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The Detection and Treatment of Vertical Root Fractures

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Early vertical root fractures are difficult to detect. After a period of weeks or months, when there is a breakdown of the periradicular tissues, detection may be facilitated. When the segments of the fracture have separated, detection is quite simple. However, in these cases prognosis for healing is poor.

Newer techniques for treating vertical root fractures are presented.

The early detection of vertical root fractures can be difficult and treatment frequently hopeless. Texts suggest several treatment modalities, ranging from extraction to hemisection and radisectomy in multirooted teeth. The subject is particularly well documented in articles by Bender and Freedland (1), Bouchan et al. (2), and Mori and Iijima (3). Pitts and Natkin (4) have also studied the problems of diagnosis and treatment of vertical root fractures. Their findings are similar to those of the other authors.

The histopathogenesis of vertical root fractures is documented by Walton et al. (5). They concluded that invading microorganisms and tissue breakdown products cause the destruction of the supporting structures.

Pitts et al. (6) have studied the forces required to cause vertical root fractures. They concluded that roots can be split during obturation with lateral condensation of gutta-percha.

The first article to indicate that the potential may exist for encouraging the natural healing of these fractures was presented by me in 1975 (7).

After considering some factors that can produce vertical root fractures, this article will focus primarily upon the more positive approaches of treating and restoring these teeth to health and normal function.

SOME CAUSES OF VERTICAL FRACTURES AND SOME AIDS IN RECOGNIZING THESE FRACTURES

Sudden trauma or trauma associated with occlusal disharmonies or extreme clenching and gritting can produce vertical fractures. The defect need not be a complete fracture, but may at times extend through part of the root or crown. If the trauma is extreme, it could shatter the crown and root.

A variety of situations that can be detected via radiographs are illustrated. Figure 1 illustrates a simple vertical fracture with a thickening of the periodontal ligament. The tooth may also be discolored and will frequently respond with tenderness to percussion and palpation. In the early stages a sinus tract may not be present.

Figure 2 represents a chronic inflammatory process that has existed for some time and has caused resorp-

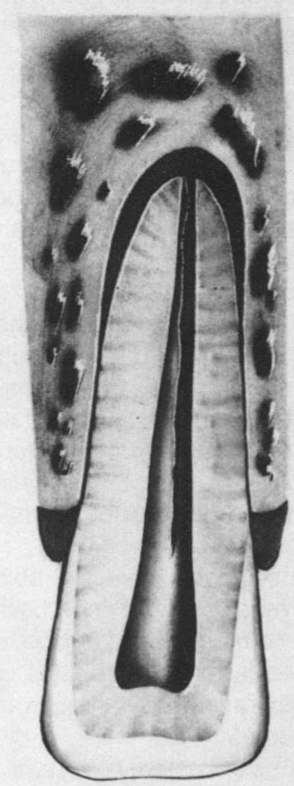

Fig 1. An artist's concept of a simple vertical root fracture. The fracture is illustrated, as is the thickened periapical space of the periodontal ligament.

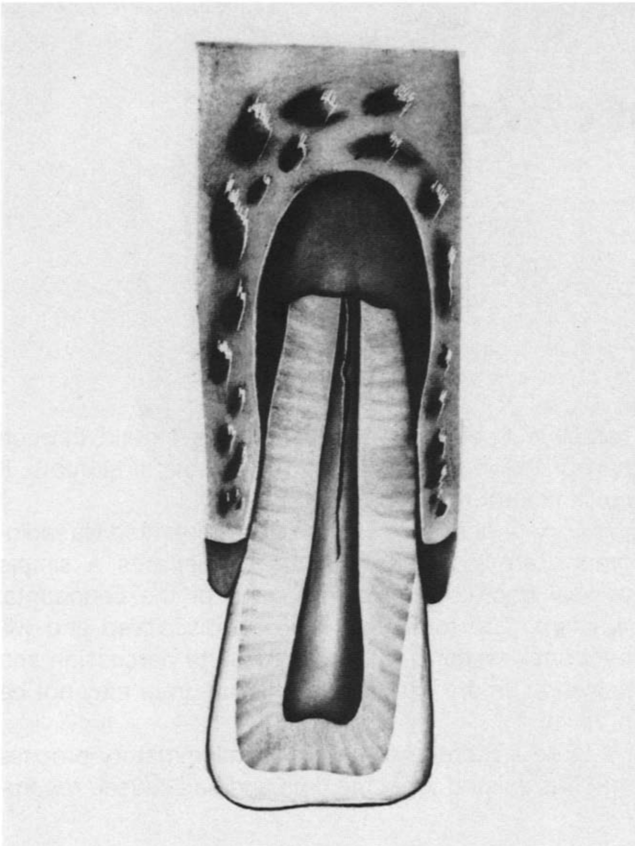

FIG 2. This illustration shows the vertical fracture and the resorption of the root apex. It could also represent a tooth that had been traumatized and maturation of the apex impeded.

tion of the root apex. It could also represent an immature tooth with a history of trauma, that destroyed the pulp and prevented maturation of the root apex. The tooth could be tender to percussion and palpation, loose, and have an active sinus tract. The defect at the apex would generally be well defined.

Recognition of a vertical fracture in the cases illustrated in Figs. 1 and 2 could be difficult, unless the radiograph is of good quality and contrast. Even so, the clinician must have a high degree of suspicion and must check the radiographs carefully for evidence of fracture in each film. A complete history is also important, particularly noting incidents of trauma and occlusal evidence of gritting and clenching.

When the root segments show an obvious separation, diagnosis is much easier (Fig. 3) because there is usually some discomfort and drainage present. The prognosis becomes less favorable if the crown itself is involved in the separation and there is marked loss of supporting structures.

Figure 4 illustrates excessive root canal enlargement during instrumentation and a disregard of the anatomy of the root. One must always be mindful of the anatomical configuration of each root and use reasonable judgment in selecting instruments that will not weaken or fracture the walls. It is unwise to follow some arbitrary root size or diameter for each canal and fail to take into consideration the fact that no two teeth have the same anatomy. Each tooth must be evaluated for size, root length, root configuration, etc.

Figure 5 illustrates the failure to follow the root curvature, and the consequent weakening of the wall of the root, by excessive and improper root canal preparation. Excessive compaction of gutta-percha is perhaps the next most frequent factor which produces root fractures during treatment. This is an impression gained by me during more than 40 yr of practice. Vertical root fracture occurring during condensation of gutta-percha was demonstrated by Pitts et al. (6). The clinician may be aware of a "cracking" sound and the patient may experience a momentary twinge of discomfort. The actual fracture will, in all probability, not be noted on the radiograph at this time. Only weeks or months later will the patient have some discomfort, and perhaps swelling or a draining sinus tract. The problem may be confused with a periodontal pocket.

The diagnosis can be further complicated if the patient is unfortunate enough to also have extensive periodontal involvement. The actual fracture may not be found until a surgical flap has been made and the extent of the defect noted. In these cases, if a root end

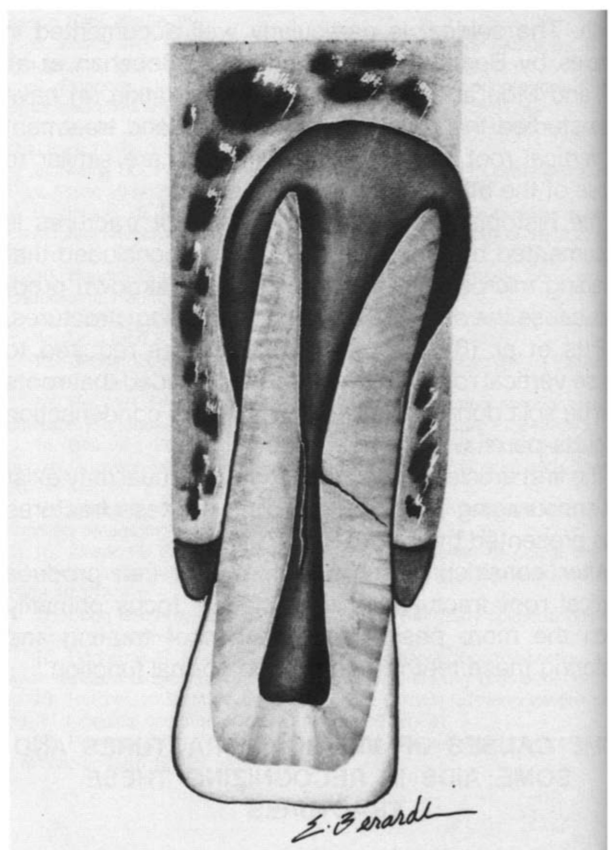

FIG 3. A fracture where the segments are actually separated, with marked destruction of the supporting periapical tissues.

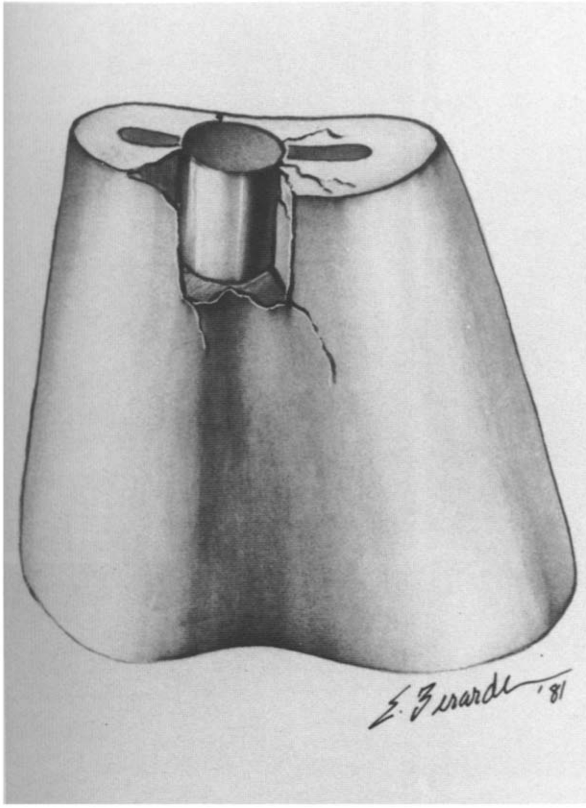

FIG 4. There was excessive instrumentation, and failure to consider anatomical shape of the root canal.

filling is inserted, it is doomed to failure. It will not hold the tooth segments together, but rather act to further separate them. The patient is thus exposed to needless surgery and the dentist to frustration. I have observed that many teeth with vertical root fractures have had large posts in the canal. The impression gained is that these fractures were related more frequently to screw-type posts than to smooth tapered or cast posts. The following case reports illustrate some newer techniques for treating vertical root fractures.

CASE 1

A patient was referred for curettage and root-end filling. Careful review of the radiograph, as shown in Fig. 6*A*, shows a slight line within the gutta-percha filling, suggestive of a vertical root fracture. Removal of the gutta-percha, as noted in Fig. 6*B*, shows the dark line consistent with a vertical fracture.

Figure 6*C* shows the canal filled with $Ca(OH)_2$ plus the contrast medium $BaSO_4$, as suggested in an earlier publication (7). The use of the contrast medium will help in determining when to change the $Ca(OH)_2$ and to ensure that the entire canal is filled with this medicament.

As noted in Fig. 6*D*, after 1 yr, healing of the supporting structures is taking place. From the author's past experience, at least 9 to 12 months are needed for healing. There is a greater probability for denser bone formation and more mature cementum which helps prevent separation of the root segments. It is also advisable to have a full crown constructed to protect the tooth. As noted in Fig. 6*E*, the root was sealed with gutta-percha and it is difficult to see where the fracture had existed. The final radiograph (Fig. 6*F*) shows the tooth 10 yr later. Healing is complete, as the bone is dense, and there is no longer evidence of the presence of the original fracture.

CASE 2

The treatment of this patient was rather complex because the fracture was not obvious. The patient originally exhibited swelling that required gingival drainage and antibiotics before root canal therapy could be initiated.

As noted in Fig. 7*A*, there was evidence of periapical changes. The unusually deep grooves present on the mesial and distal marginal ridges are not evident in this figure.

Figure 7*B* shows a second instrument in what at first was thought to be another canal. However, marked bleeding was noted whenever an instrument was placed into that one area. Judgment suggested that

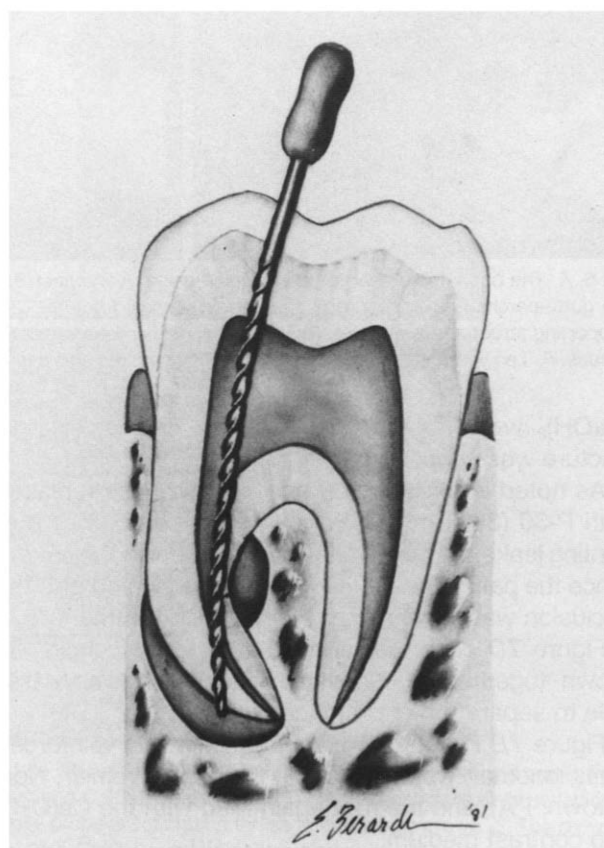

FIG 5. The failure to follow the anatomy of the root canal with weakening of the wall of the root resulted from overinstrumentation.

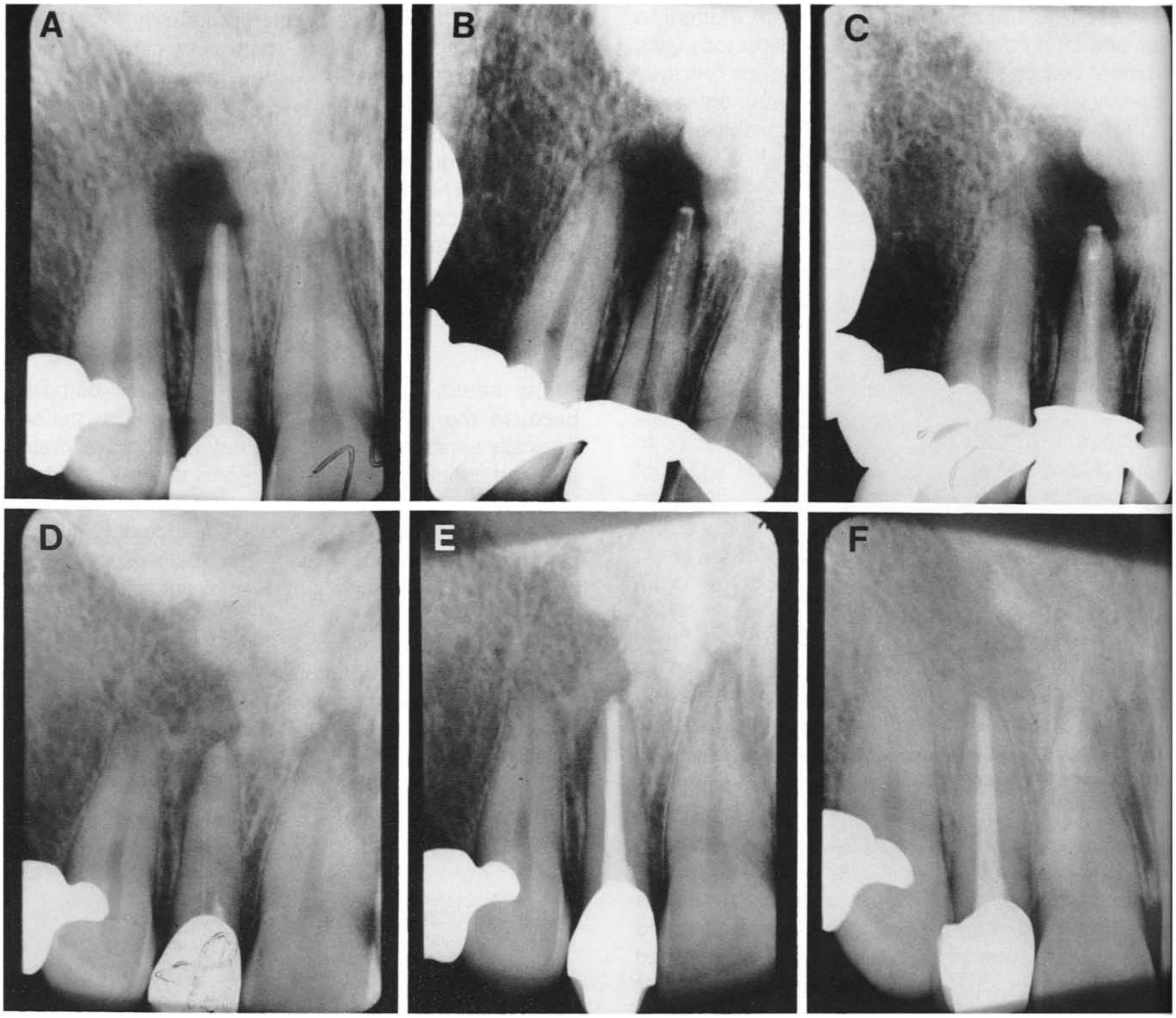

Fig 6. *A*, The patient had a large periradicular lesion. A line seen in the gutta-percha caused suspicion of a vertical root fracture. *B*, Removal of the gutta-percha and exposure of the classic vertical fracture. *C*, Tooth being treated with $Ca(OH)_2$ and contrast medium. *D*, Healing of the supporting structures is obvious. *E*, The root canal has been sealed with gutta-percha. There is evidence of continued healing of the periradicular tissues. *F*, Ten years after treatment. Healing is complete and there is no longer evidence of the fracture.

$Ca(OH)_2$ would be the treatment of choice, since a fracture was suspected.

As noted in Fig. 7*C*, the old amalgam was replaced with P-30 (3M Co., St. Paul, MN) in the hope of preventing leakage and lending more support to the crown. Since the patient had a tendency to clench and grit, the occlusion was reduced to relieve added trauma.

Figure 7*D* shows a failure of the P-30 to hold the crown together. The multipurpose probe was easily able to separate the tooth segments.

Figure 7*E* shows the tooth rebuilt with a reinforced glass ionomer, Ketac Silver (R) (E.S.P.E.-Premier, Norristown, PA), and the root again filled with the $Ca(OH)_2$ and contrast medium.

In Fig. 7*F* the tooth had been further reinforced with a crown that had an occlusal vent to facilitate entry and continued treatments. It is also evident that the root canal is filled with $Ca(OH)_2$ and that the supporting structures, including the periodontal ligament, were healing.

A further complication occurred when an acute abscess developed in the area. As noted in Fig. 7*G*, there was considerable loss of supporting structure between the premolar tooth and the first molar. There was no evidence of root segment separation, and the bone between the two premolar teeth had shown continued healing. The offending tooth was thought to be the first molar, since it failed to respond to pulp testing, and the gutta-percha probe, also noted in Fig. 7*G*, indicated that the source of infection was the first molar. The molar tooth was treated endodontically and the canals were sealed via lateral condensation of gutta-percha.

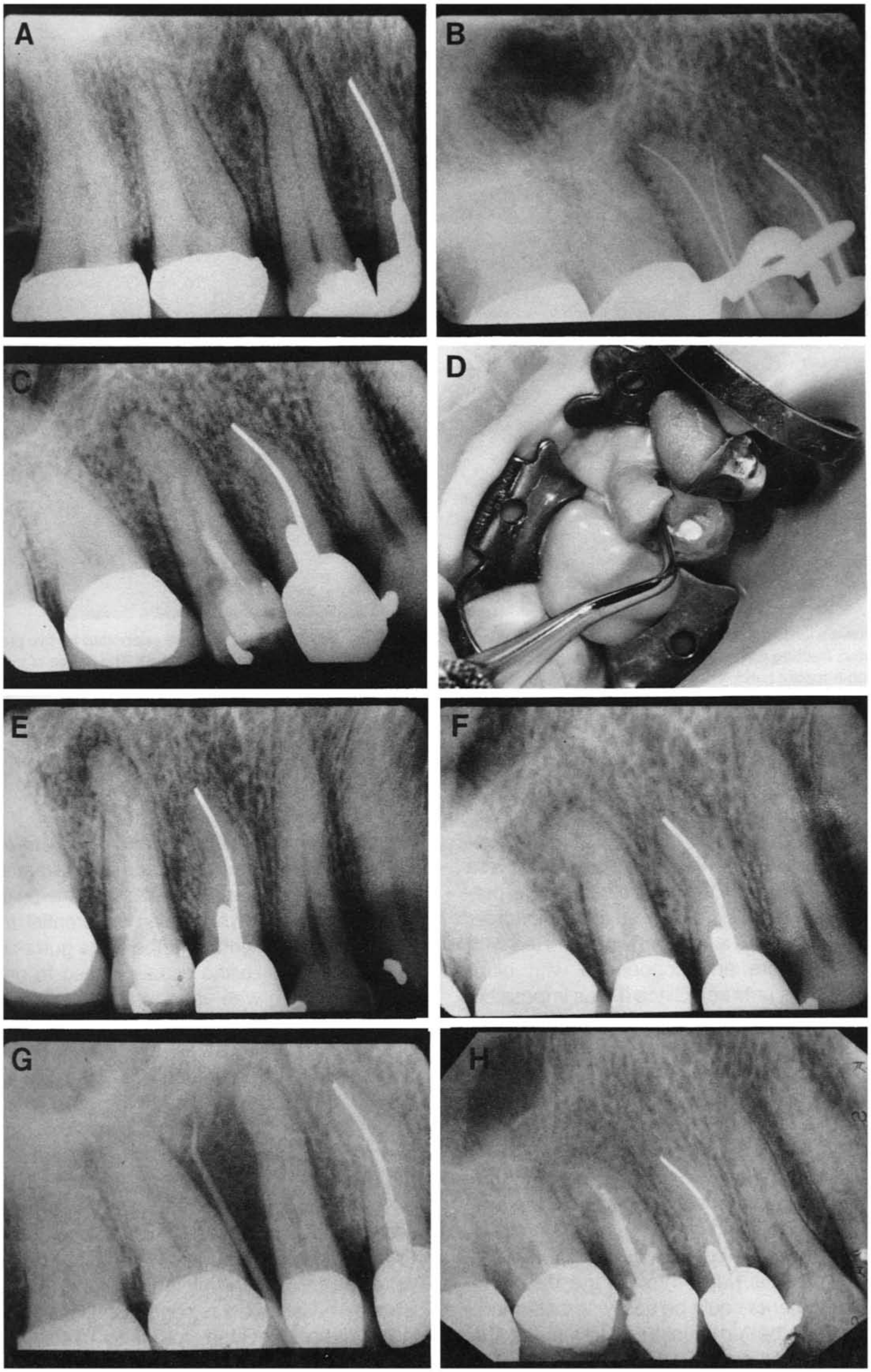

FIG 7. *A*, A second premolar tooth with periapical tissue changes. *B*, There are two instruments in the tooth; one in the root canal and one in the area that proved to be a root fracture. *C*, There is a new restoration in the crown and $Ca(OH)_2$ in the canal. There is evidence of early periapical healing. *D*, The restoration failed to keep the segments together. The multipurpose probe is separating the segments of the crown. *E*, The crown has been restored, this time with a reinforced glass ionomer. The root is filled with $Ca(OH)_2$ and its contrast medium. *F*, The tooth has been further reinforced with a full crown and continued periapical healing is obvious. *G*, A lesion has developed between the molar and second premolar teeth. There is extensive destruction of the supporting tissues. The gutta-percha probe shows the source of the lesion is the molar tooth. The bone between the two premolar teeth shows continued healing. *H*, Six months later. The root canal has been sealed with a glass ionomer filling material. There is continued healing of the supporting tissues.

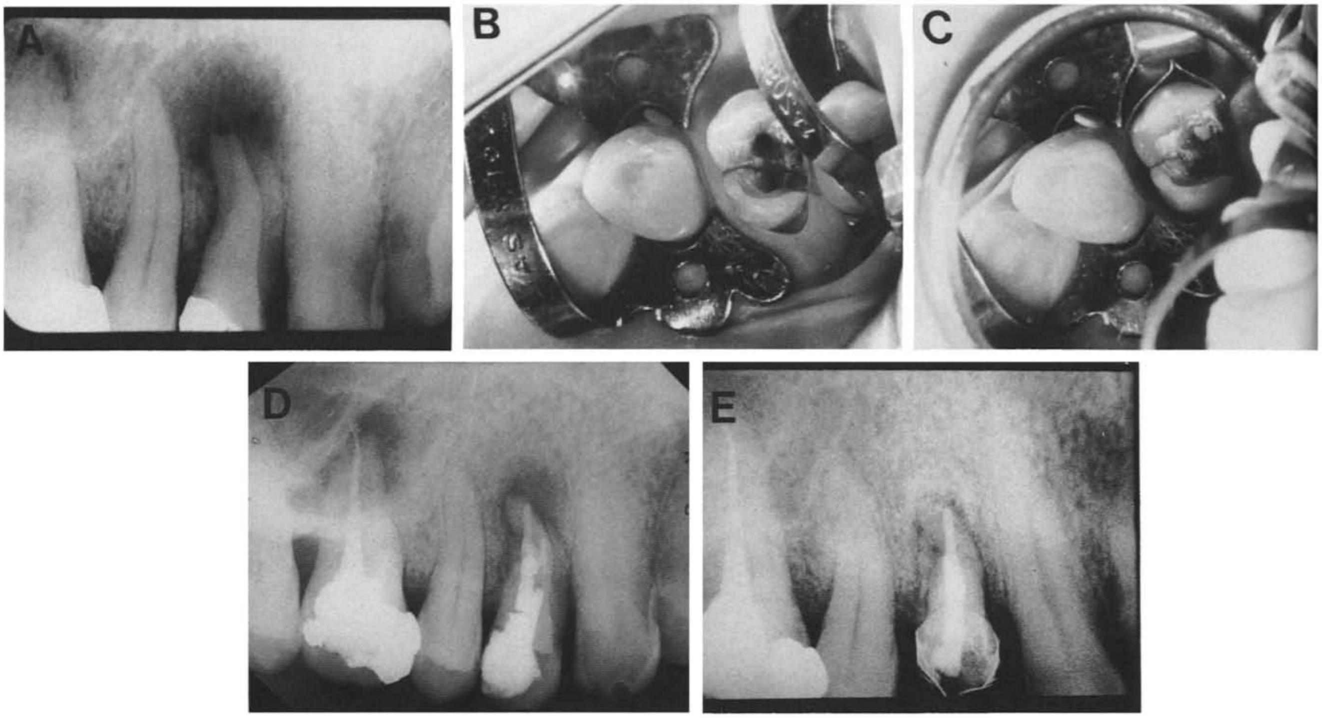

FIG 8. *A*, Film shows a large periradicular defect as well as apical root resorption. *B*, The rubber dam in place supported by two premolar clamps. There is an obvious fracture running along the floor of the pulp chamber and involving the distomarginal wall. *C*, The crown of the tooth is being held together with a matrix band. There are gutta-percha plugs in the openings of the root canals to prevent the reinforced glass ionomer from entering the canals when the crown is restored. *D*, The root canals have been sealed with a modified glass ionomer. There is evidence of continued healing. *E*, Four months after root canal sealing, the crown preparation has been completed and continued healing of the periradicular tissues is evident.

As noted in Fig. 7*H*, taken 6 months later, the supporting structures were healing. The soft tissues were healthy in appearance, and the root canal of the premolar was sealed with the reinforced glass ionomer cement, Ketac Silver (R). The cement was inserted with McSpadden compactors and condensed with blunt gutta-percha pluggers until set. Since it was impossible to seal the canal beyond the level shown on the radiograph, it indicated that the foramen had been sealed with regenerated bone and cementum.

CASE 3

The final case history is represented in Fig. 8*A*. In this two-rooted first premolar, there is an obvious periradicular lesion that included some apical root resorption. Also present on the gingival tissue was a draining sinus tract. The fracture was obvious and extended from the mesial marginal ridge through the distomarginal ridge. The segments could be easily spread apart.

In order to provide better access for treatment, the rubber dam was placed over the canine and the premolar teeth and held in position by using two premolar clamps. One clamp was on the canine and the second clamp was on the second premolar tooth. Figure 8*B* shows the clamps in position. After the old amalgam filling had been removed and the canals had been cleaned and shaped, the fracture could more easily be seen, extending across the floor of the pulp chamber.

Figure 8*C* shows the circumferential matrix band holding the segments together. The gutta-percha plugs in the entrance to the canals helped to prevent glass ionomer, which was used to fill the crown, from being forced into the root canals. The reinforced glass ionomer, Ketac Silver (R), chemically as well as physically, bonds the tooth segments (8). After the material had hardened, reentry was made through the occlusal surface. The plugs of gutta-percha were then removed and the treatment was continued using $Ca(OH)_2$ until the periapical tissues showed obvious healing.

Approximately 4 months later, the root canals were sealed with a modified glass ionomer cement, Ketac Fil, and the area through which the canals were treated was sealed with a reinforced glass ionomer, Ketac Silver (R). The mix was condensed into the root canals, in the space provided, to act as posts and core (Fig. 8*D*). It was suggested to the patient that a full crown be made to insure maximum support. Four months after root canal sealing (Fig. 8*E*), the crown preparation was completed and continued healing of the periradicular tissues was evident.

SUMMARY

It is, at times, difficult to recognize vertical fractures or potential fractures, even in well-exposed and processed radiographs. It is now possible to treat many of these fractures, and they need no longer be thought of as "hopeless" problems.

This article is based on a presentation that was given in Boston during the 1986 annual meeting of the American Association of Endodontists. It represents but a small number of the case histories and a small portion of the research presented.

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