Incidental Findings in Small Field of View Cone-beam Computed Tomography Scans

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Abstract

Introduction: The use of cone-beam computed tomography (CBCT) in endodontics has increased in recent years. In clinical application of small field of view (FOV) CBCTs, these scans are not reviewed routinely by a radiologist. Studies of large FOV CBCT scans show the prevalence of incidental findings to be greater than 90%. The purpose of this study was to evaluate the prevalence of missed findings by endodontic residents as compared with a radiologist on small FOV CBCT scans. **Methods:** Two hundred three small FOV CBCTs obtained for endodontic purposes were analyzed by an endodontic resident and a medical radiologist. The reported findings of each practitioner were compared to evaluate for missed incidental findings by the endodontic resident. **Results:** The radiologist reported abnormalities in 176 of the 203 subjects (87%), with a total of 310 abnormalities reported. The endodontic resident reported abnormalities in 102 of the 203 subjects (50%), with a total of 126 abnormalities reported. The percentage of scans with any abnormality reported by the radiologist was significantly greater than the endodontic resident ($P < .001$). There was no significant difference between jaw locations in percentage of missed findings for the 3 most common types of finding—rarefying osteitis, sinusitis/mucosal lining thickening, and excess restorative material in the periapical area. Rarefying osteitis was missed significantly less than the other 2 types of findings ($P < .001$). **Conclusions:** A radiologist is significantly more likely to identify incidental findings in small FOV CBCT scans than an endodontic resident. Scan location had no significant association with the rate of missed findings. *(J Endod 2017;■:1–4)*

Key Words

CBCT, cone-beam computed tomography, CS 9000, dental radiography, endodontics, imaging, incidental findings, limited field of view, radiology, small field of view

Significance

Small field of view cone-beam computed tomography scans are not routinely reviewed by a radiologist. Our study demonstrates that a radiologist is significantly more likely to report incidental findings in a small field of view cone-beam computed tomography scan than an endodontic resident.

Cone-beam computed tomography (CBCT) technology has existed since the 1980s (1). Cone-beam technology uses a cone-shaped beam of radiation to acquire a volume in a single 360-degree rotation (2). CBCT reduces scan time, radiation dose, and cost for patients compared with conventional computed tomography (3). In 2000, the Food and Drug Administration approved the first CBCT unit for dental use in the United States (4). As technology has improved, limited or small field-of-view (FOV) CBCT machines have become available and popular in endodontics. CBCT FOVs range from less than 100 mm in height for small FOV, 100-150 mm in height for medium FOV, and 150-200 mm in height for large FOV (5). Voxel sizes of CBCT units can range from as low as 76 microns to as high as 400 microns (6). The voxel size of the small FOV generally is smaller and therefore provides a greater resolution, which is more useful for endodontics (7).

Effective radiation dosage can vary based on the location of a small FOV CBCT scan. It has been demonstrated that maxillary posterior small FOV scans create 9.8 μSv in effective dosage, whereas mandibular posterior scans create 38.3 μSv. Anterior small FOV scans create 4.7 μSv in effective dose (8).

Cone-beam use in endodontics has increased significantly in recent years and is now advised jointly by the American Association of Endodontists and the American Academy of Oral and Maxillofacial Radiology as the imaging modality of choice for treatment of complex canal morphology, calcified canals, apicoectomy, resorption, trauma, and nonsurgical retreatment (9). In clinical application of small FOV CBCTs, these scans are not read routinely by a radiologist. The primary clinician is responsible for interpretation of the full content of a CBCT volume, not just limited to the specific area of interest (9). It should be expected that incidental findings may appear within a scanned volume but outside the primary clinician's area of interest, requiring additional investigation. Studies of large FOV CBCT scans show the prevalence of incidental findings to be greater than 90% (10–13). No known studies have examined incidental findings in small FOV CBCT.

The primary objective of this study was to evaluate prevalence of missed findings by endodontic residents compared with a radiologist on small FOV CBCT scans and to make a recommendation on when these scans should be read by a radiologist. Other objectives were to determine whether type of finding and location of scan are associated with the prevalence of missed findings.

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0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2017.01.033

Materials and Methods

Two hundred three ($n = 203$) small FOV CBCT scans obtained for endodontic purposes on 203 different subjects between December 1, 2013, and December 1, 2015, at Tufts University School of Dental Medicine Post Graduate Endodontics Program were reviewed for this study. These scans were located by the use of a search for American Dental Association code D0364 CBCT limited less than one jaw. All codes had associated chart notes. The scans were analyzed by both an endodontic resident and by a medical radiologist. The cone-beam volumes were acquired with a CS 9000 3D CBCT system (Carestream Dental LLC, Atlanta, GA). A single volume is 50 mm diameter × 37 mm height, acquiring scans at 0.076 mm (76 microns) voxel size. The scans were viewed for interpretation by use of the CS 3D Imaging Software (version 3.3.9; Carestream Dental). The Tufts Health Sciences Institutional Review Board approved the protocol for this study.

All endodontic residents received the same postgraduate training on radiographic interpretation and analysis of CBCT. This training is completed with a postgraduate level course on oral and maxillofacial radiology, which includes training on reading and interpretation of CBCT scans. The residents are instructed to view each set of slices of the CBCT (axial, coronal, and sagittal) in a systematic fashion and report on all abnormal findings as part of their routine clinical practice when ordering CBCT scans. The radiologist was employed as part of the study. The radiologist was only given access to the CBCT scan. No access to the patient's record or any previously reported findings was given to the radiologist. The radiologist was instructed to report on all abnormal findings. For each scan interpretation, the radiologist formulated the report by using a blank checklist of common dental radiographic findings (sinusitis/mucosal lining thickening, mucous retention pseudocyst, rarefying osteitis, sclerosing osteitis, idiopathic osteosclerosis/enostosis, impactions, retained root tips, root resorption, excess restorative material in periapical area, cemento-osseous dysplasia, fibrous dysplasia, nasopalatine duct cyst). The radiologist was instructed to write-in any additional findings for each scan.

The radiologist's reported findings were compared with findings reported by the endodontic resident at the time the scan was acquired. Concordant findings as well as missed findings were noted. Location of the scan also was noted and divided into 4 areas: posterior maxilla, posterior mandible, anterior maxilla, and anterior mandible.

Statistical analysis primarily involved comparing the findings of the endodontic resident with the findings of the radiologist. These findings were enumerated into common types of findings for small FOV CBCT scans. For each type of finding, the percentage of the radiologist's findings that were missed by the endodontic resident was calculated. The percentage of scans with any abnormality reported was compared between the radiologist and the endodontic resident via the McNemar test. The percentage of missed findings by the endodontic resident was compared between the different types of findings, among those that were reported at least 10 times by the radiologist, with the χ^2 test; post-hoc comparisons were conducted via the χ^2 test with Bonferroni correction. In addition, for each type of finding reported at least 10 times by the radiologist, the Fisher exact test was used to compare the different locations of scan (maxillary anterior, maxillary posterior, mandibular anterior, and mandibular posterior) in terms of the percentage of missed findings by the endodontic resident. Statistical significance was set at $P < .05$, with the exception of tests using the Bonferroni correction, for which significance was set at $0.05/3 \approx 0.0167$.

Results

The radiologist reported abnormalities in 176 of the 203 subjects (87%), with a total of 310 abnormalities reported. The endodontic resident reported abnormalities in 102 of the 203 subjects (50%), with a total of 126 abnormalities. The percentage of scans with any abnormality reported was significantly different between the radiologist and the endodontic resident ($P < .001$). The mean (standard deviation) number of abnormalities reported by the radiologist was 1.53 (0.92); the median (interquartile range) was 2 (1). The mean (standard deviation) number of abnormalities reported by the endodontic resident was 0.62 (0.70); the median (interquartile range) was 1 (1).

For each type of finding, Table 1 shows the total number of findings by the radiologist and the number and percentage of missed findings by the endodontic resident. In no case was there a finding reported by the endodontic resident that was not reported by the radiologist. The 4 findings in the "other" category (Table 1) reported by the radiologist were fungal sinusitis, dental caries, retention of primary teeth, and root fracture. Fungal sinusitis was the only finding missed by the endodontic resident among those four "other" findings.

The most common findings reported by the radiologist were rarefying osteitis, sinusitis/mucosal lining thickening, and excess restorative material in the periapical area. These were the only 3 categories of findings that were reported at least 10 times. The χ^2 test comparing these categories in terms of the percentage of missed findings by the endodontic resident was statistically significant ($P < .001$). In post-hoc comparisons, the percentage of missed findings was significantly different between rarefying osteitis and sinusitis/mucosal lining thickening ($P < .001$) and between rarefying osteitis and excess restorative material in the periapical area ($P < .001$), with rarefying osteitis having a lower percentage of missed findings than the other categories

TABLE 1. Number and Percentage of Missed Findings by Type of Finding ($n = 203$ Total Scans)

Type of finding	Number of findings by radiologist	Number (%) missed findings by endodontic resident
Rarefying osteitis	133	39 (29)
Sinusitis/mucosal lining thickening	78	70 (90)
Excess restorative material in periapical area	64	48 (75)
Mucous retention pseudocysts	9	9 (100)
Impactions	7	5 (71)
Root resorption—external or internal	7	4 (57)
Sclerosing osteitis	4	4 (100)
Nasopalatine duct cyst	2	2 (100)
Retained root tips	1	1 (100)
Idiopathic osteosclerosis/enostosis	1	1 (100)
Cemento-osseous dysplasia	0	0 (N/A)
Fibrous dysplasia	0	0 (N/A)
Other	4	1 (25)

N/A, not applicable.