



Implant-associated Vertical Root Fracture in Adjacent Endodontically Treated Teeth: A Case Series and Systematic Review

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Abstract

Introduction: This study aimed to report a possible effect of the presence of an adjacent implant on the development of a vertical root fracture (VRF) in endodontically treated teeth. **Methods:** A series of 8 cases in 7 patients with teeth diagnosed with VRF after the placement of implants in the adjacent area is described and analyzed. In addition, a comprehensive literature search with strict inclusion and exclusion criteria was undertaken to identify additional clinical studies that assessed this clinical scenario. **Results:** The case series analysis revealed that the time from implant placement to the diagnosis of VRF was between 5 and 28 months (average = 11 months). The majority of cases occurred in female patients who received 2 or more implants. Six of the 7 patients were older than 40 years, with an average age of 54 years. The majority of teeth with VRF were premolar or mandibular molar teeth (6/8 teeth). All fractured teeth had been restored with a crown and had a post present, and the quality of the root canal filling was determined to be adequate. The systematic review revealed that implant-associated VRF has not been investigated or reported in the literature yet. **Conclusions:** Based on a systematic review of the literature, this case series, although limited in its extent, is the first clinical report of a possible serious adverse event of implant-associated VRF in adjacent endodontically treated teeth. Additional clinical studies are indicated to shed light on this potential phenomenon. (*J Endod* 2016;42:948–952)

Key Words

Endodontically treated teeth, implant, vertical root fracture

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Tooth replacement with an oral implant may be indicated because of tooth loss as a result of trauma, dental caries, periodontal disease, and in case of a congenitally missing tooth. The missing tooth space may be restored with an implant when it is surrounded with healthy teeth or with intact prosthetic reconstruction of the neighboring teeth (1).

The retention of implants is directly related to their osseointegration (2), which is defined as close contact between the bone and implant (3). The most significant difference between natural teeth and implants is the periodontal ligament (PDL), which surrounds only natural teeth, and the unique characteristics of this ligament (4). The PDL enables stress distribution, mobility, occlusal trauma tolerance, and proprioception, thus acting as a modulator of excessive occlusal forces. This modulation mechanism is missing in osseointegrated implants, potentially exposing them to occlusal overload (4).

Although the exact effects of occlusal overload on implants are not fully clarified (5, 6), it has been suggested that implant occlusion should be designed not only according to conventional occlusal schemes but also from the standpoint of reducing overloading factors (7). However, when the occlusion of an implant is altered in order to prevent occlusal overload to the implant, it may change the force distributed to the adjacent natural teeth (8, 9).

Vertical root fractures (VRFs) may initiate from the root at any level (10–12). Under occlusal loads, endodontically treated teeth showed reduced resistance to fracture. However, the exact occlusal relationship between implants and adjacent endodontically treated teeth is not fully elucidated (13–15), and the ensuing possible risk of VRF of the natural teeth is unknown.

Evidence-based dentistry is an approach to oral health care that integrates the best available clinical evidence to support a practitioner's clinical expertise for each patient's treatment needs and preferences (16–18). It is based on the process of systematically finding, appraising, and using research findings as the basis for clinical decision making. Systematic reviews constitute the basis for practicing evidence-based dentistry (15, 17, 18). The application of evidence-based principles in dentistry should result in a reduction of errors in the clinical decision-making process (16–19). Thus, an evidence-based review of the available literature regarding the possible phenomenon of implant-associated VRF is important.

It may be hypothesized that the incidence of VRFs is higher in endodontically treated teeth adjacent to implants ("implant-associated VRF"), especially if the occlusal loads were intentionally decreased from that implant while an ensuing increase of occlusal load was distributed to the adjacent natural teeth.

In this study, a series of 8 cases of implant-associated VRFs is described and analyzed. In addition, a systematic review of the literature was performed, aiming to identify and analyze the currently available evidence regarding implant-associated VRFs.

Materials and Methods

The inclusion criteria for the selected cases and studies in the systematic review were as follows:

1. The implants were placed adjacent to endodontically treated teeth with no periradicular pathology.

- There were occlusal contacts between the endodontically treated teeth and the opposing teeth.
- The VRF was diagnosed after implant loading based on a clinical and radiographic evaluation.
- The VRF was confirmed by microscopic evaluation of the extracted tooth (10).

Reviews, expert opinions, and studies not relevant to the topic of this study were excluded from the systematic literature search.

Search Methods for the Identification of Studies for the Systematic Review

The following electronic databases were searched: MEDLINE using the PubMed search engine (<http://www.ncbi.nlm.nih.gov/sites/pubmed>) and Scopus (<http://www.scopus.com>).

The following key words were used for an initial search through MEDLINE: ((vertical root fracture) OR cracked tooth) AND implant. The Medical Subject Heading (MeSH) received was as follows: ((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 (“cracked tooth syndrome”[MeSH Terms] OR (“cracked”[All Fields] AND “tooth”[All Fields] AND “syndrome”[All Fields]) OR “cracked tooth syndrome”[All Fields] OR (“cracked”[All Fields] AND “tooth”[All Fields]) OR “cracked tooth”[All Fields])) AND implant[All Fields].

An additional search was then performed through the Scopus database using the same key words. The MeSH received for Scopus was as follows: (“vertical root fracture” OR “cracked tooth”) AND (implant) AND NOT INDEX(medline) AND (LIMIT-TO(DOCTYPE,“ar”)) AND (LIMIT-TO(SUBJAREA,“DENT”)).

Related literature reviews that appeared in the MEDLINE search engine were manually evaluated, and their reference lists were searched for possible eligible articles that were not yet identified by the electronic search.

Data Collection and Analysis for the Systematic Review

The identified articles in the literature search were initially evaluated for relevance on the basis of their titles and abstracts by 2 observers independently (I.T. and E.R.). Possibly relevant studies were planned to be submitted to a full-text evaluation based on the inclusion criteria for selected cases and studies in the systematic review. Eventually, the identified eligible articles were planned to be subjected to data extraction and analysis.

The identified relevant cases were planned to be analyzed for the patients' demographics and parameters of the implants and of the associated teeth with VRFs. The studies were also planned to be evaluated regarding their methodologic quality and their heterogeneity for the possibility of a meta-analysis of their results.

Data Collection and Analysis for the Case Series

Data from a series of 7 patients referred for implant treatment in a private practice limited to periodontics between 2010 and 2014 with 8 cases of confirmed VRFs in adjacent endodontically treated teeth that were diagnosed after implant loading were retrospectively collected and analyzed. The following factors were recorded for each patient based on the patients' medical records and clinical and radiographic examinations: age and sex, the number and location of the dental implants, the VRF tooth type (divided into maxillary and mandibular anterior \ premolar \ molar teeth), the presence of a crown, the presence

of a post, the radiographic quality of the root canal filling (“adequate” was defined as cases in which all visible canals were obturated, no voids were present, and the root canal filling terminated between 0 and 2 mm short of the radiographic apex; root fillings that did not fulfill these criteria were defined as “inadequate” [20, 21]), the time from implant placement, and the time from implant loading to the diagnosis of VRF.

Results

Results of the Systematic Review

The MEDLINE search identified 16 studies published between 1983 and July 2014. The Scopus database search identified an additional 25 articles. The manual search did not identify additional relevant articles.

The identified articles ($N = 41$) were assessed based on their titles and abstracts. However, based on the prespecified inclusion and exclusion criteria, all articles were excluded because they were not relevant to the topic of this study. Therefore, the systematic literature search revealed that currently there are no available relevant studies assessing implant-associated VRFs. Figure 1 presents the search results (22).

Results of the Case Series

Data from 7 patients with 8 cases of confirmed VRFs in adjacent endodontically treated teeth were collected and analyzed. There were 5 women and 2 men between the ages of 34 and 65 years (average age = 54 years). In 2 patients, 1 implant was placed, in 4 patients 2 implants were placed, and in 1 patient 3 implants were placed. In 5 patients, the implants were located adjacent to the VRF teeth, and in 2 patients the implants were located opposing ($n = 1$) or contralateral ($n = 1$) to the VRF teeth.

One of the fractured teeth was a maxillary anterior tooth, 5 were premolars (4 maxillary and 1 mandibular premolar), and 2 were molar teeth (1 maxillary and 1 mandibular molar). All 8 fractured teeth had been restored with a post-retained crown, and the radiographic quality of the root canal filling was deemed adequate.

The time from implant placement to the diagnosis of VRF was between 5 and 28 months (average = 11 months). The time from implant loading to the diagnosis of VRF was between 0 and 22 months (average = 6 months).

Figure 2 shows a case of an endodontically treated maxillary premolar that was diagnosed with VRF after the placement of implants in the adjacent space.

Discussion

This study reports and evaluates a series of 8 cases in 7 patients in whom VRF was diagnosed in endodontically treated teeth after tooth loss and implant placement in the adjacent area. In addition, a systematic review of the literature was performed to assess whether this possible adverse event was previously reported (16–19).

Systematic reviews use a systematic approach and explicit methodology to review and synthesize research evidence aimed to minimize bias and explicitly address the issues of the completeness of the identified evidence and assess the quality of the included studies and the combinability of the studies (10). This systematic process requires a comprehensive literature search to identify as much of the relevant literature as possible (17, 18, 21, 23).

In the present study, a combined comprehensive literature search of 2 electronic databases and a hand search of related articles and literature reviews resulted in the identification of 41 potential articles. To overcome heterogeneity of information, strict inclusion and exclusion criteria were applied to assess studies for the systematic review. These

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