A paradigm shift in oral and maxillofacial imaging

From Roentgen's discovery of x-rays in 1895 until the early 1970s, radiographs were planar, 2D views of anatomy. Thanks to the efforts of early pioneers, including Godfrey Hounsfield, computed tomography (CT) became a reality. It was considered a major leap in diagnostic radiology. Over the past few decades, there have been similar diagnostic and treatment paradigm shifts in dentistry, including the advent of high-speed handpieces, root-form implants, and digital radiography, but perhaps the most dramatic is the rapid adaptation of the cone beam CT (CBCT).

The explosion of dental implant procedures resulted in the demand for improved visualization of 3D anatomy, as well as applications directly related to the selection and placement of dental implants. Stereolithographic surgical models of the mandible or maxilla by way of rapid prototyping were manufactured using the CBCT volumes, either locally or remotely. Image-guided surgical navigation has become a reality. The proliferation of CBCT device manufacturers within the previous decade is the direct result of the growing demand for the virtual 3D anatomy by dental practitioners. Not surprisingly, the demand for CBCT services is unprecedented in dental diagnostics.

With the advent of CBCT technology for anatomic imaging, there are concerns regarding radiation dosage and its associated long-term risks. If one goes back to the era of CT imaging and the introduction of the EMI scanner in the mid '70s, there were similar concerns over the increase in the radiation doses that patients received. After the "technology-amazed" period ended, concerns regarding radiation exposure surfaced after the introduction of the first CT scanners. In the end, science prevailed. Radiation doses from CT procedures were deemed duly justified because diagnosis of disease was considered paramount. The potential risks posed by radiation effects came to be regarded as acceptable, when the imaging is appropriately selected. Thereafter, the ALARA principle was used conceptually in making recommendations for all CT scans. The United States Nuclear Regulatory Commission's Guide, 10 CFR 20.1101(b), reiterated that "the licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as reasonably achievable (ALARA)." Dentistry has long been on the cutting edge of radiation technology, having developed and published radiographic selection criteria more than 20 years ago. The dental profession now faces a similar dilemma with CBCT scanners. While medical CT is an initial diagnostic tool for disease identification, CBCT can be used as a primary diagnostic modality, as well as an adjunct tool for the assessment of a patient for implant, orthodontic, or endodontic needs. However, when obtained for preimplant assessment, it is recommended that an oral and maxillofacial radiologist read the volume to assess the normal neurovascular anatomy and its variations, as well as to identify the presence of any incidental abnormalities. A radiology report is necessary with each scanned volume. This is a standard practice in the medical world and analogous to a pathology report that accompanies a biopsy.

Applying selection criteria demonstrates where the use of the CBCT may be justified as an imaging modality. In 2007, the International Commission on Radiological Protection (ICRP) updated the methodology for calculating the effective doses based on the current scientific information. Literature revealed that these revised dose calculations in dental radiographic procedures were 32% to 422% higher than previously thought.[1] Even though the effective doses for CBCT were not estimated by the same risk-assessment strategy, it can be argued that CBCT uses far more radiation than any intraoral exposure and may therefore be far more risky when it comes to radiation damage. Fortunately, other common dental radiographic techniques are still valid and, when used appropriately, are quite informative for the diagnosis of dental caries, periodontal disease, and periapical dental pathoses.

Dentists should be trained in appropriate selection criteria for prescribing CBCT examinations. Just as the introduction of FDA's radiographic guidelines addressed the selection criteria for common dental diagnostic procedures, recommendations for optimal use of CBCT are necessary for guiding clinicians in choosing the CBCT as a diagnostic tool. To further lower the dose and enhance the resolution, CBCT machines with smaller fields of view for regional imaging were introduced. The image intensifiers were replaced by the solid-state, flat panel detectors, leading to improvements in resolution while reducing scanning times. A recent executive opinion statement[2] by the American Academy of Oral and Maxillofacial Radiology (AAOMR) on performing and interpreting diagnostic CBCT suggested that the "dental practitioner use appropriate patient selection, dose optimization, technical proficiency, and assessed diagnostic or treatment needs." It is also the opinion of the AAOMR that the dentists using CBCT should be held to the same standards as certified oral and maxillofacial radiologists.

As health care providers, we have the responsibility to sensibly use modern technology for the benefit of our patients. We also have the obligation to stand by the Hippocratic oath and do no harm. The CBCT has established itself as a powerful diagnostic imaging modality in the dental profession. As Uncle Ben told Peter Parker in *Spider-Man*, "with great power comes great responsibility."

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