EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 69, 1113:1118, APRIL, 2023
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
ORAL MEDICINE, X-RAY, ORAL BIOLOGY AND ORAL PATHOLOGY
Submit Date :24-01-2023 • Accept Date : 28-02-2023 • Available online: 01-04-2023 • DOI : 10.21608/edj.2023.187318.2407

DIMENSIONAL ACCURACY OF SIMULATED INTRA ORAL SOFT TISSUE LESION ON CONE BEAM COMPUTED TOMOGRAPHY OF MANDIBLE

Aya Mohamed Ahmed Hassanine* *and* Maha Ishak Amer**

ABSTRACT

Objective: The aim of this study is to evaluate the accuracy of cone beam computed tomography in assessment of intra oral mucosal lesion. **Methods**: double layers of pink baseplate wax as simulated soft tissue were overlaid on all the seven dry mandibles. 21 simulated lesions were made, three on each mandible (one at right side, one at left side and one at the midline) The diameter of the lesions was measured with a digital caliper as the physical measurements. The mandibles were scanned using CBCT machine, the maximum dimension of each lesion ere measured by software tools. CBCT measurements were compared to the physical measurements. **Results**: showed a significant difference between the CBCT measurements compared to the true measurements. CBCT overestimate the size of simulated lesion. Conclusions: CBCT scans are not the accurate method for assessment of intra oral soft tissue lesion size

KEYWORDS: Cone beam computed tomography; soft tissue lesion, introral

INTRODUCTION

Radiological diagnosis of the oral cavity is challenging because of the proximity of osseous structures with soft tissues. The assessment of intra-oral soft tissue during the examination of oral and maxillofacial radiographs is crucial for dental purposes, such as surgical correction after trauma or in the case of anatomical or developmental deformities, periodontal therapy, orthodontic treatment, restorative procedures, dental implant treatment [(1)]. In addition, it is significant for the diagnosis of incidental finding of the soft tissue of the oral cavity as a metastatic oral soft tissue lesion.

Distant metastasis of malignant tumors to the oral cavity is significantly rare and accounts for 1-1.5% of all malignant oral tumors. Oral

* Assistant Professor Oral Radiology Department, Faculty of Dentistry, Minia University
** Professor Oral Radiology, Faculty of Dentistry, Minia University

metastatic tumors are found to be the first sign of metastatic spread in 25% of cases. In 23% of cases, they indicate unidentified primary malignancy of a distant site. Compared to metastasis to the jaw bones, metastasis to the soft tissues of the oral cavity is very uncommon [2]. Consequently, the diagnosis of these types of metastatic lesions is frequently misleading and presents a formidable challenge.

CBCT has become a leading imaging modality in diagnostic radiology of oral and maxillofacial areas due to its potential to obtain images with subjects in the upright position. It provides the radiologists with high-resolution images while exposing the patient to less ionizing radiation than multislice CT, is clinically acceptable, and has high precision regarding all linear, angular, and volumetric measurements of hard tissue with an accuracy of 1.0 mm [1,3,4]. However, the primary limitation of CBCT imaging is the inability to distinguish between tissue attenuation differences due to poor soft tissue contrast. This limited contrast resolution hinders the expansion of CBCT technologies into diagnostic imaging, where the detection of small changes in soft-tissue attenuation is a priority [5].

Recently the use of CBCT for accurate reproduction of linear dental and hard tissue measurements has garnered considerable attention (6). Several studies have measured the thickness of soft tissue in patients using CBCT. For instance, the thickness of palatal soft tissue was measured in order to place temporary anchorage devices at the correct sites in orthodontic patients [7]. In forensic medicine, the reliability of facial soft tissue thickness obtained by CBCT was evaluated for craniofacial reconstruction (8). Moreover, in implant dentistry, soft tissue thickness was investigated prior to planning esthetic crown lengthening procedures and for evaluating periodontal soft tissues[9]. Other studies that evaluated the thickness of soft tissue in CBCT in comparison to gingival probing depth [8,10] demonstrated that CBCT is an effective diagnostic method for visualizing and measuring the thickness of soft tissues.

As CBCT resolution improves and its use increases, occult pathologies unrelated to the initial diagnostic question are increasingly detected. The probability of these incidental findings increases with the head volume included in the scan [11]. Their nature and frequency can vary widely [12]. However, no studies evaluated the size of soft tissue lesions. Therefore, this study aimed to determine whether CBCT can be used for the assessment of intraoral mucosal lesion size.

MATERIALS AND METHODS

The present study was approved by The Research Ethics Committee of the Faculty of Dentistry, Minia University, Minia, Egypt. A sample of seven (5 dry mandible and 2 mandibular models) were obtained from Department of Anatomy, Faculty of Medicine, Bani Suef University, Egypt.

Because mandible is an open volume, differing from a skull, and for this reason, more sensitive to any geometrical distortion [13] we decided to make our study only on mandible

Double layer of pink base plate wax was added as a soft tissue simulant. In numerous studies, base plate wax is approved for the simulation of soft tissue. [10] The wax was adapted carefully to ensure that it was added uniformly without voids or air bubbles (Figure1)

Fig. (1) Show all dry mandibles covered by pink wax for soft tissue simulation.

In order to simulate soft tissue lesions, circular lesions are created artificially in the wax by a dental drill with round bur. A total of 21 lesion were created, Three in each mandible; one in the right posterior area, one in the left posterior area, and one in the anterior midline area.

The mandibles were scanned by Pax -i3D green CT CBCT machine (VATECH, KOREA). On field of view 8 x 5 mm, 85 Kvp, 10 mA. EZ 3D plus software used to create MPR views and maximum mesiodistal diameter of each lesion was measured on Axial cut with a slice thickness 0.1mm (Figure 2) by the measuring tool in the software and compared to the physical measurement on the mandibular models which taken by a digital caliper.

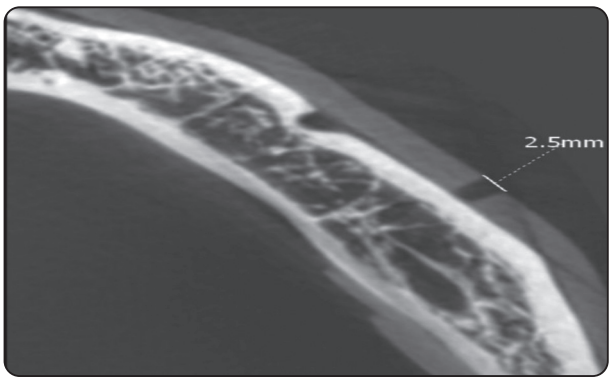

Fig. (2): The diameter of soft tissue lesion measured on the CBCT axial cut of one of the mandibular models using EZ3D- I linear measurement tool.

Sample size

Sample size used in this study is small but it is acceptable in terms of invitro studies and in accordance with other similar studies.[14, 15, 16, 17]

Statistical analysis

The statistical analysis was performed using the R software (R Core Team 3.3.1, the R Foundation for Statistical Computing). Descriptive analysis (Mean,standard deviation,Median and interquartile range) of both CBCT and physical measurements for all different lesion categories were calculated.

For comparison between CBCT and physical measurement groups,Non parametric Wilcoxon Signed Rank test was used . The significance level was set $\alpha = 0.05$.

RESULTS

Descriptive analysis for all measurements in different groups (Mean, Median, Standard deviation and Interquartile range) were calculated in table (1) which shows that all CBCT measurements are higher than the real measurement as follows**:**

- **Right posterior measurement:** The mean CBCT measurement is 2.88 (±0.47) mm which is higher than the gold standard (2.13±0.19 mm).
- **Anterior measurement:** The mean CBCT measurement is 3.03 (±0.5) mm which is higher than the gold standard (2.33 ±0.47 mm).
- **Left posterior measurement:** The mean CBCT measurement is 2.56 (±0.28) mm which is higher than the gold standard (2.21 ±0.39 mm).

All CBCT measurements show overestimated Median (Figure 3)

TABLE (1): Descriptive analysis of soft tissue defect regarding each group:

		Mean	SD	Median	Interquartile Range
Right	**CBCT**	2.88	0.47	2.1	2.55 – 3.23
	Gold Standard	2.13	0.19	2.85	2.03 – 2.1
Anterior	**CBCT**	3.03	0.50	2	2.65 – 3.35
	Gold Standard	2.33	0.47	3.1	2 – 2.65
Left	**CBCT**	2.56	0.28	2	2.4 – 2.65
	Gold Standard	2.21	0.39	2.4	2 – 2.25

TABLE (2) Absolute and Relative difference between CBCT and Gold standard measurements regarding soft tissue defect and results of the between-group comparison:

	Absolute Error		Relative (Percentage) Error		Wilcoxon Rank Sum test for paired data	
	Mean	**SD**	**Mean**	**SD**	**p-value***	**Interpretation**
Right measurement	0.75	0.49	24.47	12.76	0.0355	Statistically Significant difference
Anterior measurement	0.7	0.54	22.05	15.63	0.0223	Statistically Significant difference
Left measurement	0.34	0.21	13.72	7.99	0.0213	Statistically Significant difference

Significance level at p-value ≤0.05.

Statistically significant difference was present between all CBCT measurements and the physical measurement obtained from the digital caliper as shown in table (2)

- **Right posterior measurement:** The absolute difference in measurement between CBCT and the gold standard is 0.75 (±0.49) mm, which means that the CBCT measurement is 24.47% higher than that of the gold standard. The Wilcoxon Rank Sum test results show that this difference is statistically significant (p-value<0.05).
- **Anterior measurement:** The absolute difference in measurement between CBCT and the gold standard is 0.7 (±0.54) mm, which means that the CBCT measurement is 22.05% higher than that of the gold standard. The Wilcoxon Rank Sum test results show that this difference is statistically significant (p-value<0.05).
- **Left posterior measurement:** The absolute difference in measurement between CBCT and the gold standard is 0.34 (±0.21) mm, indicating that the CBCT measurement is 13.72% higher than that of the gold standard. The Wilcoxon Rank Sum test results indicate that this difference is statistically significant (p-value<0.05).

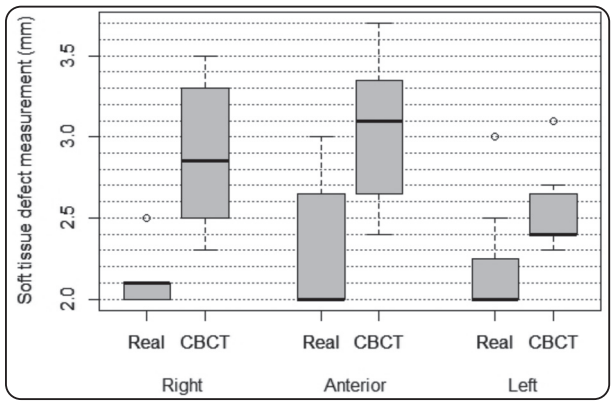

Fig. (3): Box plot showing how CBCT measurements in different groups are overestimated in comparison to physical measurement (gold standard) on the mandibular model.

DISCUSSION

CBCT is a commonly used imaging technique for dental implant planning and other pre-operative examinations. In recent years, numerous attempts have been made to determine the accuracy of CBCT measurements of soft and hard tissues. CBCT accurately measures the linear dimensions of hard tissues, such as the mandible [6], and assesses periodontal defects [18].

Because of the low-density resolution and contrast of CBCT, qualitative evaluation of soft tissues has been limited. However, CBCT has been proven beneficial for quantitative linear measurements. The combination of CBCT and digital 3D reconstruction technology can also obtain high measurement accuracy [19].

Most previous studies compared the measurement accuracy of CBCT with that of other methods as the study of Patcas et al., who compared the accuracy of CBCT and multidetector CT in the measurement of hard tissues and verified the effectiveness of CBCT in measuring oral soft tissues. They illustrated that CBCT was less affected by metal artifacts and that the accuracy of intraoral soft tissue measurements using CBCT was comparable to that of hard tissue measurements [20], but few studies have examined the accuracy of soft tissue measurements using CBCT.

Fourie et al. demonstrated the accuracy of CBCT measurements of facial soft tissue by measuring benchmarks on cadaveric heads for extra-oral soft tissue measurement. There was no clinically significant difference between the measurements made on the CBCT images and the physical measurement**.** Compared to physical measurements, the cone beam computed tomography measurements were highly accurate (0.962 to 0.999). They considered the mean absolute error clinically significant if it exceeded 1.5 mm, which is unsuitable for oral mucosal measurement [21, 22].

Regarding the intra-oral soft tissue measurement, A systematic review of the accuracy of linear measurement in CBCT images revealed a wide range of errors, with no clear trends indicating whether measurements are consistently underestimated or overestimated relative to the gold standard [23].

Januario et al. exposed the buccal gingiva using soft tissue using retraction to overcome the interference that occurs when the lips, tongue, and cheeks collapse on the facial gingiva during CBCT scanning. They demonstrated that CBCT is effective in soft tissue measurements [24].

In a study by Moudi et al.[1], different thicknesses of pink baseplate wax were applied to a dry human skull. The skull was scanned using two CBCT scanners with 0.01- and 0.15-mm voxel sizes. Results showed no significant difference between CBCT and digital caliper measurements in thickness less than 2.0 mm, while a significant difference was observed for thicknesses greater than 2.0 mm ($P<0.05$).

In this study, there was a statistically significant difference between all groups and the gold standard with a mean absolute error ranging from 0.3 to 0.7 mm with a tendency of CBCT to overestimate the diameter of the simulated lesion compared to the real physical measurement.

Our findings concur with those reported by Xue et al., who evaluated the accuracy of measuring soft tissue thickness in different areas of the jaw. They found that the measurements were significantly greater than those in the control images [21]. Our findings contradict the results of this study in which the linear measurements on CBCT images were underestimated compared to the physical measurements with no significant difference in thicknesses over 2mm for four different voxel sizes [22]. Variations in observer performance and a larger sample size in this study could account for disparities between the studies' findings.

REFERENCES

1. Moudi E, Haghanifar S, Johari M, Gholinia H, Ghanbarabadi MK. Evaluation of the cone-beam computed tomography accuracy in measuring soft tissue thickness in different areas of the jaws. J Indian Soc Periodontol. 2019;23(4):334-8.
2. van der Waal RI, Buter J, van der Waal I. Oral metastases: report of 24 cases. Br J Oral Maxillofac Surg. 2003;41(1):3-6.
3. De Donno A, Sablone S, Lauretti C, Mele F, Martini A, Introna F, et al. Facial approximation: Soft tissue thickness values for Caucasian males using cone beam computer tomography. Leg Med (Tokyo). 2019;37:49-53.
4. Meundi MA, David CM. Application of cone beam computed tomography in facial soft tissue thickness measurements for craniofacial reconstruction. J Oral Maxillofac Pathol. 2019;23(1):114-21.
5. Miracle AC, Mukherji SK. Conebeam CT of the head and neck, part 1: physical principles. AJNR Am J Neuroradiol. 2009;30(6):1088-95.

6. Kobayashi K, Shimoda S, Nakagawa Y, Yamamoto A. Accuracy in measurement of distance using limited cone-beam computerized tomography. Int J Oral Maxillofac Implants. 2004;19(2):228-31.
7. Vu T, Bayome M, Kook YA, Han SH. Evaluation of the palatal soft tissue thickness by cone-beam computed tomography. Korean J Orthod. 2012;42(6):291-6.
8. Hwang HS, Choe SY, Hwang JS, Moon DN, Hou Y, Lee WJ, et al. Reproducibility of Facial Soft Tissue Thickness Measurements Using Cone-Beam CT Images According to the Measurement Methods. J Forensic Sci. 2015;60(4):957-65.
9. Schertel Cassiano L, Barriviera M, Suzuki S, Giacomelli Nascimento G, Lourenço Januario A, Hilgert LA, et al. Soft tissue cone beam computed tomography (ST-CBCT) for the planning of esthetic crown lengthening procedures. Int J Esthet Dent. 2016;11(4):482-93.
10. Dong T, Xia L, Cai C, Yuan L, Ye N, Fang B. Accuracy of in vitro mandibular volumetric measurements from CBCT of different voxel sizes with different segmentation threshold settings. BMC Oral Health. 2019;19(1):206.
11. Barghan S, Tahmasbi Arashlow M, Nair MK. Incidental Findings on Cone Beam Computed Tomography Studies outside of the Maxillofacial Skeleton. Int J Dent. 2016;2016:9196503.
12. Enciso R, Shigeta Y, Nguyen M, Clark GT. Comparison of cone-beam computed tomography incidental findings between patients with moderate/severe obstructive sleep apnea and mild obstructive sleep apnea/healthy patients. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;114(3):373-81.
13. Mazzoli A, Germani M, Moriconi G. Application of optical digitizing techniques to evaluate the shape accuracy of anatomical models derived from computed tomography data. J Oral Maxillofac Surg. 2007;65(7):1410-8.
14. Kayipmaz S, Sezgin OS, Saricaoglu ST, Bas O, Sahin B, Küçük M. The estimation of the volume of sheep mandibular defects using cone-beam computed tomography images and a stereological method. Dentomaxillofac Radiol. 2011;40(3):165-9.
15. Fernandes TM, Adamczyk J, Poleti ML, Henriques JF, Friedland B, Garib DG. Comparison between 3D volumetric rendering and multiplanar slices on the reliability of linear measurements on CBCT images: an in vitro study. J Appl Oral Sci. 2015;23(1):56-63.
16. Al-Rimawi A, Shaheen E, Albdour EA, Shujaat S, Politis C, Jacobs R. Trueness of cone beam computed tomography versus intra-oral scanner derived three-dimensional digital models: An ex vivo study. Clin Oral Implants Res. 2019;30(6):498-504.
17. Abramson Z, Scoggins MA, Burton C, Choudhri AF, Holladay C, Pont Briant NR, et al. CT-Based Modeling of the Dentition for Craniomaxillofacial Surgical Planning. J Craniofac Surg. 2021.
18. Misch KA, Yi ES, Sarment DP. Accuracy of cone beam computed tomography for periodontal defect measurements. J Periodontol. 2006;77(7):1261-6.
19. Yan S, Shi SG, Niu ZY, Pei ZH, Shi SM, Mu C. Soft tissue image reconstruction using cone-beam computed tomography combined with laser scanning: a novel method to evaluate the masticatory mucosa. Oral Surg Oral Med Oral Pathol Oral Radiol. 2014;118(6):725-31.
20. Patcas R, Markic G, Müller L, Ullrich O, Peltomäki T, Kellenberger CJ, et al. Accuracy of linear intraoral measurements using cone beam CT and multidetector CT: a tale of two CTs. Dentomaxillofac Radiol. 2012;41(8):637-44.
21. Fourie Z, Damstra J, Gerrits PO, Ren Y. Accuracy and reliability of facial soft tissue depth measurements using cone beam computer tomography. Forensic Sci Int. 2010;199(1-3):9-14.
22. Fourie Z, Damstra J, Gerrits PO, Ren Y. Accuracy and repeatability of anthropometric facial measurements using cone beam computed tomography. Cleft Palate Craniofac J. 2011;48(5):623-30.
23. Fokas G, Vaughn VM, Scarfe WC, Bornstein MM. Accuracy of linear measurements on CBCT images related to presurgical implant treatment planning: A systematic review. Clin Oral Implants Res. 2018;29 Suppl 16:393-415.
24. Januário AL, Barriviera M, Duarte WR. Soft tissue cone-beam computed tomography: a novel method for the measurement of gingival tissue and the dimensions of the dentogingival unit. J Esthet Restor Dent. 2008;20(6):366-73; discussion 74.
21. Xue-Yu Wang1,2, Yan-Wei Shi3, Song Zhou4, Yu-Hui Chen2, Shu Yan1,2 Evaluation of the accuracy of cone-beam computed tomography for measuring intraoral soft tissue thickness. Int J Clin Exp Med 2022;15(1):37-44
22. Mostafa R . Influence of CBCT Different Voxel Sizes on Soft Tissue Thickness Measurement. Egyptian Dental Journal. 66. 2401-2409. 10.21608/edj.2020.42200.1252.