How Cone Beam Computed Tomography Increases Endodontic Success

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Endodontic treatment has benefited by the increased use of cone beam computed tomography (CBCT). CBCT machines vary in their field of view (FOV) and image resolution capacity. The type of machine required in endodontics should have the highest resolution to visualize small objects, such as constricted canals or fractures. Resolution is determined by the size of the volumetric pixel, which is referred to as a voxel. According to the Nyqvist-Shannon Sampling Theorem, accurate representation of an analog signal (anatomy) needs to be sampled at a rate greater than twice the highest frequency (size) of the signal. Anatomical structures can be visualized and represented accurately when they are at least twice the voxel size.[1] Practically speaking, the Carestream 9000 machine used to create the images for the cases in these case presentations can accurately detect anatomy that is the size of a #15 endodontic file (76 micron voxel = .076 millimeters × 2 = .15 millimeters). Since increasing the resolution is associated with more radiation, only machines capable of limited FOV should be used in endodontic treatment.[2] Limited FOV machines visualize only one quadrant and may be as small as 37 mm × 50 mm.

Limited FOV CBCT scans can be used to facilitate endodontic treatment in a variety of situations:[3]

- 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

Successful endodontic treatment relies on the location, disinfection, and obturation of the root canal system. The following cases present situations where the scanning procedure enabled finding calcified canals. These are just a few examples of how this technology helped to facilitate success over failure.

CASE 1: RETREATMENT OF TOOTH #15—UNTREATED MB2 CANAL

A 41-year-old female with a limited vertical opening came in with symptoms involving previous pain accompanied by percussion sensitivity from tooth #15. Radiographic evaluation revealed that there was an additional root that had not been previously treated. After gaining access to the obturated canals and not locating the additional canal, it was decided to take a limited FOV CBCT. The patient was informed that the radiation exposure in the scanned area would be equal to the equivalent dose of 1.4 days of

Figure 1. Case 1: Preoperative radiograph

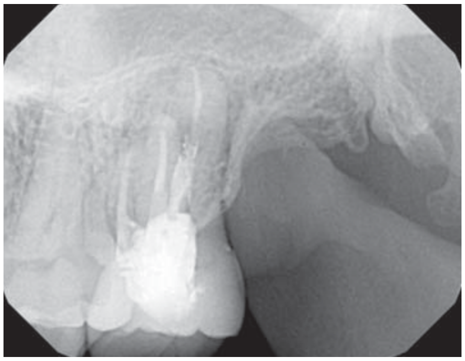


Figure 2. CBCT axial slice; the white arrow is at the canal while the green line shows the depth.

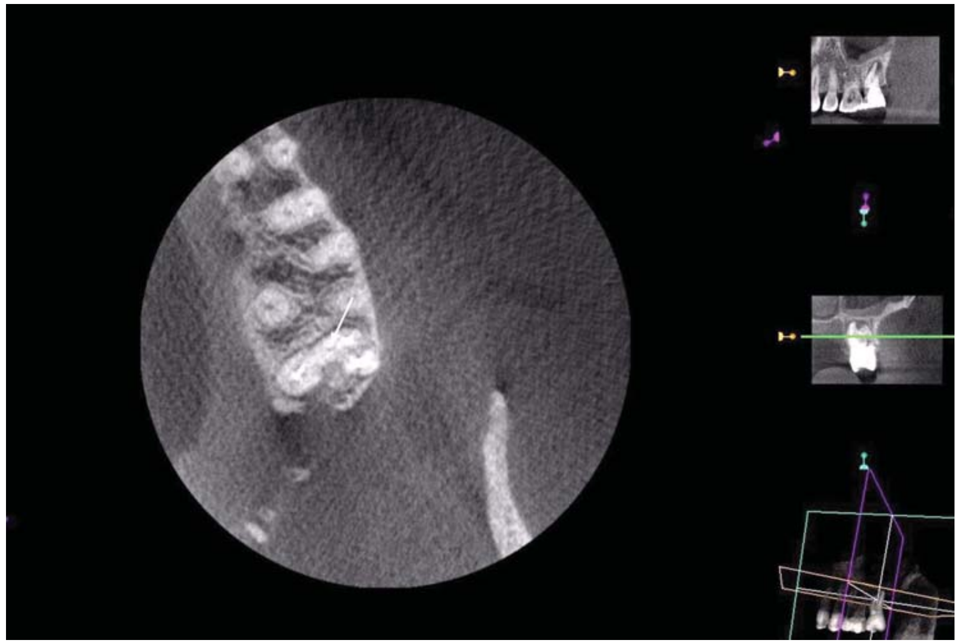
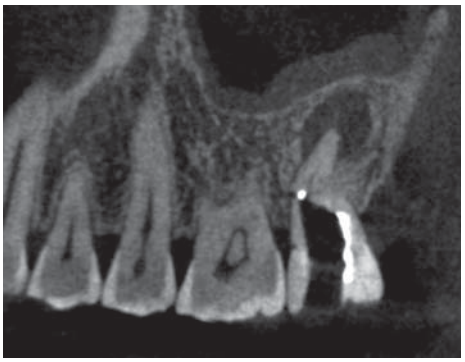
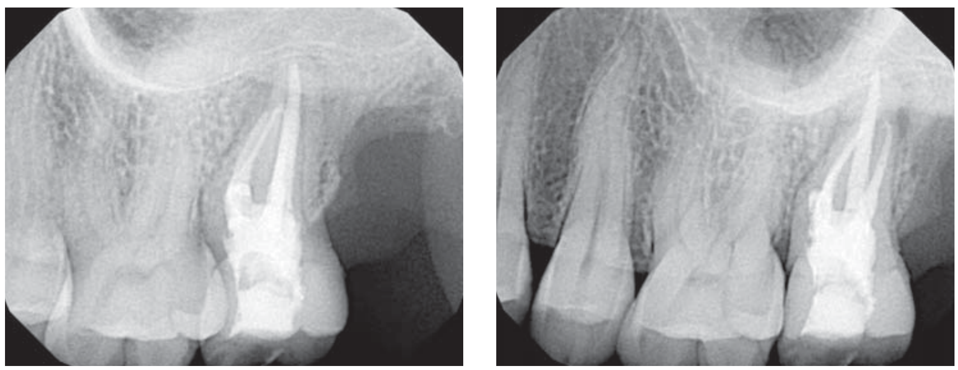


Figure 3. CBCT saggital slice



Figures 4a–4b. Completed case



background radiation. (A digital periapical radiograph is equal to slightly less than 1 day of background radiation at sea level.[4]) Figure 1 shows a radiograph of the failing root canal procedure on tooth #15. I told the patient that although the filled canals needed to be retreated, I would only attempt to locate the MB2 initially, as failure to find it would necessitate extraction. The scan revealed that the MB2 was seen at the level of the post, quite a distance apically into the root. (See Figure 2.)

In Figure 2, the white arrow is pointing to the MB2 canal, located apically at the depth of the green line, on the smaller coronal section to the right, which is at the level of the post. The canal was found just next to the gutta-percha marker in the saggital view (see Figure 3), while Figures 4a–4b show the completed retreatment.

CASE 2: LOCATING A CALCIFIED CANAL—TOOTH #19

A 51-year-old female presented with chronic apical periodontitis involving tooth #19. (See Figure 5.) I was unable to locate the MB canal due to calcification and took a scan for orientation purposes. Microscopic evaluation revealed no dentinal lines or color changes that would indicate the proper direction to proceed apically. While it is very tempting to just keep drilling more, a perforation could have been likely. A marker was placed where I stopped drilling and a scan was taken. The scan showed that I was 1 mm away from the canal (see Figure 6), which was located shortly thereafter. The tooth was completed (see Figure 7), and a one-year recall shows healing in progress. (See Figure 8.) The limited FOV CBCT was invaluable in saving this tooth in a timely manner with conservation of anatomical structure.

CASE 3: RETREATMENT OF A TOOTH WITH A POST—TOOTH #5

A 72-year-old female presented with a sinus tract tracing to the lateral surface of tooth #5. (See Figure 9.) Periapical surgery was automatically ruled out because of the short root length that would remain. A scan was ordered to evaluate the feasibility for retreatment or extraction. The scan revealed that the buccal canal was never treated but present. (See Figure 10.) The decision was made to perform a nonsurgical retreatment and drill alongside the post to locate the buccal canal. A conservative access was made (see Figure 11) and a marker was placed for orientation purposes (see Figure 12, coronal view), and the canal was located. There was no reason to remove the incompletely treated canal under the palatal post because it was not involved in the pathology. The case was completed and the sinus tract resolved. (See Figure 13.) A one-year recall showed bone regeneration and the absence of clinical pathology. (See Figure 14.) Proper decision making and conservative treatment would have been extremely difficult without the use of a limited FOV CBCT for this patient.

CONCLUSION

These are just a few of many cases demonstrating that the judicious use of limited FOV

Figure 5. Case 2: Starting radiograph

Figure 6. Marker is 1 mm away from canal

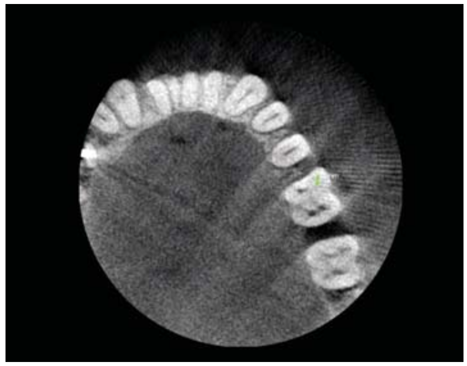


Figure 7. Completed case

Figure 8. One-year recall

Figure 9. Case 3: Sinus tract traced

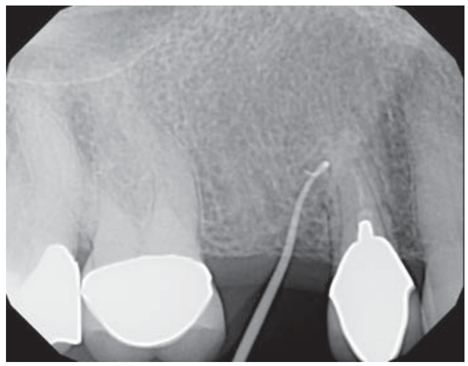
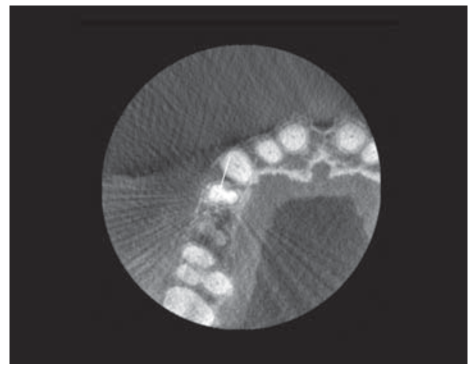


Figure 10. Arrow at buccal canal



CBCT can enhance the success of endodontic treatment by being able to locate calcified canals with minimal tooth structure removal. Fracture resistance of endodontically treated teeth decreases when excessive tooth structure has been removed,[5] and the risk of perforation increases when 3D orientation is unavailable. Patients should be informed prior to treatment that a scan may be necessary during the procedure and told of the level of exposure. The value of limited FOV CBCT cannot be overlooked for the diagnostic and intraoperative advantages given to the operator in the practice of current best endodontic therapy. JMDS

Figure 11. Conservative access opening

Figure 12. Arrow at the marker

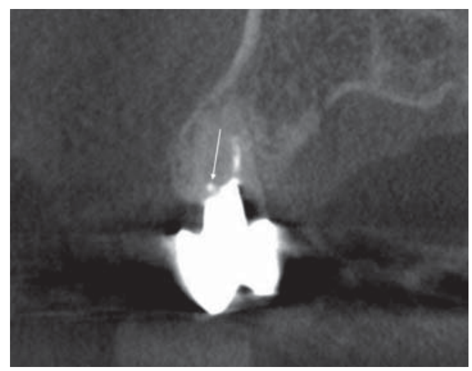


Figure 13. Case completed

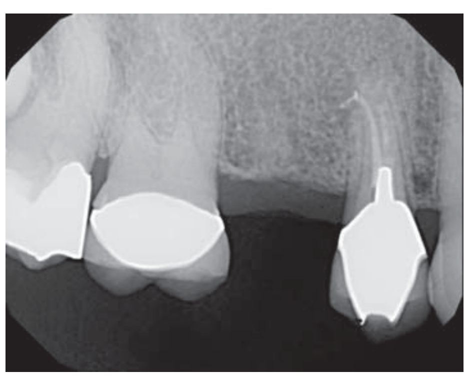
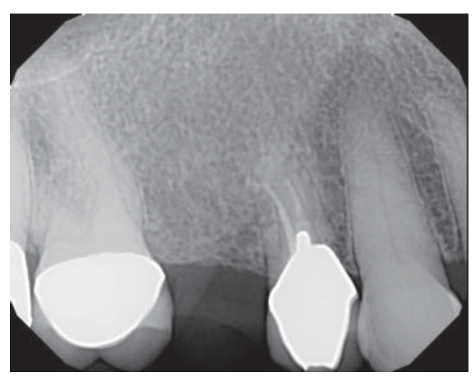


Figure 14. One-year recall



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