

Vertical Root Fractures in Endodontically Treated Teeth: A Clinical Survey

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SUMMARY

Vertical root fracture of endodontically treated tooth is a frustrating complication that leads tooth to extraction. The aim of this study was to evaluate clinical and radiographical findings in endodontically treated and restored teeth with the vertical root fractures.

During a three year period the authors examined 50 patients with 53 root-canal-treated teeth with vertical fracture. During study the existence of vertical root fracture, the type of root canal therapy, the type of coronal restoration, the type, length of the post and the height of the tooth coronal part were evaluated. In 60.4 % of all studied cases with vertically fracture were premolars, 22.6 % constituted incisors followed by molars 13.2%. Thirty seven vertically fractured teeth out of 53 (70%) served as bridge abutment, 16 (30%) vertically fractured teeth were restored with single restoration.

Cast posts, screw posts, amalgam or composite cores were observed in 43 teeth out of 53 (81 %). In 38 cases out of 43 (88,4%) filling material or post was ending at the coronal third of the root canal. The mean of the length of the post was 4.1mm (SD±1.5), while the mean of the height of coronal restorations was 7.6 mm (SD±1.1). The correlation between the length of the post from the root canal orifice and the height of the coronal restoration was observed ($p=0.025$). A V-shaped pattern osseous defect (dehiscence) was typical and was found in 96 % of cases. Periodontal pocket was detected in 46 out of 53 cases with mean depth 4.63mm (SD±1.1).

This study confirm the findings of other studies where was stated that vertical root fractures are caused by poorly designed dowels (too short, too wide or both), inappropriate selection of the tooth as a bridge abutment or as a consequence of overzealous endodontic forces by a restoration that exerted lateral pressure on the axial walls of the preparation.

Key words: vertical root fracture, pattern of bone resorption, post

INTRODUCTION

Early clinical detection and management of vertical root fractures remain a vexing issue that has caused needless suffering for patients as well as for dentists. Difficulties encountered in the identification and diagnosis of vertically fractured teeth has led to the clinical diagnosis of cracked-tooth syndrome, split root syndrome, vertical root fracture and others (1). Vertical root fracture of endodontically treated tooth is a frustrating complication that leads tooth to extraction.

Many factors that predispose teeth to vertical fractures cannot be altered or controlled by the practitioner. These include masticatory accidents (1), natural tight cusp-fossa relationships, steep intercuspation or bruxism (2).

Clinical detection of fractures can be exceedingly difficult in the initial stages of development under beneath extensive restorations or in teeth after prosthetic

treatment. Clinical signs and symptoms are often elusive in nature and may be difficult to detect or reproduce during patient examination. The patients symptoms may mimic many other possible diagnoses such as sinus problem, vague headaches or ear pain. Subjective symptoms may often be predicated on the extent. Radiograph examination is of little value in the initial stages of vertical fracture (3,4,5,6). In some cases surgical intervention may actually be necessary for fracture identification. Efficacious management of fractured teeth is highly dependent on a complete set of variables that are often not controllable by the practitioner, such as extent of fracture, tooth and root anatomy, position of fracture, masticatory function and previous dental intervention. The creative management of vertically fractured teeth is a crucial part of the problem-solving process. This implies that the choice of extraction may often be the wisest course of treatment, provided that all other possibilities have been considered. Prevention of vertical root fractures is difficult because many are predisposed by nature, but some of contributing factors (restorative and endodontic procedures) can be controlled and part of fractures could be prevented. These factors must be considered by all practitioners.

The aim of this study was to evaluate clinical and radiographical findings in endodontically treated and re-

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stored teeth with the vertical root fractures (VRF), to aid the dentist in recognizing VRF's listening to the patient's chief complaints, examining of periapical radiographs and performing a thorough clinical examination and also to evaluate the role of operative procedures in the etiology of this complication.

MATERIALS AND METHODS

The endodontic therapy in these teeth had been completed by a variety of dentists. Each tooth before extraction and after it was evaluated by the endodontist and oral surgeon. Periapical radiographs were taken with *Eggers* holder and right-angle technique from each clinical case before tooth extraction. The film was placed parallel to the long axis of the tooth and the central beam was directed at right angles to the film aligned through the root apex. The radiographic features of 53 endodontically treated teeth were evaluated and compared.

A total of 53 endodontically treated vertical root fractured teeth were cleaned and washed after extraction and maintained in individual vials.

During this survey periapical radiographs taken before extraction of the tooth, clinical findings before extraction were studied. During study the existence of vertical root fracture, the type of root canal therapy, the type of coronal restoration, the type, length of the post and the height of the tooth coronal part were evaluated in all 53 teeth. Existence of fistula was recorded. The heights of bone resorption, of the tooth coronal part, width of root dentin medial and distal walls, length of post were measured with special forceps.

Patients complaints and clinical symptoms also were evaluated.

Vertical fracture line after tooth extraction was studied with endodontic microscope at the magnification of x10 (*Carl Zeiss*).

RESULTS

During this clinical survey 53 teeth with radiographically and clinically detected vertical fractures were examined. All they were extracted between 1 to 5 years after final restoration. In 24 out 53 cases (48%) teeth extraction was conducted within 1 year after restoration.

Twenty five vertically fractured teeth were detected in the maxillae and 28 in the mandible. In 60.4 % of all studied cases with vertically fracture were premolars, 22.6 % constituted incisors followed by molars 13.2%.

Thirty seven vertically fractured teeth out of 53 (70%) served as bridge abutment, 16 (30%) vertically fractured teeth were restored with single restoration.

Table 1. Type of restoration of examined teeth.

Type of restoration	Number of teeth	Percentage (%)
Cast posts	22	41.5
Screw posts with composite	13	24.5
Composite filling alone	7	13.2
Amalgame core	11	20.8
Total	53	100

Mesial deviation of the root from the vertical axis of tooth was observed in 17 out of 53 (32%) clinical cases.

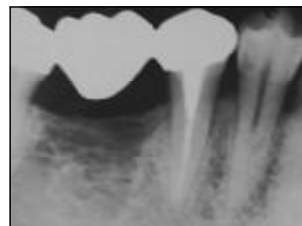
For the restoration of coronal part of 53 examined teeth cast posts, screw posts with amalgam or composite cores and amalgam or composite fillings alone were used. Cast posts, screw posts, amalgam or composite cores were observed in 43 teeth out of 53 (81 %). In 38 cases out of 43 (88,4%) filling material or post was ending at the coronal third of the root canal. Type of restoration of examined teeth is shown in table 1.

The mean of the length of the post was 4.1mm (SD±1.5), while the mean of the height of coronal restorations was 7.6 mm (SD±1.1). The correlation between the length of the post from the root canal orifice and the height of the coronal restoration was observed (p=0.025).

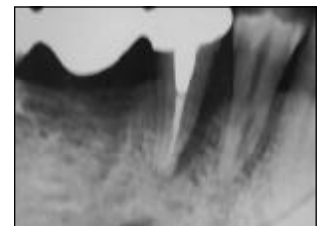
Examination of x-rays before tooth extraction revealed two different patterns of alveolar bone resorption: V-shaped was to the buccal plate and U-shaped shallow, rounded, slow grade resorption in the palatal or lingual plate (5,7) A V-shaped pattern osseous defect (dehiscence) was typical and was found in 96 % of cases (Fig. 1,2,3). The mean depth of the V-shaped defect was 6.0 mm (SD±1.5). The mean depth of the U-shaped defect was 7.0 mm (SD±2.8). Only two cases out of 53 demonstrated U- shaped pattern (4%). One of them was on the lingual and another on the palatal plate.

The influence of the types of root canal therapy used in treatment of these teeth was compared. In 27 root canals, the tapered pattern of canal therapy, as well as in 26 cases "box" method of endodontic therapy were used. No statistically significant difference was found between these two types of root canal therapy.

The evidence and symptoms most often found are mild pain in the area of the fractured tooth often accompanied by swelling and fistula, along with a deep pocket in just one area of the attachment surrounding the tooth. Periodontal pocket was detected in 46 out of 53 cases



Picture 1a. Tooth 45 served as bridge abutment and was restored with a cast post.



Picture 1b. The same tooth one year later. A V-shaped pattern osseous defect (dehiscence) was observed.



Picture 2,3. A V-shaped pattern osseous defect (dehiscence) was observed and fracture line was seen in tooth 45.

with mean depth 4.63mm (SD±1.1). In 12 out of 53 (23%) cases a fistula was detected and it appeared closer to the gingival margin than to the apical area.

Subjective symptomatology may often be predicated on the extent and duration of the fracture. During this survey such symptoms were observed. Sensitivity of endodontically treated teeth to sweet food was recorded in 54.7 % of examined patients. Sensitivity to thermal changes was found in 24.5%, persistent dull pain in 43.4%, momentary sharp pain during mastication in 13.2%.

DISCUSSION

Vertical root fractures is a dilemma not only for practitioners but also for scientists. For a long period of time they are trying to find the solution for this problem but up till now all trials have ended without success.

Vertical root fractures can occur during different phases of root canal treatment: instrumentation, obturation or during post placement (8). The risk of fracture during root canal space obturation in both lateral and vertical condensation techniques is high if too much force is exerted during compaction. Similarly, during post placement, if the post is forced apically during seating or cementation, the risk of fracture is high, particularly if the post is tapered (9,10). According to the results of our survey we can state that treatment procedures can influence the outcome because failure in 48% of cases occurred in one year period after the treatment was ended. So it is important to understand that all vertical pressures exerted during treatment procedures can predispose vertical fractures.

To confirm the diagnosis of a vertical fracture, one good way is exploratory surgery to visualize the fracture line. According to the results of our study we could say that finding of a deep periodontal pocket of recent origin in a tooth with a root canal filling accompanied with V-shaped pattern osseous defect (dehiscence) and such subjective symptom as pain for sweet food are most suggestive of a vertical fracture. Beside this other studies concluded that many morphologic, physical, and iatrogenic factors, such as deep grooves, pronounced intraoral temperature fluctuation, poor cavity preparation design, and wrong selection of restorative materials, may predispose posterior teeth to an incomplete fracture (11, 12, 13).

Epidemiologic data reveals that splits or fractures are the third most common cause of tooth loss in industrialized countries, primarily affecting maxillary molars and premolars and mandibular molars (8, 10). These findings indicate that the cracked tooth syndrome is of high clinical importance.

Conclusion from this material could be made that some preventive measures exists and best of all of them is that teeth at-risk should be reinforced early, for instance by castings with cusp coverage or by internal splinting with adhesive ceramic restorations.

Unfortunately we are trying to use preventive measures only when we have pathology. Vertical root frac-

tures in most cases have one treatment plan - extraction. Only in rear cases in molars we can use hemisection procedure.

Up till now, no consistently successful techniques have been reported to correct this problem. Because this mishap produces irreversible damage the tooth, it is most important to recognize the causes. Vertical root fracture can be attributed to overinstrumentation ("overflaring") of the canal, resulting in unnecessary removal of dentin along the canal walls, with subsequent weakening of its shaft. Preventive measures involves avoidance of overpreparing canals and the use of a passive, less forceful obturation technique and seating of posts.

Helfer et al. found a 9% moisture loss in pulpless teeth compared with vital teeth (11). As a result of that study, they concluded that endodontically treated teeth are more brittle. Lewinstein and Grajower, however, found no such increased brittleness (12). Although controversy still exists concerning the brittleness. Tidmarsh remarked that the change in architecture of an endodontically treated tooth required a restoration that will protect the tooth during function (13). Full cuspal coverage is recommended.

One may speculate that in the future it may be possible to "glue" such fractures. Glass ionomer cement repairs for furcal perforations have been reported by Alhadainy and Himel (9). The bonding ability of glass ionomer cement has led other investigators to use it in attempts to repair vertical root fractures. A 1-year success was reported in a single case (10).

In conclusion the post placement and root canal treatment are the major iatrogenic factors for vertical root fractures. Because signs and symptoms can appear years after the operative procedures in the root when treatment procedures have been completed, coronal restorations would 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.

CONCLUSIONS

Vertical root fractures can be detected early by listening to the patient's chief complaints, carefully examining periapical and bitewing radiographs and performing a thorough clinical examination.

A typical vertical pattern of bone resorption in vertical root fracture cases as shown in our study can be helpful to the clinician in diagnosing vertical root fracture. Exploratory full flap surgical procedure can be performed for diagnostic purposes.

Vertical root fractures are caused by poorly designed posts (too short, too wide or both), inappropriate selection of the tooth as a bridge abutment or as a consequence of overzealous endodontic forces by a restoration that exerted lateral pressure on the axial walls of the preparation.

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