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Diagnostic Accuracy of Digital Periapical Radiography and Cone-beam Computed Tomography in Detection of Simulated External Root Resorption

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ABSTRACT

Aim: The purpose of this study was to evaluate the diagnostic accuracy of digital Periapical radiography and Cone-beam Computed Tomography in Detection of Simulated External Root Resorption. **Subjects and methods:** This study was initiated with sample selection calculation 90 maxillary central incisors teeth. Round burs in 3 different size small, medium large were used to create simulated cavity in cervical, middle and apical root third. Digital caliper used to measure the simulated cavity. Teeth were covered by wax and mounted in block made from silicon impression putty and placed in phantom to simulated soft tissue. CBCT scan was made and digital preapical radiograph PSP was taken then the images were analysis and compared with the result gathered from digital caliper. **Results:** Digital preapical radiograph PSP clearly detected the simulated cavity CBCT showed statistically significantly lower mean cavity measurement than the actual measurement at cervical, middle and apical root levels (P-value <0.001), (P-value <0.001) and (P-value = 0.001), respectively in large cavity . **Conclusion:** Under the condition of present study, it can be conclude that there was no difference in accuracy of identifying defects between digital periapical radiographs PSP and CBCT images

KEYWORDS

CBCT, External Root Resorption, Digital Periapical Radiography, Roots, digital caliper.

INTRODUCTION

Tooth resorption is a pathologic condition that still remains a mystery in many aspects. It may go unnoticed over many years as most cases of resorption are asymptomatic in nature. Early detection of resorption is essential for successful management.[1]

There are several types of ERR including external surface resorption, external inflammatory resorption, external replacement resorption, and external cervical resorption. [2]

Because ERRs do not present clinical symptom, they are almost detected by rotini x-ray examinations. The problem with periapical radiography is that the 3-dimensional compressed into a 2-dimensional

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image, and its diagnostic accuracy is affected by anatomic superposition and the angle of the x-ray spectrum.[3]

Cone-beam computed tomographic **(CBCT)** imaging can be used. The determination of the extension and location of ERRs [4] .

So that this study compared the ability of digital periapical radiography and CBCT in detection of external root resorption

MATERIAL AND METHODS

Selection of the teeth:

The study protocol was approved from Research Ethics committee regulations of Faculty of Dentistry, Minia University after the approval of Ethical Committee no.(256) 2019/10/28_total of 90 maxillary central incisors were collected from the Department of Oral and Maxillofacial surgery, Samples were recently extracted from patients for untreated mobility reasons.

The inclusion criteria were as follows:

No root destruction Sound teeth, teeth inspected by trans illumination to detect any root fracture or cracks, Complete root formation Absence of caries/ abrasions in the cervical region No endodontic treatment.

Specimen Preparation

Teeth were cleaned All of the teeth were be disinfected by 2% glutaraldehyde solution.

3 types of artificial external root resorption defects were created shallow, moderate, and deep using round burs (meisinger–Germany) carbide size HM1 NO 010 for shallow cavity, HM1 NO 014 for moderate cavity and HM1 NO 018 for deep cavity created by used hand piece high speed .

All teeth were numbered All cavities were measured by digital caliper and the result were recording. All specimens were coated by a wax layer to decrease the artifacts and to resembled the periodontal Ligament.

Grouping of samples

Teeth were divided into the following groups:

1. Shallow (30) teeth with artificial, ERR simulated cavities.
2. Moderate (30) teeth with artificial, ERR simulated cavities.
3. Deep (30) teeth with artificial, ERR simulated cavities.

Each group were subdivided into 3 subgroups according to simulated cavity position:

1. (10) Cervical cavity
2. (10) Middle cavity
3. (10) Apical cavity

Teeth were randomly distributed and each 3 teeth were mounted separately in a block that were made from silicon impression putty.

Radiographic Examination

CBCT examination

Phantom preparation The blocks were placed in a fine plastic cylinder containing water to simulate soft tissue. The cylinder was placed on the chin rest of CBCT unit**.**

SCANORA® 3Dx was used to obtain the **CBCT** images The teeth were imaged by centering the block (contain 3 teeth) of interest in a smallest field-of-view **(FOV)** which name is (s) (with dimensions (H × D) (mm) (50 × 50), and Voxel sizes (mm); 0.15mm for Standardized resolution and 0.1mm for High resolution.

All the 30 block were scanned with the following parameters: (10 mA) (90 k v) (6 S)with standardized high resolution 50x50

Image interpretation:

The images were visualized using the scanner's native software (SCANORA® 3Dx produces image data in DICOM®* format) OnDemand3d software.90 Teeth scanned to evaluations.

Digital periapical radiographic examination

Digital periapical radiographs were acquired for each tooth. with PSP Digital size 2 imaging plate system **(Dürr Dental, Lichtschutzhüllen)**

Using parallel technique a The radiographs were obtained using x-ray machine with the following exposure parameters: 60 kVp, 7 mA, 120 volts direct current _ 10%, and 0.25 seconds.

Images of each tooth were scanned by (VistaScan Mini Easy machine) operated at the following specifications Plate sizes 2 (3× 4 cm), Effective resolution (lp/mm) 22 (1100 dpi), Weight (Kg) 6.5, Dimensions (H×W×D mm) 226× 234× 243

Statistical Analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov-Smirnov and Shapiro-Wilk tests). Actual measurements data showed normal (parametric) distribution while error measurements data showed non-normal (non-parametric) distribution. Data were presented as mean, standard deviation (SD), median and range values. For parametric data, two-way repeated measures ANOVA test was used to compare between actual and CBCT measurements. For non-parametric data, Kruskal-Wallis test was used to compare between errors of measurement with different cavity depths. Friedman's test was used to compare between errors of measurement at different root levels within each group. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

Result Axial view

Comparison between actual and CBCT measurements

With shallow cavity depth; **CBCT** showed statistically significantly lower mean cavity measurement than the actual measurement at cervical and middle root levels (*P*-value = 0.006) and (*P*-value = 0.010), respectively. At the apical level, there was no statistically significant difference between **CBCT** and **actual measurements** (*P*-value = 0.191). With moderate cavity depth; **CBCT** showed statistically significantly lower mean cavity measurement than the actual measurement at cervical, middle and apical root levels (*P*-value = 0.016), (*P*-value = 0.005) and (*P*-value = 0.015), respectively. With large cavity depth; CBCT showed statistically significantly lower mean cavity measurement than the actual measurement at cervical, middle and apical root levels (*P*-value <0.001), (*P*-value <0.001) and (*P*-value = 0.001), respectively.

Table (1) *Descriptive statistics and results of two-way repeated measures ANOVA test for comparison between actual and CBCT cavity measurements (mm) in axial view*

Cavity depth	Root level	Actual measurement (n = 10)		CBCT measurement (n = 10)		*P*-value
		Mean	SD	Mean	SD	
Shallow	Cervical	1.52	0.15	1.33	0.17	0.006*
	Middle	1.46	0.12	1.32	0.13	0.010*
	Apical	1.53	0.19	1.45	0.23	0.191
Moderate	Cervical	1.89	0.12	1.73	0.19	0.016*
	Middle	1.89	0.21	1.72	0.24	0.005*
	Apical	1.81	0.24	1.64	0.23	0.015*
Large	Cervical	2.63	0.14	2.34	0.14	<0.001*
	Middle	2.54	0.09	2.32	0.15	<0.001*
	Apical	2.50	0.28	2.25	0.32	0.001*

*: Significant at $P \leq 0.05$

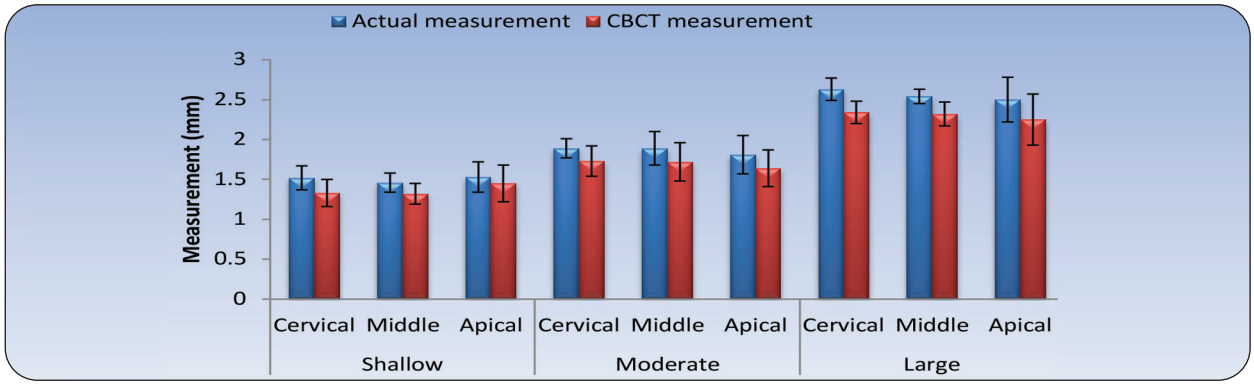

Fig. (1) Bar chart representing mean and standard deviation values for actual and CBCT cavity measurements in axial view

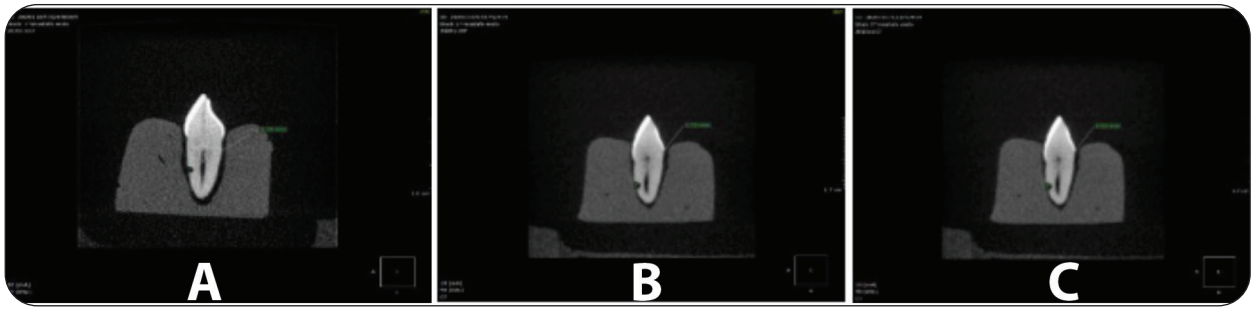

Fig. (2) CBCT image showing axial view A shallow cavity in the middle of the root B moderate cavity in the middle of the root C large cavity in the apical third of the root.

DISCUSSION

External Root Resorption occurs without any symptoms. And difficult to be detected during routine radiographic examination at early stages. when it is detected a significant loss of dental hard tissue occurred.

Intraoral radiography is generally the first choice in most clinical situations. However, this method presents limitations, such as showing a two-dimensional image of a three-dimensional object, superimposition of anatomical structures, and magnification of images.

Digital radiographs are currently preferred because of their greater sensitivity using lower radiation doses. Rapid image production, the possibility to enhance, edit the image

CBCT has proven its efficiency in diagnosing external root resorptions. by precisely determining the location and the dimensions of resorptions, allowing the establishment of adequate therapeutic measures

Results of the current study showed that the simulated cavity in the 3-cavity size (shallow, moderate and deep) was detected in the coronal, middle and apical third by both digital periapical radiograph and CBCT

In this study, the sensitivity of CBCT, digital periapical radiographs PSP in detection of cavities located in the apical one-third of the root was100% According to our findings, CBCT did not have any statistically significant superiority than digital periapical radiographs in cavity detection this result were not in full agreement with the study done by Shokri et al [5] as the exposure time for PSP was 0.40s and the operating at 300 dpi and they used small cavity size 0.5 mm.

The sensitivity of CBCT and, digital periapical radiographs PSP in detection was equal in detection

of simulated ERR defects located in the middle and cervical one-third of the root. According to our findings ,this result in full agreement with the study done by **Schröder et al.**[6]as the radiographs were obtained using a VistaScan No. 2 phosphor sensor with the following exposure parameters: 60 kVp, 7 mA, 120 volts alternating current _ 10%, and 0.175–0.25 seconds which is similar to our parameter and CBCT scan: 120 kV, 5 mA, a 0.25-mm voxel size, and a 26.9-second exposure time which is similar to our parameter.

Results of the current study showed that there was statistically significant lower mean cavity measurement than the actual measurement between (axial view) in both CBCT and ACTUAL ERR at the apical, middle, and coronal thirds. This result was in agreement with the study done by [7]as thy used cavity size 1 mm and 1.8mm and the parameter operating at 96 kVp, 7mA, 15 seconds and 55 mm x 50 mm field of view (FOV) and 0.10mm voxel sizes for high resolution which is similar to our parameter.

CBCT still delivers greater effective doses when compared to intraoral imaging. The effective dose for the **CBCT** unit utilized in the present study is higher than the effective doses from periapical radiography taken with Therefore, clinicians should use caution when prescribing **CBCT** imaging.

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الدقة التشخيصية للاشعه السينيه الرقمية والتصوير الاشعاعي المخروطي للكشف عن التآكل الخارجي المحاكي لجذور الأسنان (دراسه معمليه)

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الملخص :

الهدف: الهدف من هذه الدراسة هو تحديد الدقة التشخيصية للاشعه السينيه الرقميه و التصويرالاشعاعي المخروطي للكشف عن التاكل الخارجي المحاكي لجذور الاسنان .

المواد والأساليب : تم استخدام مجموعه 90 قواطع مركزية ذات جذور فردية واحدة تم إنشاء ثلاثة أنواع من تآكل الجذر الخارجي المصطنعة الضحلة ، المتوسطه ، والعميقة باستخدام ثاقب كروي الشكل (MEISINGER - ألمانيا) تم الحصول على صور شعاعية رقمية حول كل سن. تم الحصول على الصور التي تم فحصها من وحده التصوير الاشعاعي المخروطي لكل سن. وتم استخدام SCANORA® 3DX للحصول على صور التصوير الاشعاعي المخروطي من عينة الدراسة تم تقييم الصور الشعاعية. وتم تسجيل البيانات .تم جدولة النتائج وتحليلها إحصائياً.

ظهر متوسط قياس تجويف المصطنع لصور التصوير الاشعاعي المخروطي أقل إحصائيًا من القياس الفعلي.

النتائج: ظهر متوسط قياس تجويف المصطنع لصور التصوير الاشعاعي المخروطي أقل إحصائيًا من القياس الفعلي..

الخلاصة: لا يوجد اى فرق بين الطرقتين للكشف عن التآكل الخارجي المحاكي لجذور الأسنان

الكلمات المفتاحية: اشعه مقطعيه مخروطيه, للاشعه السينيه الرقمية, التآكل الخارجي المحاكي لجذور الأسنان ، جذور السن ,المقياس الرقمى