use of topical fluorides. J Dent res, 69 (Spec. Iss.):805-812, 1990.
42. Sümbüloğlu, K. and Sümbüloğlu, V.: *Bioistatistik.* Ankara: Çağ Matbaasi, 1987.
43. Thornton, C.B. and Stewart, G.P.: Effect of waxed versus unwaxed floss on fluoride uptake by enamel. J Dent Child, 45:203-206, May-June 1978.
44. Van Loveren, C.: The antimicrobial action of fluoride and its role in caries inhibition. J Dent Res, 69 (Spec. Iss.):676-681, 1990.
45. Weatherell, J.A.; Naylor, G.; Hallsworth, A.S.: Measurement of topical fluoride acquired by sound human enamel. Caries Res, 11: 231-236, March 1977.
46. Wei, S.H.Y. and Connor, C.W.: Fluoride uptake and retention in vitro following topical fluoride applications. J Dent Res, 62:830-832, July 1983.
47. Wei, S.H.Y. and Hattab, F.N.: Enamel fluoride uptake from a new APF foam. Pediatr Dent, 10:111-114, February 1988.
48. White, D.J. and Nancollas, G.H.: Physical and chemical considerations of the role of firmly and loosely bound fluoride in caries prevention. J Dent Res, 69 (Spec. Iss.):587-594, 1990.

Plaque removing efficacy of individually modified toothbrushes in cerebral palsy children

S.G. Damle, BDS, MDS
J.P. Bhavsar, BDS, MDS

In our society, there are children who are incapable of using personal oral hygiene devices. The problems of oral health grow more complex, in the cases of physically and mentally handicapped children, because such children usually cannot apply the necessary techniques of plaque removal.[1] In many instances the handicapped child's oral hygiene becomes the responsibility of another person, generally a parent, a guardian, or an institutional attendant.[2] Periodontal problems have also been reported in handicapped children.[3-7]

Children suffering from cerebral palsy are included in "God's forgotten children". Cerebral palsy is a disorder of movement and posture resulting from a nonprogressive lesion of the brain stem. A number of studies have shown that the incidence of periodontal disease is high in most of these children, because of the impaired manual dexterity.[8-10]

MATERIAL AND METHODS

For this study, children suffering from cerebral palsy were selected: three were ataxic athetoids; three, spastic diplegics; three, spastic quadriplegics; and one, spastic athetoid. The selection was based on the fact that children suffering from cerebral palsy manifest the disorder with paralysis and abnormal posture and movement of the extremities. The children were twelve to fourteen years of age (Table 1).

Evaluation of cleaning efficacy of toothbrushes

The examiner made morning visits to these children, to study their plaque levels. Plaque was disclosed on the tooth surfaces using basic fuchsin solution. The plaque score was determined using the Turesky—Gilmore—Glickman modification of the Quigley-Hein Plaque Index.[11] A thorough oral prophylaxis was done and plaque levels were reduced to zero. This was confirmed by using a disclosing agent.

A horizontal, scrubbing technique was demonstrated to these children. They were given standard toothbrushes, similar to the ones they were using at home. They were asked to brush without parental help for a period of seven days. The brushing sessions were supervised daily, after which the plaque was disclosed and the index score recorded. The children were asked to abstain from any other oral hygiene measures during this test period.

DESIGN OF INDIVIDUALLY MODIFIED TOOTHBRUSHES (FIGURE 1)

The standard toothbrush was individually modified, with the help of an occupational therapist: Various attachments were made to the toothbrush, in accordance with the physical disabilities of the individual.

Dr. Damle is Professor and Head, Department of Pediatric Dentistry and Dr. Bhavsar is Lecturer, Department of Pediatric Dentistry, Nair Hospital Dental College, Bombay-8, India.

Table 1 ☐ Number of children included in the study according to the type of disorder.

Disorder	Number
Ataxic athetoid	3
Spastic diplegic	3
Spastic quadriplegic	3
Spastic athetoid	1

For two of the three children afflicted with diplegia, a thick wooden handle was attached, varying the length; and for the third, a bicycle-grip handle was attached to the toothbrush head.

For the three children afflicted with quadriplegia, three different modifications were used: a white styrofoam handle, a forked rubber handle, and a single Velcro strap modification.

The three ataxic children need heavier handles; and the only athetoid child in the group required a double Velcro strap attachment on the toothbrush handle.

The children were then asked to brush with these toothbrushes (Figure 2). The brushing sessions were supervised each day and the plaque score was determined after a period of seven days. The toothbrushes were then distributed to each of these children for home use for a period of one week. The toothbrushing was unsupervised during this period. The plaque levels were once again recorded after this period of unsupervised brushing, and the collected data were analyzed statistically.

RESULTS

The mean plaque score in cerebral palsy children using normal toothbrushes at the end of one week was 3.677 ± 0.6333.

After one week of supervised brushing with individually modified toothbrushes, the mean plaque score was 1.912 ± 0.289.

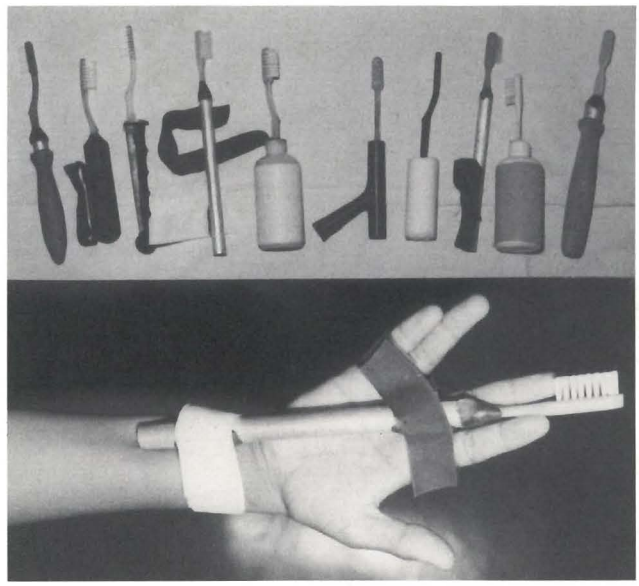


Figure 1. A variety of altered toothbrush handles, adapted to the requirements of individual patients.

The difference between the two mean scores was 1.765, statistically significant ($t > 2.101$).

The mean plaque score after one week of unsupervised brushing with individually modified toothbrushes was 2.222 ± 0.264. This value was compared with the value obtained after the use of normal toothbrushes. The difference between the two means was 1.455, which was significant ($t > 2.101$) (Table 2).

The difference between the mean plaque scores of individually modified toothbrushes with supervised and unsupervised brushing was evaluated statistically and was also found to be significant ($t > 2.26$).

It was also observed that supervised toothbrushing with individually modified toothbrushes cleaned 48 percent better than the normal toothbrushes; whereas, un-

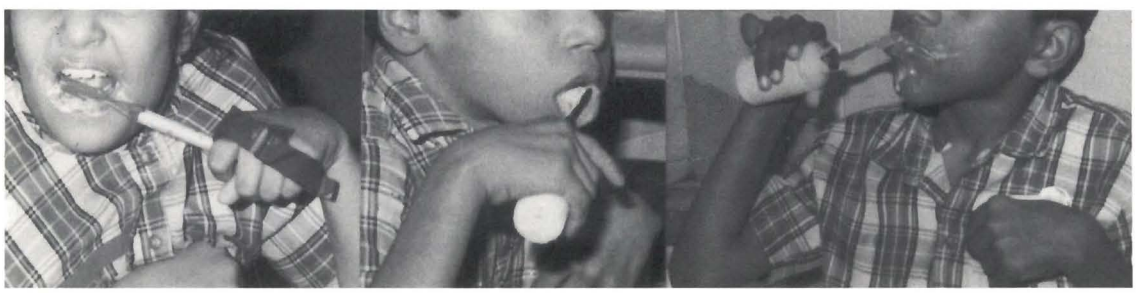


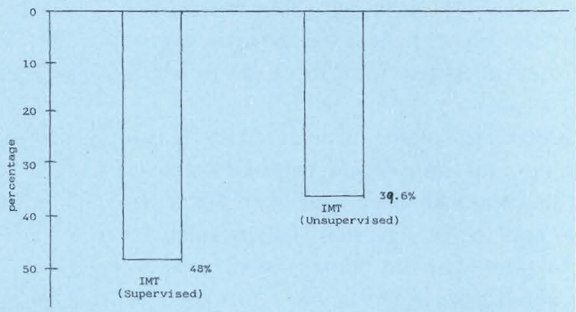
Figure 2. A montage of children using the altered brushes.

Table 2 ☐ Significance of difference between mean plaque scores of normal toothbrush and individually modified toothbrushes (IMT) after one week of supervised and unsupervised toothbrushing.

	Mean score	Difference	*Value of 't'	Significant
Normal	3.677			
		−1.765	7.607	Yes
IMT (Supervised)	1.912			
Normal	3.677			
		−1.455	6.409	Yes
IMT (Unsupervised)	2.222			

*At 0.05 level of significance for 18 degrees of freedom. Table value of t = 2.101

Table 3 ☐ Percentage change from mean plaque score of normal toothbrush.



supervised brushing cleaned 39.5 percent better than the normal toothbrushes (Table 3).

DISCUSSION

In attempting to provide the benefits of personal oral hygiene to handicapped children, several programs have been successfully instituted.[12-14] In many instances, the handicapped child has been able to assume personal responsibility for his or her own oral hygiene.

The results of this study showed a marked reduction in the plaque levels, following use of individually modified toothbrushes, as compared to the normal toothbrush.

The mean plaque score following the use of normal toothbrush after seven days was 3.677, whereas it was 1.912 following the supervised use of individually modified toothbrushes. The difference was found to be statistically significant. Also, the mean plaque score following unsupervised brushing, using individually modified toothbrushes was 2.222 and the difference from the normal was also statistically significant. Soncini (1989), observed that using individually modified toothbrushes, the children suffering from cerebral palsy cleaned a significantly higher percentage of the tooth surfaces covered with plaque.[15] Goho (1983), found a reduction of 26 percent following the home use of a digital brush.[16] Similar findings were reported by Kritsinelli (1992), who showed that the 'Myo' appliance was effective in reducing plaque and gingival inflammation.[17]

The results of the present study revealed that the success of individually modified toothbrushes could be due to the enthusiasm of these children for the 'special' toothbrushes, designed exclusively for their own needs. This pilot study indicates, therefore, the need for research on these modified toothbrushes, created according to the individual's needs, and its application to larger populations.

A child with cerebral palsy is often termed as 'An active mind trapped in a disobedient body". As professionals, it is our duty to help this mind conquer its rebellious body. Sometimes this can be achieved by small changes in a common and familiar object, which we are inclined to take for granted. As seen from this study, it takes only small modifications and a little effort to bring a smile back to these lovely faces.

CONCLUSION

The results of toothbrushing with individually modified toothbrushes used by cerebral palsy children showed a marked reduction in plaque levels, under supervision as well as during home use.

REFERENCES

1. Murray, J.J. and Mcleod, J.P.: The dental condition of severely subnormal children in three London boroughs. Brit Dent J, 134: 380-385, May 1973.
2. Johnson, R. and Albertson, D.: Plaque control for handicapped children. J Am Dent Assoc, 84:824-828, April 1972.
3. McClurin, E.T.: Dental study of handicapped children attending special schools in Birmingham, Part II—Dental cleanliness and periodontal treatment requirements. Comm Dent Health, 2:259-262, March 1985.
4. Mchrotra, A.K.; Saimbi, C.S.; Chawla, T.N. *et al*: A comparative assessment of dental health in physically and mentally handicapped individuals. J Ind Dent Assoc, 54:371-374, October 1982.
5. Nunn, J.H.: the dental health of mentally and physically handicapped children. A review of the literature. Comm Dent Health, 4:157-168, June 1987.
6. O'Donnell, J.P. and Cohen, M.: Dental care for the institutionalized retarded individuals. J Pedodontics, 9:3-38, Fall 1984.
7. Pieper, K.; Dirks, B.; Kessler, P.: Caries, oral hygiene and periodontal disease in handicapped adults. Comm Dent Oral Epidemiol, 14:28-30, January 1986.
8. Album, M.M.; Korgman, W.M.; Baker, D. *et al*: An evaluation of the dental profile of neuromuscular deficit patients: A pilot study. J Dent Child, 31:204-227, Third Quarter 1964.
9. Lizaire, A.L.; Borkent, A.; Toor, V.: Dental health status of non-dependant children with handicapping conditions in Edmonton, Alberta. Spec Care Dent, 6:74-79, March-April 1986.

10. Nunn, J.H. and Murray, J.J.: The dental health of handicapped children in New Castle and Northumberland. Brit Dent J, 162:9-14, January 1987.
11. Turesky, S.; Gilmore, N.D.; Glickman, I.: Reduced plaque formation by the chloromethyl analogue vitamine C. J Periodont, 41: 41-43, February 1970.
12. Arblaster, D.G.; Rothwell, P.S.; White, G.E.: A toothbrush for patients with impaired manual dexterity. Brit Dent J, 159:219-221, October 1985.
13. Full, C.A.; Kerber, P.E.; Boender, P. *et al*: Oral health maintenance of the institutionalized handicapped child. J Am Dent Assoc, 94:111-113, January 1977.
14. Leeds, J.J.: Clinical modifications for treatment of handicapped children. J Dent Child, 43:42-45, January-February 1976.
15. Soncini, J.A. and Tsamtsouris, A.: Individually modified toothbrushes and improvement of oral hygiene and gingival health in cerebral palsy children. J Pedodont, 13:331-344, Summer 1989.
16. Goho, C.: A digital brushing technique for patients with perceptuomotor difficulties. Clin Prev Dent, 5:6-8, March-April 1983.
17. Kritsineli, M.; Venetikidou, A.; Grigorakis, G.: The Myo as an oral prophylactic device used by Motor Skill Functionally Disabled patients. J Clin Pediatr Dent, 16:159-161, Spring 1992.

THE NATURAL TOOTHBRUSH

Chewing sticks were used by the Babylonians some 7000 years ago; they were later used throughout the Greek and Roman empires, and have been used by Jews, Egyptians and many other peoples. Today they are used in Africa, Asia, the Eastern Mediterranean Region and South America.

The commonest source of chewing sticks is *Salvadora persica*, a small tree or shrub with a crooked trunk. Its stems and roots are spongy and can easily be crushed between the teeth. Pieces of the root usually swell and become soft when soaked in water. In West Africa the lime tree (*Citrus aurantafolia*) and the orange tree (*Citrus sinensis*) sometimes provide chewing sticks. The roots of senna (*Cassia vinnea*) were used by American Blacks, and those of African laburnum (*Cassia sieberianba*) were used in Sierra Leone. Neem (*Azadirachta indica*) is widely used to provide chewing sticks in the Indian subcontinent.

Chewing sticks contain trimethylamine, salvadorine, chlorides, fluoride in large amounts, silica, sulfur, vitamin C, and small quantities of tannins, saponins, flavenoids and sterols. The fluoride content is well known to be beneficial, and the silica present in many chewing sticks helps to clean the teeth, acting as an abrasive. Chewing sticks derived from the Rutaceae contain alkaloids that have a bactericidal effect. Those obtained from *Aegles marmelos, S. persica, A. indica, Fagara zantholoxoids* and some other plants contain essential oils and exert carminative, antiseptic and analgesic action. The tannins and resins in many chewing sticks have an astringent effect on the mucous membrane and form a layer over the enamel, thus giving protection against caries.

Some chewing stick plants, most notably *S. persica*, have recently been used in the commercial manufacture of toothpastes in Egypt, India, Pakistan, Switzerland and the United Kingdom. The root and/or bark of *S. persica* contains 27% ash, alkaloids, resin and large amounts of chlorine and trimethylamine; silica, vitamin C and negligible quantities of tannins and saponins are also present. The high chloride content helps to remove tartar and stains from the teeth; the silica helps to whiten them; the resin may form a coating over the enamel, thus giving protection against decay; trimethylamine has a stimulatory effect on the gums; vitamin C contributes to the healing and repair of tissues; and the presence of sulfur compounds and possibly the alkaloid content lend antibacterial activity to the products.

The use of the chewing stick conforms with the notion of primary health care and has long-established associations with certain cultural and religious beliefs.

The chewing stick can be a good alternative to the toothbrush as a means of preventing oral and dental diseases. It is suitable for cleaning all the teeth, it costs little, possesses various medicinal properties, is available in most rural areas of developing countries, and requires no expertise or special resources for its production.

Almas, K. and Al-Lafi, T.R.: The natural toothbrush.
World Health Forum, 16(2):206-210, 1995.

EPIDEMIOLOGY

A study of dental caries and risk factors among Native American infants

Jiro Tsubouchi, DDS, PhD
Mihoko Tsubouchi, DDS
Ronald J. Maynard, MSW
Peter K. Domoto, DDS, MPH
Philip Weinstein, PhD

Baby Bottle Tooth Decay (BBTD) is one of the most severe dental problems in children, characterized by a distinctive rampant caries pattern in the primary dentition, in which maxillary incisors and frequently the maxillary and mandibular molars are affected.[1-4] The labial and lingual surfaces of four maxillary incisors almost always are most affected. Inappropriate feeding behavior; such as prolonged bottle and breast feeding or giving the bottle with fermentable liquid as baby sleeps, appear to be an important component of the etiology.[3,5-7] Treatment of severe BBTD is costly and stressful for children, parents and dental personnel; general anesthesia and hospitalization are often required. Cook *et al* (1994) examined the dollar costs of restoring the teeth affected by nursing caries and reported that the average cost of treating BBTD patients, using general anesthesia, was $2140.[8]

The prevalence of BBTD has been found to be very high in Native American populations.[8-11] Kelly and Bruerd (1987) reported the overall prevalence of 53 percent in 514 Native American children at Head Start programs in Alaska and Oklahoma. They diagnosed BBTD retrospectively when children had carious lesions progressing beyond the decalcification to cavitation on three of the four maxillary incisors.[9] Similarly, an overall retrospective prevalence of 70 percent was found when Navajo (Arizona) and Cherokee (Oklahoma) Head Start students, ages four to five years, were examined by Broderick *et al* (1989), classifying children with two or more maxillary anterior tooth surfaces affected by caries as having BBTD.[10] Cook *et al* (1994) examined 629 children ranging in age from two to five years in a Mississippi Choctaw Indian Head Start program and found over 50 percent of these children had nursing caries.[8] O'Sullivan *et al* (1994) collected caries data for 2003 Navajo children, ages three to five years, in the Head Start program and 115 children younger than three years old in the Women, Infants and Children (WIC) program, using WHO criteria; and found caries prevalences of 10.5 percent in the younger two-year-olds, 43.6 percent in the two-year-olds, 81.2 percent in the three-year-olds, 87.7 percent in the four-year-olds and 89.6 percent in the five-year-olds.[11]

Many studies have been conducted to identify the etiology, prevalence, and treatment of this disease.[12-14] But, a few studies have not been retrospective and have investigated behavioral risk factors associated with caries

Drs. Tsubouchi are visiting scholar, Department of Pediatric Dentistry, University of Washington and Assistant Professor, Department of Pediatric Dentistry, Okayama University Dental School. Mr. Maynard is Research Coordinator, Department of Pediatric Dentistry, University of Washington. Dr. Domoto is Associate Professor and Chairman, Department of Pediatric Dentistry, University of Washington. Dr. Weinstein is Professor, Department of Dental Public Health Science, University of Washington.

in Native American infants. The purpose of this study was to establish the prevalence of caries among Native American infants and to identify risk factors contributing to this disease.

METHOD

The subjects were seventy-seven infants, twelve to thirty-six months of age, and their parents/caregiver, who participated in a Women Infant Children (WIC) program at the Tulalip Health Center, Marysville, Washington. This number constituted 41 percent of children under thirty-six months enrolled on this reservation. The local water in this area is not fluoridated.

All parents/caregivers completed questionnaires that consisted of twenty-nine questions focusing on behavioral risk factors for dental diseases. This questionnaire includes the following four main categories: demographic variables (sex, age, parents' education level etc.), children's feeding behavior (breast fed now, bottle fed now, content in bottle etc), general care (use of cup, frequency of snack between meals, setting a time for snack etc.) and dental health behavior (cleaning child's teeth, using fluoride supplements or toothpastes etc.). After completing questionnaires, dental examinations were conducted with mouth mirror and explorer under natural light by one dentist. Caries experience was assessed in the entire mouth as *decalcified tooth, decayed tooth, filled tooth* and *missing tooth* caused by caries. No dental radiographs were taken. After collecting data, all questions were compared between children with caries and those without caries, to assess risk factors contributing to caries. Chi-square test and a two-tailed t-test were used to evaluate the differences between two groups. A p-value 0.05 and below was considered significant.

RESULT

Table 1 presents the caries status of all subjects by age. The overall caries prevalence was 46.8 percent. Twenty-six percent of children in the 12-18-month group, 55.6 percent in the 18-24-month group, and 55.6 percent in the 24-36-month group had caries experience. Approximately one-third of children with caries in all age-groups had only decalcified teeth (8.7/26.1, 16.7/55.6, and 16.7/55.6, respectively). The average number of carious teeth per child (deft) was 2.09 in all children. In each age-group, the average deft was 0.83, 2.17, and 2.86, respectively. There were no children who had filled or missing teeth caused by caries.

Table 2 presents demographic information of all subjects. The average age of the children was 23.6 months (S.D.=7.0). Over 70 percent of mothers have a job or go to school in the daytime and have completed high-school. Regarding the comparison between children with caries and without caries, no significant difference was found in sex, child's age, number of other children, mother's job and education.

Table 3 presents the results of child feeding and general care questions. Only 4 percent of subjects were not weaned from the breast and almost 50 percent continue

Table 1 ☐ Caries status by age.

Variable	12≤ ≤18	18< ≤24	24< ≤36	Totals
Number of children	23	18	36	77
Caries prevalence (%)	26.1	55.6	55.6	46.8
children with only decalcified teeth (%)	8.7	16.7	16.7	14.3
children with decalcified and decayed teeth (%)	17.4	38.9	38.9	32.5
deft* per child (range)	0.83 (0-5)	2.17 (0-7)	2.86 (0-12)	2.09 (0-12)

* The indicator of deft means total number of decayed teeth, missing teeth caused by caries and filled teeth. Decayed teeth includes decalcified teeth. In this subjects, no child had filled teeth and missing teeth caused by caries.

Table 2 ☐ Demographics of sample.

Variable	Total n=77	Carious n=36	Noncarious n=41	Test statistics
Sex (male)	44.2%	41.7%	46.3%	x^2= .03, p=.86
Child's age (months)	23.6	25.0	22.4	t=−1.68, p=.10
Number of other children (three or more)	28.6%	38.9%	19.5%	x^2=2.64, p=.10
Mother has job or goes to school (yes)	72.0%	70.6%	73.2%	x^2= .03, p=.86
Mother's education (completed high school)	77.4%	69.0%	84.8%	x^2=1.42, p=.23

to use the nursing bottle. Forty percent of children who stopped using the nursing bottle did so at an early age (one year or less). Over 70 percent of caregivers gave the bottle as baby fell asleep. Regarding the snacking behaviors, approximately 60 percent of the children were given something between meals, three times or more, and did not have a set time for snacks. In the comparisons between children with caries and those without caries, children using the bottle now were significantly associated with having caries (63.9 percent vs. 29.3 percent). The group stopping use of the bottle at an early age was less likely to have caries, although differences between two groups (15.4 percent vs.50.0 percent) was not statistically significant ($p=.08$). Giving the bottle as child falls sleep was significantly related to caries (82.4 percent for caries vs. 61.0 percent for non-caries). The parents/caregivers of children with caries were less likely to put water in the bottle than the non-caries group (33.3 percent vs. 58.5 percent). Similarly, the children with caries reported eating three or more snacks between meals per day at a much higher rate than the children without caries (73.5 percent vs. 40.0 percent).

The results of answers to dental health questions are presented in Table 4. Three quarters of the caregivers indicated that it made sense for them to begin cleaning a child's teeth by twelve months. Almost all caregivers tried to clean the child's teeth and half of them had problems at that age. Approximately 50 percent of caregivers reported that they cleaned the child's teeth everyday in the week, previous to the dental examination. Regarding questions of fluoride, less than 10 percent used fluoride supplements and over 80 percent used fluoride toothpastes. In the comparisons of the caries group with the non-caries group, caregiver's consciousness of *beginning cleaning the child's teeth under twelve months* was significantly related to *having caries* (57.7 percent vs. 90.0 percent). The caregivers in the caries group had more problems in cleaning the child's teeth than in the non-caries group (66.7 percent vs. 32.5 percent). Thirty-three percent of caregivers in the caries group reported that they cleaned the child's teeth everyday, the previous week; while over 70 percent of caregivers in the non-caries group did so.

DISCUSSION

In this study, an overall caries prevalence of 46.8 percent and average number of carious teeth per child (deft) of 2.09 were obtained. These results are difficult to compare with other findings; our subjects were very young children ages twelve to thirty-six months, and few researchers have investigated this age-group. It must be pointed out that decalcifications were not considered carious lesions in this study. Most other studies of BBTD were conducted with older children, usually ages three

Table 3 ☐ Responses to behavioral questions by age.

Variable	Totals n=77	Carious n=36	Noncarious n=41	Test statistics
Breast fed now (yes)	4.0%	2.9%	5.0%	$x^2=.00$, $p=1.00$
Age breast stopped (1 year or less)	90.9%	100%	84.2%	$x^2=.90$, $p=.34$
Bottle fed now (yes)	47.2%	63.9%	29.3%	$x^2=7.92$, $p=.00$
Age bottle stopped (1 year or less)	38.5%	15.4%	50.0%	$x^2=3.05$, $p=.08$
Content in bottle (juice)	58.4%	66.7%	51.2%	$x^2=1.30$, $p=.25$
Content in bottle (milk)	77.9%	75.0%	80.5%	$x^2=.09$, $p=.76$
Content in bottle (only water)	46.8%	33.3%	58.5%	$x^2=3.93$, $p=.05$
Given bottle as baby falls sleep (yes)	70.7%	82.4%	61.0%	$x^2=4.45$, $p=.03$
Cup using (more than 1 times per day)	84.4%	88.9%	80.5%	$x^2=.49$, $p=.48$
Frequency of snack between meals (3 or more)	55.4%	73.5%	40.0%	$x^2=7.06$, $p=.01$
Have a set time for snack (yes)	39.2%	34.3%	46.3%	$x^2=1.36$, $p=.24$

Table 4 ☐ Dental questions.

Variable	Totals n=77	Carious n=36	Noncarious n=41	Test statistics
Consciousness of beginning cleaning child's teeth under 12 months	75.0%	57.7%	90.0%	$x^2=6.13$, $p=.01$
Try to clean the child's teeth (yes)	94.7%	91.2%	97.6%	$x^2=.50$, $p=.48$
Have problems as clean the child's teeth (yes)	47.9%	66.7%	32.5%	$x^2=7.14$, $p=.01$
Clean the child's teeth last week everyday (yes)	55.9%	33.3%	73.7%	$x^2=9.50$, $p=.00$
Giving the child fluoride supplements (yes)	7.9%	11.4%	4.9%	$x^2=.40$, $p=.53$
Using fluoride toothpaste (yes)	84.8%	96.7%	75.0%	$x^2=4.41$, $p=.04$

to five years. Using their BBTD criteria of one or more faciolingual cavitated lesions, Johnson *et al* (1984) found a BBTD prevalence of 11 percent in the Head Start population, ages 3.5 to 5 years, in Ohio.[15] Louie *et al* (1990) investigated 1796 three-year to five-year-old Head Start children using the criteria in which BBTD was defined as the carious involvement of three or four maxillary incisors, and reported a 28 percent prevalence, ranging from 12 percent to 36 percent.[16] In comparisons with these findings, children in our study showed a higher prevalence of disease. Consequently, it appears that even very young Native American infants may be at high risk for caries, as other studies conducted among Native American population have reported.[8-10,17]

It is interesting to note that no child had filled or missing teeth caused by caries. This may suggest that these Native American young children under three years of age do not have access to dental care. In another study, non-dental health workers and parents/caregivers were trained to examine briefly a young child in a non-dental environment to make the determination whether or not maxillary anterior teeth were decalcified/decayed or healthy.[18] Results were reliable, i.e. dentists and non-dentists were able to identify caries, including decalcification. It is therefore feasible to join both low-income parents/caregivers and non-dental caregivers, such as WIC workers and others, who have regular contact with high risk children, to examine these high risk children and to take appropriate preventive steps. Such steps may involve referral and visits to dentists for a mix of services that may include oral hygiene instruction, dietary counselling, application of fluoride varnish, or non-invasive repair of carious teeth, using glass ionomer cement or restorative material.

In each age-group, one-third of children with caries had decalcified teeth. Dental caries is caused by acid that microorganisms, i.e. *S. mutans*, produce in dental plaque as a by-product of metabolism of fermentable carbohydrates.[19] A decalcified tooth is early evidence that the disease process is active. Such teeth may be remineralized by appropriate dental procedures; decalcification can be reversed through the process of remineralization. Weinstein *et al* (1994) conducted a preliminary study to investigate the effectiveness of a semiannual application of fluoride varnish in 133 Mexican-American children, ages twelve to twenty-four months. He reported a significant decrease of caries prevalence after such six-month applications.[20] This finding suggested that fluoride varnish might have an effect in the prevention of caries in the primary teeth, and might have contributed to remineralization of the decalcified teeth. Other studies also have found fluoride varnish to be effective in caries prevention.[21-23]

In addition, the average number of carious teeth per child increased with age, though the caries prevalence stayed at the same level, from eighteen to thirty-six months. It appears that the caries status becomes more severe with age. Consequently, early dental interventions are useful especially for high risk populations, to reduce the prevalence and severity of infant caries. For example, Bruerd *et al* (1989) implemented an experimental program to prevent BBTD in twelve Native American communities and reported statistically significant decreases in BBTD.[24] Recently, we have instructed groups of public health and private dentists in methods of examining and treating children under four years of age. Dentists are generally not familiar with infants and toddlers and the developmental, patient management, and technical skills required to provide care for children in this age-group. Changes in dental education and programs in continuing education are necessary, therefore, so that dental personnel can effectively apply prevention measures, in a timely manner, on a large number of these high risk infants and toddlers.

Demographic factors, e.g. number of other children in the house and mother's educational level, were not associated with the infant's dental health status in the present studies. While other investigators have found that such social environmental factors influence dental health within a given ethnic group, we believe that the behavioral factors rather than the social environmental factors are likely to be more directly influential on dental health. Of these behavioral factors, bottle feeding, snacking, and brushing behaviors were identified in our study as risk behaviors. Children with caries are more likely to be fed with a bottle beyond one year old, especially as they fall sleep. The caregivers of children with caries also are less likely to put water in the bottle. Many investigations have found that prolonged and inappropriate bottle feeding affects caries rate; similarly our findings also demonstrated a relationship between feeding patterns and caries status.[3,5-7]

It appears that children with caries ingest snacks between meals more frequently than children without caries. This may be caused by the fact that the caregivers indulge children; they give sweetened snacks whenever their children want something to eat between meals. This indulgence of children may be culturally determined. Instructions to influence caregivers to change these habits may not be successful until community-wide efforts are undertaken to alter normative feeding behaviors.

We believe that it is important to begin cleaning children's teeth between the ages of six- and twelve-months. Early cleaning helps develop the brushing habit. Moreover, because erupting teeth are at high risk, cleaning infant/toddler teeth may be an effective preventive measure.[25] Only half of caregivers of children with carious teeth, however, think it makes sense to begin cleaning their children's teeth by twelve-months-old, while 90 percent of caregivers with noncarious children see the need. Almost all of caregivers both of the caries group and the noncaries group actually have attempted to clean their children's teeth. But, as caregivers with carious children try to clean their children's teeth, they have more difficulties. These caregivers noted specific problems, such as children would not remain still, would not keep mouth open, would not allow caregiver to brush, etc. It appears that these caregivers cannot deal with these problems effectively and are not willing to continue brushing everyday for their children. In all, caregivers of children with caries are less likely to be aware of the need to clean at an early age and are less likely to be able and willing to cope with children who do not want to cooperate. While this finding is new for oral self-care, others have found that caregivers were not willing to tolerate stress and the upset child was at higher risk for baby bottle tooth decay.[6] These results suggest that caregivers with high risk children need more information concerning the age to begin cleaning. Caregivers who do not do well with stress or confrontation may lack a sense of their own effectiveness and may benefit from the counsel of others who have overcome these problems. Specific strategies to overcome problems should be presented.

In conclusion, our results suggest that the infant Native American population which was studied is at a high risk for caries and that feeding patterns that they follow appear to be behavioral risk factors. In addition, other life-style-related behaviors, e.g. brushing behavior, were found to be risk factors for dental caries. Consequently, we believe culturally appropriate preventive and early screening efforts targeted and tailored to American Indian caregivers are needed in order to reduce caries rates in these high risk populations.

REFERENCE

1. Gardner, D.E.; Norwood, J.R.; Eisenson, J.F.: At will breast feeding and dental caries: Four case reports. J Dent Child, 44:186-191, May-June 1977.
2. Dilley, G.J.; Dilley, D.H.; Machen, J.B.: Prolonged nursing habit: A profile of patients and their families. J Dent Child, 47:102-108, March-April 1980.
3. Johnsen, D.C.: Characteristics and Backgrounds of Children with "Nursing Caries." Pediatr Dent, 4:218-224, September 1982.
4. Ripa, L.W.: Nursing Caries: a Comprehensive Review. Pediatr Dent, 10:268-282, December 1988.
5. Kotlow, L.A.: Breast feeding: A cause of dental caries in children. J Dent Child, 44:192-193, May-June 1977.
6. Weinstein, P.; Domoto, P.; Wohlers, K. *et al*: Mexican-American parents with children at high risk for baby bottle tooth decay: Pilot study at a migrant farmworkers clinic. J Dent Child, 59:376-383, September-October 1992.
7. Tsubouchi, J.; Higashi, T.; Shimono, T. *et al*: A study of baby bottle tooth decay and risk factors for 18-month old infants in rural Japan. J Dent Child, 61:293-298, July-August 1994.
8. Cook, H.W.; Duncan, W.K.; De-Ball, S. *et al*: The Cost of Nursing Caries in a Native American Head Start Population. J Clin Pediatr Dent, 18(2):139-142, Winter 1994.
9. Kelly, M. and Bruerd, B.: The Prevalence of Baby Bottle Tooth Decay among Two Native American Populations. J Public Health Dent, 47:94-97, Spring 1987.
10. Broderic, E.; Mabry, J.; Robertson, D. *et al*: Baby Bottle Tooth Decay in Native American Children in Head Start Centers. Public Health Rep, 104:50-54, January-February 1989.
11. O'Sullivan, D.M.; Douglass, J.M.; Champany, R. *et al*: Dental caries prevalence and treatment among Navajo preschool children. J Public Health Dent, 54(3):139-44, Summer 1994.
12. Derkson, G.D. and Ponti, P.: Nursing Bottle Syndrome; Prevalence and etiology in non-fluoridated city. J Can Dent Assoc, 48: 389-393, June 1982.
13. Kaste, L.M.; Marianos, D.; Chang R. *et al*: The Assessment of Nursing Caries and Its Relationship to High Caries in the Parmanent Dentition. J Public Health Dent, 52(2);64-68, Winter 1992.
14. Barnes, G.P.; Parker, W.A.; Lyon, T.C. *et al*: Ethnicity, Location, Age and Fluoridation Factors in Baby Bottle Tooth Decay and Caries Prevalence of Head Start Children. Public Health Rep, 107: 167-173, March-April 1992.
15. Johnson, D.C.; Schultz, D.W.; Schubot, D.B. *et al*: Caries Patterns in Head Start Children in a Fluoridated Community. J Public Health Dent, 44(2):61-66, Spring 1984.
16. Louie, R.; Brunelle, J.A.; Magglore, E.D. *et al*: Caries Prevalence in Head Start Children, 1986-87. J Public Health Dent, 50(5):299-305, Fall 1990.
17. Waldman, H.B.: Rediscovering the health status of Native Americans. J Dent Child, 59:216-220, May-June 1992.
18. Lee, C.; Rezaiamira, N.; Jeffcott, E. *et al*: Teaching parents at WIC clinics to examine their high caries risk babies. J Dent Child, 61: 347-349, September-December 1994.
19. Newbrun, E.: *Cariology Third edition, Chapter 1 History and early theories of the etiology of caries.* Chicago: Quintessence Publishing Co, 1989, pp 13-28.
20. Weinstein, P.; Domoto, P.K.; Koday, M. *et al*: Results of promising open trial to prevent baby bottle tooth decay: A fluoride varnish study. J Dent Child, 61:338-341, September-December 1994.
21. Wegner, H.: The clinical effect of application of fluoride varnish. Caries Res, 10:(4)318-320, September 1976.
22. Holm, A.: Effect of a fluoride varnish (Duraphat) on pre-school children. Community Dent Oral Epidemiol, 7:241-245, October 1979.
23. Seppa, L. and Tolonen T.: Caries preventive effect of fluoride varnish applications performed two or four times a year. Scand J Dent Res, 98:102-105, April 1990.
24. Bruerd, B.; Kinney, M.B.; Bothwell, E.: Preventing baby bottle tooth decay in American Indian and Alaska Native communities: a model for planning. Public Health Reports, 104(6):631-640, November-December 1989.
25. Tenovuo, J.; Hakkinen, P.; Paunio, P. *et al*: Effects of chlorohexidine-fluoride gel treatments in mothers on the establishment of mutans streptococci in primary teeth and the development of dental caries in children. Caries Res, 26:275-280, July-August 1992.

DEMOGRAPHICS

Immigrant children and pediatric dental practice

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

"In (the) 1990 (Census) Americans claimed membership in nearly 300 races or ethnic groups and 600 American Indian tribes. Hispanics had seventy categories of their own."[1]

It is not uncommon for a politician to make the point that one of the strengths of our country is the diversity of our population. Yet it is this diversity itself that at times has resulted in conflicts between groups. To emphasize this complexity even further, "...doubts about the conventional racial categories—black, white, Asian..." (which is the basic trichotomy used in the presentation of general health statistics) are now being raised.[1] In a recent cover story *Newsweek* asks the questions, "What color is black? And what color is white?"[2]

Scientists have moved beyond the classification of our population of skin color, shapes of noses and eyes, and other superficial factors. The reality is that, "(t)here is no organizing principle by which you could put 5 billion people into so few categories in a way that would tell you anything important about human diversity.".[2]

The need to know more about the diversity of the individuals in our communities takes on increased importance as health providers increasingly recognize the impact that varying cultural, ethnic, racial, and gender factors have on the health of our patients. Earlier presentations by this writer emphasized both the variety and increasing numbers of the many minority children (and adults) in our communities, their particular needs and their impact on the future practice of pediatric dentistry.[3-8]

But in all these discussions limited attention was directed to the continuing, but changing flow of immigrant children (less that fifteen years of age) who enter the United States each year. Because of varying backgrounds, languages, food preferences, health conditions (some of which may be quite unfamiliar to U.S. practitioners) and a seeming endless array of special needs, new immigrants present health providers with unique problems that must be considered and overcome. The following presentation will provide a general introduction into the numbers and changing backgrounds of immigrant children who are entering the United States—as they add their increasing diversity to our communities and the complexities of dental practice.

NUMBERS AND ORIGINS OF IMMIGRANTS

During the past four decades there has been a progressive increase in the number of immigrants entering the United States. Between the 1950s and 1980s the number of immigrants per decade almost tripled, from 2.5 million to 7.3 million persons. Note: throughout this presentation, all data (except those presented in Table 1) are for legal immigrants. It is estimated that in 1992 there were 3.2 million illegal aliens who were resident in the United States. Forty percent were resident in California, 15 percent in New York, 11 percent in Florida, 10 percent in Texas, and 5 percent in Illinois. Two-thirds were from North America (including Canada, Mexico, West Indies and Central America) with almost one-third (31 percent) from Mexico (Table 1).

But even more significant than the general increase in numbers have been the dramatic changes in the origin of individuals entering this country.[10] During the 1950s, approximately 60 percent of immigrants were from Europe, 6 percent were from Asia and 31 percent were from North America. By contrast, during the 1980s, only 10 percent of immigrants were from Europe, while 38 percent were from Asia and 43 percent were from North America (Table 2, Figure 1).

Dr. Waldman is Professor and Chairman, Department of Dental Health, School of Dental Medicine, State University of New York at Stony Brook, Stony Brook, NY 11794-8715.

Table 1 ☐ Estimate of the resident illegal alien population, by state and origin: October 1992.[9]

U.S. residence			Origin		
State	Number (in 000s)	Percent	Region	Number (in 000s)	Percent
California	1,275	40%	North America°	2,100	66%
New York	485	15	Asia	335	10
Florida	345	11	Europe	310	10
Texas	320	10	South America	200	6
Illinois	170	5	Africa	120	4
			Oceania	15	< 1
New Jersey	125	4			
Massachusetts	48	2			
Arizona	47	1		Number (in 000s)	
Virginia	37	1			
Georgia	28	1	Country		Percent
Maryland	27	1	Mexico	1,002	31%
Washington	26	1	El Salvador	298	9
Pennsylvania	19	1	Guatemala	121	4
Connecticut	17	1	Canada	104	3
Oregon	16	1	Poland	102	3
Nevada	16	1	Philippines	101	3
New Mexico	16	1	Haiti	98	3
North Carolina	15	< 1	Nicaragua	76	2
Colorado	14	< 1	Colombia	75	2
Dist. Col.	14	< 1	Bahamas	72	2
All others	137	4	Honduras	69	2
			Italy	67	2
Total	3,200	100%	Ecuador	53	2
			Dominican Republic	51	2
			Jamaica	50	2
			Trinidad	41	1
			Iran	37	1
			Ireland	37	1
			Pakistan	33	1
			Portugal	32	1
			India, Peru, Israel, China,Dominica and Nigeria	24–31	
			Yugoslavia, Lebanon, Guyana, Belige, and France	15–19	
			Other countries not listed	< 15	

Note: As a result of rounding of data, totals may not equal 100 percent
° Includes Canada, Mexico, West Indies and Central America

Immigrants enter the United States under a series of classifications, including family relationships, refugee and asylum status, skilled status, or residents of an underrepresented country (Table 3). For example, between 1975 and 1992, almost 1.1 million Southeast Asian refugees and Amerasians emigrated to the United States.[12°]

RESIDENCE IN THE UNITED STATES

The extent of the immigration to particular states (e.g. Florida and California) have reached the front pages of our newspapers with efforts by the state governments to secure federal funds for the health and social programs for these new residents. The reality is, however, that with the exception of the East South Central Region (KY, TN, AL, MS) of the country, tens of thousands of immigrants have settled annually in each of the regions throughout the nation (Table 4).

☐ In 1991, immigration by state ranged from 732,000 in California, 212,000 in Texas, 188,000 in New York, 141,000 in Florida and 73,000 in Illinois, to 566 in Wyoming, 565 in North Dakota and 519 in South Dakota.[10]

Table 2 ☐ Distribution of all immigrants entering the United States by region of birth: selected FY years 1951–1990.[10]

	Fiscal years			
	1951–1960	1961–1970	1971–1980	1981–1990
Total number of immigrants (in 000s)	2,515.5	3,321.7	3,502.2	7,338.1
	Percent			
Europe	59.3%	37.3%	19.1%	9.6%
Asia	6.2	13.4	34.5	38.4
North America°	30.6	40.7	37.8	42.6
South America	2.9	6.9	6.0	6.2
Africa	0.6	1.2	1.8	2.6
Australia	0.1	0.3	0.3	0.2
Other countries	0.2	0.2	0.4	0.4

°Includes Canada, Mexico, West Indies and Central America

°See Appendix for a summary of immigration legislation which establishes limits and categories.

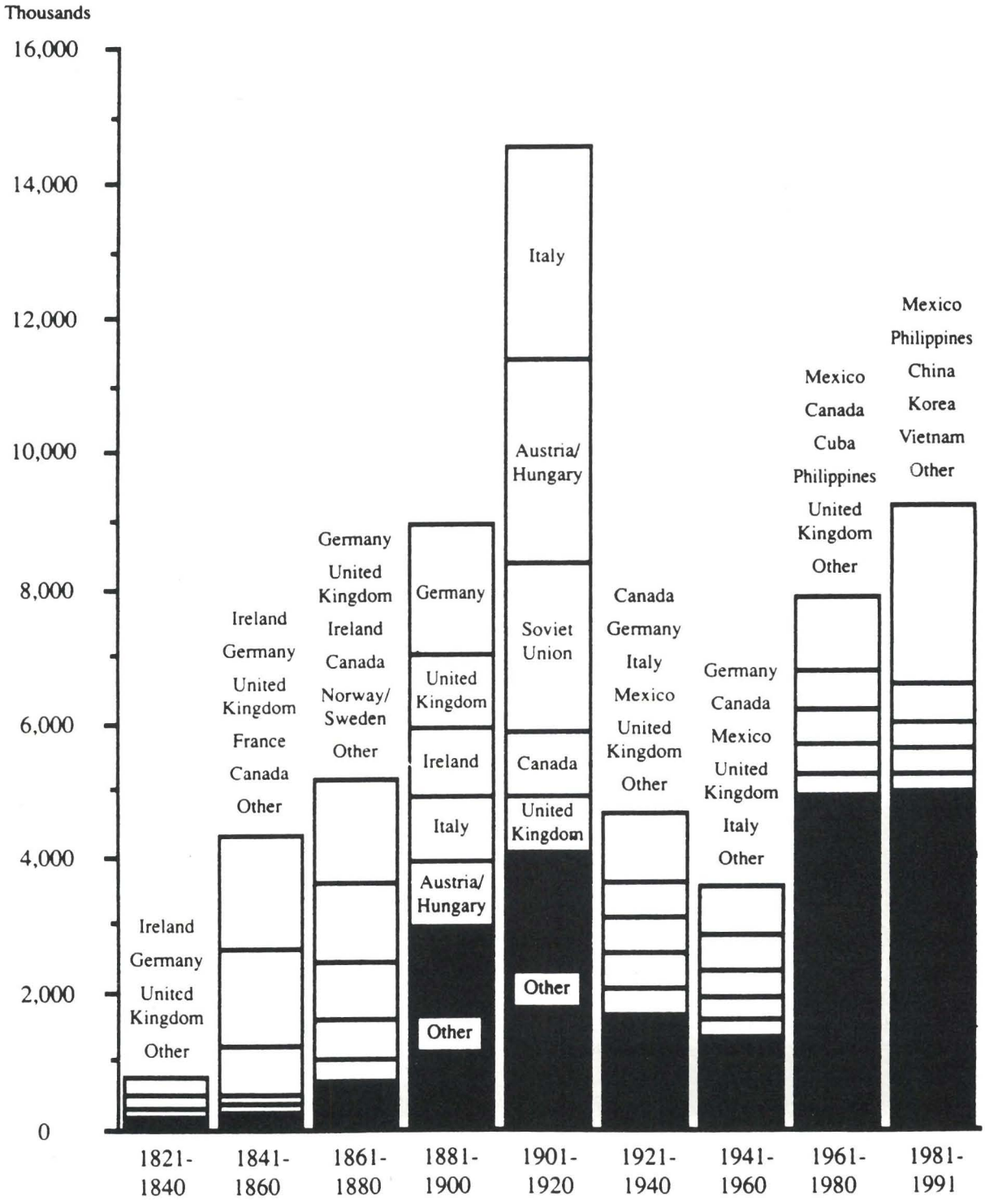


Figure 1. Immigrants admitted to the United States from the five top countries of last residence: 1821-1991.[11,12]

Table 3 ☐ Immigrants admitted by class of admission: 1991.[10]

	Number (in 000s)
Numerically limited	293.8
Unmarried daughters/sons of US citizens and their children (1st preference)	15.4
Spouses, unmarried sons/daughters of alien residents, and their children (2nd preference)	110.1
Professional or highly skilled immigrants (3rd preference)	27.7
Married sons/daughters of US citizens (4th preference)	27.1
Brothers or sisters of US citizens (5th preference)	63.5
Need skilled or unskilled worker (6th preference)	27.2
Nonpreference	12.2
Natives of under represented countries	9.8
Other	.7
Exempt from numerical limitations	1,553.3
Immediate relatives (spouses, children, parents) of US citizens	237.1
Refugees and asylees	139.1
Special immigrants (ministers, employees of US government, foreign medical graduates)	4.5
Immigration Reform and Control Act of 1986	1,123.1
Other	27.0

Table 4 ☐ Number of immigrants admitted by residence in the United States: FY 1991.[10]

	Number (in 000s)
New England	46.3
Middle Atlantic	264.3
East North Central	108.5
West North Central	24.9
South Atlantic	235.9
East South Central	9.5
West South Central	226.4
Mountain	92.6
Pacific	801.3
Total	1,827.2

☐ Between 1983 and 1992, a total of almost 868,000 refugees was settled in all the states and the District of Columbia (Figure 2).

☐ In 1991, of the 139 thousand refugees granted permanent resident status, only 2,900 became residents of nonmetropolitan areas. Of those settling in metropolitan statistical areas (MSA), 19.3 thousand established residence in the New York MSA, 17.9 thousand in the Los Angeles-Long Beach MSA, 12.2 thousand in the Miami-Hialeah MSA, 5.3 thousand in the Chicago MSA, 4 thousand plus in each of the San Francisco MSA and the San Jose MSA, and 3 thousand plus in each of the Washington, D.C. MSA, the Philadelphia MSA and the Anaheim-Santa Ana MSA.[12]

☐ During the 1980s, between one hundred and two hundred thousand immigrants became residents in each of five states (Arizona, Maryland, Pennsylvania, Virginia, and Washington); between two and four hundred thousand became residents in each of three states (Illinois, Massachusetts, and New Jersey); between 660 and 720 thousand became residents in each of two states (Florida and Texas); and 1.2 million and 3.3 million, respectively, became residents of New York and California.[13]

NUMBER OF CHILDREN

Since the mid-1970s, approximately 100,000 to 180,000 children less than fifteen years of age have immigrated annually to the United States. In most years, children represent about a fifth of the annual total number of immigrants. While thirty to forty thousand of these children are less than five years of age, the majority of the youngsters are of school age (Table 5). By the time these school-age children immigrate to this country, they have taken the initial and very important steps in learning the language, customs, and culture of their particular country of birth. The continuing influx of these many children throughout our communities has resulted in the increasing efforts by our public school systems to develop special transitional programs, including English as a second language and bilingual educational classes. The need for these programs for children (and adults) continues to grow. For example, between 1980 and 1990,

☐ There was a more than one-third increase in the number of U.S. residents who were non-English speaking (from 23.7 million to 31.8 million).

☐ Of the non-English speaking residents, there was a 50 percent increase in the number who spoke Spanish, a 98 percent increase in number who spoke Chinese, a 150 percent increase in the number who spoke Vietnamese, a 155 percent increase in the number who spoke Hindi, and a 654 percent increase in the number who spoke French Creole.

☐ By contrast, there generally were decreases in the number of non-English speaking residents who spoke various European languages (Table 6).

FROM WHERE DO THE CHILDREN COME?

As a result of the many changes in the immigration laws of this country, and the continuing economic, social, and political climates, as well as the particular needs of the people of other countries, there have been continuing changes in the countries of origin from which the new arrivals have come. Whereas in the past decades the primary source of immigrants was Europe, during the mid-

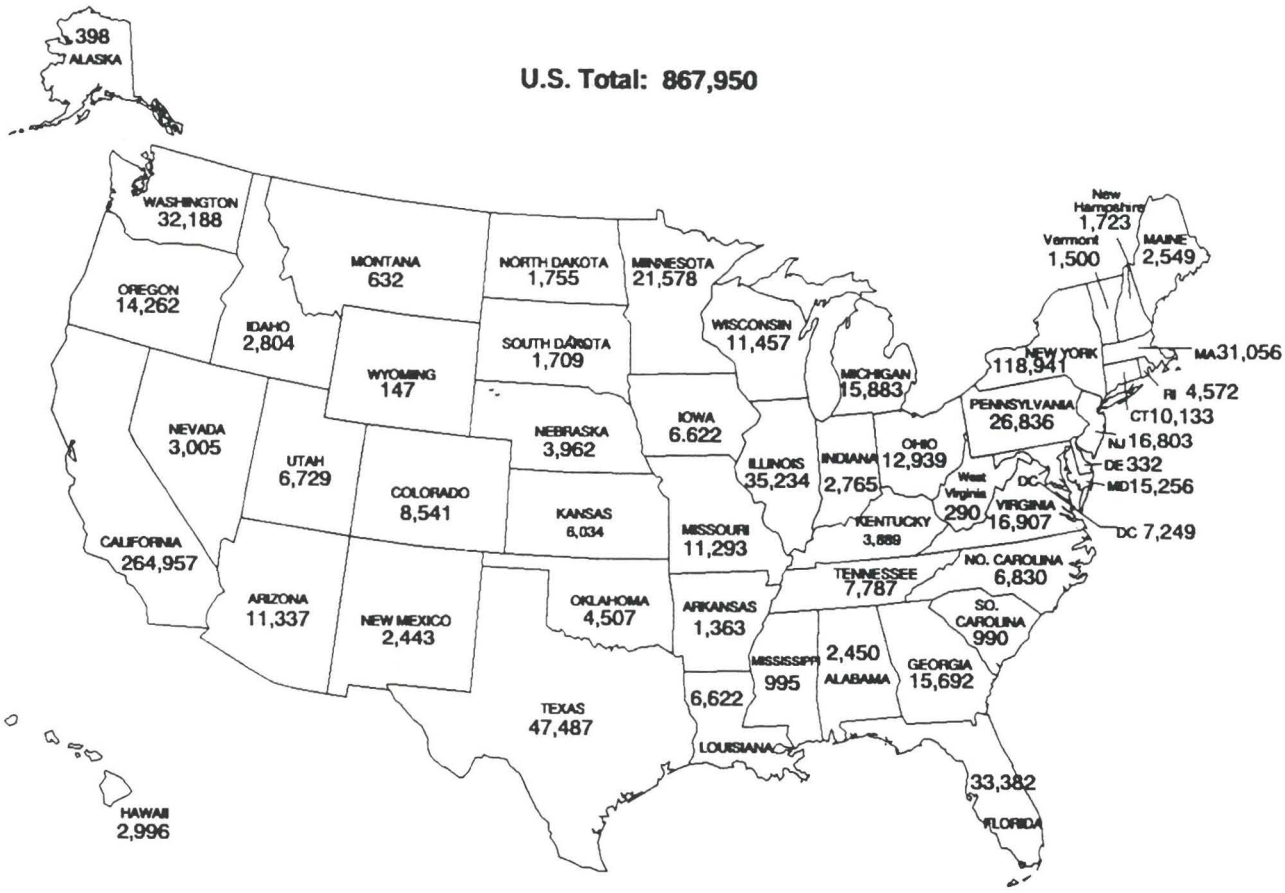


Figure 2. Number of refugee arrivals by state: Fiscal year 1983-1992.[12]

1980s and early 1990s, the countries of origin for some of the greater number of children immigrating to the United States were China (mainland), Dominican Republic, El Salvador, India, Korea, Mexico, Philippines, (the former) Soviet Union, and Vietnam (Table 7).

FROM THE PERSPECTIVE OF THE PEDIATRIC DENTIST

By now most practitioners have been in circumstances where communication with parents or guardians has been difficult—whether because of language and/or cultural differences. But added to these difficulties are those situations where language differences exist between the practitioner and the youngsters in need of treatment. Attempting to complete medical and dental histories, earning the confidence of your young patient, assuring home care follow-up, and any number of other steps in the care process can at times be a difficult task in some normal circumstances. But in the case of recent immigrants, the difficulties could be far more complex.

Convincing parents of the need to retain primary teeth, the value of space maintainers, the worth of sealants, and any number of other preventive and reparative services may run counter to the dental experiences of immigrants from different areas of the world.

While there is little national published data on the oral health status of the many immigrant populations, some local studies of the children of recent refugees and immigrants who are enrolled in Head Start programs do provide indications of greater unmet restorative treatment needs. Note: "refugee status" confers welfare benefits (such as Medicaid for the first 18 months, as well as English as a second language programs and job training for parents). As a result, refugee children have a higher utilization of dental services.[16**]

This review of the evolving immigration to this country should demonstrate the reality that between one hundred and one hundred and eighty thousand youngsters (and their families):

- ☐ Are arriving from any and every country in the world and bringing with them a wide variety of languages,

**See a previous presentation in the *Journal of Dentistry for Children* for a more detailed presentation.[8]

Table 5 ☐ Immigrant children less than fifteen years entering the United States as a percent of all immigrants: selected FY year 1975–1993.[11]

Fiscal year	Less than 5 years	5-9 years	10-14 years	Total children less than 15 yrs	Total number of all immigrants	Percent children
1975	30,089	32,934	35,392	98,415	386,194	25.4%
1980	32,946	40,555	44,140	117,641	540,639	22.1
1985	32,867	37,717	44,890	115,474	570,009	20.3
1990	33,520	51,922	95,453	180,895	1,536,483	11.8
1993	39,111	62,949	78,157	180,277	904,292	19.1

Table 6 ☐ Number of non-English speaking language US residents (rankings of languages spoken at home by more than one hundred thousand persons): 1990.[15]

Language	Number (5 yrs and over)	Percent change between 1980 & 1990
	(in 000s)	
Spanish	17,339	50.1%
French	1,702	8.3
German	1,547	−3.7
Italian	1,308	−19.9
Chinese	1,249	97.7
Tagalog°	843	86.6
Polish	723	−12.4
Korean	626	127.2
Vietnamese	507	149.5
Portuguese	429	19.0
Japanese	427	25.0
Greek	388	−5.4
Arabic	355	57.4
Hindi and related	331	155.1
Russian	241	38.5
Yiddish	213	−33.5
Thai	206	131.6
Persian	201	84.7
French Creole	187	654.1
Armenian	149	46.3
Navaho	148	20.6
Hungarian	147	−17.9
Hebrew	144	45.4
Dutch	142	−2.6
Mon-Khmer°°	127	676.3
Gujarathi°°°	102	177.8
Total US	31,844	34.3

° Filipino language of Manila and adjacent provinces
°° Language spoken in Southeast Asia, mostly in Cambodia
°°° Language of Gujarat region of western India

Table 7 ☐ Number of immigrant children less than fifteen years of age entering the United States by age and country of birth: FY 1986 and FY 1993.[11]

	Less than 5 years		5-9 years		10-14 years	
	1986	1993	1986	1993	1986	1993
Total	33,767	39,111	39,720	62,949	47,152	78,157
Cambodia	291	na	1,379	na	1,697	na
Canada	824	1,070	923	1,532	702	1,535
P.R. China	325	1,087	926	2,549	1,564	2,618
Colombia	798	754	787	772	766	1,229
Cuba	37	212	1,945	472	3,273	483
Domin. Rep.	1,402	3,268	1,992	3,901	2,502	4,552
El Salvador	313	425	897	1,155	1,201	4,653
Germany	476	335	367	411	228	289
Guatemala	381	699	338	700	492	1,852
Guyana	473	278	1,041	499	1,228	901
Haiti	346	367	1,029	361	1,198	1,467
Hong Kong	na	507	na	697	na	1,029
Honduras	309	378	403	603	479	1,035
India	1,707	1,932	1,290	1,944	1,355	2,337
Iran	362	196	689	640	746	897
Ireland	na	260	na	299	na	275
Jamaica	940	703	1,812	1,492	2,348	2,100
Korea	6,959	2,350	2,254	726	2,319	1,395
Laos	111	na	936	na	1,088	na
Lebanon	125	na	161	na	203	na
Mexico	3,463	4,214	2,902	12,857	5,018	14,743
Pakistan	499	778	341	677	267	668
Peru	191	495	232	600	312	1,012
Philippines	2,840	2,448	3,371	4,260	4,081	5,435
Poland	187	1,470	603	1,928	539	2,426
Romania	220	na	516	na	438	na
Soviet Union	na	3,451	na	5,540	na	4,754
Taiwan	611	364	1,079	695	1,090	1,416
Thailand	2,141	na	1,301	na	203	na
United Kingdom	687	716	995	1,145	882	1,158
Vietnam	681	2,155	2,368	4,093	3,825	4,248
Other	6,068	7,775	6,843	11,745	7,168	12,747

customs and experiences, which may be quite different from those of previous waves of immigrants.

☐ Are becoming residents of every region, state and community in our nation.

☐ Can and do present a challenge to dental and medical practitioners.

But isn't that why we practice dentistry?

APPENDIX

Summary of immigration legislation

Prior to 1875 anyone from any foreign country could enter the country freely and take up permanent residence. Over the next 60 years, Congress passed laws restricting immigration on the basis of morality (no prostitutes or convicts), race (the Chinese Exclusion Act of 1882 was the first) and national origin (immigration from Southern and Central Europe as well as Asia were severely limited during the 1920s). The 1952 Immigration and Naturalization Act reaffirmed national origin as the central criterion for eligibility and established a preferential system for skilled workers and for relatives of U.S. citizens.

For many years the total number of immigrants was restricted to 270,000 each year. There were, however,

many exceptions. An average of 700,000 immigrants entered the country each year during the 1980s (not counting illegal aliens naturalized under provisions of the 1986 Immigration Reform and Control Act).

In 1992, the 270,000 limit was replaced with a sliding cap that is less restrictive than previous immigration laws. The 1990 Immigration Act limits the total number of immigrants to 700,000 from 1992 to 1995 and 675,000 thereafter (excluding refugees whose admission numbers are announced annually and some others not subject to limitation). The act increases the number of openings for immigrants with valuable employment skills from 54,000 to 140,000 each year, and reserves 55,000 openings each year for immigrants of underepresented countries. In addition, the new law introduces a sliding scale for admitting family sponsored immigrants. As in previous years, there is no limit to the number of immediate family members admitted each year. Beginning in 1992, however, the number of immediate family members admitted each year is used in the determination of the number of family sponsored immigrants that will be approved.[13]

As the galley proofs for this material were being reviewed, I received a request from the administration of my university seeking assistance in programs for students whose primary language is Vietnamese, Gaelic, Chinese dialects other than Mandarin and a variety of West African languages.

REFERENCES

1. Begley, S.: Three is not enough: surprising new lessons from the controversial science of race. Newsweek, February 13, 1995, pp 67-69.
2. Morganthau, T.: What color is black? Newsweek, February 13, 1995, pp 62-65.
3. Waldman, H.B.: An increasing Hispanic population and the practice of dentistry. Illinois State Dent J, 61:81-85, March-April 1992.
4. Waldman, H.B.: "Rediscovering" the health status of Native Americans. J Dent Child, 59:216-220, May-June 1992.
5. Waldman, H.B.: Asian Americans: an increasing reality in the population and the dental profession. Ohio Dent J, 66:38-43, Spring-Summer 1992.
6. Waldman, H.B.: More minority children and the need to stress dental care. J Dent Child, 60:403-407, November-December 1993.
7. Waldman, H.B.: African-Americans and their use of dental services. Comp Cont Educ in Dent, in press.
8. Waldman, H.B.: Asian American and Pacific Islander children: They will become an increasing reality in your practice. J Dent Child, 62:136-140, March-April 1995.
9. Estimates of the resident illegal alien population, October 1992. Washington, D.C.: Congressional Information Service, 1993.
10. 1980; 1993; 1994 Statistical Abstract of the United States. Washington, D.C.: Government Printing Office, 1980; 1993; 1994.
11. 1984; 1986; 1992; 1993 Statistical Yearbook of Immigration and Naturalization Service. Washington, D.C.: Government Printing Office, 1986; 1987; 1993; 1994.
12. Schorr, A.E.: Refugee and Immigrant Resource Directory, third edition. Juneau, AK, Danali Press, 1994.
13. Universal Almanac, 1993. Kansas City, MO: Andrews and McMeel, 1993.
14. World Almanac and Book of Facts, 1993. Mahway, NJ: World Almanac Books, 1994.
15. Information Please Almanac, 1994. Boston: Houghton Mifflin Co., 1994.
16. Pollick, H.G.; Rice, A.J.; Echenberg, D.: Dental health of recent immigrant children in the Newcomer School, San Francisco. Amer J Pub Health, 77:731-733, June 1987.

ABSTRACTS

Jessee, Stephen A.: Physical manifestations of child abuse to the head, face, and mouth: A hospital survey. J Dent Child, 62:245-249, July-August 1995.

The incidence of physical injury to the head, face, mouth, and neck of 266 suspected cases of child abuse was studied at Texas Children's Hospital in Houston, Texas, from January 1993 through December 1994. While there was an even distribution of physical abuse by gender, 74.8 percent of the children were under the age of three. A hospital physician performed every examination. The most frequently occurring injury was contusion or ecchymosis of soft tissue, while the face was the part of the body injured most often. Although 66.2 percent of the children reviewed had some type of injury to the head, face, mouth, or neck, only seven cases (2.6 percent) of intraoral injury were mentioned. These results point out the need for dentists to become active participants on multidisciplinary child maltreatment teams.

Physical abuse; Locations of injuries; Nature of injuries

Cherry-Peppers, Gail; Gift, Helen C.; Brunelle, Janet A.: Sealant use and dental utilization in U.S. children. J Dent Child, 62:250-255, July-August 1995.

The use of dental sealants has remained relatively low in the U.S. in comparison with other proven oral disease preventive therapies, and particularly among black children. Dental visits have also been consistently lower among black children. This paper describes the reported use of dental sealants and dental visits in U.S. children ages 6-17 using data from the 1989 National Health Interview Survey (NHIS). Family income and education interact with race in explaining the use of dental sealants and dental visits. Racial differences in sealant use and dental visits are more apparent in middle and upper socioeconomic levels, than lower socioeconomic level children. Overall, 15 percent of children ages 6-17 have dental sealants and 73 percent had a dental visit in the past twelve months. More white children whose parents had higher income levels and at least one year of undergraduate education (24 percent) had sealants than similar socioeconomic status (SES) black children (11 percent). Additionally, black children whose parents had a college education (68 percent) were less likely to have dental visits during the past 12 months than white children of similar SES (86 percent). These results provide an opportunity to evaluate factors and conditions that could form a basis of targeting programs to improve behaviors, attitudes, as well as access to preventive dental services.

Dental sealants; Frequency of use; Racial differences in usage; Usage in relation to socioeconomic levels

Fried, Irwin and Erickson, Pamela: Anterior tooth trauma in the primary dentition: Incidence, classification, treatment methods, and sequelae: A review of the literature. J Dent Child, 62:256-261, July-August 1995.

A review of the literature is presented to discuss anterior tooth trauma in the primary dentition. Studies show that the incidence ranges from 4 percent to 30 percent and varies depending upon the sex and age of the child. Classification of the type of trauma is subdivided into trauma to the tooth and trauma to the periodontium. Treatment modalities depend upon various factors and range from nontreatment to splinting to extraction. Possible sequelae of primary tooth trauma may include tooth discoloration, loss of vitality, root resorption and/or abscess formation. Careful follow-up is recommended following any type of trauma, because the ultimate goal in treatment is to prevent damage to the permanent successor.

Dental trauma; Primary anterior teeth; Sequelae to trauma; Treatment

Liu, Jeng-fen: Characteristics of premaxillary supernumerary teeth: A survey of 112 cases. J Dent Child, 62:262-265, July-August 1995.

The purpose of this study was to investigate the characteristics of premaxillary supernumerary teeth among children in Taiwan. The study population consisted of 112 children, ranging in age from four years to fourteen years. The characteristics of supernumerary teeth were obtained from radiographs and clinical examination, and were confirmed by surgical intervention. The results showed that males were affected approximately three times as frequently as female. About 36 percent of the patients had more than one supernumerary tooth and more than 96 percent of supernumerary teeth occurred in the central incisor region. About 46 percent of the supernumerary teeth were in the vertical position, 34 percent of the supernumerary teeth were erupted; and the eruption rate of conical shaped and tuberculate shaped supernumerary teeth were similar.

Supernumerary teeth; Location; Sex predilection

Wiedenfeld, Kenneth R.; Draughn, Robert A.; Goltra, Sheryl E.: Chairside veneering of composite resin to anterior stainless steel crowns: Another look. J Dent Child, 62:270-273, July-August 1995.

The chairside veneering of stainless steel crowns using the technique described in our original article (J Dent Child, 61: 321-326 September-December 1994) has proven to be a very dependable and successful technique for restoring severely damaged primary anterior teeth. In this article an advancement in the technique is described using new light-cured materials that simplify the veneering process and produce thinner veneers. The resulting veneers maintain the adaptability, strength, and gingival contour benefits of the stainless steel crown in conjunction with the cosmetics of composite facings. The chairside

technique can be quickly mastered by a dental auxiliary and results in veneered crowns with very high shear and bond strengths.

Stainless steel crown; Veneer

Us, Zerrin; Ören, Cemal; Ulusu, Tezer *et al*: In vitro evaluation of fluoride uptake with application of acidulated phosphate fluoride to interproximal enamel of primary teeth using dental floss. J Dent Child, 62:274-278, July-August 1995.

As a result of application of acidulated phosphate gel with a dental floss on adjoining surfaces of primary molars it has been established that there has been significant fluoride intake as compared with the control group. It has been concluded that it is an efficient method of increasing fluoride content of the primary teeth.

Fluoride uptake; Primary molars; Dental floss

Tsubouchi, Jiro; Tsubouchi, Mihoko; Maynard, Ronald J. *et al*: A study of dental caries and risk factors among Native American infants. J Dent Child, 62:283-287, July-August 1995.

Seventy-seven infants, ages twelve to thirty-six months, were examined in a Women Infant Children (WIC) program at the Tulalip Health Center, Marysville, Washington. All parents/caregivers completed questionnaires, which consisted of twenty-nine questions regarding children's feeding, general care, and dental health behavior. After completing questionnaires, dental examinations were conducted with mouth mirror and explorer by one dentist. Results indicated overall caries prevalence of 46.8 percent (26 percent for twelve to eighteen months, 56 percent for eighteen to twenty-four months and 56 percent for twenty-four to thirty-six months groups). The overall average number of carious teeth per child (deft) was 2.09 (0.83, 2.17 and 2.86, in order). Caries in children was significantly associated with following factors; bottle fed now (63.9 percent vs 29.3 percent, $p=.00$), giving bottle as baby falls sleep (82.4 percent vs 61.0 percent, $p=.03$), and 3 times or more snacks between meals (73.5 percent vs 40.0 percent, $p=.01$). Similarly, brushing behavior was related to caries. These results suggest that the present population was at risk for caries and that feeding patterns beyond bottle use appear to be behavioral risk factors in the prevalence of infant caries in this population.

WIC program; Caries prevalence; Bottle feeding

Waldman, H. Barry: Immigrant children and pediatric dental practice. J Dent Child, 62:288-294, July-August 1995.

One of every five of the almost one million annual immigrants to the United States is less than fifteen years of age. Many of today's immigrants are from areas of the world with language, customs and cultures that are far different from those persons who immigrated in past decades or were reared in this country. Providing dental care to these new youngsters with particularly diverse backgrounds is another challenge that faces pediatric dentists.

Immigrants; Language; Customs; Cultures

COMMUNICATION *cont from page 244*

than thirty years I have been sitting with children in hospitals; clinics; homes; schools; playgrounds; classrooms connected to churches, synagogues, mosques—sitting with boys and girls as they draw or paint. Those drawings and paintings, for me, have amounted to a continual flow of instruction, so much told, though not through wordy insistence—instead, through shapes and forms and colors, mobilized, arranged, presented. Often children don't want to talk very much; often there are barriers of race and class, of language, which separate doctors (or teachers) like me from those we want to get to know; often, even in the midst of the intimacy of psychiatric and psychoanalytic work with boys and girls, a spell of grim, unyielding silence or suspicion or aloofness takes hold—hence the great alternative and opportunity of drawing, painting, together."

Pediatric dental clinicians rely heavily on sedation at varying levels to control the behavior of their patients. There is no intent here to argue the validity of sedation used to the extent that it is today. It should be clear, however, that one cannot teach the importance of prevention and proper dental care to a sedated patient. To do so effectively, one must enjoy an easy and respected relationship with the patient.

The growing complement of immigrant children makes imperative a thorough study of ways to establish lines of communication that will help healthcare providers meet their dentalcare needs. From a purely practical standpoint, we should realize that if immigrants come as political refugees, they and their families are eligible immediately for Medicaid and other social benefits. They may become your patients sooner than you can imagine.

Those of you who encourage your pediatric patients to draw, might consider carrying it a step further: Become acquainted with the fascinating work of professionals such as Robert Coles, Jacquelyn Gillespie (*The projective use of mother-and-child drawings.* New York: Brunner/Mazel Publishers, 1994), and others, and develop the concept as a diagnostic and therapeutic tool to open the portals to a meaningful relationship with those children who would otherwise remain unreachable.

GWT