

# Comparison of the Furcation Involvement by Clinical Probing and Cone Beam Computed Tomography with True Level of Involvement during Flap Surgery

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## ABSTRACT

**Aim:** The aim of the study was to evaluate and compare the clinical probing and cone beam computed tomography (CBCT) imaging technique for examination of the furcation involvement with the true level of involvement seen during open flap surgery (OFS).

**Materials and methods:** The study included 22 patients (50 molar teeth) who met the inclusion and exclusion criteria with at least one molar tooth with grade II or III furcation involvement. After phase I therapy, furcation involvement was measured using both clinical probing and CBCT imaging technique. The measurements obtained during the OFS were then compared with those obtained by clinical probing and CBCT. To avoid bias, the assessments of furcation involvement by all three techniques were done by three different examiners.

**Results:** The agreement in the furcation gradings between clinical and CBCT findings gave a Cohen Kappa value of 0.03 [statistically insignificant ( $p = 0.80$ )] and between clinical and open surgical measurements gave a Cohen Kappa value of 0.11 [statistically insignificant ( $p = 0.38$ )]. However, agreement in the furcation gradings between CBCT and open surgical measurements gave a Cohen Kappa value of 0.89 and it was statistically significant ( $p = 0.001$ ).

**Conclusion:** Thus, the results indicated that there was the highest agreement between measurements obtained using CBCT imaging technique and true level of involvement seen during OFS (89%) when compared to clinical and OFS measurements (11%) and clinical and CBCT measurements (3%).

**Clinical significance:** Thus, CBCT can be considered as an efficient diagnostic tool to accurately assess osseous defects at furcation sites when compared to clinical probing.

**Keywords:** Clinical probing, Cone beam computed tomography, Furcation involvement, Observational study (cross-sectional study), Open flap surgery.

**How to cite this article:** Aghanashini S, Jayachandran C, Mundinamane DB, Nadiger S, Bhat D, Andavarapu S. Comparison of the Furcation Involvement by Clinical Probing and Cone Beam Computed Tomography with True Level of Involvement during Flap Surgery. *World J Dent* 2017;8(4):267-272.

**Source of support:** Nil

**Conflict of interest:** None

## INTRODUCTION

Periodontal disease is defined as an inflammatory condition that causes alveolar bone resorption and attachment loss. It has a multifactorial etiology. Although plaque is recognized to be the primary etiological factor,<sup>1</sup> several environmental, genetic and developmental factors have been identified to modify disease progression.<sup>2</sup> Among the many clinical features, furcation involvement is commonly observed in periodontitis. The term furcation involvement refers to the invasion of the bifurcation and trifurcation of multi-rooted teeth by periodontal disease.<sup>3</sup> Due to the complex and irregular anatomy of furcations, there is limited access for routine oral hygiene procedures that favors plaque retention.<sup>4</sup> Furthermore, the distal location in the arch and difficult access may possibly impair professional plaque control procedures in the furcation area. Thus, the difficulties in early detection, management and maintenance of furcation areas increase the chances of tooth loss.

Treatment of the patients with advanced periodontal diseases requires both extensive clinical recording and radiological examination.<sup>5</sup> However, current diagnostic approaches have shown several limitations.<sup>6</sup> These include nonstandardized probing force and lack of three-dimensional (3D) information respectively. These drawbacks may implore the periodontist to perform exploratory surgery to determine the severity of the bone defect and decide the proper treatment modality. These on-the-spot treatment decisions may be very difficult and costly for patients. Better treatment-making decisions in questionable situations became possible with the introduction of 3D imaging in dentistry.<sup>7</sup>

Cone beam computed tomography (CBCT) is a 3D imaging modality used in a variety of dentoalveolar surgeries, implantology, and general/specialized dentistry (orthodontics, endodontics, periodontics, and forensic dentistry). Numerous studies have reported higher precision in diagnosing periodontal defects especially furcation defects and interdental craters while using CBCT as compared with conventional radiographs.<sup>8</sup> Therefore, this study was designed to determine the validity of assessing furcation involvement by clinical furcation probing (FP) and CBCT in comparison to the true level of involvement seen during open flap surgery (OFS).

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## AIMS

- To evaluate the grade of furcation involvement using Glickman classification with a Nabers probe
- To evaluate the furcation involvement by using the CBCT imaging technique
- To compare the clinical probing and imaging technique examination of the furcation involvement with the true level of involvement seen during OFS.

## MATERIALS AND METHODS

A clinical study was conducted in the Department of Periodontology, DA Pandu Memorial RV Dental College and Hospital, Bengaluru, Karnataka, India. This study was conducted on 22 patients (12 males and 10 females) with 50 molar teeth with furcation involvement to determine the validity of assessing furcation involvement by clinical FP and CBCT in comparison to the true situation during OFS. The ethical clearance for the study was obtained from the ethical committee and review board of the institution. The participants were explained about the study, and a written consent was obtained from all participants.

### Inclusion Criteria

- Patients with chronic periodontitis with one or more Glickman grades II or III furcation defects with horizontal and vertical components of at least 1 mm
- Aged between 30 and 65 years
- Both sexes were included in the study
- No systemic conditions that would contraindicate routine periodontal procedures.

### Exclusion Criteria

- Pregnant and lactating patients
- Uncontrolled systemic disease
- History of radiation therapy
- Grade I furcation involvements (minimal bone loss) and grade IV furcation involvements
- Third molars
- Patients under the age of 18
- Teeth exhibiting grades II and III mobility
- Acute oral infections.

The study population included 22 patients who met the inclusion and exclusion criteria with at least one molar tooth with grade II or III furcation involvement. All these patients were asked to participate in the study and give the informed consent. A total of 50 molar teeth with furcation involvement were then measured using both clinical probing and CBCT imaging technique.

Phase I therapy, which included oral hygiene instructions, scaling and root planing using hand and ultrasonic instruments, were performed before the clinical and CBCT measurements.

Clinical measurements were done with a Nabers probe. To detect involvement, the tip of the probe is moved toward the presumed location of the furcation and then curved into the furcation area. For the mesial surfaces of maxillary molars, this is the best done from a palatal direction, as the mesial furcation is located palatal to the midpoint of the mesial surface. The distal furcation of maxillary molars is located from a buccal or palatal approach.<sup>9</sup> The grading was done according to the Glickman grading system. All these measurements obtained were recorded.

CBCT was taken using the Sirona Orthophos XG-3D CBCT (Vowel size of 0.1 mm in HD mode). The CBCT measurements were performed by measuring the deepest horizontal furcation defect at each furcation entrance. The CBCT measurements were analyzed in the axial, sagittal, and coronal sections that made the defect visible and easily measurable. The furcation entrance was used as the anatomical location to align the cross-sections of the different planes.<sup>10</sup> These measurements were then recorded. The examiner did not have access to clinical measurements while evaluating the CBCTs.

Routine preparation with povidone iodine was carried out and local anesthesia (2% lignocaine hydrochloride with 1 in 80,000 adrenaline) was instituted. Then, crevicular incisions were given using No. 15 blade, and the flaps were elevated using blunt dissection with the help of a No. 9 Molt periosteal elevator. A thorough debridement was carried out using curettes #7-8 and #9-10 in the furcation areas. All the granulation tissue was removed to ensure a clean site followed by thorough root planing. After the in-depth debridement, the furcation area was evaluated using Nabers probe. All the measurements were recorded.

The measurements obtained during the OFS were then compared with those obtained by clinical probing and imaging technique CBCT.

To avoid any kind of bias, the assessment of furcation involvement by clinical probing, CBCT imaging technique, and during OFS were done by three different examiners. Cohen Kappa statistical test was used to compare the agreement of furcation gradings obtained during clinical probing, CBCT imaging, and OFS.

## RESULTS

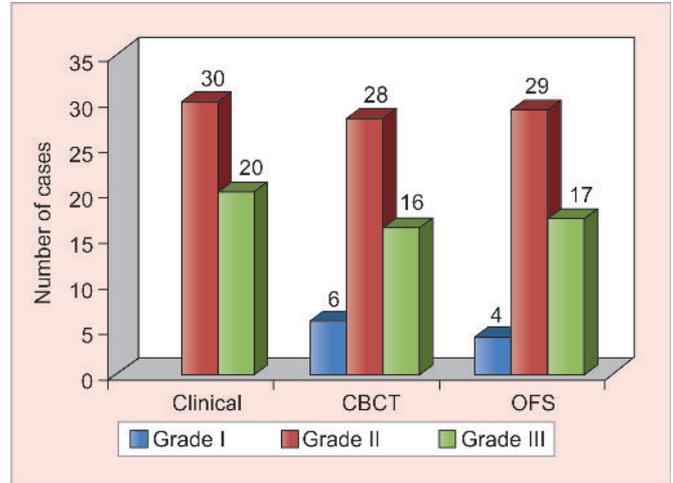
The distribution of the furcation grading obtained by all three different techniques is presented in Table 1 and Graph 1.

The test results revealed that CBCT finding yielded 6 grade I, 28 grade II and 16 grade III defects, whereas clinical evaluation yielded 30 grade II and 20 grade III defects. This agreement in the furcation gradings between clinical and CBCT findings gave a Cohen Kappa value



**Table 1:** Distribution of furcation gradings obtained using three different techniques

Method	Grading	n (%)
Clinical	Grade II	30 (60)
	Grade III	20 (40)
CBCT	Grade I	6 (12)
	Grade II	28 (56)
OFS	Grade I	4 (8)
	Grade II	29 (58)
	Grade III	17 (34)



**Graph 1:** Distribution of furcation gradings obtained using three different techniques

of 0.03 and it was not statistically significant ( $p = 0.80$ ) (Table 2 and Graph 2).

The test results revealed that findings obtained during OFS yielded 4 grade I, 29 grade II and 17 grade III defects, whereas clinical evaluation yielded 30 grade II and 20 grade III defects. This agreement in the furcation gradings between clinical and open surgical measurements gave a Cohen Kappa value of 0.11 and it was not statistically significant ( $p = 0.38$ ) (Table 3 and Graph 3).

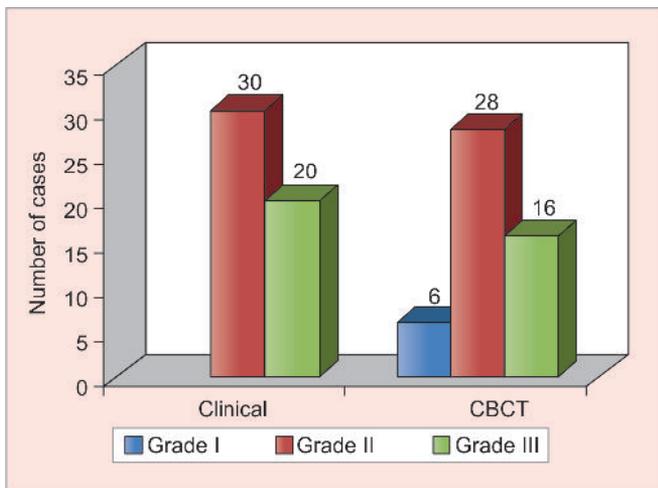
The test results revealed that findings obtained during OFS yielded 4 grade I, 29 grade II and 17 grade III defects, whereas CBCT imaging technique yielded 6 grade I, 28 grade II and 16 grade III defects. This agreement in the furcation gradings between CBCT and open

**Table 2:** Comparison of the agreement between clinical probing and CBCT measurements

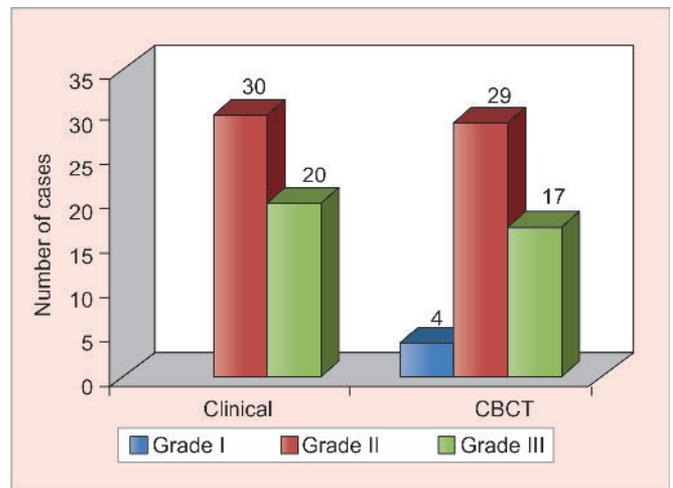
Clinical	CBCT n (%)			Total	Cohen's Kappa	p-value
	Grade I	Grade II	Grade III			
Grade II	6 (100.0)	16 (57.1)	8 (50.0)	30 (60.0)	0.03	0.80
Grade III	0 (0.0)	12 (42.9)	8 (50.0)	20 (40.0)		
Total	6 (100.0)	28 (100.0)	16 (100.0)	50 (100.0)		

**Table 3:** Comparison of the agreement between clinical probing and true situation during OFS

Clinical	OFS n (%)			Total	Cohen's Kappa	p-value
	Grade I	Grade II	Grade III			
Grade II	4 (100.0)	18 (62.1)	8 (47.1)	30 (60.0)	0.11	0.38
Grade III	0 (0.0)	11 (37.9)	9 (52.9)	20 (40.0)		
Total	4 (100.0)	29 (100.0)	17 (100.0)	50 (100.0)		



**Graph 2:** Comparison of the agreement between clinical probing and cone beam computed tomography measurements

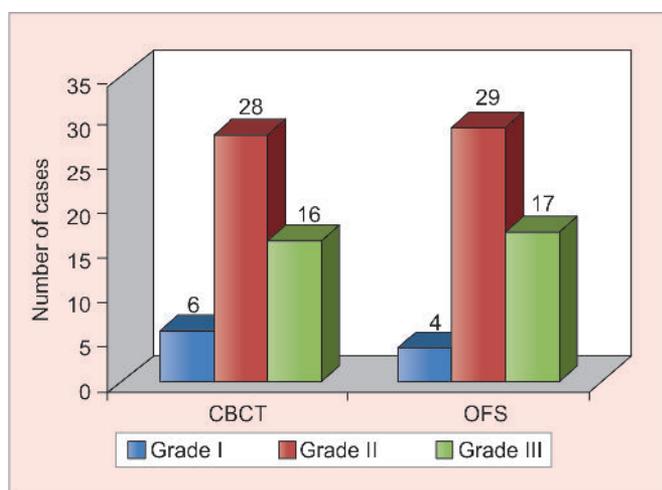


**Graph 3:** Comparison of the agreement between clinical probing and true situation during open flap surgery

**Table 4:** Comparison of the agreement between measurements obtained using CBCT imaging and true situation during OFS

CBCT	OFS n (%)			Total	Cohen's Kappa	p-value
	Grade I	Grade II	Grade III			
Grade I	4 (100.0)	2 (6.9)	0 (0.0)	6 (12.0)	0.89	<0.001 <sup>a</sup>
Grade II	0 (0.0)	27 (93.1)	1 (5.9)	28 (56.0)		
Grade III	0 (0.0)	0 (0.0)	16 (94.1)	16 (32.0)		
Total	4 (100.0)	29 (100.0)	17 (100.0)	50 (100.0)		

<sup>a</sup>Statistically significant, Cohen's Kappa Coefficients; <0.0 or negative values: No agreement; <0.2: Poor agreement; 0.21-0.40: Fair agreement; 0.41-0.60: Moderate agreement; 0.61-0.80: Good agreement; >0.80: Very good agreement

**Graph 4:** Comparison of the agreement between measurements obtained using CBCT imaging and true situation during OFS

surgical measurements gave a Cohen Kappa value of 0.89 and it was statistically significant ( $p = 0.001$ ) (Table 4 and Graph 4).

## DISCUSSION

The progress of periodontal disease results in attachment loss, sufficient enough to affect the bifurcation or trifurcation of multi-rooted teeth.<sup>11</sup> The risk of losing the affected tooth increases when a furcation becomes visible.<sup>12</sup> The magnitude of furcation disease can be determined by evaluating the extent of vertical and horizontal bone loss.<sup>13</sup>

Proper presurgical furcation diagnosis is generally performed with a good comprehensive periodontal examination by clinical probing and radiographic imaging. Conventional radiographic techniques have their limitations in diagnosing furcation involvement like overlapping of anatomical structures and lack of 3D information; therefore, the use of 3D imaging may provide the clinician with a better diagnostic tool for furcation diagnosis and management. The body of literature clearly shows the benefits of using CT and CBCT imaging systems for diagnosing osseous defects. However, due to high cost and radiation dose, the use of CT has been limited.<sup>14</sup>

CBCT, on the contrary, differs from CT in that, it uses a single X-ray source that produces a cone beam of radiation (rather than a fan beam, as with CT).<sup>15</sup> A single rotational sequence would capture enough data for volumetric image construction.<sup>16</sup> When compared to periodontal probing and 2D intraoral radiography, 3D CBCT scanning was found to be more effective in assessing periodontal structures.<sup>17</sup> Noujeim et al<sup>18</sup> created periodontal lesions of different depths in dried human hemi-mandibles and analyzed them using intraoral radiography and CBCT. They found that CBCT was more accurate in detecting the defects than the conventional radiograph. Vandenberghe et al<sup>14</sup> studied 30 periodontal bone defects of two adult human skulls using intraoral digital radiography and CBCT to assess and compare periodontal bone levels and defects. The study concluded that the intraoral radiography was significantly better for contrast, bone quality, and delineation of lamina dura, but CBCT was superior for assessing crater defects and furcation involvements.

Phase I therapy was performed before FP to avoid any interferences in the measurement due to deposits on the root surfaces. Following phase I therapy, the teeth selected for the study were evaluated clinically for furcation involvement using Nabers probe. In a prospective study with 100 molars, a good-to-excellent agreement of replicate measurements of furcation degrees was obtained with a Nabers probe for a single operator ( $kw = 0.706-0.944$ ) without significant differences between furcation.<sup>19</sup> However, Theil et al<sup>20</sup> found that probe readings are not a very precise measure of attachment loss, predominantly with increasing severity of destruction and with multi-rooted teeth. There are multiple classification systems described by authors, such as Glickman et al, Goldman et al, Hamp et al. Ramfjord and Ash, Tarnow & Fletcher et al, Eskow and Kapin et al, Fedi et al, and Ricchetti et al.<sup>21</sup>

Glickman's classification was used in this study as it is the most commonly used system of classification and also because most of the dentists are well versed with it.

Among these, molars with grades II and III furcation involvement were included in this study as surgery is indicated in only grades II and III furcation involvement.

The measurements obtained by clinical probing and CBCT were then compared with true level of involvement seen during OFS. The statistical analysis used was Cohen's Kappa statistics as it is appropriate for binomial variables or categorical variables that are not ordinal. There was only 3% agreement between clinical probing and linear measurements obtained using CBCT and it was not statistically significant ( $p = 0.80$ ). This high disagreement attained could have occurred due to the exclusion of grade I furcation involvements before clinical probing in the study. Hence, we can infer from these results that 24% of clinical probing measurements acquired were overestimated than the CBCT measurements. Similar results were obtained by Walter et al wherein he found that the degree of furcation involvement for maxillary molars noted during clinical examination only correlated with CBCT measurements 27% of the time, while 29% of clinical measurements were overestimated and 44% were underestimated.<sup>22</sup>

There was only 11% agreement between clinical probing and linear measurements obtained using OFS and it was not statistically significant ( $p = 0.38$ ). Hence, we can infer from these results that 16% of clinical probing measurements acquired were overestimated than the true situation during OFS. In a similar scenario, Zappa et al reported that 7 and 24% of the measurements in classes I and II furcations respectively, were overestimations compared with OFS.<sup>23</sup> However, contradictory results were obtained by Mealey et al where he found that clinical vertical and horizontal furcation measurements underestimated the furcation defect when compared with surgical measurements.<sup>24</sup>

There was 89% agreement between CBCT and open surgical measurements and it was statistically significant ( $p = 0.001$ ). The results obtained were comparable to the one performed by Qiao et al in 2014. Intrasurgical findings obtained in this study confirmed 86.8% of the CBCT data with a weighed Kappa of 0.976.<sup>25</sup>

Thus, in this study, clinical measurements obtained during an initial periodontal examination was significantly overestimated compared to CBCT and open surgical measurements.

## LIMITATIONS

- In the present study, there was no categorization done into maxillary and mandibular molars. This could be a limitation of the study since clinical probing of the maxillary molars is difficult compared to mandibular molars due to its complex root anatomy.

## CONCLUSION

The application of CBCT in the dental field as a diagnostic tool to evaluate osseous defects may provide additional

benefits to the clinician to address furcation involvements. The utility of small field of view CBCT imaging can provide the clinician and the patient with benefits in evaluating and treating osseous defects. This study certainly does not rule out the need for a comprehensive periodontal examination by a dental professional but it may allow justification to the clinician, especially the periodontist, to use CBCT imaging to accurately assess osseous defects at furcation sites.

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