Cone-beam computed tomography and periapical radiograph as follow-up methods of periapical lesions in cleft patients

Tulio Lorenzo Olano **DEXTRE**[1]
Celso Kenji **NISHIYAMA**[2]
Lidiane Castro **PINTO**[2]
Danieli Colaço Ribeiro **SIQUEIRA**[3]
Thais Marchini de **OLIVEIRA**[4]

doi: http://dx.doi.org/10.14436/2178-3713.5.1.008-012.oar

ABSTRACT

Objective: The aim of this study was to compare the effectiveness of cone-beam computed tomography (CBCT) and periapical radiograph as follow-up methods of periapical lesions after endodontic treatment in patients with cleft lip and palate. **Methods:** Periapical radiographs (Group I) and CBCTs (Group II) were evaluated in 46 single-rooted teeth with periapical lesions in patients with cleft lip and palate. These patients were referred to the Endodontics Department of the Hospital for Rehabilitation of Craniofacial Anomalies/USP (HRAC/USP) for endodontic treatment from 2009 to 2011. They returned for follow-up after 6 months to 2 years. Periapical index was used for the evaluations. Intraexaminer reproducibility was determined by Kappa test. Data were analyzed by means of Wilcoxon test ($p < 0.05$). **Results:** In Group I, 27 teeth were assigned score 1 (58.7%); 10 teeth, score 2 (21.7%); 7 teeth, score 3 (15.2%); 1 tooth, score 4 (2.2%) and 1 tooth was assigned score 5 (2.2%). In Group II, 7 teeth were assigned score 1 (15.2%); 8 teeth, score 2 (17.4%); 18 teeth, score 3 (39.1%); 10 teeth, score 4 (21.7%) and 3 teeth were assigned score 5 (6.6%). There was statistically significant difference between the groups studied. The CBCT scores were higher than the scores attributed to the radiographs of the same teeth. **Conclusion:** Cone-beam computed tomography is more effective than periapical radiograph in following-up periapical lesions after endodontic treatment in patients with cleft lip and palate.

Keywords: Cone-beam computed tomography. Endodontics. Periapical periodontitis. Cleft palate. Cleft lip.

[1]PhD resident in Rehabilitation Sciences, Universidade de São Paulo, Hospital for Rehabilitation of Craniofacial Anomalies (HRAC-USP), Bauru, São Paulo, Brazil.

[2]Professor of Endodontics, Universidade de São Paulo, Hospital for Rehabilitation of Craniofacial Anomalies (HRAC-USP), Bauru, São Paulo, Brazil.

[3]Professor of Imaging, Stomatopathology and Endodontics, Universidade do Sagrado Coração de Jesus (USC), Bauru, São Paulo, Brazil.

[4]Full professor, Universidade de São Paulo, School of Dentistry (FOB-USP), Department of Pediatric Dentistry, Orthodontics and Collective Health; and Hospital for Rehabilitation of Craniofacial Anomalies (HRAC-USP), Bauru, São Paulo, Brazil.

Contact address: Tulio Lorenzo Olano Dextre
E-mail: olanotulio@hotmail.com

Submitted: August 18, 2014. Revised and accepted: September 19, 2014.

How to cite this article: Dextre TLO, Nishiyama CK, Pinto LC, Siqueira DCR, Oliveira TM. Cone-beam computed tomography and periapical radiograph as follow-up methods of periapical lesions in cleft patients. Dental Press Endod. 2015 Jan-Apr;5(1):8-12. DOI: http://dx.doi.org/10.14436/2178-3713.5.1.008-012.oar

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

Introduction

Cleft lip and palate is the most frequent craniofacial malformation involving the face and oral cavity. It results from deficiency or lack of coalescence of facial and/or palatal processes during the embrionary period.[1] Cleft lip and palate patients have considerable difficulty maintaining good oral hygiene, which increases the occurrence of tooth cavity, where cariogenic bacteria and their by-products may contaminate the tooth pulp, thereby demanding endodontic treatment.[2]

Bacterial contamination of periapical tissues, originated from either pulp necrosis or prior endodontic treatment failure leads to an inflammatory process in the periapical area. This process is known as apical periodontitis (AP).[3,4] AP frequently develops without specific symptoms; for this reason, imaging exams play an important role in detecting the pathology.[5,6,7] Although many times asymptomatic, these lesions represent a considerable risk for one's general and oral health; therefore, they should be correctly diagnosed and treated.[6]

Several studies available in the literature highlight the importance of periapical radiographs for the diagnosis, treatment and follow-up of periapical lesions.[8-12] Periapical radiographs have been considered the gold standard to evaluate endodontic lesions healing; however, they are seen as inappropriate to determine the presence of root fractures, tooth resorptions and the size of periapical lesions.[7,8] Cone-beam computed tomography (CBCT) seems to overcome these limitations, as it enables the acquisition of tridimensional images and provides better diagnosis, treatment plan and follow-up for patients.[7,13]

In Endodontics, CBCT has proved very useful in the differential diagnosis of pathologies of endodontic origin; evaluation of alveolar and root fractures, root canal morphology, as well as internal and external resorption; endodontic pre-surgical planning; root anatomy visualization; assessment of root preparation, obturation, retreatment, detection of bone lesions; and endodontic research.[7,14-19]

Aiming at other options for the follow-up of periapical lesions after endodontic treatment, the objective of this study was to compare the effectiveness of CBCT and periapical radiograph as follow-up methods after endodontic treatment of periapical lesions in patients with cleft lip and palate.

Material and methods

The Institutional Review Board of Universidade de São Paulo, Hospital for Rehabilitation of Craniofacial Anomalies (HRAC-USP) approved the protocol of this study (# 30/2011).

In selecting the sample of teeth, the following inclusion criteria were applied: patients with complete cleft lip and palate, males and females, with radiographs and CBCT scans of single-rooted teeth showing prior periapical lesion. These patients were referred to the Department of Endodontics of the referred institution for endodontic treatment from 2009 to 2011, and returned for follow-up after 6 months to 2 years. Exclusion criteria were: patients with associated syndromes or malformation and/or incomplete records.

Periapical radiographs and CBCT scans taken from the archives of the Department of Endodontics and Radiology of the Hospital for Rehabilitation of Craniofacial Anomalies (HRAC-USP) were used. The examinations were obtained from the same patient and the same tooth as a follow-up method of endodontic treatment for periapical lesion.

Sample size calculation was based on a previous study[8] of which sample included 44 single-rooted teeth, with a power of 80% and a 5% significance level. In the present study, a total of 1,462 individuals with cleft lip and palate who underwent endodontic treatment were analyzed. The ample comprised 46 single-rooted teeth with periapical lesions.

The 46 periapical radiographs comprising the radiographic evaluation (Group I) were taken with size 2 (3 x 4 cm), intraoral radiographic films, (Ektaspeed, Eastman Kodak Company, Rochester, New York, USA). These radiographic films were placed into the radiographic positioner for adults (Indusbello, Indústria de Instrumentos Odontológicos Ltd., Londrina, Paraná, Brazil) by means of the parallel technique so as to standardize the geometric orientation of the X-ray beams towards the tooth. Radiographic exposures were performed with a X-ray unit (X 70; Dabi Atlante, Ribeirão Preto, SP, Brazil), at 70 kVp and 8 mA, with exposure time of 0.5 seconds, focus-object distance of 40 cm, and object-receptor distance of 2 cm. Patient protection was assured through lead aprons and thyroid shields. To evaluate the radiographs, a dental x-ray film viewer (Tele, Essence Dental/VH, Brazil) containing a crystal magnifying glass 75 mm in diameter and 3.5 x magnification was employed.

Tomographic scans (Group II) were obtained by a CBCT device (i-CAT Next Generation, Imaging Sciences International, Inc., Hatfield, PA, USA) with visualization at the axial, coronal, and sagittal planes for 20-40 seconds, 0.20 mm of voxel size and a field of vision (FOV) of 16 x 6 cm or 16 x 8 cm for the maxilla and/or mandible, at 80 kV and 5 mA. Immediately after acquisition, images were reconstructed on i-CAT Vision software. To assess the tomographic scans, i-CAT Vision and 3DVR software were used on a Dell computer (Intel Core 2 Duo with 2.13 GHz and 3.25 GB RAM, 24" flat screen with resolution of 1920 x 1200 pixels, model 2408WFP).

The examiner, a specialist in Endodontics, was previously trained and calibrated to assess radiographs and CBCT scans (k = 0.94 for intraexaminer reproducibility). The periapical index (PAI)[11] was used with scores ranging from 1 to 5: (1) normal periapical structure; (2) small alterations in bone structure; (3) alterations in bone structure with loss of mineral tissue; (4) AP with well-defined radiolucent area; (5) advanced AP with significant radiolucent areas.

Data were submitted to statistical analysis performed by means of Statistica 9 software (StatSoft Inc, Tulsa, Oklahoma, USA). Intraexaminer reproducibility was determined by Kappa test. Data were analyzed by Wilcoxon test.

Results

A total of 46 single-rooted teeth were evaluated: 18 maxillary incisors, 9 maxillary canines, 7 maxillary premolars, 5 mandibular incisors, 2 mandibular canines and 5 mandibular premolars.

In Group I (periapical radiographs), 27 teeth were assigned score 1 (58.7%); 10 teeth, score 2 (21.7%); 7 teeth, score 3 (15.2%); 1 tooth, score 4 (2.2%) and 1 tooth was assigned score 5 (2.2%).

In Group II (CBCT), 7 teeth were assigned score 1 (15.2%); 8 teeth, score 2 (17.4%); 18 teeth, score 3 (39.1%); 10 teeth, score 4 (21.7%) and 3 teeth were assigned score 5 (6.6%).

There was significantly difference between the groups studied ($p < 0.001$). Group II (CBCT) scores were higher than the scores attributed to Group I (radiographs) when the same teeth were compared.

Discussion

The periapical index (PAI) was used as a score system for radiographic evaluation of AP, as suggested by Ørstavik, Kerekes and Eriksen.[5] The PAI score system has been accepted as a valid tool used to determine results and reveal alterations in the extension and severity of periapical inflammation after endodontic treatment.[20] It provides a visual reference scale and scores regarding the radiographic images of apical periodontitis, based on the alterations of bone mineral content in the periapical area.[11]

Statistical analysis revealed significant differences between the groups studied. CBCT scores were higher than the scores attributed to radiographs when the same teeth were compared. In 34 teeth, the scores assigned to CBCT were higher than those assigned to the radiographs, thereby proving greater CBCT accuracy. Current scientific evidence emphasizes that CBCT is more sensitive in detecting AP than periapical radiograph.[8,10,11,21-26]

The results of the present study demonstrate that CBCT scans are highly efficient in detecting apical periodontitis of which diagnosis by means of periapical radiograph is frequently underestimated. CBCT advantages include increased accuracy, high resolution, reduced scan time and radiation dose. The results of the present study are in agreement with the findings in the literature.[8,11,14,25,26] Velvart, Hecker and Tillinger[8] correlated information obtained by means of periapical radiograph and high-resolution CBCT scans, obtained during surgery, in terms of the presence of apical lesion in 50 subjects. All 78 lesions diagnosed during surgery were also visible by tomographic scans. On the other hand, only 61 (78.2%) lesions were detected by conventional radiographs. Cotton et al[14] reported that CBCT ability to tridimensionally evaluate an area of interest could favor both inexperienced and experienced clinicians.

Considering the periapical index (PAI),[11] data analysis revealed discrepancy in the results: 27 teeth (58.7%) of Group I (periapical radiograph) received score 1 *versus* 7 teeth (15,2%) of Group II (CBCT). This difference is alarming, as the literature reveals a different success rate percentage regarding the repair of post-endodontic treatment lesions evaluated by periapical radiograph, as reported by a meta-analysis study conducted by Kojima et al.[27] The authors conducted a search in MEDLINE database and only included studies in which success or failure criteria had been perfectly described. They found a radiographic success rate of 78.9% in non-vital teeth. Therefore, we can assume that the mean success rate exhibited in the literature may be mistaken when conducting a study with conventional radiographic assessment.

The therapeutic protocol for endodontic treatment has been routinely based on the evaluation of clinical and pathological characteristics frequently complemented by radiographic findings. Radiographic image is the diagnosis and treatment resource most frequently employed in Endodontics, although image distortions are a major inconvenience. It is important to highlight that AP prevalence and severity criteria are sometimes based on periapical radiograph of which accuracy is questionable. Diagnosis of endodontic lesion is a challenge, particularly in patients with cleft lip and palate, due to the proximity of tooth roots and/or lesions close or superposed to the cleft area. Radiographically, cleft appears as an irregular radiolucent area within the alveolar bridge at the canine area, often extending to the nasal cavity. This is the same area where periapical endodontic lesions occur. Accordingly, it is necessary to carefully differentiate endodontic lesions in patients with cleft lip and palate.[28] Moreover, the presence of tooth crowding, mal-positioned teeth, and oftentimes, supernumerary teeth may confuse the diagnosis.[2] Lack of tridimensional information in areas of interest, in addition to the superposition of structures may interfere in the elaboration of an accurate diagnosis, thereby rendering AP visualization difficult.[23]

The presence of AP proves the maintenance of the infectious process in the periapical area and it may be associated with infection affecting other organs. The literature has reported an association between AP and intracranial, retropharinx, and pulmonary infections; hematogenic disseminations causing rheumatic problems, and risk for coronary disease, especially bacterial endocarditis.[29] This proves the importance of a well-conducted endodontic therapy so as to reach radiograph and clinical success.

Notwithstanding, the literature has pointed out periapical radiograph limitations in detecting AP, since the real extension of the lesion and its relationship with important anatomic limits may not be easily seen. The use of periapical radiographic images for AP detection should be carefully performed due to potential false-negative diagnosis. The greatest advantage of CBCT use in Endodontics is to aid the identification of periapical lesions and differential diagnosis by means of a non-invasive, highly accurate technique.[10]

Imaging diagnosis methods are rapidly improving. New technologies are emerging and CBCT is a tool currently available to dentists. However, despite of marked expansion regarding its diagnosis, clinical and research applications, CBCT technology is new and further studies on accuracy and sensibility/specificity are necessary.[30] It is essential that dentists understand that CBCT should not be routinely recommended in daily practice. The cost-benefit and the need for accuracy should be analyzed, taking into consideration patient exposure to a high radiation level when compared with conventional radiograph.[31,32] Therefore, facing the need for a more sophisticated imaging method, CBCT should be considered.[18,31,32]

Based on the results of this study, it is reasonable to conclude that cone-beam computed tomography is more effective for follow-up of periapical lesions, in comparison to periapical radiograph, after endodontic treatment in patients with cleft lip and palate.

References

1. Freitas JA, Neves LT, Almeida AL, Garib DG, Trindade-Suedam IK, Yaedú RY, et al. Rehabilitative treatment of cleft lip and palate: experience of the Hospital for Rehabilitation of Craniofacial Anomalies/USP (HRAC/USP) - Part 1: overall aspects. J Appl Oral Sci. 2012;20(2):268-81.
2. Hussne RP, Berbert FLCV, Nishiyama CK, Câmara AS, Pinheiro CR, Leonardo RT. Investigation of the endodontic needs and planning in patients with cleft lip and/or palate submitted to surgical treatment. Perspect Oral Sci. 2009;1:19-23.
3. Ricucci D, Siqueira Jr JF, Bate AL, Pitt Ford TR. Histologic investigation of root canal-treated teeth with apical periodontitis: a retrospective study from twenty-four patients. J Endod. 2009;35(4):493-502.
4. Ricucci D, Siqueira Jr JF. Biofilms and apical periodontitis: study of prevalence and association with clinical and histopathologic findings. J Endod. 2010;36(8):1277-88.
5. Ørstavik D, Kerekes K, Eriksen HM. The periapical index: a scoring system for radiographic assessment of apical periodontitis. Endod Dent Traumatol. 1986;2(1):20-34.
6. Abbott PV. Classification, diagnosis and clinical manifestations of apical periodontitis. Endod Top. 2004;8:36-54.
7. Cotti E. Advanced techniques for detecting lesions in bone. Dent Clin North Am. 2010;54(2):215-35.
8. Velvart P, Hecker H, Tillinger G. Detection of the apical lesion and the mandibular canal in conventional radiography and computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001;92(6):682-8.
9. Stavropoulos A, Wenzel A. Accuracy of cone beam dental CT, intraoral digital and conventional film radiography for the detection of periapical lesions. An ex vivo study in pig jaws. Clin Oral Investig. 2007;11(1):101-6.
10. Estrela C, Bueno MR, Azevedo BC, Azevedo JR, Pécora JD. A new periapical index based on cone beam computed tomography. J Endod. 2008;34(11):1325-31.
11. Estrela C, Bueno MR, Leles CR, Azevedo B, Azevedo JR. Accuracy of cone beam computed tomography and panoramic and periapical radiography for detection of apical periodontitis. J Endod. 2008;34(3):273-9.
12. Petersson A, Axelsson S, Davidson T, Frisk F, Hakeberg M, Kvist T, et al. Radiological diagnosis of periapical bone tissue lesions in endodontics: a systematic review. Int Endod J. 2012;45(9):783-801.
13. Nair MK, Nair UP. Digital and advanced imaging in endodontics: a review. J Endod. 2007;33(1):1-6.
14. Cotton TP, Geisler TM, Holden DT, Schwartz SA, Schindler WG. Endodontic applications of cone-beam volumetric tomography. J Endod. 2007;33(9):1121-32.
15. Wang Y, Zheng QH, Zhou XD, Tang L, Wang Q, Zheng GN, et al. Evaluation of the root and canal morphology of mandibular first permanent molars in a western Chinese population by cone-beam computed tomography. J Endod. 2010;36(11):1786-9.
16. Cheng L, Zhang R, Yu X, Tian Y, Wang H, Zheng G, et al. A comparative analysis of periapical radiography and cone-beam computerized tomography for the evaluation of endodontic obturation length. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;112(3):383-9.
17. Bernardes RA, Paulo RS, Pereira LO, Duarte MA, Ordinola-Zapata R, Azevedo JR. Comparative study of cone beam computed tomography and intraoral periapical radiographs in diagnosis of lingual-simulated external root resorptions. Dent Traumatol. 2012;28(4):268-72.
18. Cavalcanti MG. Cone beam computed tomographic imaging: perspective, challenges, and the impact of near-trend future applications. J Craniofac Surg. 2012;23:279-82.
19. Kim S. Endodontic application of cone-beam computed tomography in South Korea. J Endod. 2012;38(2):153-7.
20. Wu MK, Shemesh H, Wesselink PR. Limitations of previously published systematic reviews evaluating the outcome of endodontic treatment. Int Endod J. 2009;42(8):656-66.
21. Jorge EG, Tanomaru-Filho M, Tanomaru JM. Detection of periapical lesion development by conventional radiography or computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;106(1):e56-61.
22. Moura MS, Guedes OA, Alencar AH, Azevedo BC, Estrela C. Influence of length of root canal obturation on apical periodontitis detected by periapical radiography and cone beam computed tomography. J Endod. 2009;35(6):805-9.
23. Patel S, Kanagasingam S, Mannocci F. Cone beam computed tomography (CBCT) in endodontics. Dent Update. 2010;37(6):373-9.
24. Liang YH, Li G, Wesselink PR, Wu MK. Endodontic outcome predictors identified with periapical radiographs and cone-beam computed tomography scans. J Endod. 2011;37(3):326-31.
25. Patel S, Wilson R, Dawood A, Mannocci F. The detection of periapical pathosis using periapical radiography and cone beam computed tomography - part 1: pre-operative status. Int Endod J. 2012;45(8):702-10.
26. Patel S, Wilson R, Dawood A, Foschi F, Mannocci F. The detection of periapical pathosis using digital periapical radiography and cone beam computed tomography - part 2: a 1-year post-treatment follow-up. Int Endod J. 2012;45(8):711-23.
27. Kojima K, Inamoto K, Nagamatsu K, Hara A, Nakata K, Morita I, et al. Success rate of endodontic treatment of teeth with vital and nonvital pulps. A meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;97(1):95-9.
28. Wilcox LR. Endodontic considerations in patients with cleft palate. Gen Dent. 1991;39(6):466-8.
29. Murray CA, Saunders WP. Root canal treatment and general health: a review of the literature. Int Endod J. 2000;33(1):1-18.
30. Lorenzoni DC, Bolognese AM, Garib DG, Guedes FR, Sant'Anna EF. Cone-beam computed tomography and radiographs in dentistry: aspects related to radiation dose. Int J Dent. 2012;2012:813768.
31. Gurgel CV, Costa AL, Kobayashi TY, Rios D, Silva SM, Machado MA, Oliveira TM. Cone beam computed tomography for diagnosis and treatment planning of supernumerary teeth. Gen Dent. 2012;60(3):e131-5.
32. Kobayashi TY, Gurgel CV, Cota AL, Rios D, Machado MA, Oliveira TM. The usefulness of cone beam computed tomography for treatment of complex odontoma. Eur Arch Paediatr Dent. 2013;14(3):185-9.