RESEARCH ARTICLE

Comparison of the influence of FOV sizes and different voxel resolutions for the assessment of periodontal defects

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Objectives: This study assessed the influence of different voxel resolutions of two different CBCT units on the *in vitro* detection of periodontal defects.

Methods: The study used 12 dry skulls with a maxilla and a mandible. Artificial defects (dehiscence, tunnel, fenestration) were separately created on the anterior, premolar and molar teeth using burs. A total of 14 dehiscences, 13 fenestrations, 8 tunnels and 16 non-defect controls were used in the study. Images were obtained from two different CBCT units in six voxel sizes (voxel size: 0.080, 0.100, 0.125, 0.150, 0.160 and 0.200 mm³). Kappa coefficients were calculated to assess both intra- and interobserver agreements for each image set.

Results: Overall intraobserver kappa coefficients ranged between 0.978 and 0.973 for the 0.080-mm³ images and between 0.751 and 0.737 for the 0.160-mm³ images, suggesting notably high intraobserver agreement for detecting periodontal defects. CBCT performed significantly better at detecting fenestrations ($p < 0.05$) than tunnel and dehiscence defects. No statistically significant difference was found between the detection of dehiscence and tunnel defects ($p > 0.05$).

Conclusions: A voxel size of 0.150 mm³ was identified as the cut-off point for overall detection of periodontal defects. CBCT should be considered the most reliable imaging modality for the diagnosis of periodontal defects.

Dentomaxillofacial Radiology (2015) **44**, 20150070. doi: 10.1259/dmfr.20150070

Cite this article as: Kolsuz ME, Bagis N, Orhan K, Avsever H, Demiralp KÖ. Comparison of the influence of FOV sizes and different voxel resolutions for the assessment of periodontal defects. *Dentomaxillofac Radiol* 2015; **44**: 20150070.

Keywords: diagnosis; cone beam computed tomography; radiology; periodontal diseases; voxel size

Introduction

Periodontal disease is a chronic bacterial infection that affects the gingiva and bone supporting the teeth. The detection of bone defects or furcation involvement poses significant challenges for the practitioner. The correct assessment of the bone condition is essential for the diagnosis, treatment planning and prognosis of periodontal disease. Knowledge of the morphological component is of fundamental importance for therapy and prognosis of periodontally compromised teeth, because it

is likely that some of the identified furcation defects could be suitable for surgical regenerative therapy.¹ There is ample research demonstrating that funnel-shaped or lingually located defects cannot be detected, and that destruction of the buccal plate can be undiagnosed or is undistinguishable from lingual defects.² The information derived from probing the gingival tissues in association with diagnostic imaging provides guidance in assessing alveolar bone height and checking for the presence of vertical bone defects. Radiographs are necessary for showing hidden anatomical structures such as the alveolar bone.

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Received 25 February 2015; revised 3 April 2015; accepted 20 April 2015

They expose the degree of interdental and interradicular bone loss, root length, crown–root ratio, periodontal ligament space and any apical pathology in the tooth.³

Since buccal and lingual defects cannot be diagnosed with intraoral radiography, three-dimensional (3D) examination could be considered a superior technique. Earlier studies have shown that CT assessment of periodontal bone height and intrabony defects is reasonably accurate and precise. However, the higher radiation exposure cannot always be justified.⁴ Considering the various benefits, CBCT is currently being evaluated as a superior diagnostic tool for applications in periodontology.⁵ CBCT scans produce reconstructed multiplanar images that allow the clinician to three dimensionally assess the area of interest,⁶ resulting in more accurate diagnoses that should improve patient management. CBCT shows 3D images of dental structures and offers clear, high-contrast structural images. Furthermore, the examination can be performed using lower patient exposure doses than those used in multislice CT.⁷ Research comparing the use of 3D volumetric images and two-dimensional images in artificial bone defects has shown that CBCT has a sensitivity of 80–100% in the detection and classification of bone defects, whereas intraoral radiographs have a sensitivity of 63–67%.^{2,8,9}

The quality of images obtained by CBCT depends on acquisition parameters such as milliamperage, kilovoltage and voxel size. The ability to view periodontal structures such as the periodontal ligament space, cortical bone, alveolar crest and alveolar cortical plate is important when establishing the diagnosis of periodontal disease. To accomplish this, images with a higher definition and smaller voxel size are needed, resulting in increased milliamperage and kilovoltage values.^{10–12} The voxel size is of paramount importance in terms of quality, scanning times and reconstruction times of CBCT images. The influence of voxel size on image resolution has been widely confirmed in the literature, especially in relation to the diagnosis of different diseases.¹³ Small voxel sizes generate images with high diagnostic power that can detect several changes such as root fractures, canals and root resorption.¹⁴ Differences have been observed in the quality of images obtained from different CBCT devices when the field of view (FOV) or voxel size is changed.¹³ Limited data are available on the detection of periodontal defects by CBCT or on the effect of voxel size in such diagnoses. This study assessed the use of different voxel resolutions of two different CBCT units in the detection of periodontal bone defects.

Methods and materials

Using retrospective data of the literature, a power analysis (Power And Precision™ software; Biostat, Englewood, NJ) was conducted that indicated that detection of differences between two-dimensional radiographs and 3D CBCT images could be obtained with at least 35 defects at a power of 0.8 ($\alpha = 0.05$). Therefore, this

study was conducted using 12 dry skulls with maxilla and mandible and 35 artificial defects [dehiscence, tunnel (furcation defect Level III) and fenestration], which were separately created using burs on incisors, premolars and molar teeth. In total, 14 dehiscences, 13 fenestrations, 8 tunnels and 16 controls without a periodontal defect were used in the study. These defects were randomly created on dry skulls by a periodontal consultant (NB). The consultant noted the periodontal defects that were used as the gold standard for the radiographic evaluation. For soft-tissue simulation, the maxilla and mandible were covered by double layers of boxing wax (Figure 1).

Radiographic imaging

Images were obtained from two different CBCT units: the first unit was a 3D Accuitomo 170 (J Morita Manufacturing Corporation, Kyoto, Japan) with a flat-panel detector offering nine different FOVs: 40 × 40, 60 × 60, 80 × 80, 100 × 50, 100 × 100, 140 × 50, 140 × 100, 170 × 50 and 170 × 120 mm. Using the Accuitomo system, images were obtained at 65 kV at 2.0 mA with an exposure time of 30.8 s for three different FOV settings: 40 × 40 mm FOV (0.080-mm³ voxel size; radiation dose, 1.4 mGy), 60 × 60 mm FOV (0.125-mm³ voxel size; radiation dose, 1.7 mGy) and 80 × 80 mm FOV (0.160-mm³ voxel size; radiation dose, 1.9 mGy). All of the images were taken in the high-resolution mode; axial scans and multiplanar reconstructions were obtained. Next, volumetric data were reconstructed using the system software to provide serial coronal and sagittal sections along each tooth plane. All of the images were reconstructed on a 21.3-inch flat-panel colour active-matrix thin-film-transistor medical display (MultiSync® MD215MG; NEC, Munchen, Germany) with a resolution of 2048 × 2560 at 75 Hz and 0.17-mm pixel pitch and greyscale reproduction at 11.9 bits.

The second unit was a Planmeca ProMax® 3D CBCT (ProMax 3D max; Planmeca Oy, Helsinki, Finland). The scanner offers multiple FOVs, allowing the dentist to select the optimum scan on a case-by-case basis. Images were obtained using a 5.0 × 5.5 FOV (0.100 mm³ voxel size), a 5.0 × 5.5 FOV (0.150 mm³ voxel size), and a 10.0 × 5.5 FOV (0.200 mm³ voxel size) with isotropic voxels. All of the images were reconstructed on a 21.3-inch flat-panel colour active-matrix TFT medical display (MultiSync MD215MG; NEC) with a resolution of 2048 × 2560 at 75 Hz and 0.17-mm pixel pitch and greyscale reproduction at 11.9 bits.

A total of six image sets were obtained as follows: (1) 3D Accuitomo 170, 4 × 4 cm FOV (voxel size, 0.080 mm³); (2) 3D Accuitomo 170, 6 × 6 cm FOV (0.125 mm³); (3) 3D Accuitomo 170, 8 × 8 cm FOV (0.160 mm³), (4) Planmeca 3D ProMax, 5 × 5.5 cm FOV (0.100 mm³), (5) Planmeca 3D ProMax, 5 × 5.5 cm FOV (0.150 mm³); and (6) Planmeca 3D ProMax, 10 × 5.5 cm FOV (0.200 mm³, Figure 2).

Image evaluation

Each image set was evaluated separately in random order by two trained oral and maxillofacial radiologists

(KO, MEK) with an experience of 15 and 7 years, respectively who used the software and enhancement tools of the imaging systems. Image sets were viewed at 2-week intervals, and evaluations of each image set were repeated 2 months after the initial viewings. The observers were asked to define the types of defects, and to identify the teeth without periodontal defects. In line with Braun's study,¹⁵ the defects were classified as being present, absent or uncertain while making the diagnosis (correct, false or questionable). In addition, all of the images were evaluated by the same examiners. For this reason, the positive-correct and negative-correct results were summarised as "correct." The positive-false, positive-questionable, negative-false and negative-questionable answers were classified as "incorrect." The level of significance was set at $p < 0.05$.

All of the observers' inter- and intraevaluations were compared according to the gold standard that was created, and noted by the periodontal consultant. The specificity and sensitivity for each radiographic technique were calculated. Kappa statistics were used for assessing the agreement between observers using the Number Cruncher Statistical System (NCSS) 2007 statistical software package (NCSS and GESS, NCSS; LLC, Kaysville, UT). Kappa statistics were used to determine inter- and intraobserver agreement. The kappa values were interpreted according to guidelines of Landis and Koch adapted by Altman: $^{16} \kappa \leq 0.20$ poor, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 good, 0.81–1.00 very good. The determination of significance level was carried out with the t -test using paired samples. Results were considered significant at $p < 0.05$.

Results

Table 1 shows the intraobserver kappa coefficients calculated for each observer according to voxel sizes of two

different CBCT units. In this study, we tested six different voxel sizes. We found higher intraobserver agreement for voxel sizes of 0.080, 0.100, 0.125 and 0.150 mm³ than for those from 0.160 and 0.200 mm³. For detection of all of the periodontal defects, overall intraobserver kappa coefficients had nearly identical values of 0.978 mm³ for the 0.080 mm³ images, whereas they ranged from 0.825 to 0.815 mm³ for the 0.125-mm³ images, suggesting higher intraobserver agreement for detecting periodontal defects.

Table 2 shows overall interobserver kappa coefficients for both the first and second readings according to voxel sizes. Similarly, higher interobserver agreement was obtained from the images with voxel sizes of 0.080 and 0.125 mm³ than with the others. Very good interobserver agreement was found for the first and second readings from these voxel sizes. Moreover, good interobserver agreement was found for images of 0.100 mm³ voxels (from 0.814 to 0.811 mm³). In general, good interobserver agreement was found for the first and second readings for CBCT images of <0.125 mm³ voxels. Images with values >0.150 mm³ voxels showed moderate interobserver agreement.

Comparisons between modalities according to the t -test revealed statistical significance among the voxel sizes smaller and larger than 0.150 mm³ ($p < 0.05$). The 0.150 mm³ voxel size was found to be the cut-off point for the overall detection of periodontal defects. When evaluating the periodontal defects individually, we divided the regions into molar, premolar and anterior, and then evaluated the scores according to image types. Table 3 shows mean interobserver agreement according to CBCT machines and voxel sizes. A significant difference was again found between voxel sizes smaller than and larger than 0.150 mm³. The kappa values for interobserver agreement between observers ranged between 0.978 and 0.617 for all CBCT units, which shows good agreement for detecting the periodontal defects. The kappa values

Figure 1 The photograph of the skulls (a) with defects, and (b) with wax coverings to simulate the soft tissue.

Figure 2 CBCT images showing (a) the position of the skull in the machine and (b) the periodontal defects in CBCT cross-section images.

for detecting defects on anterior teeth were lowest after premolar and molar teeth in every voxel size (Table 3). Table 4 summarises the survey results for defect types dehiscence, tunnel and fenestration. The statistical analysis also showed similar results for detection of the defects with a cut-off point of 0.150 mm³. CBCT showed statistically better performance on detecting fenestrations than on tunnel defects (*p* < 0.05).

Discussion

CBCT is a better diagnostic tool than conventional radiography for detecting periodontal bone defects.^{2,3,5,9,15} Bony dehiscences and fenestrations cannot be visualized

by traditional two-dimensional radiography because of the superimposition of contralateral cortical bony or dental structures. The present study compared the diagnostic accuracy of CBCT scans with different voxel resolutions in the detection of simulated periodontal defects. Both intra- and interobserver agreement values were better for 3D Accuitomo 170 images in which the highest kappa values were obtained with 4 × 4-cm FOV (voxel size, 0.080 mm³) images. Moreover, this study evaluated the effects of voxel size on the detection of periodontal defects using two different CBCT systems. Under clinical conditions, the subjective image quality of CBCT-based images and the ability of CBCT to display various features are influenced by a number of variables, including the unit itself, the FOV, the tube voltage and current, the voxel size and other technical factors.¹⁷ Voxel size is directly linked to the spatial resolution of an image. In general, the smaller the voxel size, the better the results for both the resolution and details.¹⁸ It may be suggested that the image quality is more closely associated with voxel size than with FOV size. For the same voxel protocol, a restricted FOV seems to be adequate, especially for small areas, because these protocols were obtained with low radiation exposure dose.¹⁹ Despite many studies in the literature regarding the effect of voxel sizes on root fracture, internal and external root resorption, and occlusal caries detection, no reports exist about the impact of voxel size on the visibility of periodontal bone defects. This visibility is important for accurate diagnosis of periodontal defects. Wenzel et al²⁰ and Melo et al²¹ showed that high-resolution CBCT (voxel size <0.2 mm) should be used when a root fracture is suspected but not visualized in a periapical image. Contrary to that, da Silveira et al²² and Ozer²³ did not find important differences among voxel sizes ranging from 0.125 to 0.400 mm. In another study, Liedke et al²⁴ used three voxel sizes (0.4, 0.3 and 0.2 mm³), and showed similar results among voxel sizes. Dalili et al²⁵ and Kamburöglu and Kursun²⁶ determined that high-resolution images (voxel size <0.16 mm³) were more accurate for the detection of artificially created internal root resorption. Meanwhile, Kamburöglu et al²⁷ indicated that voxel size did not affect the detection of occlusal caries lesions. Haiter-Neto et al¹⁷ indicated that voxel size of 0.125 mm³, but not 0.16, 0.25 or 0.36 mm³ provided more veritable lesion depth estimates for approximal lesions

Table 1 Overall intraobserver agreement calculated for each observer according to images

FOV and voxel sizes	Observer 1		Observer 2	
	κ	SE	κ	SE
3D Accuitomo 170.4 × 4.0 cm (voxel size, 0.080 mm ³)	0.978	0.024	0.973	0.025
3D Accuitomo 170.6 × 6.0 cm (voxel size, 0.125 mm ³)	0.825	0.056	0.815	0.058
3D Accuitomo 170.8 × 8.0 cm (voxel size, 0.160 mm ³)	0.751	0.069	0.737	0.060
Planmeca 3D 5.0 × 5.5 cm (voxel size, 0.100 mm ³)	0.823	0.052	0.827	0.054
Planmeca 3D 5.0 × 5.5 cm (voxel size, 0.150 mm ³)	0.804	0.061	0.798	0.062
Planmeca 3D 10.0 × 5.5 cm (voxel size, 0.200 mm ³)	0.708	0.084	0.698	0.085

FOV, field of view; κ, kappa coefficient; SE, standard error.
3D Accuitomo 170 was obtained from J Morita Manufacturing Corporation, Kyoto, Japan; Planmeca ProMax® 3D CBCT was obtained from Planmeca Oy, Helsinki, Finland.

Table 2 Overall interobserver kappa coefficients between observers for the first and second readings

FOV and voxel sizes	First reading Observer 1–2		Second reading Observer 1–2	
	κ	SE	κ	SE
3D Accuitomo 170.4 × 4.0 cm (voxel size, 0.080 mm ³)	0.982	0.024	0.981	0.027
3D Accuitomo 170.6 × 6.0 cm (voxel size, 0.125 mm ³)	0.882	0.051	0.802	0.038
3D Accuitomo 170.8 × 8.0 cm (voxel size, 0.160 mm ³)	0.580	0.084	0.594	0.038
Planmeca 3D 5.0 × 5.5 cm (voxel size, 0.100 mm ³)	0.814	0.078	0.811	0.074
Planmeca 3D 5.0 × 5.5 cm (voxel size, 0.150 mm ³)	0.622	0.089	0.624	0.092
Planmeca 3D 10.0 × 5.5 cm (voxel size, 0.200 mm ³)	0.546	0.090	0.558	0.094

FOV, field of view; κ , kappa coefficient; SE, standard error.

3D Accuitomo 170 was obtained from J Morita Manufacturing Corporation, Kyoto, Japan; Planmeca ProMax[®] 3D CBCT was obtained from Planmeca Oy, Helsinki, Finland.

than the histological gold standard or intraoral images. For detecting the simulated temporomandibular joint erosion, Librizzi *et al*²⁸ determined that images acquired with a voxel size of 0.2 mm³ were significantly more veritable.

When considering bone measurements made by CBCT images and comparing them with digital caliper measurements (as a gold standard), Sun *et al*²⁹ indicated (by

evaluating bone thickness) that bone measurements of 0.25 mm³ in voxel size were closer to the direct measurement than were images of 0.4 mm³ voxels. Patcas *et al*³⁰ indicated that when evaluating bone height and width, images of 0.4 mm³ voxels provided results as accurate as those of 0.125 mm³ voxels. This finding is the same as the study by Torres *et al*³¹ that did not find any

Table 3 Overall interobserver comparisons according to regions for different voxel sizes

FOV and voxel sizes	Molar			Premolar			Anterior		
	First reading Observers 1–2	Second reading Observers 1–2	Pairwise comparisons (significant)	First reading Observers 1–2	Second reading Observers 1–2	Pairwise comparisons (significant)	First reading Observers 1–2	Second reading Observers 1–2	Pairwise comparisons (significant)
3D Accuitomo 170, 4 × 4.0 cm (voxel size, 0.080 mm ³)	0.978 ¹	0.972 ⁴	1–6 4–6	0.886 ¹	0.893 ⁴	1–6 4–6	0.757	0.753	1–6 4–6
3D Accuitomo 170, 6 × 6.0 cm (voxel size, 0.125 mm ³)	0.951 ²	0.901 ⁵	2–6 5–6	0.829 ²	0.815 ⁵	2–6 5–6	0.753	0.712	2–6 5–6
3D Accuitomo 170, 8 × 8.0 cm (voxel size, 0.160 mm ³)	0.773 ³	0.758 ⁶	1–3 4–3 2–3 5–3	0.742 ³	0.727 ⁶	1–3 4–3 2–3 5–3	0.695	0.688	1–3 4–3 2–3 5–3
Pairwise comparisons (significant)	1–3 2–3	4–6 5–6	$p < 0.05$	1–3 2–3	4–6 5–6	$p < 0.05$	1–3 2–3	4–6 5–6	$p < 0.05$
Planmeca 3D, 5.0 × 5.5 cm (voxel size, 0.100 mm ³)	0.938 ^a	0.96 ^d	a–f d–f	0.91	0.924	a–f d–f	0.78	0.73	a–f d–f
Planmeca 3D 5.0 × 5.5 cm (voxel size, 0.150 mm ³)	0.714 ^b	0.758 ^e	a–b a–e d–b d–e	0.698	0.693	a–b a–e d–b d–e	0.646	0.693	a–b a–e d–b d–e
Planmeca 3D, 10.0 × 5.5 cm (voxel size, 0.200 mm ³)	0.617 ^c	0.654 ^f	a–c d–c	0.618	0.620	a–c d–c	0.644	0.692	a–c d–c
Pairwise comparisons (significant)	a–b a–c	d–e e–f	$p < 0.05$	a–b a–c	d–e e–f	$p < 0.05$	a–b a–c	d–e e–f	$p < 0.05$

FOV, field of view.

Different superscript letters and numbers indicate a statistical significance level of 0.05.

3D Accuitomo 170 was obtained from J Morita Manufacturing Corporation, Kyoto, Japan; Planmeca Pro Max[®] 3D CBCT was obtained from Planmeca Oy, Helsinki, Finland.

Table 4 Pairwise comparisons according to defect types

Identification of defects	Voxel size (mm ³)	Voxel size (mm ³)	Voxel size (mm ³)	Voxel size (mm ³)	Voxel size (mm ³)	Voxel size (mm ³)
Voxel size (mm ³)	0.080	0.125	0.160	0.100	0.150	0.200
Dehiscence						
Positive correct (%)	79.53	77.20	51.40	78.20	59.30	56.80
Positive false (%)	20.47	22.80	18.60	21.80	18.10	21.10
Positive-questionable (%)	0	0	30	0	22.6	22.1
Negative correct (%)	93.14	92.30	83.20	93.40	74.20	76.40
Negative false (%)	2.57	6.20	15.10	5.40	16.80	19.20
Negative-questionable (%)	4.29	1.50	1.70	1.20	9.0	4.40
Fenestration						
Positive correct (%)	81.40	87.20	49.30	89.10	42.80	44.70
Positive false (%)	18.60	7.44	28.40	8.14	29.20	34.60
Positive-questionable (%)	0	5.36	22.30	2.76	28	20.70
Negative correct (%)	95.70	97.30	71.0	95.30	73.30	77.70
Negative false (%)	2.40	1.10	7.20	1.20	6.40	4.80
Negative-questionable (%)	1.90	1.60	21.8	3.50	20.3	17.5
Tunnel						
Positive correct (%)	74.20	76.30	50.30	79.20	56.60	69.80
Positive false (%)	19.80	13.40	12.20	15.40	20.40	14.60
Positive-questionable (%)	6	10.30	37.50	5.40	23.0	15.60
Negative correct (%)	75.40	75.20	77.20	75.70	70.20	72.40
Negative false (%)	15.40	14.20	10.20	18.20	15.10	16.20
Negative-questionable (%)	9.20	10.60	12.60	6.10	14.70	11.40

differences among voxel sizes of 0.2, 0.3 and 0.4 mm³ in evaluating the 0.4-mm linear bone measurement. In another study, Sherrard et al³² found no statistical difference between the gold standard and CBCT-based measurements using the selected voxel size (0.2, 0.3 and 0.4 mm³) in terms of measuring tooth and root lengths. Ballrick et al¹² and Damstra et al³³ concluded that linear measurements made on CBCT surface renderings of 0.40 and 0.25 mm³ voxel resolutions are accurate, and there was no difference between the voxel resolution groups compared with anatomical measurements.

de-Azevedo-Vaz et al³⁴ tested the effect of voxel sizes and scan modes on peri-implant fenestration and dehiscence detection. It was indicated that the half-scan mode was similar to the full-scan mode for fenestration

but was *vice versa* for dehiscence. On analysing the kappa values, the authors stated that the voxel size of 0.12 mm³ was not statistically different from the 0.2-mm linear bone measurement for both defects. Thus, the voxel sizes tested did not influence accuracy in fenestration or dehiscence detection.

In this study, we tested voxel sizes <0.20 mm³. It was found that the kappa values decreased with an increase in voxel size (0.08–0.20 mm³). CBCT again performed better in detecting fenestrations than tunnel and dehiscence defects with a significant difference ($p < 0.05$). In terms of voxel sizes, no statistical significance was found for detection of all periodontal defects up to 0.150 mm³. However, >0.150 mm³, the detection of all periodontal defects was statistically significant ($p < 0.05$, Table 4).

In clinical practice, the detection of fenestration and dehiscence in CBCT may be less accurate, owing to the presence of teeth, metallic dental fillings, scatter related to soft tissue, or other producers of artefacts. Observer ability in this study might have been enhanced by the use of artificial defects, which have clear borders that are easier to detect than those of natural defects. Moreover, patient movement, which represents a significant drawback in the clinical use of CBCT, was not a factor in this study. The six different voxel resolutions showed similar results in terms of detecting simulated periodontal defects. However, if a high-resolution image is required for the detection of any periodontal defect, one should choose a voxel size up to 0.150 mm³ and a limited FOV (4 × 4 or 5 × 5.5 or 6 × 6 cm) with a standard radiation dose, which may make reconstruction difficult using a personal computer.

A limitation of this study was the use of various FOV sizes in CBCT units. The voxel sizes in CBCT units can also be changed and tested in fixed FOVs. According to the various FOV sizes, the images can be affected by scattered radiation that can affect the quality of the images, this issue was not considered in this study; however, in this study, it was attempted to change the voxel sizes in relation to FOV to test the observer agreements as a combination of these. Since FOV sizes may also affect the periodontal defects diagnosis together with voxel sizes. Further studies must also be conducted to test the voxel sizes in fixed FOV sizes.

CBCT provides high-resolution images that can be used to gather diagnostic and quantitative information on periodontal bone health. Routine CBCT examinations are discouraged, because the acquisition should only be indicated if such defects are suspected and if a patient would benefit from their detection. To do otherwise would violate the As Low As Reasonably Achievable Radiation Safety Guidelines for detection of periodontal bone defects.

Conclusions

Based on the results of this study, a voxel size of 0.150 mm³ was found to be the cut-off point for detection of the periodontal defects. CBCT should be considered the most reliable imaging modality of choice for the diagnosis of periodontal defects.

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