The Use of Limited-Field Cone Beam Computed Tomography in Endodontics

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With the U.S. Food & Drug Administration's 2001 approval of the use of cone beam computed tomography (CBCT) machines, dentists have come to appreciate the advantages of 3-D imaging technology over conventional radiography. While CBCT technology has had an enormous influence on implantology and oral surgery, its use in endodontics has been insufficiently appreciated by the dental community. Similar to one's initial feeling after looking through a surgical operating microscope, the first exposure to CBCT technology in endodontics is impressive relative to how much additional useful clinical information it provides. Studies have shown that CBCT can identify 28 percent more periapical lesions than conventional radiology.[1]

CBCT machines vary in their field of view (FOV) and image resolution capacity. As with conventional imaging, where smaller pixel size is associated with better resolution, in 3-D imaging, the smaller the voxel size (volumetric pixel), the better the resolution and image quality. Just as increasing the number of voxels in a given scan increases the radiation, decreasing the radiation can be achieved by decreasing the FOV. In endodontics, smaller- or limited-field machines are preferred over larger-field machines for the following reasons:[2]

1. Increased resolution improves the diagnostic accuracy of endodontic-specific tasks, such as visualization of small features, including calcified and accessory canals, missed canals, etc.
2. Highest possible resolution
3. Decreased radiation exposure to the patient
4. Time savings due to smaller volume to be interpreted

Unlike the lower resolution required to evaluate scans for implant and oral surgical procedures, endodontic scans, which visualize small structures, require much higher resolution for adequate interpretation. To offset the higher radiation, a smaller field of view is employed, bringing to a minimum the radiation the patient is exposed to, in accordance with the ALARA (as low as reasonably achievable) principle.

The radiation dose to the patient using a limited-field FOV unit is surprisingly small. Some systems, for example, expose the patient to the equivalent of approximately 1–6 digital radiographs. (See Table 1.)[3]

Limited-field CBCT scans can be used to facilitate endodontic treatment in a variety of situations:

- Unusual anatomy
- Endodontic and non-endodontic pathosis
- Calcified or missed canals detection
- Vertical root fracture
- Resorptions and perforations
- Presurgical case planning
- Diagnosis and management of traumatic injuries
- Pain without any radiographic correlation

In 2010, the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology jointly developed a position statement on the use of cone beam-computed tomography in endodontics.[2] In their summary, they stated that "all radiographic examinations must be justified on an individual needs basis whereby the benefits to the patient of each exposure must outweigh the risks. In no case may the exposure of patients to X-rays be considered 'routine,' and certainly CBCT examinations should not be done without initially obtaining a thorough medical history and clinical examination. CBCT should not be considered an adjunct to two-dimensional imaging in dentistry. Limited field of view CBCT systems can provide images of several teeth from approximately the same radiation dose as two periapical radiographs, and they may provide a dose savings over multiple traditional images in complex cases."

Table 1. Ionizing Radiation Dosages (Approximate)[3]

Activity	Effective Dose in μSv	Dose as Days of Equivalent Background Radiation
1 day background radiation, sea level	7–8	1
1 digital PA radiograph	6	1
4 dental bite-wing radiographs, F-speed film	38	5
FMX; PSP or F-speed film	171	21
Kodak® CBCT focused field, anterior	4.7	0.71
Kodak® CBCT focused field, maxillary posterior	9.8	1.4
Kodak® CBCT focused field, mandibular posterior	38.3	5.47
3D Accuitomo, J. Morita	20	3
NewTom 3G, ImageWorks	68	8
Chest X-ray	170	25
Mammogram	700	106
Medical CT scan (head)	2,000	243
Medical CT scan (spiral CT abdomen)	10,000	1,515
Federal occupation safety limit per year	50,000	7,575

Figure 1. Radiograph shows tooth #30 prior to retreatment.

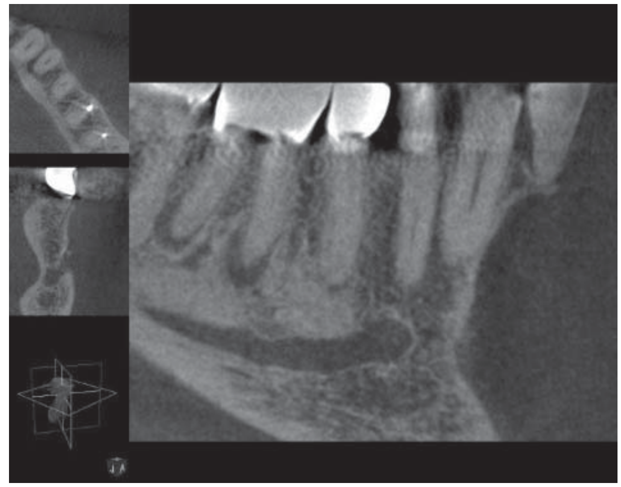

Figure 2. CBCT scan shows an area around the distal root.

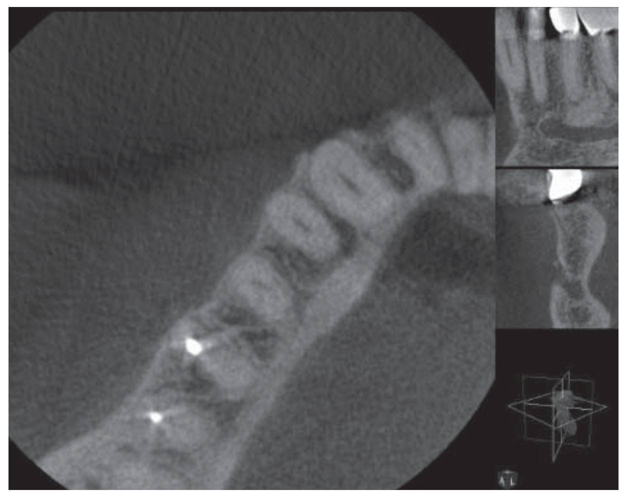

Figure 3. CBCT scan indicates that the mesiolingual and distolingual canals were never treated.

Case Studies

The following two cases are presented to demonstrate how this technology was invaluable in treatment. In the first case, a 77-year-old male patient presented with discomfort associated with buccal apical palpation sensitivity. The options for treatment consisted of extraction or endodontic retreatment. As the first choice would be to avoid surgery, if possible, it was necessary to find out if the distal root required retreatment, as the image supplied by the referring dentist was inconclusive, and if so, the post would have to be removed, preferably with the crown intact. (See Figure 1.)

The scan revealed an area around the distal root (see Figure 2) and indicated that the mesiolingual and distolingual canals were initially never treated (see Figure 3). The asymmetric position of a root filling indicates the presence of another canal. After the post was removed and the tooth was retreated (see Figure 4), the patient returned to his general dentist for the restoration of the access opening.

Figure 4. Radiograph shows the completed retreatment.

In the second case, a 55-year-old male was having percussion sensitivity associated with tooth #12. (See Figure 5.) After the buccal canal was located, the palatal canal could not be found. A scan was taken with a gutta-percha marker in place so that it could be determined if the pathway to the palatal canal was accurate. (See Figure 6). Scrolling down the scan showed that the canal was located 3 mm apical to the current

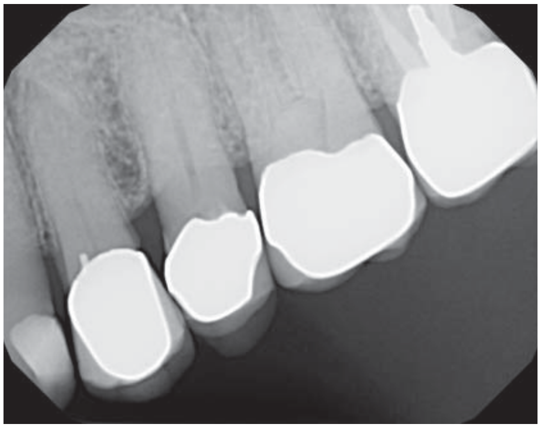

Figure 5. Pretreatment radiograph of tooth #12.

position. After going down 2 mm more, another scan (see Figure 7) was taken to recheck the orientation, as there were no indicators of the canal, such as dentinal color changes, that could be seen through the microscope. Maxillary bicuspids are usually thin proximally and drilling blindly opens one up to the possibility of a perforation. The canal could be seen 1 mm in an apical and slight mesial direction. (See Figure 8.) The canal was located, the procedure was completed (see Figure 9), and the patient was referred to his dentist for the restoration of the access opening.

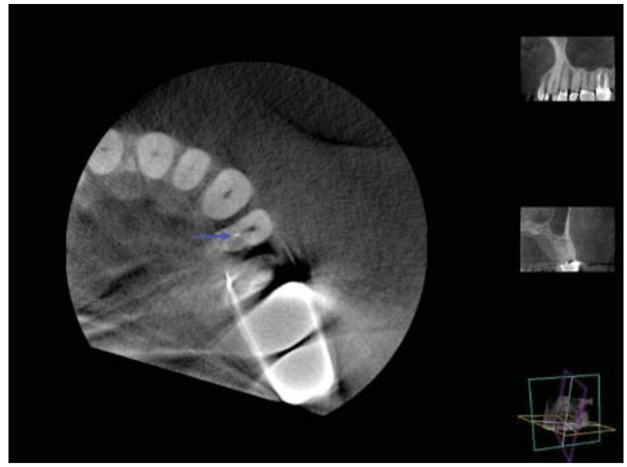

Figure 6. The CBCT scan shows the buccal canal enlarged and a marker of gutta-percha placed (see arrow) to determine the accuracy of the pathway to the palatal canal.

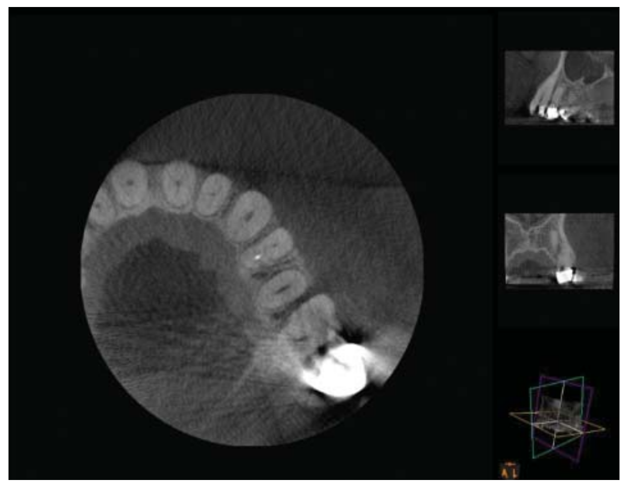

Figure 7. The CBCT scan indicates the location of the marker 2 mm apical to its previous location.

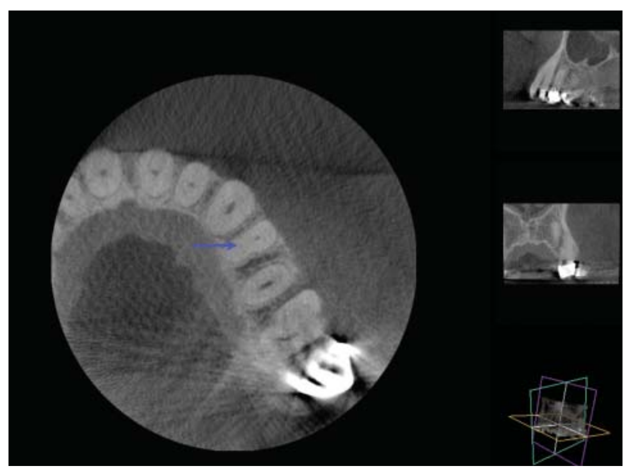

Figure 8. The CBCT shows that the palatal canal (see arrow) is located 1 mm apical (and slightly mesial) to the last marker.

Conclusion

These are only a couple of examples of how high-resolution limited FOV CBCT enhances treatment strategy and the quality of endodontic therapy. The information obtained by this technology cannot be gathered in certain cases using conventional 2-D radiography. Proper decision making is in the best interest of the patient. While many treatment choices may be available, the best ones will always involve proper informed consent and the availability of the best technology for the operator. ■

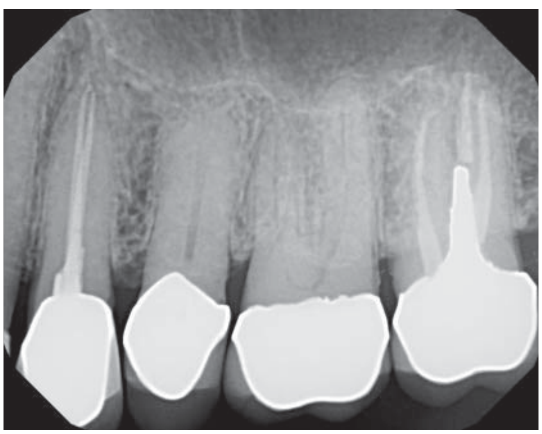

Figure 9. Radiograph of the completed procedure.

References

1. Estrela C, Bueno MR, Azevedo BC, et al. A new periapical index based on cone beam computed tomography. J Endod. 2008;34(11):1325-1331.
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