Original Study

COMPARING THE ACCURACY OF CBCT IMAGES AND DIGITAL INTRA-ORAL RADIOGRAPHY IN ESTIMATING THE PERIAPICAL INDEX

Mehralizade S,[1] Moshari AB, [2] Rahnama P,[3] Ahmadpour S [4]

1. Assistant Pofessor, Department of Oral & Maxillofacial Radiology, Faculty of Dentistry, Tehran Branch, Islamic Azad University, Tehran, IRAN.
2. Assistant Pofessor, Department of Endodontics, Faculty of Dentistry, Tehran Branch, Islamic Azad University, Tehran, IRAN.
3. DDS, Faculty of Dentistry, Tehran Branch, Islamic Azad University, Tehran, IRAN.
4. Resident, Department of Oral & Maxillofacial Radiology, Faculty of Dentistry, Tehran Branch, Islamic Azad University, Tehran, IRAN.

ABSTRACT

Aim: The importance of evaluating the periapical index and its effect on the treatment plan, prognosis and the inconsistencies and shortcomings done, the aim of this study was to measure the accuracy of digital intra-oral radiography and CBCT in evaluating the periapical index in Islamic Azad University in 2017 and providing a better method for this assessment.

Materials & Method: In this in vitro study, 12 extracted single-rooted premolar teeth were subjected to root treatment. In the apex of the teeth, one of the six sizes of the periapical index was placed based on 0-5 scoring with waxy globes. In 12 generators from sawdust and gypsum were mounted for rebuilding the trabecular bone of teeth. Each generator was photographed by the CMOS detector of Villa machine (HD Videograph) at 2 angles of orthogonal and mesial with 25 degrees of difference in horizontal angle. CBCT images were photographed by the Villa machine. The images provided were observed and evaluated in 2 sessions at intervals of 1 week by 1 observer (experienced radiologist) on a DELL laptop LCD monitor with a resolution of 1024 * 1280 at a distance of about 40 cm in a semi-dark room and were recorded in information form number 2. The information was entered into the SPSS software and was statistically analyzed by KRUSKALWALLIS test.

Results: The largest difference with the actual size was related to CMOS imaging with mesial angle and with an average difference of 0.0472 ± 0.081 mm, and then CMOS imaging with orthogonal angle with an average difference of 0.0414 ± 0.061 mm, and the most accurate CBCT imaging is with a difference of 0.0179 ± 0.021 from the actual size. The KRUSKAL WALLIS test showed that this difference is significant ($p \leq 0.01$). The pairwise comparison of three groups by MANN-U-WITHNEY test showed that the difference is significant ($p \leq 0.05$).

Conclusion: Despite the high accuracy of CBCT radiography, there was no significant difference in the accuracy of CBCT and CMOS imaging with orthogonal angle, and the greatest difference from the actual size is in CMOS with mesial angle.

Key words: CBCT, CMOS, Digital Intra-Oral Radiography, Periapical Index.

Introduction

One of the concerns in dentistry, especially in endodontic treatments, is the evaluation of periapical lesion.[1] Since evaluation of periapical indexes is important in assessing post-treatment successes, the choice and recognition of superior radiography in this field seems to be important, because an inadequate assessment will not have a good prognosis.[2] For the first time, Orstavik D, Kerekes K, Eriksen MH at the Institute of Dental Materials of Oslo University in 1986 evaluated the periapical index.[3] The common current methods for evaluating periapical lesions are intra-oral radiographies and CBCT, in which CBCT provides 3D images of the tooth structure and provides clear images of structures such as bones, while intra-oral radiographies due to 2D image presentation have some limitation in detecting the actual development of the lesion. Currently, a numerical system with 6 numbers from 0 to 5 with 2 variables, namely, cortical bone expansion and cortical bone destruction, are used to evaluate PAI.[4,5] Since studies conducted show some contradictions, in which some of them have only considered the difference between these two methods and have not considered the clinician errors, and the CBCT features have changed in recent years, and in some of these changes, there has not been a specific time limit, these make the results of these studies not generalizable.[6,7]

Patel *et al* (2009) conducted an in vivo study to compare the accuracy of intra-oral periapical radiography and CBCT in the diagnosis and treatment of root resorption. According to the results of this study, although the accuracy of intra-oral radiography was acceptable, but the CBCT diagnostic accuracy was higher.[8]

Ozen *et al* (2009) also assessed the diagnostic accuracy of two types of CBCT devices and digital intra-oral sensors and film in periapical lesions that are generated by chemical means. The results of this study showed that two types of CBCT devices had similar efficiency and also had a higher accuracy than digital and conventional intra-oral radiographies.[9]

von Arx T *et al* published a cross sectional study in 2016 entitled "Evaluation of new cone-beam computed tomographic criteria for radiographic healing evaluation after apical surgery: assessment of repeatability and reproducibility". The purpose of this study was to evaluate the repeatability and reproducibility of CBCT in the radiographic evaluation of rehabilitation after apical surgery. 61 roots of 54 teeth of 54 patients with an average age of 54 years and 4 months were selected, and CBCT images of them were prepared twice, so they would be interpreted two times separately to obtain the rates of intraobserver agreement and interobserver agreement. B index had the highest intraobserver agreement (94%) and interobserver agreement (72.1), and for all indexes the

similarity between the first and second results was more than 80%.[1]

Considering the importance of evaluating the periapical index and its effect on the treatment plan and prognosis, and the inconsistencies and shortcomings in this study, we were determined to examined the accuracy of digital intra-oral radiography and CBCT in evaluating the periapical index in Islamic Azad University in 2017, and based on the results, it was possible to introduce a better method for this evaluation.

Materials & Method

This study was conducted as in vitro 12 single-rooted and single-canal premolar teeth after being extracted were stored into containers containing physiological serum, and they were sterilized by autoclave, and their profile including canal shape, decay, repair, horizontal and vertical fractures were recorded in Form number 1.

Project title: Comparison of Precision of CBCT Images and Intraoral Dental Radiography in Estimation of Periapical Index		
Tooth type:		
Shape of the channel	Direct☐	Curved☐
Decay	has it☐	does not have☐
Restoration	has it☐	does not have☐
Horizontal fracture	has it☐	does not have☐
Vertical fracture	has it☐	does not have☐
External analysis	has it☐	does not have☐
Observer's Name	Date:	Signature:
Controller's Name	Date:	Signature:

Form 1: Description of canal shape, decay, repair, horizontal and vertical fractures

With the fissure bursts and the Angle process, the cavity of these teeth was created. Flaring of these teeth was performed by lateral condensation method using watch winding and obturation. In the apex of the teeth, one of the six sizes of the periapical index based on 0-5 scoring was placed in order to create a lucent view of periapical lesion in diameters of 0.5-1, 1-2, 2-4, 4-8 and more than 8 mm, which was measured and prepared by a caliper. In 12 generators from sawdust and gypsum were mounted for rebuilding the trabecular bone of teeth.

Imaging was performed as an exposure with OriX-65 device with specifications of kVp = 65, mA = 8 and T = 0.2s. Digital intra-oral radiographic images were prepared by CMOS detector of Villa machine (HD Videograph) in parallel with Dentsply preventive film and in two different plans (perpendicular and mesial) with 25 degrees of difference at horizontal angle. The images provided were observed and evaluated in 2 sessions at intervals of 1 week by 1 observer (experienced radiologist), who were aware of the implementation of the research but did not know the PAI dimensions, on a DELL laptop LCD monitor with a resolution of 1024 * 1280 at a distance of about 40 cm in a semi-dark room and were recorded in information Form number 2. Finally, the difference between the size of the lesion in the generator and the radiographic images was entered into the SPSS software and was statistically analyzed by KRUSSKALWALLIS test in the three groups.

Project title: Comparison of Precision of CBCT Images and Intraoral Dental Radiography in Estimation of Periapical Index (IN-VITRO)						
Imaging method: CBCT ☐ CMOS ☐	With angles: Orthogonal ☐ CMOS ☐					
Score based on PAI lesion	0	1	2	3	4	5
Pain Loss Based on PAI (mm)						
The size of the lesion is in the Gold standard						
The size of the lesion in the radiographic image						
Observer's Name	Date:				Signature:	
Controller's Name	Date:				Signature:	

Form 2: Description of other indices.

Results

This experimental study was performed on 12 eligible teeth (2 control and 10 original samples) and 36 radiographic images. The largest difference from the actual size was related to CMOS imaging with mesial angle with an average difference of 0.0472 ± 0.081 mm, and then CMOS imaging with orthogonal angle with an average difference of 0.0414 ± 0.061 mm, and the most accurate CBCT imaging is with a difference of 0.0179 ± 0.021 from the actual size ($p \leq 0.01$). The pairwise comparison of the three groups showed that there is a significant difference ($p \leq 0.05$). [Table 1 and Table 2]

Sample Number	**The actual size of the lesion (mm)**	**Size of lesion in CBCT (mm)**	**Lens size in periapical CMOS image with mesial angle (m)**	**The size of the perio-apical CMOS image with an orthogonal angle (mm)**
1	83/0	79/0	83/0	93/0
2	87/0	92/0	01/1	00/1
3	91/1	89/1	95/1	86/1
4	93/1	92/1	85/1	93/1
5	34/2	30/2	26/2	28/2
6	3	97/2	06/3	05/3
7	02/10	02/10	12/10	10
8	50/4	51/4	60/4	60/4
9	09/5	09/5	14/5	11/5
10	5/11	51/11	66/11	58/11
11	0	0	0	0
12	0	0	0	0

Table 1: Estimation of the size of periapical lesions in mm separated by type of imaging methods.

Level	**The difference is less than the actual amount** / **Imaging method**
0.021 ± 0.0179	CBCT
0.081 ± 0.0472	CMOS with a mesial angle
0.061 ± 0.0414	CMOS with an orthogonal angle
$p \leq 0.01$	Test result *

* KRUSKAL WALLIS test has been used

Table 2: The difference of estimates from the actual size separated by the imaging methods.

Discussion

Two different CMOS digital intra-oral radiography and CBCT systems were designed to evaluate the estimation of periapical simulated lesions.[1] In the present study, it has

been separately identified that in comparison between two CMOS digital intra-oral radiography and CBCT systems in both orthogonal and mesial angles, CBCT has a higher accuracy. The accuracy level for the CBCT image is 97.99%, for a CMOS image with an orthogonal angle is 93.99%, and for a CMOS image with a mesial angle is 91.99%.

In the study by von Arx T *et al*., the highest intra-observer agreement was obtained in the apical region of coronal (94%),[1] which is in line with this study. Contrary to the above study, R Christiansen in a study simultaneously examined the P.A and CBCT radiographies in periapical bone defects and stated that bone defects in P.A are 10% smaller than CBCT, which was not statistically significant. But one year after the operation, there was a significant difference between the observers in the discovery of defects and the consensus in the images of P.A and CBCT was 67%, in which there was more defects in CBCT than P.A,[2] which contradicted the results of this study. The results of the study by Tadasvenskutonis *et al* (2014), which was conducted in Latvia with the aim of evaluating the accuracy of digital radiography and CBCT in the diagnosis of periapical radiolucency in the teeth,[4] also confirms the findings of this study. Some other studies[6,10] were also in line with the results of this study.

CBCT images can overcome the shortcomings of digital radiography by creating 3D images without superimposition and distortion. Due to the low difference of 4% in the accuracy between CMOS imaging with an orthogonal angle and CBCT images, the relative benefits of digital intra-oral radiography with an orthogonal angle, the low radiation, availability, and lower cost, we can use this radiography to evaluate the periapical index. The only problem with CBCT is the effective dose, that is addressed by CBCTs that have a limited FOV for effective dose reduction.[11-13] In general, despite the high accuracy of CBCT radiography, there is no significant difference in the accuracy of CBCT and CMOS imaging with orthogonal angle, and the greatest difference from the actual size is related to CMOS with mesial angle. Considering the significance of the differences, this conclusion is logical; the difference is significant, but probably not clinically applicable, and both CBCT and CMOS systems with orthogonal angle will be equally accurate in estimating the periapical index. Out of the problems and limitations of this study, coordinating the use of the CMOS digital intra-oral radiography device was time consuming and difficult, and the use of CBCT software required specific training and experience.

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Corresponding Author

Dr. Sogol Ahmadpour
Resident,
Department of Oral & Maxillofacial Radiology,
Faculty of Dentistry, Tehran Branch, Islamic Azad University, Tehran, IRAN.
Email Id: - sogol_ahmadpour@yahoo.com