

CLINICAL ARTICLES

An Evaluation of Endodontically Treated Vertical Root Fractured Teeth: Impact of Operative Procedures

Zvi Fuss, DMD, Joseph Lustig, DMD, Alexander Katz, DMD, and Aviad Tamse, DMD

Vertical root fractures of endodontically treated teeth are a frustrating complication that leads to extraction. The aim of the current survey was to evaluate the role of operative procedures in the etiology of this complication. A total of 154 endodontically treated vertical root fractured teeth were cleaned and washed after extraction and maintained in individual vials. Periapical radiographs before extraction, clinical findings and previous operative procedures were recorded. A post was observed in 95 teeth (61.7%), with 66 of these ending at the coronal third of the root. Most were screw posts of the Dentatus type ($n = 64$) and tapered cast posts ($n = 14$). A full crown was observed in 118 teeth, and 65 of these (55%) were extracted between 1 to 5 yr after final restoration. In 24 crowned teeth extraction was conducted within 1 yr after restoration and in 28 teeth after >5 years. It was concluded that post placement and root canal treatment are the major etiological factors for root fractures. Because signs and symptoms can appear years after the operative procedures in the root have been completed, coronal restorations would not interfere with the correct clinical diagnosis of vertical root fractures. Frequent recalls are recommended to diagnose vertical root fractures early, especially in susceptible teeth, such as premolars and mesial roots of mandibular molars.

Vertical root fractures (VRFs) in endodontically treated teeth are a frustrating phenomenon for both the patient and dentist. Diagnosis is often difficult because the signs, symptoms, and radiological features imitate true endodontic failures or periodontal disease, an issue that has been discussed previously in case reports (1–3). In

two recent surveys (4, 5) vertical root fractured endodontically treated teeth were evaluated for their prevalence, and clinical and radiological features before and after extraction.

Several etiologies for VRFs have been previously suggested, mostly iatrogenic in origin. Two major causes are excessive pressure during lateral condensation of gutta-percha (1, 3) and root canal reinforcement of these teeth at a later stage (1, 3, 6, 7). To complicate the situation, signs, symptoms, and radiologic features of VRFs can occur years after the dental procedures are completed.

The purpose of this survey was to evaluate retrospectively the operative procedures performed in 154 endodontically treated vertically fractured roots and their role in the etiology of the fracture.

MATERIALS AND METHODS

From July 1995 to February 1998 patients from five public clinics with possibly VRF teeth were referred to an oral surgeon (J.L.) for tooth extraction. The initial diagnosis made by the referring dentist (VRF, endodontic failure, or periodontal disease) was recorded. The operative procedures performed in each tooth were found in personal dental files, as were recent periapical radiographs. The oral surgeon examined the patients for chief complaint and signs and symptoms. After extraction each tooth was cleaned of external remnants and washed for VRF verification. Teeth with VRFs were maintained in an individual vial and the periapical radiograph, clinical findings, and previous operative procedures were recorded as follows:

1. Presence and type of radicular restoration—cast, Dentatus, or ParaPost posts, and their apical extension—coronal, middle, or in the apical third of the root.
2. Presence and type of coronal restoration (full crown, amalgam restoration, or none).
3. Presence and type of root canal therapy—original treatment or retreatment. An “acceptable” root canal obturation was recorded when a well-obturated gutta-percha filling extended between 0 to 1 mm from the radiographic apex.
4. Time sequence between each operative procedure and extraction.

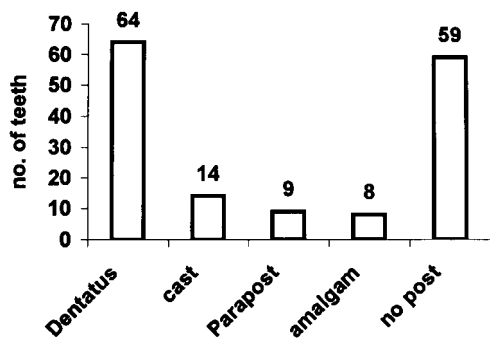


FIG 1. Types of posts in 154 endodontically treated vertical fractured teeth.

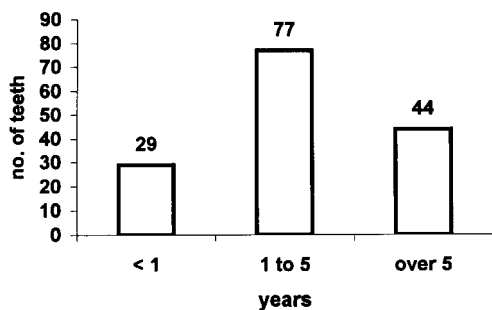


FIG 2. Time between root canal treatment (r.c.t.) (or retreatment) to extraction.

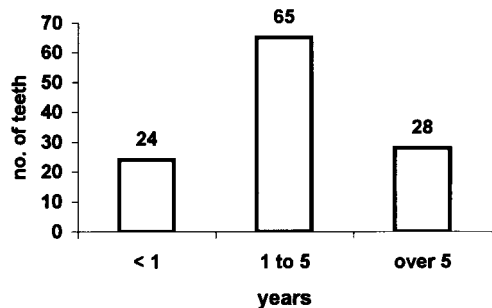


FIG 3. Time between crown placement to extraction.

RESULTS

VRF was observed in 154 teeth after extraction. A post was observed in 95 teeth (61.7%), of which 82 also had a full crown. Of the posts 66 (69.5%) ended at the coronal third of the root and 29 (30.5%) at the middle third. Most were screw posts of the Dentatus type ($n = 64$, 67.3%) and tapered cast posts ($n = 14$, 14.7%); 9 were of the ParaPost type and 8 were amalgam (Fig. 1). With regard to the coronal restoration, 118 teeth (76.6%) had full crowns and 17 (11%) amalgam build-up; 16 had no coronal restoration and 3 had only a core composed of composite resin. Root canal obturation was considered "acceptable" in 42 of the 59 teeth with no posts (71.2%).

The time sequence between root canal treatment or retreatment and extraction is shown in Fig. 2. In 77 teeth (50%) extraction was conducted between 1 to 5 yr after root canal treatment or retreatment, and 29 teeth (18.8%) were extracted within 1 yr after root canal treatment. In 44 teeth extraction was conducted after >5 years, and in four teeth the date of root canal treatment could not be obtained. Figure 3 shows the time sequence between crown



FIG 4. VRF in a maxillary first premolar showing radicular restoration with a Dentatus type post and a full crown. Note typical bilateral radiolucency around the root.

placement and extraction. Of 118 teeth with crowns 65 (55%) were extracted between 1 to 5 yr after the final restoration, and 28 teeth after >5 yr. In 24 teeth extraction was conducted within 1 yr after placement of a crown, and with one tooth the date of crown placement could not be obtained.

DISCUSSION

VRFs in endodontically treated teeth occur most frequently as a result of iatrogenic-operative procedures performed in the root canal (6). It has been suggested that improper selection of intracanal posts and cementation techniques (1, 3) or excessive pressure during lateral condensation of gutta-percha (3) are among the main etiologic factors causing root fractures.

In our survey 64 (67.3%) of the 95 intracanal restorations were screw posts of the Dentatus type (Fig. 4). This type of tapered serrated dowel was also observed in other surveys and case reports of VRFs. Sorensen and Martinoff (8) examined the manner of failure of 123 teeth with various methods of intracanal reinforcements. Tapered cast dowel and core were observed in 31 root canals, of which 4 (12.9%) showed VRF. Threaded posts were observed in only two root canals, and both were fractured. Torbjorner et al. (9) observed that Dentatus screw posts were the main type of intracanal reinforcement in 16 of 21 fractured roots. Recently a Dentatus screw post was also used as the intracanal restoration in a case report of VRF (10).

In the present survey most of the posts (69.5%) were observed in the coronal third of the root, and only 29 (30.5%) reached the middle third. These findings may suggest that longer posts are preferable than shorter ones. However other major factors are involved, e.g. dowel design and the force applied while placing and cementing the posts in the root canal space (6). Further in vitro studies should be conducted to evaluate the role of the post length in relation to undesirable forces involved in radicular restorations.

The appearance of signs and symptoms for VRF, leading to extraction, can occur between 1 to 5 yr after root canal treatment (7). In 50% of the present cases teeth were extracted between 1 to 5 yr after root canal treatment, and another 29 teeth (18%) were extracted within the first year, which is in agreement with the previous study. The time sequence between completion of treat-

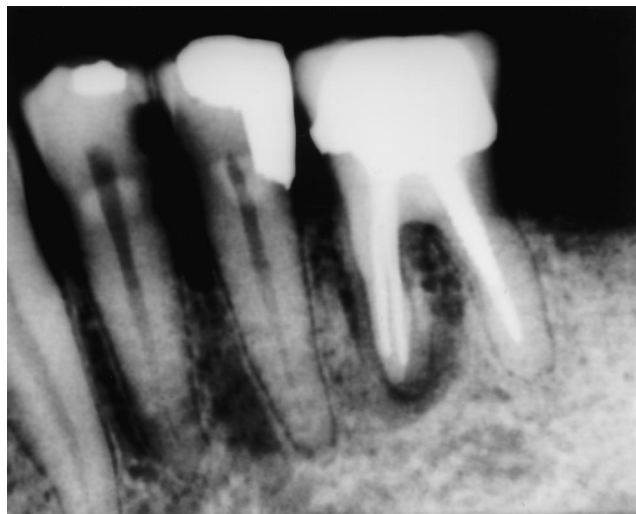


FIG 5. VRF in the mesial root of a mandibular first molar showing acceptable root canal obturation with no post. Tooth restored by a post in only the distal root and a full crown.

ment and VRF diagnosis and extraction is an important factor, because a future new restoration in the area will also depend on the amount of remaining bone after extraction. The patient requires more frequent follow-ups, especially in VRF susceptible teeth, the premolars, and mesial roots of mandibular molars. Attention should also be given to predisposing factors, such as specific anatomy and morphology, amount of remaining tooth structure as a result of various endodontic procedures (7, 11–13), previous cracks (14), and loss of moisture (15).

Vire (16) evaluated the reasons for extracting 116 endodontically treated teeth and observed that the average time between completion of a crown and extraction was 7 yr. Teeth without crowns were extracted ~5 yr after coronal restoration, suggesting that crowns could provide better protection and prevent root fracture for longer periods. However root fracture occurs at an earlier stage (i.e. at the obturation phase) or during post preparation and placement. A full coronal coverage may only delay the radiological features and clinical signs and symptoms that appear years later when there is contact between the gingival margin and the fractured area (4). In the present survey no correlation was found between full coronal restorations and root fractures. Extraction of 44 teeth was conducted >5 yr after root canal treatment, and only 28 of these were crowned (64%). Within the first 5 yr after root canal treatment, 89 crowned teeth were extracted of 106 (83%).

VRF was observed in 59 teeth with no post of which 42 teeth were considered “acceptable” regarding root canal obturation (Fig. 5). In the remaining fractured roots the presence of an intraradicu-

lar post interfered with radiographic assessment of the root canal obturation quality. It is conceivable that, in well-obtured canals, condensation forces play a role in the etiology of the fracture (6). However in root canals with “unacceptable” obturation other factors in canal preparation could be involved with the etiology.

In conclusion endodontically treated teeth should always be restored to regain the patient’s function and esthetics, to minimize coronal leakage, and to prevent crown fractures. However coronal restorations do not prevent VRFs because the fractures occur at an earlier stage during root canal treatment and post preparation and placement.

The authors thank Ms. Rita Lazar for editorial assistance.

Drs. Fuss, Katz, and Tamse are affiliated with the Department of Endodontology and Dr. Lustig is affiliated with the Department of Oral and Maxillofacial Surgery, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel. Address requests for reprints to Dr. Zvi Fuss, Department of Endodontology, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv 69978, Israel.

References

1. Meister F, Lommel TJ, Gerstein H, Bell WA. An additional clinical observation in two cases of vertical root fracture. *Oral Surg Oral Med Oral Pathol* 1991;52:91–6.
2. Linaburg RG, Marshall FJ. The diagnosis and treatment of vertical root fractures: report of a case. *J Am Dent Assoc* 1973;86:679–83.
3. Meister F, Lommel TJ, Gerstein H. Diagnosis and possible causes of vertical root fracture. *Oral Surg Oral Med Oral Pathol* 1980;49:243–53.
4. Tamse A, Fuss Z, Lustig J, Kaplavi J. An evaluation of endodontically treated vertical fractured teeth. *J Endodon* 1999;7:506–8.
5. Fuss Z, Lustig J, Tamse A. Prevalence of vertical root fractures in extracted endodontically treated teeth. *Int Endod J* 1999;32:283–6.
6. Tamse A. Iatrogenic vertical root fractures in endodontically treated teeth. *Endod Dent Traumatol* 1988;4:190–6.
7. Testori T, Badino M, Castagliola M. Vertical root fractures in endodontically treated teeth: a clinical survey of 36 cases. *J Endodon* 1993;19:87–90.
8. Sorensen JA, Martinoff JT. Clinically significant factors in dowel design. *J Prosthet Dent* 1984;52:28–34.
9. Torbjorner A, Karlsson S, Ödman PA. Survival rate and failure characteristics of two post designs. *J Prosthet Dent* 1995;73:439–44.
10. Tamse A, Zilburg I, Halpern J. Vertical root fractures in adjacent maxillary premolars: an endodontic-prosthetic perplexity. *Int Endod J* 1998;131:127–32.
11. Harvey TE, White JT, Leeb IJ. Lateral condensation stress in root canals. *J Endodon* 1981;7:151–5.
12. Felton DA, Webb EL, Kanoy BE, Dogoni J. Threaded endodontic dowels and effect of post design on incidence of root fracture. *J Prosthet Dent* 1991;65:179–87.
13. Pilo R, Corcino G, Tamse A. Residual dentin thickness in mandibular premolars prepared with hand and rotary instruments. *J Endodon* 1998;24:401–4.
14. Onnink PA, Davis RD, Wayman BE. An in vitro comparison of incomplete root fractures associated with three obturation techniques. *J Endodon* 1994;20:32–7.
15. Sedgley CM, Messer HH. Are endodontically treated teeth more brittle? *J Endodon* 1992;18:332–5.
16. Vire DE. Failure of endodontically treated teeth: classification and evaluation. *J Endodon* 1991;17:338–42.