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ORIGINAL ARTICLE

Disappearance of Intracanal Medication: A Preliminary Clinical Finding from Retrospective Review of Teeth with Vertical Root Fracture

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ABSTRACT

Objective: The purpose of this article was to report the finding of the disappearance of intracanal medication as a supporting evidence of vertical root fracture (VRF) through non-surgical intervention.

Methods: A retrospective review of the dental records of patients seen by an endodontist in a private endodontic office from September 2013 to September 2016 was conducted by the same endodontist. Cases that met the inclusion and exclusion criteria were assigned as the subjects of this study, and data were extracted from their clinical and radiographic records. Patient's demographic features, pre-operative signs and symptoms, details of rendered clinical procedures, follow-up visits, clinical and radiographic findings were recorded. Seventeen teeth for which non-surgical exploratory re-treatment was initiated were included in this study. Calcium hydroxide-based intracanal medication was placed for 2-4 weeks. Obturation of the root canals was performed if the tooth showed improvement of clinical signs and symptoms. If not, a cone-beam computed tomography (CBCT) scan was proposed to the patient to rule out VRF.

Results: After the non-surgical re-treatment was initiated, 13 teeth showed improvement of clinical symptoms and the re-treatment was therefore completed. The remaining 4 teeth presented with unresolved clinical presentations (deep pocket, presence of sinus tract and/or tender to percussion and palpation). Four teeth showed partial disappearance of intracanal medication where VRF was confirmed using CBCT in 3 teeth and with a conventional periapical (PA) radiograph in 1 tooth.

Conclusion: The disappearance of intracanal medication during non-surgical intervention was often associated with VRF. Thus, this feature may serve as an aid in diagnosing VRF.

Keywords: Calcium hydroxide, disappearance, intracanal medication, vertical root fracture

HIGHLIGHTS

- Diagnosing vertical root fracture clinically is very challenging.
- The concurrent presence of halo- or J-shaped periradicular radiolucency, isolated deep pocket, sinus tract and tenderness on percussion and/or palpation is not pathognomonic of vertical root fracture.
- Disappearance of intracanal medication after the non-surgical re-treatment was initiated may be an indication of the presence of vertical root fracture.

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INTRODUCTION

According to American Association of Endodontists (AAE) classification, longitudinal tooth fractures can be divided into 5 categories: craze lines, cracked tooth, split tooth, fractured cusp and vertical root fracture (VRF) (1). VRF is defined as a complete or incomplete longitudinal fracture initiated from the root at any level, which extends coronally and is often directed bucco-lingually (1). The characteristic features of VRF, namely 'halo' or 'J' -shaped periradicular radiolucency, presence of sinus tract(s) and presence of an isolated deep pocket are not pathognomonic to VRF (2). Therefore, VRF cannot be diagnosed solely through these common clinical and radiographic manifestations. With the advancement of cone-beam computed tomography (CBCT), some studies have suggested that the use of CBCT could positively detect the presence of VRF (3). However, other studies have shown insufficient evidence to prove CBCT is accurate

enough in diagnosing VRF, particularly in the root canal-treated teeth (4, 5). With all the limitations of current clinical tools and tests, clinical diagnosis of VRF is undoubtedly one of the most challenging diagnosis.

In teeth with VRF, the fracture line could continuously irritate the surrounding periodontal tissue, thereby resulting in patients' persistent signs and symptoms on the tooth, such as discomfort on biting, persistent sinus tract, deep periodontal pocket and the presence of a periradicular radiolucency (6). However, as shown in various studies, persistent periradicular pathology can be caused by other factors as well, such as intraradicular infection, extraradicular infection, radicular cyst and foreign body reaction (7-10). Therefore, at what point should a clinician draw a line under this diagnostic challenge? If exploratory surgery is not feasible, VRF is often difficult, if not impossible, to diagnose through non-surgical means. Therefore, it would be very helpful if an additional feature could be identified as an aid in the diagnosis of VRF clinically under non-surgical intervention.

The purpose of this article was to report the finding of disappearance of intracanal medication as a supporting evidence of VRF through non-surgical intervention.

METHODS

This study was conducted through secondary analysis of existing anonymised database; therefore, based on World Medical Association Declaration of Helsinki ethics, a committee approval was not required. Informed consent was not required as radiograph images were used retrospectively.

A retrospective review of the dental records for patients seen by an endodontist in a private endodontic office from September 2013 until September 2016 was conducted by the same endodontist.

Patients' dental records identified in the database were screened for the eligibility of this study following the inclusion and exclusion criteria listed below:

Inclusion criteria:

1. Only permanent tooth was acceptable.
2. The pulpal diagnosis (according to AAE diagnostic terminology) of the tooth must be 'previously treated therapy'.
3. The tooth must be presented with either a J-shaped or halo-shaped periradicular radiolucency in periapical (PA) radiograph.
4. The tooth must be presented with at least one of the following signs and symptoms:
    a. Isolated deep pocket (>5 mm) when examined using Marquis Periodontal Probe
    b. Presence of sinus tract(s) where the gutta-percha traced the sinus tract to the periradicular lesion
    c. Tenderness to percussion and/or palpation

Exclusion criteria:

1. The tooth should be with no previously treated root canal(s).
2. The tooth presenting with an evidence of moderate to severe chronic periodontal disease where uniform deep pocket (>5 mm) was detected around the tooth.
3. Cases with incomplete or missing clinical and radiographic records were rejected.

Data extraction:

Cases that met the aforementioned criteria were assigned as the subjects for this study and relevant data were extracted from their clinical and radiographic records. Information, such as patient's demographic features, pre-operative signs and symptoms, details of rendered clinical procedures, follow-up visits and clinical and radiographic findings were recorded.

A total of 57 teeth from 53 patients were suspected to present with VRF based on the clinical and radiographic data. After a full dental record analysis, 40 teeth were excluded from this study because of the following reasons:

1. VRF was visible through clinical inspection.
2. VRF was visible in PA radiograph or CBCT images.
3. Patients refused exploratory treatment or decided to have dental extraction instead.
4. Patients did not return for exploratory treatment after the consultation.
5. Patients started the exploratory treatment but did not return for subsequent visit/treatment.
6. The tooth was diagnosed with poor prognosis due to extensive coronal crack(s) detected during the non-surgical re-treatment.

In all, only 17 teeth were included in this study where non-surgical exploratory treatment was initiated (Figure 1). An operating microscope was used throughout the exploratory procedure. All the teeth underwent the same non-surgical exploratory procedure, namely the removal of the previous root filling materials; full instrumentation of the canals to the working length; irrigation with 3% sodium hypochlorite (NaOCl), 17% EDTA and 2% chlorhexidine (CHX), all canals filled with calcium hydroxide-based paste (Calcipex II®, Nishika, Japan) as intracanal medication for at least 2-4 weeks (depending on the clinician's and the patients' availability for the next visit); and the accessed cavity temporised with glass-ionomer-based restoration (Fuji VII®, GC Corp, Japan). A PA radiograph would be taken immediately after the procedure to ensure the canals were filled with the intracanal medication.

When the patients returned for the second visit, clinical signs and symptoms including the depth of periodontal pockets, tenderness to palpation and/or percussion and the presence of patent sinus tract were re-examined. If the tooth showed resolution of clinical signs and symptoms, the canal(s) was/

were then obturated with a gutta-percha and resin-based sealer (AH-Plus®, Dentsply Maillefer, Switzerland) using a warm vertical compaction technique, and the accessed cavity was restored with composite restoration before sending the patient back to the referring dentist for cuspal protective restoration, if applicable. All patients were scheduled with 6-12 months follow-up.

If the tooth showed unresolved clinical sign(s) or symptom(s), a CBCT scan to rule out VRF was proposed to the patient. If patient consented to the CBCT scan, the remaining intracanal medication was flushed out with 3% NaOCl before the CBCT scan to minimise the risk of image artifacts. If the patient refused the CBCT scan, a replacement of new intracanal medication (Calcipex II®) was proposed to the patient for another 2-4 weeks to give the tooth a second chance to show clinical healing.

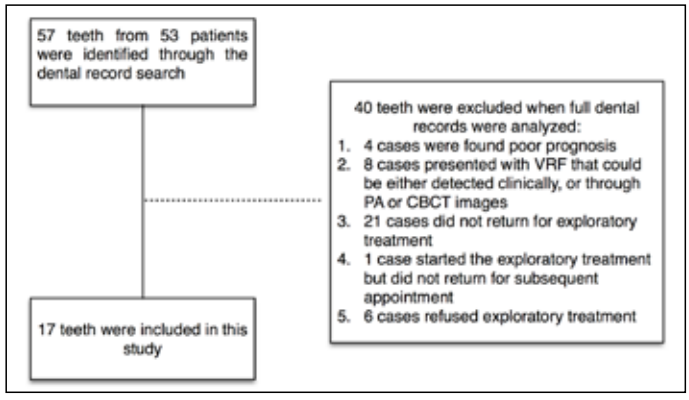

Figure 1. Flowchart of the patient selection procedure

Data were collected, tabulated and statistically analysed using Excel 2016 software (Microsoft Corporation, Redmond, WA, United States).

RESULTS

Table 1 summarises the baseline demographic and clinical presentations of patients included in this study. The mean age of the patients were 44.1 (standard deviation [SD], 12.3) years, with a range from 30-69 years. Thirteen of these teeth were tender to percussion or palpation, 15 had sinus tract present and 9 had pocketing >5 mm. Five (29.4%) teeth presented with a combination of any of these 2 symptoms, while 7 (41.2%) teeth presented with all 3 symptoms.

After the exploratory re-treatment with the placement of Calcipex II® as intracanal medication for about 2-4 weeks, 13 teeth showed improvement of clinical presentations, namely reduction of periodontal pockets, non-tenderness to palpation and percussion and resolution of sinus tract. All these teeth were then root filled or obturated under an operating microscope. Five teeth were followed up after 6 months or 1 year, and all 5 teeth showed signs of healing, as visualised radiographically, with the absence of clinical signs and symptoms.

The remaining 4 teeth showed unresolved clinical presentations (deep pocket, presence of sinus tract and/or tenderness to percussion and palpation). All 4 teeth showed partial disappearance of intracanal medication in a PA radiograph (with at least 2 weeks of intracanal dressing). VRF (complete or incomplete) was confirmed using a CBCT scan in 3 teeth where

TABLE 3. Baseline demographic and clinical presentations of patients included in this study

	Age, years	Gender (M = male, F = female)	Tooth #	Tenderness on percussion and/or palpation	Presence of sinus tract(s)	Periodontal pocket >5 mm	Resolution of clinical signs and symptoms after intracanal medication placement	Date of treatment completion (NA = not applicable)
1	34	F	12	YES	YES	NO	YES	Sep 2013
2	36	M	36	NO	YES	NO	YES	Feb 2016
3	40	F	47	NO	YES	NO	NO	NA
4	69	M	47	YES	YES	YES	YES	Sep 2015
5	63	M	36	YES	YES	NO	NO	NA
6	53	M	46	NO	YES	NO	YES	Dec 2013
7	53	M	46	YES	YES	NO	YES	Nov 2015
8	52	M	36	NO	YES	YES	YES	May 2015
9	64	M	47	YES	YES	YES	NO	NA
10	43	F	36	YES	YES	YES	YES	Apr 2015
11	35	F	36	YES	YES	YES	YES	Sep 2015
12	36	M	46	YES	YES	YES	YES	May 2015
13	30	F	46	YES	YES	NO	YES	Dec 2013
14	34	M	36	YES	YES	YES	YES	Jan 2016
15	37	M	46	YES	NO	NO	YES	May 2016
16	38	F	36	YES	NO	YES	NO	NA
17	33	F	36	YES	YES	YES	YES	Jul 2015

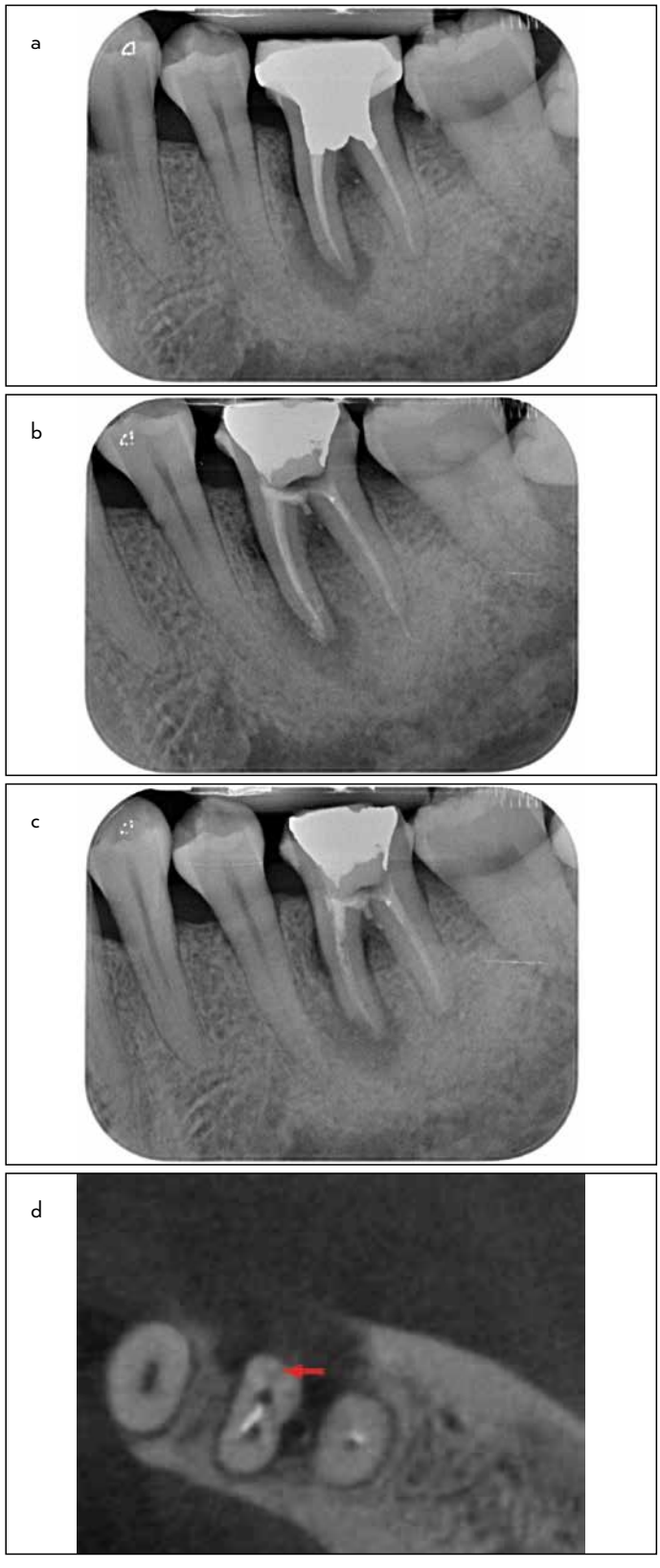

Figure 2. a-d. One case of unresolved clinical presentation after non-surgical exploratory re-treatment. Tooth #36: pre-operative PA radiograph (a); PA radiograph taken immediately after placement of intracanal medication (Calcipex II®). Furcal perforation was repaired with White MTA (ProRoot®, Dentsply, USA) (b); PA radiograph taken 4 weeks after intracanal medication placement: partial disappearance of intracanal medication noted at the middle third of the mesial root (c); and CBCT taken and showing fracture line (arrowed) at the lingual aspect of mesial root (d)

Figure 3. a-d. One case of unresolved clinical presentation after non-surgical exploratory re-treatment. Tooth #47: Pre-operative PA radiograph (a); PA radiograph taken immediately after placement of intracanal medication (Calcipex II®) (b); PA radiograph taken 2 weeks after intracanal medication placement: Partial disappearance of intracanal medication noted in the distal canal (c); and PA radiograph taken immediately after the replacement of intracanal medication: part of the medication is not confined in the root canal of the distal root noted (d)

fracture line was detected (Figures 2). In another tooth where no CBCT scan was performed because the patient refused the scan, a replacement of intracanal medication was done. When a PA radiograph was captured immediately after the replacement of the intracanal medication, part of the medication was found not confined in the canal, supporting the presence of VRF (Figure 3).

DISCUSSION

VRF is a type of longitudinal tooth fracture, which often originates from the root and extends coronally (1). Due to its location, VRF is often not detectable clinically without surgical intervention, unless the extension has involved the supragingival tooth structure. VRF often presents with certain clinical and radiographic manifestations, such as halo- or J-shaped periradicular radiolucency, tenderness on palpation and/or percussion, presence of sinus tract(s) and presence of an isolated deep pocket (3). However, Pradeep Kumar et al. (11) showed that not all VRF present with all the aforementioned features at the same time. In this current study, of those 4 cases with VRF, only 1 case manifested all the signs. Therefore, occasionally, the clinical and radiographic presentations of VRF could be confused with endodontic failure or periodontal disease with similar clinical and radiographic manifestations. Thus, clinicians should not depend solely on those features to arrive at a diagnosis for VRF. A VRF is often associated with poor prognosis. Extraction and replacement of the tooth with implant is nowadays the preferred options for many clinicians. Therefore, a wrong diagnosis might sacrifice a tooth unnecessarily.

In this study, 17 teeth with the typical clinical and radiographic characteristics of VRF were included, 13 teeth showed improvement of clinical signs and symptoms and therefore re-treatment was completed. After completion of the root canal re-treatment, only 5 patients (5 teeth) returned for the scheduled 6 month or 1-year follow-up visit. All 5 teeth showed healing, as visualised radiographically, and the absence of clinical signs and symptoms. Despite the low follow-up rate (38.5%), this finding clearly showed that a tooth might not necessarily present with VRF despite the similarity in clinical and radiographic features.

PA radiography is a 2-dimension conventional imaging, which plays a vital role in endodontic diagnosis. A PA radiograph has a high specificity in the detection of VRF, but its sensitivity is rather low (12). Therefore, PA radiograph is not very reliable in detecting VRF. CBCT however is a 3-dimension radiograph that provides more information on the dental structure compared to conventional radiography. CBCT is often used to detect VRF because studies have proven its accuracy in diagnosing VRF (12, 13). Edlund et al. (13) showed that the sensitivity and specificity of CBCT in detecting VRF in root-treated teeth was 88% and 75%, respectively. Despite its high sensitivity, the comparatively low specificity of CBCT creates a higher chance of over-diagnosing the presence of VRF. This is supported by a recent systematic review where the authors found that there was no strong evidence to support the accuracy of CBCT in detecting VRF in root-treated teeth (4). Therefore, the CBCT images should be interpreted cautiously, and pure dependence on CBCT in the diagnosis of VRF might sacrifice a tooth unnecessarily.

The width of the fracture line on a root plays a vital role in VRF detection using CBCT (14). If the size of the fracture line is smaller than the voxel size of CBCT, the fracture line would not be visible in the CBCT images (14). Also, the presence of the root filling or metal post in the canal could give rise to image artifacts that would either mask the presence of VRF or mimic the features of VRF (15). Therefore, pre-operative CBCT scan might not be highly accurate in detecting VRF. Hence, one should consider a CBCT scan after the root filling and post are removed to avoid unnecessary artifacts. In this study, CBCT was captured after the root filling was removed in 3 out of the 4 cases where VRF was suspected. Indeed, VRF was detected for all cases through CBCT imaging.

Unfortunately, the CBCT machine is an expensive investment. Therefore, not all dentists, including endodontists could afford a CBCT in their office. Moreover, some patients might not be able to pay for the fee charged for CBCT scan, as the cost for the scan could be 10 times higher than a conventional PA radiograph. For these reasons, not all clinicians would have the luxury of diagnosing VRF using CBCT. Thus, it would be helpful if there are other less expensive means for the clinicians to diagnose VRF. With the lack of clinical tools, clinicians often struggle in making the right diagnosis and proposing the appropriate treatment options or treatment plan. As suggested by some authors, surgical exploratory procedure could be done to rule out the presence of VRF (16-18). However, this might not always be feasible depending on the location of the fracture line, the tooth involved and if buccal cortical bone is present. For example, in a posterior tooth with apically located VRF where thick intact buccal cortical plate is present or with lingually located VRF, surgical exploratory procedure could be extremely difficult, if not impossible.

In this study, a retrospective review was done on the teeth with suspected VRF based on the clinical and radiographic presentations. Non-surgical re-treatment was initiated in those teeth and resolution of clinical signs and symptoms were observed in 13 out of 17 teeth which were included in this study, whereas the remaining 4 teeth presented with persistent clinical signs and symptoms. A very interesting observation was found in this process, wherein all the teeth with the disappearance of calcium hydroxide-based paste (Calcipex II®) as intracanal medication (which was detected radiographically after at least 2 weeks of intracanal dressing) was often associated with persistent clinical signs and symptoms. The disappearance of intracanal medication was previously reported in cases with open apex

and cases with severe external root resorptions because there is a portal of exit for the intracanal medication (19, 20). There is another case report asserting the resorption of the intracanal medication in primary teeth months after the medication was first placed (21). However, that study did not consider the possibility of bodily root resorption by the erupting permanent teeth. To date, to the best of the author's knowledge, there is no report or study suggesting that VRF can lead to the disappearance of intracanal medication. Nevertheless, it seems logical, although yet to be proven scientifically, that the crack or fracture line could serve as the portal of exit for the intracanal medication and thus its disappearance.

The word 'disappearance' as used in the title of this study may sound non-professional as compared to the word 'resorption' that is preferred by some authors (21). However, 'resorption' by definition is the loss of substance by lysis or by physiologic or pathologic means (22). In cases described in this study, the missing of the intracanal medication, as speculated, is the exit of the substance through the fracture line to the periradicular region before being resorbed. Therefore, technically, the intracanal medication was not resorbed in the canal; and thus using the word 'resorption' might cause confusion to the readers.

Although in this study the author cannot fully rule out other possibilities of intracanal medication disappearance, VRF appears to logically explain this occurrence. Of all the 4 teeth with partial disappearance of intracanal medication, 3 were confirmed with VRF by detection through CBCT images. However, the author was unable to confirm the presence of VRF in another case because the patient refused a CBCT scan and surgical exploratory treatment to rule out VRF. However, based on the PA radiograph taken immediately after the replacement of intracanal medication, where part of the medication was not confined in the root canal, this finding itself is a strong evidence of VRF.

There are some limitations of the preliminary clinical finding in this study. Despite the association between the disappearance of intracanal medication and VRF that we found in this study, there are some unknown dominations that might affect this phenomenon, such as the size of the fracture line, duration needed for intracanal medication to show significant disappearance in a PA radiograph and if different types/brands of intracanal medication could show the similar result. Also, the small sample size in this study has restricted the generalizability and clinical applications of the finding. Therefore, further studies with a bigger sample size are needed to prove the validity of this study. However, if it is confirmed that the disappearance of intracanal medication is associated with VRF, perhaps this manifestation can serve as an alternative in diagnosing VRF. Consequently, clinicians without CBCT machine in their office, or patients who cannot afford the CBCT scan could have an alternative option, if applicable to all clinicians, in verifying if the tooth is salvageable.

CONCLUSION

In conclusion, within the limitation of this study, it was speculated that the disappearance of intracanal medication during non-surgical intervention was associated with VRF. Thus, this feature may serve as an aid in diagnosing VRF. However, further studies will be needed to testify the validity of this speculation.

Ethics Committee Approval: This study has been conducted in full accordance with the World Medical Association Declaration of Helsinki.
Peer-review: Externally peer-reviewed.
Conflict of Interest: No conflict of interest was declared by the author.
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