CBCT Use in Endodontic Diagnosis

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The first step in endodontics is reaching the correct diagnosis. While duplicating the patient’s chief complaint is paramount in the treatment planning process, radiographic images are necessary to confirm clinical findings. Periapical (PA) radiographs are useful aids to help clinicians examine teeth and their supporting structures. Unfortunately, current technology only allows intraoral radiographs to expose 2-D images of 3-D anatomical structures.

CBCT imaging overcomes some of the limitations of conventional dental radiography. CBCT scans provide clinicians with 3-D images of the anatomic structures in the selected field of view. The software programs associated with CBCT machines allow 3-D manipulation of obtained images. Teeth can be examined in axial, coronal, and sagittal planes. Surrounding alveolar bone and anatomic structures such as the sinus can be evaluated. CBCT takes some of the guessing and postulating out of the diagnostic process.

CBCT imaging is now an essential tool in endodontics. It has been demonstrated in studies that CBCT is superior to detecting PA lesions rather than conventional PA radiographs alone. CBCT is also better able to detect lesions than the use of PA radiographs in combination with panoramic images. Using cadavers, it was shown that even the exposure of multiple-angled PA radiographs was inferior to the diagnostic capabilities of CBCT.

The following case presents a situation in which CBCT imaging led to an accurate diagnosis and treatment plan involving a difficult to observe lesion.

A 68-year-old female patient presented with buccal swelling of the marginal gingiva between teeth Nos. 18 and 19. The patient reported no other symptoms. A PA radiograph revealed previous endodontic therapy on tooth No. 19 and the presence of coronal restorations on teeth Nos. 18 to 20 (Figure 1a). Clinical examination was inconclusive. None of the teeth in the lower left quadrant were symptomatic to percussion or a bite stick. Teeth Nos. 18 and 20 tested vital and thus could not be the source of infection. A sinus tract was not present, and the swelling was confined to the coronal third of the gingival. The decision had to be made as to...

![Figure 1. (a) Periapical (PA) radiograph of the lower left quadrant showing previous endodontic therapy on tooth No. 19, and (b) CBCT scan of the same area revealing a PA lesion on the distal root of tooth No. 19.](image)
whether the swelling was originating from a re-infection of tooth No. 19, or a periodontal abscess in a pocket between Nos. 18 and 19. Radiographic examination of the PA region of tooth No. 19 was inconclusive. A CBCT image was taken (Figure 1b). The various 3-D slices clearly showed a PA lesion on the distal root of tooth No. 19. Nonsurgical endodontic retreatment was discussed with the patient and then performed.

PRESURGICAL ASSESSMENTS
Periradicular microsurgery is sometimes necessary to address teeth that were previously treated endodontically and display re-infections that could not be addressed with nonsurgical retreatment. Determining the proximity of infected teeth to anatomical structures is important in any presurgical treatment plan. Maxillary teeth need to be evaluated with respect to their location near the sinus or incisive nerve. An awareness of the relationship of mandibular teeth to the inferior alveolar nerve or the mental nerve is critical to avoid accidental damage during surgery. CBCT allows a clinician to not only view the tooth in question in 3-D, but also the surrounding anatomical structures as well. Accurate measurements can be made with CBCT software programs to map out the distances between a root apex and any adjacent structures.

ENDODONTIC RETREATMENT
CBCT can be a valuable tool in the diagnostic workup of teeth requiring nonsurgical endodontic retreatment. Unlike 2-D PA radiographs, the 3-D imaging that CBCT provides allows a clinician to view a tooth in several different planes of view. The CBCT images of a tooth requiring retreatment can be manipulated on-screen to look for the presence of missed canals, root fractures, perforations, and other conditions that may be the etiology of the problem. With the current emphasis on minimally invasive endodontics (MIE), the use of CBCT can help avoid the unnecessary removal of tooth structure while searching for a missed canal in retreatment. Access preparations need to be cut large enough to allow for the location of all canals, but a balance must be achieved to maintain sound tooth structure. The following case presents a situation in which CBCT was used to accurately determine the location of a missed canal and thus allow conservation of the coronal dentin.

A 51-year-old female patient presented with spontaneous pain and tenderness to chewing in the lower right quadrant. A PA radiograph revealed previous endodontic therapy on tooth No. 30, and clinical examination led to the identification of this tooth as the source of pain. Tooth No. 30 displayed a PA radiolucency on the mesial root, with only one canal appearing to have been treated endodontically (Figure 2a). CBCT was used to identify the location of the missed canal in the mesial root prior to beginning retreatment (Figure 2b). By viewing 3-D images of tooth No. 30, it was evident that the mesiolingual canal had been left untreated. With this knowledge, the principle of MIE could be followed. Instead of accessing the tooth, and guessing in which direction to start removing tooth structure to find the missed canal, it was...
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known where to cautiously and conservatively begin exploring. An access preparation that is cut too large to help a clinician locate a canal will leave a tooth structurally compromised. In this case, the mesiolingual canal was found and treated, along with retreatment of the remaining canals. An MIE access preparation prevented the pulp chamber space from being over-enlarged, yet allowed all the canals to be treated (Figure 2c).

TRAUMA CASES
Diagnosing injuries resulting from certain types of dental trauma can often be difficult using conventional PA radiographs. Alveolar fractures and horizontal root fractures are sometimes not visible and require multiple-angled radiographs to identify. Traumatic injuries to the dentition and the resulting sequelae can be viewed with CBCT in 3-D, thus gaining valuable information on their extent and severity. CBCT is especially helpful in diagnosing the presence and extent of internal and external resorptive defects. With 2-D PA radiographs, it is often difficult to determine if a resorptive defect is either internal or external, and whether it is on the facial/buccal side of a tooth or the lingual/palatal. With CBCT, guessing is eliminated and resorptive defects can be accurately diagnosed. The following case presents an example of the use of CBCT in diagnosing a resorptive defect.

A 38-year-old female patient presented for evaluation of a maxillary incisor tooth on which her referring dentist noted a suspicious area from the radiograph. The patient was asymptomatic, and her maxillary anterior teeth appeared normal in color. A PA radiograph revealed a resorptive defect on tooth No. 9 in the cervical area (Figure 3a). CBCT imaging was obtained to determine the characteristics of the resorption. While the 2-D image was helpful in identifying the existence of a problem with tooth No. 9, the 3-D image provided all the diagnostic information. The defect was clearly located on the facial of No. 9, and was definitely external, not internal, resorption (Figure 3b). The appropriate treatment plan was then formulated due to the valuable information gathered from the CBCT images.

VERTICAL ROOT FRACTURES
One of the biggest misconceptions among clinicians not familiar with CBCT technology is its ability to detect vertical root fractures (VRFs) in endodontically treated teeth. The sensitivity and specificity of CBCT to detect VRFs is around 79.4% and 92.5%, respectively. It is not 100%. A fracture line must be within the resolution of the CBCT machine to be directly visualized (Figure 4a). To complicate matters, artifacts can be present that can be mistaken for VRFs. Scatter and beam hardening artifacts can be produced by structures with high radiographic density, such as metal posts and gutta-percha. These appear as dark bands in roots but are not fracture lines (Figure 4b).

Despite this, CBCT can be advantageous in detecting VRFs indirectly through changes in the surrounding structures. It has been shown that even if a VRF cannot be directly seen, it is present if a CBCT scan shows a loss of bone in the mid-root area with intact bone apical and coronal to the defect, an absence of the entire buccal plate of bone in 3-D views, a radiolucency around the termination point of a post in a root, or if a space between the buccal and/or lingual plate of bone and root surface exists that is wider than normal and corresponds with a deep isolated periodontal probing measurement. Experience and training in reading CBCT scans are necessary to correctly identify the indirect signs of a VRF.

IN SUMMARY
Endodontic diagnosis and treatment planning has taken a giant leap forward due to the introduction of CBCT in dentistry. While conventional 2-D radiographs remain the most cost-effective and routine method to evaluate a patient’s dentition, their diagnostic potential is limited. The 3-D manipulation of images that CBCT offers provides better insight into diagnostic dilemmas and complicated treatment decisions. Despite the advantages of CBCT imaging, it should be used complementary to 2-D radiography, not as a replacement. The principle of ALARA (in which patients should be exposed to radiation “as low as reasonably achievable”) still applies to this technology. CBCT should not be used routinely in the absence of clinical signs or symptoms that necessitate a more in depth view of a tooth and surrounding structures. In other words, if a conventional 2-D radiograph will suffice, then a CBCT pretreatment scan is not
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necessary. However, if more information is needed to make an accurate diagnosis, a 3-D CBCT image is justified and highly beneficial as shown through several case examples shared in this article.♣

References


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1. The software programs associated with CBCT machines allow 3-D manipulation of obtained images; however, teeth cannot be examined in the coronal plane with this technology.
   a. True  b. False

2. CBCT has been demonstrated to be useful in the detection of peripapical (PA) lesions that otherwise would go undetected, and in the detection of vertical root fractures.
   a. True  b. False

3. CBCT is also better able to detect lesions than the use of PA radiographs in combination with panoramic images.
   a. True  b. False

4. Periradicular microsurgery is never needed to address teeth that were previously treated endodontically and display re-infections that cannot be addressed with nonsurgical retreatment.
   a. True  b. False

5. With the current emphasis on minimally invasive endodontics, the use of CBCT can help avoid the unnecessary removal of tooth structure while searching for a missed canal in retreatment.
   a. True  b. False

6. CBCT is not very helpful in diagnosing the presence and extent of internal and external resorptive defects.
   a. True  b. False

7. The sensitivity and specificity of CBCT to detect vertical root fractures (VRFs) is 100%, respectively.
   a. True  b. False

8. Experience and training in reading CBCT scans is necessary to correctly identify the indirect signs of a VRF.
   a. True  b. False
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