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COMPARISON BETWEEN THE VALIDITY OF USING INTRA-ORAL RADIOGRAPHS AND CBCT IN DETERMINATION OF FURCATION THERAPY

Mahmoud Ashraf Said Sayed [1*], Mostafa Hosny [2], Abd El-Fattah M. Amer [3]

ABSTRACT

Objectives: The present study Assessed, the Intra-oral radiographs Vs CBCT to determine furcation involvement and their response to treatment. **Subjects and methods:** Twenty patients suffering from moderate to severe generalized chronic periodontitis, according to the criteria of Armitage were enrolled in this study. They were subjected to intra-oral radiographs and Cone-Beam Computed Tomography before and after Furcation involvement therapy. **Results:** Both intra-oral radiographs and CBCT were effective to determine furcation involvement as well as the response to preformed treatment. The difference between CBCT vertical and Clinical attachment loss(CAL), before was lower (0.19) than the difference between Intra-oral radiograph and Clinical attachment loss (1.10), establishing the validity of CBCT to assess furcation, The difference between CBCT vertical and CAL, recorded initially and after therapy was lower (0.39) than the difference between Intra-oral radiographs and CAl (0.47), Denoting the validity of CBCT in furcation assessment. **Conclusion:** There is no significant difference between measurements taken using CBCT and measurements taken by Clinical attachment loss. CBCT Proved to be a valuable tool in identification of furcation involvements and their responses to Performed therapy compared to that obtained wit intra-oral radiographs.

KEYWORDS: Chronic periodontitis, furcation involvement, CBCT, IOPA.

INTRODUCTION

Furcation involvement is defined as the pathologic resorption of bone within the furcation area of multirooted teeth and is a result of a progression of periodontal disease into this area. Furcation involvement has been considered as the most prognostic factor for the survival of the molars[1]. Treatment of furcation involvement represents a challenge to clinicians, due to the anatomy of the furcation as well as the limited physical access to the area. Therefore, it is often appropriate for early manifestations of these lesions to be evaluated and managed by the periodontist [2, 3].

Diagnosis of the furcation involvement requires careful examination and is based on applying various methods such as measurement of probing pocket depth (PPD), determining the clinical attachment level (CAL), the probing of furcation entrance,

1. Masters Candidate, Dentist at Egyptian Ministry of Health
2. Associate Professor of Oral medicine, Periodontology, Diagnosis and Oral Radiology, Faculty of Dental Medicine (Boys-Cairo), Al -Azhar University
3. Professor of Oral medicine, Periodontology, Diagnosis and Oral Radiology, Faculty of Dental Medicine (Boys-Cairo), Al -Azhar University

• ***Corresponding author*:** mahmoudashrafsaid@gmail.com

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as well as performing periapical radiographs[4]. However, dental radiography is an adjunct to clinical examination and represent a valuable aid in the diagnosis of periodontal diseases, determination of prognosis and the assessment of treatment outcomes. Intraoral radiographs have been used for a long time to assess the bone loss in furcation-involved teeth, but they have some limitations that can lead to incorrect diagnosis of some cases [5]. Additionally, these images are not accurate enough regarding the assessment of furcation involvement due to the overlap of anatomical structures and the lack of three-dimensional (3D) information that can be gained [6].

During the last two decades, Cone-Beam Computed Tomography (CBCT) has established itself as a lower-cost alternative to conventional CT, with high image quality, reduced radiation exposure, and small footprint suitable for the dental offices [7, 8]. CBCT generates images with excellent morphologic details and dimensional accuracy and eliminates the structural distortion and overlapping commonly encountered in 2D imaging [9, 10].

It should be emphasized that, treatment of furcation involvement should be intended to meet two objectives: elimination of microbial plaque from the exposed surfaces of the root complex and the establishment of an anatomy of the affected surfaces that facilitate the proper self-performed plaque control [11]. However, the current diagnostic methods lack consistency and have many limitations. Accurate clinical analysis of the furcation is not possible most of the times due to limited access to the depth of the furcation, morphologic variations, and measurement errors. There is little evidence regarding the comparison of intra-oral radiograph and cone beam computed tomography (CBCT) on the assessment and management of furcation involvement. In view of these, it seems to be of value to compare the intra-oral radiograph and cone-beam computed tomography in diagnosis and management of furcation involvement.

SUBJECTS AND METHODS

Study design: Observational descriptive study.

The study setting and population: Twenty patients ranged in age between 35.0-55.0 years with a mean age of 51.40±3.93 years suffering from moderate to severe generalized chronic periodontitis according to the criteria of Armitage [12] were enrolled in this study. They were selected from those attendant outpatient clinics in the Department of Oral Medicine, Periodontology, Diagnosis and Oral Radiology at faculty of Dental Medicine, Al-Azhar University. Research procedures were explained to all patients, and they were signed on informal written consent.

Eligibility criteria of population

The inclusion criteria were as follows:

Patients aged between 35–55 years of both sexes, systemically healthy patients according to criteria of Cornell Medical Index [13]. The presence of intrabony defects, with probing depth ≥5mm, with at least one molar with Grade II furcation involvement indicated for periodontal treatment.

The exclusion criteria were as follows:

Patients having clear furcation seen clinically with dental caries, pregnant women, and Patients with metal crowns in the CBCT irradiation area.

All participants were clinically examined thoroughly using

1. Gingival Index of Loe and Silness [14] .
2. Plaque Index of Silness and Loe [15].
3. Probing Pocket depth using Nabers probe
4. Clinical Attachment loss measurements
5. Radiographic evaluation which the patients were subjected to intra-oral radiograph before and after periodontal treatment. They were subjected also to Cone-Beam Computed Tomography before and after periodontal treatment.

Interventions: All patients received Phase I periodontal therapy including oral hygiene instructions & scaling and root planning. Re-evaluation was done 4 and 8 weeks later, according to the situation of the indicated therapy carried out. After the completion of the nonsurgical periodontal treatment, clinical evaluation of furcation was performed, using Williams graduated periodontal probe (Hu-Friedy, Chicago, IL, USA) was used to measure vertical component measurements and Nabers probe (Hu-Friedy, Chicago, IL, USA) was used for horizontal component measurements. Vertical component was measured from CEJ until resistance was felt in mid buccal area after placing stent [Figure 1]. Horizontal component was measured with Nabers probe. Probe was penetrated till resistance was felt [Figure 1].

Radiographic measurements of Furcation

Intraoral radiograph: Measurement of the furcation defect was performed using intraoral radiographs for all patients before and after treatment Fig (1).

Cone beam computed tomography: Patients were further scanned using CBCT (Planmeca Proface, Finland) using field of view 8*10, voxel size 150 micron. The CBCT DICOM format were exported to dedicated software (Planmeca Romexis software version 5.3.4.39).

One trained observer blinded to the clinical findings, assessed the full CBCT volumes for furcation. CBCT assessments were performed on two separate occasions Fig (1).

Measurements

Vertical component measurements (Fig 1): Cementoenamel junction (CEJ) was identified and a horizontal line joining the CEJ was made from mesial to the distal side of the tooth. A perpendicular line to the first line was made in such way that it runs from the middle of the tooth to the middle of the furcation till the alveolar crest. This distance between the alveolar crest and the point where this line meets the first line was measured.

Horizontal component measurements (Fig 1) a line was drawn from the most buccal end of one root to the other. A perpendicular line was drawn to the first line from the center of first line till the bone trabeculae starts.

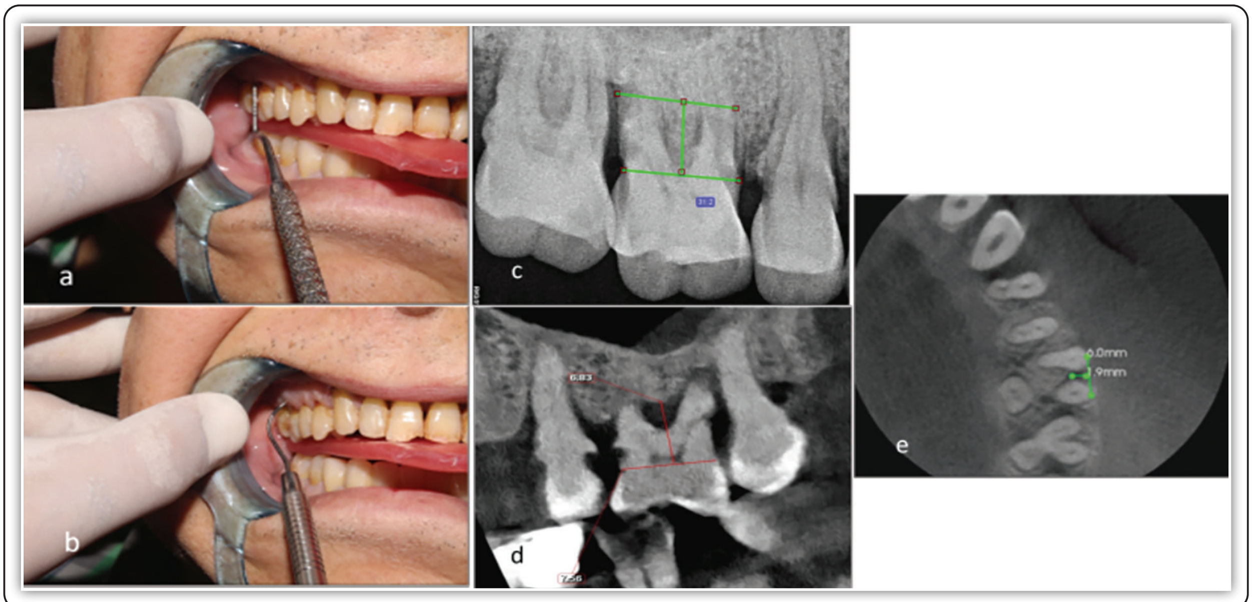

FIG (1) **a.** Intraoral clinical photograph detecting vertical furcation involvement of the maxillary right first molar using graduated periodontal probe. **b.** Intraoral clinical photograph detecting horizontal furcation involvement of the maxillary right first molar using Nabers periodontal probe. **c**. Intra-oral radiograph measurement of vertical component. **d**. Cone beam computed tomography measurement of vertical component. **e**. Cone beam computed tomography measurement of horizontal component.

Statistical analysis of the data: Data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

RESULTS

Twenty patients ranged in age between 35.0 – 55.0 years with a mean age of 51.40 **±** 3.93 years included in the present study. Cases were 12 (50.0%) males and 8 (40.0%) females. Regarding to gingival index, Plaque index, probing depth, and Clinical attachment loss before and after: Studied cases showed a statistically a significant decrease in mean gingival index plaque index, probing depth, and Clinical attachment loss after treatment ($p<0.001^*$). Table (1)

TABLE (1) Comparison between different periods according to clinical parameters (n = 20)

	Before	After 4 weeks	After 8 weeks	P
Gingival index	1.05 ±0.10	0.85 ±0.10	0.57 ±0.12	<0.001*
p_0		<0.001*	<0.001*	
Plaque index	0.94 ±0.08	0.74 ±0.08	0.53 ±0.11	<0.001*
p_0		–	<0.001*	
Probing depth	6.12 ±0.51	5.73 ±0.46	5.54 ±0.45	<0.001*
p_0		<0.001*	<0.001*	
Clinical attachment loss	5.89 ±0.47	5.53 ±0.46	5.33 ±0.46	<0.001*
p_0		<0.001*	<0.001*	

Data was expressed by using Mean ± SD.

F: F test (ANOVA) with repeated measures, Sig. bet. Periods was done using Post Hoc Test (adjusted Bonferroni)

p: p value for comparing between the studied periods

p0: p value for comparing between before and each other period

**: Statistically significant at p ≤ 0.05*

Regarding CBCT Vertical measurements, studied cases showed a statistically a significant decrease in mean CBCT Vertical measurements after treatment ($p<0.001^*$). Regarding CBCT Horizontal measurements, studied cases showed a statistically a significant decrease in mean CBCT Horizontal measurements after treatment ($p<0.001^*$). Regarding Intra-oral radiograph measurements, studied cases showed a statistically non-significant decrease in mean Intra-oral radiograph measurements after treatment ($p<0.001^*$). Table (2)

TABLE (2) Comparison between before and after treatment according to CBCT (n = 20)

	Before	After	P
CBCT			
Vertical	5.72 ± 0.47	5.14 ± 0.45	<0.001*
Horizontal	3.35 ± 0.31	3.19 ± 0.31	<0.001*
Intra-oral radiograph	5.19 ± 0.93	5.13 ± 0.44	0.788

Data was expressed by using Mean ± SD.

t: Paired t-test

p: p value for comparing between before and after

**: Statistically significant at p ≤ 0.05*

There was a statistically significant highly positive correlation between Clinical attachment loss and CBCT vertical before and after 4 and 8 weeks ($p<0.001^*$). Pearson coefficient revealed strong positive correlations between CBCT and Clinical attachment loss measurements, thereby establishing the validity of CBCT in periodontal assessment. Pearson coefficient revealed non-significant correlations between Intra-oral radiograph and Clinical attachment loss measurements before and after 4 and 8 weeks (p=0.904, 0.402 & 0.402 respectively). Table (3)

TABLE (3) Correlation between clinical attachment loss with CBCT vertical and Intra-oral radiograph

	Clinical attachment loss					
	Before		After 4 weeks		After 8 weeks	
	r	p	r	P	R	p
CBCT vertical	0.976	<0.001*	0.996	<0.001*	0.996	<0.001*
Intra-oral radiograph	0.029	0.904	0.198	0.402	0.198	0.402

r: Pearson coefficient **: Statistically significant at p ≤ 0.05*

The difference between CBCT vertical and Clinical attachment loss, before treatment was lower (0.19) than the difference between Intra-oral radiograph and clinical attachment loss (1.10), establishing the validity of CBCT in functional assessment. Table (4)

TABLE (4) Comparison between Clinical attachment loss and CBCT vertical, Intra-oral radiograph before (n = 20)

	Clinical attachment loss	CBCT vertical	Intra-oral radiograph
Mean ± SD.	5.89 ± 0.47	5.72 ± 0.47	5.19 ± 0.93
Difference		**0.19**	**1.10**
% Difference		**3.25**	**18.40**
p		<0.001*	0.007*

p: p value for **Paired t-test** *for comparing between* **Clinical attachment loss** *and other*

**: Statistically significant at p ≤ 0.05*

The difference between CBCT vertical and Clinical attachment loss, after was lower (0.39) than the difference between Intra-oral radiograph and Clinical attachment loss (0.47), establishing the validity of CBCT in functional assessment. Table (5)

TABLE (5) Comparison between Clinical attachment loss and CBCT vertical, Intra-oral radiograph after 4 weeks (n = 20)

	Clinical attachment loss	CBCT vertical	Intra-oral radiograph
Mean ± SD.	5.53 ± 0.46	5.14 ± 0.45	5.13 ± 0.44
Difference		**0.39**	**0.47**
% Difference		**7.08**	**8.05**
p		<0.001*	0.006*

p: p value for **Paired t-test** *for comparing between* **Clinical attachment loss** *and other*

**: Statistically significant at p ≤ 0.05*

The difference between CBCT vertical and Clinical attachment loss, after was lower (0.19) than the difference between Intra-oral radiograph and Clinical attachment loss (0.46), establishing the validity of CBCT in functional assessment. Table (6)

TABLE (6) Comparison between Clinical attachment loss and CBCT vertical, Intra-oral radiograph in after 8 weeks (n = 20)

	Clinical attachment loss	CBCT vertical	Intra-oral radiograph
Mean ± SD.	5.33 ± 0.46	5.14 ± 0.45	5.13 ± 0.44
Difference		**0.19**	**0.46**
% Difference		**3.57**	**8.33**
p		<0.001*	0.141

p: p value for **Paired t-test** *for comparing between* **Clinical attachment loss** *and other*

**: Statistically significant at p ≤ 0.05*

DISCUSSION

Chronic periodontal diseases are inflammatory conditions affecting the periodontium and are currently considered as one of the most prevalent oral diseases affecting the adult population[16]. Proper diagnosis is extremely crucial to determine the prognosis and adopt an adequate treatment strategy. Diagnosis of furcation involvement is based on many methods such as probing pocket depth (PPD), determining clinical attachment level (CAL), probing of furcation entrance, and periapical radiographs [17,18].

The correct diagnosis of furcation involvement with Class II seems especially important because at these sites a regenerative surgical procedure might be a possible treatment of choice [19, 20] . Hence, accurate diagnosis is a necessity for appropriate treatment to be carried out and to achieve optimum clinical results. Furcation involvement diagnosis includes the amount of horizontal and vertical bone loss in the furcation area and evaluation of root morphology, length of root trunk, and the angle of root separation[21]. Clinical diagnosis seems to be difficult at times or error some due to lack of proper knowledge and inter-examiner related bias. Furthermore, other methods such as IOPA radiographs have its own limitations of reflecting only 2D structures. CBCT has set a new avenue for the accurate diagnosis of furcation involvement and has proved to be better as compared to conventional imaging modalities [22].

In the current study, the established Hamp classification was modified by a sub-classification of furcation involvement (FI) degree II. This sub classification allowed to differentiate horizontal loss of periodontal tissue exceeding 6 mm without detectable "through and through" destruction[23]. Also, three sections of the CBCT were used to analyze the furcation area and several morphological variations like root proximity or root fusion were detected. Owing to various morphological factors such as long root trunks, root concavities, bifurcation ridges and small furcation entrances, these contribute considerably to the difficulties in accurately assessing the FI clinically[24].

Despite many studies that have been carried out, there is still a need to add more data to make a decision regarding the method that should be followed for accurate diagnosis of furcation defects and to evaluate postsurgical results. The present study compared between the intra-oral radiographs and cone beam computed tomography in determination the furcation involvement and their response to the planned treatment. Twenty patients with a mean age of 51.40±3.93 years, 12 (50.0%) males and 8 (40.0%) females) were included. Cases' results showed a statistically a significant decrease in mean Gingival index, Plaque index, probing depth, and Clinical attachment loss after treatment. There was a statistically significant highly positive correlation between Clinical attachment loss and CBCT vertical before and after 4 and 8 weeks ($p<0.001^*$). Pearson coefficient revealed strong positive correlations between CBCT and Clinical attachment loss measurements, thereby establishing the validity of CBCT in periodontal assessment. Pearson coefficient revealed non-significant correlations between RVG and Clinical attachment loss measurements before and after 4 and 8 weeks (p=0.904, 0.402 & 0.402 respectively).

The difference between CBCT vertical and Clinical attachment loss, before treatment was lower (0.19) than the difference between RVG and Clinical attachment loss (1.10), establishing the validity of CBCT in functional assessment. The difference between CBCT vertical and Clinical attachment loss, after treatment was lower (0.39) than the difference between RVG and Clinical attachment loss (0.47), establishing the validity of CBCT in functional assessment. The difference between CBCT vertical and Clinical attachment loss, after treatment was lower (0.19) than the difference between RVG and Clinical attachment loss (0.46), establishing the validity of CBCT in functional assessment.

Presumably, CBCT is more accurate than panorama/bitewing (PA/BW) for periodontal assessment, because it does not involve the magnification and distortion that are commonly associated with intraoral radiography. In addition, CBCT, like CAL, measures both the buccal and palatal/lingual sides of the interproximal contact areas of teeth, unlike PA/BW, which allows only one measurement with no distinctions between the buccal or palatal/lingual sides. This could probably explain why there is a higher association of DVT with CAL compared to PA / BW with CAL.

According to Misch et al.(25), conducted a study in 2006 that created artificial bone defects in the mandible in dry skulls and found that CBCT measurements were similarly accurate to direct measurements with a periodontal probe in the cheek and speech defects. In addition, Banodkar et al. (26) in 2015 tested the accuracy of CBCT measurements of alveolar bone defects caused by periodontal disease by comparing them to actual surgical measurements, which are the gold standard. They concluded that DVT was very accurate in measuring periodontal defects and was a very useful tool in periodontal diagnosis and treatment evaluation.

The accuracy of CBCT imaging in assessing maxillary molar furcation involvement was compared to results obtained at the time of furcation surgery. The CBCT and intra-surgical assessments presented a strong agreement. CBCT demonstrated high accuracy in assessing the loss of periodontal tissue in areas with furcation involvement (27).

Findings were consistent with those of Feijo et al.(28), in 2012, confirmed the accuracy of CBCT in measurements of horizontal periodontal bone defects. Six patients with 8 maxillary molars were evaluated. The authors concluded that there was no difference between CBCT and clinical measurements. Moreover Grimard et al.(29) in 2009 compared the measurements from digital intraoral radiographs (IRs) and CBCT images to direct surgical measurements for the evaluation of regenerative treatment outcomes. The authors have concluded that compared to direct surgical measurements CBCT was significantly more precise and accurate than IRs.

When CBCT was compared to traditional two-dimensional intraoral radiographs employing a digital RVG, CBCT imaging was found to be superior for the imaging of defect shape, lingual or buccal furcation defects and furcation involvement although more bone detail like bone quality, contrast and lamina dura was present on the RVG (30,31).

The results further demonstrate that CBCT provides substantial additional information about the root morphology and the residual attachment of maxillary molars. In addition to the degree of furcation, this study verified the accuracy of CBCT on the 3D measurements of FI bone level in vivo. These CBCT-derived data can help in understanding the severity and morphology of bony defects of the furcation lesion and provide more evidence for periodontal diagnosis and treatment planning. Feijo et al. 2012 (28), evaluated the accuracy of CBCT in the measurement of horizontal periodontal bone defects. They measured periodontal bone defects of eight maxillary molars during surgery and compared the results with data taken from CBCT images. The results showed that CBCT accurately reproduced the clinical measurement of horizontal periodontal bone defects.

Zhong et al.(32) evaluated the accuracy of the measurement of second-order involvement in dry mandibular molars by CBCT. They measured the vertical defect dimension, the horizontal defect dimension, and the input scattering dimension for each FI by scan and CBCT, and found that CBCT can provide accurate and detailed 3D images of the magnitude of second order correlations. In conclusion, the use of CBCT in advanced periodontal disease diagnosis appears to be more informative and prudent. A comprehensive assessment of furcation involvement is possible with CBCT and further to optimize treatment decisions. Although it may seem that the results indicate towards a better insight of details in Grade II furcation defects, the same can be applied to other types of periodontal defects, which may be evaluated and confirmed in additional investigations in future.

CONCLUSION

Within the limitation of the present study it can be concluded that: There is no significant difference between measurements taken using CBCT and measurements taken by Clinical attachment loss. CBCT is an accurate way in assessing furcation defects. Although it may seem that the results indicate towards a better insight of details in Grade II furcation defects, the same can be applied to other types of periodontal defects, which may be evaluated and confirmed in additional investigations in future.

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