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Mini Review

Evaluation of Vertical Root Fractures Using Cone-Beam Computed Tomography: A Mini Review

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Abstract

There are inadequate data or reviews to confirm the reliability and efficacy of cone-beam computed tomography (CBCT) in evaluation of vertical root fractures (VRFs). Thus, the aim of this mini review is to discover the reliability and efficacy of CBCT in the evaluation of VRFs and prove CBCT as a picturing addition in the different aspects of VRFs.

Keywords: Diagnosis; Vertical Root Fractures (VRFs); Cone-Beam Computed Tomography (CBCT); Teeth Fractures

Introduction

The inflammatory practicability can occur due to the vertical root fracture (VRF) which is the strictest form of longitudinal tooth fracture [1]. Therefore, it can lead to the resorption of bone and formation of granulation tissue [2]. The radiographic signs, clinical signs and symptoms of vertical root fractures (VRFs) can be different, indefinite, and take a similar appearance to periodontal lesions and periapical lesions of dental origin [3-5].

For the time being, a good diagnosis and evaluation of longitudinal root fractures can be obtained through the patient's dental history, by asking him about the symptoms, the nature and aspect of the pain, the presence of swelling, as well as the formation of deep and shallow periodontal pockets, in order to reach an accurate diagnosis [6].

The presence of different types of longitudinal root fractures makes the radiographic evaluation process somewhat difficult, in addition to its lack of clarity on the radiographs in many situations [7]. One of the disadvantages of traditional radiographs is that it can show only one third of the VRFs [8-10]. Using periapical displacement radiography (PDR), it is possible to discover the VRFs at the level of the X-ray beam [8,11] but in such situations, the anatomical details can appear on the radiographs indistinctly [12,13]. It is known that the traditional radiography shows radiographs in only two-dimensions (2D), those are the length and width without showing depth that needed for illustrating the anatomical structures and may be obtained using three-dimensionas (3D) radiographs [14]. Several three-dimensional radiography methods and devices such as conventional computed tomography (CT), cone-beam computed tomography (CBCT), and multi-detector computed tomography have been developed to overcome the limitations of using two-dimensional intraoral radiographs. Recently, a lot of research has been published to confirm the reliability and effectiveness of these devices. The results of many studies were in favor of CT devices, as they provided very great credibility and effectiveness in evaluating root fractures [3-10,15-18]. In any case, there are many disadvantages related to CT, including: the large amount of radiation exposure, the factitious product, and the space dissolution [16]. As a result, companies have produced CBCT devices to eliminate these disadvantages, and to be the perfect solution for diagnosing many complex cases [3].

Many researchers have explained the usefulness and importance of CBCT in the diagnosis and arrangement in identified as-

pects of dentoalveolar trauma, especially root fractures [19-22], luxation and/or displacement, and alveolar fracture [20].

Previous studies

Many *in vitro* studies have been conducted regarding the use of CBCT, and it has shown its credibility and great effectiveness for discovering cases similar to the VRFs [3,23]. There are special uses of CBCT for the evaluation of root fractures. Hassan., *et al*. [3] showed in their *in vitro* study to discover the VRFs, that there is an effect of root canal filling on fracture clarity, by evaluating radiographs taken using CBCT, and periapical radiography (PR). They concluded that the radiographs taken using CBCT are more reliable (0.86) than the PR (0.66) for discovering the VRFs. However, these images are less accurate in the root canals filled with opaque material. Moudi., *et al*. [24] concluded that the accuracy of CBCT does not reduce in the presence of root canals filled with gutta-percha, and therefore, CBCT has a great reliability. However, the presence of prefabricated posts may have a slight impact on the reliability of these devices, but without statistically significant differences (Figures 1,2). There is a contrast between the researches [25], especially with regard to the method of creating the root fracture, which can lead to the formation of many broken pieces, and this in turn can be discovered clinically within (0.2 mm-0.4 mm), but this is still controversial [3,10]. As a solution to that, root fractures can be formed by applying a large compressive load to the posts within roots [12,13]. Several machines have been used in these researches to test the development and extension of these fractures. The overall reliability of the CBCT for discovering two fracture patterns was 0.87 for the non-filled root canals, and 0.45 for the filled root canals. The evaluative reliability of the PR was 0.63 for the non-filled root canals, and 0.53 for the filled root canals [12,13].

Discoverability also reveals to be CBCT scanner-specific [26,27]. The observation of discoverer, as well as the parameters used and specified in each device, can affect the reliability of the CBCT [25,28,29].

The hardened beam resulting from the root canal filling reduces the reliability and effectiveness of complete or incomplete fractures discovery in the filled root canals (Figures 3-5) [5,30-32]. Finally, there are many errors in the evaluation of root fractures [33], which may result in unsuitable treatments of these cases [34]. Disarrange from radiopaque materials may be misinterpreted as fracture lines [3,34].

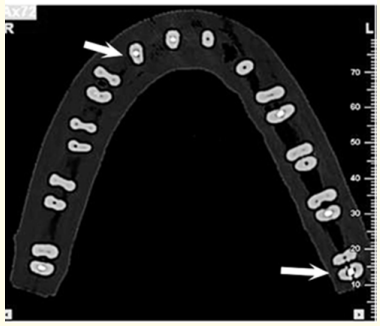

Figure 1: An axial CBCT picture shows the molar and premolar with VRF [24].

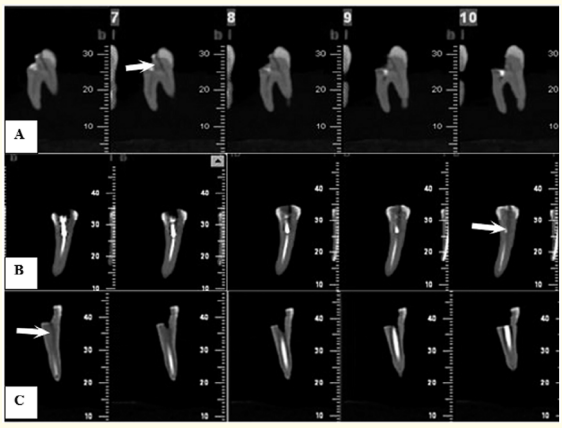

Figure 2: Cross sectional pictures of molar and premolar with VRF. (A). A molar with VRF. (B). A premolar with prefabricated post and gutta-percha has VRF. (C). A premolar with gutta-percha shows VRF [24].

Figure 3: CBCT, axial view; (Orange arrow): VRF in gutta-percha filled root canals [32].

Figure 4: CBCT, axial view; (Orange lines): VRF in non-filled root canals (without gutta-percha) [32].

Figure 5: Effect of hardened beam on producing artifacts similar to VRF in gutta-percha filled root canals (Orange lines) [32].

When using CBCT, the presence of the hardened beam reduces the evaluative result in the discovery of root fractures when the metallic posts are present [35]. In contrast, the fiber posts do not seem to interpose with the reliability and efficacy of CBCT for discovery of VRF [31,36].

On the evaluation of ninety-five root fractures, Wang., *et al*. [37] showed that the CBCT has greater reliability than RP. Nevertheless, The disarranging of rays due to the presence of radiopaque root canal filling material reduces the reliability of CBCT [37]. Long., *et al*. [38] suggested that the CBCT has a great evaluative result for discovery of tooth fractures, with a reported reliability and efficacy of 0.92 and 0.85, respectively.

Chavda., *et al*. [39] compared several radiographs taken using PR or CBCT of atraumatically extracted teeth to confirm the presence or absence of root fractures. They found a reliability of 0.16 for PR, and 0.27 for CBCT, and a great efficacy of 0.92 for PR and 0.83 for CBCT.

A systematic review confirmed the existence of contrast between the available results, as well as the bias of many researchers to the inefficacy of CBCT in discovery VRFs in filled root canals [40]. This is also consistent with systematic reviews in other researches [41,42].

Conclusion

There is inadequate proof to support the use of CBCT for discovery of VRF. Nevertheless, CBCT can be used when longitudinal root fractures are suspected with the patient's absence or fuzzy of signs and symptoms. So, CBCT can show that there is a periradicular bone resorption, and this is evidence of a VRF in the accompanying root.

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