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Research Paper: Comparison of CBCT and Digital Periapical Radiography in Detection of Pulpal Exposure in External Cervical Root Resorption: an in-vitro study

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ABSTRACT

Introduction: pulpal exposures originated from the external cervical root resorptions have major effects, on the treatment and prognosis, that could result in tooth loss. This study was performed to compare two different imaging systems-digital radiography with PSP Sensor in three horizontal different views and CBCT images- to assess pulpal exposure in simulated cavity of external cervical root resorptions.

Materials and Methods: Eighty maxilla central incisor teeth with straight roots were included. Teeth were randomly divided to two groups (40 teeth with and 40 without pulpal exposures). Each sample was assessed digital radiography with PSP Sensor (in 3 horizontal angles) and CBCT image system, to detect the presence of pulpal exposures. False Negative and False Positive results in 2 imaging procedures were judged with ratio test.

Results: The results showed in CBCT (P.P.V = 85/7) and (N.P.V = 89/5) and in digital intraoral radiography (P.P.V = 80) and (N.P.V = 80) in proximal defects and in CBCT (P.P.V = 93 / 3) and (N.P.V = 100) and intraoral digital radiography (P.P.V = 77/8) and (N.P.V = 75) in buccal defects. In buccal defects, ratio test showed that there is a significant difference between CBCT and intraoral digital radiography technique (0/03>P) but is not significant in proximal defects (0/4>P), (Significance level was 0/05).

Conclusion: The results showed that despite the higher resolution CBCT images than digital intraoral radiography, there were no significant differences in detection of exposure in proximal surfaces between two imaging systems. The differences in detection of buccal defects was significant, the accuracy of CBCT images in detection of buccal defects was significantly higher than PSP digital radiographies

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Introduction

External cervical root resorption is a process that may result to tooth loss (1-5). The process of root resorption is a physiologic or pathologic condition that causes activation of degenerative cells (2,6,7). External cervical resorption is initiated by damage to the cementum immediately below the epithelial attachment allowing osteoclasts to colonize the damaged portion of the root (8-10). Orthodontic treatment, trauma and intra coronal bleaching may damage the cervical region of the root surface and cause initiate external cervical resorption (1,6,10-12). The Process of resorption usually develops very slowly and it is initially asymptomatic; therefore, an accurate diagnosis is essential for proper treatment (5,6,13-15).

Although conventional intraoral radiography is the method of choice of orthodontists for detecting apical root resorption during treatment, it has inherent disadvantages, especially in the diagnosis of early resorption (16). This technique has limited ability to determine the exact site and size of the lesions, especially about the buccal and lingual lesions (17). Conventional radiographs produce false negative results in 51.9% and false positive results in 15.3% of cases investigated. It has been shown that lesions under 0.6 mm in diameter and 0.3mm in depth are not detected by conventional radiography. Identify the site and size of the lesions is necessary to determine the proper treatment and the chances of success (3).

Cone Beam Computed Tomography (CBCT) is a radiographic technique using in various Diagnostic aspects (18). Because of the limitations of conventional radiography, 3-D imaging techniques such as CBCT can be useful in detection Cervical root resorption (19,20). This imaging system is useful for effective diagnosis and treatment of endodontic diseases. The Advantages of the CBCT images are removing anatomical noise, removing distortion, and high accuracy of the 3D images, in spite of digital sensors and parallel techniques which have 5% magnification (21).

pulpal exposures originated from the external cervical root resorptions have major effects, on the treatment and prognosis, that could result in tooth loss and yet researches could not compensate this lack of information; Therfore, this study was performed to compare two different imaging systems-digital radiography with PSP Sensor in three horizontal different views and CBCT images- to assess pulpal exposure in simulated cavity of external cervical root resorptions in Dental Branch of Islamic Azad University in 2019.

Material and methods

In this in-vitro study, eighty maxilla central incisor teeth without decay, fracture of the crown and roots, internal and external resorption, restoration and anomaly at the cervical site and without curvature of the canal and root were randomly,that were extracted due to periodontal disease or due to complete denture , selected. Teeth were sterilized by autoclaving after extraction. Simulation of external cervical root resorption was conducted using inverted diamond bur with 014 mm in diameter (No. 805, Tiz Kavan, Iran, Tehran) with High Speed hand piece at the proximal surfaces of 20 teeth and palatal or buccal surfaces of 20 others (at cervical) to form a cavity with dimensions of 1×1 mm^2 in both groups. 40 teeth had been exposed and 40 others had not ,Pulp exposure was performed with needle diamond bur (No. 012, Tiz Kavan, Iran, Tehran) with high speed, then a drop of Hydrochloric Acid(6N) was dripped in prepared cavity with the Sampler, kept for 10 minutes then were carved with excavator and were washed (16,17). After drying the samples, a layer of 0.2-0.4 mm (0.25 mm average) wax was applied around the roots to simulated the PDL.

Imaging methods:

The teeth were arranged on an arc made with sawdust and plaster (22,23). An acrylic ring was used to simulate the soft tissue. Digital intraoral X-ray images with parallel technique in 1 Straight angle and 2 different horizontal angles (20° mesial and distal) were prepared using Endoray film holder (Dentsply Rinn, Elgin,IL,IL,USA) and also CBCT images were

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prepared.

imaging conditions:

Intraoral digital X-ray images was provided by GROUP PSPIX Device (ACTEON¬, LA¬-CIOTAT‹¬ FRANCE) with 70 KvP and 8 mA with parallel method. The exposure's duration was 0.04 Seconds for the maxillary anterior teeth. The distance of the object to the radiation source was 20 cm. The PSP sensor was used to produce images.

CBCT images was provided by NewTom, VGi Device (NTV; QR SRL CO, Verona, Italy) within 12 seconds. Field of View of device was 8×8 cm and resolution was 0.16 mm. Images were prepared in the coronal and axial planes and multiple cross-sectional slices for each samples. The observers had the opportunity to magnify the images.

All images were coded (1 was for straight angle, a1 was for mesial angle, b1 was for distal angle and c1 was for the CBCT radiation) and arranged randomly.

evaluation of images:

Three calibrated blinded observers evaluated the images separately at two meetings with seven days interval (2 endodontists and 1 radiologist). The Kappa coefficient was used to assess interobserver agreement (6). Images was observed on 15 inches laptop LCD with 1280×1024 resolution at 40 cm distance in a semi-dark room. There was no time limitation for observers to view the images. The results were recorded for each samples.

Results:

Following results were obtained by doing this study on the obtained images from 80 samples in two groups -with and without pulpal exposure originated from external cervical root resorption- and with two imaging systems, CBCT and Intraoral Digital Radiography. Sample distribution in the exposure diagnosis of the proximal surfaces, according to actual method and CBCT can be seen in Table 1. As results, if CBCT imaging shows exposure at the proximal surfaces, the sample will have exposure with possibility of % 85.7 (P.P.V = 85/7) and if it does not show exposure at the proximal surfaces, the sample will not have exposure with possibility of 89.5% (N.P.V = 89/5). (table1)

Table 1: Sample distribution, according to pulp exposure originated from external cervical root resorption in the proximal surfaces, according to actual method and CBCT.

ACTUAL EXPOSURE OF THE PULP / IMAGING CBCT	DO NOT HAVE	HAVE	TOTAL
DO NOT HAVE	17	2	19
HAVE	3	18	21
TOTAL	20	20	40

Sample distribution in the exposure diagnosis of the buccal surfaces, according to actual method and CBCT can be seen in Table 2. As results, if CBCT imaging shows exposure at the buccal surfaces, the sample will have exposure with possibility of 93.3% (P.P.V = 93.3) and if it does not show exposure at the buccal surfaces, the sample will not have exposure with possibility of % 100 (N.P.V = 100).(table2)

Table 2: Sample distribution, according to pulp exposure originated from external cervical root resorption in the buccal surfaces, according to actual method and CBCT.

ACTUAL EXPOSURE OF THE PULP / IMAGING CBCT	HAVE	DO NOT HAVE	TOTAL
DO NOT HAVE	0	13	13
HAVE	14	1	15
TOTAL	14	14	28

Sample distribution in the exposure diagnosis of the proximal surfaces, according to actual method and digital intraoral imaging can be seen in Table 3. The results show that if digital intraoral imaging shows exposure at the proximal surfaces, the sample will have exposure with possibility of 80% (P.P.V = 80) and if it does not show exposure at the proximal surfaces, the sample will not have exposure with possibility of 80 % (N.P.V = 80). (table3)

Table 3: Sample distribution, according to pulp exposure originated from external cervical root resorption in the proximal surfaces, according to actual method and digital intraoral imaging.

ACTUAL EXPOSURE OF THE PULP / Digital Intraoral Imaging	HAVE	DO NOT HAVE	TOTAL
DO NOT HAVE	4	16	20
HAVE	16	4	20
TOTAL	20	20	40

Sample distribution in the exposure diagnosis of the buccal surfaces, according to actual method and digital intraoral imaging can be seen in Table 4. The results show that if digital intraoral imaging shows exposure at the buccal surfaces, the sample will have exposure with possibility of 77.8% (P.P.V = 77.8) and if it does not show exposure at the buccal surfaces, the sample will not have exposure with possibility of 75% (N.P.V = 75).

Table 4: Sample distribution, according to pulp exposure originated from external cervical root resorption in the buccal surfaces, according to actual method and digital intraoral imaging

ACTUAL EXPOSURE OF THE PULP / Digital Intraoral Imaging	HAVE	DO NOT HAVE	TOTAL
DO NOT HAVE	3	9	12
HAVE	7	2	9
TOTAL	10	11	21

Sample distribution according to true positive+true negative to false positive + false negative in the proximal surfaces, according to imaging method can be seen in Table 5 and shows that false positive + false negative in CBCT imaging at the proximal surfaces is 12.5% (5 samples) and false positive + false negative in digital intraoral imaging at the proximal surfaces is 20% (8 samples).

Table 5: Sample distribution according to acceptable and unacceptable diagnosis at the proximal surfaces, according to imaging methods.

Diagnosis / Imaging Methods	incorrect F.P,F.N	correct T.P ,T.N	total
CBCT	5(12.5)	35(78.5)	
Intraoral Digital	8(20)	32(80)	

Sample distribution according to true positive+true negative to false positive + false negative at the buccal surfaces, according to imaging method can be seen in Table 6. and shows that false positive + false negative in CBCT imaging at the buccal surfaces is 3.6% (1 samples) and false positive + false negative in digital intraoral imaging at the proximal surfaces is 23.8% (5 samples).

Table 6: Sample distribution according to acceptable and unacceptable diagnosis at the proximal surfaces, according to imaging methods

Diagnosis / Imaging Methods	incorrect F.P,F.N	correct T.P ,T.N	total
CBCT	1(3.6)	27(96.4)	28(100)
Intraoral Digital	5(23.8)	16(76.2)	21(100)

Ratio test showed that the difference at the buccal surfaces is significant ($p<0.03$) but at the proximal surfaces is not significant ($p<0.4$). sinanse significance level was0/05.the kappa coefficient was used to assess interobserver and intraobserver agreement that it was higher 75%.

Discussion

Pulpal exposures originated from the external cervical root resorptions have major effects on the treatment and prognosis that could result in tooth loss and yet researches could not compensate this lack of information; therefore, this study was aimed to compare two different imaging systems-digital radiography with PSP Sensor in three different horizontal views and CBCT images- to assess pulpal exposure in simulated cavity of external cervical root resorptions (3-5).

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Although the pulpal exposure diagnosis and its treatment is so important, there is no in-vitro study about it. Most of studies were performed on diagnosis of external root resorption like Mavridou (24), Von Arx(20), Kamburoglu(4) and diagnosis of internal root resorption like Estrela(6), Patel(15).

Unlike this study, Da Silveira(23), Liedke(3) and Eraso(16), Westphalen(22) and Kamburoglu(4) used different types of teeth.

Despite of other studies like Roig M(5), Estrela(6), Patel(10),Dudic A(18) this study and stidies of Liedke(3) and Kamburoglu(4) was designed in-vitro to limit patients related factors.

While some studies like Liedke(3), Westphalen(22), Da Silveira(23) used bur or acid to simulate the resorption, in this study both bur and acid were used to more clinical simulation.

In order to soft tissue simulation, Westphalen et al(22) used bovine muscle that had a possibility to transmit infections. Da Silveira(23) and Liedke(3) used wax to soft tissue simulation that the separation of wax and teeth was possible.

In this study an acrylic ring was used to simulate the soft tissue and other studies like Patel(10) did not consider the soft tissue at all.

Liedke et al(3) used plaster base for teeth that make a big difference with clinical conditions and some studies like Kamburoglu(4), Westphalen(22) used alveolar bone as a base that restricts the size and type of teeth, but in this study sawdust and plaster were used as a base to simulate the bone.

Estrela et al(6) used a single angle for digital radiography, while in this study 3 different horizontal angles were used to better comparison between CBCT and digital imaging.

In spite of this current study, in none of other researches the PDL simulation was not performed(3,4,22).

Although the CBCT has higher accuracy, the current study showed that the exposure diagnosis at the proximal surfaces is the same in both imaging systems and there is no significant difference, but there is a significant difference at buccal surfaces.

The results showed the limited ability of digital radiography in pulpal exposure diagnosis at buccal surfaces, while the diagnosis ability of both imaging systems is the same at proximal surfaces.

CBCT system can produce 3D images with no superimpositions and distortions which can beats the limitation of digital radiography.

The early detection of resorption process and exposure leads to fast and proper treatment and improves the prognosis.

Eventually, in large defects that involves more than 1 surface and buccal or palatal defects, using the 3D imaging is suggested.

Because there is no significant difference between two imaging system and advantages of digital radiography (for example; less radiation, availability, less charge) in pulpal exposure diagnosis in proximal surfaces can use the digital radiography for evaluate this detections.

The only problem in CBCT system is the effective radiation dose that can be solved with use of CBCT systems with limited field of view to decrease dosage.

Conclusion

Despite of higher accuracy of CBCT system, there is no significant difference between both imaging systems in pulpal exposure diagnosis, in proximal surfaces while there is a significant difference at buccal surfaces and CBCT images have higher diagnosis ability.

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Conflicts of interest

There are no conflicts of interest

Suggestion

Studies to evaluate pulpal exposure using different resolution of CBCT and evaluation of simulated cervical resorption with different sizes.

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