Etiology of Class II malocclusions

Timothy Shaughnessy, DDS, MS, Workshop Leader
Lawrence H. Shire, DDS, Workshop Recorder

In reviewing the literature relative to the development of Class II malocclusions, it can be learned that "not every Class II is a Class II." We must remember that behind the soft tissue drape of the patient's face is a totally dynamic process that can be influenced by our heritage and altered by our environment. We realize when performing an occlusal evaluation of our young patients, findings like distal step molar relation or an unusually large overjet may be presenting a false impression of what appears to be a true skeletal Class II malocclusion.

In addition to distal step molar relation, or an unusually large overjet, tooth size discrepancy with or without malrelated mandible and maxilla may also give the first impression of a true skeletal Class II malocclusion.

Skeletal Class II malocclusions can be found to have variants in one or more of the following regions: (1) maxillo-mandibular relationship (mandibular retrognathism, midface protrusion or both); (2) the cranial base (increased length of the anterior cranial base will contribute to the midface protrusion, while lengthening of the posterior cranial base will tend to position the temporomandibular articulation more retrusively); (3) vertical dysplasia (anterior upper face height often greater than normal); (4) steep occlusal plane (a reflection of vertical skeletal dysplasia).

What role does genetics play in the etiology of Class II malocclusions? According to the study by Lundstrom (1984), investigations published prior to that article have suggested that about 40% of common anomalies in tooth position and in the relationship between maxillary and mandibular dental arches are due to genetic differences between individuals. Corruccini and Potter (1980), in studies of different dental and occlusal variables, found the heritability of dental overjet was reduced to zero. Several syndromes have Class II malocclusions as a major finding. Of these syndromes, Treacher Collins, hemifacial microsomia, achondroplasia, and mobius syndrome are a few of the more widely known.

Inter-arch problems such as Class II and Class III malocclusions are genetic in nature, while intra-arch problems also have an environmental component as well.

Looking at the importance of environmental vs. inherited factors in the etiology of malocclusions, it was suggested that urbanization (and evolution) influence malocclusions, making them more severe. The evolutionary factors involved are: a decrease in the size of the jaws, size and number of the teeth. We have no control over these evolutionary factors (as well as the hereditary factors), whereas the environmental factors can often be eliminated through preventive or interceptive treatment at the appropriate time.

Mandibular growth deficit following condylar fractures or major trauma to the joint complex is highly likely. Proffit (1980) found between 5 and 10% of all severe mandibular deficiency or asymmetry problems were related to previous fracture of the mandibular condylar process. In this article, Proffit cites Walker and also Gilhuus-Moe as noting that the younger the patient at the time of the injury, the greater the potential for complete regeneration of the condyle, and healing without residual deficit. Proffit (1978) states that Lund found essentially complete recovery in 75% of the children with early condylar fractures. The treatment goals for patients with condylar fractures include the restoration of joint function, occlusion, and facial symmetry. The current theory on early treatment of condylar fracture in the growing child calls for firm fixation for only 1 week, with physical therapy and mouth opening exercises beginning immediately after release of the rigid fixation.

Condylar fractures often go unnoticed and result in Class II malocclusions with asymmetry or severe mandibular deficiency. Progressive deformity is associated with mechanical limitations on growth and the resulting condition is referred to as "functional

ankylosis." Ankylosis of the mandible can be thought of as fusion across the TMJ. This fusion restricts motion and inhibits growth. "In order to grow properly, the mandible must be able to translate" (Proffit 1980).

Some theories to explain the growth of the craniofacial complex include: (1) Sicher's role of sutural growth; (2) Scott's role of the cartilage and the knowledge that bone growth is secondary to cartilage growth; or (3) Moss's functional matrix hypothesis that cartilage and bone respond secondarily to soft tissue growth. Still another theory is that of the influence of mouth breathing vs. nasal breathing to which Harvold (1980) eluded.

Experiments on transplantation and obvious reactions to manipulation of the sutures have, to some degree, ruled out the sutural growth theory. Cartilage studies have shown both positive and negative influences on growth when transplantation of cartilage is the variable factor of the studies. This depends upon whether the cartilage is primary (from the primordial skeleton) or secondary cartilage. Primary cartilage is a growth center whereas secondary cartilage, like that of the condyle, is a growth site. It has been shown that there is a positive correlation between the soft tissue influence and the growth of the craniofacial complex. For example, excessive intracranial pressure will cause hydrocephaly, with a marked increase in the size of the calvarium, whereas diminished growth of the brain causes microcephaly. When an eye is removed from a child for treatment of a tumor, the orbit does not continue to grow in the normal fashion.

Normally, teeth are balanced between the tongue and the lips. Resting pressure must be considered more important than the pressure created during chewing, swallowing, or speaking, since the time we are at rest far outweighs the time we are performing these other functions. When comparing forces necessary to move teeth, heavy intermittent pressure has less effect than light continuous forces.

How do habits relate to Class II malocclusions? As was previously stated, the light continuous forces are much more detrimental to the oral complex than are heavy intermittent forces. Habits such as thumb sucking, when performed for fewer than 6 hr per day, have not been shown to be responsible for anterior open bites or Class II malocclusions. Forward positioning of the tongue (seen during swallowing in patients with anterior open bite) is more likely to be an effect than a cause.

What is the mechanism by which nasal impairment could alter dentofacial form? Harvold et al. (1981), using rhesus monkeys, forced them to become mouth breathers by mechanical obstruction of their nasal airway. He was able to show that previously obligate nose breathers forced to breathe 100% of the time through their mouth, exhibited changes in their soft tissue and skeletal components. Changes in head, jaw, and tongue position could be seen in the experimental group. Some traits common among the sample were increased face height, steeper mandibular plane angle, and larger gonial angle. It should be noted that some of the animals in the experimental group developed other than Class II malocclusions. Class III malocclusions as well as Class I malocclusions were also seen. It is not the change in breathing pattern that caused the malocclusions, but rather it is the change in related functional demands on the craniofacial musculature and their obligatory response. Proffit (1978) states that the postural positioning of the head, mandible, and tongue are all at the subconscious level. Dentoalveolar morphology can be shown to be related to head posture. The more the head is held forward, the more likely that the upper dentoalveolar height will be increased. Also, there will be an increase in the steepness of the occlusal plane related to forward posturing of the head.

McNamara (1981) reviewed Linder-Aronson's work from 1975 where it was shown, on a small sample size, that removal of nasal obstruction (adenoidectomy) in 41 children, followed for 5 years postoperatively, had an average reduction in the mandibular plane angle of 4°. This was twice the reduction found in the control group (those without nasal airway obstruction and without adenoidectomy).

Are there other environmental factors that cause Class II malocclusions? Early loss of maxillary primary molars can influence the development of Class II malocclusions by allowing the maxillary molar, that may be in an end-on relation with the mandibular molar, to slip forward thus establishing a dental Class II situation. It would appear that local environmental factors influence a dental Class II more than they influence a skeletal Class II. Understanding the etiology of the malocclusion, should play a role in developing a treatment plan.

Dr. Shaughnessy is in the private practice of orthodontics in Marietta, Georgia, and Dr. Shire is deputy director, U.S. Army Pediatric Dentistry Residency Program, Ft. Lewis, Washington. Reprint requests should be sent to: Dr. Lawrence H. Shire, QTRS 2338 S. 3rd St., Ft. Lewis, WA 98433.

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Supervision of Class II discrepancies

Gerald S. Samson, DDS, Workshop Leader
Michael J. Hechtkopf, DDS, MSD, Workshop Recorder

Literature Review

Early orthodontic treatment continues to be controversial and the subject of arguments among dentists, especially pediatric dentists and orthodontists.

Clearly, there are psychological and sociological reasons for accepting the concept of early treatment. Attractiveness does have an effect on one's life. In 1978, Kalick noted that cosmetic facial alterations improve a patient's appearance and thereby directly enhance his or her social value. The way in which others perceive the individual is also based on attractiveness; physically attractive persons are preferred to the unattractive and thus receive preferential treatment (Bersheid and Walster 1974; Adams and Crossman 1978; Bersheid 1981).

Bersheid (1981) noted that physical appearance makes a difference in one's life — in education and careers. Allen (1978) showed that social choices were based on appearance, which one would expect, but also noted that attractive persons were perceived to be more honest and independent. Of special importance is another of Bersheid's comments describing how behavior is affected by our physical attractiveness, and how that behavior in turn affects another person's behavior. Self-esteem also is impacted by attractiveness, and has psychological importance associated with a variety of behaviors (Aronson and Mettee 1968).

Adams (1981) reported evidence exists to suggest that attractiveness has an impact upon the social experience for both children and adults. He revealed data that suggested that children as young as 3 and 4 years of age are potentially influenced by physical attractiveness. He also noted that appearance creates certain stereotypes, which stimulates expectations of specific attributes, and that this process may actually emerge shortly after birth and continue throughout life. Others have suggested that as early as infancy, physical attractiveness may have profound influences upon parental attitudes, expectations, and behavior with their infants (Hildebrant 1976; Boukydis 1977). Adams (1981) also made a most profound observation in noting that teachers, like parents, are influenced by attractiveness; teachers were more attentive and positive to attractive children.

Graber (1981) relates a surge in orthodontic care for younger children under early orthodontic guidance for dentofacial esthetic purposes. Graber further notes that most children present for care due to parental motivation, seeking dental and facial form alteration for personal and social gain rather than biologic or physiologic improvement.

There are, of course, other reasons for early orthodontic treatment, especially for the Class II patient. Bass (1983) raises the possibility of the risk of trauma to unprotected incisors in active children. Approximately 10% of children with severe overjet will fracture or avulse one or more maxillary incisors before attaining age 12 (Eichenbaum 1963; McEwen et al. 1967).

Another consideration is whether changes can be

effective in early treatment of Class II malocclusions. Enlow (1982) relates that the face grows and develops rapidly throughout the childhood period, as it "catches up" with the earlier maturing brain and brain case. Bass (1983) describes a first phase of orthodontics as an orthopedic phase to establish normal relationships of the skeletal components supporting the dentition. This, in turn, improves adverse soft tissue patterns.

As discussed by Krieg (1987), there are growth spurts between the ages of 5 and 12, which he describes as periods of growth in the craniofacial dimensions in which one period exceeds the growth velocity of a previous period by twice. He notes that spurts are found throughout this age range, with highest peaks of growth velocities in the younger age groups. He relates that due to the active growth that characterizes the childhood and juvenile growth periods, early treatment can be quite advantageous for certain orthodontic problems. Krieg adds that these younger patients are significantly more cooperative than older groups. There is then a good possibility that the dentist's efforts may be helped by these growth spurts.

As early as 1960, Ricketts treated a sample of 8-year-old Class II patients, and showed that the maxilla was not an immutable structure. He showed that forces transmitted to the sutures of the maxilla did affect the growth of the maxilla, changed teeth dramatically, and relieved lip strain. Also, incisors were intruded and molars distalized. The distal movement of the maxillary first molar was most evident during the transition between the primary and mixed dentitions. For this reason, Ricketts concluded, early treatment seemed advisable for maximum orthodontic orthopedic correction even at the primary dentition level. Even earlier, Hahn (1954) reported that treatment of extreme Class II, Division 1 malocclusions and maxillary protrusions in the primary dentition is valuable in that it retards the progress of the malocclusions and gives a better opportunity for success in the second period of treatment. Kloehn (1954) agreed that treatment should be directed and correlated with growth and not against it. He concluded that this philosophy demands that treatment be started as early as any factors and forces are recognized which will inhibit growth and development. Terry (1954) also advocated early treatment of Class II malocclusions. In 1962, Hahn, Cheney, and Tweed all supported the theory of early treatment of Class II, Division 1 malocclusions, in the mixed dentition stage.

It is clear from this brief review that there are sociopsychological reasons for early treatment of Class II malocclusions, and at least moderate psychological and mechanical evidence to support the effectiveness of this treatment.

The workshop concerning Supervision of Class II discrepancies was divided by moderator Dr. Gerald Samson into four major categories: (1) treatment timing; (2) records and analysis; (3) treatment objectives; and (4) selection of clinician. Each of these were presented with one or more subheadings in question form to stimulate discussion. The workshop then focused on each category and discussed it.

Treatment Timing
Age for Evaluation

The workshop participants were interested in the age that a practitioner, regardless of specialty, should evaluate the developing dental and facial structures and advise the parents regarding the need for detailed orthodontic records and analysis. There is presently no definitive literature available on the recommended age for a first orthodontic exam, so the workshop tried to establish some guidelines.

There was little disagreement among the workshop participants that for any craniofacial anomaly including cleft palate, an orthodontic evaluation should occur at birth, although this does not always mean a need for immediate treatment. Such evaluation should by done by a team, and the dentist on the team, although usually a pediatric dentist, can be any dental practitioner (pediatric dentist, orthodontist, or general dentist) who can make a critical evaluation of the patient.

Other patients who present to the dentist at birth or shortly thereafter do not need a team evaluation. Such patients are those who present due to parental concerns or physician referral, or where there is potential of malocclusion due to a family history or hereditary problem. Also included in this category are asymmetries of the skull or face. Again, the workshop participants agreed that usually a pediatric dentist was the practitioner who should evaluate this patient, but that the evaluation could be performed by an orthodontist or general practitioner qualified to do a critical exam of the patient.

The practitioner should be familiar with normal vs. abnormal skeletal and facial structures, growth and development, and the temporomandibular joint complex. The College of Diplomates made the recommendation that some type of documentation is needed for these patients, including photographs.

One of four dual-trained pediatric dentist/orthodontists attending the workshop noted how little orthodontic residency programs teach students concerning normal pediatric developmental changes. It was agreed that more information needs to be taught and shared in both pediatric dental and orthodontic residency programs concerning early growth of the skull, face, and dentition. It also was stated that orthodontists and other practitioners must realize that it is in the best interests of children to allow more dissemination of information on

this subject, so that dentists evaluating children do so with expertise, or refers to another dentists as indicated. The participants further suggested that the American Academy of Pediatric Dentistry provide more knowledge for its members regarding the anatomy of the infant face and skull, and that neonatologists and other physicians, as well as dentists, be called upon for this information. Only in this manner can criteria be set for a functional history and dentofacial exam, which should be a part of every routine exam.

Although the above criteria were agreed upon for any child's evaluation, there was far less agreement on the age that a child with a routine Class II malocclusion should be evaluated. It was decided that these patients should certainly be seen not later than the eruption of the full complement of primary teeth and possibly earlier. Some of these patients may be too young for actual treatment, but appropriate information should be related to parents; habits that contribute to the problem could be eliminated and nasal airways evaluated. It also was pointed out that there is a need for age-appropriate exam forms relating to patient development instead of the standard universal form for all ages of children used in most offices.

Age of Diagnosis

The next discussion centered on the appropriate age for diagnosis, that is, actual orthodontic records. Most agreed that for very young children, the severity of the case, the eruption of the second primary molars, and patient management had to be taken into account. In order to observe whether the malocclusion is naturally improving or worsening, it was noted that some records had to be taken, for comparison of later findings. This would be appropriate for those cases where treatment is not immediately indicated for any reason. These records might be what are termed "mini-records," which would consist of a detailed clinical description and photographs. Optional data for these abbreviated records might include study models and cephalometric analysis. The workshop participants all agreed that the detailed clinical description should include a functional temporomandibular joint exam and test for hypermobility of the mandible.

Records and Analysis

Records would include a detailed clinical exam, a functional exam, and description of discrepancy, photographs, a lateral cephalometric radiograph, traced and analyzed, a panoramic radiograph, and trimmed study models. Optional data to be included should be frontal radiograph, traced and analyzed, and a hand/wrist radiograph for determination of skeletal age. In addition, a panoramic radiograph should be repeated once a year while treatment continues to check for any possible indication of root resorption or ectopic eruption of teeth.

Attention should be given to condylar position, contour, and space on panoramic radiographs. This radiograph gives a screening of normality to the anatomy of the condyles. If suspicious areas are noted, then more detailed tomogram-type radiographs should be ordered.

In recommending a cephalometric analysis, certain key factors should be required. Most Diplomates felt that any analysis used for treatment on children should be able to be related to age, race, facial type, facial soft tissue and profile, possibly sex, and aimed at the growing patient and aging of the face.

Discussion then centered on which methods available could provide the desired information. It was noted that the Steiner analysis was not age or race related and was based on the sample analysis of one white female patient, and that Tweed's analysis did not have a known sample of patients, although the University of Michigan had age related Tweed's analysis.

It was generally accepted that the Rickett's cephalometric analysis provided most of the relating information needed for diagnosis, although a few persons present felt it might be less accurate for very young children than it is for those aged eight years and older.

Treatment Objectives

Although there was not complete agreement concerning objectives of early treatment, the following statement was adopted: "The objective of early Class II treatment should be to obtain maximally achievable results toward a Class I skeletal and dental relationship, and as closely as possible functional and esthetic normality."

It was agreed that the overall objective was to attain optimal facial and dental development, including facial harmony and balance, TMJ function, Class I skeletal and dental relationships, periodontal health, and enough space for eruption of the remaining permanent teeth.

In determining whether early treatment for Class II cases can avoid extractions or orthognathic surgery later, there was less discussion by the Diplomates. Most felt that preventing extractions in any subsequent treatment by early intervention was highly variable, but certainly more likely. The workshop participants also were in agreement that early treatment would most likely prevent the need for surgery at a later date. There was concensus that early treatment did not necessarily preclude the need for orthodontics at a later age, but surely makes a case less difficult and complicated, and as stated, with less need for extractions or surgery. In

essence, phase I treatment is not complete until phase II treatment begins.

Selection of Clinician

The final discussion by the College of Diplomates concerned who is best qualified to care and treat the Class II pediatric dental patient. The workshop concluded that any dental practitioner, whether a pediatric dentist, orthodontist, or general dentist, should treat these patients provided the clinician meets the following criteria: (1) understands how to modify growth and development of the face; (2) is adequately trained; (3) is able to enlist the compliance of the child patient; (4) is "experienced" in providing the services; (5) has stayed abreast of the current literature; (6) has adequate knowledge on adjusting and manipulating the appliances used; and (7) has provided the appropriate information to the parent, including proper informed consent and deposition of the case to completion or maturity, noting the likelihood of a second phase of treatment.

Dr. Samson is in the full-time private practice of orthodontics and dentofacial orthopedics in Marietta, Georgia, and Dr. Hechtkopf is in the private practice of pediatric dentistry in Virginia Beach, Virginia. Reprint requests should be sent to: Dr. Michael J. Hechtkopf, Rose Hall Professional Centre, 3145 Virginia Beach Blvd., Virginia Beach, VA 23452.

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Corrective methods for Class II patients

James R. Long, DMD, Workshop Leader
Paul S. Casamassimo, DDS, MS, Workshop Recorder

The Class II malocclusions represent a treatment challenge for which various appliances can be used, based on patient characteristics. This workshop addressed the following questions.

1. Can the mandible be "grown?"
2. What is a functional appliance?
3. What criteria should be considered in Class II correction?
4. What types of appliances are appropriate for Class II correction?
5. Does each treatment affect the growing face in the same way?
6. Which characteristics of a Class II malocclusion favor the selection of a functional appliance?'
7. What are the treatment effects of various appliances according to the resource readings provided?

Discussion

Can the Mandible be Grown?

It appears that with timely treatment and using an appropriate appliance, the mandible can be stimulated to grow and improve the malocclusion to some degree. The many variables affecting growth and its inherent unpredictability make it difficult to use growth stimulation reliably.

What is a Functional Appliance?

The variety of functional appliances complicates a definition. Each appliance reflects the philosophy, objectives, and experience of its originator. An encompassing definition of the functional appliance is:

A functional appliance works on the malocclusion by employing the activation of neuromuscular reflexes to guide the developing jaws and erupting teeth of children into more acceptable relationships.

Each appliance design — the Frankel, Bionator, and others — emphasizes that particular aspect of the neuromuscular physiology of the stomatognathic system which its originator considered important. These variations are reflected in differences in the construction and use of the appliance.

Any appliance which alters growth is a functional appliance. Headgear, for example, might be considered a functional appliance. A functional appliance addresses; (1) mandibular position; (2) mandibular tooth position; and (3) the neuromuscular component of orofacial complex.

What Criteria Should be Considered in Class II Correction?

The following elements should be considered in the use of any appliance in Class II correction:

Cephalometric appraisal — Chin position/relationships; maxillary position/relationships; mandibular position/relationships; tooth position/relationships
Clinical appraisal — Habits; breathing; posture; intelligence; age of patient; temporomandibular joint status
Compliance appraisal — Goal-oriented; persistence; adaptability to alternative appliance types to help patient comply.

What types of appliances are appropriate for Class II correction?

In a general sense, the following types of appliances seem appropriate for Class II correction: (1) those aimed at orthodontic change; (2) those aimed at orthopedic change; and (3) those aimed at alleviating parafunctional habits.

Ideally, an appliance should combine all 3 aspects of treatment so as to address the individual patient's needs. In most cases, the functional appliance is orthodontic, orthopedic, and corrects parafunctional problems.

Does Each Treatment Affect the Growing Face in the Same Way?

The workshop consensus was that all patients do not respond in the same fashion, nor do all appliances work in the same way. Treatment outcomes may be similar, but the mechanisms and pathways may differ. The Table shows the varying treatment effects of functional appliances.

Which Factors of a Class II Malocclusion Favor the Selection of a Functional Appliance?

The following characteristics were identified as favorable to the choice of a functional appliance: deep overbite; lower arch crowding; greater than normal overjet; Class II permanent molar relationship; protrusive maxillary incisors; retruded mandibular incisors; short corpus length; less-than-normal lower face height.

What are the Treatment Effects of Various Appliances According to the Resource Readings Provided?

The Table depicts the anticipated treatment effects for the following structures: maxillary first permanent molar; mandibular first permanent molar; upper lip; chin; mandible; maxilla; maxillary incisor; and mandibular incisor.

The appliances described in the resource readings and compared in discussion include the following fixed and removable appliances: Bionator; activator; headgear (cervical, occipital, and hook-on); combined headgear-activator; edgewise appliance; edgewise with Class II elastics; and Frankel II.

Table. Class II Treatment Effect

	Upper Molar	*Lower Molar*	*Upper Lip*	*Chin*	*Mandible*	*Maxilla*	*Max. Incisor*	*Mand. Incisor*
Bionator	Same as growth	Same as growth	No change	No change	No change	No change	Tipped lingual	Intruded with growth
Activator	Same as growth	Upward	No change	No change	Slight change	Held back from growth	Tipped lingual	No change from growth
Headgear 1. Cervical	Distal directional	Distal intruded	Flatter	Downward	No change from growth	Held back from growth/ distalized	No change	Slight lingual movement
2. Occipital	Distal directional	Same as growth	Same as growth	No change	Autorotation	Distalized	No change	No change from growth
3. Hook-on	Directional	Same as growth	Flatter/ fuller	No change	Autorotation	Distalized	Tipped lingual directional	No change from growth
Combined HG-Activator	Distal	Vertical	Same as growth	Forward	Autorotation	Distalized	Directional	Tipped labial
Edgewise	No change	No change	No change	No change	Slight change	No change	Directional	Directional
Edgewise with Class II	No change	Upward vertical	Flatter	Forward	Slight change	Distalized from growth	Directional	Tipped labial
Frankel II	Vertical	Vertical	More full	No change	No change from growth	No change from growth	Tipped lingual	Tipped labial

Conclusions

The treatment of Class II malocclusions can involve a variety of appliance designs, many of which act to stimulate mandibular growth. The functional appliance affects neuromuscular reflexes to help correct the malocclusion. Selection of appropriate appliances is based on patient characteristics as well as diagnosis. Certain Class II malocclusion characteristics seem more suited to the functional appliance. The correction of the malocclusion by different appliances can be linked to differing effects on various parts of the stomatognathic system.

Dr. Long is in the full-time private practice of orthodontics in Atlanta, Georgia, and Dr. Casamassimo is chief of dentistry and director, Pediatric Dentistry Residency Program, Children's Hospital, Columbus, Ohio. Reprint requests should be sent to: Dr. Paul S. Casamassimo, Columbus Children's Hospital, Dept. of Pediatric Dentistry, 700 Children's Dr., Columbus, OH 43205.

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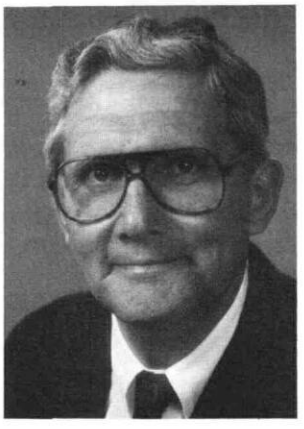
Pioneer in Pediatric Dentistry: James J. Leib



Dr. James J. Leib was born on December 21, 1945, in Los Angeles, California. He attended the local elementary schools, and was graduated from Beverly Hills High School in 1942.

After attending the University of Southern California from 1942 to 1944, he enlisted in the U.S. Navy and served from 1943 to 1946, and again from 1948 to 1949 and 1952 to 1954. In 1948 Dr. Leib received the DDS degree from the College of Physicians and Surgeons, University of the Pacific School of Dentistry.

Dr. Leib was clinical instructor in pediatric dentistry at the University of Southern California from 1957 to 1958 and from 1970 to 1972. His hospital affiliations included Children's Hospital of Los Angeles, Tarzana Hospital, and Encino Hospital where he is chairman of the dental and oral surgery staff.

He is a past-president of the San Fernando Valley Dental Society and the Southern California Society of Pediatric Dentistry. Dr. Leib served the American Academy of Pediatric Dentistry as president in 1972, and as a member of the Board of Trustees.

He was a member of the Dental Care Committee of the California Dental Association (1960-65), the Legislation Council (1961-71), and the University of the Pacific Dental Alumni Board of Directors (1948). Dr. Leib is a Fellow of the American and International College of Dentists and the American Academy of Pediatric Dentistry.

Dr. Leib, his wife Marian, and their two children, Geoffrey and Denise, reside in Pasadena, California.

Ralph L. Ireland, DDS
Historian Emeritis