3-D imaging: Changing the Diagnosis, Prognosis, and Interdisciplinary Treatment Landscape

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Q: What are the most clinically appropriate applications for using 3-D imaging?

A: Dr. Baumgarten

If this question had been asked 10 or 15 years ago, most clinicians would think of applications for 3-D radiographic imaging. In fact, computed tomography (CT) scanning has become an integral part of practices in almost every dental specialty. The ready availability of cone-beam scanners has greatly expanded the use of 3-D radiographic imaging. The obvious applications for this type of imaging include: pre-surgical work-up prior to implant placement, third-molar extractions, exposure of impacted teeth prior to orthodontic therapy, and diagnosis and treatment of traumatic injuries. CT scans allow the surgeon to fabricate precise surgical guides that allow for exact dental implant placement, often using a minimally invasive approach. Orthodontists have found CT scans invaluable in the diagnosis and treatment planning of both dental and skeletal malocclusions. Endodontists use CT scans when diagnosing and treating periapical pathology. Today, 3-D imaging encompasses a whole host of applications that are non-radiographic in nature. This author’s group has been using a number of 3-D imaging modalities in both the clinical and dental laboratory setting for several years. In the clinical setting, intraoral scanning has, for the most part, taken the place of conventional crown and bridge impression materials. The impression is made using an intraoral scanner, and that file is then sent to a milling center that mills a polyurethane model, upon which the restoration is fabricated. The 3-D file is also available to the laboratory if needed.

In the dental laboratory, 3-D imaging and CAD/CAM techniques have revolutionized the fabrication of dental restorations. The ready availability of desktop laser scanners allows technicians to image master casts and/or final impressions. These 3-D files are then used in dental design software to design almost every type of restoration imaginable. These restorations can then be fabricated using a variety of both digital and conventional laboratory techniques. As digital workflows become more refined, dentistry will start to see the merging of 3-D radiographic imaging with other modalities to greatly enhance clinicians’ ability to treat their patients.

A: Dr. Mandelaris

With regards to 3-D imaging, the first priority is safety by practicing under ALARA (as low as reasonably achievable) principles, being mindful of dosimetry and of cumulative exposure of patients to ionizing radiation (especially those who are skeletally immature).

As a periodontist practicing in an evolving era of interdisciplinary therapy, I believe it is the changing context and culture of our profession that has led to this discussion. Periodontics is a specialty that was born, in part, out of the necessity for interdisciplinary therapy. The answer to this question sparks a dialogue about the periodontist’s role in future interdisciplinary therapy. As I see it, the six cornerstones of future periodontal specialty practice will include: 1) dental implant and related bone regeneration; 2) management of inflammatory periodontal diseases; 3) perio-restorative therapy; 4) oral medicine; 5) esthetic and regenerative surgical therapy (including tissue engineering); and 6) cone-beam computed tomography (CBCT) imaging and foundational occlusion. All of these cornerstones will be viewed in the context of personalized patient evaluation, risk assessment, and wellness, of which CBCT will be an inherent component. From my context and practice culture, I would argue that 3-D imaging is hardly limited to implant therapy. CBCT is nothing short of a “game changer” when it comes to diagnosis, prognosis, interdisciplinary treatment opportunities, and opening up capabilities in the patient education process. In my opinion, volumetric DICOM assessment has become the impetus for periodontics to go beyond conventional disease-based assessment and dentogingival complex evaluation to become an even more dynamic specialty as it pertains to patient assessment and as a treatment-planning partner. CBCT imaging uniquely offers interdisciplinary opportunities with restorative dentistry, other dental specialties, and medical colleagues for collaboration on patient care, because it now makes factual data (or “anatomic truth”) available for an objective assessment by all. Nearly every component of interdisciplinary planning is improved by the inclusion of volumetric CBCT data, and regional anatomy is more accurate with CBCT compared to traditional radiology measures.1,2

Perhaps the most exciting opportunities for CBCT involve the ability to evaluate regional and craniofacial anatomy and the permutations that such information brings to comprehensive patient care. Historically, the factual condition and position of many structures went unrecognized or ignored in the diagnostic process because they were never part of the full-mouth x-ray data set for...
interpretation. Today, intermaxillary skeletal relationships, airway and pharyngeal space assessments, internal and external carotid artery calcifications, periapical status, facial bone thickness, temporomandibular joint–based evaluation, axial inclinations of teeth within dentosseous bone and corresponding inter-incisal angle relationships, dentosseous and alveosseous pattern determinations, and considerations for alternative orthodontic approaches are all part of the expanded culture of practice when taking a global and dynamic approach to patient care and diagnostics, which CBCT affords. Thus, as the context and culture of periodontics evolves and changes—yet remains interdisciplinary at its core—there will likely be few clinical situations that don’t benefit from the use of CBCT. CBCT represents a change to traditional practice culture but is no doubt a part of dentistry’s future.

In the private practice, CBCT scanners serve primarily as an adjunct tool for performing successful implant-related surgeries. Proposed recipient sites for dental implants can be surveyed in three dimensions via reformatting of the digital data (DICOM) obtained from these CT scans. Identification of maxillary sinuses, nasal cavities, inferior alveolar nerves, lingual concavities, incise and mental foramina are some of the critical structures that need to be located prior to performing surgical procedures. CBCT scanning can have a profound effect on implant treatment planning. The diameter and length of implants, as well as positioning, can be confirmed or altered from the desired treatment plan after these anatomic structures are visualized.

Other applications related to implant therapy include treatment planning and fabrication of guided surgery templates via various third-party software. Often, sites augmented prior to implant placement do not require further soft- or hard-tissue regeneration. The possibility of performing flapless implant placement under these conditions may exist. The inaccuracy of “blind” implant placement may be unacceptable. Fabrication of a computer-generated stent can greatly reduce the risk of implant malpositioning. This can reduce morbidity associated with open surgery and assure proper implant placement.4

One aspect of CBCT scanning frequently overlooked is the diagnoses of pathologies not easily identified through clinical examination and standard, 2-dimensional radiography.5 Tangential views, not obscured by the buccal and lingual/palatal cortices, often identify periapical lesions associated with endodontic pathology. Other intraosseous lesions can also be visualized, and their extent can be identified in an office setting, prior to surgical removal. The risks of these surgeries, as they relate to proximity to vital structures, can also be evaluated and discussed with the patient. Sinus pathology, such as sinusitis, cysts, mucoceles, and other neoplasms can also be discovered prior to performing surgery such as implant placement or sinus grafts; furthermore, the referral to otolaryngology can be done before untoward complications occur after dental surgery.

REFERENCES