Diagnostic Accuracy of Con Beam Computed Tomography in Detection of Dental Root Fraction in Comparing with Conventional Scanning and Real Samples After Extracting

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ABSTRACT

When a tooth has extensive root fracture, the prognosis is not good, and tooth extraction is frequently the only treatment option that can be considered at this point. Accurate diagnosis is essential to avoid unnecessary and inappropriate treatment. The aim of this study was to compare the cone beam CT diagnostic accuracy with the traditional dental scanning and extracted teeth. Root canal fillings' impact on root fracture detection was also studied. 100 cases with suspected root fractures were evaluated using a pre-established scoring system. Direct visualization of each extracted tooth and its colorization determined final patient results. 55 of 100 patients had non-endodontically treated teeth, while 45 were treated with the endodontics. The findings revealed that the cone beam CT has a high diagnostic accuracy when it comes to the detection of root fractures. Cone beam CT was superior to dental radiography in terms of its ability to detect root fractures (P value, 0.001). Root canal fillings lower the sensitivity of cone beam CT scans but do not affect their specificity. The sensitivity and specificity of dental radiography were not affected in any way by root canal fillings. In conclusion, when it comes to the detection of root fractures in patients who have been treated with non-endodontic or endodontic methods, cone beam CT appears to be more accurate than conventional dental scanning.

Keywords: computed tomography, con beam, root fracture, endodontic treatment, conventional scanning.

Introduction

It's not always easy to tell if a dental root has been broken or not; sometimes it can be difficult to tell (1). Patients will typically experience damage to their periodontal ligaments at some point in their treatment. The majority of the time, a diagnosis can be made based on symptoms such as pain, swelling, tooth mobility, periodontal pocket, sinus tract, abscess, or sensitivity to palpation or percussion. However, there are some cases in which a diagnosis cannot be made based on symptoms alone. In extremely

unusual cases, a diagnosis may not be possible solely based on the patient's symptoms (2). Teeth that have root fractures are frequently extracted. Root fractures are a type of dental trauma. One variety of dental trauma is called a root fracture (3). After a proper diagnosis has been made, the patient will no longer need to undergo treatment if it is determined that the treatment is not necessary. On dental radiographs, there is a one-fourth to one-third chance that fracture lines will be visible (4). This is the range of likelihood that fracture lines will be visible. When it comes to the detection of fractures, the sensitivity of dental radiography is approximately 70 percent lower than that of CT. CT can detect fractures more accurately (4). In endodontics, conventional CT scans have a number of drawbacks that need to be considered. These drawbacks include the high cost of the scan as well as the amount of radiation that it emits. CBCT has the capability to improve spatial resolution while at the same time reducing the amount of radiation that the patient is exposed to it (5). A first generation flat-panel computed tomography system prototype the treatment is going to be customized to the specific needs of the patient in question, taking into account factors such as the location, orientation, and severity of the fracture line. On the basis of the findings of radiographs, it is not possible to make an accurate diagnosis of root fractures. Radiographs aren't always the most useful diagnostic tool when it comes to determining whether or not a root fracture has occurred (4). The verification of VRF can only be done through surgical procedures at this time. It is imperative that a definitive diagnosis be obtained first because it is possible that the process of extracting one tooth will result in the removal of additional teeth that also need to be extracted (6). Dentists develop advanced root fracture diagnosis techniques. When it comes to evaluating root fractures, the imaging modality of choice in the majority of instances is low-dose cone beam CT (CBCT). 0.125-2 mm CBCT voxels (7). This modality is appropriate for use in maxillofacial examinations because it is particularly helpful for reconstructing images in multiple planes (axial, sagittal, and coronal). [Further citation is required] In addition to this, interference from metallic artifacts is virtually nonexistent. To date, only a small number of studies have been conducted to investigate whether or not CBCT is accurate in detecting root fractures (8). In this study, patients who had root fractures were given radiographic examinations, and the results of those examinations were compared with the findings of cone beam computed tomography (CBCT). In addition to this, the clinical findings as well as the color of the patient's teeth were taken into consideration (9). In order to achieve higher levels of diagnostic precision, it was determined that the development of a CBCT protocol was necessary (10). This was determined by the following: When it comes to evaluating root fractures, the imaging modality of choice in the majority of instances is low-dose cone beam CT (CBCT). 0.125-2 mm CBCT voxels (11). This modality is appropriate for use in maxillofacial examinations because it is particularly helpful for reconstructing images in multiple planes (12). In addition to this, interference from metallic artifacts is virtually nonexistent (13). To date, only a small number of studies have been conducted to investigate whether or not CBCT is accurate in detecting root fractures (14). The aim of this study is Diagnostic accuracy of con beam computed tomography in detection of dental root fraction in comparing with conventional scanning and real samples after extracting.

Material and methods

Design of study

The periapical radiographs and CBCT images of one hundred patients, all of whom were believed to have root fractures, were analyzed. After a period of two years, endodontists and periodontists referred these patients to our department so that we could use cone beam computed tomography (CBCT) to confirm the presence of a root fracture. After that, dental procedures were performed on these patients in

order to treat them. Dental care was provided. In order to determine whether or not CBCT scans were necessary to finish the diagnostic process, it was necessary to examine each initial dental radiograph. One of the criteria for excluding participants from the study was the presence of acute trauma-related root fractures in teeth that did not call for the intervention of a dentist during the course of the investigation. There were a total of 100 patients, with the ages ranging anywhere from 28 to 78 years old, and there were 58 men and 42 women among the total number of patients. The average age was 43, and the median age was 43. 45 teeth received endodontic treatment, while the other 55 teeth were left untreated as part of the patient's treatment plan (with root canal fillings).

Preparing steps

A total of one hundred patients who were thought to have root fractures had their periapical radiographs as well as their CBCT images examined. The most prominent clinical manifestations included a painful sensation during chewing or when the teeth were ground down. After a period of two years, endodontists and periodontists referred these patients to our department so that we could use cone beam computed tomography (CBCT) to confirm the presence of a root fracture. After that, dental procedures were performed on these patients in order to treat them. Dental care was provided. In order to determine whether or not CBCT scans were necessary to finish the diagnostic process, it was necessary to examine each initial dental radiograph (table 1)

Table 1: clinical finding of patients by conventional and con beam CT

Patient	**Gender**	**Age**	**Pain upon mastication and fistula at mid–root level**	**Primary Score**	**final Score**	**Detection state**
A	10 Male	28-35	Recurrent fistula and pain	4	3	Detected
B	12 Female	35-45	Pain upon mastication	3	2	
C	8 Female	28-35	Painful buccal and cervical swelling	1	2	Detected
D	7 Male	40-59	mastication and fistulaat mid-root level	2	3	Detected
E	11 Female	35-45	Buccal swelling and pain upon mastication	3	4	Detected
F	8 Male	40-59	Buccal swelling	2	2	Detected
G	6 Female	28-35	Apical fistula	1	1	
H	7 Female		Buccal and cervical fistula	3	2	Detected
I	25 Male		Pain upon mastication	1	1	Detected

Periapical radiographs and CBCT

We came to the conclusion that we should buy CBCT images. The height of the radiation field produced by the 3DX CT scanner is 25 millimeters, and its width is 35 millimeters, 80 kV/3 mA for 18 sec, reconstructed slices with a thickness of 1 millimeter that have undergone 450 u rotation. Isotropic 0.5 mm voxel, reslicing the 3DX images and modifying their histograms led to an improvement in the images' quality. Only X-rays of the teeth's periapical structures will be taken. Parallelization was something that was done frequently. Kodak E-speed was used, and 80 kV and 8 mA were the exposure parameters that were utilized. In order to scan the periapical films at a resolution of 900 dots per inch while using the jpg file format, a light box and magnifying glasses were utilized. In order to properly perform dental imaging, it was necessary to wear lead aprons and thyroid collars. The CBCT as well as the dental radiographs were shown on the monitor that was 20 inches in size. The software provided the capability to view CBCT images in all three dimensions simultaneously. Users of Adobe Photoshop have the ability to make adjustments to radiographs' brightness, contrast and zoom levels. In order to eliminate the possibility of observer bias, the researchers masked clinical signs and coded teeth. 15 percent of the samples were observed by two different people. Both candidates have more than 8 years of combined CBCT work experience. Both previous research and clinical practice contributed to the development of the diagnostic criteria. In the cases that were used for calibration, they compared their diagnoses to the definitive clinical diagnoses that were reached by others. Regarding the numerous diagnoses, they unanimously arrived at the same conclusion. The preliminary findings of the investigation were not taken into consideration. A radiolucent line will appear on dental radiographs whenever there is a fracture in the tooth. The findings of a root fracture that can be seen on CBCT include the presence of a hypoattenuated line on at least two three-dimensional planes and the separation of adjacent root segments on at least two contiguous sections (figure 1, 2, 3).

Cases with metallic restorations or root fillings

It was found that an artifact was not there if it passed through both the root and the bone that was adjacent to it. The responses obtained from both imaging modalities were categorized as dichotomous by the researchers who looked into the matter. After debating their findings for a period of one month and a half, the two oral radiologists eventually arrived at a consensus regarding their work. The CBCT scans were performed first, and then a surgical examination of the teeth was done two months later. The clinical and radiographic findings were used to make a determination regarding the treatment. Following the removal of the tooth, the root surface of the tooth that had been extracted was analyzed (71.2). The overwhelming majority were removable and mobile in nature. During the surgical procedure, special precautions were taken with nonmobile teeth in order to reduce the risk of the root becoming fractured. In order to remove the bone from the buccal and/or lingual regions of the patient's mouth, a mucoperiosteal flap was utilized as part of the surgical procedure. Prohibiting the application of excessive amounts of rotational forces during the procedure, a dental operating microscope was used so that an examination of the tooth's root surface could be carried out. When there was a separation between individual fragments, as well as when there were lines that appeared darker than the underlying root structure, it was determined that a fracture existed. Fractures also occurred when there was a separation. The procedure was carried out, and the author, who was in charge of making the appropriate diagnosis, made the decision regarding the teeth that were retained after the procedure. It was determined how well dental radiographs, CBCT, and direct visualization could detect root fractures by comparing the sensitivity and specificity of each method to see how well they measured up against one another to see how well they measured up against one another.

Statistical analyses

In order to conduct statistical analysis, SPSS was utilized. The kappa coefficient was utilized in order to ascertain the level of reliability and reproducibility that existed between the two observers' imaging evaluations. When comparing CBCT and dental radiography for the purpose of locating root fractures, x^2 tests were carried out. Both sensitivity and specificity were determined in a distinct manner for treated and untreated teeth in the study. The level of significance will be P, which is equal to 0.05 (15, 16).

Results

Teeth assessment

Root fractures were found in every single one of the teeth that were evaluated for this condition. There were a total of 150 teeth, and 84 of them had fractures that ran in a vertical direction, while only 15 of the teeth had fractures that ran in an oblique direction. 100 of the 150 teeth that had root fractures were extracted, and the remaining teeth either had their roots amputated (n 75) or had the root ends resected. Root fractures are a common cause of tooth loss (n 75). Following the removal of 30 teeth from a set of 20 teeth that were fracture-free, the patient underwent a procedure known as root amputation (n 75) or root-end resection (n 76) on the 20 teeth that were still intact after the extraction of 30 teeth. There were a total of 150 fractured teeth, with 5 maxillary incisors, 20 premolars, 25 maxillary molars, and 45 mandibular molars among them. In terms of the locations of the teeth that were broken, these were the tooth types that were affected. The 55 teeth that did not sustain any fractures included two maxillary canines, four premolars, fourteen maxillary molars, and twenty mandibular molars. None of the teeth in the mandible were affected.

Radiographs and CBCT according to Sensitivity and specificity

The kappa coefficient for dental radiographs was 1.2 between the two observers, 1.5 between observer A's readings and the consensus reading, and 1.7 between observer B's readings and the consensus reading. This was determined by comparing the two sets of readings to each other and to the overall consensus. The kappa coefficient between the two observers in the CBCT scans was 1.8, and the kappa coefficient between the readings of each observer and the consensus reading was 1.9. In addition to this, the kappa coefficient of agreement between individual observer readings and the overall consensus reading was 1.9. When it comes to root fractures, CBCT scans have a detection sensitivity that is noticeably higher than that of dental x-rays. This is in comparison to dental radiographs, which have lower detection sensitivity. Using the reading that was agreed upon by everyone, we came to this conclusion. High levels of specificity were demonstrated by dental radiographs as well as CBCT scans, and these levels were comparable to one another. When compared to dental radiographs, CBCT scans had a significantly higher overall accuracy rate (88.32 percent) when it came to the detection of root fractures (55.98 percent). There was not a discernible effect that the presence of root canal fillings had on the accuracy of dental radiographs in terms of either their sensitivity or their specificity. In CBCT, it had the effect of lowering sensitivity while having no discernible influence on the test's specificity (Table 2, Figures 1, 2, 3).

Table 2: sensitivity on the test's specificity

Index	Radio	CBCT	Endo. Treatment	Non- endo treatment
Specificity	99%	100%	100%	100%
Sensitivity	30%	25%	25%	25%
Correlation	33%	95%	100%	100%
Accuracy	45%	95%	100%	100%
Significant	*	****	****	****

Limitation	***	*	**	*
Indication	+	++++	++++	++++
Gap	69%	5%	7%	4%

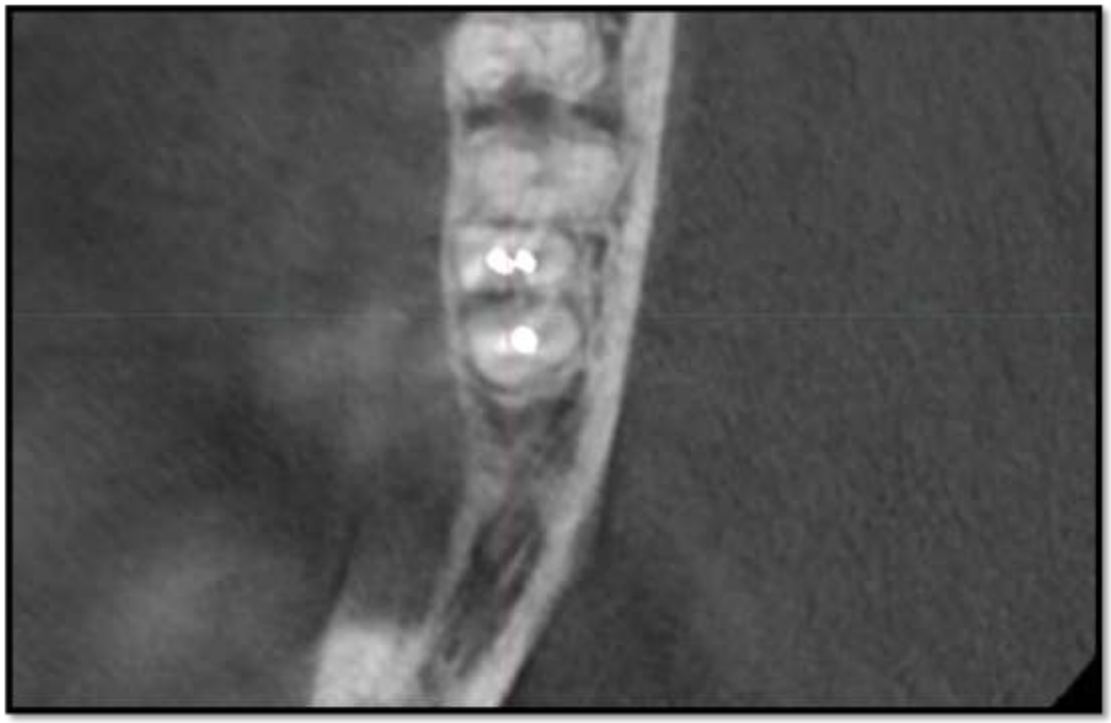

Figure 1: Mandibular molar of patient by CBCT of patient 5

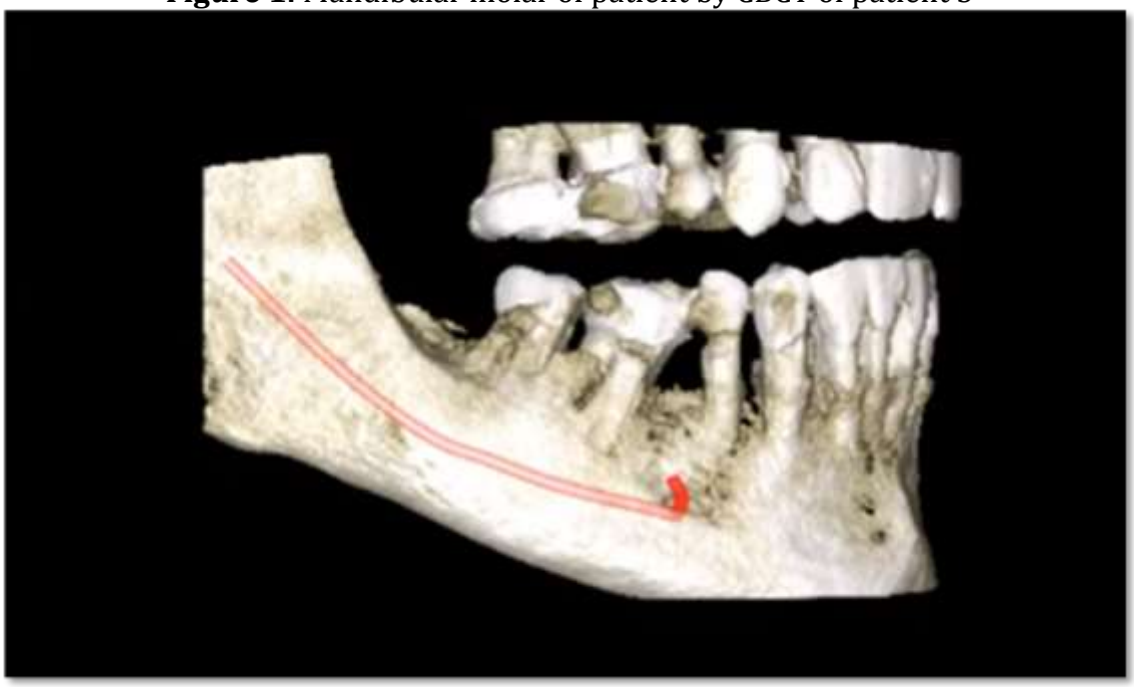

Figure 2: Digital view of dental sties operations

Figure 3: Line of radiolucent fracture patient 3

Discussion

Vital, endodontically treated teeth can fracture and Root apex or entire root can fracture. CBCT and dental radiography were compared in vivo for diagnosing root fractures (9). Untreated and treated teeth were studied with endodontically treated teeth fracture due to excessive lateral condensation force during root canal fillings, post wedging, corrosion, and post expansion. True root fractures in untreated teeth are rare in English literature but common in China (10). 65.5 percent of root-fractured teeth were non-endodontically treated and Untreated root fractures have unknown causes (17). Study suggested Chinese diet or chewing habits may cause these fractures and other one suggested heavy, repetitive mastication causes root fractures. Early detection prevents mistreatment with Variable or nonspecific symptoms complicate diagnosis (11). Conventional radiographs can be helpful when the X-ray beam is parallel to the fracture plane with radiographs can't detect root fractures due to superimposition (18). Dental radiographs showed fracture lines in 44.9% of 400 cases and According to a study, conventional dental radiographs were only 30% sensitive to root fractures (12). Recently, digital imaging exists while Digital film stores, enhances, and transfers radiographic data with less radiation (19). Decertation compared CCD images and conventional films to detect vertical root fractures in endodontically treated maxillary molars. Storage phosphor digital radiographs detected 34% of artificially fractured teeth's root fractures (20). In this clinical study, 23% of teeth had root fractures and Clinical circumstances reduced sensitivity. For maxillary molars, multiple roots and neighboring skeletal structures may obscure the fracture line; the radiolucent line, sometimes seen in premolars and mandibular molars, cannot be differentiated from root canal spaces or periodontal ligaments; and radiopaque substances, such as gutta-percha cones in endodontically treated teeth, may obstruct the fracture line (21). Several study limitations may bias dental radiographs' ability to detect root fractures and patients weren't given 20–30u angled radiographs, which may have reduced fracture visibility. Digitally scanned radiographs reportedly produce poor image quality while research is needed to compare digital imaging and CBCT for root fracture detection in vivo (22). CBCT detects root fractures better than 2D radiography and only tangent rays can visualize transmission fractures (23). CBCT relies on many projections from a circle around the object, increasing the chances

of seeing the fracture. Even if detail is lost during 3D reconstruction, the fracture is more visible in the 3D volume than in a 2D projection image and CBCT detected artificial root fractures with 80% sensitivity and 95% specificity, 20 of 20 patients with suspected root fractures had them on CBCT but only 4 on conventional radiographs (24). CBCT images detected root fractures 90.2% of the time (25). 10.5% of teeth were root-free, Statistically, root canal fillings reduce sensitivity (26). Possible causes include teeth that had root canal treatment and crown restorations, star-shaped streak artifacts on tomographic slices, fractures confined to the root apex that were not distinguishable from root resorption, and the theoretical spatial resolution (27). Nyquist's theorem requires two voxel sizes and (28). Fracture lines 0.30 mm wide were undetectable. This study excluded non-operated teeth, which may have overestimated CBCT sensitivity and Root canal fillings did not affect dental radiographs or CBCT scans' high specificity (29). The study's strict diagnostic criteria increased specificity while CBCT fracture lines were only hypo attenuated lines confined to the root and visible in two 3D planes (30). Metallic restorations or root fillings had multiple streak artifacts and Positive dental radiographs showed a radiolucent line dividing the root (31). This explains why the study's PPV was 100%. The study's disease prevalence wasn't balanced due to clinical limitations, which may affect sensitivity and specificity (32). We compared two radiographic techniques anyway and CBCT scans are beneficial but radioactive. Studies reported that Accustoms effective dose at 550 cm is 20.02 mSv and CBCT has limitations. Hardening and streaks degrade image quality (30). Every 3D scan needs a radiologist's report and training and periapical radiographs suggest root fractures. CBCT images help surgeons choose the appropriate surgical approach, identify the root to be resected, and reduce surgical trauma on adjacent tissues (33). CBCT helped detect root fractures and plan treatment (32). CBCT images are 90.2% as sensitive as dental radiographs to root fractures (30 percent). Root canal fillings affected CBCT scan sensitivity but not dental radiography. Root canal fillings did not affect dental radiographs or CBCT scans' high specificity (34).

Conclusion

Cone beam computed tomography (CBCT) was successful in producing high-quality 3D images, which proved to be beneficial in identifying dental root fractures and developing a treatment strategy for those fractures. These benefits proved to be beneficial in determining whether or not dental root fractures existed. This finding suggests that CBCT is an effective method for producing high-quality 3D images. In conclusion, this finding suggests that CBCT is an effective method. When compared to the sensitivity of dental radiographs, the sensitivity of CBCT images for the detection of root fractures was significantly higher, coming in at 95 percent. This was found to be the case when the two methods were compared to one another (45 percent).

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