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Research Article

CBCT 3rd-Party Software; Is It Really User Friendly to Dentists in Different Specialties?

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Received: May 10, 2017; **Published:** June 12, 2017

Abstract

The introduction of Cone Beam Computed Tomography (CBCT) represents a radical change for dental and maxillofacial radiology. CBCT software are friendly user Consequently, this study was undertaken in an attempt to make sure if it is really a friendly user. Methodology: The linear measurements obtained from the CBCT were measured by 7 dentists from different specialties with different experiences in interpreting CBCT images. Results: high agreement was detected between the readings. Conclusion: Dentists can deal with the currently used CBCT software and manipulate it in a" friendly –user" manner.

Keywords: *CBCT; Software; Linear measurement; Implant planning*

Introduction

Radiography has been one of the frequently applied aids in human biometric research when using images for measurement. The introduction of Cone Beam Computed Tomography (CBCT) represents a radical change for dental and maxillofacial radiology [1]. CBCT is a technology that provides cross-sectional images without superimposition or blurring [2,3] and reduces the risk of radiation significantly [4,5]. CT images provide high accuracy of measurement with no significant difference between the measurement of actual landmarks or CT images [6-8]. However, the high radiation dose, availability and cost limit the use of this modality in the maxillofacial region for preoperative implant planning purposes. CBCT provides 3D imaging dedicated to the maxillofacial region at low cost and low dose of radiation [8].

CBCT was developed as an alternative to conventional CT to shorten the time of image acquisition of the entire FOV (Field of View) with a comparatively less expensive radiation detector. The lack of patient translational movement results in improved sharpness of the image which is reduced in conventional CT imaging. The reduced time of acquisition also reduces image distortion that may be caused by internal organ movement [9].

The information obtained from CBCT can be used for evaluation of hard tissues for dental implant placement or grafting, the temporomandibular joint complex, pathosis, anatomic variations and trauma as well as for orthodontic treatment planning [10-12]. CBCT is particularly helpful in presurgical planning for dental implant placement by localizing the anatomy to be avoided during surgery. It helps to measure the quantity and the quality of the bone available for the placement of implants [13]. CBCT provides submillimeter pixel resolution of projection images leading to high spatial resolution of the image. CBCT is primarily used for investigating bone [13]. Although CBCT is able to depict the associated soft tissue in the region imaged, it is not able to distinguish between different types of soft tissues [11].

It is mentioned in many texts and articles that the CBCT software are friendly user Consequently, this study was undertaken in an attempt to make sure if it is really a friendly user specially in the linear measurement used in assessment of dental implants.

Aim of the Study

Analyze the reliability of the readings obtained from CBCT images by different dental and maxillofacial specialists (oral radiologists, oral surgeons and prosthodontists) to judge the dentist's self-dependability in using the CBCT friendly-user software applied in the study.

Methodology

All patients were imaged using Cone Beam Computed Tomographic scanning (cross sections and reformatted panoramic images were obtained for every case).

CBCT images were performed with an i-CAT unit (Imaging Sciences International, Hatfield, PA). For the CBCT imaging the following settings were used 120 KV; 5 mA; FOV 130mm (mandible and maxilla); orientation landscape; exposure time 4 sec; voxel dimension 0.3 mm with the patient in a seated position.

An acrylic trial denture base was constructed for each patient containing round radiopaque markers (gutta-percha) at the implant site to be used as a reference point during measurements. All patients wore the denture base during imaging.

Image Analysis

The linear measurements obtained from the CBCT were measured by 7 dentists from different specialties with different experiences in interpreting CBCT images. Each clinician performed the measurements twice with 15 days interval in between the sessions, then the mean of the two trials was calculated and included in further statistical analysis in an attempt to judge the dentist's self-dependability in using the CBCT. These observers were two oral radiologists carrying a Master degree in Oral Radiology with 14 and 7 years experience, two oral surgeons carrying a Master degree in Oral Surgery with 6 and 4 years experience, and three prosthodontists carrying a Master degree in Removable Prosthodontics with 7, 4 and 3years experience. following the protocol recommended by [14-16] Amir., *et al*. 1998, Stavrpoulos and Wenzel 2007 and Liu., *et al.* 2008. Linear measurements were based on conventional craniometric anatomical landmarks that were defined by the two senior oral radiologists in the presence of the third radiologist and the other observers at a pre-measurement session.

Then the measurements were performed twice by each observer at two different sessions with a two-weeks interval in between the two sessions. The measurements were performed in a blind fashion. Results from these two trials were statistically analyzed to reveal the intra-examiner reliability and diagnostic performance (between each observer and himself).

The inter-examiner reliability and diagnostic performance (between the three observers) were also tested between the measurements of the three observers (the repeatability of the measurements).

All the measurement were performed using the software included in each used unit. Panoramic measurements were performed using the Planmeca Romixes viewer, while CBCT measurments were performed using the i-CAT-vision software, and the CT measurments were performed using eFilm Lite software.

From the 20 patients, readings for 30 implant sites were recorded in millimeters, a standardized tangent of fixed length drawn to the lower border of the markers at each investigated site was considered as the reference line for all measurements; all calculated measurements were recorded along lines drawn perpendicular to the midpoint of that reference line as follows:

Maxillary Measurements:

Anterior area measurements: This measurement is represented by the distance between the intersection of the midpoint of a tangent to the lower border of the marker and the intersection of the mid-point of another tangent to the lower border of the nasal cavity (M-NC).

Premolar- molar area measurements: This measurement is presented by the distance between the intersection of the midpoint of a tangent to the lower border of the marker and the intersection of the mid-point of another tangent to the lower border of the maxillary sinus (M-MS).

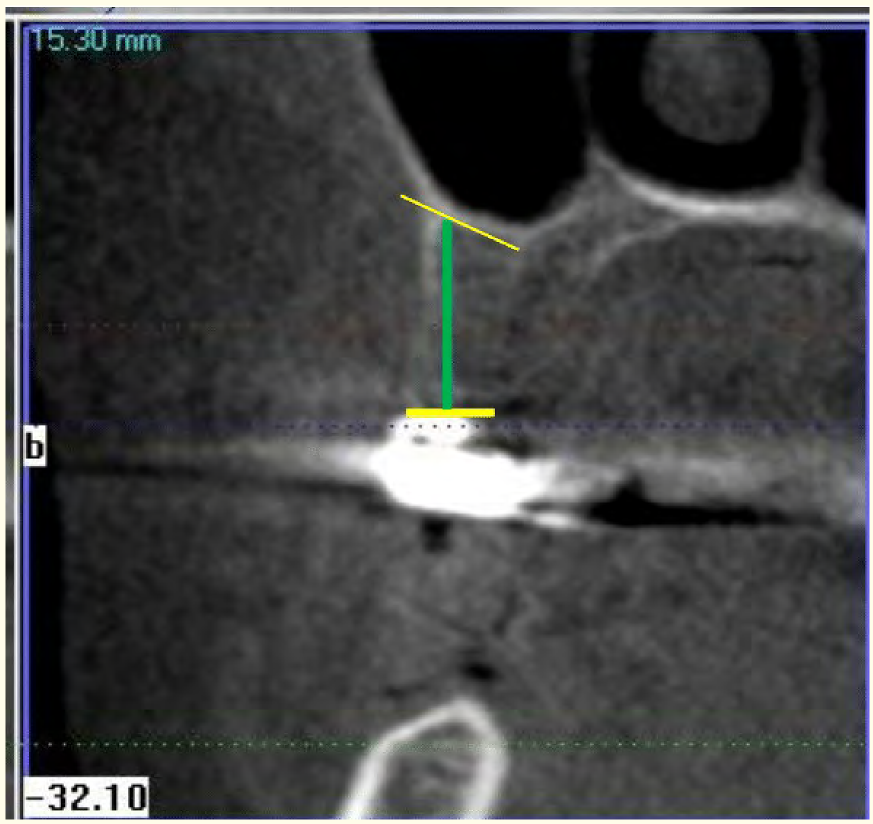

Figure 1: *A cross-sectional CBCT image showing the performed measurement (green line) at the same area from the mid-point of a tangent to the lower border of the marker (yellow thick line) to the mid-point of another tangent to the inferior wall of the maxillary sinus (yellow thin line) (M-MS).*

Mandibular Measurements:

Anterior area measurements: This measurement is presented by the distance between the intersection of the midpoint of a tangent to the lower border of the marker and the intersection of the mid-point of another tangent to the upper border of the mandibular cortex (M-IBA).

Premolar area measurements:

a- The first measurement is presented by the distance between the intersection of the midpoint of a tangent to the lower border of the marker and the intersection of the midpoint of another tangent to the upper border of the mental foramen (M-MF).

b-The second measurement is presented by the distance between the intersection of the midpoint of a tangent to the top of marker and the intersection of the midpoint of another tangent to the upper border of the mandibular cortex (M-IBP).

Molar area measurements:

a- The first measurement is presented by the distance between the intersection of the midpoint of a tangent to the lower border of the marker and the intersection of the mid-point of another tangent to the upper border of the inferior alveolar canal (M-IAC).

b- The second measurement is presented by the distance between the intersection of the midpoint of a tangent to the lower border of the marker and the intersection of the midpoint of another tangent to the upper border of the mandibular cortex (M-IBM).

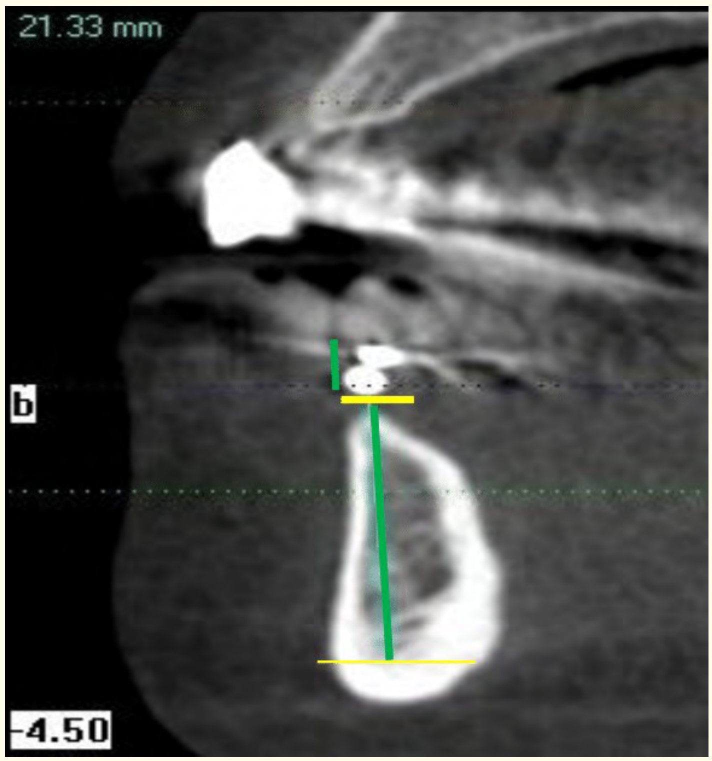

Figure 2: *A cross-sectional CBCT image of one of the cases showing the performed measurement (green line) at the lower right second molar area from the mid-point of a tangent to the lower border of the marker (yellow thick line) to the mid-point of another tangent to the upper border of the mandibular cortex (yellow thin line) (M-IBM).*

Method of Statistical Analysis

The seven observers who analyzed the CBCT images were given codes (1-7) and the mean measurements were calibrated using Kappa co-efficient tests for inter-observers degree of agreement in CBCT readings.

Results

For analyzing the results of the measurements given by the seven dentists, the Kappa coefficient analysis test was used to detect the degree of agreement between the recorded CBCT data. All the readings are presented in Table 1, while the Kappa test results are presented in Table 2.

Serial	Jaw	Area	1st	2nd	3rd	4th	5th	6th	7th
1	Upper	M-MS	18.92	18.9	18.95	18.92	18.93	18.88	19.1
2	Upper	M-MS	13.89	14	13.9	13.78	13.95	13.87	13.89
3	Upper	M-MS	15.6	15.55	15.58	15.6	15.58	15.62	15.58
4	Upper	M-MS	17.81	17.9	17.85	17.85	17.83	17.81	17.81
5	Upper	M-MS	10	9.98	9.96	10	10	9.92	9.88
6	Upper	M-MS	23.4	23.38	23.38	23.41	23.41	23.41	23.42
7	Upper	M-NC	15.7	15.6	15.72	15.7	15.6	15.7	15.7
8	Upper	M-NC	15.22	15.22	15.2	15.25	15.2	15.22	15.25
9	Upper	M-MS	14.3	14.28	14.29	14.32	14.32	14.3	14.3
10	Upper	M-NC	15.8	15.78	15.8	15.8	15.75	15.82	15.78
11	Upper	M-MS	17.9	17.84	17.85	17.9	17.92	17.9	17.86
12	Upper	M-MS	15.98	15.98	15.95	15.96	15.94	15.96	15.94
13	Upper	M-MS	15.8	15.82	15.82	15.8	15.8	15.79	15.79
14	Upper	M-MS	17.81	17.82	17.81	17.81	17.82	17.8	17.78
15	Upper	M-NC	16.35	16.35	16.38	16.28	16.35	16.33	16.36
16	Lower	M-IAC	15.05	15	15	15.1	15	15.12	15.2
		M-IBM	21.91	21.9	21.88	21.92	21.92	21.9	21.9
17	Lower	M-IAC	11.42	11.42	11.42	11.4	11.42	11.44	11.42
		M-IBM	15.65	15.62	15.64	15.65	15.62	15.64	15.65
18	Lower	M-MF	9.82	9.81	9.82	9.83	9.84	9.8	9.8
		M-IBP	15	15	15	15.1	15.2	14.8	15
19	Lower	M-IBA	18.6	18.62	18.6	18.58	18.6	18.6	18.5
20	Lower	M-MF	12.9	12.76	12.88	12.88	12.9	12.79	12.88
		M-IBP	20.1	20.1	20.05	20.15	20.18	20.25	20.22
21	Lower	M-IAC	8.7	8.7	8.6	8.6	8.7	8.75	8.7
		M-IBM	13.55	13.52	13.55	13.64	13.55	13.58	13.6
22	Lower	M-MF	21.65	21.64	21.64	21.65	21.66	21.65	21.62
		M-IBP	30.3	30.32	30.3	30.25	30.2	30.18	30.2
23	Lower	M-IAC	14.1	14	14.12	14.25	13.97	13.99	14.2
		M-IBM	24.69	24.7	24.69	24.68	24.72	24.55	24.65
24	Lower	M-IAC	13.1	13.12	13.18	13.2	13.1	13	13
		M-IBM	20.45	20.45	20.45	20.4	20.45	20.48	20.5
25	Lower	M-MF	13.59	13.6	13.62	13.57	13.6	13.6	13.62
		M-IBP	18.78	18.8	18.74	18.74	18.8	18.82	18.75
26	Lower	M-IAC	15.9	15.95	15.86	15.9	15.88	15.88	16
		M-IBM	24.6	24.6	24.59	24.58	24.6	24.62	24.58
27	Lower	M-IAC	13.7	13.6	13.64	13.82	13.76	13.71	13.72
		M-IBM	21.4	21.42	21.42	21.42	21.36	21.36	21.35
28	Lower	M-IAC	13.7	13.6	13.64	13.82	13.76	13.71	13.72
		M-IBM	14.9	14.95	14.86	14.9	14.88	14.88	15
29	Lower	M-MF	14.9	14.95	14.86	14.9	14.88	14.88	15
		M-IBP	19.1	19.12	19.18	19.2	19.1	19	19
30	Lower	M-MF	13.7	13.64	13.6	13.76	13.82	13.71	13.72
		M-IBP	21.2	21.1	21.05	21.15	21.18	21.25	21.22

Table 1: *The measurements recorded by the 7 dentists for all the cases.*

	FIRST	SECOND	THIRD	FOURTH	FIFTH	SIXTH	SEVENTH
First							
Second	0.951						
Third	0.975	0.975					
Fourth	0.975	0.926	0.951				
Fifth	0.926	0.975	0.951	0.951			
Sixth	0.926	0.926	0.901	0.901	0.901		
Seventh	0.902	0.852	0.877	0.877	0.828	0.926	

Table 2: *Kappa test between observer.*

- *Poor agreement = less than 0.20*
- *Fair agreement = 0.20 to 0.40*
- *Moderate agreement = 0.40 to 0.60*
- *Good agreement = 0.60 to 0.80*
- *Very good agreement = 0.80 to 1.00*

Discussion

One of the most important advantages of CBCT is the fact that it is interactive; in other words, the dentist can deal with its software to measure and plan for his implant surgery easily. In the current study, a trial was taken to analyze the reliability of the readings obtained from CBCT images by different dental and maxillofacial specialists. A very high agreement between all of the multi-specialty and varying experience dentists was detected. These results assure that most of CBCT softwares are "friendly-user", "self-dependent" and can be easily applied in any field in the dental practice using personal computers not sophisticated workstations as in CT scanning. Efficient use of the x-ray beam in CBCT imaging produces a relatively low x-ray tube power requirement, which, along with flat panel detection and limited anatomic coverage, has facilitated the production of compact CBCT scanners suitable for use in an office-based dental setting.

Conclusion

Dentists can deal with the currently used CBCT software and manipulate it in a" friendly –user" manner to measure different linear measurements in both jaws with great feasibility and reproducibility.

Bibliography

1. Munetaka Naitoh., *et al*. "Comparison between cone-beam and multislice computed tomography depicting mandibular neurovascular canal structures". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 109.1 (2010): e25-e31.
2. Mozzo P., *et al*. "A new volumetric CT machine for dental imaging based on the cone-beam technique: preliminary results". *European Radiology* 8.9 (1998): 1558-1564.
3. Arai Y., *et al*. "Development of a compact computed tomographic apparatus for dental use". *Dentomaxillofacial Radiology* 28.4 (1999): 245-248.
4. Hashimoto K., *et al*. "A comparison of a new limited cone beam computed tomography machine for dental use with a multidetector row helical CT machine". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 95.3 (2003): 371-377.
5. Ludlow JB., *et al*. "Accuracy of measurements of mandibular anatomy in cone beam computed tomography images". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 103.4 (2007): 534-542.
6. Cavalcanti MG., *et al*. "Three-dimensional computed tomography landmark measurement in craniofacial surgical planning: experimental validation in vitro". *Journal of Oral and Maxillofacial Surgery* 57.6 (1999): 690-694.
7. Lo LJ., *et al*. "Quantitative measurement on three-dimensional computed tomography: an experimental validation using phantom objects". *Chang Gung Medical Journal* 23.6 (2000): 354-359.
8. Cavalcanti MG., *et al*. "3D volume rendering using multislice CT for dental implants". *Dentomaxillofacial Radiology* 31.4 (2002): 218-223.
9. Scarfe WC and Farman AG. "What is Cone-Beam CT and How Does it Work?" *Dental Clinics of North America* 52.4 (2008): 707-730.
10. Egger G., *et al*. "The accuracy of CT based craniofacial models for robotic surgery". *Proceedings of Surgetica* (2005): 399-405.
11. Howerton WB and Mora MA. "Advancements in digital imaging. What is new and on the horizon?" *Journal of the American Dental Association* 139 (2008): 20s-24s.
12. De Vos W., *et al*. "Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: A systematic review of the literature". *International Journal of Oral and Maxillofacial Surgery* 38.6 (2009): 609-625.

13. Salem WS., *et al*. "Precision of Measurements from Computed Tomography (CT), Cone Beam Computed Tomography (CBCT) and their Reformatted Images in Pre-Operative Implant Assessment". *International Journal of Surgery Research and Practice* 1 (2014): 1004-1010.

14. Amir C., *et al*. "Evaluation of the precision of dimensional measurements of the mandible on panoramic radiographs". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 86.2 (1998): 242-248.

15. Stavropoulos A and Wenzel A. "Accuracy of CB dental CT, intra-oral digital and conventional film radiography for the detection of periapical lesions. An ex vivo study in pig jaws". *Clinical Oral Investigations* 11.1 (2007): 101-106.

16. Liu D., *et al*. "Localization of impacted maxillary canines and observation of adjacent incisor resorption with cone-beam computed tomography". *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 105.1 (2008): 91-98.

Volume 11 Issue 3 June 2017