

In this month's letter, Dr. Rick Valachovic, Executive Director of the American Dental Education Association, considers the implications of the widespread use of cone-beam computed tomography for dentists, patients, and educators.



Has CBCT Become Too Much of a Good Thing?

Imagine you are one of two specialists in a town 30 miles outside a large city with a dental school. You are excited to learn about the advantages that cone-beam computed tomography (CBCT) provides in planning treatment for patients referred to you for dental implant placement. You begin sending these patients to the oral and maxillofacial radiology practice at the dental school for CBCT scans. The school-based practice performs the scan and converts it to the treatment planning software you use, and an oral and maxillofacial radiologist completes a radiologic interpretation, looking for any anomalies or evidence of pathology that may appear in the images—all for a charge that is well within your patients' means. You are satisfied with the service and intend to go on using it—until, that is, the other specialty dental practice in town acquires a CBCT machine.

Before long, you learn that your referring dentists are sending patients to the other specialty practice, because that practice has CBCT equipment in their office.

As more and more patients opt for the convenience of a CBCT scan in town, you reluctantly conclude that you, too, need to acquire the technology. That's a big investment, and you have far fewer patients than the radiology practice at the dental school. To make your monthly lease payments, you (like the other specialty practice in town) charge your patients 60 percent more for their scans, and you save yourself the cost of converting the images to your usual treatment planning software, even though it's what you've used for years.

You also take on the responsibility of interpreting the images yourself, even though your professional education and training ended long before CBCT even came into existence. In most cases, this works out just fine, but occasionally an image reveals what appears to you to be an anomaly. When this happens, you send the scans to the oral and maxillofacial radiologists at the dental school for interpretation. The radiologists there wonder how many other anomalies you may have missed, and they notice that some of the time the size of the scan and its resolution are greater than they need to be. Might you be exposing your patients to more ionizing radiation than their treatment planning warrants?

This hypothetical scenario, variations of which are playing out across the country, raises troubling questions that can arise with the advent of any new technology. The technology may have undisputed, tangible benefits, but do we know if it is being deployed appropriately, if its users are adequately trained, if it has unintended health or financial consequences, and if so, whether professionals are always making the risk/benefit calculation with their patients' best interests in mind?

The proliferation of CBCT imaging devices in the past decade suggests a general consensus among dentists of all stripes that this revolutionary technology has the potential to significantly improve diagnosis and treatment planning when it comes to certain procedures. Its volumetric images provide a level of clarity and detail that should allow dentists to maximize the efficiency and effectiveness of the treatment they provide. Nevertheless, we have to ask, what does it mean to have a sophisticated radiologic technology that requires an expert to fully interpret the images?

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During my residency program in pediatric dentistry at Children's Hospital in Boston, I became interested in the efficacy of the use of ionizing radiation in the diagnosis of dental diseases and conditions in children. Panoramic radiology was just coming into use, and it was becoming somewhat routine for young kids to be exposed to a full mouth series and a panoramic view. My research focused on the biological effects of ionizing radiation as used in dentistry. The Three Mile Island accident happened around that time and, like the events at the nuclear reactors in Japan after this year's earthquake, there was a popular interest in radiation in the lay media. With a mentor of mine, Dr. Alan Lurie, I published one of my first journal articles in [Pediatric Dentistry](#). Entitled "Risk-benefit considerations in pedodontic radiology," it provided evidence of the potential harm to children from ionizing radiation and created considerable controversy in our community. I remember one prominent pediatric dentist trying to demean our work by saying, "I have never seen a child fall out of my dental chair with leukemia from my x-rays."

As some of you may know, I continued my interest in radiology, becoming a Diplomate of the American Board of Oral and Maxillofacial Radiology and eventually serving as President of the [American Academy of Oral and Maxillofacial Radiology](#) (AAOMR). Those of us in dental radiology at that time were eager to get the specialty recognized by the American Dental Association (ADA) House of Delegates, so we could have our oral and maxillofacial radiology (OMR) advanced education programs approved by the Commission on Dental Accreditation. That finally occurred in 1999.

The advent of volumetric imaging and the appearance of CBCT technology about a decade ago have played a large role in shaping our specialty. To get some perspective on this, I called Dr. Bill Scarfe, Editor of the Oral and Maxillofacial Radiology Section of [Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology](#), the official publication of AAOMR and four other professional societies. Bill is also a Professor at the [University of Louisville School of Dentistry](#).

"The original cone-beam units that came out could scan the head, the whole head, and nothing but the head," Bill reminded me. "Then another unit became available that offered scalability, that let you see just the top jaw or the lower jaw. Now we have a panoramic unit that allows you to select just three or four teeth for CBCT scanning. This is the maturity of the market."

Bill expressed admiration for the CBCT industry's ability to refine this complex technology over the last decade so that it can be used with greater and greater safety and precision, but he shares some of my concerns about how the technology is being used. He mentioned a [New York Times article](#) describing the routine over-exposure of premature babies to ionizing radiation through the use of full-body radiographs when chest x-rays were ordered at a hospital in Brooklyn, New York. The article (part of [a series](#) that included a discussion of children's radiation exposure in dental offices) revealed a pervasive lack of understanding among many individuals that children are not just small adults when it comes to radiographic imaging. Children under age 15 are in fact three to five times more sensitive to radiation than are adults.

Bill told me that under Dr. Alan Farman's leadership as its current President, AAOMR has made an effort to convey this message to those in industry. As he put it, "With CBCT, we now have a modality that, depending on the field of view, provides five to eight times the x-ray dose of conventional panoramic radiography with one press of a button. CBCT is not a replacement for current imaging technology. It's a supplement to it. As an organization, we have underlined this."

Bill is leading a collaborative effort between AAOMR and the [American Association of Orthodontists](#) to develop guidelines and selection criteria for the use of CBCT in orthodontics, with special consideration for minimizing radiation dose in children. As Bill points out, "Patients and their parents need to know what the real risks are, because orthodontics involves a course of treatment over a period of time with multiple radiographic exposures." The association hopes to finalize the guidelines later this year and send them out for review within the associations. AAOMR has already published [joint guidelines](#) with the [American Association of Endodontists](#) and plans to do likewise with other specialty associations.

Guidelines such as these are essential, and the ADA agrees. The ADA Council on Scientific Affairs is [currently developing](#) its own set of guidelines on the use of CBCT.

Unfortunately, guidelines alone will not ensure that practitioners adhere to best practices. That will require education, for practicing professionals as well as for students and residents. AAOMR has also developed a basic-level CBCT certification course covering image quality and dose, general principles of machine operation, some aspects of radiation biology, and the interpretive aspects of CBCT, especially related to incidental findings. The course will be offered at [this year's ADA Annual Session](#). AAOMR plans to introduce two additional, more advanced courses in future years.

Helping all users of CBCT achieve basic competency is critical. According to AAOMR, there are 140 oral and maxillofacial radiologists in the United States, and there are

about 5,000 CBCT machines in use. Presumably all of their users have received basic operating instruction from the manufacturers, but most have no additional education and training. And the allied dental personnel who may be operating the machines presumably have even less understanding of how to utilize them to minimize the risk to patients.

This concern came home to me in speaking with Dr. Bernard Friedland, an oral and maxillofacial radiologist colleague of mine on the faculty at the [Harvard School of Dental Medicine](#). In addition to scans taken in his own practice, Bernard is asked about 15 to 20 times a year to convert scans taken elsewhere, typically by dentists in private offices who want images converted to a digital format other than what their machine software provides. In some cases, he sees patients may be receiving up to two and a half times the appropriate dose of ionizing radiation because the resolution is higher than needed or the scanned area, called the field of view, is too large. He assumes that with greater education and experience, these dentists will do a better job of applying the ALARA, or "As Low As Reasonably Achievable," principle in their practices, but he has been particularly troubled by conversations he has had with some dental assistants. In arranging to send scans back and forth, it has become clear they do not always possess even the most basic computer literacy skills. "It is critical that whoever is operating these machines fully appreciates the need to minimize radiation exposure to patients and understands how to operate the scanner to achieve this goal," Bernard told me.

So what does all this mean for Oral and Maxillofacial Radiology as a specialty? Bill Scarfe believes that CBCT technology has been "revolutionary, not only for dentistry but for our specialty, because it gives us the ability to contribute to dentistry in terms of radiographic issues, technical issues, and radiation biology issues. It's a good time to be a radiologist. It's exciting. We're looking at expanding courses for those who want to consider this as a career."

Bernard agrees with Bill's assessment of the technology, but he is not so sanguine about its impact on the profession. "When so many people are buying their own machines," he told me, "the only available business for OMRs increasingly is interpretation, and sending the scans for review is not currently the standard of care, or at least not actual practice. In many cities today, it would be difficult or next to impossible for an oral and maxillofacial radiologist to set up an imaging facility and to earn a living from it."

There is discussion within the academic community about whether we should teach CBCT interpretation to dental students, and if so, how much. My guess is that most schools do a fairly minimal amount, but we will know better later this year after a student at the University of Louisville surveys dental schools as part of a summer research project to find out what is being taught about CBCT and at what level. In the meantime, I can tell you that a student at the [University of California, San Francisco](#) has developed and published a manual for use by his fellow students on how to read and evaluate CBCT scans. You can read more about it in the [ADEA CCI Liaison Ledger fall 2010 issue](#) on students and residents as agents of change.

Not surprisingly, students and residents are in the vanguard in demanding education on this and other technological advances. As always, progress marches on. The task for us is to determine how we can best avail ourselves of its benefits and minimize the damage that comes about when we ignore the need for thorough preparation and established standards.

The body that regulates dental practice in the province of [Ontario](#) recently released minimum standards for the [use of dental CT scanners in dentistry](#). They make for interesting reading, but I don't foresee this type of government oversight finding favor in the United States any time soon. As far as I know, Michigan is the only state that requires dental providers to file a Certificate of Need before acquiring a CBCT scanner, just as other health care providers would for a medical CT scanner. The rest of the country seems content to let CBCT fly under the regulatory radar.

No one seems in a hurry to enact national legislation either. For the past twelve years, the [American Society of Radiologic Technologists](#) has been lobbying Congress to pass [a bill](#) that would amend the Consumer-Patient Radiation Health & Safety Act of 1981 to require imaging personnel and others to meet federal certification requirements. They have made progress in their effort, but passage is far from imminent.

Nevertheless, Ontario's standards, like AAOMR's guidelines, may help our profession reach consensus around best practices. I was really encouraged that the ADA decided to take a lead role in addressing this issue early on. I am also glad to see AAOMR doing educational work in this area and bringing it to the ADA Annual Session, where general dentists and specialists can both avail themselves of this much-needed resource.

Even when CBCT ceases to be on the cutting edge and some of these issues resolve or fade away, academic dentistry will still need to wrestle with the challenges posed by the introduction of new technologies. I recently learned that researchers at the

[University of Minnesota Center for Magnetic Resonance Research](#) are developing a novel MRI technique that can simultaneously image both hard and soft dental tissue. A [newly published study](#) discusses their findings. What will they mean for the quality, safety, efficiency, and cost of dental care? I don't have a crystal ball, but I do foresee a robust dialogue in our community around this technology as well.



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