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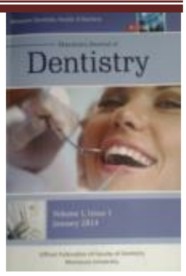

Accuracy of two CBCT machines in periodontal defect detection

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Abstract:

Objective:

CBCT replace the use of conventional radiographs in many fields in nowadays dentistry.

Aim:

Measuring the accuracy of the two CBCT machines in detection of periodontal defects.

Material and method:

With its small field of view Planmecca 3D machine was used in detection of fenestration and dehiscence periodontal defects around anterior, premolar and molar teeth and a control group were done. They were made on human mandibles and maxillae made by using dental drills with high coolant. The studied bone was covered by soft wax as soft tissue simulation and the selected voxel sizes were used. Real measurements were done by graded periodontal probe to the nearest 0.5 mm. Radiographic measurements were done by measurements of CBCT software. Were there no restricted time for evaluation was chosen. The resulted measures were compared statistically.

Results:

No statistical difference between the radiographic measurements and on-skull measurement was detected.

Conclusion:

CBCT is important tool in measurements for fenestration and dehisence periodontal defects.

Keywords: CBCT, defect, machine, field of view.

Introduction

The periodontium is a complex tooth-supporting structure consisting of four main components: the alveolar bone, cementum, gingiva, and periodontal ligament[1]. Alveolar bone, at times, may undergo alterations in its morphology due to many factors as local anatomical variations or during pathological condition as periodontal diseases resulting in osseous defects such as fenestration and dehiscence [2]. Periodontal disease is a set of infectious oral inflammatory conditions that affect the periodontal apparatus of the tooth. It results due to the disruption of the symbiotic relationship between oral flora and the host immune system, characterized by successive periods of microbial exacerbation followed by periods of remission, causing progressive tooth destruction and loss[3].

Although bacterial plaque is an initial factor in periodontal disease, periodontitis is a multifactorial disease because of a broad spectrum of systemic, genetic, social, and tooth level factors. Chronic periodontitis is characterized by the destruction of dental supporting tissues, ultimately leading to tooth loss [4]. In multi-rooted teeth, the bone destruction can reach the area of root separation, thus exposing it to microbial colonization. In this occurrence, furcation involvement is created[5].

A radiographic survey is another key parameter in periodontal diagnostic decision making, which can help determine the severity of periodontitis and bone related damage[6]. Through maxillofacial imaging, information on general and local alveolar bone levels, factors causing plaque involvement, caries, furcation defects, subgingival calculus, and additional pathologies can be obtained. Commonly used radiographic methods in periodontology are periapical, bitewing and panoramic radiographs [7].

When compared with periapical and panoramic images, the CBCT has also shown an absence of distortion and overlapping, and the dimensions of the images that it presents were compatible with the actual size of the individual[8]. CBCT was found to be significantly more accurate than digital intraoral radiographs when direct surgical measurements served as the gold standard for the evaluation of intra-bony defects' regenerative treatment outcomes. CBCT can replace surgical re-entry by providing 3D images and measurements that are almost equivalent to direct surgical measurements[9].

Materials and methods:

The artificial defects where made randomly on incisors, premolars and molars using round diamond bur and/or fissure dental bur mounted on a high-speed hand piece with copious air/water spray.

The artificial periodontal defects with various width and height were created by the help of a periodontal consultant.

Planmecca Promax 3D CBCT (Promax 3D;Planmeca Oy, Helsinki Finland). The X-ray source is attached opposite to the detector unit arrangement and both rotate around the centre of rotation (the human skull's maxilla or mandible in this study) at 360°. The skull position on the machine was adjusted using the 3positioning laser beams guide in the same orientation as a live patient.

CBCT images were acquired in DICOM format that saved. Then the analysis was conducted independently, and on separate occasions by experienced maxillofacial radiologist (observer 1), experienced periodonticst (observer 2) and general practioner (observer 3). They were totally blinded about the essential data of the scans like FOV, voxel size & about the teeth that have the defects. The observers were aware that some teeth have no periodontal defects. For further assurance of blindness& limit experimental bias, all the gold standard measurements (that also done by the periodontist observer) were done two weeks after CBCT measurements were done.

The measurements were performed with the maximum possible zoom. All the CBCT measurements were taken two times at different sessions separated by two weeks' time gap by the same examiners. Each observer recorded his observation as (observation 1) for his primary assessment as observer 1, observation1 .., etc. And each of them recorded the second assessment as observation 2 as observer 1, observation2.

The teeth were coded as a preparation for radiographic assessment and measurements data sheets to be ready for statistical analysis procedure. They coded by number from 1 to 35,started from the most right tooth included in each model ended by the most left one in each model. All of the observers' inter- and intra-evaluations were compared according to the gold standard that was created, and noted by the periodontal consultant.

Figure (1) shows fenestration and dehiscence defects.

Results:

In present study we tested the accuracy of CBCT machines for detection of periodontal defects.

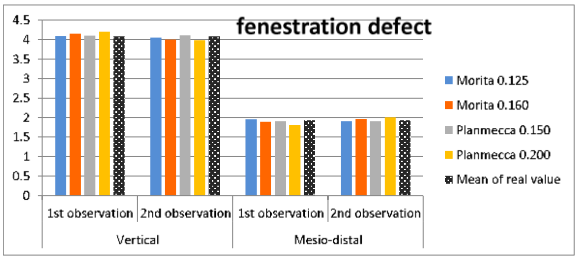

Figure (2) shows fenestration defect results

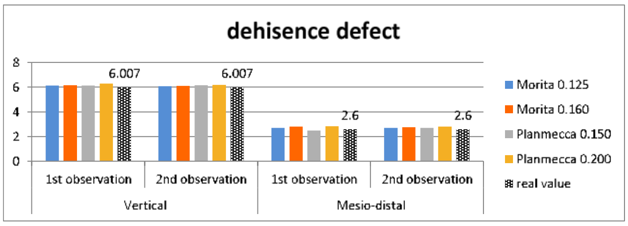

Figure (3) shows dehisence defect results

Table (1) shows relation between both machines voxel sizes used results and real value measurements (on-skull) of fenestration defect:

Fenestration defect (n=6)	Voxel sizes used				
	Real value	Iorita 0.125	Iorita 0.160	lanmeca 0.150	lanmeca 0.200
Vertical					
1st observation	4.08±1.15	4.09±1.12	4.09±1.18	4.11±1.11	4.12±1.10
Paired t test		**P=0.87**	**P=0.79**	**P=0.82**	**P=0.42**
		P1=0.98		***P2=0.89***	
		p3=0.93			
		p4=0.90			
2nd observation		4.08±1.12	4.06±1.13	4.10±1.15	4.12±1.09
Paired t test		**P=0.88**	**P=0.71**	**P=0.77**	**P=0.42**
		P1=0.90		***P2=0.87***	
		p3=0.89			
		p4=0.91			
Mesiodistal					
st observation	1.93±0.33	1.89±0.32	1.89±0.27	1.88±0.29	1.87±0.24
Paired t test		**P=0.50**	**P=0.43**	**P=0.45**	**P=0.38**
		P1=0.96		***P2=0.97***	
		p3=0.97			
		p4=0.98			
nd observation		1.89±0.25	1.88±0.25	1.86±0.29	1.81±0.30
Paired t test		**P=0.54**	**P=0.27**	**P=0.52**	**P=0.25**
		P1=0.61		***P2=0.62***	
		p3=0.62			
		p4=0.90			

Table (1) shows that there is no significant difference between both machines measurements and real value (measurements on skull) for fenestration defect.

Table (2) shows inter and intra- observer agreement for fenestration defect measurements by both used machines and real value on skull:

Fenestration defect		Mesio distal			Vertical		
		First observer	2nd observer	3rd observer	First observer	2nd observer	[illegible]
Morita 0.125	1st observation 2nd observation	0.928 (0.820-0.961)	0.809 (0.795-0.918)	0.807 (0.780-0.959)	0.933 (0.890-0.999)	0.812 (0.639-0.982)	(
Morita 0.160	1st observation 2nd observation	0.803 (0.707-0.887)	0.876 (0.756-0.930)	0.923 (0.811-0.964)	0.880 (0.756-0.954)	0.865 (0.705-0.892)	(
Planmecca 0.150	1st observation 2nd observation	0.725 (0.650-0.809)	0.819 (0.697-0.909)	0.952 (0.891-0.990)	0.763 (0.657-0.895)	0.776 (0.598-0.894)	(
Planmecca 0.200	1st observation 2nd observation	0.789 (0.654-0.808)	0.854 (0.789-0.899)	0.897 (0.803-0.973)	0.784 (0.552-0.852)	0.809 (0.681-0.909)	(
ICC between observer 1 &2		0.799 (0.686-0.900)			0.789 (0.609-0.897)		
ICC between observer 1&3		0.777 (0.653-0.895)			0.895 (0.675-0.899)		
ICC between observer 2&3		0.974 (0.905-0.985)			0.943 (0.756-0.989)		

ICC: Interclass correlation CI: Confidence interval

Table (2) shows that there were high inter and intra-observer agreement for the mesio-distal and vertical measurements for fenestration defect.

Table (3) shows intra-observer & inter-observer agreement for measured vertical and mesio-distal measurements of dehiscence defect.

dehiscence defect		Mesio distal			Vertical		
		First observer	2nd observer	3rd observer	First observer	2nd observer	3rd o
Morita 0.125	1st observation 2nd observation	0.987 (0.867-0.992)	0.889 0.784-0.891)	0.884).800-0.875)	0.833 (0.654-0.900)	0.812 0.711-0.912)	0 0.89
Morita 0.160	1st observation 2nd observation	0.813 (0.718-0.894)	0.882 0.749-0.910)	0.906).832-0.983)	0.980 (0.786-0.993)	0.765 0.651-0.800)	0 0.69
Planmecca 0.150	1st observation 2nd observation	0.799 0.650-0.891)	0.712 0.601-0.916)	0.824).712-0.890)	0.752 (0.643-0.895)	0.800 0.732-0.854)	0 0.78
Planmecca 0.200	1st observation 2nd observation	0.843 0.700-0.892)	0.790 0.523-0.893)	0.811).783-0.923)	0.777 (0.652-0.832)	0.799 0.564-0.895)	0 0.87
ICC between observer 1 &2		0.823 (0.719-0.901)			0.796 (0.719-0.901)		
ICC between observer 1&3		0.910 (0.876-0.96)			0.883 (0.800-0.907)		
ICC between observer 2&3		0.811 (0.705-0.902)			0.801 (0.700-0.921)		

ICC: Interclass correlation CI: Confidence interval

Table (3) shows high inter and intra-observer agreement for mesio-distal and vertical measurements for dehiscence defect.

Discussion:

The success of periodontal therapy depends on many factors. One of the most important factors is an accurate imaging of the morphology of periodontal bone destruction which affects the treatment plan and needed time for treatment and improves the quality of periodontal care and thus improves the outcome.[10]. We found the accuracy for detection fenestration and dehiscence defects by planmecca promax 3D was 100%. It would be due to the defects were relatively large in size. It was about (78%-95%) with Bagis et al, in their ex-vivo study with the same machine to compare between the findings of CBCT and intra-oral radiograph [11]. The difference would be due to the variation in voxel sizes used in both studies.

Conclusion:

Periodontal defects can be detected early enough, be classified, and thereby be treated so affect the time and prognosis of the treatment by correct diagnosis by the aid of dental imaging.

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