

## Accuracy of Cone Beam Computed Tomography in the Assessment of Mandibular Molar Furcation Defects

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### Abstract

**Objective:** To evaluate the accuracy of cone-beam computed tomography (CBCT) in the assessment of mandibular molar furcation defects. **Material and Methods:** Thirty patients with furcation defects were selected, oral hygiene instructions, scaling, and root planing with ultrasonic devices and hand instruments and occlusal adjustments were performed. Pre-surgical clinical measurements were carried out at the buccal aspect of the selected mandibular molars. The horizontal furcation measurements were measured with a Nabers Probe starting at the furcation entrance to the greatest horizontal depth. The degree of furcation involvement was graded from 0 to III. Bone loss in the horizontal and vertical direction and the width of the furcation entrance were measured on CBCT and after reflecting the full-thickness flap and debridement of the defects. The data were analyzed using t-test and Pearson's correlation coefficient. **Results:** The width of furcation entrance in clinical method was  $3.27 \pm 0.77$ , while in CBCT method was  $3.35 \pm 0.71$ , clinically the vertical bone loss was  $3.61 \pm 1.09$ , while in CBCT was  $3.57 \pm 1.15$ , horizontal bone loss in clinical method was  $5.08 \pm 2.21$ , while in CBCT was  $5.11 \pm 2.23$ . No significant difference between the two methods was noted, and a high correlation between the two methods was observed. With regards to the agreement between the two methods of assessment, the width of furcation entrance revealed a difference between the two methods by  $0.08 \pm 0.21$ , while vertical bone loss showed difference between the two methods by  $-0.04 \pm 0.19$ , the horizontal bone loss showed a mean difference between the two methods by  $0.03 \pm 0.21$ . **Conclusion:** CBCT provided high accuracy for the furcation involvement detection and anatomy of surrounding periodontal tissues.

**Keywords:** Cone-Beam Computed Tomography; Furcation Defects; Molar.

## Introduction

Periodontal diseases are among the most common conditions affecting humans [1]. The extension of periodontal disease into the bi- or trifurcation of multi-rooted teeth is known as furcation involvement (FI). Periodontists commonly find a great challenge in assessing and treating furcations affected by periodontal disease. Complex anatomy and morphology of the molars pose difficulty for the effective and thorough instrumentation of the furcation defects [2].

The precise diagnosis of periodontal disease affecting a furcation requires the evaluation of the patient's clinical history, periodontal and radiographic examination and, if necessary, laboratory tests. The condition of a furcation must be known before a prognosis can be established [3].

The extent of furcation disease can be determined by evaluating the vertical bone loss and horizontal bone loss [4]. Traditionally, the gold standard diagnosis of furcation involvement is based on clinical examination with a Nabers probe and the periapical radiography (PR). PR is a 2-dimensional imaging technique and might not be accurate enough for the assessment of furcation involvement, mainly as a result of image overlay and a consequent lack of sufficient information [5]. To overcome the inherent difficulties of PR, advanced 3-D image analysis imaging systems has been introduced and are widely used in dentistry [6-12].

Cone-beam computed tomography (CBCT) allows the clinicians to visualize all of the required parameters easily in all dental fields. The utilization CBCT seems to improve the diagnosis and the management in the conventional periodontal treatment and surgeries for the treatment of furcation involved; however, more clinical studies are needed to support this conclusion [13-18]. Therefore, the current study is designed to evaluate the accuracy of CBCT in the assessment of mandibular molar furcation defects.

## Material and Methods

### Design

This prospective comparative study was conducted on thirty patients with furcation defects selected from patients presenting to the outpatient clinic at the Department of Periodontology, Oral Diagnosis and Oral Radiology, Faculty of Dentistry, Jouf University. Patients received a CBCT examination to measure their mandibular molar furcation defect, and the measurements were compared with clinical intra-surgical readings taken during the surgical treatment.

### Setting and Participants

The following inclusion criteria were established: Patients with periodontal disease with one or more advanced furcation defects, defined as horizontal inter-radicular loss of periodontal tissues of degree II or III [7]; Patients age range between 30-60 years; and Patients indicated for the surgical approach for the treatment of the furcation defect. Exclusion criteria were: Pregnant females; Patients with furcation caries; Silver amalgam fillings near the alveolar crest; and Metal crowns in the CBCT irradiation area.

### Patient Preparation and Data collection

Initial therapy, including oral hygiene instructions, scaling and root planing with ultrasonic devices and hand instruments and occlusal adjustments, were performed.

### Evaluation of the Furcation Defect

#### Pre-surgical Clinical Measurements

It was measured at the buccal aspect of the selected mandibular molars. The horizontal furcation measurements were measured with a Nabers Probe (Hu-Friedy, Chicago, USA) starting at the furcation entrance to the greatest horizontal depth. The degree of FI was graded, according to Hamp et al. classification system [19]:

- Grade 0: no horizontal loss of periodontal tissue support, i.e., no radiolucency in the furcation area;
- Grade I: being up to one-third of the width of the tooth;
- Grade II: more than one-third but not encompassing the total width of the tooth;
- Grade III: being a through-and-through destruction of the periodontal support.

#### Measurements of CBCT

Prior to surgery, CBCT was performed in the posterior mandibular area using the high-resolution imaging system 3D (J. Morita Corp., Kyoto, Japan). Measurements were made to the nearest 0.01 mm using the On-Demand 3D Software (Cybermed Inc., Seoul, South Korea) with a linear measurement tool and a digital magnification lens.

1. Furcation involvement was calculated in the horizontal plane by measuring to the nearest millimeter, the distance between the outer root surface and the inter-radicular bone (bone loss in the horizontal direction – ‘BL-H’). The degree of FI was graded, according to Hamp et al. classification system [19].
2. The degree of bone loss in the vertical direction (BL-V) was decided by measuring the distance from the furcation entrance to the base of the defect in the vertical direction.
3. The width of the furcation entrance (FW) was measured by measuring the greatest mesiodistal distance in the furcation.

#### Intra-Surgical Measurements

After administering the local anesthesia, full-thickness flaps were reflected, defects were debrided, and all direct surgical measurements were made.

1. Furcation width (FW) from the buccal aspect of furcation was a measure of the greatest mesiodistal distance in the furcation.
2. The degree of BL-V in the furcation was decided by measuring the distance from the furcation entrance to the base of the defect in the vertical direction.
3. FI was classified according to horizontal measurements [19]. Representing the distance between the outer root surface and the inter-radicular bone (bone loss in the horizontal direction – ‘BL-H’).
4. Hard tissue measurements rounded up to the nearest 1 mm were taken for each defect using a curved graduated Nabers probe (HU-Friedy, Chicago, USA), marked at 3 mm intervals, and a manual 9 mm periodontal probe (HU-Friedy, Michigan probe, Chicago, USA).

#### Data Analysis

The Data was analyzed using Statistical Package for Social Sciences (SPSS, version 21) software. The arithmetic mean, standard deviation, for numerical data t-test was used to compare two groups. To find the association between the two methods of measurements, Pearson’s correlation coefficient was used. The level of significance was set at 0.05.

#### Ethical Aspects

Ethical clearance was obtained from the Institutional Ethical Committee of College of Dentistry, Jouf University. All patients were informed of the study purpose, and consent was obtained from them.

## Results

Table 1 shows the comparison between the clinical and CBCT method and its correlations, regarding width of furcation entrance (FW) in clinical method was  $3.27 \pm 0.77$ , while in CBCT method was  $3.35 \pm 0.71$ , no significant difference between the two methods was noted, the correlation coefficient between the two methods was 0.82, i.e., there was a high correlation between the two methods. Vertical bone loss (BL-V) in clinical method was  $3.61 \pm 1.09$ , while in the CBCT method was  $3.57 \pm 1.15$ , no significant difference between the two methods was observed, the correlation coefficient between the two methods was 0.911, i.e., there was a high correlation between the two methods. Horizontal bone loss (BL-H) in clinical method was  $5.08 \pm 2.21$ , while in the CBCT method was  $5.11 \pm 2.23$ , with no significant difference between the two methods, the correlation coefficient between the two methods was 0.89, i.e., there was a high correlation between the two methods.

**Table 1. Comparison between the clinical and CBCT method and its correlations.**

Variables	Method of Assessment		p-value	Pearson's Correlation (r)
	Clinical	CBCT		
Width of Furcation Entrance (FW)				
Range	2.0-5.0	2.4-5.0	0.339	0.82
Mean (SD)	$3.27 \pm 0.77$	$3.35 \pm 0.71$		
Vertical Bone Loss (BL-V)				
Range	2.0-6.0	2.0-5.7	0.450	0.911
Mean (SD)	$3.61 \pm 1.09$	$3.57 \pm 1.15$		
Horizontal Bone Loss (BL-H)				
Range	2.0-8.9	1.8-8.8	0.479	0.89
Mean (SD)	$5.08 \pm 2.21$	$5.11 \pm 2.23$		

Table 2 shows the agreement between the two methods of assessment, Mean difference (clinical-CBCT) and 95% limits of agreement. Width of furcation entrance (FW), show difference between the two methods by  $0.08 \pm 0.21$ , while Vertical bone loss (BL-V) show difference between the two methods by  $-0.04 \pm 0.19$ , the Horizontal bone loss (BL-H), show a mean difference between the two methods by  $0.03 \pm 0.21$ , the three mean difference can be neglected.

**Table 2. Agreement between the two methods of assessment.**

Variables	Under Estimation (%)	Absolute Agreement (diff=0) (%)	Over Estimation (%)	Difference Mean (SD)	Lower 95% Limit	Upper 95% Limit
Width of Furcation Entrance (FW)	33.3	6.7	60.0	$0.08 \pm 0.21$	-0.30	0.52
Vertical Bone Loss (BL-V)	46.7	13.3	40.0	$-0.04 \pm 0.19$	-0.31	0.32
Horizontal Bone Loss (BL-H)	33.3	16.7	50.0	$0.03 \pm 0.21$	-0.29	0.30

## Discussion

The present study has shown that FI assessment by CBCT has shown no significant difference between the intra-surgical and CBCT for all 3 assessed measurements (FW, BL-V, BL-H); thus, CBCT appears to offer a significant advantage over conventional clinical assessments. Furthermore, CBCT provided detailed information about the form of the furcation, the anatomy of the defect, the morphology of the roots and the severity of the lesions that cannot currently be obtained from conventional clinical assessments.




It has been shown that CBCT provided more detailed information about the degree of FI compared to the clinical findings and periapical radiographs, these results differ from the current study and this may be due to assessment of the defects of the maxillary molars which have different furcation entrance than the mandibular molars [20]. Previous authors concluded that the detected number of the FI was larger by CBCT than clinical examination by means of periodontal probing and suggested that CBCT may be used as an adjunct tool for FI assessment [21].

The accuracy of CBCT in the measurement of horizontal periodontal bone defects was evaluated [22]. The authors 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, which are similar to the current study. It is obvious that the precise detection of the furcation involvement and the evaluation of the root morphology affects the diagnosis and treatment plan and is consequently essential for the tooth prognosis and the maintenance procedures.

## Conclusion

CBCT provided high accuracy for the furcation involvement detection and anatomy of surrounding periodontal tissues. CBCT can thus provide a clear decision about the definitive surgical option.

## Authors' Contributions

AA  0000-0002-6951-5163 Conceptualization, Methodology, Investigation, Formal Analysis, Writing – Original Draft Preparation and Writing – Review and Editing.  
HSI  0000-0002-0113-3900 Conceptualization, Formal Analysis and Writing – Review and Editing.  
SRP  0000-0003-0715-497X Methodology, Investigation and Writing – Review and Editing.  
All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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## Conflict of Interest

The authors declare no conflicts of interest.

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