CASE REPORT

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The uncovered extensive fusion of two separated periapical lesions in CBCT imaging: an importance of multiplanar radiographic appraisal

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ABSTRACT

Objectives: This report is aimed to present a case of an uncovered fusion of two seemingly separated periapical rarefying osteitis lesions on two adjacent teeth through Cone Beam Computed Tomography (CBCT) imaging and to describe the significance of a comprehensive multiplanar appraisal in interpreting CBCT radiographs.

Case Report: An 18-year-old female patient came to Universitas Airlangga Dental Hospital for a CBCT examination of her right central maxillary incisor (tooth 11) as referred by her dentist. Based on the clinical report provided, the patient had a slight palpable swelling of the labial gingival anterior maxilla with sign of crepitus. Caries lesions were found on teeth 11 and 12 in which the vitality tests showed negative responses. Thus, it was provisionally suspected as a periapical inflammatory lesion. CBCT was done and the 3D-reconstructed images of the bone showed there were two neighboring radiolucent ovoid lesions attached on one-third apical of teeth 11 and 12, separated by a firm-apparent cortex. It was later discovered that the two lesions were actually fused as one elongated and extensive lesion through the multiplanar appraisal of three orthogonal views provided in CBCT application.

Conclusion: CBCT 3D-reconstructed and panoramic reformatted images should be used with caution, either for linear measurement or diagnostic purposes, as they should only be used to illustrate the diagnosis and/or provide a better understanding of the problem to the patients and their treatment plans. A comprehensive multiplanar appraisal is required to provide a diagnostically complete interpretation.

Keywords: *Periapical rarefying osteitis, multiplanar, CBCT, health service*
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INTRODUCTION

Cone Beam Computed Tomography (CBCT) is a three-dimensional (3D) imaging modality that plays an important role in the diagnosis of oral and maxillofacial pathologies. CBCT produces radiograph images of the dentition and maxillofacial region with acceptable to high accuracy, as well as a complete multiplanar reformation and 3D reconstruction, making it often being chosen by clinicians to support their plan and evaluation to any dental treatments. These multiplanar and 3D images are both critical for detailed and comprehensive CBCT interpretation.

The main challenge in CBCT application is that most dental professionals are unfamiliar with the concept of multiplanar imaging.[1] Multiplanar imaging in CBCT acquisition contains a bundle of reformatted images of the object that is shown in three basic tomographic planes: coronal, sagittal, and axial. Viewing anatomy and pathology in all three planes is useful when determining the extent of disease in a patient. Meanwhile, the 3D reconstructed image becomes more preferable to evaluate as it is easier to see the shape of the bone or teeth directly, and/or the relationship of anatomic structures properly. It was reported that the landmark identification on 3D surface rendering images was more realistic and accurate than that on 2D images because of the stereoscopic images could be displayed and rotated in intended direction for identification. Some landmarks might be difficult to localize when using only one multiplanar plane e.g. axial slices.[2]

A study about Indonesian dentist's knowledge of the use of CBCT 3D discovered a greater number of dentists were unable to distinguish the three multiplanar planes of the CBCT images, confirming a lack of understanding in which dentists tended to only understand the basic theory of the modality without being supported by clinical skills and applications.[3] It was stated that the problem arose as a result of respondents' lack of experience in using CBCT, thus it was unfamiliar to do interpretation. Several findings also confirmed there is notable lack of awareness about CBCT among dentists and dental students, and knowledge about this promising modality needs to

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be improved.[4–7] It is claimed that CBCT was not adequately covered as part of the curriculum in dental schools, in which the absence of a CBCT unit appears to be the primary reason, considering the theoretical education must be supplemented by routine CBCT practice.[5,7]

Seeing the fact that the demand for CBCT application is increasingly expanding in recent years, it is necessary for dentists to have a better understanding and interpretive skills. This article is aimed to show the multiplanar planes-based discovery of an extensive fusion of two seemingly separated periapical rarefying osteitis lesions on two adjacent teeth in CBCT 3D reconstructed image and to describe the significance and importance of a comprehensive multiplanar appraisal in interpreting CBCT radiographs.

CASE REPORT

An 18-year-old female patient came to Universitas Airlangga Dental Hospital for a CBCT examination of her right central maxillary incisor (tooth 11) as referred by her dentist. Based on the clinical report provided, the patient had a slight palpable swelling of the labial gingival anterior maxilla with sign of crepitus. Caries lesions were found on teeth 11 and 12 in which the vitality tests showed negative responses. Thus, it was provisionally suspected to be periapical inflammatory lesions.

CBCT examination was done and the 3D-reconstructed (Figure 1) and panoramic reformatted images (Figure 2) showed there were constantly two neighboring radiolucent ovoid lesions attached on one-third apical of teeth 11 and 12, separated by a firm-apparent cortex. Through the multiplanar assessment of the three orthogonal views provided in CBCT application, it was discovered that the two lesions were actually fused as one elongated and extensive lesion (Figure 3 – 4). The well-defined radiolucent lesions at the apical thirds of teeth 11 and 12 have coalesced into a single lesion that extends from the maxillary midline to the apical edge of tooth 12, with the appearance of "eggshell" thinning of the labial cortex due to the lesion's expansion. The density analysis (ROI) of the internal structure of the lesion showed a density resembling a soft or non-solid mass. Radiographically, the radiolucent lesion in tooth 11 showed the characteristics of an inflammatory lesion leading to a cystic formation, whereas the radiolucent lesion in tooth 12 had the characteristic of a cystic lesion with localized expansion. Thus, the diagnosis of radicular cyst was made.

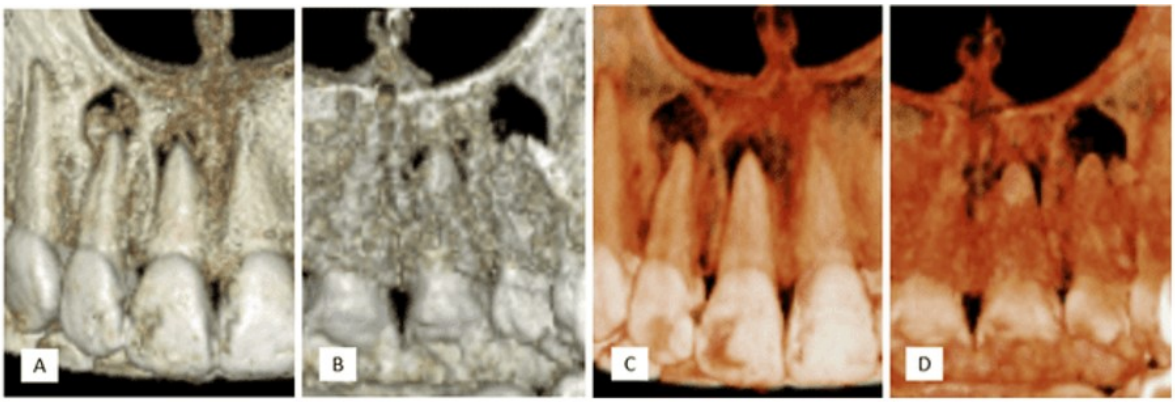

Figure 1. Reconstructed 3D images in CBCT radiograph of the patient showed that there are two seemingly-separated periapical rarefying osteitis lesions in apical third of 11 and 12; A) Bone labial view, B) Bone palatal view, C) Tooth labial view, D) Tooth palatal view

Figure 2. Panoramic reformatted image from the CBCT dataset consistently shows the image of two different radiolucent periapical lesions in apical third of 11 and 12

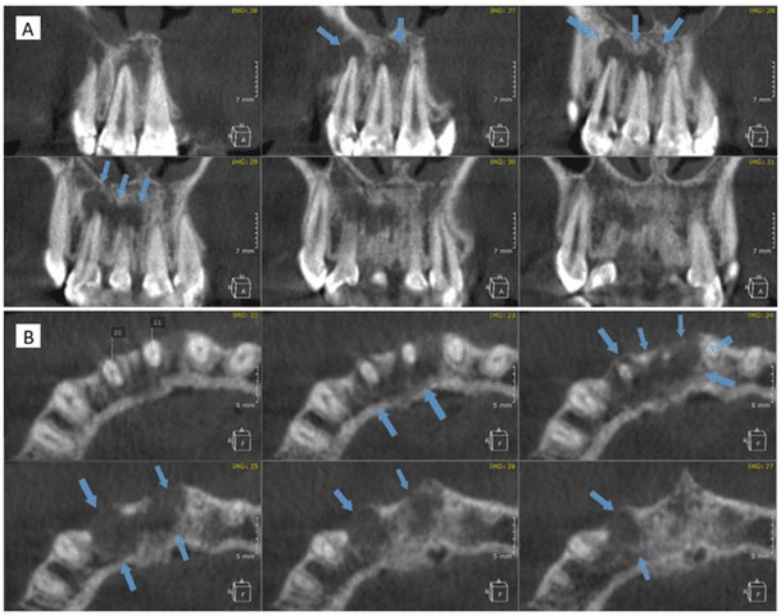

Figure 3. Multiplanar appraisal of the CBCT radiograph through, A) Coronal slices, and B) Axial slices. Note the transitional gradation of the lesion connection at the anterior upper maxilla region (blue arrow)

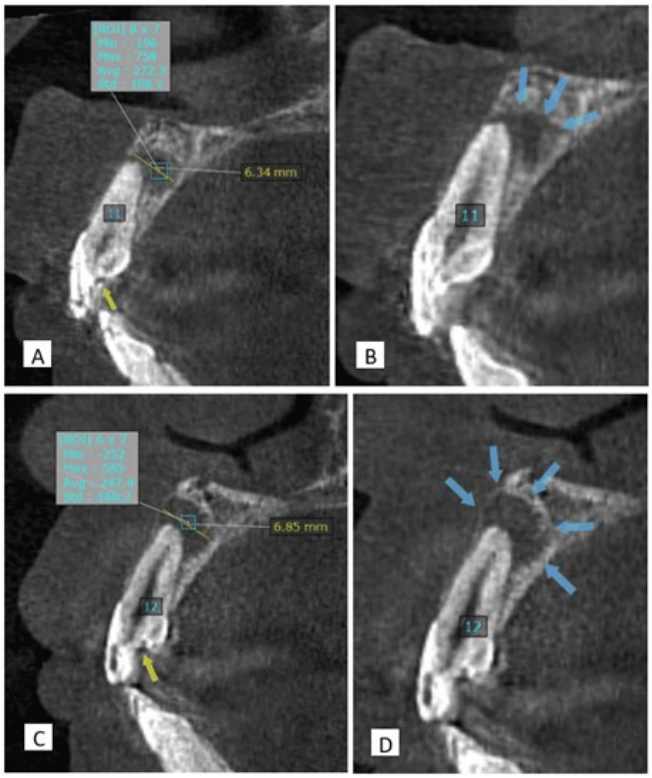

Figure 4. Sagittal view of the central upper right incisor (A, B) and lateral upper right incisor (C, D). Note the uneven border of the periapical lesion at the central incisor despite the perfect circular-shaped and corticated border at the lateral incisor, showing the "eggshell" thinning of the labial cortex caused by the lesion's expansion (blue arrow)

DISCUSSION

CBCT reconstruction generates a 3D matrix that can be viewed as a series of 2D cross-sectional images in the coronal, sagittal, and axial planes. Axial plane is a series of segments in volume that extend from top to bottom. The sagittal plane is a slice taken vertically from the left to the right, while the coronal plane is a slice taken horizontally from the front to the back. These three orthogonal planar views are linked in a multiplanar reformation (MPR) window by lines or crosshairs, which helps with orientation and navigation.[8]

In addition to displaying a series of 2D images at specific planes, CBCT also gives clinicians the ability to produce 3D volumetric rendering of the craniofacial complex with doses equivalent to

dental radiographs. 3D reconstruction models of teeth or bone from CBCT dataset is being an effective tool of visualization in dentistry.[9] Most dentists were reported to show the CBCT images to patients to illustrate the diagnosis or treatment plan[10], and the 3D volumetric reconstructed images may become an advantage because the anatomical structure and pathological abnormalities can be well-visualized and easily understood by the patient. Our report emphasized the significance and importance of a comprehensive multiplanar appraisal, along with the 3D reconstructed images, in interpreting CBCT radiographs.

CBCT examination in this report shows a different shape and size of the periapical lesion from three available views. The 3D-reconstructed and panoramic reformatted images constantly depict two neighboring radiolucent ovoid lesions attached on one-third apical of teeth 11 and 12, separated by a firm-apparent cortex. Meanwhile, it was discovered that these two lesions were actually fused as one elongated and extensive lesion through the assessment of the three orthogonal multiplanar views. The difference could be due to the fact that the data displayed in the 3D image is a whole volumetric reconstructed image, which cannot be traced or modified slice by slice within a certain distance as in an original multiplanar view. This is why operators must be more cautious when reading CBCT radiographs, especially when it comes to determining the extent and involvement of the pathological lesion with the surrounding tissue anatomy, as in this case. The risk of incorrect treatment plans or inadequate care provided as a result of incomplete diagnostic information should be avoided.

The lesions seen on this study are typical periapical rarefying inflammatory lesions as a cause of necrotic pulp. Both teeth were found to have a carious appearance with a depth reaching the pulp, indicating a non-vital condition. However, the radiographic characteristics of the lesions differ slightly in the form of these two fused lesions. Although it cannot be definitively diagnosed without histopathological examination, the central incisor lesion had a more irregular border that closely resembles periapical abscesses or granulomas, whereas the lateral incisor lesion was well-defined, ovoid-shaped, expansive and resulting in labial cortical thinning or eggshell effect, thus suggesting a radicular cyst formation. The inflammatory cell infiltrates in granulomas and radicular cysts are primarily mononuclear cells.[11] The large number of inflammatory stimuli and their interactions can influence and change the state and progression of the disease, which in this case may also lead to contiguous fusion of the neighboring lesions. Although distinguishing periapical granulomas from cysts has no clinical implication,[12] it should be taken into account when there is a suspect of larger lesions such as benign tumors or other pathological cases.

The CBCT provides several display modes for different diagnostic and treatment-planning purposes (Figure 5), namely the basic orthogonal views, oblique slicing, curved slicing, cross-sectional view, ray sum and volume rendering.[13]-- The volume rendering function in CBCT enables one to selectively display voxels within a dataset to visualize volume and construct 3D-reconstructed images. Surface rendering, also known as indirect volume rendering, is a technique that renders image data by converting it into geometric primitives, in which some information may be lost as a result.[8] This rendering involves selection of the density of the voxels to be displayed within an entire dataset, resulting in a volumetric surface reconstruction with depth. Two kinds of views are

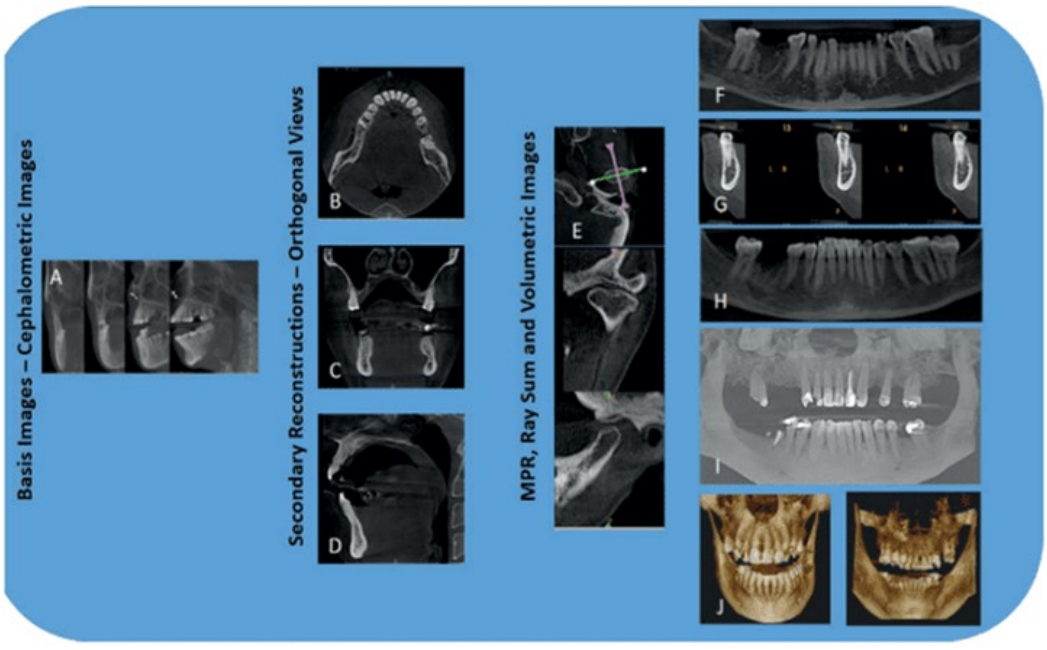

Figure 5. The display modes and image acquisition in CBCT[13]

possible: views that are solid (surface rendering) and views that are transparent (volumetric rendering).[13,14] Iso-surfacing techniques, such as the marching cubes algorithm, are one type of surface rendering technique that produces surfaces with the same iso-surface value, displaying only the surface of thresholded areas. Different threshold values produce different types of 3D surface rendering; therefore, it is important to remember that 3D rendering is only for visualization and not for diagnosis and analysis. The visualization software can provide a variety of 3D image qualities with varying render times.[8]

Multiplanar view of three orthogonal planes provided enormous radiographic information as it allows interactive sections and creates 2D images at any angle by cutting across a set of images, thus being more indicated to assess particular structures such as on the extent of bone resorption, sclerosis, cortical expansion, internal or external calcifications, and proximity to other vital structures which paved the way for precise surgical management in case of jaw cysts using CBCT.[15] In terms of the reliability for measurements, a study by Fernandes *et al.*[16] discovered that linear measurements performed on 2D CBCT multiplanar images are more accurate for clinical diagnosis and treatment planning than on 3D rendering images. However, another study focused on the orthodontic purposes of CBCT found no significant difference of results between 2D multiplanar slices and 3D surface-rendered images.[17] According to the findings, performing cephalometric measurement analysis on 3D-rendered models is the most appropriate approach in terms of accuracy and convenience, as conducting on multiplanar views requires more observer time and effort to identify anatomical landmarks. The landmark identification on 3D surface rendering images was tend to be more accurate and realistic than on 2D images since the stereoscopic images could be presented and repositioned in an intended way.[2] Sang *et al.*[18] stated that 3D reconstruction models from CBCT data is quite accurate for linear, volumetric and geometric measurements, but it is also figured out that different CBCT systems may have different results.

The entire CBCT dataset volume must be evaluated and reported on in a systematic manner. It is best to assess the entire dataset including in all three orthogonal planes, rather focusing only on one specific area of interest.[19] Most dental clinicians are not oral and maxillofacial radiologists and are unfamiliar of interpreting anatomy and pathologic conditions in the head-and-neck region outside of their immediate clinical interest.[20] Failure to recognize and report any incidental or pathological findings can lead to medical complications for the patient as well as potential medicolegal implications for the dentist. American Academy of Oral and Maxillofacial Radiology (AAOMR) have issued a statement that clinician is liable for missed diagnosis even if it is outside their area of practice with no consent is allowed to interpret only certain areas of the image volume.[21]

The operators' lack of proficiency in CBCT application and utilizing all of the available multiplanar images might be the issue to be concerned of. Many dentists who install a machine are not adequately trained to fully understand and utilize the capabilities of their machine.[22] Hol *et al.*[10] reported that the vast majority of dental specialists usually interpret the CBCT results before receiving the radiological report, with approximately one-third of them usually starting treatment before receiving the report. A few respondents stated that their greatest challenges were developing competence in the procedures and learning to use the equipment and interpret the images correctly. An Indonesian study[3] discovered that more than half dentists did not have enough knowledge of how to correctly interpret the CBCT images and could not state the right multiplanar planes in the radiographs. It is also confirmed by several other studies that investigated on dentist and students' awareness and attitude towards CBCT in which the results showed relatively low understanding, knowledge and interpret ability of the images.[4–6,23] It is critical to emphasize that practitioners who order CBCT scans are responsible for interpreting the entire image volume for potentially significant incidental findings that may necessitate additional intervention.[22,24]

As CBCT imaging becomes more popular, learning how to interact with the data to recognize incidental findings, that is, findings unrelated to the scan's original intent, as in this case report, becomes critical. In 3D imaging, incidental findings are more visible than in 2D radiographs. Any unexpected findings in CBCT images may not always indicate a more serious pathology or huge urgency in remodeling the treatment plan, but being aware of them and the negative consequences associated with them might ensure a correct diagnosis and better prognosis. The main objective of a CBCT report is to provide an accurate interpretation of the images evaluated; similarly to any radiographic report, it should conclude with a clinical impression and an appropriate answer to the clinical question. Thus, it is strongly advised that, the diagnostician should understand and apply the concept of multiplanar reformatting to the greatest extent possible in order to fully utilize the CBCT imaging. Despite its complexity to lear, the multiplanar view may provide more adequate information on the pathologic conditions of a patient. A consultation with oral and maxillofacial radiologists should be sought if the clinicians feel they are out of their competence.

CONCLUSION

CBCT 3D-reconstructed and panoramic reformatted images should be used with caution, either for linear measurement or diagnostic purposes, as they should only be used to illustrate the diagnosis and/or provide better understanding the problem to the patients and their treatment plans. Interpreting CBCT radiographs using the

combination of both MPR and 3D reconstructed images offers several benefits for accurate interpretation and enables the dentist to improve clinical outcomes. A comprehensive multiplanar appraisal is required to maximize the utility of CBCT and provide a diagnostically complete interpretation.

FOOTNOTES

All authors have no potential conflict of interest to declare for this article. Informed consent was obtained from the patient for being included in this case report.

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