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Improved Detection and Localization of Apical Lytic Lesions in Previously Obturated Teeth Using Cone Beam Computed Tomography as Compared to Conventional Radiography

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Abstract:
Purpose: *To determine the diagnostic ability of Cone Beam Computed Tomography (CBCT) to detect and localize apical pathoses as compared to two-dimensional conventional direct digital intraoral radiographs (DDR), in order to accurately determine the location and extent of these lesionsto improve treatment outcomes.*
Methods: *Previously obtained CBCT and DDR data from 45 patients with a diagnosis of failed endodontic therapy were included. Images were analyzed by three calibrated observers for the presence of periapical radiolucencies, number and location of roots involved, and any cortical erosion/perforation resulting from the lytic lesion. The readings were repeated after an interval of two weeks.*
Results: *Significantly more number of roots (25%) involved with periapical pathoses were detected using CBCT. Localization of cortical erosions/perforations was possible only with CBCT. Validation of imaging findings was effected using direct visualization of the regions of interest at the time of surgery.*
Conclusions: *CBCT images were significantly superior to DDR for detection of apical pathoses and localization of erosion/perforation of cortices with respect to roots of teeth.Results illustrate the advantages of three-dimensional imaging for localization of pathoses in diagnostically challenging cases with possible implications on treatment planning.Accurate localization of these lesions and a higher and accurate detection rate may result in better outcomes in re-treatment cases. More studies are needed to assess the time required for full healing post endodontic treatment using the additional information gleaned from CBCT data.*
Keywords: *computed tomography, endodontic, digital, radiography, periapical, dental.*

I. Introduction

There are many predictive indicators to determine outcomes of root canal treatment. A major indicator of success following endodontic procedures is healing of apical periodontitis that appears as widening of the apical periodontal ligament space or apical lytic lesions in the form of well-defined radiolucencies with or without a corticated margin [1]. Not only is the presence of lesions important for the clinician to recognize, but the size of pre-operative lesions can indicate the prognosis of timely endodontic intervention [2]. The ability to accurately judge the extent and position of such lesions can aid in better treatment outcomes, and consequently increase chances of success.

Medical and dental history, a thorough clinical evaluation, the patient's chief complaint and description of the clinical problem, as well as the type and quality of imaging examinationscontribute to a meaningful diagnosis and treatment outcome, especially in previously root canal treated teeth. It is common place to have diagnostic intraoral studies such as bitewing and periapical radiographs to help determine the optimal type of endodontic intervention applicable to the case of interest, restorability of the tooth, the overall prognosis and pre-operative state of the teeth and surrounding tissues in question. Maxillary teeth produce even more difficulty as roots often overlap maxillary sinus and zygomatic arches causing blurredimages [3].

In recent years the inclusion of Cone Beam Computed Tomography (CBCT) in maxillofacial imaging, has added yet another valuable tool to the arsenal of the endodontist in order to further aid in the evaluation of tooth and complex root canal anatomy, presence of discrete vertical root fractures, associated bone defects and pathoses such as apical periodontitis, andother apical lesions such as rarefying osteitis, in addition to providing valuable information about the surrounding structures, including critical anatomic entities such as the maxillary sinuses and regional neurovascular bundles [5, 14].CBCTgenerates three-dimensional (3D) images of the tooth of interest at significantly less radiation doses for the patient thanmulti-detector computed tomography (MDCT) with significant limitations on spatial resolution[10].The use of computed tomography (CT) has enabled evaluation of the true extent of lesions and their spatial relationship to important anatomic landmarks [3]. The improved detection rate of periapicalpathoses using CBCT as compared to conventional intraoral radiography as shown in prior studies[6], indicated that 62.5% of bone defects that intraoral radiographs could not accurately diagnose were detected. Comparison of intraoral direct exposureradiography and CBCT for detection of such lesions associated with posterior maxillary teeth further showed that 34% of lesions missed by two-dimensional radiographywere,in fact, detectedby CBCT.

In this study, Cone Beam Volumetric Computed Tomography (CBCT) was used in detecting apical lytic lesions as compared to direct digital intraoral radiographs (DDR) in previously treated teeth. Presence of a pre-existing restoration further complicated the diagnostic task owing to the generation of beam hardening artifacts with advanced imaging modalities. However, in order to prevent unnecessary extraction of teeth following perceived failure of endodontic therapy as determined using intraoral periapical radiographs, it was decided to evaluate CBCT for this purpose.Furthermore, if the utility of CBCT for this task is established, it would aid the clinician for surgical planning that could include various procedures such as hemisection, radisection, apicoectomy, re-treatment in cases with complex and unusual root canal morphology, and extraction, in addition to providing valuable information on the proximity of critical structures in or near the field of surgery [11].

II. Material And Methods

Previously acquired CBCT data from 45 patients with at least one endodontically treated tooth were included in this study, after obtaining Institutional Review Board (IRB) approval. Patients were referred for persistent pain or periapicalpathoses diagnosed using conventional radiographs following an initial root canal treatment. Theinclusion criteria were: (1) presence of clinical signs and/or symptoms, and/or radiographic findings associated with apical periodontitis such as abnormal widening of the periodontal ligament space, severe localized bone loss, apical osteolysis, reactive sclerosis noted alongside rarefying osteitis, suspected osteomyelitis, or unresolved apical lucencies, (2) teeth that had been previously Endodontically obturated and restored, and (3) cases where DDR and CBCT were available to aid in diagnosis and treatment planning. 45 teeth, yielding a total of 80 roots, were thus included in the study.

All patients had at least two periapical radiographs (DDR) of the tooth of interest, obtained using paralleling technique using a sensor holder (Rinn XCP; Dentsply, Elgin, IL, USA), exposed with a CS 6100 sensor size #1 (Carestream Dental, Atlanta, GA, USA). All images were acquired at 12 bit depth and stored as DICOM for viewing in InVivo (Anatomage, San Jose, CA, USA). All images were histogram equalized by a trained radiologist for viewing.

The CBCT images were obtained using a CS 9000 unit (Carestream Dental, Atlanta, GA) with a limited field-of-view (FoV) and isotropic voxel size of 76 microns. All studies were protocoled by board-certified radiologists and acquired by a single trained operator in the Oral and Maxillofacial Radiology Clinic. All images were saved as DICOM as well, to be viewed in InVivo.

All images were assigned unique, random alphanumeric identifiers. The images were analyzed by a calibratedboard-certified endodontist, a senior endodontic resident in the final year of the training program, and an endodontic intern (a general dentist, in training for entry into a formal residency program). A calibration session was held using ten sets of images in order to ensure consistency in recording information. Following training, all images were presented in no particular sequence to each observer. The observers were allowed to page through the stack of slices for the CBCT data, and manipulate images interactively as is done in a clinical setting. Each CBCT study included image data sets in multiplanar mode – coronal, axial, sagittal, and 3D volume rendered. Results were entered into an online database for each case.

A periapical lytic lesion was defined as a distinct lucency in direct association with at least the apical third of the root, ora radiolucency that exceededat least twice the width of the periodontal ligament space. For CBCTimages, the same criteria were applied. Presence or absence of periapical pathoses in each of the roots of the tooth being evaluated received a score of 1 or 0 for the presence or absence of pathoses respectively.

Other recorded parameters included evidence of cortical plate erosion/perforation. Cortical plate erosion was recorded by evaluating thinning of cortical plates in thearea and perforation was recorded when there was complete loss of cortical plate in relation to the periapical pathology. Any disagreement in interpretation was resolved by taking the mode of the three assigned scores by the three observers.

The percentage of number of roots involved with the periapical pathoses with respect to the total number of roots on the teeth was calculated and the significance was evaluated using Mann Whitney U test to enable meaningful comparison of the outcomes using the two imaging modalities.

III. Results

A total of 80 roots on 45 teeth were examined using DDR and limited FoV CBCT. A total of 56 roots showed apical lesions on CBCT (70%) while only 36 apical lesions were detected using DDR (45%) (p=0.004)(Fig 1). CBCT also revealed erosion/perforation of the cortices in association with16 of the roots evaluated, while only 13 of the lesions with erosion/perforation were detected via DDR. Validation was achieved at the time of surgery in all patients in order to assess the accuracy of detection.

IV. Discussion

The present study compared the efficacy of DDRandCBCT in detecting periapical lytic lesions in teeth referred for re-treatment or apical surgery due to persistent symptoms or radiographic signs of apical pathoses as detected on intraoral radiographs. The study showed that of the total of 56root apices with lesions that were detectedusing CBCT, 33%were not even detected using DDR. This difference was statistically highly significant (p = 0.004). In a prior study, Lofthag-Hansen et al [8] showed that 38% of lesions remained undetected by periapical radiography despite the fact that an additional periapical radiograph using different projection geometry was exposed to help with the diagnosis.

Previous studiesshowed that lesions associated with apicesnear the maxillary sinus floor had a higher probability of being missed on periapical radiographsthan those associated with apices located away from or overlapping thesinus floor. Lesions associated with molars, in particular, second molars, were more likely to be missed on periapical radiographs thanthose onpremolars [3]. Additional findings such as extensionof the lesion into the maxillary sinus, missed canals, and presence of cortical plate erosion/perforationwere more frequently detected with CBCT than with DDR.

It is noteworthy that this study confirmed the hypothesis in a previous study by Bender in 1997 showing that cortical plate erosion was required for a periapical lesionto be detected on periapical radiography[12]. In this study, 16 of the cases in which cortical plate erosion was noted on CBCT also revealed the same finding on only 13 of these cases in DDR. Thus, based on the finding that 81% of the cases had established cortical perforation as determined by CBCT and validated at the time of surgery, it is evident that histologic progression of the condition associated with failed endodontic therapy occurs in more of the cases than what was known before. In these cases CBCT would be greatly helpful in early detection where demineralization is not sufficient to showsuch defects on DDR.

The value of CBCT in treatment planning for apical surgery is significant. It was shown that 70% of the cases in which CBCT was obtained revealed clinically relevant information not found on intraoral radiographs[9]. Rigolone et al [13] foundCBCT useful to optimize information for the feasibility of access to the palatal root of maxillary molars.This may allow the clinician to decide whether or not surgery is necessary without waiting through a recall period to see if healing has occurred [1]. There is a multitude of recently published reviews to summarize the benefits of CBCT in this regard[9-11].

Future studies evaluating the diagnostic outcome on the basis of variables such as the exposure parameters, FoV, voxel size, reconstruction parameters, dose, and post-processing techniques are in order to attempt to further fine-tune the image acquisition process in CBCT for a specific diagnostic task. The effect of the training and experience of the observers on the diagnostic outcome needs to be evaluated as well.

CBCT should be prescribed only for select, challenging cases in which information gleaned from conventional two-dimensional data precludes an accurate evaluation of the tooth of interest [14]. The “As Low As Reasonably Achievable (ALARA)” principle should always be considered when prescribing a CBCT study as dose concerns must be outweighed by the benefit of the procedure.

V. Conclusions

CBCT allows for detection of periapical lytic pathoses resulting from failed endodontic intervention which may not be detected with conventional standard periapical intraoral radiography.The presence of erosion and perforation of thecortical plates directly correlates to the detection of such lesions on DDR (81%). Detection of these lesions prior to further destruction of bone is important. If surgery is considered in a tooth with prior endodontic treatment, evaluation using CBCT to better localize and characterize the apical lytic lesions, as determined on a case-by-case basis is advocated. Under no circumstances should CBCT be routinely prescribed for all cases.

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References

[1]. Chevigny C, Dao T, Basrani B, Marquis V, Farzaneh M, Abitbol S, DDS, Friedman S (2008).Treatment Outcome in Endodontics: The Toronto Study—Phase 4: Initial TreatmentJ Endod 34:258-263

[2]. Rud J, Andreasen JO, Moller Jensen J (1972). A multivariate analysis of various factors upon healing after endodontic surgery. Int J Oral Surg1:258 –71.
[3]. Low K, Karl D, Bürgin W, Von Arx T (2008). Comparison of Periapical Radiography and Limited Cone-Beam Tomography in Posterior Maxillary Teeth Referred for Apical Surgery. J Endod34:557–562.
[4]. Moura M,GuedesO,Gonc A¸ De Alencar A, Azevedo B, Estrela C (2009). Influence of Length of Root Canal Obturation on Apical Periodontitis Detected by Periapical Radiography and Cone Beam Computed Tomography. J Endod35:805–809.
[5]. Shemesh H, Van Soest G, Wu M, Wesselink P (2008). Diagnosis of Vertical Root Fractures with Optical Coherence Tomography. J Endod34: 739 –742.
[6]. Estrela C,Bueno M, Leles C, Azeved B, Azevedo J (2008). Accuracy of Cone Beam Computed Tomography andPanoramic and Periapical Radiography forDetection of Apical Periodontitis. J Endod 34:273–279
[7]. Fuhrmann RA, Bucker A, Diedrich PR (1997). Furcation involvement: comparison of dental radiographs and HR-CT-slices in human specimens. J Periodontal Res 32:409 –18.
[8]. Lofthag-Hansen S, Huumonen S, Grondahl K, Grondahl HG (2007). Limited cone-beam CTand intraoral radiography for the diagnosis of periapical pathology. Oral SurgOralMed Oral Pathol Oral RadiolEndod 103:114 –9.
[9]. Nair MK, Nair UP(2007).Digital and advanced imaging in endodontics: a review.JEndod33:1- 6.
[10]. Cotton TP, Geisler TM, Holden DT, Schwartz SA, Schindler WG (2007). Endodontic applicationsof cone-beam volumetric tomography. J Endod 33:1121–32.
[11]. Patel S, Dawood A, Ford TP, Whaites E (2007). The potential applications of cone beamcomputed tomography in the management of endodontic problems. IntEndod J40:818 –30.
[12]. Bender I (1997). Factors influencing the radiographic appearanceof bony lesions J Endod23:5-14
[13]. Rigolone M, Pasqualini D, Bianchi L, Berutti E, Bianchi S (2003). Vestibular Surgical Access to the Palatine Root of the Superior First Molar: "Low-dose Cone beam" CT Analysis of the Pathway and its Anatomic Variations. J Endod29:773-775.
[14]. AAE and AAOMR Joint Position Statement: Use of Cone Beam Computed Tomography in Endodontics 2015 Update (2015). J Endod. Sep;41(9):1393-6. doi: 10.1016/j.joen.2015.07.013.

Figure 1: Root apices with periapical pathoses identified using two-dimensional intraoral direct digital radiography (DDR) and Cone Beam Computed Tomography (CBCT).