Study on the application of CBCT in the diagnosis of chronic periapical periodontitis with different depth of periodontal pocket

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Abstract: Objective To investigate the application of conical beam CT(CBCT) in the diagnosis of VRF with chronic periapical inflammation and different depth of periodontal exploration. Methods 40 teeth with chronic periapical inflammation suspected of VRF in 39 patients were examined by X-ray apical film, CBCT and periodontal examination respectively. Diagnosis and statistical analysis were performed for each affected tooth by two specialists, and subgroup analysis was performed according to the influence of the depth of the peridental pocket on the diagnosis results of CBCT. Results The sensitivity, missed diagnosis rate and consistency rate of CBCT in the diagnosis of VRF were 78.8%, 21.2% and 82.5%, respectively, which were significantly different from that of X-ray root tip film (54.8%, 45.2% and 60.0%) ($P<0.05$). The sensitivity and missed diagnosis rate of CBCT in the deep periodontal pocket group (probing depth ≥5mm) were significantly different from those in the non-deep periodontal pocket group (probing depth <5mm) ($P<0.05$). Conclusion CBCT is superior to X-ray apical film in the diagnosis of VRF. The presence of deep periodontal pocket has influence on sensitivity and missed diagnosis rate.

Keywords: CBCT; Chronic Periapical Inflammation; Longitudinal Root Cleft; Periodontal Pocket Depth

Vertical Root Fracture (VRF), also known as vertical root fracture (VRF), is a noncaries disease of hard tissue of teeth with complex etiology. It refers to longitudinal fracture occurring in the root of teeth, which can spread to the tooth body, pulp and periodontal tissue, and can be clinically manifested as spontaneous pain, knock pain and deep periodontal pocket, etc. [1]. Therefore, the clinical symptoms of VRF teeth often lack specificity, and the site of onset is deep root, which increases the difficulty of early diagnosis [2]. X-ray apical radiography and conical beam CT (CBCT) are often used to assist the diagnosis of VRF in clinic. Previous studies [3] have shown that conical beam CT (CBCT) has the advantages of good image quality, non-trauma and high precision, and has higher sensitivity and accuracy in the diagnosis of VRF. However, it is not clear whether CBCT is different in the diagnosis of VRF with different depth of periodontal exploration. The purpose of this study was to investigate the application of conical beam CT(CBCT) in the diagnosis of VRF with chronic periapical inflammation and different depth of periodontal probe.

1. Object of study

Choose materials and methods from January 2021 to August 2022 in the First Affiliated Hospital of Bengbu Medical University of dental patients with suspected type VRF (variable refrigerant flowrate) as the research object. Inclusion criteria [4]: The chief complaint of the affected tooth has obvious clinical symptoms, and there is percussion or palpable pain; Deep isolated periodontal pockets (reduced bone mass) with one or more sinuses; X-ray apical film and CBCT were performed. The ability to track the final treatment outcome. Exclusion criteria: VRF can be directly observed in clinic; Patients with contraindications such as tooth extraction and periodontal flap exploration; No treatment or clinical absence; Into standard with a total of 39 cases, teeth 40, age 28 ~ 69, the average age of 51.3 years. The basic information of the patients is as follows (Table 1).

Table 1 Basic situation

	39 patients (40 teeth)
Year	
＜ 45 years old	13 (32.7%)
≥45 years old	27 (67.5%)
Gender	
Man	23 (57.5%)
Woman	17 (42.5%)
Tooth Position	
Dentes premolares	12 (30.0%)
Molar teeth	28 (70.0%)
Probing depth of periodontal pocket	
＜ 5mm	15 (37.5%)
≥5mm	25 (62.5%)

1.1 Research methods

X-ray affected tooth root, CBCT examination and periodontal examination, examination results by the physician, and a mouth of an oral cavity radiation image doctor diagnosis analysis together, and record the results.

1.1.1 Radiography of root tips

Instrument parameters:

the X-ray diagnostic criteria [5] root slices: periodontal membrane lacuna broadening; Tooth root linear projection; Periapical transmission area showed root fracture segments. Displacement of root cleft; The defect of root bifurcation was obvious.

1.1.2 CBCT inspection

Instrument parameters:

diagnostic criteria [6] of CBCT: observe the linear projection, parallel to the root fracture of periodontal membrane to root canal; Obvious displacement of root fracture lobes; Fracture images appear on at least two consecutive fault images and two coordinate planes; Eliminate artifacts from adjacent tissues, such as adjacent metals and dental filling materials.

1.1.3 VRF diagnostic gold Standard [7] :

Reference CBCT test results, the CBCT diagnosed as type VRF (variable refrigerant flowrate) and not to pull out the tooth, signed in patients after informed consent, for regular one-time root canal therapy and root canal treatment, again in oral microscope the existence of root crack, and to develop Asia periodontal flap surgical exploration or half tooth resection; For patients diagnosed with VRF who could not undergo endodontic treatment or had a poor prognosis, extraction, root-amputation, semi-resection, periapical curettage, etc., were also performed after signing the informed consent. VRF was observed during operation as the diagnostic criterion. For patients diagnosed as VRF negative by CBCT, if there are no symptoms after clinical follow-up after corresponding treatment, they are diagnosed as non-VRF.

1.1.4 Periodontal charting

Periodontal pocket depth was measured at six sites of buccal distal, buccal central, buccal mesial, lingual mesial, lingual central and lingual distal, respectively, and periodontal probing depth (PD) was recorded. The affected teeth were divided into two groups according to the depth of periodontal probing (PD < 5mm; PD≥5mm).

1.2 Accounting-based measures

According to the gold standard of VRF diagnosis, the diagnostic results of the two methods were compared, and the true positive, false positive, true negative and false negative were recorded. The sensitivity, specificity, missed diagnosis rate, Jorden index and agreement rate of the diagnosis of VRF by X-ray apical film and CBCT were calculated. Then, the affected teeth were grouped according to the depth of perio-

dontal pocket, and the CBCT diagnostic analysis was performed. The results were recorded and sensitivity, specificity, missed diagnosis rate, Jorden index and consistency rate were calculated. Sensitivity = true positive/(true positive + false negative), specificity = true negative/(true negative + false positive), missed diagnosis rate = false negative/(true positive + false negative), Jordan index = (sensitivity + specificity) -1, agreement rate = (true positive + true negative)/(true positive + true negative + false positive + false negative).

1.3 statistical analysis

By SPSS 25.0 statistical software for data analysis, data classification powerusageeffectiveness (%), using χ squared inspection and Fisher's exact probability method, inspection standard of alpha = 0.05, $P < 0.05$, the difference was statistically significant.

2. Results

2.1 Diagnostic results

The gold standard for diagnosis: Of 40 affected teeth, 33 were VRF positive and 7 were VRF negative. X-ray apical radiography showed that 19 affected teeth were diagnosed as VRF positive and 21 affected teeth were diagnosed as VRF negative. CBCT showed that 26 teeth were VRF positive and 14 were VRF negative. According to the depth of periodontal exploration, 15 affected teeth with PD < 5mm were grouped, of which 10 were confirmed VRF positive and 5 were confirmed VRF negative. CBCT diagnosis showed that 5 were VRF positive and 10 were negative. Of the 25 affected teeth with PD≥5mm, 23 were confirmed VRF positive and 2 VRF negative. CBCT diagnosis showed that 21 were VRF positive and 4 were VRF negative. The diagnosis results are shown in Table 2:

Table 2 Diagnostic results

diagnostic method	VRF（+）	VRF（-）	true positive	false positive	true negative	false negative
X-ray apical film	19	21	17	2	7	14
CBCT	26	14	26	0	7	7
CBCT(PD ＜ 5mm)	5	10	5	0	5	5
CBCT(PD≥5mm)	21	4	21	0	2	2

2.2 Diagnostic analysis

The sensitivity, specificity, consistency and Jorden index of CBCT in the diagnosis of VRF were 78.8%, 100%, 82.5% and 78.8%, respectively, which were higher than 54.8%, 77.8%, 60.0% and 32.6% of X-ray root tip film, and there were statistical differences in sensitivity and consistency. The missed diagnosis rate of CBCT was 21.2%, which was lower than 45.2% of X-ray root tip film, and the difference was statistically significant. The diagnosis results were analyzed as shown in Table 3. According to periodontal probing depth of diagnosis group, CBCT diagnosis of PD group 5 mm or higher sensitivity, consistent rate, about an index were 91.3%, 92.0%, 91.3% were greater than PD < 5 mm group, of which the sensitivity statistically difference; The missed diagnosis rate of CBCT in the PD≥5mm group was 8.7%, which was lower than 50.0% in the PD < 5mm group, and the difference was statistically significant, as shown in Table 3:

Table 3 X-ray and CBCT diagnostic results

	Sensitivity	Specificity	Rate of missed diagnosis	Concordance rate	Jordan index
Apical radiogram	54.8%	77.8%	45.2%	60.0%	32.6%
CBCT	78.8%	100%	21.2%	82.5%	78.8%
P 值	0.041*	0.475	0.041*	0.026*	-
CBCT PD ＜ 5mm	50.0%	100%	50.0%	66.7%	50.0%
CBCT PD≥5mm	91.3%	100%	8.7%	92.0%	91.3%
P 值	0.028*	-	0.028*	0.107	-

* : $P < 0.05$, the difference was statistically significant

3. Discussion

The longitudinal root crack can occur at any position of the tooth root and extend longitudinally to form a complete or incomplete crack. Once it occurs, the prognosis is poor and often requires complex treatment, with severe cases even removal [8]. VRF is more common in middle-aged and elderly people, and patients often have a history or habit of biting hard objects [9], and the incidence rate is highest in the first molar. Its clinical symptoms lack specificity and can be manifested as pulp, periapical and periodontal symptoms, which increases the difficulty in the diagnosis of VRF. Clinically, imaging methods such as X-ray apical film and CBCT are often used to assist in the diagnosis of VRF[10].

In this study, the diagnostic effect of CBCT and X-ray apical film on VRF was compared. The results showed that the diagnostic sensitivity and consistency rate of CBCT were higher than those of the latter, while the rate of missed diagnosis was lower, with statistical significance ($P < 0.05$). In the study, there were 2 cases of false positives in the diagnosis of X-ray apical film, and artifact interference from root canal contents was found after examination. The image of the X-ray apical film is a two-dimensional plane, which is difficult to display due to the influence of the overlapping image or artifact of the shooting Angle or adjacent tissues [11]. When the fractured lobes of VRF teeth do not shift significantly, it is also difficult to observe the fractured lines through the two-dimensional image, and the diagnosis cannot be made. Compared with X-ray apical film, CBCT can observe the fracture line from multiple angles and levels to avoid the occurrence of overlapping images. The imaging accuracy is high, and the broken line image is clearer; Doctors can freely choose the examination area and conduct three-dimensional analysis, which has higher flexibility [12].

Clinically, VRF is often accompanied by periodontal symptoms, including recurrent swelling of the gums and discharge of pus, persistent fistula, and deep and narrow periodontal pockets. Studies have shown [13] that periodontal tissue damage is more likely to be secondary to root fractures, and the periodontal tissue damage is aggravated with the extension of root fractures. In this study, suspected VRF cases were grouped according to different periodontal pocket depth to observe whether the diagnostic results of CBCT were different. The results showed that the diagnosis sensitivity of the deep periodontal pocket group was higher, the rate of missed diagnosis was lower, and the difference was statistically significant ($P < 0.05$). In the shallow periodontal pocket group, the diagnostic sensitivity was only 50.0%, while the rate of missed diagnosis was as high as 50%, which may be related to the degree of VRF lesions. Wen Lingying et al. believed that the destruction of periodontal bone was aggravated with the extension of fracture, so when the destruction of periodontal tissue was light, the degree of VRF was light, and the difficulty of CBCT diagnosis was increased. There are also studies [14-15] that long-term periodontal tissue inflammation and alveolar bone absorption will change the tooth stress point and form occlusal trauma, thus increasing the risk of VRF. VRF and periodontal tissue damage promote each other, periodontal damage will increase the probability of VRF, VRF will aggravate the periodontal tissue damage. Therefore, when the CBCT image of the affected tooth shows complex periodontal destruction, periapical bone destruction combined with vertical bone resorption, the occurrence of VRF can be considered [16]. For those with shallow periodontal pockets and light periodontal destruction, CBCT has low diagnostic sensitivity and can be combined with periodontal endoscopy to improve the diagnostic accuracy [17].

In this study, the diagnostic results of 39 patients and 40 teeth suspected to be VRF were statistically analyzed, and it was concluded that the diagnostic effect of CBCT was better than that of X-ray apical film. CBCT has different diagnostic results for VRF teeth with different periodontal probing depths: when $PD \geq 5mm$, the diagnostic sensitivity is higher; when $PD < 5mm$, it should be combined with other examination methods, such as periodontal endoscopy, to further diagnose and improve the diagnostic accuracy. In addition, this study also has some limitations, such as a small sample size.

To sum up, the diagnostic effect of CBCT is better than that of X-ray apical film. CBCT has different diagnostic results for VRF teeth with different periodontal probing depths: when $PD \geq 5mm$, the diagnostic sensitivity is higher; when $PD < 5mm$, it should be combined with other examination methods, such as periodontal endoscopy, to further diagnose and improve the diagnostic accuracy.

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