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CLINICAL ARTICLE

An Evaluation of Endodontically Treated Vertically Fractured Teeth

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For this survey, 92 vertically fractured endodontically treated teeth were evaluated clinically and radiographically before and after extraction. The maxillary second premolars (27.2%) and mesial roots of the mandibular molars (24%) were the most fractured teeth. In 67.4% of the teeth, a solitary buccal pocket was present; in 34.8%, a fistula frequently appeared closer to the gingival margin than to the apical area. A lateral radiolucency or a combination of lateral and periapical radiolucency was found in more than half of the cases. The general practitioners correctly diagnosed vertical root fracture in only one-third of the 92 fractured teeth in this survey.

A vertical root fracture (VRF) in an endodontically treated tooth is a postendodontic treatment complication that leads to extraction of either the tooth or root. The VRF may be a longitudinally or diagonally oriented root fracture, either originating in the crown or limited to the root only (1). A complete VRF extends from one external root surface to the other side and includes a portion of the root canal space (2). The signs, symptoms, and radiographic features may imitate periodontal disease or root canal treatment failure (3), thus making diagnosis difficult.

The prevalence of VRFs in various populations has been shown to be between 2 to 5%. The surveys were based either on case reports (4, 5), recall of prosthetically treated patients (6, 7), or evaluation of radiographs from dental records (8). In one survey (9), 375 extracted vertically fractured teeth with relevant radiographs were evaluated. However, only 65 had full case histories.

The purpose of this survey was to evaluate the clinical manifestations and radiographic features of 92 endodontically treated teeth referred for extraction after a clinical diagnosis of VRF or endodontic failures and that proved to indeed have a VRF following the extraction.

MATERIALS AND METHODS

Patients from five public clinics were referred from July 1995 to January 1997, to one oral surgeon (J.L.) for extraction, accompanied with the initial diagnosis of VRF or endodontic failure and a recent periapical radiograph. For this sample, 92 endodontically treated teeth were selected from 90 patients.

Patients were examined by the oral surgeon for chief complaints and for signs and symptoms: (a) sensitivity to palpation and percussion; (b) presence and location of a fistula; (c) presence, location, and depth of a periodontal pocket; and (d) swelling. The diagnostic periapical radiographs and clinical findings were later evaluated by the authors.

Radiographs were analyzed using a viewbox with variable illumination and a viewer with a higher magnification. Each preextraction radiograph was evaluated for the presence, location, and size of radiolucencies around the tooth or the involved root. In cases of disagreement, the issue was discussed among the authors until agreement was achieved.

RESULTS

Patients ranged in age from 17 to 79 years. More than 50 patients were >45 years of age.

The analysis according to tooth type is summarized in Table 1. Premolars were the predominant group (52%), and the maxillary second premolar accounted for 27%. In the mandible, the fracture was found in the mesial root in 17 of 22 molars (77%), whereas the distal root was fractured in only five teeth. In the maxillary molars, the fracture was in the mesiobuccal root (55.5%) and palatal root (33.3%). Only one distobuccal root was fractured.

Pain (51%) or abscess (31%) was the major complaint (Fig. 1). The distribution of signs and symptoms presented by these patients is given in Fig. 2. The most predominant sign was a deep pocket (67.4%). Other signs and symptoms were sensitivity to percussion, mobility, and a fistula. There was a combination of both a deep pocket and a fistula in 22 cases (23.9%).

The presence and location of bone rarefaction is described in Fig. 3. The most significant finding was that a lateral radiolucency

TABLE 1. VRFs of 92 teeth according to tooth type

Tooth	No.	%
Maxillary 2nd premolar	25	27
Mandibular molar	22	24
Maxillary lateral plus central	10	11
Maxillary 1st premolar	10	11
Maxillary molar	9	10
Mandibular 2nd premolar	9	10
Mandibular 1st premolar	4	4
Mandibular lateral plus central	3	3
Total	92	100

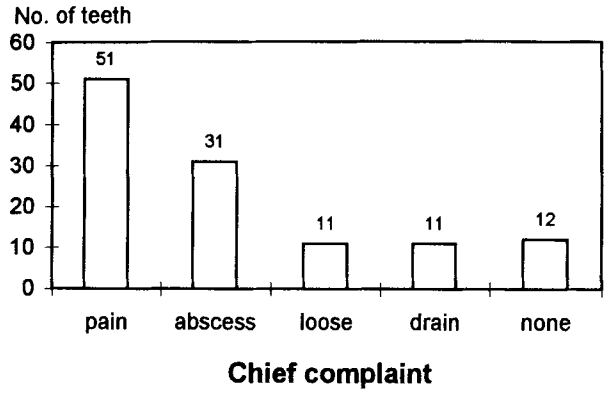

FIG 1. Patients' chief complaint in vertically fractured teeth.

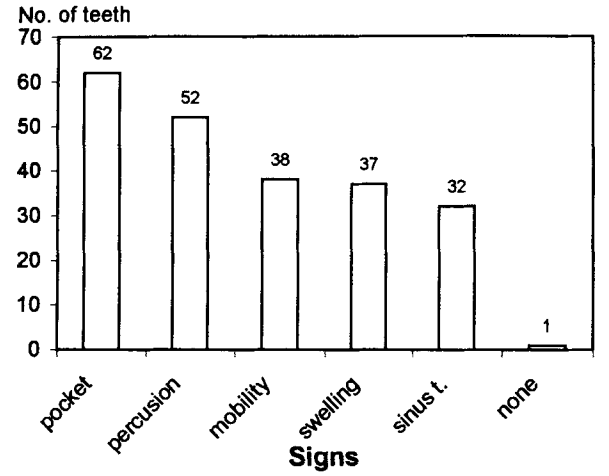

FIG 2. Signs and symptoms of the fractured teeth as recorded by the oral surgeon before extraction.

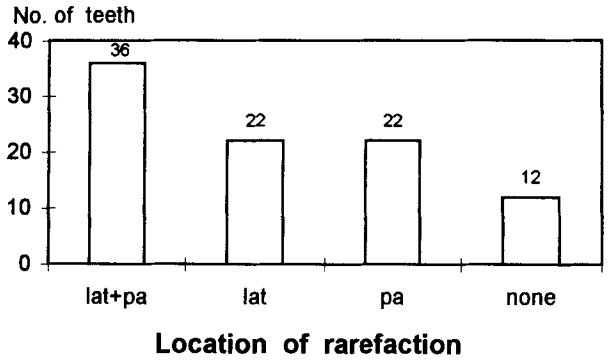

FIG 3. Presence and location of bone rarefaction around 92 vertically fractured teeth.

plus the combination of periapical and lateral radiolucency was present in 58 cases (63%). Among the teeth that showed a combined lateral and periapical radiolucency, eight teeth (22.2%) showed separation of the root segments.

DISCUSSION

Diagnosis of VRF in an endodontically treated tooth is a complicated problem for the clinician. An attempt has been made to identify the most prominent clinical findings and radiographic features for VRFs in endodontically treated teeth in case reports and review of case reports (1). In a survey conducted by Rud and Omnell (9), extracted teeth due to VRFs were investigated. A pre-extraction radiograph was available for 375 of 468 teeth. Of the fractures, 75% occurred in the maxilla, with the maxillary premolars as the predominant group (62%). In the current survey, only 59% of the fractures were in the maxilla, with the maxillary premolars as the predominant group, although in a lower percentage (40%) (Table 1).

It is of interest to note that the mesial roots of the mandibular molars were fractured more (17 of 22) than the distal ones. It is possible that the anatomy of these roots, with their narrow mesiodistal diameter, is a predisposing factor for these fractures (Fig. 4).

In this survey, pain was classified under one category, instead of four (discomfort, mixed or severe pain, pressure, or strange feeling) as in the previous survey (9). The total of 42 teeth (57%) is similar to 51 (Fig. 1) in this survey. Pain is often an expression of the inflammatory process around the root as a result of the fracture. The second most frequent complaint was swelling; 31 teeth were clinically verified as an acute abscess. Both are typical of a "regular" failing endodontic treatment; thus, making diagnosis more difficult for the practitioner. Patients also complained of a loose tooth or drainage; and, in 12 teeth (Fig. 1), there was no complaint at all. In these cases, the VRFs were suspected only from the periapical radiograph.

The most predominant clinical sign was deep pockets in 62 cases (67.4%), usually located at the buccal side of the tooth or the root involved (Fig. 2). It is a solitary pocket where no other pockets are found surrounding the tooth. This pocket, which often reaches the root apex is, in fact, a fistula in an area otherwise free from periodontal problems. Such pockets have been previously described in cases of VRFs (10, 11), but their appearance probably depends on the extent and duration of the fracture (2, 9).

When a fracture line in a root reaches the cementum and the periodontal ligament, the area becomes a source of chronic inflammation (2). Subsequently, the local inflammatory process leads to periodontal breakdown and development of a deep pocket, which is not typical in cases of root canal treatment failures.

Two interesting clinical findings were also noted. One was the combination of a fistula and pocket that was found in 11 of the cases in premolar teeth (Fig. 5) and in 6 of the cases of the mesial roots of mandibular molars (35.3%). The other was that, when the fistula appeared in the attached gingivae (with or without a deep pocket) in 24 of the 32 (75%) cases with a fistula, it was located <4 mm from the gingival margin. In VRF cases, the fistula may appear more toward the gingival margin, rather than apically oriented as in cases of failures of root canal treated teeth (9).

Because the presence of a radiolucent area around the involved root may be an important aid in achieving a correct diagnosis, a careful radiographic examination was conducted as previously described. In 12 cases (13%), no periapical or lateral radiolucency was found, which is consistent with our previous survey (1) that, in 6 of 42 cases (14%), lesions were not visible on the radiograph. Periapical radiolucency in 22 cases (24%) and lateral radiolucency in 22 (24%) were found in one or both sides of the root. In a recent study (12), widening of the periodontal ligament space along one or both sides of the root was found in 18.4%. As shown in this survey and suggested by others (4), the combination of lateral and periapical radiolucencies in 63% can be indicative of VRFs. A combination of periapical and lateral radiolucencies was present in 36 cases (39%), which is over one-third of the cases (Fig. 3). The 22 cases (24%) of only lateral radiolucencies and the combination of lateral and lateral-periapical radiolucencies consisted of 58 cases (63%) (Fig. 3).

The diagnosis of "root canal failure" by the referring dentist was made in 53% of the cases; in only 33.7% was a correct diagnosis of VRF made. However, in one-third of the cases, a lateral radiolucency was present on one or both sides of the roots and in 7.4% a clear separation of root

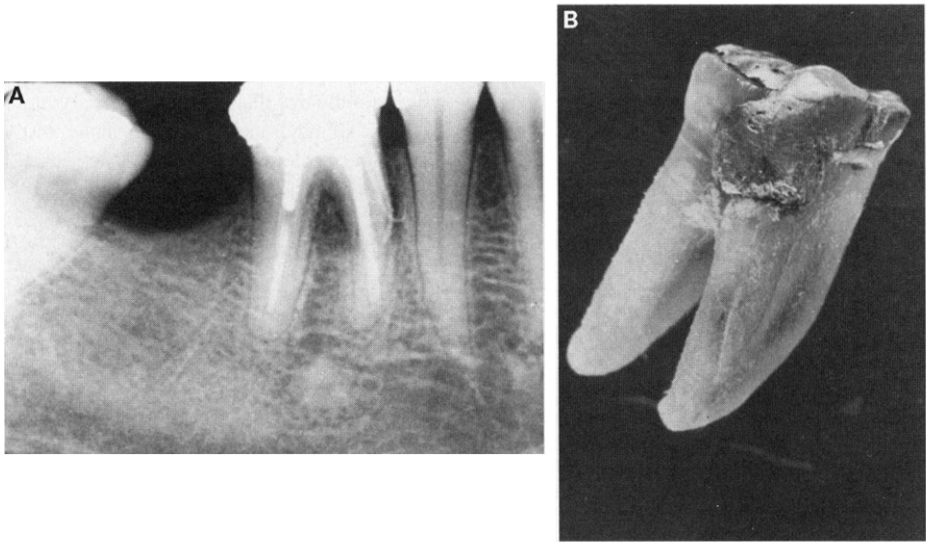

FIG 4. (*a*) A diagnostic periapical radiograph of the first mandibular molar showing the involved mesial root, 7 mm deep pocket, and radiolucency in the furcation and at the mesial aspect of the root. A gutta-percha cone was placed to detect the location and extent of the pocket. (*b*) Diagonally oriented VRF is clearly seen along the mesial side of the tooth seen in (*a*) after extraction.

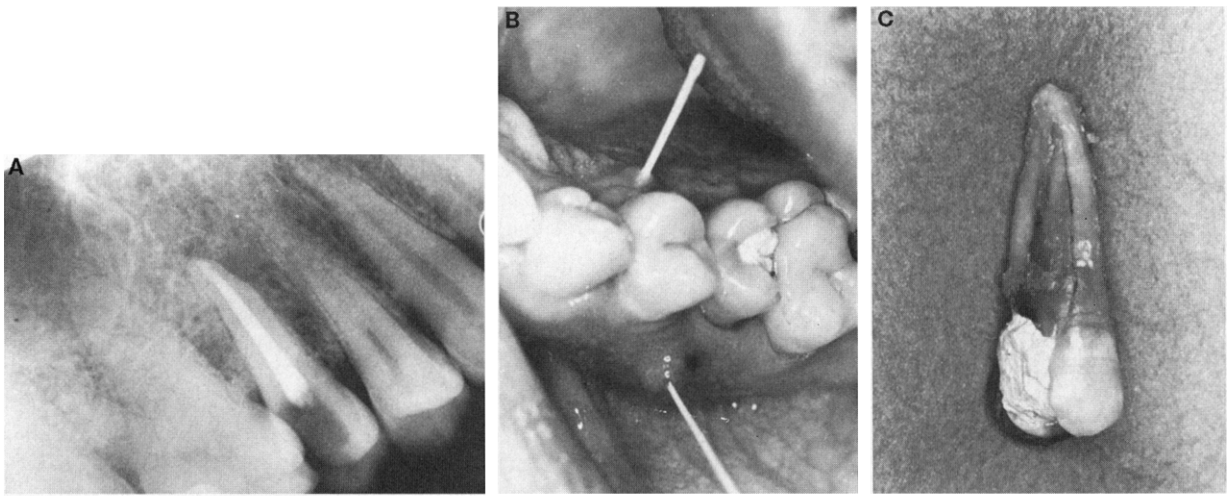

FIG 5. (*a*) A periapical radiograph of a second maxillary premolar showing a lateral radiolucency in the apical third of the root. (*b*) Buccal and palatal fistulas near the maxillary first premolar led to the apical third of the second premolar. (*c*) Extracted tooth showing VRF.

segments could be seen in the radiograph. Although lateral radiolucency along the root at one or both sides has been previously mentioned (1) as a meaningful radiographic sign for a possible VRF, a visible separation of segments is the only absolute radiographic evidence of VRF.

The results of this survey showed that one or more of the typical findings in vertically fractured endodontically treated teeth (lateral radiolucency, a solitary pocket, and a coronally located fistula) can help the clinician to make the correct diagnosis in these perplexed cases.

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