

Pathognomonic Combination of Clinical Signs for Diagnosis of Vertical Root Fracture: Systematic Review of the Literature

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Abstract: Introduction: Vertical root fracture (VRF) is a root-canal treatment complication and is a major reason for extraction of the root-canal-treated teeth. The diagnosis of VRF can be complicated because of absence of specific signs, symptoms, and radiographic features. A combination that includes the presence of deep pocket and a sinus tract in root-canal-treated tooth was proposed as a pathognomonic for VRF. The purpose of this study was to systematically search and evaluate the literature regarding the correlation between the clinical signs considered pathognomonic for the diagnosis of VRF, with the actual reference standard by means of systematic review of the literature. Methods: A systematic search of the literature was performed to identify studies evaluating the clinical signs considered pathognomonic for the diagnosis of VRF. The following databases were searched: Medline (PubMed), Scopus, and Cochrane Central. The identified studies were subjected to strict inclusion and exclusion criteria. Results: Initially, 1141 possible relevant articles were identified. After title and abstract screening, 40 articles were subjected to a full-text evaluation, 3 articles met the inclusion criteria and contained data regarding the prevalence of the pathognomonic combination in VRF's-confirmed teeth. The presence of deep pocket and a sinus tract in endodontically treated teeth was found in 28% of the cases. Conclusion: To date, the current scientific knowledge regarding the correlation between the clinical symptoms considered pathognomonic for VRF diagnosis in the root-canal-treated tooth and the actual reference standard is quite low.

Keywords: vertical root fractures; endodontics



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1. Introduction

Vertical root fracture (VRF) is a fracture which originates in the root of a tooth and can propagate either coronally or apically. Vertical root fracture (VRF) is a root-canal treatment complication [1] and is considered the third leading cause for extraction among the root-canal-treated teeth after caries and periodontal disease. The prevalence of extracted vertically fractured teeth among those who were endodontically treated is between 11% to 20% [2–4].

This complication of the endodontically treated tooth is often frustrating, both for the dentist and the patient alike. Firstly, because often it is difficult to diagnose this complication accurately and in a timely manner, and secondly, because in most cases the tooth or the involved root has to be extracted. In some cases, it is possible to save the tooth or the involved root during endodontic surgery [5,6].

The etiology of this complication is multifactorial and consists of predisposing factors and a variety of operating factors. For this reason, it is hard to prevent this complication, resulting in both a destructive inflammatory process in the supporting tissues and bone loss, which at times can spread easily. This inflammatory process can be looked at as an endodontic-periodontal entity [7].

An incorrect and/or delayed diagnosis of the vertical root fracture usually leads to more bone loss and to inappropriate management [8]. As long as the infection stays in the

supporting tissues, more bone is resorbed. Therefore, there is the need for not only timely diagnosis but meticulous clinical and radiographic examination, coupled with the highly important relevant information of the tooth history.

The largest clinical diagnosis issue is that these chronic, longitudinal root fractures often imitate other dental pathological conditions [9]. The signs and symptoms in these cases, such as acute apical periodontitis, dull pain or pain on mastication, tooth mobility, presence of a sinus tract, deep probing defects (a periodontal pocket), a periodontal-type abscess or periapical and lateral radiolucencies, are often similar to those found in cases of endodontic treatment failure or imitate periodontal disease [1,8,10–13].

Based on the literature available until 2008, the AAE Communiqué [14] has published a statement declaring that there is a combination of signs and symptoms that, when present in a specific tooth, is considered “pathognomonic” for the presence of a VRF. This can be called “the pathognomonic combination”. These entities include a presence of deep pocket and a sinus tract in root-canal-treated teeth [15].

The aim of the present study was to evaluate the correlation between the clinical signs considered pathognomonic for the diagnosis of VRF and the actual reference standard, through systematic review of the literature.

2. Materials and Methods

2.1. Criteria for Considering Studies for This Review

The studies included patients with confirmed VRF’s (target condition) in root-canal-treated teeth according to the following criteria:

1. Clinical studies that evaluated the diagnosis of VRF with the following definition: complete or incomplete fracture initiated at any level from the root [7].
2. Only endodontically treated teeth were included.
3. Cases presenting the combination of deep periodontal pocket and presence of sinus tract.
4. VRF confirmation method was similar to one of the defined reference standards: The VRF was confirmed during surgical flap procedure, the VRF was confirmed following tooth extraction, or the VRF was identified radiographically as a clearly discernable separation of segments of fractured roots.

Exclusion criteria:

1. Case reports.
2. Reviews.
3. In vitro studies.
4. Studies of teeth without root-canal treatment.
5. Studies which did not include detailed data regarding the clinical signs and symptoms of the evaluated teeth.

2.2. Search Methods for Identification of Studies

The following electronic databases were searched: MEDLINE using PubMed search engine (<http://www.ncbi.nlm.nih.gov/sites/pubmed> (accessed on 4 July 2021)), Scopus (<http://www.scopus.com> (accessed on 18 April 2021)), and the Cochrane library (<https://www.cochranelibrary.com/central> (accessed on 10 July 2021)).

The following key words were used for an initial search through MEDLINE: “vertical root fracture OR “longitudinal root fracture” OR “root originated fracture”, and we applied Entrez PubMed limits to “humans” and “English”.

MeSH received the following: (vertical[All Fields] AND (“plant roots”[MeSH Terms] OR (“plant”[All Fields] AND “roots”[All Fields]) OR “plant roots”[All Fields] OR “root”[All Fields]) AND (“fractures, bone”[MeSH Terms] OR (“fractures”[All Fields] AND “bone”[All Fields]) OR “bone fractures”[All Fields] OR “fracture”[All Fields])) OR (longitudinal[All Fields] AND (“plant roots”[MeSH Terms] OR (“plant”[All Fields] AND “roots”[All Fields]) OR “plant roots”[All Fields] OR “root”[All Fields]) AND (“fractures, bone”[MeSH Terms] OR (“fractures”[All Fields] AND “bone”[All Fields]) OR “bone fractures”[All Fields] OR

“fracture”[All Fields])) NOT (“animals”[MeSH:noexp] NOT “humans”[MeSH Terms]) AND (“humans”[MeSH Terms] AND English[lang]).

Related articles, literature reviews that appeared in the MEDLINE, and textbook chapters were evaluated, and their reference lists were manually checked using backward and forward searches.

2.3. Data Collection and Analysis

Selection of Studies

The articles were initially evaluated for relevance based on their titles and abstracts, by two observers independently (T.G and D.L). Possibly relevant studies were submitted to a full-text evaluation. The full texts of the studies were obtained and reviewed for suitability by the two observers. Cases of discrepancy were debated together until agreement was achieved. Eventually, the identified suitable articles were subjected to data extraction and analysis.

2.4. Data Extraction

Data were to be extracted by two authors independently using properly designed data extraction forms. Cases of disagreement were to be subject to combined evaluation until an agreement was reached. For each trial, two types of data were to be recorded.

Study methodological characteristics including authors and date of publication; study design; sample size; demographic, radiographic and clinical details of the subjects.

3. Results

Systematic Literature Search

The search covered all articles published between 1971 and June 2021. After duplicates were removed, 953 articles were identified (Figure 1). Finally, a total of three articles that contained data regarding the number of the root-canal-treated teeth with confirmed VRF that presented the combination of deep periodontal pocket and presence of sinus tract were included for the systematic review [8–10].

The identified suitable articles were subjected to data extraction as presented in Table 1. In total, 351 cases were described in the included studies.

Table 1. The characteristics of the included studies.

Study	Number of Cases	Gender	Tooth Type	Radiographic Appearance	Sinus Tract	Deep Periodontal Pocket	Pathognomonic Combination	VRF Confirmation
Tamse et al., 1999	92		Anterior-13 Posterior-79	Halo-36	32	62	22	Extraction
Karygianni et al., 2014	200	Male-69 Female-123	Anterior-53 Posterior-147		39	82	53	Extraction
See et al., 2019	59	Male-26 Female-33		Halo-31	37	35	25	Surgical exploration

Gender was available for 251 VRF cases [8,9]. There were 156 women (62%) and 95 men (38%).

The tooth location was available for 292 VRF cases [8–10] there were more posterior teeth 226 (77%) than anterior 66 (23%).

Radiographic appearance of “halo” was found in 67 VRF cases (44%) out of 151 cases available [9,10].

The presence of deep periodontal pockets was reported in 179 of 351 VRF cases (51%) [8–10].

The presence of sinus tract was reported in 161 of 351 VRF cases (46%) [8–10].

The combination of the presence of deep periodontal pocket and sinus tract was reported in 100 of 351 VRF cases (28%) [8–10].

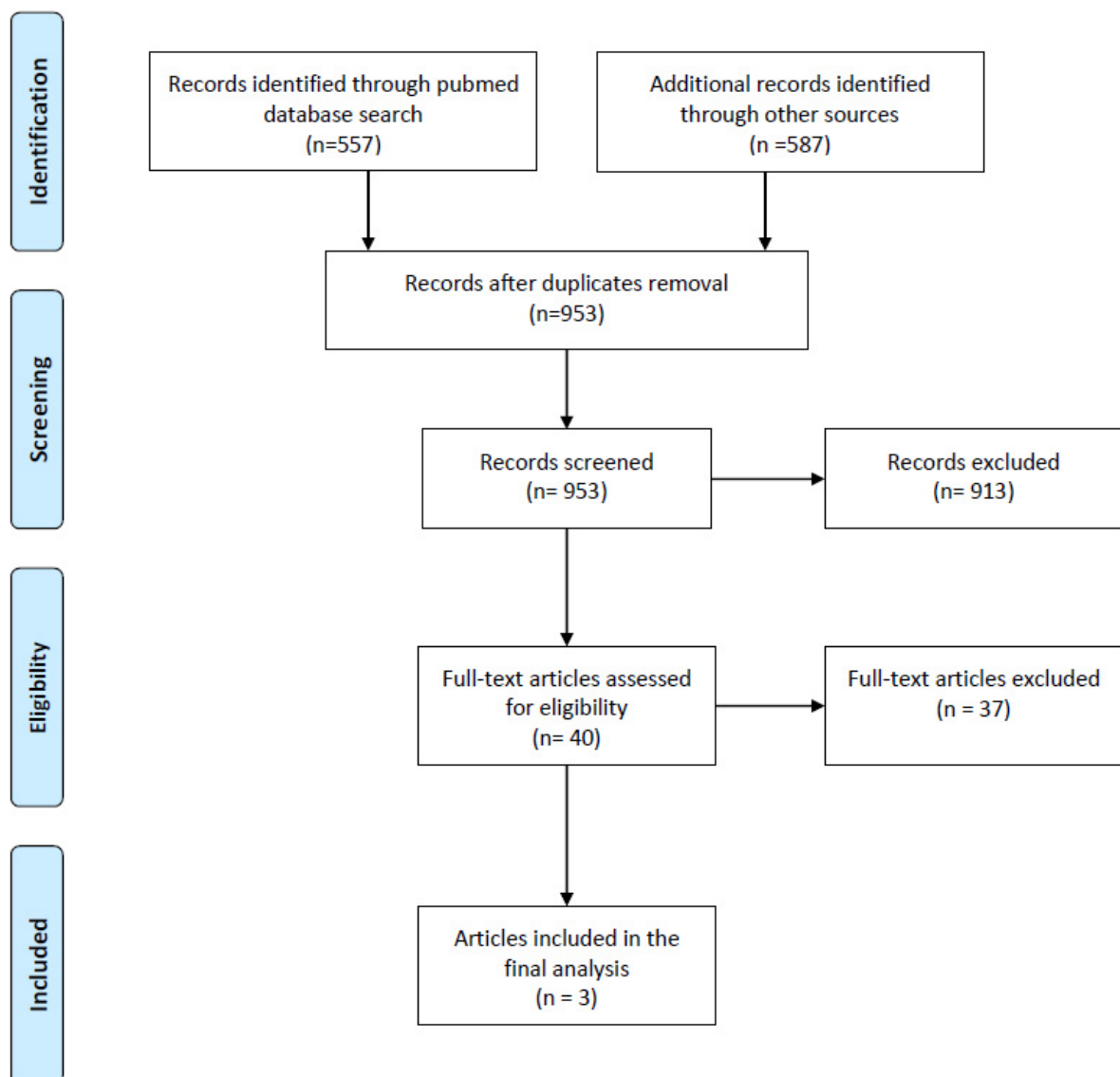


Figure 1. A flow chart of the systematic search process.

4. Discussion

The aim of the present study was to evaluate the correlation between the clinical signs considered pathognomonic for the diagnosis of VRF and the actual reference standard, using the principles of evidence-based dentistry by means of systematic review of the literature.

The fundamental principle of evidence-based dentistry, is the usage of the best available clinical evidence to support the practitioner's everyday practice [16–18].

Evidence-based dentistry is based on the process of methodically finding, evaluating, and using investigative findings as the basis for clinical decision making [14,16–22].

In the present systematic review, the methodological quality of the included studies was appraised, and risk of bias was calculated for each study according to Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy parameters [23]. All included studies were graded to have a low risk of bias.

Various studies regarding the diagnosis of VRF and the clinical and radiographic features of vertically root-fractured teeth have been published. However, their study design, VRF definition, VRF confirmation methods, and assessed clinical and radiographic data have been highly variable, which results in the publication of varying and unclear results [1]. In

the present systematic review, we included studies that used VRF confirmation methods in agreement with the one of the defined reference standards: The VRF being confirmed during surgical procedure, the VRF being confirmed following tooth extraction, or the VRF being identified radiographically as a distinctly discernable separation of segments of fracture.

In the current study, a detailed literature search of several electronic databases was conducted. To overcome the heterogeneity of data, strict inclusion and exclusion criteria were applied to the identified studies. Only three studies fulfilled the criteria [8–10].

Meta-analysis was not preformed because of the small number of the articles.

It has been reported in the literature that deep periodontal pocket was found in VRF clinical studies at a rate between 23.9% to 100% [8,9,13,15,24–26]. In the present study, it was found in 51% of the cases.

Another clinical sign usually associated with VRF is the presence of sinus tract. From previous studies, sinus tracts associated with VRF, different to those that result from a typical chronic periapical abscess, were not typically located in the apical area, but rather located several millimeters below the gingival margin [10]. In our systematic review, sinus tract was found in 46% of the cases, and there were no data regarding the position of the sinus tract [8–10].

In 2008, the AAE has published a statement saying that when there is a combination of deep pocket and a sinus tract in endodontically treated tooth it is considered “pathognomonic” for the presence of a VRF. [20] The three articles which were included in our systematic review showed that the “pathognomonic combination” was found only in 28% of the VRF-confirmed teeth. The real prevalence of this combination might be different, and there are many more articles observing the clinical signs and symptoms of VRF-confirmed teeth which detail the finding of deep pocket and a sinus tract, but did not address the cases in which they appear together.

The lucent “halo” radiographic appearance, which is associated with VRF [27], was found in 44% of the cases in this study.

This radiographic heterogeneity could be clarified by the time that has passed until VRF was diagnosed, which affects the amount and pattern of bone destruction [12,28].

Cone beam CT (CBCT) has been suggested in some studies as a preferable method to diagnose VRF compared with periapical radiographs. However, there is still lacking evidence to suggest the advantage of CBCT over conventional radiographs to detect VRF [23].

Posterior teeth seem to be more prone to VRF, with mandibular molars and maxillary premolars being more susceptible to VRF than any other teeth [29]. This is in corroboration with our study: there were more posterior teeth (77%) than anterior (23%).

The anatomy of the root displaying a narrow mesiodistal diameter and a thin and flat morphology may be a predisposing factor for VRF [10].

In our study, posterior teeth comprised 77% of the cases which is consistent with other studies [24,25,30–35]. Earlier studies have reported that VRF to be found significantly more in females than in males [24–26,32,34,35]. In our systematic review, 62% of the cases were women. Gender may not effect VRF formation in the root-canal-treated group because root-canal treatment or post construction may alter the tooth structure. Hence, the occurrence of VRF in root-canal-treated teeth may not be closely related to gender [26,36].

Currently, there is no scientific evidence suggesting the availability of a safe, precise technique for the diagnosis of VRF. Although there have been technological developments in imaging investigations such as CBCT, the diagnosis of a VRF continues to be a clinical challenge. If the clinician is facing a dilemma in attaining accurate diagnosis of a vertical root fracture when the “pathognomonic diagnosis” is not present, an explorative surgical procedure can be recommended for either final VRF diagnosis or a surgical procedure to save the tooth [37].

In conclusion, for now, the current scientific data concerning the correlation between the clinical symptoms considered pathognomonic for VRF diagnosis in the endodontically

treated tooth, and the actual reference standard, is quite low, and is based on only three publications [8–10].

Thus, it is highly recommended that the practitioner conducts a careful, thorough clinical approach for the diagnosis of a vertically fractured, endodontically treated tooth, looking for the typical signs, symptoms and radiographic features. Naturally, more research studies should be done on this topic.

5. Summary

Vertical root fracture in a root-canal-treated tooth is a complication of root-canal therapy and is at times difficult to diagnose due to variety of reasons. While the combination of sinus tract and a deep periodontal pocket in such teeth is considered pathognomonic for clinical diagnosis, in most cases this combination does not exist.

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Abbreviation

VRF—Vertical root fracture.

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