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Evaluation of Dental CBCT in Assessing the Furcation Involvement in Mandibular Molars.

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ABSTRACT

Background: Furcation involvement (FI) refers to the invasion of the bifurcation and trifurcation areas of multi-rooted teeth by periodontal disease. Diagnosis of FI by 2D radiographs can be overcome by the use of cone-beam computed tomography (CBCT) imaging technique. Objective: To compare the measurements of furcation depth by clinical method and CBCT in assessing the FI. **Methods**: The present study comprised of 60 furcation involved mandibular molars from 45 patients suffering from Chronic Generalized Severe Periodontitis. Teeth having probing pocket depth of ≥6mm were considered for the study. Clinical measurements of furcation depth were made on buccal or lingual sides of mandibular molars by using endodontic file with stopper which was done by two clinicians. The CBCT measurements were performed by measuring the deepest vertical and horizontal furcation defects at each furcation entrance. These measurements were then recorded, compiled and statistically analysed. **Results**: The comparison of furcation involvement clinically by clinician 1 and CBCT measurements in buccal side was statistically significant (p=0.0255*), while it was statistically not significant (p=0.3696 NS) on lingual side. Similarly, the comparison of furcation involvement clinically by clinician 2 and CBCT measurements in buccal side was statistically significant (p=0.0278*), while it was statistically not significant (p=0.4951 NS) on lingual side. **Conclusion**: CBCT technique can be considered a reliable tool for detecting FI as CBCT imaging showed high accuracy and moderate reproducibility in the assessment of furcation depth.

Keywords: Chronic Periodontitis; Clinical attachment level; Cone-beam computed tomography (CBCT); Furcation involvement.

INTRODUCTION

Periodontal disease is defined as an inflammatory condition that causes alveolar bone resorption and attachment loss.[1] Although dental plaque is recognized to be the primary etiological factor,[1] several environmental, genetic and developmental factors have also been identified in the progression of this disease.[2] Among the various clinical features like clinical attachment loss, mobility and bone loss etc, furcation involvement is commonly observed in periodontal involvement of multirooted teeth. The term furcation involvement (FI) refers to the invasion of the bifurcation and trifurcation areas of multi-rooted teeth by periodontal disease.[3] Due to the complex and irregular anatomy of furcations, there is limited access for routine oral hygiene procedures which favors plaque retention in these areas.[4]

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Furthermore, the distal location of furcation in the arch and subsequent difficulty in access adds up to impaired or compromised professional plaque control procedures in the furcation area, thus increase the chances of tooth loss. A thorough knowledge of furcation anatomy and precise assessment of degree of FI is important for accurate assessment of the etiological factors, diagnosis, prognosis, and treatment of involved teeth.[5]

According to proceedings of the World Workshop in Clinical Periodontics, teeth with FI are at greater risk of tooth loss than those without such involvement.[6] Diagnosis of FI is mainly by assessment of probing pocket depth (PPD), clinical attachment level (CAL), furcation entrance probing, and use of intraoral periapical and panoramic radiographs. However, in most cases, it is difficult to accurately analyze furcations clinically.[7]

Conventional two-dimensional (2D) radiographs are routinely employed for diagnosing bone levels in periodontal disease, but the magnification and distortion caused because of the projection geometry of X-ray beam makes accurate diagnosis almost impossible. These 2D radiographs generate images with tooth roots superimposed on region of interest, thus obscuring bony changes such as FI, buccal, and lingual alveolar bone defects.[8]

The limitations of 2D radiographs can be overcome by the use of cone-beam computed tomography (CBCT) imaging technique, which provides 3D volumetric images with multiplanar reconstruction in axial, coronal, and sagital planes without magnification. CBCT collects high-resolution 3D data at lower cost and reduced radiation doses than conventional CT.[9]

Three-dimensional CBCT images also reveal the surrounding bony support of each maxillary molar root, fusion and root proximity; therefore, these images may be a reliable basis for making treatment decisions.[10] CBCT may be poised to succeed current intra-oral imaging methods for the assessment of periodontal architecture. Limited clinical studies are available to support this conclusion. Therefore, the aim of this study was to compare the measurements of furcation depth by clinical method and CBCT in assessing the FI in tooth in chronic periodontitis patients.

MATERIALS AND METHODS

The present study comprised of 60 furcation involved mandibular molars from 45 patients aged between 35 to 60 years suffering from Chronic Generalized Severe Periodontitis who reported to Department of Periodontology, Vananchal Dental College and Hospital. Informed consent was taken from patients for the study.

Inclusion criteria comprised of patients clinically & radiographically diagnosed with moderate to severe periodontitis with probing pocket depth of ≥6mm in at least one mandibular molar and Grade II or III furcation involvement indicated for periodontal surgery.

Exclusion criteria were mandibular third molars, pregnant or lactating women, patients with furcation caries, patients with metallic crowns in CBCT irradiation area, patients with amalgam fillings near the alveolar crest, patients with uncontrolled systemic diseases, smokers, teeth indicated for extraction and teeth with Grade I and Grade IV furcation involvement.

Periodontal status of the patient was assessed by using the probing pocket depth (PPD) and clinical attachment level (CAL), intra oral periapical radiographs (IOPA) and grade of furcation involvement. PPD was measured with a William's periodontal probe held parallel to the vertical axis of the tooth and walking it circumferentially around the surface of each tooth. Mandibular molars having PPD of ≥6mm were considered for the study.

CAL was measured by using a William's periodontal probe with the cemento-enamel junction as the reference point. IOPA were taken on the selected teeth prior to surgery to determine the degree of furcation. Radiographs may or may not depict the furcation involvement in Grade II furcation. Grade III furcations display the defect as a radiolucent area in the crotch of the tooth.

Non-surgical periodontal treatment i.e scaling and root planning, was performed at least 6 weeks before initiation of the study on all teeth with periodontal probing depths of ≥6mm.

Clinical measurements of furcation depth were made on buccal or lingual sides of mandibular molars by using endodontic file with stopper which was done by two clinicians. To obtain maximum accuracy a calibrated digital Vernier caliper was used. The depth was measured from the crest of alveolar bone till the interradicular bony resistance was felt or between the inner aspect of the crest of alveolar bone on either side. Grading of furcation was done according to Glickman's classification (1953).

The CBCT measurements were performed by measuring the deepest vertical and horizontal furcation defects at each furcation entrance. The furcation entrance was used as the anatomical starting point using the measuring tool provided within the Kodak software (Oblique view, Care stream 3D Imaging Software Version 3.1, C3 9300.84kv, 5mA, 20Sec. Voxel size of 180µm). The CBCT measurements were analyzed in the coronal sections that made the defect most visible and easily measured. The furcation entrance was used as the anatomical location to align the cross-sections of the different planes. Scrolling back and forth in the different planes allowed to identify and measure the horizontal extent of bone loss.

These measurements were then recorded and compared with clinical measurement. The data so obtained was compiled using SPSS-20 and expressed as mean and standard deviation and statistically analysed.

RESULTS

Table 1: Clinical measurement of furcation involvement by different Clinicians

Side	Furcation Depth in mm (by Clinician 1) (Mean ± SD)	Furcation Depth in mm (by Clinician 2) (Mean ± SD)
Buccal	5.481±1.696	5.456±1.665
Lingual	3.763±0.7496	3.811±0.7829

The [Table 1] depicts that the clinical measurement of furcation involvement in buccal side was 5.481±1.696 mm by clinician 1 and 5.456±1.665 mm by clinician 2. In lingual side was

3.763±0.7496 mm & 3.811±0.7829 mm by clinician 1 & clinician 2 respectively.

Table 2: CBCT measurement of furcation involvement

Side	Furcation Depth in mm (Mean ± SD)
Buccal	4.463±1.857
Lingual	4.016±1.497

[Table 2] depicts that the CBCT measurement of furcation in buccal side was 4.463±1.857 mm and lingual side was 4.016±1.497 mm in our study.

Table 3: Comparison of furcation involvement between CBCT measurement and clinical measurement by Clinician 1.

Side	Clinical measurement (by Clinician 1) (Mean ± SD)	CBCT measurement (Mean ± SD)	p-value
Buccal	5.481±1.696	4.463±1.857	0.0255*
Lingual	3.763±0.7496	4.016±1.497	0.3696 NS

The measurements of furcation involvement clinically by clinician 1 and CBCT measurements in buccal side was 5.481±1.696 mm & 4.463±1.857 mm respectively, which was statistically significant (p=0.0255*) [Table 3]. But in lingual side (3.763±0.7496 mm & 4.016±1.497 mm respectively) was not statistically significant (p=0.3696 NS).

Table 4: Comparison of furcation involvement between CBCT measurement and clinical measurement by Clinician 2.

Side	Clinical measurement (by Clinician 2) (Mean ± SD)	CBCT measurement (Mean ± SD)	p-value
Buccal	5.456±1.665	4.463±1.857	0.0278*
Lingual	3.811±0.7829	4.016±1.497	0.4951 NS

The measurement of furcation involvement clinically by clinician 2 and CBCT in buccal side was 5.456±1.665 mm & 4.463±1.857 mm respectively, which was statistically significant (p=0.0278*) [Table 4]. But in lingual side (3.811±0.7829 mm & 4.016±1.497 mm respectively) was not statistically significant (p=0.4951 NS).

DISCUSSION

The progress of periodontal disease results in attachment loss, sufficient enough to affect the bifurcation or trifurcation of multi-rooted teeth.[1] The risk of losing the affected tooth increases when a furcation becomes visible.[2] The magnitude of furcation disease (FD) can be determined by evaluating the extent of vertical and horizontal bone loss.[3]

For the past two decades, the use of CBCT method in the periodontal region was mainly related to the assessment of intrabony and furcation defects caused by periodontitis.[4-9] CBCT images are supposed to provide the 3D presentation of periodontal defects, which may help in creating an appropriate treatment plan.[10] However, CBCT image analysis requires the knowledge of the software recommended by the manufacturer. The fact that clinical detection of FI is challenging even for the experienced dentists, raises the question whether the clinical experience and experience in working with CBCT method have an impact on the accurate detection of FDs on CBCT images.

In the present study, two observers, with different level of clinical experience, analyzed the furcation regions of lower molars on CBCT images. Our study showed that the clinical measurement of furcation involvement in buccal side was 5.481±1.696 mm by clinician 1 and 5.456±1.665 mm by clinician 2. On lingual side it was 3.763±0.7496 mm & 3.811±0.7829 mm by clinician 1 & clinician 2 respectively [Table 1]. The CBCT measurement of furcation in buccal side was 4.463±1.857 mm and lingual side was 4.016±1.497 mm [Table 2]. These results are in accordance with the results of study Cimbaljevic et al (2015) where FDs were more accurately detected on CBCT images than during the clinical examination.[11]

The anatomical limitations associated with maxillary and mandibular molars make diagnosis of furcation involvement difficult. However, clinical diagnosis of FI is helpful for periodontal treatment planning. Periodontal therapy most often is selected based on the clinical assessment of the severity of these furcation invasions. A study used the Glickman system to classify FIs in maxillary molars and compared measurements taken during initial patient examination with those made after surgical debridement. The study showed that only 62% of furcations were diagnosed correctly before surgery, with 28% initially underestimated and 10% overestimated.[12]

Our study showed that the comparison of furcation involvement clinically by clinician 1 and CBCT measurements in buccal side was 5.481±1.696 mm & 4.463±1.857 mm respectively, which was statistically significant (p=0.0255*) [Table 3]. But in lingual side (3.763±0.7496 mm & 4.016±1.497 mm respectively) was not statistically significant (p=0.3696 NS). Similarly, the measurement of furcation involvement clinically by clinician 2 and CBCT in buccal side was 5.456±1.665 mm & 4.463±1.857 mm respectively, which was statistically significant (p=0.0278*) [Table 4]. But in lingual side (3.811±0.7829 mm & 4.016±1.497 mm respectively) was not statistically significant (p=0.4951 NS).

The results of the present study are comparable with the study carried out by Misch et al (2006), in which artificial osseous defects on mandible were generated in dry skulls, and it was observed that CBCT measurements were similarly accurate as direct measurements using a periodontal probe in buccal and lingual defects.[5]

Walter et al showed that CBCT provides more detailed information about the degree of FI compared to the clinical findings and periapical radiographs.[13] Zappa et al stated that clinical FI diagnosis is limited, and should be supplemented by other diagnostic methods.[14] Data from CBCT could be helpful in preoperative evaluation of size and architecture of the defect and in surgical treatment plan optimization. Without precise information of FI, periodontal surgery may reveal unexpected findings, leading to changes in the treatment plan during the surgery,[15] and causing unanticipated treatment costs.[16]

For the patients suffering from chronic generalized severe periodontitis, in which surgical treatment is necessary, a CBCT examination prior to definitive treatment plan should be performed. Preliminary to the decision of a CBCT examination, the clinician should also consider the amount of additional information that would be provided, and to what extent the treatment plan would be altered.

CONCLUSION

CBCT imaging showed high accuracy and moderate reproducibility in the detection of furcation involvement. Based on these results, it can be concluded that CBCT technique can be considered a reliable tool for detecting furcation involvement.

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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