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Diagnostic Accuracy of High Resolution Cone-beam Computed Tomography and Standard Mode Cone-beam Computed Tomography in Internal Root Resorption

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ABSTRACT

Introduction: The purpose of this study was to compare the high resolution cone-beam computed tomography (CBCT) and standard mode CBCT diagnostic accuracy in internal root resorption with different sites and sizes. **Methods and Materials:** Eighty single rooted human teeth with visible pulps in periapical radiography were split mesiodistally along the coronal plane. Internal resorption like lesions were created in three areas (cervical, middle and apical) in labial wall of the canals in different diameters. High resolution CBCT (CBCT-H) and standard mode CBCT (CBCT-C) were taken from each tooth. Two observers examined the high resolution CBCT and standard mode CBCT to evaluate the presence of resorption cavities. The data were statistically analyzed and degree of agreement was calculated using Cohen's kappa (k) values. Data were analyzed by SPSS 20 software and sensitivity, specificity and positive and negative predictive value for both methods were calculated. Data were analyzed using the Mac-Nemar and chi-square tests. **Result:** The positive predictive value and negative predictive value in CBCT-H was higher than that of CBCT-C, all of which indicates that the CBCT-H diagnostic test is more sensitive and more accurate than CBCT-C. Kappa statistics showed that there is a strong and complete agreement between the CBCT high resolution and reality (kappa: 0.72) and in the Standard CBCT method, a moderate agreement has been obtained with reality (Kappa: 0.45). **Conclusion:** According to our *in vitro* study CBCT high resolution has a higher diagnostic accuracy than conventional CBCT.

Keyword: CBCT; Cone-beam Computed Tomography; High Resolution CBCT; Root Resorption; Standard Mode CBCT

Introduction

Internal root resorption occurs in the pulp chamber and canal of the teeth and leads to loss of the surrounding dentin. In the initial lesions there may not be radiographic imaging. The initial diagnosis of this lesion was effective in its prognosis, since the lack of recognition and treatment led to poorer treatment and therefore, without the early diagnosis of prognosis of the tooth, it is poor [1-3].

Conventional periapical radiographies are usually used to evaluate this lesion which is found to have a diagnostic limit in detecting initial changes in internal root resorption [2].

The internal root resorption was first reported in 1830 and is a progressive resorption of intraocular dentin and dentinal tubules during a third middle and apical canal due to clastic activity that is degraded due to inflammation and infection in the pre-dentin protective layer in the canal and clastic activity leads to resorption [2-5]. The causes of the absence of pre-

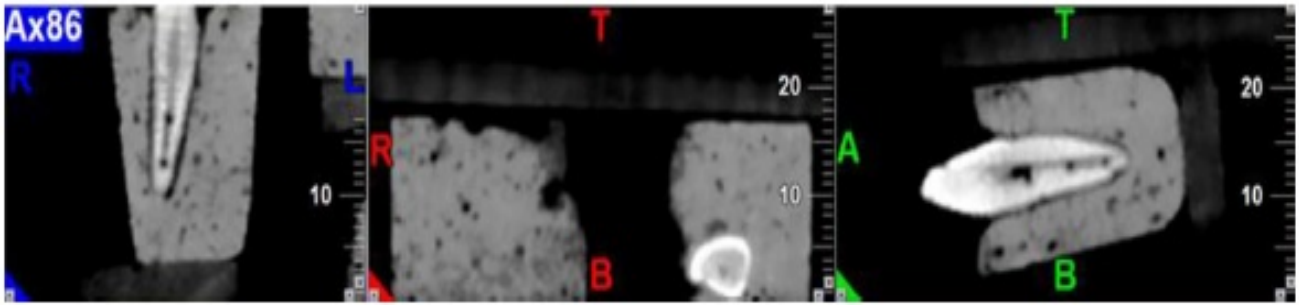

Figure1. Radiographic view of internal root resorption

dentin adjacent to the granulation tissue are not clear, but most trauma has been raised, which may even be an initial factor in internal root resorption. It appears some cases of internal root resorption classified as idiopathic might have viral etiology [6]. Another possible reason for the loss of pre-dentin may be the high heat generated by dentin being cut by the dentist without water spray. The internal root resorption is usually asymptomatic and is detected in advanced stages through routine radiographs [7, 8].

Cone-beam computed tomography (CBCT) is a new technology used by a two-dimensional sensor and cone beam and the volume data from the scanned area is obtained with a beam of rotation and receiver rotation. This type of scanner has less radiation dose and high resolution in the axial dimension than conventional CT scans [9]. The CBCT technique, which is a new technique, is used to treat implants, craniofacial anomalies, endodontic treatment, orthodontics, and periodontics [10]. CBCT produces images that do not have superimposition and deformity which is more accurate than ordinary images [11]. Diagnosis of internal root resorption using conventional periapical radiography is influenced by the size and location of the lesion, and it is said that small lesions in apical third of the root are the hardest lesions for diagnosis in radiography [12].

Table 1. The characteristic of groups

Group (N)	Location of internal resorption		
	Cervical	Middle	Apical
Group 1 (10)	-	-	-
Group 2 (10)	-	+	+
Group 3 (10)	-	+	-
Group 4 (10)	-	-	+
Group 5 (10)	+	+	+
Group 6 (10)	+	-	-
Group 7 (10)	+	+	-
Group 8 (10)	+	-	+

Considering the important role of early detection of internal root resorption in prognosis and treatment design, as well as the limited studies have been done on the high-resolution CBCT (CBCT-H) accuracy in the diagnosis of both internal and external root resorption, the purpose of this study was to compare the high resolution CBCT and standard mode CBCT (CBCT-C) diagnostic accuracy in internal root resorption with different sites and sizes, in order to determine the indication of high resolution CBCT in suspected cases to internal root resorption in treatment, and by detecting time to improve the prognosis of affected teeth.

Materials and Methods

This study was performed on 80 single-rooted human teeth. Teeth were placed in a solution of 5.25% sodium hypochlorite for disinfection and removal of soft tissue for one h and then kept in normal saline until the study was performed. Radiographs were first prepared from the teeth. The criteria for entering the study included: visible pulp in radiographs, no anomalies and no root filling. The teeth were divided into two semi-buccal and lingual by diamond disks in a mesiodistal direction (Figure1). Grouping of teeth was done as a factorial according to Table 1. The teeth were divided into 7 groups and one control group, each group containing 10 teeth. Depending on which groups the teeth are located, resorption cavities were prepared in the cervical, midroot, and apical regions or a combination of them on the semi-labial internal wall of the tooth. The first group, as shown in Table 1, is the control group with no resorption cavities in it. From group two to eight, the teeth were divided into a subgroup of four and two subgroups of three. In each group, the resorption cavities were prepared in the cervical, midroot or apical regions, or a combination of them in accordance with the table shown with the+sign. In the first subgroup, resorption cavities were prepared in two regions of the midroot and apical, using a round bur with a

diameter of 0.8 with half its depth. In the second subgroup, resorption cavities were prepared in 2 midroot and apical regions with the help of round bur with a diameter of 1.2 with half its depth. In the third subgroup, resorption cavities were prepared in 2 midroot and apical regions with the help of round bur with a diameter of 1.6 with half its depth. The two half-buccal and lingual teeth were joined together by drop adhesive. The root of the teeth was covered with a layer of wax to reduce artifact. The teeth were mounted on a mixture containing equal ratios of plaster and ground rice in the center of cylindrical mold. Samples from other groups were prepared in the same way.

The CBCT images of the samples were prepared with the Newton 5G device (QR Srl Company, Verona, Italy). High-resolution images with 6 inch Fov and Voxel size (0.125-0.150 mm) and standard images with 4 "Fov and Voxel size (0.200-0.240 mm) was prepared. Exposure parameters were considered for high-resolution images of 110 kVp, 7.07 mA and 5.4 sec, and the standard images were 110 kVp, 5.05 mA and 3.6 sec. The CBCT images were reconstructed and investigated in three planes: axial, coronal, sagittal and MPR using NTT Viewer software program (NTT Software Corporation, Yokohama, Japan) CBCT images on the monitor were twice examined by one oral and maxillofacial radiologist and one endodontist, individually and blindly. Observers noted their findings as internal root resorption or lack of internal root resorption along with the names of the resorption locations. The data were statistically analyzed and degree of agreement was calculated using Cohen's kappa (k) values. Data were analyzed by SPSS 20 software and sensitivity, specificity and positive and negative predictive value and negative predictive value and the positive and negative likelihood ratio were for both methods were calculated by kappa index. The level of significance was set at 0.05. Data were analyzed using the Mac-Nemar and chi-square tests.

Results

In this study, which was done on 80 teeth, after statistical assessing and analyzing the sensitivity and specificity of both methods, the diagnostic sensitivity of the high resolution CBCT method was higher than the standard CBCT, which was 88% and 66%, respectively and the CBCT-H diagnostic specifity is also higher than CBCT-C (83% and 79%, respectively) (Table 2).

The positive predictive value and negative predictive value in CBCT-H was higher than that of CBCT-C.

Kappa statistics showed that there is a strong and complete agreement between the CBCT high resolution and reality (kappa: 0.72) and in the Standard CBCT method, a moderate agreement has been obtained with reality (Kappa: 0.45).

After examining 240 areas of 80 teeth, using CBCT-H 206 (85.8%) regions and using CBCT-C, 174 (72.5%) regions were detectable, indicating a higher CBCT-H diagnostic accuracy and sensitivity than CBCT-C in the internal root resorption, A significant relationship was found for this difference (P<0.001) (Table 3).

Separately, areas with internal root resorption of the teeth with three different sizes were examined and analyzed by the McNemar and Chi-square tests. In the size of 0.3 mm internal root resorption using CBCT-H 42 (87.5%) area and CBCT-C area 29 (60.4%) and in the size of 0.6 mm CBCT-H 35 (97.2%) areas and CBCT-C 27 (75%) of the area were diagnosed which is in both sizes CBCT-H was significantly higher. CBCT-H was higher in areas with 0.4 mm area using CBCT-H 29 (80.6%) and CBCT-C 23 (63.9%), but no significant correlation was found for this difference. Considering the high accuracy of CBCT-H compared to CBCT-C in 0.3 and 0.6, there was a significant relationship (Table 3).

Table 2. Percent (range) of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), positive likelihood ratio (LR+) and negative likelihood ratio (LR-) (confidence interval, CI=95%), kappa, accuracy

Imaging	Sensitivity	Specificity	PPV	NPV	LR+	LR-	kappa	accuracy
CBCT-H	88 (83-94)	83 (77-90)	84 (78-91)	88 (82-94)	5.3 (3.53-7.95)	0.14 (0.09-0.23)	72 (63-81)	86 (81-90)
CBCT-C	66 (57-74)	79 (72-86)	76 (68-84)	70 (62-78)	3.16 (2.18-4.58)	0.43 (0.33-0.56)	45 (34-56)	73 (67-78)

Table 3. Diagnostic accuracy [N (%)] of internal resorption with different sizes.

Size (N)	0 mm (120)	0.3 mm (48)	0.4 mm (36)	0.6 mm (36)	Total (240)	*P*-value
CBCT-H	100 (83.3%)	42 (87.5%)	29 (80.6%)	35 (97.2%)	206 (85.8%)	0.145
CBCT-C	95 (79.2%)	29 (60.4%)	23 (63.9%)	27 (75%)	174 (72.5%)	0.054
p-value	0.509	0.005	0.188	0.014	<0.001	

Discussion

In this study, the accuracy of two methods of high resolution CBCT and standard CBCT was compared in the diagnosis of internal root canal lesions. According to the results, the sensitivity and specificity of high resolution CBCT was significantly higher than the standard CBCT.

The results obtained in this study are similar to the study by Kamburoglu *et al.* [4] who compared the diagnostic accuracy of CBCT images with different resolution voxels in determining internal resorption. Their results showed that in high resolution two devices operate the same, and their performance is greater than when the low resolution is used [4], which is consistent with the results obtained in our study. In 2013, Stacy *et al.* [13] measured the magnitude of external root resorption by CBCT images of high and low resolution and periapical radiography. They concluded that high resolution CBCT images and micro-CT have a higher resolution of low-resolution CBCTs in detecting lateral lesions, but high and low resolution CBCT images are highly accurate in measuring external root resorption in the apical region, and are better than radio-graphic images [13]. In our study, the accuracy of detection of internal root resorption areas by CBCT is also higher furthermore consistent with the Stacy study.

Taramsari *et al.* [14] compared the standard CBCT and high-resolution images in the diagnosis of vertical root fractures in 2013. The percentage of correct diagnosis in high resolution and standard CBCT images was reported as 71.8% and 59%, respectively [14]. Sensitivity and specificity in high-resolution images were higher than standard images, with no significant relationship found for this difference[14]. In our study, the sensitivity and specificity of the high-resolution CBCT were found to be higher than the CBCT standard, with the difference that this difference was significant in our study, because the difference in these two studies could be different in the type of diagnostic field under consideration in these two. The results obtained in both studies indicate that both types of imaging techniques have the appropriate diagnostic accuracy to examine lesions.

In 2009, Patel *et al.* [15]conducted an *in vivo* study to compare the accuracy of intraoral periapical radiography and CBCT in the diagnosis and treatment of root resorption. For each technique, sensitivity, specificity, positive predictive value, negative predictive value, ROC curve and repeatability were calculated. According to the results of this study, although the diagnostic accuracy of intra-oral radiography was acceptable, the CBCT diagnostic accuracy was higher than that [15]. Our study also indicates the high diagnostic accuracy of CBCT in internal lesions, which is consistent with the study.

Ahlowalia *et al.* [16] in 2012 a study was conducted to evaluate the accuracy of CBCT to measure the dimensions of periapical lesions. The results of this study showed that both CBCT and micro-CT show the closest volume to reality. CBCT showed the most accurate measurement of the volume of resorption cavity in the bovine bone in *ex vivo* model, suggesting that CBCT could be a valuable tool for monitoring apical periodontitis improvement [16]. In our study for CBCT-C, a modest agreement was reached with the fact that the result is consistent with the result obtained in the study by Ahlowalia *et al.* [16].

Ozen *et al.* [17] evaluated the accuracy of two types of CBCT devices and digital intraoral sensor and film in perianal lesions that were chemically developed. The findings of this study showed that the two types of CBCTs were similar to each other and that they were more accurate than conventional digital and intraoral radiography. The results of this study were also consistent with our study in terms of the efficacy and accuracy of CBCT. In conclusion, the cavities created by a round bur have more defined borders than natural shapes which make diagnosis easier [18]; as a consequence, this suggests further studies to be carried out to investigate the natural forms of resorption lesions.

Conclusion

According to our study, CBCT high resolution has a higher diagnostic accuracy than conventional CBCT. Therefore, it is recommended that high-resolution CBCT be used in certain cases not detectable in standard CBCT.

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Conflict of Interest: 'None declared'.

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