

Clinical considerations and potential liability associated with the use of ionizing radiation in orthodontics

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Ionizing radiation is a known carcinogen. Its damaging effects can be deterministic or stochastic. Deterministic effects occur only after radiation exposure thresholds are reached, but stochastic effects are random, and there is no known threshold below which harmful effects will not occur. Therefore, the use of ionizing radiation in orthodontic treatment should bring a benefit to the patient that outweighs the risks. No legally binding statutes, rules, or regulations provide explicit radiographic prescription protocols for orthodontic practice. The objective of this article was to discuss guidelines and risk management strategies for appropriate and defensible use of ionizing radiation in orthodontics. Guidelines are discussed for radiographic acquisition at different points along the orthodontic treatment timeline. In addition, risk management strategies and best practices are presented regarding adequate and defensible radiographic interpretation. These guidelines are not rigid and do not establish standards of care; they should be modified as necessary for each patient and each clinical encounter. (*Am J Orthod Dentofacial Orthop* 2018;154:15-25)

Ionizing radiation is one of the world's most studied carcinogens. Its damaging effects are either deterministic or stochastic. Deterministic effects cause tissue reactions and occur only after certain radiation exposure thresholds are reached. They are not reached for exposure levels used in dentistry, including orthodontics; hence, only stochastic effects can occur. Stochastic effects are random; the main concern is the risk of cancer induction. The likelihood of a stochastic effect is proportional to the dose: the higher the dose, the greater the risk. This risk is also age dependent; it is highest in children and lowest for the elderly.¹

Children, who comprise most orthodontic patients, are at highest risk because they are sensitive to radiation and have a long life span; therefore, radiation-induced cancer with a long latent period may be expressed later

in their lives.² In general, the exposure to low-dose radiation during childhood results in a small, insignificant increase in the lifetime risk of fatal cancer.^{3,4} Unfortunately, there is no known threshold below which no harmful effect will occur. Therefore, the diagnostic value of a radiographic imaging study needs to be balanced against this risk.⁵

Dental radiography is 1 basic tool for diagnosis; when ionizing radiation is used appropriately, it brings benefits that outweigh the low, future, and theoretical risks of the radiation received.⁶ There is no legally binding statute, rule, or regulation that outlines clear radiographic prescription protocols in orthodontic practice, including which radiographs to prescribe or not to prescribe.⁷

The objectives of this article were to review relevant evidence and to discuss general guidelines and practices that can assist orthodontists in evidence-based clinical decision making for justifiable, defensible, and sensible radiographic acquisitions at different points along the orthodontic treatment timeline: initial, progress, and final. Additionally, evidence-based guidelines are presented regarding the acquisition and radiographic interpretation of cone-beam computed tomography (CBCT) scans.

These guidelines are not meant to provide legal advice or establish professional rules or standards of care. They should always be modified as necessary for

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each patient and each clinical encounter. All guidelines or regulations on the use of ionizing radiation have changed over time and often vary by location and situation in the United States and abroad.

General guidelines for radiographic acquisition

From a purely risk management perspective, not taking a clinically necessary radiograph is worse than taking an unnecessary one. Beyond risk management, it is widely considered beneath the standard of care to initiate orthodontic care without first acquiring proper diagnostic information. A clinician who begins orthodontic treatment without appropriate radiographs necessary for creating an adequate and appropriate diagnosis and treatment plan may be breaching the standard of care.⁸

Radiographic imaging is justified if there is an expected benefit to the patient. No dental organization or any authority can make clear rules on when and which radiographs to take, because each clinical encounter and each patient are different. A minor finding during a clinical examination could make or break the decision on which radiographs to take, if any.

The American Dental Association and the Food and Drug Administration provide general and broad guidelines for dental radiographic examinations and recommendations for patient selection.^{9,10} For new adolescent and adult patients with permanent dentition, they advise an “individualized radiographic examination consisting of posterior bitewings with panoramic examination or posterior bitewings and selected periapical images; a full-mouth intraoral radiographic examination is preferred when the patient has clinical evidence of generalized dental disease or a history of extensive dental treatment.”⁹ These recommendations were made for dentistry overall but not specifically for orthodontics.

The process of prescribing radiographs in orthodontics is based on the practitioner’s clinical judgment for a particular patient’s presentation, and the ALARA directive—keeping radiation as low as reasonably achievable—should be adhered to.¹¹ Because most orthodontic patients are children, the ALARA directive is heightened in orthodontics.¹²

In general, the justification for taking radiographs is based on each patient’s presentation including considerations of the chief complaint, the medical and dental history, and the requirement to diagnose, monitor, or examine the need, status, or outcome of a procedure or treatment.¹³ Radiographs should always be prescribed after (not before) a clinical examination has been performed.^{7,10}

Initial radiographic acquisition in orthodontics

After reviewing the patient’s health history and completing a clinical examination, radiographs should be considered if they are likely to provide confirming or clarifying information that can affect the diagnosis and treatment.¹⁴ Because each patient is different, there is no indication for taking a standard or the same series of radiographs for all orthodontic patients.¹

To establish a comprehensive diagnosis for most orthodontic patients, case-specific radiographs are necessary for the patient’s benefit.¹⁵ With the ever-increasing quality of radiographic machines and images, the combination of pretreatment panoramic and cephalometric radiographs appears to be appropriate and sufficient in most cases.^{15,16}

For initiating orthodontic therapy, a panoramic radiograph has many advantages and provides much information, including the status of dental development.¹⁷ This single image provides an excellent and broad view of a variety of structures, including maxillary and mandibular dentitions, adjacent structures, and temporomandibular joints, and is quite helpful for patients with asymmetry.¹⁸ The panoramic radiograph is simple to obtain and easy to interpret and explain to patients.

Whereas a panoramic radiograph of good quality can show a significant amount of information, it comes with 3 main limitations. First, it lacks the fine detail required to diagnose and monitor carious lesions and periodontal status, and the objects outside the focal trough will not be shown in detail.¹⁹ Second, the panoramic radiograph is not dimensionally accurate and may include geometric distortion and unequal magnification throughout the image.¹⁸ Third, panoramic radiography requires the patient to be positioned accurately in the focal trough.¹⁸ To do so, it is valuable to follow the manufacturer’s recommendations for patient positioning, including the appropriate use of light beam markers.¹ Staff members should be able to identify patient positioning errors and optimize the quality of patient positioning during panoramic radiography.

The value of the initial cephalometric radiograph, when appropriately acquired, should not be ignored. It can be useful for assessing growth and dental and skeletal relationships.¹⁰ However, it may not be necessary for some patients who have mild crowding or spacing, or when a limited treatment plan will not change the maxillomandibular relationship.²⁰ For example, an adult with a chief complaint of mild crowding or spacing of the anterior teeth who requests limited treatment is unlikely to benefit from a cephalometric radiograph; taking this image is unlikely to change the treatment plan or the

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