A landmark report on understanding the human dentition

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Dentists today, and particularly those practicing pediatric dentistry, orthodontics, periodontics and public dental health, owe a great debt of gratitude to the seminal work of Dr. Isaac Schour and Dr. Maury Massler, from the Department of Histology, University of Illinois College of Dentistry, Chicago. The 1941 article by these two authors, “The Development of the Human Dentition,” is truly a landmark article from two perspectives: first, as a culmination and synthesis of many years’ work by the authors; and, second, in the undergirding of far-reaching applications that remain relevant today.

When the article was published in 1941, the authors no doubt did not realize the level of esteem it would attain in dental education and practice. Their foresight at the time recognized that foundational knowledge of the development of the human dentition was lacking, and they set out to rectify that deficiency. Notably, their approach was practical, and they aimed...
their article specifically toward everyday dental practice—the place where their work would do the most good for the profession and its patients.

During the 1930s, 1940s and 1950s, the authors collected clinical observations, performed epidemiological surveys and conducted animal laboratory experiments on a wide range of issues. These included growth of the child, development of the dentition, theories of tooth eruption, caries, gingival disease, alveolar bone disease, endocrines, pulp reaction to filling materials, endemic fluorosis and malnourishment. The two authors were prolific in bringing their findings to the dental profession through journal articles, atlases, textbooks and lectures. This article represents the culmination of research they began in the late 1930s. The objectives and methodology of their effort were reported in two previous articles\(^1\)^\(^2\) that laid the foundation for this definitive treatise. The first considered the histologic stages of tooth development, and the second introduced the topic of eruption, including a preliminary chronological chart showing the stages of development and eruption in the maxillary arch only. This article brought their entire effort together, via both discussion and illustration, with the focus being on the practical aspects of tooth development and eruption that would be most beneficial for dentists and their patients.

Given that pedodontics, as the specialty was then called, became a recognized specialty in the United States only in 1938, the publication date of 1941 is significant. Whether by careful thought or happenstance, the timing of the article approximated the 1942 recognition of the American Board of Pedodontics, which, in turn, led to the formation of the American Academy of Pedodontics in 1948. (The specialty, Board and Academy now all use the name “pediatric dentistry.”) Thus, this article has special significance as a foundational article for dentists who limit their practices to children, becoming one of the first articles to define the specialty. The article became required reading in the undergraduate dental curricula of both pediatric dentistry and orthodontics and quickly became a standard requirement for graduate school curricula in both specialties; successful candidates for Board certification in both specialties were expected to be fluent in its content. During the decades since its publication, this has become one of the most cited articles in dental literature.

The organization of the article also places it at the top of the class, and could serve as a model for any longitudinal study of human physiology. The article is written in a straightforward style, with pithy factual statements. On reflection and with the eye of retrospect, it is apparent that many of these have become tenets embedded in modern pediatric dentistry and orthodontics. This commentary will highlight a few of these tenets.

**EARLY UTILIZATION OF AUDIOVISUAL AIDS IN DENTAL EDUCATION**

That the value of the article was immediately recognized by the American Dental Association is shown in the footnote at the bottom of the first page. This indicates that the Association gave “special attention” to the content of the article and arranged for its ready access (the paper had been presented previously in a lecture format) to the dental profession. The lecture was made available in “film or stereopticon form”—surely a very early utilization of audiovisual dissemination of continuing dental education! Of note, while the stereopticon form of projection has evolved over the past 75 years through a series of stages to carousels, light-emitting diode, 3-D and multiple-screen projection, the advent of modern technology and newer research methods have not altered Schour and Massler’s basic concepts regarding the order and age of development of the human dentition. Their description of the eruption and exfoliation of the primary teeth, the mixed-dentition stage and development of the adult occlusion have all stood the test of time and have remained essentially unchanged.

The authors were aware of the need to make their observations accessible and available to their professional readership, and possibly to a
lay audience, as they frequently used a professional artist to illustrate their work (two artists are acknowledged on Figure 1, and artists were also used in the atlases they authored). While technology has moved forward, Dr. Schour and Dr. Massler were truly leaders in the profession and well ahead of their time in promoting continuing professional education with the latest visual aids.

EARLY INFLUENCES ON DENTAL DEVELOPMENT

Beginning with the prenatal period, the article explains the development of the dentition and its relationship to other orofacial structures through eight stages of human development, culminating in adulthood. The section on the neonatal period is of particular interest, as this is the time when genetic defects and congenital anomalies, yet to be described by later oral pathologists, exert effects on tooth morphology and structure. The point made that parents mistake the first permanent molar for another primary molar is still pertinent in the 21st century, when many parents fail to institute home oral health care or seek a professional “dental home” for the young child until the school-age years. The mention of nutrition as a contributor to early enamel defects is also still pertinent, when we see young children with hypoplasia of the primary dentition related to nutritional defects.3

The time marker of calcification of the incisal edge of the maxillary lateral incisor toward the end of the first year of life remains a key diagnostic tool in determining the timing of, for example, trauma to the permanent incisors, or the impact of an exanthematous condition on calcification. Recognition of the developmental sequence and importance of the first permanent molar is an important factor from the perspective of both prevention and development of occlusion. The authors point out correctly that these teeth frequently are mistaken for primary teeth by parents, who at that time had less regard for their importance. Thus, many first permanent molars were lost prematurely, which, in turn, resulted in malocclusions.

DEVELOPMENT OF OCCLUSION

This article presented the most complete description of the development of the human dentition that had been published up to that date. Earlier articles had described the eruption of the primary and permanent teeth, and some had studied development through the use of cadavers and skeletal specimens. Dr. Schour and Dr. Massler conducted their research with living individuals, using radiographs to chart development in stages, and correlated their findings with the subject’s age. Dental radiography had existed for only a short time when this article was written, yet it played a significant role in the study, showing clearly radiography’s potential in dental research and allowing in vivo study of a developing organism. The radiographs and figures indicate clearly the transition from the primary to the permanent dentition and the growth and development of a Class I occlusion, showing the intermediate stages. These cases remain useful teaching cases.

The explanation of the physiology of eruption of permanent teeth, especially the maxillary anterior segment, eased the fears of both dentists and parents who viewed the wide interproximal spaces as abnormal. No doubt this description contributed to preserving many labial frena, thought in earlier times to be the cause of midline spacing. Particular attention is drawn to the importance of the first permanent molar in development of normal occlusion—an emphasis that later became embedded in Andrews’4 six keys to normal occlusion and remains paramount in modern textbooks of pediatric dentistry and orthodontics.

CONTRIBUTION OF NUTRITION TO EARLY ENAMEL DEFECTS

A particularly relevant statement appears on the third page, where the authors comment on the timing of metabolic disturbances that may cause hypoplastic defects in the enamel of teeth forming at that time—for example, first permanent molars and the permanent anterior teeth. This has proved to be a prescient statement in view of what we are now struggling to explain in the condition known as molar incisor hypomineralization and the variability observed in this condition.5 Dr. Schour and Dr. Massler comment that “no amount of dietary regulation or calcium therapy” will correct these defects; such observations proved a valuable introduction to the current emphasis on extrinsic remineralization using fluoride and casein-
phosphopeptide amorphous calcium phosphate.6

The mention of a link between diet and “functional wearing” of the primary dentition is again of contemporary interest, showing that physiological dental wear in children was already recognized. This serves as a prelude to the three forms of tooth surface loss now recognized in the primary dentition (abrasion, attrition and erosion) and the current need to consider diet-based erosion in the young child.

**CHRONOLOGY AND DEVELOPMENT TABLES AS EDUCATIONAL TOOLS**

The simple chronology tables (Tables 1 and 2) have surely been key memorization tools for thousands of clinicians (then and equally now), examining the dentitions of young children, explaining eruption sequences and advocating to parents the value of the primary dentition. Similarly, the straightforward development chart (Figure 1) has been used chairside countless times by clinicians in explaining chronology, missing teeth, space maintenance, the effects of disease and trauma, and developing malocclusion to parents. Of interest, the American Dental Association recognized this chart’s value, making it available as a 12-by-18-inch visual aid in three colors, suitable for framing, for a purchase price of 15 cents! Next to dentists’ diplomas and licenses, this chart still adorns more dental office walls throughout the United States than any other item.

Both of the present authors can attest personally to the ongoing value of the development chart, noting that it has been drummed into the heads of every dental student and resident for at least the last 50 years, and is still used widely in the clinical teaching of undergraduate and postgraduate students. Even as newer and more sophisticated measurement devices became available, many revisions included the acknowledgment “modified from Schour and Massler.”

**TIMELY MONITORING OF DENTAL DEVELOPMENT**

Dr. Schour and Dr. Massler advocated in this article the need to monitor dental development during the mixed dentition, noting, for example, the potential for development of malocclusion related to early extraction or over-retention of primary teeth, or consequences of tongue and digit habits. These factors in the development of malocclusion have not changed in the intervening years, and the caution...
remains most timely. The article confirmed the value of early orthodontic consultation and foreshadowed today’s professional emphasis on anticipatory guidance in the care of the dentition of the young child. The precise descriptions of the normal development of the primary, mixed and young permanent dentitions proved foundational for later work on diagnosis of syndromes that affect the number, morphology, calcification and eruption of teeth (example: ectodermal dysplasia) and congenital disorders (example: amelogenesis imperfecta).

The recommendation today that every child needs a “dental home” from infancy onward is a contemporary application of the caution the authors introduced in this article in 1941, and it remains most pertinent in 2013. The article also comments briefly on the effects of dental trauma during the transitional periods in dental development, noting the possibility for “profound effects” at this stage. Again, this is shown in the development chart, which depicts the developing relationships of the permanent and primary teeth in lateral view, illustrating the potential for the permanent teeth to be affected indirectly by trauma to the primary teeth. This is a reminder alerting clinicians to examine thoroughly the child with anterior dental trauma—a lesson still fully current.

CONCLUSION
This article proved a starting point for recognition of normal development of the dentition and occlusion, forming the basis of pediatric dentistry and orthodontics. Among this article’s greatest contributions was its inspiration for the ongoing study of dental growth and development. Researchers throughout the world have modeled similar studies following the work of Dr. Schour and Dr. Massler. Even a cursory review of the literature shows not only numerous citations of their work, but also studies that emanated directly from their research.

Rarely does an article appear in which the entire content can be used immediately. This is one such article; it remains valuable to anyone involved in oral health—student, general practitioner or specialist. All can read and immediately apply its contents to their patients. General practitioners and dental hygienists are in the front line in answering questions posed by concerned parents, and hygienists assume the major role in preventive education in most dental offices. The practical, visual illustration of the development of the human dentition is readily understood by parents and conveys the importance of the primary teeth in the development of a healthy adult dentition. The old adage “a picture is worth 1,000 words” is certainly true in explaining oral development, and by that standard, the illustrations still are worth millions of words.

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