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DIAGNOSING THE ELUSIVE VRF USING CONE BEAM CT: CASE REPORTS

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ABSTRACT

Background: *Vertical root fracture (VRF) is one of the most difficult and perplexing conditions in clinical endodontics, to diagnose and treat. The fracture line is overlapped by different radio-opaque structures like the alveolar bone and root dentine in three dimensions that makes it very difficult to recognize on a traditional radiograph. The only other way to identify a vertical root fracture is to surgically expose the suspected site and visualize the defect.* ***Case description***: *The first case is of a 45year old male with periapical lesion in relation to 15 which was root canal treated 9 years ago. The swelling was asymptomatic and hence a fracture was suspected. The CBCT images confirmed the fracture on the axial sections. The second case is of a 52 year old male who reported with buccal swelling in relation to 36 which was endodontically treated 5years back. The location of the swelling was close to the marginal gingiva and in the furcation region. The intraoral radiograph showed halo type radiolucency, suggestive of VRF. The CBCT images confirmed the root fracture.* ***Discussion***: *The use of three-dimensional imaging has been prevalent in the medical field for a long time now and the dental fraternity is soon catching up. The introduction of CBCT in dentistry has opened up a wide range of applications for three-dimensional imaging at a fraction of the radiographic x-ray exposure. This newer method of acquiring hard tissue volume data has shown great promise. CBCT has been used for bone volume analysis for implants and surgical planning. Since the newer CBCT machines are capable of providing images with resolution as high as 90 microns, they could be used to detect vertical root fractures in the teeth without having to surgically expose the site. The application of CBCT in endodontics is increasing with the improved sensors and the sophisticated software to manipulate the volume data. A clear understanding of the data acquisition, the rendering process and the limitations of this diagnostic technique would help its applications in various other clinical aspects. Clinical significance: The use of CBCT to identify the presence of vertical root fracture would significantly reduce the prevailing ambiguity in the clinical diagnosis of VRF.*

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KEY WORDS

CBCT; 3D Imaging; FOV; VRF; "Halo-appearance"

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[I] INTRODUCTION

Vertical root fracture (VRF) is one of the most difficult and perplexing conditions in clinical endodontics, to diagnose and treat. Causes for VRF may include excessive mechanical root canal preparation, excessive forces during the compaction of root-filling materials, excessive canal widening for post placement, lack of periodontal support, internal resorptions or occlusion stress [1-4]. Identifying the presence of vertical root fractures (VRF) is often an endodontic challenge [5]. Clinical and radiographic evidence of the presence of root fractures does not always present itself until the fracture has been present for some time. However, even with long- standing VRF clinical signs of their existence maybe little more than a draining buccal sinus, which is certainly not pathognomonic of the problem. While a deep, isolated, thin periodontal pocket is suggestive of VRF, difficulty aligning the periodontal probe along the periodontal defect sometimes means this sign is missed [6]. Radiographic features suggestive of VRF such as J-shaped and halo-shaped radiolucencies do not appear until significant bone destruction has occurred and similarly shaped radiolucencies may manifest themselves in cases of apical periodontitis not associated with VRF. In this paper we present two cases of endodontically treated teeth with vertical root fracture diagnosed by CBCT imaging.

[II] CASE DESCRIPTION

2.1. Case 1

A 45 year old male patient reported to the clinic for evaluation of the upper right premolar with a buccal swelling. The tooth was endodontically treated 9 years ago. The patient did not complain of pain either on biting or spontaneously. He reported that he first noticed a small painless swelling about a month back which subsided on its own. It reoccurred few days back but was larger in size but still remained painless. Radiographic evaluation showed a fairly diffuse periodical radiolucency with apparent blunting of the root apex **[Figure– 1.1]**. The slight widening of the periodontal space all around the tooth suggested that the swelling was not purely periapical in nature. The patient was explained the possibility of a VRF and the possible diagnostic aids of surgical exploration and use of CBCT. The patient opted for the CBCT which was noninvasive in nature. The CBCT imaging was carried out using the Orthophos XG 3D by Sirona. The data acquired was then computed and rendered by the Galaxis software. The axial, coronal, and

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sagittal sections were then studied to identify the fracture line. The Volume rendering image showed the fracture line **[Figure–1.2]**. The axial sections also showed the fracture line **[Figure–1.3]**. The images provided showed the presence of VRF on the buccal surface of the tooth. The results were then discussed with the patient and an informed decision to extract the tooth was taken. The tooth was extracted and the fracture was confirmed visually **[Figure–1.4]**.

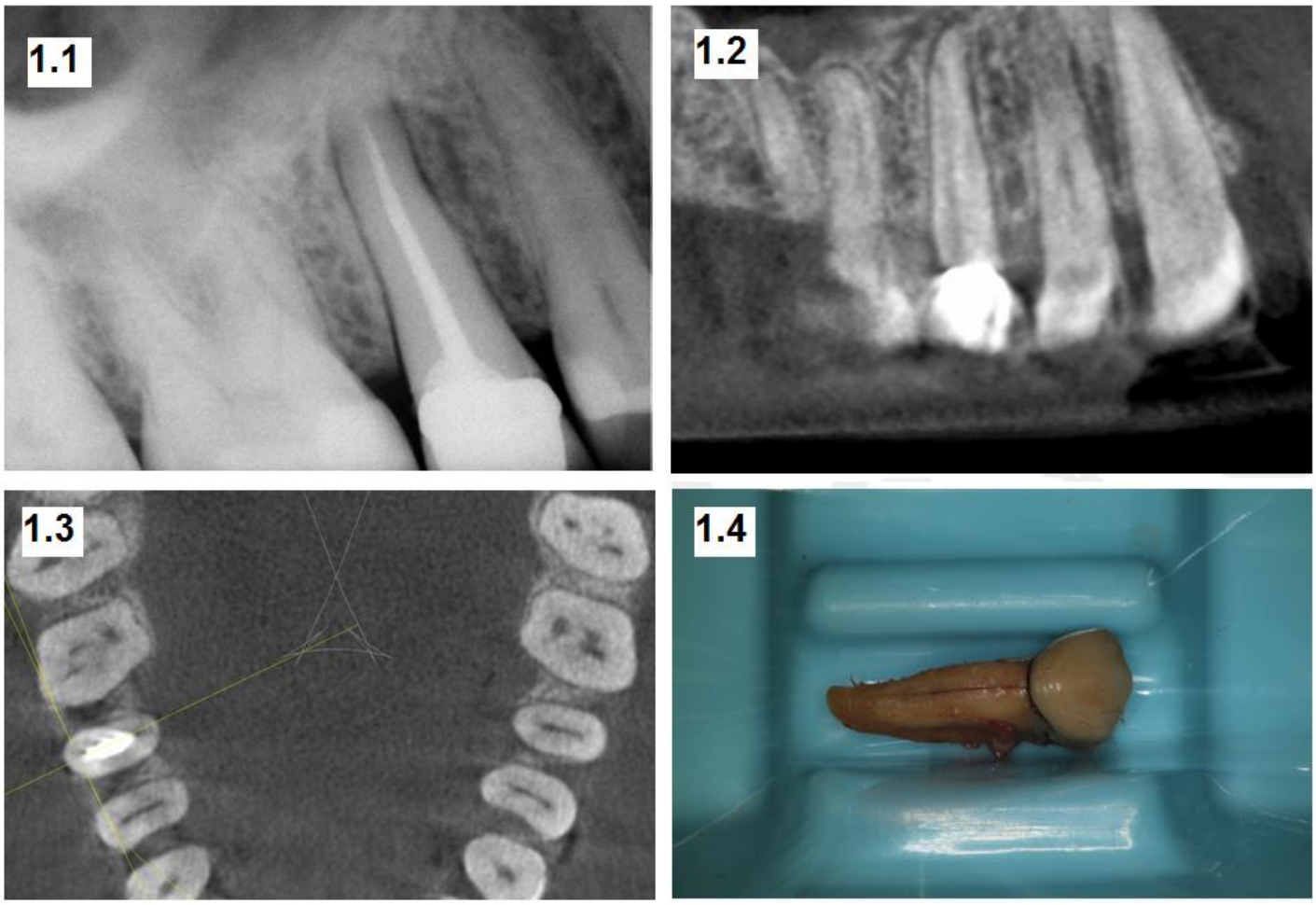

Fig: 1.1. Diagnostic radiograph; **Fig: 1.2.** CBCT Image longitudinal section showing fracture line; **Fig: 1.3.** Axial section of CBCT Image showing fracture; **Fig: 1.4.** Fracture evident after extraction

2.2. Case 2

A 52 year old male patient reported with a non painful buccal swelling in relation to 36 which recurred every few days since the last six months. The patient gave a history of root canal treatment about 5 years back. He did not complain of pain in the tooth but expressed some discomfort while biting on the side. Intraoral examination revealed the swelling to be closer to the furcation region. The intraoral radiograph showed radiolucency in the furcation and also along the length of the mesial root, the "halo" appearance **[Figure– 2.1]** suggestive of VRF. The patient was explained the possibility of a vertical root fracture and the treatment options. A CBCT Imaging was suggested to confirm the diagnosis of vertical root fracture as the patient wanted to avoid a surgery. The CBCT was carried out using the CS9300 by Carestream. The DICOM files were then computed using the Carestream software. The 3D volume rendering image and the various sections of the tooth was observed and the vertical root fracture was identified. The CBCT images showed the fracture on the mesial root **[Figure– 2.2, 2.3, 2.4, 2.5]**. The existing fracture line was then demonstrated to the patient and the need to extract the tooth to avoid further bone loss was also explained. The tooth was then extracted atraumatically and the fracture was visually identified **[Figure–2.6]**.

[III] DISCUSSION

Radiographic imaging is essential in diagnosis, treatment planning and follow-up in endodontics. The interpretation of an image can be confounded by a number of factors including the regional anatomy as well as superimposition of both the teeth and surrounding dento-alveolar structures. As a result of superimposition, periapical radiographs reveal only limited aspects, a two-dimensional view, of the true three-dimensional anatomy[7, 8].Additionally, there is often geometric distortion of the anatomical structures being imaged with conventional radiographic methods [9].These problems can be overcome by utilizing small- or limited-volume cone beam-computed

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tomography imaging techniques, which produce accurate 3-D images of the teeth and surrounding dento-alveolar structures [7, 8, 10].CBCT provides precise, essentially immediate and accurate 3-D radiographic images. As CBCT exposure incorporates the entire FOV, only one rotational sequence of the gantry is necessary to acquire enough data for image reconstruction. At the present time, CBCT is considered a complementary modality for specific applications rather than a replacement for 2-D imaging modalities [10].

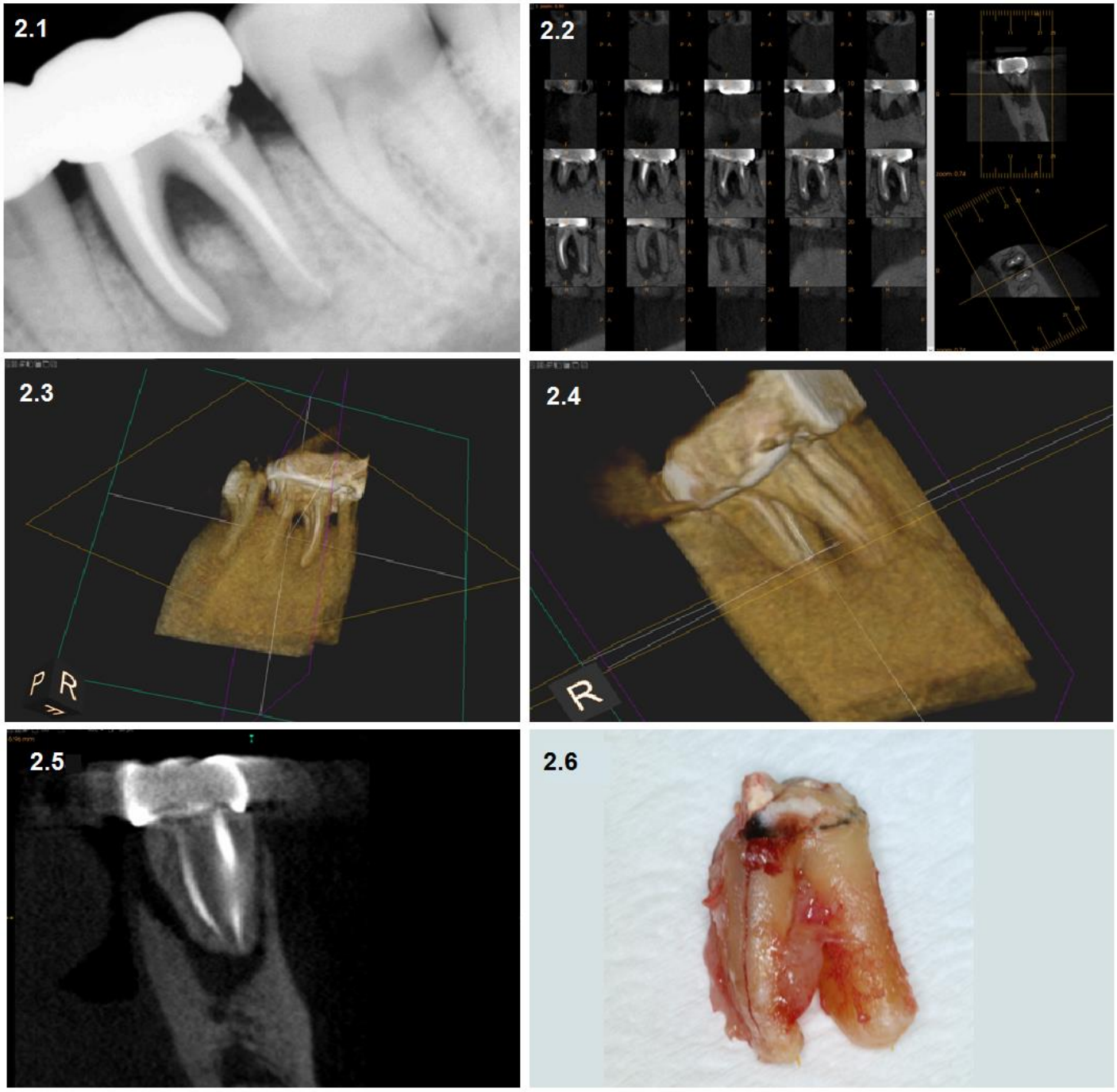

Fig: 2.1. Diagnostic radiograph; **Fig: 2.2.** CBCT Images showing sagittal / axial sections and fracture on mesial root; **Fig: 2.3. and 2.4.** CBCT Images showing oblique sections and fracture on mesial root; **Fig: 2.5.** CBCT Images showing oblique section and fracture on mesial root; **Fig: 2.6.** Fracture evident after extraction

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Identifying the presence of vertical root fractures (VRF) is often an endodontic challenge [5]. Radiographic features suggestive of VRF such as J-shaped and halo-shaped radiolucencies do not appear until significant bone destruction has occurred and similarly shaped radiolucencies may manifest themselves in cases of apical periodontitis not associated with VRF. The most common radiographic feature of VRF is a halo radiolucency located on the lateral face of the root and extending to the periapical area, contrasting with the periapical radiolucency that remains surrounding only the periapex which is typical of the endodontic disease [9]. Radiographic angular bone loss and periodontal radiolucency may also be present in the VRF.

Lusting et al, from their extensive study on the cases of VRF, concluded that, the bone resorption, surrounding the fracture line on the bone plate, is consequential to VRF and it is due to the chronic inflammatory process where the granulation tissue replaces the bone following a bacterial infection that was able to gain an easy passage through the fracture line bypassing the defense line of the epithelial attachment. The same authors propose, after a correct VRF diagnosis, the extraction of the tooth without delay to prevent a more severe resorption of the bone plate [11]. Four standard procedures have been described to allow a correct and definitive diagnosis of VRF: a visualization during an exploratory surgery, a visualization after tooth extraction, a radiographic visualization as long as there is a separation of fragments, [12] and a Cone Beam Computer Tomography visualization of the fracture.[13,14] Ex vivo studies have demonstrated that CBCT is more sensitive than conventional radiography in the detection of vertical fractures in roots .However, care should be taken when assessing root filled teeth for VRF using CBCT as scatter produced by the root filling or other high-density intraradicular material may incorrectly suggest the presence of a fracture [14].

The use of CBCT technology in clinical practice provides a number of potential advantages for maxillofacial imaging [15]:

- **X-ray beam limitation:** Reducing the size of the irradiated area by collimation of the primary x-ray beam to the area of interest minimizes the radiation dose. Most CBCT units can be adjusted to scan small regions for specific diagnostic tasks.
- **Image accuracy:** The volumetric data set comprises a 3D block of smaller cuboid structures, known as voxels, each representing a specific degree of x-ray absorption. The size of these voxels determines the resolution of the image. All CBCT units provide voxel resolutions that are isotropic — equal in all 3 dimensions. This produces sub-millimetre resolution (often exceeding the highest grade multi-slice CT) ranging from 0.4 mm to as low as 0.125 mm (Accuitomo).
- **Rapid scan time:** Because CBCT acquires all basis images in a single rotation, scan time is rapid (10–70 seconds) and comparable with that of medical spiral MDCT systems. Although faster scanning time usually means fewer basis images from which to reconstruct the volumetric data set, motion artifacts due to subject movement are reduced.
- **Dose reduction:** Published reports indicate that the effective dose of radiation (average range 36.9–50.3 microsievert [μSv]) is significantly reduced by up to 98% compared with "conventional" fan-beam CT systems (average range for mandible 1,320–3,324 μSv; average range for maxilla 1,031–1,420 μSv). This reduces the effective patient dose to approximately that of a film-based periapical survey of the dentition (13–100 μSv) or 4–15 times that of a single panoramic radiograph (2.9–11 μSv).

[IV] CONCLUTION

This paper highlights the potential uses of CBCT in the assessment and management of common endodontic problems like VRF. This three-dimensional imaging technique overcomes the limitations of conventional radiography and is a beneficial adjunct to the endodontist's armamentarium. Nevertheless, the effective radiation dose to patients when using CBCT is higher than in conventional intraoral radiography and any benefit to the patient of CBCT scans should outweigh any potential risks of the procedure, in order to be justified. The radiation should be as low as reasonably achievable (ALARA). The decision to prescribe CBCT scans in the management of endodontic problems must be made on a case-by-case basis and only when sufficient diagnostic information is not attainable from other diagnostic tests, be they clinical or radiographic.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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