The digitized occlusion: Using something old with something new

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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 occasional axial view of an occlusal film. Medical CT scans and images began in the early 1970s and were sometimes used by dentists, offering our first multi-planar views. The adoption of 3-D cone-beam imaging is appropriate and has important advantages for all modalities of dentistry. From every specialist to the general dentist, the increased amount of radiographic information as well as increased accuracy will aid in the most sound diagnosis possible.

CBCT description

CBCT is a single or partial rotation of an X-ray source around the head, capturing X-rays on various flat panel arrays and sensors. The information is converted to a series of axial slices by computed tomography and stored as virtual anatomy in the computer. With the use of sophisticated software, the dentist is able to view information in several different views, including axial slices (head-to-toe orientation), coronal slices (front-to-back orientation), sagittal slices (side-to-side orientation). The inherent geometric deficiencies of 2-D radiographs may appear to be normal. The inherent geometric deficiencies of 2-D radiographs may appear to be normal. Studies render the most accurate information available at a low radiation dose. The periapical shows an obvious disease to an existing integrated implant. Clinically, a buccal fistula was present with exudate and a dehiscence of the coating of the implant (Fig. 2). Three-dimensional views show the floor of the sinus and a variety of other views.

This nearly endless ability to manipulate the data aids in the diagnosis and identification of disease, nerve canals, sinus morphology, dental caries, bone density, fractures, endodontic pathology, implant placement criteria, periodontal defects, bone pathology, fractured teeth, iatrogenic trauma, TMJ morphology and disease, third-molar position and many more healthy or diseased conditions.

Early CBCT adoption with implants

The first and primary use of CBCT for early adopters was implant placement. As the scope and the value of the information became better known, dentists of all branches began to see the value of MRPs and 3-D renderings including periodontics, endodontics, oral surgery, treatment of TMJ, orthodontics, implantology and general dentistry. Clinical peripical 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 peripical 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 and grafting with the immediate placement of the implant fixture (Fig. 10). Other surgical advantages include the ability to follow all canals in any direction, long axis and oblique directions gives the ability to follow all canals in any direction and show their relationship and measurements from other known structures. This virtual tour of the root morphology is a great benefit to the final treatment outcome (Fig. 5).

CBCT and endodontics

Endodontics is a field that is rapidly adopting the use of CBCT and for good reason. The inherent geometric deficiencies of 2-D radiographs may appear to be normal. The use of CBCT with MRPs 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 molar gave no solid evidence the canal lies between the roots. It is now easier to use the CBCT and the MRPs that the nerve can accurately be seen traversing between the mesial buccal and mesial lingual root (Fig. 11). Other surgical advantages include the identification and the position of supernumerary or impacted teeth. The images show accurate positions and show definitive morphology that will aid in removing 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 peripical 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 root. The distal root structure and fill appear normal. There is little indication of peripical radiolucency only a widening of the periodontal ligaments of the mesial root. A CBCT scan reveals a completely different picture. The coronal MPR reveals a short fill near the apex of the mesial lingual root and a large radiolucency (Figs. 7, 8) not visible on the peripical radiograph (Fig. 6). Missed canals are difficult to see in a buccal-lingual projection of the peripical radiograph as one canal is superimposed on the other (Fig. 9). Often, as viewed in this radiograph, we see peripical pathology with an apparently normally 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 periapicals.

Oral surgery

Oral surgery, with its inherent invasive nature, can be better served using CBCT with MRPs as well as 3-D images. The ability to perform virtual surgery is a benefit to both the doctor and the patient. Doctors have the advantage of seeing morphology and landmarks in real time and space with accurate measurements, and patients will gain a better understanding 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 sinuses 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 MRPs 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.

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al of the proper teeth (Fig. 12). Knowing the exact position of many of these teeth is a benefit to both the doctor and patient. It will lead to the most precise surgical path 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. 13).

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 panoramics. Studies have shown that CBCT images are more accurate than panoramic radiographs. For the periodontist placing implants, the ability to measure bone density and avoid important anatomy is important.15

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).16 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 to the condyles. Impacted teeth are easily identified and position either buccal or lingual to the condyles.

Conclusion

We treat our patients in 3-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.

Contact Information

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