Clinical and diagnostic advantages of PreXion 3-D imaging system

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Fig. 1: Sagittal CBCT MPR showing bone defect at point of dehiscence of the implant coating.

Fig. 2: Periapical does not show the sinus anatomy or the width of the bone.

Fig. 3: MPR showing post op of sinus graft and implant placement.

Fig. 4: The 3-D CBCT showing anatomy of the maxillary sinuses.

Fig. 5: Axial MPR showing maxillary buccal roots in first, second and third molars.

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For nearly 100 years, dentists have relied on 2-D radiographic imaging for diagnosis and treatment planning. With the 1999 introduction of cone-beam computed tomography (CBCT), all dentists now have tools available for more accurate diagnosis and treatment. The ability to look at a tooth in any direction and orientation, as well as in 3-D, eliminates much of the guesswork commonly experienced with 2-D radiographs. We have been limited in most cases to only a buccal-lingual view provided by periapicals, bitewings and panoramic radiographs with the occlusional axial view of an occlusal film. Medical CT scans and axial slices (head-to-toe orientation), coronal slices (front-to-back orientation), sagittal slices (side-to-side orientation) all known as multiplanar reconstructions (MPR). The thickness of each slice can be varied to include more or less information.

Because the voxels (volumetric pixels 3-D) are isotropic, other MPR images can be generated by slices drawn at any angle or curve of thickness through the scan to view areas critical to the final diagnosis. The final view offered by CBCT is a 3-D view that can be rotated and viewed in any direction. Once again through software manipulation, 3-D images can be viewed as conventional radiographs, maximum intensity projections (MIP), soft-tissue projections and a variety other views.

Fig. 2: Periapical does not show the sinus anatomy or the width of the bone.

The evaluation of the available bone for the initial implant placement can be crucial for the long-term success of the case. If there is inadequate bone available, grafting may be a necessity. CBCT studies render the most accurate information available at a low radiation dose. The periapical shows an obvious lack of bone height, but does not show the buccolingual dimensions or an accurate view of the sinus morphology (Fig. 2).

The MPR view of the CBCT shows all necessary measurements to perform the sinus lift and grafting with the immediate placement of the implant fixture (Fig. 5). Three-dimensional views show the floor of the sinus and any soft-tissue pathology (Fig. 4). Having accurate measurements in all dimensions is an advantage of CBCT scanning.

Early CBCT adoption with implants

As the scope and the value of the information became better known, dentists of all branches began to see the value of CBCT and 3-D renderings including periodontics, endodontics, oral surgery, treatment of TMJ, orthodontics, implantology and general dentistry.

Clinical periapical and panoramic radiographs for the placement of implants can be misleading with elongation, foreshortening, superimposition and geometrically incorrect data. A look at the implant in the periapical shows no obvious disease to an existing integrated implant. Clinically, a buccal fistula was present with exudate and slight pain. The CBCT scan (Fig. 1) reveals a more accurate view showing a buccal defect on a sagittal MPR. A surgical flap revealed a dehiscence of the coating of the implant. Removal of the foreign body resulted in an asymptomatic and healthy patient.

The ability to view MPR slices in cross-section, long axis and oblique directions gives the ability to follow all canals in any direction and show their relationship and measurements for pathology. This virtual tour of the root morphology is a great benefit to the final treatment outcome (Fig. 5).

Post root-canal infection can be difficult to diagnose with the standard periapical. The endodontic files may appear to be normal even though other clinical findings and symptoms are abnormal. The patient presents several months post root-canal treatment with pain on palpation and pressure and avoids this side of the mouth. A periapical radiograph shows minimal pathology (Fig. 6). The roots appear to be filled and a small puff of sealer extends through the apex of the mesial roots. The distal root structure and fill appear normal. There is little indication of periapical radiolucency or loosening of the periodontal ligaments of the mesial roots.

A CBCT scan reveals a completely different picture. The coronal MPR reveals a short fill near the apex of the mesial root lingual and a large radiolucency (Fig. 7, 9) not visible on the periapical radiograph (Fig. 6).

Missed canals are difficult to see in a buccolingual projection of the periapical radiograph as one canal is superimposed on the other (Fig. 9). Often, as viewed in this radiographic, we see periodontal pathology with an apparent normal fully filled canal. CBCT scans allow dentists to look for pathology in MPR planes to identify the actual problem before invasive procedures are performed on the patient. The axial view shows a lingual canal exists and is untreated. The coronal view confirms the diagnosis and treatment can be completed (Fig. 10).

Today’s endodontists, as well as general dentists, are benefiting from the diagnostic capabilities of the high-resolution CBCT scanners available over conventional 2-D periapical.

Oral surgery

Oral surgery, with its inherent invasive nature, can be better served using CBCT with MPR as well as 5-D images. The ability to perform virtual surgery is a benefit to both the doctor and the patient. Doctors have the advantage of seeing morphologies and landmarks in real time and space with accurate measurements, using patients will gain a better understanding of the standing of the problems and the solutions their doctors are offering them.

Third-molar extractions can be risky based on 2-D and panoramic radiographs.
These radiographs can often superimpose nerves and sinususes over root structures. Dentists using 2-D radiographs must often rely on experience to assess the risks of iatrogenic trauma. The use of CBCT with MPRs and 3-D images reduces any guessing as well as the chance for any permanent damage to the patient. With the adoption of CBCT, the judgment is based on solid evidence and the risk will decrease.

A panorex of the superimposed third molars gave no solid evidence the canal lies between the roots. It is only with the use of CBCT and the MPRs that the nerve can accurately be seen traversing between the mesial buccal and mesial lingual root (Fig. 11). Other surgical advantages include the ability to view the position of supernumerary or impacted teeth. The panoramic image is only a poor representation of the anatomical structures. For the periodontist interested in dental implants, the ability to view with CBCT is of vital importance in planning and accepting treatment and the least invasive procedure.

Periodontics

The explanation of periodontal problems are often misunderstood by the patient. As doctors we talk about pockets, point to X-rays and propose treatment only to have patients refuse treatment because they do not understand what we are clinically describing. Using the 3-D portion of the CBCT scan can improve the understanding and acceptance of treatment plans. The images are a picture of the problem that is owned by that patient and much easier to understand by the layperson. Illustrating periodontal defects and pockets allows the patient to better participate in the process (Fig. 15). The MPRs and the 3-D projections aid in surgical planning for periodontists, allowing for accurate measurements and bone analysis prior to osseous surgery that doctors cannot get using the periapicals or panoramic images. Other surgical advantages include the ability to view the position of supernumerary or impacted teeth. The panoramic image is only a poor representation of the anatomical structures. For the periodontist interested in dental implants, the ability to view with CBCT is of vital importance in planning and accepting treatment and the least invasive procedure.

Orthodontics

Orthodontists are beginning to adopt large field-of-view CBCT. Recent studies show that linear measurements of bony structures are more accurate using CBCT and have less distortion than currently used methods of measurement: lateral cephalometric, posteroanterior (PA) and submentovertex (SMVT). Accurate measurements of tooth volume and tooth position can aid in accelerated treatment times and more precise treatment. Along with tooth position, density of bone and size of arches, the orthodontist also has an accurate evaluation of the temporomandibular joint and position of the condyles. Impacted teeth are easily identified and position either buccal or lingual can be confirmed prior to movement or removal. Both MPRs and 3-D projections give the clinician a complete picture of the problems and the treatment course.

With a single CBCT scan, orthodontists can produce all of the information they need: panoramic, cephalometric, PA, SMVT, tooth size and volume, crowding evaluation in any plane, TMJ evaluation and airway analysis, all with both soft-tissue and skeletal information. Conclusion

We treat our patients in 2-D, and now, with cone-beam computed tomography, we are changing the way we diagnose from 2-D to 3-D. The addition of this technology will increase your diagnostic skills with better and more complete information at your disposal. As with any type of invasive diagnostic tool, clinicians should weigh the risk to benefit in using CBCT scans. Judicious use of CBCT and knowledge of patient’s lifetime doses should always be a consideration as well as the availability of other diagnostic tests appropriate for the problems of the patient. When adopting new technology, training is paramount. Along with training comes the responsibility of the doctor to read and diagnose information from CBCT scans. Do not avoid CBCT from lack of knowledge; instead, take this opportunity to become a better diagnostician and radiologist. As you review radiology and pathology, your use of CBCT will aid in making the most accurate diagnosis and the most complete treatment plans.

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About the author

Dan McEowen, DDS, is a 1982 graduate of Loma Linda School of Dentistry and has been in private practice for 20 years. He is a founding member of the World Clini-
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Fig. 6: Periapical showing minimal pathology with no radio lucency.

Fig. 7: Coronal MPR showing a short fill on the mesial lingual and radio lucency.

Fig. 8: Saggital MPR showing un filled canal and radio lucency.

Fig. 9: Periapical showing a normal fill with a radio lucency.

Fig. 10: Coronal MPR showing the superimposed lingual root un filled.

Fig. 11: Coronal MPR showing nerve between roots of the third molar.

Fig. 12: The 3-D Rendering showing supernumerary teeth and positions.

Fig. 13: The 3-D Rendering with periodontal defects and calculus bridge.

Fig. 14: The 3-D Rendering showing a short fill on the mesial lingual and radio lucency.