To Correlate Cone - Beam Computed Tomography and Direct Surgical Measurements in the Mandibular Molar Furcation Involvement

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Abstract: ***Aim**: The aim of the present study was to correlate cone - beam computed tomography and direct surgical measurements in the mandibular molar furcation involvement. **Material and Method**: Study population included 25 patients who fulfilled the inclusion criteria with 30 mandibular molar furcation sites. CBCT was performed to measure height, width, and depth of furcation defects of mandibular molars with Grade II and Grade III FI. Intrasurgical measurements of the FI were assessed during periodontal flap surgery in indicated teeth which were compared with CBCT measurements. **Statistical Analysis**: Collected data was entered into excel sheet and analysis was done using appropriate statistical software. Descriptive and inferential analysis were carried in the present study. To check if significant variation exists between the radiographic and surgical measurements, paired t - test was used. **Result**: The CBCT versus intrasurgical furcation measurements were 2.87 ± 1.08 mm and 2.80 ± 1.11 mm for furcation height, 2.28 ± 0.75 mm and 2.27 ± 0.74 mm for furcation width, and 3.87 ± 1.34 mm and 3.82 ± 1.31 mm for furcation depth, respectively. Results showed that there was no statistical significance between the measured parameters, indicating that the two methods were statistically similar. **Conclusion**: The present study showed that CBCT and intrasurgical assessment of mandibular molar FI were found to be in good agreement, thus implying that the accuracy of assessment of mandibular molar FI by CBCT was comparable to that of direct surgical measurements.***

Keywords: CBCT, intrasurgical, mandibular molar

1. Introduction

Periodontitis is defined as "An infectious disease resulting in inflammation within the supporting tissue of teeth, progressive attachment and bone loss and is characterized by pocket formation and/or gingival recession". (AAP) [1] Generally, molars have multiple roots with their broad bifurcation or trifurcation of root trunk. Whereas this complex anatomy become disadvantageous when involved by periodontal disease in terms of difficulty in proper debridement during routine periodontal instrumentation and cleaning during routine home - care practices. The Glossary of Periodontal Terms defines furcation as "the anatomic area of a multirooted tooth where the roots diverge" and furcation invasion refers to the "pathologic resorption of bone within a furcation".1

Inflammatory periodontal disease, if unabated, ultimately progresses to attachment loss sufficient to affect the bifurcation or trifurcation of multirooted teeth. The furcation is an area of complex anatomic morphology that may be difficult or impossible to debride by routine periodontal instrumentation. Routine home care methods may not keep the furcation area free of plaque.2 Furcation involvement is therefore an important complication in the progression of periodontitis and is a risk factor for progression of further attachment loss and, at the same time, reduces the efficacy of periodontal therapy and presents both diagnostic and therapeutic dilemma. The presence of furcation-involved teeth in a periodontal patient will influence the treatment plan. The selection of procedures to be used in the treatment of periodontal disease at multirooted teeth can first be made when the presence and depth of furcation lesions have been assessed.

Studies have concluded that the diagnosis of furcation involvement (FI) can be assessed based on probing pocket depth (PPD), clinical attachment level (CAL), and furcation entrance (FE) by using periodontal probe and Naber's probe. However, it may be difficult to accurately assess, diagnose, and treat a molar with furcation defects due to anatomical and morphological variations. Thus, additional diagnostic procedures such as radiographic investigations are necessary to assist clinicians, especially periodontists, in the decision - making process concerning management plan from diagnosis to definitive treatment.3

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.4More recently, 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 sagittal planes without magnification. CBCT collects high - resolution 3D data at lower cost and reduced radiation doses than conventional CT.5 Hence, the present study was undertaken to investigate the accuracy of CBCT in assessing mandibular molar FI by comparing it to direct surgical measurements during furcation surgery.6

2. Subjects and Methods

Study population

Systemically healthy patients in age group between 20 to 60 years, reporting to Department of Periodontology, A. M. C. Dental College and Hospital, Ahmedabad, Gujarat, India were selected for the study. Patients clinically and radiographically diagnosed with moderate - to - severe chronic periodontitis with at least one mandibular molar with Grade II or Grade IIIFI indicated for periodontal surgery were included in study.

Patients with systemic disease, smokers & tobacco chewers, pregnant & lactating women were excluded from the study. Teeth with furcation caries, mandibular 3rd molar, tooth indicated for extraction, Grade I and IV FI were also excluded from the study. Fifteen patients with 30sites who fulfilled above inclusion and exclusion criteria were included in the study. Informed consent was obtained from all the participant. Study period was period from November 2020 to September 2021.

Study Protocol

At baseline, periodontal status of the patient was assessed using the PPD and CAL measurements and clinical grading of the FI was done. All patients underwent full - mouth scaling and root planning. This was followed by CBCT measurements performed to measure dimension of furcation defect (width, height and depth) at each furcation entrance for the specified tooth.

Method of Data Collection [FIG A TO K]

Clinical Parameters

PPD and CAL were measured using UNC 15 (PCPUNC - 15, Hu - Friedy, Chicago, IL, USA) probe at baseline. FI was measured at two sites (Buccal and Lingual) using Nabers Periodontal Probe and UNC 15. Grading of furcation was according to Glickman's classification system.7 All the clinical parameters were assessed by a single calibrated examiner.

Radiographic parameters

Cone - beam computed tomography measurements

CBCT [NewTom GiANO CBCT MACHINE] measurements were performed by measuring the deepest vertical and horizontal (height, width and depth) furcation defects at each furcation entrance. The furcation entrance serves as anatomical starting point for measurements.

CBCT measurements were analyzed in axial, sagittal, and coronal sections that make the defect most visible and easily measurable. The cross sections of different planes were aligned using the furcation entrance as anatomical landmark.

Back and forth scrolling in the different planes was allowed to identify and measure the deepest vertical and horizontal extent of bone loss.

These measurements were then recorded and compared to intrasurgical measurements.

Intrasurgical measurements

Conventional flaps were reflected under local anesthesia. Debridement of periodontal osseous defects were performed at each tooth surface and direct surgical defect measurements were made using endodontic file with transparent stopper.

Furcation height, width, and depth were measured by the same examiner.

To obtain maximum accuracy, a calibrated digital vernier caliper was used.

The measurements:

1) **Height:** was measured from the furcation fornix to the base of the alveolar base.
2) **Width**: was measured between the greatest dimensions of separation between the two roots above the crest of alveolar bone.
3) **Depth:** was measured from the crest of alveolar bone till the interradicular bony resistance felt.

Figure A: Probing with Nabers Probe

Figure B: Flap Reflection

Figure C: Measurement of Depth (INTRASURGICALLY)

Figure D: Intrasurgical Measurements Were Transferred To Digital Vernier Caliper (DEPTH)

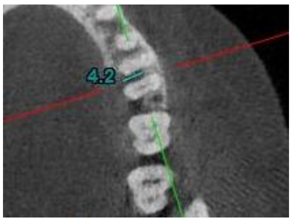


Figure E: Measurement of Depth (CBCT)

Figure F: Measurement of Height (Intrasurglly)

Figure G: Intrasurgical Measurements were transferred to Digital Vernier Caliper (Height)

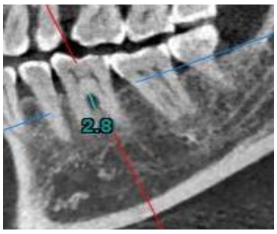


Figure H: Measurement of Height (CBCT)

Figure I: Measurement of Width (Intrasurgically)

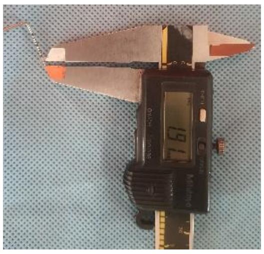


Figure J: Intrasurgical Measurements were Transferred to Digital Vernier Caliper (Width)

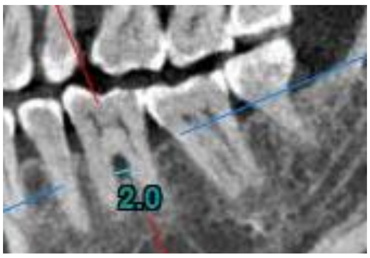


Figure K: Measurement of Width (CBCT)

Statistical Analysis

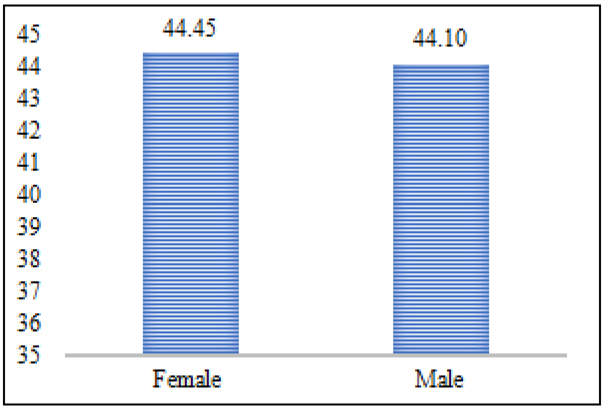
Collected data was entered into excel sheet and analysis was done using appropriate statistical software. Descriptive and inferential analysis was carried in the present study. For all statistical analysis, probability levels of P < 0.05 were considered statistically significant. To check if significant variation exists between the radiographic and surgical measurements, paired t - test was used.

3. Results

Table I: Age and Gender wise distribution of Subjects

Gender	Age		Number Of Site	Percentage
	Mean	SD		
Female	44.45	10.07	20	66.67
Male	44.10	9.13	10	33.33
Total	44.33	9.61	30	100

A total **30 sites** with furcation involvement from **25 patients** were included in the study in which there were 12 males and 13 females with a **Male: Female ratio of 0.67: 1.** There was no statistically significant difference between mean age of Male and Female (*p*>0.05).

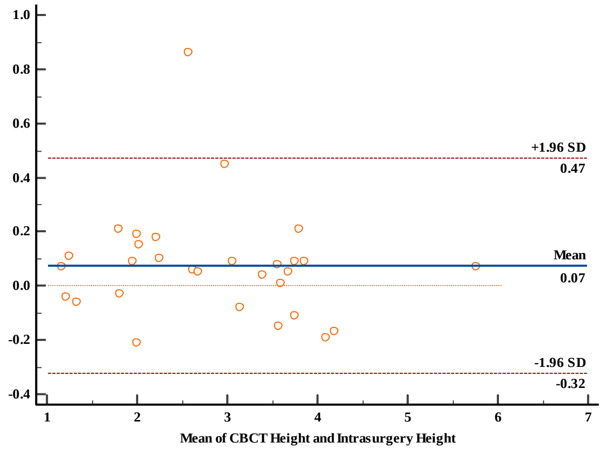


Graph I: Bar chart showing Mean Age of Female and Male

Table II: Comparison between cone - beam computed tomography and direct surgical measurements with respect to furcation height

Variable	Mean	SD	Pair Difference		t	DF	p value
			Mean	SD			
CBCT	2.87	1.08	0.07	0.20	1.98	29	0.056
Intra surgery	2.80	1.11					

The mean height of the furcation defects was 2.87 ± 1.08 mm and 2.80 ± 1.11 mm by CBCT method and intrasurgical method, respectively. Difference between mean height measure by CBCT and intrasurgically was only 0.07±0.20 mm. There was no statistically significant difference in furcation height measurement when measured with CBCT as well as intrasurgically. (p < 0.05).



Graph II: Agreement level between CBCT measurements and intrasurgical measurements for furcation height t - test value: 1.987, DF=29, *p*=0.056

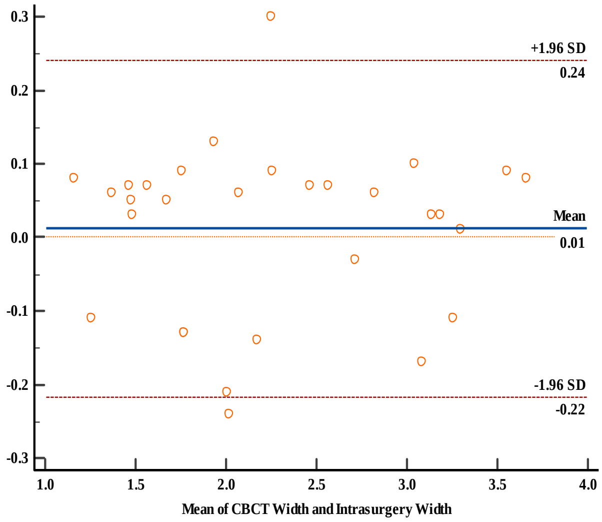
Height

30% of patients, the CBCT method measured lower value than intrasurgical measurements. Irrespective of the positive and negative signs, 96.67% of cases had deviation between − 0.50 and 0.50. Out of the 30 observations, 29 observations lie between the upper and lower limits.

Table III: Comparison between cone - beam computed tomography and direct surgical measurements with respect to furcation width.

Variable	Mean	SD	Pair Difference		t	DF	p value
			Mean	SD			
CBCT	2.28	0.75	0.01	0.12	0.546	29	0.589
Intra surgery	2.27	0.74					

The mean width of the furcation defects was 2.28 ± 0.75 mm and 2.27 ± 0.74 mm by CBCT method and intrasurgery method, respectively. Difference between mean width measure by CBCT and intrasurgically was only 0.01±0.12 mm. There was no statistically significant difference in furcation width when measured with CBCT as well as intrasurgically. ($p < 0.05$).



Graph III: Agreement level between CBCT measurements and intrasurgical measurements for furcation width t - test value: 0.546, DF=29, *p*=0.589

Width

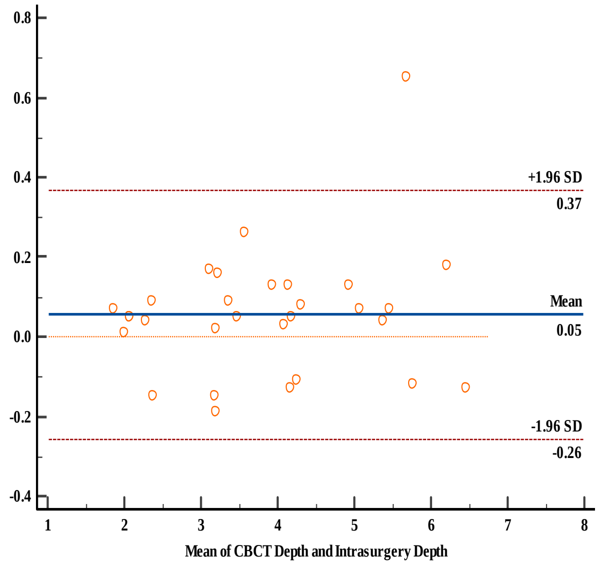
30% of patients, the CBCT method measured lower value than intrasurgical measurements. Irrespective of the positive and negative signs, 100% of cases had deviation between − 0.50 and 0.50.

Out of the 30 observations, 28 observations lie between the upper and lower limits.

Table IV: Comparison between cone - beam computed tomography and direct surgical measurements with respect to furcation depth.

Variable	Mean	SD	Pair Difference		t	DF	p value
			Mean	SD			
CBCT	3.87	1.34	0.05	0.16	1.885	29	0.069
Intra surgery	3.82	1.31					

The mean depth of the furcation defects was 3.87 ± 1.34 mm and 3.82 ± 1.31 mm by CBCT method and intrasurgery method, respectively. Difference between mean depth measure by CBCT and intrasurgically was only 0.05±0.16 mm. There was no statistically significant difference in furcation depth when measured with CBCT as well as intrasurgically. ($p < 0.05$).



Graph IV: Agreement level between CBCT measurements and intrasurgical measurements for furcation depth t - test value: 1.885, DF=29, *p*=0.069

Depth

23.33% of patients, the CBCT method measured lower value than intrasurgical measurements. Irrespective of the positive and negative signs, 96.67% of cases had deviation between − 0.50 and 0.50. Out of the 30 observations, 29 observations lie between the upper and lower limits.

4. Discussion

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 involvement.[6]

Although we routinely employ conventional two - dimensional (2D) radiographs for diagnosing bone levels in periodontal disease, 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 it is difficult to diagnose exact bone loss in furcation area as well as site of furcation (buccal, lingual or mesio - palatal/disto - palatal). The study by **Anderegg CR Jr et al in 1991**[8]showed that only 62% of furcations were diagnosed correctly before surgery, with 28% initially underestimated and 10% overestimated.

The most important thing in case of furcation involved teeth is **ACCURATE DIAGNOSIS**. While diagnosing grade of furcation defect clinically, there are many anatomical factors which hamper the diagnosis (i. e., enamel pearl, bifurcation/trifurcation ridges, cervical enamel projection, narrow degree of separation, long root trunk). If the diagnosis of furcation involvement isn't correct it will lead to improper treatment plan and it will lead to poor prognosis of tooth.

Eickholz P et al in 2000[9] showed that there was about 1.41–2.58 mm underestimation of amount of bone loss with the use of periapical radiographs for radiographic assessment. Conventional radiographs (IOPA/Bitewing) are 2 - Dimensional, so in that case we can not measure the exact site of defect, degree of involvement, as well as there are chances of super imposition / magnification / distortion of images. Similar outcomes were observed in study by **Benn DK et al in 1990**[10].

Owing to these drawbacks, CBCT has revolutionized dental imaging from 2D to 3D images and expanded its role from being a mere diagnostic tool to providing image guidance for operative and surgical procedures. A study by **Vandenberghe B et alin 2007**[11] compared assessment of periodontal bone architecture using 2D intraoral digital images obtained using a charged couple device and 3D full - volume CBCT - based imaging modalities. They concluded that CBCT images demonstrated more potential than intraoral digital images for describing periodontal bone defect morphology. Similar results were described in study by **Misch KA et al in 2006**[12].

In the present study, mandibular molars with FI were included. We have calculated dimensions of furcation (height, width and depth) on CBCT and corelate it with intrasurgical measurement.

Out of 30 sites, the mean of the furcation **height** measured from the furcation fornix to base of the defect was 2.87 ± 1.08 mm by CBCT method and 2.80 ± 1.11 mm by intrasurgical method. Difference between the two methods was 0.07 mm which was not statistically significant. The result of the present study is in accordance with the findings of another study which was done by **Padmanabhan S et al (2017)** [6], **Qiao J et al (2014)** [13].

In the present study, CBCT and intrasurgical measurements of furcation **width** was 2.28± 0.75 and 2.27± 0.74 mm, respectively. Difference between mean width measure by CBCT and intrasurgically was only 0.01±0.12 mm. There was no statistically significant difference in furcation width when measured with CBCT as well as intrasurgically, which was in accordance with study by **Padmanabhan S et al (2017)** [6], **Qiao J et al (2014)** [13].

In the present study, CBCT and intrasurgical measurements of furcation **depth** was 3.87 ± 1.34 mm and 3.82 ± 1.31 mm respectively. Difference between mean depth measure by CBCT and intrasurgically was only 0.05±0.16 mm. There was again no statistically significant difference in furcation depth when measured with CBCT as well as intrasurgically, which was in accordance with study by **Padmanabhan S et al (2017)** [6], **Qiao J et al (2014)** [13].

Previous studies[14, 15, 16] used the Hamp furcation classification system[17] which uses a 3 mm increment to differentiate the degree of FI. The present study used the Glickman classification system for FI as this system uses both clinical and radiographic assessments for diagnosis and hence provides more details than the Hamp classification system which separates furcation severity by arbitrary millimeter increments. This was done to avoid a measurement error.

One of the highlights of the present study was that the actual intrasurgical measurements were done using a UNC 15 probe with transparent stopper and assessed with a digital vernier caliper as it has an accuracy of up to 0.01 mm hence is more accurate.

To obtain the accuracy of CBCT measurements, it was done with the help of OMR Department. The measurements of CBCT and mean of the measurements was taken for final analysis. The results of our study showed that CBCT accurately reproduced the clinical measurements of FI (height, width, and depth) which was similar to another study comparing intrasurgical and CBCT measurements.[6, 13]

5. Conclusion

The present study showed that CBCT and intrasurgical assessment of mandibular molar FI were found to be in good agreement, thus implying that the accuracy of assessment of mandibular molar FI by CBCT was comparable to that of direct surgical measurements. Most of the previous studies were done in vitro but this study was done in vivo so results of this study maybe more useful. A comparable result between the groups signifies that CBCT is an accurate adjunctive diagnostic tool in diagnosis of mandibular furcation involvement and for strategic treatment planning for different grades of furcation involvement. So, we can conclude that 3D imaging as a pre - operative tool is very useful and accurate for decision making in furcation surgery.

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