ARC Journal of Radiology and Medical Imaging
Volume 1, Issue 1, 2016, PP 8-12
www.arcjournals.org

Artifacts in Cone Beam Computed Tomography Imaging Mimicking a Dental Fracture in Unfilled Root Canals: A Case Report

[1]Ruy Paschoal Ramos-Junior, DDS , [2]Evaldo Almeida Rodrigues, DDS,MSc, [3]IedaCrusoe-Rebello, DDS, MSc, PhD,[4]Gabriella Lopes Rezende Barbosa, DDS, MSc , [5]Frederico Sampaio Neves, DDS, MSc, PhD, [*]Emmanuel Joao Nogueira Leal Silva,DDS, MSc, PhD

[1]Private Practice, Feira de Santana, Bahia, Brazil.
[2] Department of Health, School of Dentistry, Feira de Santana State University, Feira de Santana, Bahia, Brazil
[3]Department of Oral Radiology, School of Dentistry, Federal University of Bahia, Salvador, Bahia,Brazil
[4] Department of Oral Diagnosis, Division of Oral Radiology, University of Campinas, Piracicaba, São Paulo, Brazil
[5]Department of Oral Radiology, School of Dentistry, Federal University of Bahia, Salvador, Bahia,Brazil
*****Department of Endodontics, School of Dentistry, Grande Rio University (UNIGRANRIO) and Rio de Janeiro State University(UERJ), Rio de Janeiro, Brazil
**nogueiraemmanuel@hotmail.com.*

Abstract: *The aim of the present study was to report a case of cone beam computed tomography (CBCT) artifact mimicking the presence of root fracture in a tooth without intracanal material. A 27-year-old woman was referred to a private clinic after dental trauma during physical activity. Clinical examination revealed oblique crown fracture in the middle third of the left maxillary central incisor involving enamel and dentin without pulp exposure. Reattachment of tooth fragment was performed. However, one month after treatment, the patient returned with severe pain. During CBCT examination a hypodense line in the middle third of the root, buccal-palatal oriented, suggesting the presence of root fracture was observed. The planned treatment was extraction and immediate implant placement. After the extraction, the tooth was visually inspected and no root fracture was detected. For this reason, the tooth was replanted into the alveolus. A 03-year follow-up was performed and no complaints were reported. CBCT exams aiming the diagnosis of root fracture have some pitfalls and should be assessed carefully. It is necessary to evaluate properly the presence of beam hardening artifacts, regardless the presence of filling materials, not only in the tooth with the suspicion of root fracture, but also in all adjacent teeth.*

Keywords: *Cone Beam Computed Tomography; Root Fracture; Beam Hardening Artifact*

1. INTRODUCTION

One of the challenges in Oral Radiology and Endodontics is the correct identification of root fractures. In most of the cases, the correct diagnosis of the fracture is only possible when clinical (e.g. pain, local swelling and dental mobility) and radiographic (e.g. widening of the periodontal space and periapical lesion) findings are correlated [1-3]. However, in specific cases, the root fracture diagnosis is only confirmed under periodontal surgical procedure or after extraction of the tooth [2, 4].

Cone beam computed tomography (CBCT) is an imaging modality that shows the dental structures in a three-dimensional view, as well as it offers clear structural images with high contrast. CBCT is increasingly replacing the medical computed tomography (CT) use in dentistry because it provides an adequate image quality associated with a lower exposure dose. Other advantages of CBCT are low cost, shorter scanning time and lower production of beam hardening artifacts when compared to CT [5, 6].

The presence of artifacts in CT and CBCT images due to the presence of filling materials as gutta-percha and metal posts might influence the endodontic diagnosis, especially in cases of root fractures

[7-11]. Moreover, beam hardening artifacts represented by hypodense lines (dark lines) can be misdiagnosed as root fractures due to a similar radiographic appearance, leading to an incorrect management and, in some cases, culminating in unnecessary tooth extractions [4].

To the best of our knowledge, there is only one clinical report in the literature report the effects of CBCT and CT artifacts in the diagnosis of root fractures [4]. Therefore, the present article aimed to describe a case of CBCT artifact mimicking root fracture in a tooth without intracanal material.

2. CASE REPORT

A 27-year-old woman was referred to a private clinic after local trauma during physical activity. The patient did not have pain or other complains, and her medical history was not contributory. The dental status was satisfactory, being noted on the right lateral incisor, the presence of a dental piercing: a piece of jewelry applied on the vestibular surface of the crown. Clinical examination revealed oblique crown fracture in the middle third of the left maxillary central incisor involving enamel and dentin without exposure of the pulp. The treatment was reattachment of the tooth fragment. However, after one month, the patient returned to the clinic complaining about severe pain. The vitality pulp test was performed and the tooth had a positive response. In the periapical radiograph, no signs of root fracture or periapical pathology were observed (Fig. 1).

Fig1. *Periapical radiography showing no signs of root fracture*

The patient underwent CBCT examination (Eagle 3D CBCT unit; Dabi Atlante, São Paulo, Brazil) in order to evaluate the possible presence of periapical lesion or root fracture. During the image observation, it was detected in the sagittal view, a hypodense line in the middle third of the root, buccal-palatal oriented, suggesting the presence of root fracture (Fig. 2).

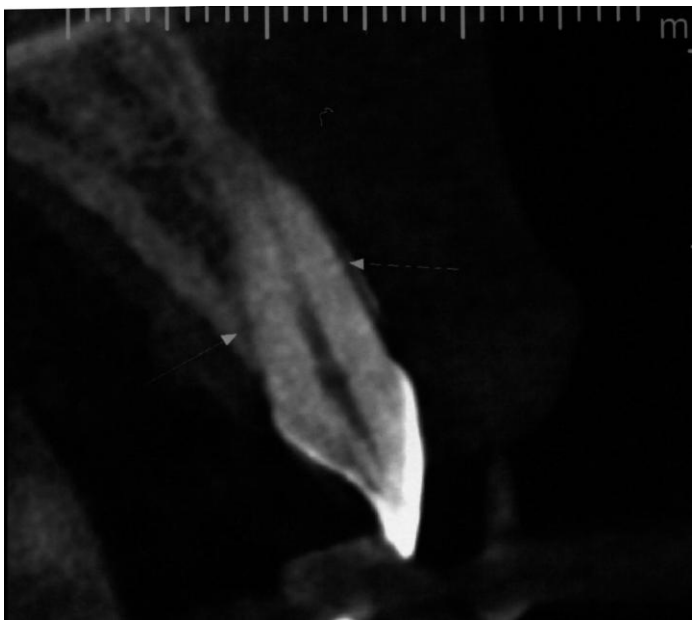

Fig2. *Sagittal CBCT slice showing the possible fracture in the middle third of the root (white arrows).*

The treatment of choice was extraction of the tooth and immediate dental implant placement. After the extraction, the tooth was visually inspected and no root fracture was detected. For this reason, the tooth was replanted into the alveolus and a semi-flexible splint was used during seven days.

After fifteen days, the patient was revaluated and the replanted tooth had a negative response to the vitality pulp test and the endodontic treatment was performed. Calcium-hydroxide was used as the temporary intracanal material to avoid root resorption, and it was replaced every month, during one year. After this period, the root canal was sealed with gutta-percha.

A 03-year follow-up was performed and no complaints were reported. During clinical examination, the absence of the dental piercing was noticed. The patient underwent a second CBCT examination and no signs of root resorption or ankylosis were detected in the tooth (Fig. 3). Additionally, no hypodense line was observed on the images.

Fig3. *Sagittal slice of CBCT image acquired at the three-year follow-up of the replanted tooth showing no signs of root fracture or external root resorption.*

3. DISCUSSION

The present case shows that artifacts present in CBCT exams may simulate alterations even in teeth without filling materials or intracanal posts; demonstrating a significant disadvantage of this imaging technique and highlighting the importance of further studies that attempt the artifact reduction in tomographic images.

There is no doubt that CBCT is a valuable aid in endodontic practice, allowing the three-dimensional visualization of structures differently from plain radiographs. However, SEDENTEXCT guidelines [12] and the European Society of Endodontology [13] stated that CBCT exams should not be requested routinely for all patients with suspected dental fracture. In fact, the potential risks and benefits of CBCT for each patient should be fully assessed based on both conventional radiographs and clinical signs and symptoms. In the present case, CBCT was used initially for the diagnosis of a possible root fracture and for the further follow-up of the replanted tooth.

CBCT artifacts arise from the inherent polychromatic nature of X-ray projection, resulting in beam hardening artifact formation due to the increase of the average energy of the beam due to the absorption of low energy photons. This effect is generated by discrepancies between physical condition and mathematics formatting used to make the reconstruction in three dimensions [14]. Two types of artifacts are formed: distortion of metal structures due to differential absorption (cupping artifacts) and hypodense streaks and bands between two objects of high radiodensity (streaking artifacts) [15].

In some cases, false-positive diagnosis can occur in CT or CBCT images acquired for root fracture diagnosis. This may happen due to artifacts obscuring the tooth root. In the case reported, it was possible to clearly observe the hypodense line in the root on CBCT images; however, no fracture was visualized in visual inspection after the extraction of the tooth. Consequently, it was possible to conclude that the hypodense line was a beam hardening artifact, despite the fact that the tooth and adjacent teeth did not have any intracanal materials, which would justify the formation of the artifact due to the high densities of the objects.

It is hypothesized that the artifact present on the image was originated from the dental piercing placed on the right maxillary lateral incisor, which could explain the hypodense line in the image. Another point that supports this hypothesis is the second CBCT examination that was acquired when the patient no longer had the dental piercing and does not present any hypodense line, this artifact or assumed fracture was not visualized.

It is worth saying that a careful interpretation of CBCT data adjusted to the diagnostic task is necessary to attain the examination goals. Moreover, the final diagnosis and decision regarding the management of the finding should be associated with clinical evidences.

The false diagnosis of root fracture in CBCT images was previously reported in the literature; however, as described by Kajan & Taromsari [4] the common condition of the involved tooth is the presence of filling material. These authors reported several clinical reports of root fracture in teeth with intracanal restorations and in one of them, as in the presented case report, the fracture was visualized on the CT image but not clinically. Nonetheless, the absence of any intracanal material in the present case makes it very uncommon, highlighting the importance of a careful evaluation of tomographic images and its artifacts even in cases of unrestored teeth.

In conclusion, CBCT exams aiming the diagnosis of root fracture have some pitfalls and should be assessed carefully. It is necessary to evaluate properly the presence of beam hardening artifacts, regardless the presence of filling materials, not only in the tooth with the suspicion of root fracture, but also in all adjacent teeth.

REFERENCES

[1] Edlund M., Nair M. K., Nair U.P., Detection of vertical root fractures by using cone-beam computed tomography: a clinical study. J. Endod. 37, 768-772 (2011).

[2] Fayad M.I., Ashkenaz P.J., Johnson B.R., Different representations of vertical root fractures detected by cone-beam volumetric tomography: a case series report. J. Endod. 38, 1435-1442 (2012).

[3] Metska M.E., Aartman I.H., Wesselink P.R., Ozok A.R., Detection of vertical root fractures in vivo in endodontically treated teeth by cone-beam computed tomography scans. J. Endod. 38, 1344-1347 (2012).

[4] Kajan Z.D., Taromsari M., Value of cone beam CT in detection of dental root fractures. Dentomaxillofac. Radiol. 41, 3-10 (2012).

[5] Loubele M., Jacobs R., Maes F., Denis K., White S., Coudyzer W., Lambrichts I., van Steenberghe D., Suetens P., Image quality vs radiation dose of four cone beam computed tomography scanners. Dentomaxillofac. Radiol. 37, 309-318 (2008).

[6] Suomalainen A., Kiljunen T., Käser Y., Peltola J., Kortesniemi M., Dosimetry and image quality of four dental cone beam computed tomography scanners compared with multislice computed tomography scanners. Dentomaxillofac. Radiol. 38, 367-378 (2009).

[7] Hassan B., Metska M.E., Ozok A.R., van der Stelt P., Wesselink P.R., Detection of vertical root fractures in endodontically treated teeth by a cone beam computed tomography scan. J. Endod. 35, 719-722 (2009).

[8] Hassan B., Metska M.E., Ozok A.R., van der Stelt P., Wesselink P.R., Comparison of five cone beam computed tomography systems for the detection of vertical root fractures. J. Endod. 36, 126-219 (2010).

[9] Melo S.L., Bortoluzzi E.A., Abreu M. Jr., Corrêa L.R., Corrêa M., Diagnostic ability of a cone-beam computed tomography scan to assess longitudinal root fractures in prosthetically treated teeth. J. Endod. 36, 1879-1882 (2010).

[10] da Silveira P.F., Vizzotto M.B., Liedke G.S., da Silveira H.L., Montagner F., da Silveira H.E., Detection of vertical root fractures by conventional radiographic examination and cone beam computed tomography - an in vitro analysis. Dent. Traumatol. 29, 41-46 (2013).

[11] Khedmat S., Rouhi N., Drage N., Shokouhinejad N., Nekoofar M.H., Evaluation of three imaging techniques for the detection of vertical root fractures in the absence and presence of gutta-percha root fillings. Int. Endod. J. 45, 1004-1009 (2012).

[12] SEDENTEXCT guidelines. Safety and Efficacy of a New and Emerging Dental X-ray Modality. Radiation protection no. 172: cone beam CT for dental and maxillofacial radiology (evidencebasedguidelines).2012.Availablefrom:http://www.sedentexct.eu/files/radiation_protection_172.pdf.

[13] Patel S., Durack C., Abella F., Roig M., Shemesh H., Lambrechts P., Lemberg K., European Society of Endodontology position statement: The use of CBCT in Endodontics. Int. Endod. J. 47, 502-504 (2014).

[14] Schulze R., Heil U., Gross D., Bruellmann D.D., Dranischnikow E., Schwanecke U., Schoemer E., Artefacts in CBCT: a review. Dentomaxillofac. Radiol. 40, 265-273 (2011).

[15] Scarfe W.C., Farman A.G., What is cone-beam CT and how does it work? Dent. Clin. North. Am. 52, 707-730 (2008).