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Intra Oral Digital Radiography versus Cone Beam Computed Tomography for Detection of Infra Bony Periodontal Defects.

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Abstract

Objectives: the present study compared between cone beam computed tomography (CBCT) and intra oral digital radiography in detection of linear interproximal periodontal defects.

Patients and Methods: 20 patients complained from symptoms of chronic periodontal diseases were subjected to clinical examination using straight periodontal probe (PCP UNC 15, Hu Friedy, Chicago, IL) then examined radiographically by intraoral digital radiography using photostimulable phosphor (PSP) plate,and CBCT scans were obtained using an i-CAT system, furcation involvement was measured clinically using NABERS probe, evaluated by intraoral digital radiography and evaluated by CBCT scan. Two radiologists were instructed to measure the linear periodontal defect on both types of the scans.

Results: There was statistically significant difference between CBCT and intraoral digital radiography in measurement of linear periodontal defects (CCC ranged between 0.540 to 0.588), percentage of agreement 95.65%between CBCT and clinical measurement of furcation involvement

Conclusion: 1-CBCT provided more additional benefits over IO Digital radiography on infrabony defect assessment especially with maxillary molar teeth and when the defect extends at buccal or palatal / lingual surfaces.2-PSP was diagnostically acceptable in cases of infrabony defects at mesial or distal surfaces, FI with Grade III and Grade IV and no need for CBCT in these cases.3-There was perfect correlation between CBCT and clinical measurement of FI.

Keywords: CBCT, Digital radiology, Furcation involvement, Periodontal defects.

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Introduction:

Periodontal diseases are chronic inflammatory disease that affect the gingiva and the periodontium (a term used to describe the supportive apparatus surrounding a tooth, which includes gingiva, alveolar bone, cementum, and periodontal ligament). In addition, periodontal disease is one of the most important oral diseases and represents a major public health problem.[1]

When periodontitis occurs, this triggers the host response to defend against the bacteria which leads to destruction and loss of attachment of the periodontium and finally progresses to alveolar bone loss, resulting in loss of the affected tooth.[2] The most important thing in managing periodontitis is timely and accurate diagnosis, as the diagnosis of the periodontitis is difficult because it is found without symptoms, first it appears as gingivitis with its symptoms like redness, swelling of the gingiva, bleeding upon brushing.[3] Accurate diagnosis requires recording probing depth and clinical attachment at six sites per tooth[4].and couldn't be achieved without interpretation of radiographic data including severity and pattern of bone loss.[5]

The accuracy of intra-oral radiography for the evaluation of bony defects depends on the degree of bone loss as it is showed that it is underestimated in the initial diseases and may be overestimated in case of sever diseases.[6] The periodontal defects are more accurate to detected by digital radiography and this is can be achieved by a number of methodologies for computerized analysis of digital intra-oral images. Cone beam computed tomography (CBCT) scanning has become valuable imaging modality in the field of periodontology for the detection of very small osseous defects[7] that it can predict of disease from the beginning as it provides accurate information of periodontal space and lamina dura, besides. In case of furcation involvement CBCT can be used in accurate diagnosis of furcation involvement and its classes clearly without any overlapping or distortion.[8]

Patients and methods

Patient selection:

This study was expedited from the Faculty of Dentistry Ain Shams University research ethics committee. All patients were informed by the procedure and a detailed written consent was signed. Twenty patients of both sexes (7 females and 13 male ranging in age between 18-60 years) were selected from Oral Medicine and Periodontology Department Faculty of Dentistry Ain Shams University (60 maxillary and mandibular teeth were examined (45 molars and 15 premolars)

- Inclusion criteria for our study were 1) patients complaining of chronic periodontal diseases with bleeding upon probing and deep periodontal pockets. 2) patients with at least two posterior infra bony periodontal defects in the same jaw with probing depth > 5mm in at least one of the interproximal aspects of the tooth. 3) completion of the initial treatment by exposing to scaling and oral hygiene measures.
- Exclusion criteria were 1) pregnant women 2) Patients with systemic diseases which affect bone as Diabetes and Osteoporosis. 3) patients had metal prothesis.4) sever crowding of dentition.
- *Patients in our study were subjected to the following:*

A: Clinical examination.

- measuring probing depth (**PPD**) distance from the free gingival margin (**FGM**) to the base of the sulcus and vertical probing attachment level (**CAL-V**) distance from cemento enamel junction (**CEJ**) to the base of the sulcus at six sites per tooth (mesiobuccal, buccal, distobuccal, disto-lingual, lingual and mesio-lingual) encircling the tooth using straight periodontal probe (PCP UNC 15, Hu Friedy, Chicago, IL)

In case of molar teeth, furcation involvement measurement performed using (NABERS

probe) recorded according to Glickman's classification.[9]

- Grade I involvement: it is the incipient or early lesion. The pocket is supra-bony, involving the soft tissue; there is slight bone loss in the furcation area, bone loss < 2 mm into the furcation area.
- Grade II involvement: the bone is destroyed on one or more aspects of the furcation, but a portion of the alveolar bone and periodontal ligament remain intact, thus allowing only partial penetration of the probe into the furcation area, bone loss deeper than 2 mm but less than6 mm into the furcation area.
- Grade III involvement: the inter-radicular bone is completely absent, but the facial and/or lingual orifices of the furcation are occluded by gingival tissue. Therefore, the furcation opening cannot be seen clinically, but it is essentially a through and through, these lesions will appear on the radiograph as a radiolucent area between the roots.
- Grade IV involvement: the inter-radicular bone underneath the roof of furcation is completely destroyed. The gingival tissue is also receded apically so that the furcation opening is clinically visible. The radiographic image is essentially the same as in grade III lesions.

B: Radiographic examination:

I. Image acquisition:

After clinical examination of the patients and diagnosis of each case, all patients included were exposed to two radiographic imaging techniques at the Oral Radiology, department, Faculty of Dentistry, Ain Shams University as follows:

1- Intra oral indirect digital radiograph using Digora-Optima system (Orion Corp.; Soredex, Helsinki, Finland) system and reusable photostimulable phosphor plate (PSP) size two. Using XGenus Dental X-Ray Radiography System TG Group X Genus Intraoral X-Ray operating at 70 kVp, 8 mA, 2.5 mm Aluminum filtration, focal spot size 0.7 mm and the exposure time selected was 0.1sec. The paralleling technique was applied using plastic film holder (DENTSPLY XCP-DS; DENTSPLY, Elgin, IL, USA) attached to a metal arm with a cone-guiding ring to stabilize the intra oral receptor in position.

2- 2-CBCT images were obtained using an i-CAT CBCT (Imaging Sciences International, Hatfield, PA), with 120 kV and 5 mA. The field of view (FOV) was (diameter 16- height 4cm) and the voxel size (0.125×0.125×0.125 mm)[10] and the exposure time was 20 seconds.

II. Image analysis

- **Intra oral indirect digital radiograph:**

After image acquisition, images were subjected to adjustment of brightness and contrast, then linear measurements were performed using the measurement tool **Fig (1).**

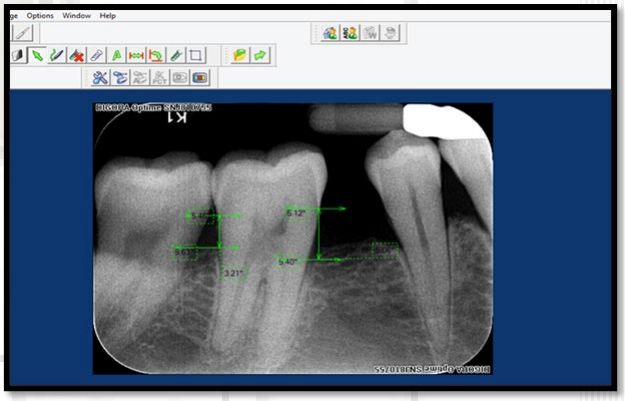

Fig. (1): linear measurement of periodontal defect using digital intraoral radiograph.

- We measured at the mesial and distal surfaces from cemento enamel junction to the bony defect. As well as evaluation of furcation involvement was performed and we recorded the cases as present or not present.

2. **CBCT image analysis:**

- The images saved as DICOM files and transferred to a 3rd party software On Demand (Cybermed, Seoul, South Korea)bright and contrast were adjusted then analysed by axial, cross-sectional and sagittal reconstructions with (.02) millimeter slice thicknesses, on the sagittal cut we adjust the axial plane to tangent the bone level at the furcation area, on the axial cut we adjusted the sagittal plane to be once on the buccal border , on middle and once on lingual border to measure the defect using the measurement tool on the sagittal view and this repeated on the mesial and distal side. **Fig (2,3)**

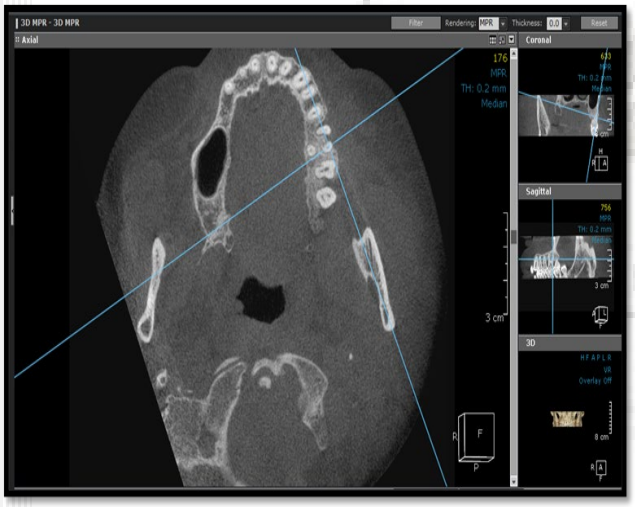

Fig. (2): Adjusting of the sagittal plane at the buccal border on the axial cut.

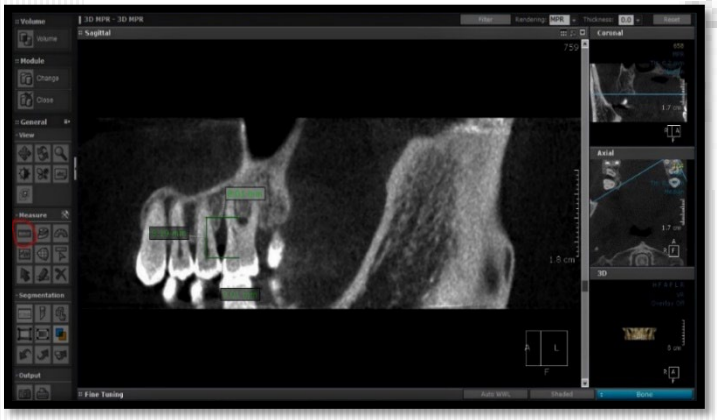

Fig. (3): Measuring linear defect from CEJ to AC on sagittal cut.

- Furcation involvement was evaluated by measuring the depth of FI on axial view where the slice showed the greatest amount of bone loss. On this slice, a line was drawn tangentially to the adjacent root surfaces. The distance from this line to the deepest point of bone loss was measured as the amount of furcation bone loss. In case of trifurcation assessment as in upper molars buccal, mesio-palatal and disto-palatal furcation bone loss were measured for maxillary molars **Fig. (4)**

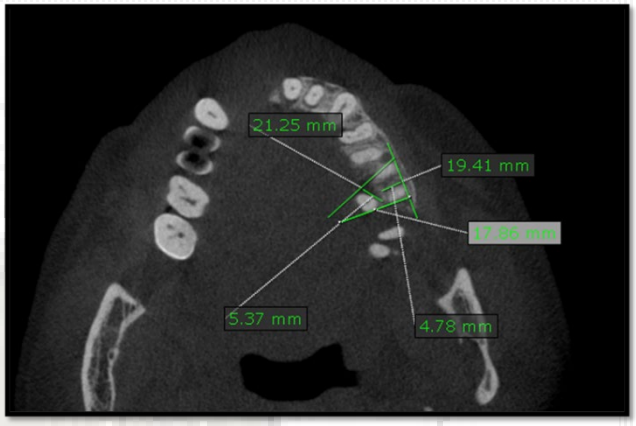

Fig (4): Furcation involvement measurement on axial cut where measurement at the buccal side was 4.78mm class II and measurement at mesiopalatal side was 5.37 mm class II. Bone loss deeper than 2 mm but less than6 mm into the furcation area.

Results:

Linear measurement.

Concordance Correlation Coefficients of both mesial and distal show just fair agreement of Digora and CBCT for both observers, mean of difference with negative values indicating overestimation of Digora when compared to CBCT.

Relative Dahlberg Errors ranged between (17.7% - 23.4%) > 5 suggesting poor error value between CBCT and Digora in detection of linear periodontal defects.

These results showed there was statistically significant difference between CBCT and Intraoral Digital radiography in measurement of linear periodontal defect. (CCC ranged between 0.540 to 0.588)

Table (1): shows assessment between CBCT and digora in linear measurement of the periodontal defect.

									Bland & Altman Limits of Agreement (LOA)		Concordance Correlation Coefficient		
							Mean of Difference	SD of the Difference	95%confidence limits			95%confidence limits	
			Mean	SD	DE	RDE			Lower	Upper	CCC	Lower	Upper
Observer One Reading 1	Mesial	Digora	5.29	1.56	1.11	23.4%	-0.5391	1.49	-3.45	2.38	0.569	0.366	0.720
		CBCT	4.75	1.76									
	Distal	Digora	5.08	1.29	0.85	17.8%	-0.3203	1.17	-2.61	1.97	0.586	0.414	0.717
		CBCT	4.76	1.33									
Observer One Reading 2	Mesial	Digora	5.28	1.55	1.07	21.2%	-0.5619	1.42	-3.34	2.22	0.588	0.382	0.739
		CBCT	4.72	1.72									
	Distal	CBCT	5.05	1.24	0.84	17.7%	-0.2852	1.17	-2.57	2.00	0.569	0.371	0.718
		Digora	4.77	1.32									
Observer Two Reading 1	Mesial	Digora	5.29	1.56	1.09	21.6%	-0.5444	1.45	-3.39	2.30	0.579	0.374	0.730
		CBCT	4.74	1.73									
	Distal	Digora	5.04	1.24	0.85	17.7%	-0.2249	1.19	-2.56	2.11	0.555	0.381	0.691

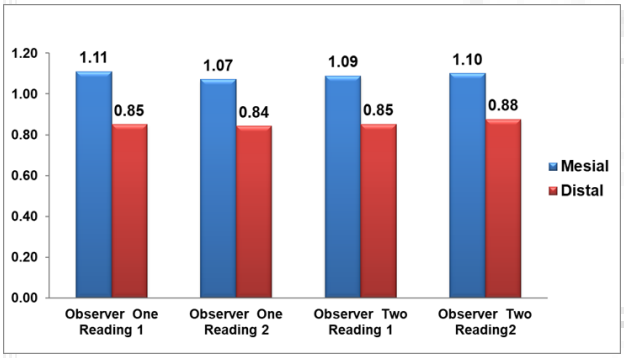

Fig. (6): Shows Dahlberg Error for Digora and CBCT with values relatively larger for mesial than distal side of both observers.

Table (2): shows correlation between CBCT and clinical measurement of furcation involvement

		CBCT			
		Class I	Class II	Class III	Total
probing measurement according to GLICKMAN'S Classification	Class I	1 50.0 %	1 50.0 %	0 0.0%	2 100.0%
	Class II	0 0.0%	19 100.0%	0 0.0%	19 100.0%
	Class III	0 0.0%	0 0.0%	2 100.0 %	2 100.0%
	Total	1 4.3%	20 87.0 %	2 8.7%	23 100.0%

The results showed Percentage of agreement 95.65%between CBCT and clinical measurement of furcation involvement. Standard kappa, k was 0.84 which suggest perfect agreement. With 95 % Confidence limits was for lower teeth 0.53 and upper teeth was 1.15.

Discussion:

Periodontitis is the leading cause of tooth loss in adults worldwide. Individuals with severe periodontal disease are at risk for extensive tooth loss, edentulism, and masticatory dysfunction. Early diagnosis of the periodontal diseases prevents further loss of tooth structure.[11]

Plain conventional radiography is the most commonly used method for diagnosis of periodontal defects because of low cost, convenience and high resolution however, conventional 2D image is hard to detect 3D structures especially periodontal defects so, third dimension is important in order to identify the nature and course of the defect.[12]

So, this study was performed to compare CBCT scans and PSP in detection of periodontal defects as **Ruetters M et al** [13]who performed their study to investigate the accuracy of CBCT and PA in imaging periodontal defects using Bland-Altmann plots. This also was in accordance with **Bagis N et al** [14] who performed their study to Compare intraoral radiography and CBCT for the detection of periodontal defects. So, the present study was performed to correlate clinical findings with 2D and 3D images.

In our study we selected patients with infrabony defects similar to **Nibali L et al**[15] who compared the accuracy of digital and CBCT in detection of the defect. IN this study periodontal examination was done, i.e., periodontal probing and attachment loss in six sites per tooth (disto-buccal, mid-buccal, mesio-buccal, disto-palatal/lingual, mid-palatal/lingual, mesio-palatal/lingual). When this approach is adopted, there are few chances of misdiagnosis of periodontal diseases as **Kingman A et al**[16] reported. Furcation involvement measurement was performed using Nabers probe similar to **Gusmão ES et al**[17] and **Suphanantachat S et al** [18]

In accordance with **Ruetters M et al** [13]and **Wolf B et al** [19] we measured the defect from the cemento enamel junction (CEJ) to the bottom of the defect (BD).In our study there was statistically significant difference between digora and CBCT in detection of infrabony periodontal defects similar to **De Faria Vasconcelos K et al** [20] who reported that there were differences between CBCT and intaoral radiology when the distance between the cemento-enamel junction (CEJ) and the alveolar crest (AC) was measured but there were no statistically significant differences between the imaging methods in terms of identification of the pattern of bone loss.

There was excellent agreement between CBCT and clinical measurement of furcation involvement in our study and we compared the classification of furcation involvement clinically with CBCT and reported excellent agreement similar to **Vandenberghe B et al** [21], **Suphanantachat et al** [18]**and Braun X et al** [22]who reported in their study that CBCT has superiority in detection of furcation involvement when compared with intra oral digital radiography.

Conclusion:

Based on the results of our study we concluded the following:

1- CBCT provided more additional benefits over IO Digital radiography on infrabony defect assessment especially with maxillary molar teeth and when the defect extends at buccal or palatal / lingual surfaces.
2- PSP was diagnostically acceptable in cases of infrabony defects at mesial or distal surfaces, FI with Grade III and Grade IV and no need for CBCT in these cases.
3- There was perfect correlation between CBCT and clinical measurement of FI.

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