Clinical recommendations regarding use of cone beam computed tomography in orthodontics. Position statement by the American Academy of Oral and Maxillofacial Radiology

American Academy of Oral and Maxillofacial Radiology

Aims. To summarize the potential benefits and risks of maxillofacial cone beam computed tomography (CBCT) use in orthodontic diagnosis, treatment and outcomes and to provide clinical guidance to dental practitioners.
Methods. This statement was developed by consensus agreement of a panel convened by the American Academy of Oral and Maxillofacial Radiology (AAOMR). The literature on the clinical efficacy of and radiation dose concepts associated with CBCT in all aspects of orthodontic practice was reviewed.
Results. The panel concluded that the use of CBCT in orthodontic treatment should be justified on an individual basis, based on clinical presentation. This statement provides general recommendations, specific use selection recommendations, optimization protocols, and radiation-dose, risk-assessment strategies for CBCT imaging in orthodontic diagnosis, treatment and outcomes.
Conclusions. The AAOMR supports the safe use of CBCT in dentistry. This position statement is periodically revised to reflect new evidence and, without reapproval, becomes invalid after 5 years. (Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116: 238-257)

Malocclusions and craniofacial anomalies adversely affect quality of life. Orthodontics and dentofacial orthopedic treatment address the correction of malocclusions and facial disproportions due to dental/skeletal discrepancies to provide esthetic, psychosocial, and functional improvements. For almost a century, two-dimensional (2D) planar radiographic imaging and cephalometry have been used to assess the interrelationships of the dentition, maxillofacial skeleton, and soft tissues in all phases of the management of orthodontic patients, including diagnosis, treatment planning, evaluation of growth and development, assessment of treatment progress and outcomes, and retention. However, the limitations of 2D imaging have been realized for decades as many orthodontic and dentofacial orthopedic problems involve the lateral or "third dimension."[1-3] For instance, relapse of and unfavorable responses to orthodontic therapy remain poorly understood despite implications that considerations in the transverse plane are important factors in stability.[4] For years, multiple radiographic projections were obtained to attempt to display complex anatomic relationships and surrounding structures; however, interpreting multiple-image inputs is challenging. With the increasing availability of multi-slice computed tomography (CT) and, more recently, cone beam computed tomography (CBCT), visualization of these relationships in three dimensions is now feasible.

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SCOPE AND PURPOSE OF THE RECOMMENDATIONS AND CONCLUSIONS

This position statement was developed by board-certified orthodontists and oral and maxillofacial radiologists convened by the American Academy of Oral and Maxillofacial Radiology (AAOMR). Their objectives were to 1) review and evaluate critically the current science, guidance and other resources available from professional organizations on the clinical benefits and potential limitations of the use of CBCT in orthodontics, and 2) develop consensus derived, orthodontic-specific clinical guidelines. Imaging selection recommendations, optimization protocols and radiation-dose, risk-assessment strategies were developed to assist professional clinical judgment on the use of CBCT in orthodontics. The panel concluded that there is no clear evidence to support the routine use of ionizing radiation in standard orthodontic diagnosis and treatment planning, including the use of CBCT.

BACKGROUND

Imaging considerations in orthodontic therapy

One purpose of radiographic imaging in orthodontics is to supplement clinical diagnosis in the pretreatment assessment of the orthodontic patient. Radiographic imaging may also be performed during treatment to assess the effects of therapy and posttreatment to monitor stability and outcome. Imaging for a specific orthodontic patient occurs in at least three 3 stages: 1) selection of the most appropriate radiographic imaging technique, 2) acquisition of appropriate images, and 3) interpretation of the images obtained. In some instances, these steps need to be repeated. Selection of the appropriate radiographic imaging technique (or techniques) is

based on the principle that practitioners who use imaging with ionizing radiation have a professional responsibility of beneficence—that imaging is performed to "serve the patient's best interests." This requires that each radiation exposure is justified clinically and that procedures are applied that minimize patient radiation exposure while optimizing maximal diagnostic benefit. The extension of this principle, referred to as the "as low as reasonably achievable" (ALARA),[5] to CBCT imaging is supported by the American Dental Association.[6] Justification of every radiographic exposure must be based primarily on the individual patient's presentation including considerations of the chief complaint, medical and dental history, and assessment of the physical status (as determined with a thorough clinical examination) and treatment goals.[6]

In 1987, a panel of representatives from general dentistry and various academic disciplines in the United States was convened by the Food and Drug Administration. This panel published broad selection recommendations for intraoral radiographic examinations.[7] These were updated in 2004.[8,9] The guidelines suggest that for monitoring growth and development of children and adolescents, "clinical judgment be used in determining the need for, and type of radiographic images necessary for, evaluation and/or monitoring of dentofacial growth and development." In both the European Union[10-12] and the United Kingdom[13] orthodontic imaging guidelines state that there is neither an indication for taking radiographs routinely before clinical examinations nor for taking a standard series of radiographic images for all orthodontic patients. The latter document provides clinical decision algorithms based on the ages of the patients (less than or over 9 years of age) and clinical presentation (delayed or ectopic eruption, crowding, or anteroposterior discrepancies such as overjet or overbite, etc.).

CBCT imaging in orthodontics

There has been a dramatic increase in the use of CBCT in dentistry over the last decade. This technology has found particular applications in orthodontics for diagnosis and treatment planning for both adult and pediatric patients.[14-20] CBCT imaging provides two unique features for orthodontic practice. The first is that numerous linear (e.g., lateral and posteroanterior cephalometric images) or curved planar projections (e.g., simulated panoramic images) currently used in orthodontic diagnosis, cephalometric analysis, and treatment planning can be derived from a single CBCT scan. This provides for greater clinical efficiency. The second, and most important, is that CBCT data can be reconstructed to provide unique images previously unavailable in orthodontic practice. Innately CBCT data are presented as inter-relational undistorted images in three orthogonal planes (i.e., axial, sagittal, and coronal); however, software techniques are readily available (e.g., maximum intensity projection and surface or volumetric rendering) that provide three-dimensional visualization of the maxillofacial skeleton, airway space and soft tissue boundaries such as the facial outline. The current diagnostic uses of CBCT are summarized in Appendix A.[21-158]

Evidence based assessments

The potential for extracting additional diagnostic information from volumetric imaging and the technical ease of obtaining scans has led some clinicians and manufacturers to advocate the replacement of current conventional imaging modalities with CBCT for standard orthodontic diagnosis and treatment.[15,18,159,160] Although CBCT imaging increases clinician confidence in orthodontic diagnosis[161] and has demonstrated clinical efficacy in altering treatment planning for impacted maxillary canines,[37,43,161] unerupted teeth, severe root resorption, and severe skeletal discrepancies,[161] no benefit has been demonstrated for patients specifically referred for abnormalities of the temporomandibular joint, airway assessment or dental crowding.[161] Despite the number of publications on the use of CBCT for specific orthodontic applications, most are observational studies of diagnostic performance and efficacy with wide ranging methodological soundness.[162] Few authors have presented higher levels of evidence and measured the impact of CBCT on orthodontic diagnosis and treatment planning decisions.

Fundamentals to guideline development are systematic reviews of the published literature. Systematic reviews use well-defined and reproducible literature search strategies to identify evidence focused on a specific research question. Evidence is graded according to its level of methodological rigor (or quality), relevance and strength. There is a lack of CBCT-orthodontic systematic reviews. There is a need for rigorous investigation on the efficacy of CBCT imaging for all aspects of orthodontics related to its influence on therapy decisions and ultimately patient outcome.[163] Because of the lack of CBCT-orthodontic systematic reviews, the panel used consensus and published criteria.[164-168] to develop three hierarchical recommendations for CBCT imaging in orthodontics (Table I). An important consideration in the use of CBCT is that ionizing radiation is a risk to patient health.

Radiation dose considerations in orthodontics

There are two broad potential harmful effects of ionizing radiation in orthodontics. The first is deterministic effects that cause the death of cells from high doses over short periods of time and usually occur only after thresholds are reached. Below these thresholds no clinical change has been reported. These levels are never reached for a single exposure in the diagnostic range