

Comparison of the Assessment Potential of Three Different Methods to Diagnose Furcation Involvement in Mandibular Molar

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Abstract

Introduction: The unique dentogingival junction and its association with dental biofilm give rise to infection in gingiva which if left untreated progresses to periodontitis. Involvement of furcation in a multi-rooted tooth poses a predicament in the form of diagnosis, prognosis, and treatment plan. Conventionally, diagnosis has been done through clinical probing and with the aid of radiology. However, they have their own shortcomings. Hence, the 3-D technology such as cone-beam computed tomography (CBCT) may be useful in cases of furcation lesions. The role of CBCT imaging as a new diagnostic tool in modern-day dentistry cannot be overemphasized and it serves as an important diagnostic means for clinical assessment. **Materials and Methods:** The objective of the present study is to compare 100 mandibular molars with either Grade II or Grade III furcation involvement (FI) by clinical probing, conventional (intraoral periapical radiograph [IOPA] with grid) radiograph, and CBCT. **Results:** The degree of FI by clinical probing (vertical component) was matched in 47% of cases with IOPA X-ray (vertical component), and the findings of FI by IOPA X-ray (vertical) were matched in 58% of cases with that of CBCT. Furthermore, measurements of FI by clinical probing (horizontal component) were matched in 52% of cases with CBCT (horizontal), and finally, findings by clinical probing (vertical) were matched in 68.6% of cases with CBCT (vertical). **Conclusion:** CBCT may be a better alternative and non-invasive method for the diagnosis of Grade II and Grade III furcation defects in mandibular molars.

Keywords: Cone beam computed tomography, Furcation involvement, Intra-oral periapical radiograph, Molar, Probe.

INTRODUCTION

Periodontitis is a chronic inflammatory disease of polymicrobial origin that if untreated results in the progressive destruction of the supporting tissues of the teeth. Molars are typically the ones highly susceptible to this disease partly due to their location in the mouth and partly due to their anatomy like in furcation areas. Hence, dentists and more commonly periodontists need to assess the furcation involvement (FI) to decide the treatment plan and prognosis of the tooth. Accurate clinical analysis of FI is thereby of prime importance. However, several factors such as limited physical access to the depths of the furcation, morphological variations, and measurement errors make the treatment plan cumbersome.

The traditional diagnostic tools to measure the furcation such as clinical and radiographical findings have some significant shortcomings.^[1] Clinical assessments such as probing depth

(PD), clinical attachment level, and furcation measurement by Nabers probe are somewhat subjective and time-consuming and therefore underutilized.^[2] Two-dimensional (2D) periapical (intra oral periapical radiograph [IOPA] X-ray) and panoramic radiographs (OPG), routinely used for diagnosing FI, can provide important diagnostic information but none without any limitations.^[3] Hence, the selection of the appropriate imaging technique to overcome the fundamental limitations of two-

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dimensional dental radiographic imaging (2D), 3-D technology such as computed tomography (CT) may be useful in cases of furcation lesions but has major drawbacks including high radiation, low resolution, and high cost.^[4]

A recently developed 3D imaging modality, cone-beam CT (CBCT) considerably reduces radiation exposure to the patients while producing high-quality images.^[5] The first reported use for CBCT in the field of dentistry was in 1998 by Mozzo *et al.*^[6] Although there are limited publications concerning CBCT for furcation assessment, the application of this new imaging modality with a combination of existing 2D (IOPA X-ray) may offer new perspective on the diagnosis of furcation defects and further its treatment planning.^[7] A study was therefore needed to explore the diagnostic value of CBCT in the determination of periodontal bone loss in the furcation area, compared to that of clinical probing and conventional radiographs.

MATERIALS AND METHODS

One hundred furcation defect sites of Grade II and Grade III from 100 patients, 55 males and 45 females aged 35–60 years (mean age: 45.78 ± 7.14 for males and mean age: 41 ± 5.68 for females) with the diagnosis of generalized chronic periodontitis, were selected from the outpatient department of the hospital. The diagnosis of chronic periodontitis was made as per AAP guideline 1999. Periodontal pocket depth ≥ 5 mm or clinical attachment loss ≥ 3 mm with radiological evidence of bone loss was an important inclusion criterion. Examination of the patients was done by a single examiner to avoid interoperator error. The measurement was done by means of clinical probing, gridded IOPA X-ray, and with CBCT. Pregnant or lactating mothers, systemically compromised patients, those undergoing radiation therapy at head/neck region, and those with caries in the furcation area were excluded from the study. The data collected were subjected to statistical analysis.

Furcation defects were measured as follows

Clinical

Horizontal PD of the furcation defect can be determined by measuring the horizontal extent of probe penetration into the furcation. A curved, color-coded, calibrated Nabers probe was advanced in a horizontal direction toward the presumed location of the furcation and then curved into the furcation area, until the resistance was felt. The distance from the gingival margin to the horizontal depth of probing was then noted (Figure 1). The severity of the horizontal furcation defect was established by the classification system from Glickman.^[8]

For vertical probing, a straight periodontal probe was used for bone sounding^[9] under local anesthesia to the particular furcation area. The vertical dimension of the furcation was recorded to the nearest millimeter (Figure 2) as per the classification of Tarnow and Fletcher.^[10]

Radiological

IOPA radiographs with grid plates were taken of teeth using paralleling technique with the aid of positioning Device



Figure 1: Horizontal depth determination in grade II furcation

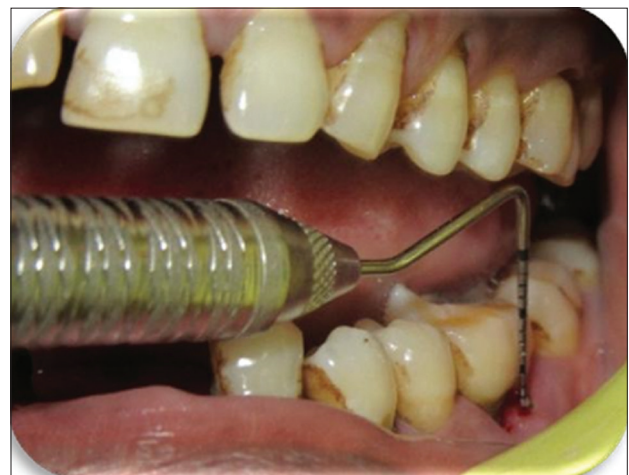


Figure 2: Vertical depth determination from gingival margin to opening of furcation

(XCP®, Rinn Corporation, IL USA) with a removable bite block (Figure 3). Measurement of Grade II or Grade III furcation were done by calculating the number of boxes in the radiolucent area of the furcation defect area (Figure 4).

CBCT

CBCT was performed in the posterior mandibular posterior area with patient being in the supine position using the high-resolution imaging system. The CBCT images of each furcation defect were included and analyzed in axial, sagittal, and coronal sections. The three measurements that were taken were (Figure 5) width of the defect, length from furcation entrance to the defect, and length from CEJ to the base of the bony defect. The degree of FI was graded according to Glickman and Tarnow and Fletcher's classification system.

RESULTS

Statistical analysis was performed with the help of Epi Info (TM) 3.5.3 which is a trademark of the Centres for Disease Control and Prevention. Using this software, basic cross-tabulation and frequency distributions were prepared. Z-test was used to test the significant difference between two



Figure 3: Film holder with gridded intra oral periapical radiograph film

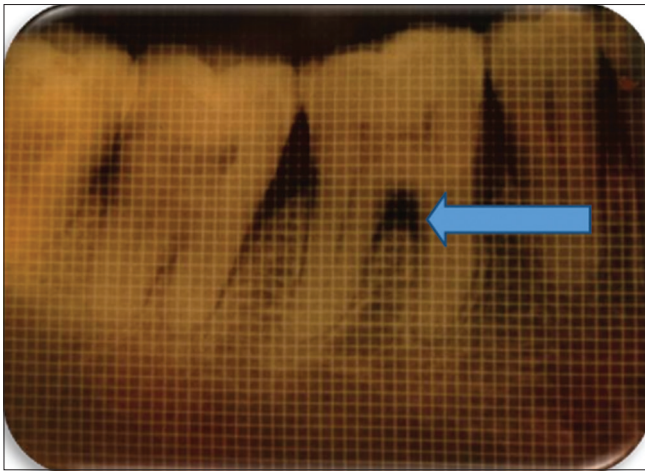


Figure 4: Calculating the number of boxes in the furcation defect

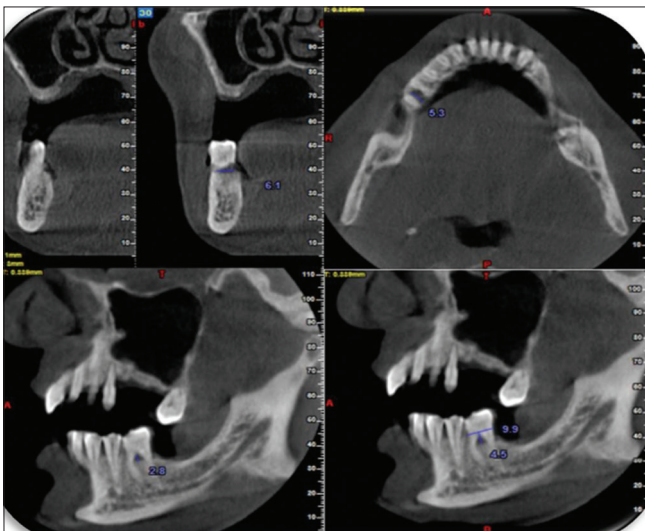


Figure 5: Analysis of furcation defect by cone-beam computed tomography

proportions. Under descriptive analysis, mean along with corresponding standard deviations was calculated. Diagnostic

accuracy was calculated to compare the findings by different methods. $P \leq 0.05$ was considered statistically significant.

Comparison between parameters

Clinical probing (vertical) in comparison with IOPA X-ray (vertical)

The diagnostic accuracy of clinical probing in comparison with IOPA X-ray (vertical) was $(47/100) \times 100\% = 47\%$. Most of the findings were matched with IOPA X-ray, followed by under estimated cases (49.0%) ($Z = 0.29$; $P = 0.77$). Only 4% of cases were overestimated by clinical probing (vertical).

IOPA X-ray (vertical) in comparison with CBCT (vertical)

Further, the diagnostic accuracy of IOPA X-ray (vertical) in comparison with CBCT was $(58/100) \times 100\% = 58\%$. Most of the findings were matched (58%) with CBCT followed by overestimated case (39%) ($Z = 2.50$; $P = 0.0124$). Only 3% of cases were underestimated by IOPA X-ray.

Clinical probing (horizontal) in comparison with CBCT (horizontal)

The diagnostic accuracy of clinical probing in comparison with CBCT was $(52/100) \times 100\% = 52.0\%$. Most of the findings were matched (52.0%) with CBCT followed by overestimated cases (39%) ($Z = 1.67$; $P = 0.09$). Only 9% of cases were underestimated by clinical probing.

Clinical probing (vertical) in comparison with CBCT (vertical)

The diagnostic accuracy of clinical probing in comparison with CBCT was $(70/100) \times 100\% = 70\%$. Most of the findings were matched (70%) with CBCT followed by overestimated cases (13%) ($Z = 4.46$; $P < 0.0001$). Only 17% of cases were underestimated by clinical probing.

DISCUSSION

The ultimate goal of treatment for teeth with FI is to eliminate the furcation by regenerative or resective surgery. While initial or incipient cases can be managed conservatively, advanced furcation involved molars result in less favorable treatment outcome and increased risk for tooth loss. Hence, accurate diagnosis of the degree of FI becomes a key factor in relation to the management of the same. In the present study, Grade II and III furcation defects of mandibular molar region, were evaluated with standard clinical measurements by means of Nabers probe (horizontal measurement) and UNC-15 probe (vertical measurement), at the initial examination appointment by the same examiner. The results were compared with that of the IOPA X-ray and CBCT measurements in both horizontal and vertical directions.

Clinical probing versus IOPA X-ray: (Vertical)

In this study, Grade II and Grade III mandibular FI cases were diagnosed and measured by means of clinical probing and were confirmed by IOPA X-ray in 47% of cases. This result was in accordance with the result of Walter *et al.* in 2009 who reported that FI measured by means of clinical probing matched in 41%

of the teeth when compared to that of periapical radiographs in case of maxillary molars.^[11] Ross and Thompson (1980) observed that only 18% of total furcation defect sites (57 out of 312 sites of the furcation defect sites) were detected both by radiographic and clinical examination, whereas 8% (23) and 9% (29) furcation defect sites were detected by radiographic examination and clinical examination, respectively. They concluded that furcation involved areas were detected more frequently by clinical examination than by conventional periapical radiographs in case of mandibular molar teeth region.^[12] This disparity in the result seems indisputable because of few facts such as, the force applied during clinical probing in detecting the defects of furcation involved areas, the size and design of the probe, and definitely the experience and skills of the examiners which influenced the detection of furcation defects by the clinical assessment. This could be an explanation for the differences in the reliability between the results obtained by both clinical probing and radiological measurements, despite almost same degree of diagnostic experience. IOPA X-ray represents 3D object in 2D view, not allowing to represent the horizontal component of FI. Hence, comparison between clinical probing (horizontal) and IOPA X-ray (horizontal) could not be made.

IOPA X-ray versus CBCT: (Vertical)

In the present study, Grade II and Grade III mandibular FI diagnosed by IOPA X-ray was confirmed by CBCT in 57% of the cases with overestimation in 39% and underestimation in 4% of cases, respectively. Hence, in case of vertical measurement, the diagnostic accuracy of IOPA X-ray was 57%. Direct comparison could not be made because of the inherent limitations of case definitions which were far beyond the natural dentition.

Grimard *et al.* who have obtained the measurements of bony changes, from intraoral radiographs and CBCT and further evaluated the regenerative outcomes and compared it with the direct surgical measurements. He concluded that CBCT was significantly more precise and accurate than intraoral radiographs and also can be seen as an equivalent substitution for direct surgical measurements of bony changes, for the evaluation of regenerative treatment outcomes.^[13] Comparison between clinical probing (horizontal) and IOPA X-ray (horizontal) could not be made.

Clinical probing versus CBCT: (Horizontal)

There was a significant difference between clinical probing and CBCT measurements when evaluating the horizontal aspect of the furcation defect in the mandible, with the probing measurements being 39% significantly greater than that of the CBCT measurements. In that case, only 52% of defects were matched by both the methods, whereas 9% of defects remained underestimated. It is necessary to keep in mind that horizontal measurements taken with the CBCT were linear and when these linear measurements were compared to the clinical measurements taken with a curved Naber's probe, some variability could be expected.

Clinical probing versus CBCT: (Vertical)

The diagnostic accuracy of clinical probing in case of vertical measurement was found to be 70% accurate than that of CBCT measurement with only 13% overestimated and 17% underestimated, respectively. Therefore, the CBCT may provide the patient with a more uniform diagnosis regarding the extent of FI. Literature survey indicates a paucity of studies matching with the material and method of the present study. Assessment of furcation was done either on dry mandibles or artificially created defects or on maxilla or assessment was done by CT 12 that prevents comparison with the present study.

Although the result was found, in accordance with a recent study by Laky *et al.* who showed that the degree of FI by clinical findings was confirmed by CT in 56% of the sites, whereas 21% were overestimated and 23% underestimated compared with the radiologic analysis. He also mentioned that the best correlation of CT scan and clinical probing was found at buccal furcation sites in the mandible.^[14]

It appears from the various studies done so far that clinical diagnosis should be always coupled with radiographic findings for improving the precision in diagnosis and executing the treatment plan, that radiographs are always supplementary tools to clinical examination and 2D imaging modalities. CBCT allowed more accurate measurement of FI than 2D radiography.^[15] Some amounts of perception errors are inherent to human observations and decision though the magnitude of the error in visual perception is modulated by image clarity.^[16]

The present study is unique with respect to utilizing simple non-invasive methods such as clinical probing, IOPA X-ray, as well as modern 3D assessment by CBCT to reach most accurate diagnosis of furcation involved molars produced as a result of periodontitis. However, the present study has some limitations such as relatively small sample size, non-inclusion of furcation involved maxillary teeth, and surgically intervened measurement.

CONCLUSION

Within the limits of present study, the following conclusions were made: Examination by clinical probing and IOPA X-ray provided almost similar findings. Clinical probing and CBCT were found to be in substantial agreement. IOPA X-ray and CBCT estimation were found to be almost comparable. In the diagnosis of Grade II and Grade III FI, estimation by CBCT was found to be more or less accurate and reliable. CBCT was the choice for radiological assessment because of certain advantages. Images were acquired within just one rotation of the source-detector system around the patient, without any movement by the patient. Consequently, the scan time required to perform the examination was much shorter, i.e., 15 s. Above all there is a significant reduction of the X-ray exposure dose to the patient. In view of the above conclusion, CBCT thus may be a better alternative for the diagnosis of such defects. However, further studies involving larger sample size and

other relevant parameters are further needed, to arrive at a definite conclusion.

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