

Radiation exposure in pediatric dentistry: an introduction

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Recently, there has been considerable information in the public media regarding the possible risks to humans from exposure to ionizing radiation. Estimates have stated that 90% of the total man-made radiation dose to which the population of the United States is exposed is from medical and dental uses of radiation. Because of the possible risk coupled with the amount of radiation attributable to medical and dental uses, the public is questioning the number of diagnostic radiographs made in dentistry and medicine.

Almost every practicing dentist has a device for taking radiographs in his/her office. Dentists have traditionally been taught to rely heavily on X-ray films to confirm or supplement their clinical examination. With each X-ray exposure, there is an associated risk to the patient from ionizing radiation that may even be greater in the pediatric patient.

In an attempt to assist the dental profession and to provide information to the public, numerous pamphlets and articles have been published and made available by the American Dental Association, various specialty associations, and federal agencies. Unfortunately, there continues to be a considerable amount of abuse and misunderstanding of ionizing radiation not only in the public sector but also within the profession. Consumer advocates bombard the lay press and media with suggestions for questioning health practitioners as to the need for radiographs for themselves or their children.¹ Consequently, the profession is challenged daily by these patients as to the need for radiographs, the frequency, and the numbers.

Frequently, radiographs are not permitted, often resulting in an incomplete diagnosis or no diagnosis at all. Many dentists, in response to these challenges, have become frustrated and fearful of legal action even with the traditional use of radiographs.²

Many pedodontists have turned to the American Academy of Pedodontics for help. The Academy assists them by providing information for distribution to the parents of patients, and by developing guidelines

on the use of radiographs in pediatric dentistry.

Unfortunately, most of the guidelines are traditional ones that have been available to the profession for a number of years, modified primarily with the subjective opinions of practicing dentists and academicians. Although significant progress has been made towards modifying X-ray equipment and developing high speed film to further reduce exposure (reduce radiation dose) traditional criteria for the taking of radiographs are still utilized.

With the decrease in the incidence of dental disease presently being reported, it is even more questionable as to whether traditional criteria for the taking of radiographs should be utilized. With over a hundred million citizens in the United States exposed to community waters with an optimal fluoride amount, and an increased tendency of patients to practice daily preventive dental routines, it is now time to review previous recommendations and to develop criteria based on contemporary health practices.

Review of pedodontic radiology

There are three types of radiographs which are used in the practice of dentistry: bitewing, periapical, and extraoral.

The technic for taking each of these films is described in detail in texts available on dental radiology³⁻⁷ and dentistry for children.⁸⁻¹¹ These textbooks, scientific articles on oral pathology, and texts on oral radiographic interpretation give many examples of how normal and abnormal oral structures appear on radiographs, and how both satisfactory and inadequate dental treatment appear on radiographs.

Most dental offices know how to take radiographs and they recognize normal and abnormal dental conditions on radiographs. However, dentists do not agree on the frequency or number of radiographs which need to be taken. The section on radiology in the *Manual for Children's Dental Care Programs*² of the American Academy of Pedodontics and The American Society of Dentistry for Children states only:

"Today there is concern about overexposure to ionizing radiation. Precautions should be practiced for the protection of the dentist, dental auxiliary, and patients. Overexposure should be minimized through the use of trained and experienced personnel and procedures for developing radiographs should yield high quality images.

The frequencies of radiographic exposure should be limited. Additional radiographs should be taken only when the dentist anticipates that the information he is likely to obtain will contribute materially to proper diagnosis and prevention of disease.

Radiation hygiene is important. Reasonable precautions should be evident that exposure to ionizing radiation is minimized to the patient and the dental personnel."

This lack of specificity is often found when dental texts approach the question, when should a radiograph be taken? Often the question is not even posed.

Bitewing Radiographs

The use of bitewing radiographs to diagnose interproximal caries is unquestioned. It is recognized that as high as 75% of posterior interproximal carious lesions in children could not be diagnosed without bitewing radiographs.¹³ However, there is little agreement in the dental literature on the frequency of bitewing radiographs or by what age the dentists should start to take these radiographs.

Finn in his text on *Clinical Pedodontics* states that bitewings should be taken every six months, and for some children every three months. Dwyer¹⁴ recommended that bitewings be taken every four months. He described research which indicated that if caries were noted to progress during the four-month period, then the teeth should be restored.

Smith¹⁵ recommended that bitewing radiographs be taken every four months for caries-active children. Van de Poel and Berendson¹⁶ recommended that bitewings be taken every six months. They further recommended that bitewings should be taken by the time the child is two and one-half years of age. Law¹¹ recommended that bitewings be taken by the time the child reaches four or five years of age.

Zamir¹⁷ in a study of 14- and 15-year-olds reported that caries progressed very slowly and was limited to a small percentage of the population. He recommended that bitewings only be taken every two years. His rationale was similar to the rationale used by Dwyer¹⁴ — that is to restore only the caries that are found to be progressing when examined with a radiograph.

None of the other texts define a caries-active child who needs bitewings nor do they develop any rationale for their recommendations on the frequency for taking bitewing radiographs. McDonald and Avery⁸ state only that, ". . . subsequent radiographs at regu-

lar intervals are necessary to detect incipient carious lesions and other developing anomalies." The new *Textbook of Pediatric Dentistry*⁸ contains no specific recommendations on the frequency for taking bitewings.

Periapical Radiographs

Periapical radiographs are taken in a set series of six, eight, ten or twelve to screen for dental pathology. However, in our current texts, the reason for taking these radiographs is usually vague and very brief. McDonald and Avery⁸ state that, ". . . the radiographic examination for children must be completed before the treatment plan can be developed . . ." Finn⁸ states that, "Children should have a complete survey of the mouth taken as part of their regular first visit and periodically thereafter." Law¹¹ noted that, "It is desirable to make a complete dental radiographic survey of the child's primary and developing permanent dentition as soon as it is practicable."

Wuehmann and Manson-Hing⁴ recommended that all children have a complete intraoral set of radiographs taken and that these intraoral radiographs be completed every five years. Langland and Sippy⁶ state, ". . . complete mouth radiographs are recommended at the first dental examination of the child." They report that these radiographs will reveal additional dental problems in 50% of young patients. No support for this statement is given.

These recommendations are in contrast to the recommendations of Van de Poel¹⁶ who stated that, ". . . these occlusal surveys are made only once, either shortly before, or at the beginning of, the mixed dentition stage." This recommendation is reinforced by Valachovic and Lurie¹⁸ who developed a risk-benefit ratio and recommended that children not receive a complete radiographic examination until early in the mixed dentition (6 to 8 years of age). They further recommended that only a six film intraoral series should be used for the examination. This series would consist of two anterior occlusal films and four posterior periapical films.

Extraoral Radiography

There are a number of extraoral radiographs that are utilized in dentistry. They include the panoramic, cephalometric, and oblique radiographs. The number, frequency, and usage varies throughout the profession.

Pelton and Bethard¹⁹ recommended that panoramic films be used rather than a periapical series of films. However, Manson-Hing states that, "we currently lack research results which allow a detailed evaluation of the specific diagnostic value of panoramic dental radiographs . . ." Valachovic and Lurie¹⁸ do *not* recommend the use of panoramic radiography and state that, "Perhaps the single greatest excess contribution to patient radiation exposure from panoramic radiographs occurs from the fact that suspected positive

findings on panoramic film generally require additional periapical films to be taken." The abnormality would have been seen on the periapical radiograph if taken as the original film.

The cephalometric radiograph is used primarily by orthodontists and pedodontists to analyze craniofacial and dentofacial disharmonies. The cephalogram is usually taken prior to orthodontic treatment to complete an analysis that assesses bone growth and position as well as revealing tooth placement in basal bone. Frequently, following treatment, the cephalogram is again taken to evaluate the attainment of treatment objectives.

No specific recommendations on frequency and number of cephalograms presently exists. They are reserved primarily for patients undergoing orthodontic treatment. One widely used orthodontic text lists them under "Supplemental Diagnostic Criteria" and not under "Essential Diagnostic Criteria" in developing a diagnosis and treatment plan. Nevertheless, the author does state, "More and more specialists recognize the significant contributions made to diagnosis and case analysis and consider cephalometrics an essential adjunct to orthodontic therapy."

The oblique radiography is a 45° lateral projection that has traditionally been used in dentistry to record the actual position of posterior teeth in either the left or right buccal segment. Primarily used in orthodontics, oral surgery, and pedodontics, it is now being used on patients who are unable to tolerate intraoral radiographs — for example, the patient with a developmental disability. Again, no recommendation on usage and frequency are presently available.

It is easy to agree with White and Tsamtsuris²⁰ when they state, "Presently there appears to be many radiographs taken routinely without consideration as to their purpose." Blaschke firmly states that, "All radiographic examinations must be absolutely indicated. X-ray diagnosis is not be used in place of a thorough clinical evaluation."

The profession is clearly at a point where we need to develop a detailed answer to the question "when does a radiograph contribute to proper diagnosis and prevention of dental disease in children?" A conference/workshop would allow for discussion and the exchange of ideas between pedodontists in academia and pedodontists in practice so necessary to develop a satisfactory answer to this complex question.

Risk of Low-level Radiation

A recent concern of agencies establishing risk and safety guidelines has been somatic damage, and primarily cancer induction in individuals exposed to low levels of radiation. This recent revival of interest appears to be leading towards new and more accurate genetic risk estimates to the population.

There is now data available that associates low

levels of X-radiation with induction of cancer, enhancement of cancer induction by other agents, and cellular changes associated with the induction of cancer. Although the dose levels and rates vary widely in the studies, many fall within the ranges used in diagnostic dental radiology. These studies also indicate that children are more susceptible than are adults to low-level radiation carcinogenesis. Therefore, when making radiographs, clinicians must do so with consideration of the child's biologic risk using a sound rationale for taking the radiographs.

Radiation Protection

The best method to reduce the exposure to the patient of radiation is to use the minimum number of films based on the needs of the individual patient.

Further reduction in radiation dose can be reduced to the absolute minimum by:

1. The use of a variable voltage X-ray machine,
2. Ultraspeed film,
3. Wrap-around leaded aprons and thyroid shields,
4. Optimal processing chemistry,
5. Use of double pack films,
6. Use of beam guiding field-size-limiting film-holding instruments,
7. A daily quality assurance program.

Nevertheless, it has been reported that many dental offices follow few of the above recommendations.²² Many offices fail to use leaded aprons and very few are using thyroid shields. Overexposure and shorter processing time are used by offices to reduce chair time in order to see more patients.

In a recent program sponsored by the Bureau of Radiological Health, 12,700 X-ray machines out of 118,000, were identified as emitting radiation doses in excess of the acceptable exposure range.

It is obvious from these reports that there still exists a considerable amount of confusion on the technical aspects of radiology once the dentist has determined the need for and number of, X-rays based upon the patients' individual needs. Clarification and recommendations are needed.

Dental Radiology For Special Patients

Often, alternative technics must be utilized for infants, very young children, or patients who are developmentally disabled. The resulting radiograph is frequently a compromise and many times unusable.²³

Alternative recommendations have been described in the literature which includes restraining the patient by auxiliaries or parents; restraining using commercial restraints; holding the film in the mouth with fingers or holders; holding the patient's head with leaded gloves; sedating the patient; transillumination with fiber optics; and simply taking no radiographs.

Too often the last recommendation is the most frequently used. Technics need to be developed that can be utilized by both the general practitioner and spe-

cialist without major changes in office routine, and which are safe for the patient.

Alternatives to Traditional Radiology

Although technics for reducing the radiation exposure to a minimum have improved and recommendations have been made to protect the patient from radiation, there have been no major advancements in technology that replaces the traditional radiograph.

Xeroradiography, although used in medicine for more than 10 years, is just now becoming a reality in dentistry. A system is now available that is compatible to standard dental X-ray equipment operating in the usual 60-100 KVP range.

Early studies report that xeroradiography has great promise and, compared to conventional intraoral films, shows more anatomic detail in teeth and bone. Most importantly, radiation exposure can be reduced one-half to one-third the exposure time of conventional intraoral films.

No reports or studies have been published yet on its use in pediatric dentistry, but if the special sensitized cassette can be tolerated by the pediatric patient, the system should be considered.

Transillumination of teeth with a fiber optics system has been suggested as an alternative method for diagnosing interproximal caries. Although a compromise, it has been used when X-ray equipment is not available or with patients who are not able to tolerate an X-ray because of management difficulties. No literature presently exists as to its use in pediatric dentistry.

Whether other alternatives to dental radiology are presently being developed needs to be determined. Only then can their use in pediatric dentistry be evaluated and recommendations offered.

Specific Conference Aims

The purpose of the conference/workshop was to review the state of art in dental radiology; to assess and promote the effective and safe use of diagnostic radiology in children, both normal and disabled; and to develop recommendations for using diagnostic radiographs in pediatric dentistry.

Specifically, the conference participants were directed to react to several questions.

1. What are the recommendations in radiographic practices presently suggested by the American Dental Association?
2. Is there any recent legislation introduced by members of Congress that would affect radiological practices presently utilized in dental offices?
3. How does the Commission of Accreditation of the American Dental Association presently evaluate dental radiology educational programs

in dental education?

4. What is the role of the Bureau of Radiological Health in developing, monitoring, and regulating radiological practices in dental offices?
5. Do individual states have regulatory agencies that monitor radiological practices in dental offices?
6. What is the present consensus on the understanding of the potential health effects in population exposed to low-level radiation?
7. What effect has the increase in preventive measures had on the incidence and progression of dental caries?
8. When can a carious lesion first be detected radiographically?
9. What is the incidence of pathology that may be present in the pediatric patient that would warrant a radiographic examination?
10. How often should radiographs be ordered to reevaluate pathosis?
11. How can we optimize the utilization of radiographs in evaluating oral/facial growth and orthodontic treatment?
12. What are the risk/benefit considerations in pedodontic radiology?
13. What are the current standards in pedodontic radiology and are there any suggestions for alternative techniques?
14. What are the various techniques presently available to take radiographs on a patient with a developmental disability?

To respond to the above questions, papers were presented to provide the participants with information on the present state of the art, and to identify areas in need of further investigation. Participants were then directed to develop high-yield criteria that would identify patients who are most likely to benefit from a particular radiographic examination.

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