
Orthodontic-Endodontic Treatment Planning of Traumatized Teeth

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Occasionally, an orthodontic patient will accidentally traumatize a maxillary anterior tooth before or during orthodontic treatment. In some situations, the trauma will be substantial and avulse the tooth. In other accidents, the tooth may not avulse, but the pulp becomes nonvital. If the pulp is devitalized, and the root has not fully formed, the apex of the root canal may be wide. In this situation, the endodontist may recommend apexification procedures to help close the apex before conventional obturation of the root canal. If the patient is currently undergoing orthodontic movement of the traumatized incisor, what effect will the tooth movement have on the success of the apexification? If the tooth were avulsed, replanted, and then ankylosed, should it be extracted? If so, when should the ankylosed incisor be removed? What effect will further facial growth have on the ankylosed tooth and the potential to achieve a successful esthetic restoration? The answers to these questions are important during the interdisciplinary treatment planning of the patient with traumatized teeth. This article will elucidate the endodontic-orthodontic considerations for patients with traumatized anterior teeth. (Semin Orthod 1997;3:39-44.) Copyright © 1997 by W.B. Saunders Company

According to Andreassen,¹ 12% to 33% of children will experience traumatic dental injuries by 12 years of age. Boys sustain injuries to permanent teeth about twice as often as girls do. The peak incidence of dental trauma occurs between ages 8 and 10 years. As a result of the prevalence and timing of dental injuries to children, orthodontic treatment planning will often require decisions regarding the long-term viability of traumatized teeth. The orthodontist may have clinical questions regarding the effect of trauma on the developing dentoalveolar complex and the success of endodontic treatment in a specific site. Answers to these questions are crucial in preparing the broader orthodontic treatment plan.

Trauma can cause many different types of

injuries to the teeth and alveolar bone of a young patient. Two common injuries are tooth avulsion and pulpal necrosis. Clinical information about a specific endodontic-orthodontic problem in each of these areas will be presented in this article. The topics to be discussed are treatment of ankylosed replanted teeth and apexification during active orthodontic movement.

Treatment of Ankylosed Replanted Teeth to Maximize Alveolar Ridge Development*

A clinical problem arises when a replanted avulsed tooth becomes ankylosed. In some children and adolescents a large alveolar ridge defect may be associated with the ankylosed tooth, whereas in other individuals there is minimal disruption to the developing ridge (Fig 1). Is it possible for a clinician to predictably intervene

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*Adapted with permission from Steiner DR: Timing of extraction of ankylosed teeth to maximize ridge development. J Endodont (in press).

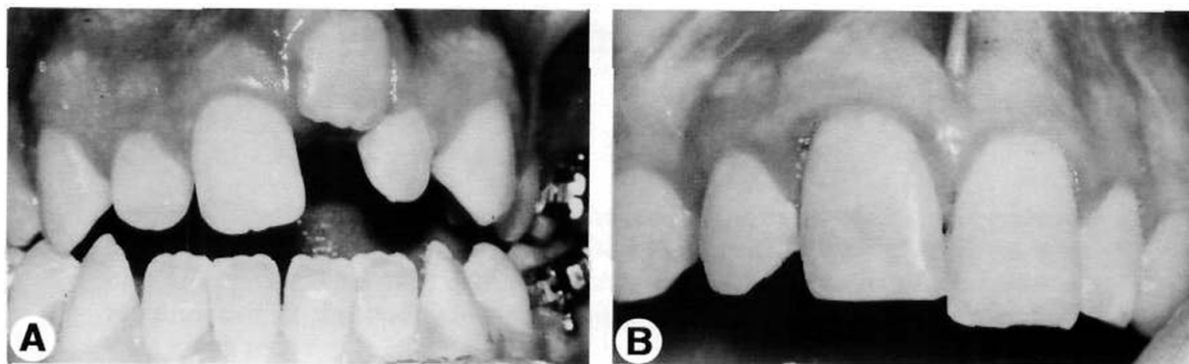


Figure 1. If a tooth is avulsed and replanted, it may ankylose and create significant (A) or minor (B) infraocclusion depending on the age of the patient at the time of the trauma.

and mitigate the formation of an extensive alveolar ridge defect?

Avulsed teeth frequently ankylose after replantation. Ankylosis leads to arrested development of the alveolar ridge associated with the ankylosed tooth.² Arrested ridge development may lead to a defect in the alveolar process in that area. The severity of the resulting ridge defect depends on the amount of facial growth after ankylosis. The extent of the defect results from the length of time an ankylosed tooth is retained during adolescent rapid growth (Fig 2).

Retaining an ankylosed tooth in a young patient is complicated by the arrested development of the alveolar ridge in the avulsion site coupled with the continuing facial growth of the child. The problem for the clinician is to determine an optimal time to remove an ankylosed replanted anterior tooth to maximize ridge development but allow the tooth to remain long enough to function as a space maintainer and an esthetic temporary.

The severity of the ridge defect depends on the amount of facial growth after ankylosis. The majority of the defect occurs during adolescent rapid growth. The solution is to determine an accurate method to estimate the patient's stage of growth. Timing the removal of an ankylosed tooth at the start of the rapid phase of adolescent

growth may achieve the treatment objective of maintaining alveolar ridge height while allowing the tooth to function as a space maintainer and temporary until the time of removal (Fig 3).

How does a practitioner determine the best time for extraction of the ankylosed tooth? Median growth distribution curves indicate adolescent rapid growth occurs between 10½ to 13 years for girls and 12½ to 15 years for boys.³ However, these estimates are based on the average age of a large population of patients, whereas the clinician is interested in the maturity of a single individual. Therefore, as a child approaches the median age range for an adolescent growth spurt, the following clinical observations and responses to key questions can refine the identification of the start of the rapid growth phase for that individual:

1. Have the parents record the height of the patient every 3 months. The change in height at each measurement will be small until rapid growth begins, when a distinct increase in overall height is recorded. Concomitantly large changes in infraposition of the ankylosed tooth will begin to occur as the growth spurt proceeds.

2. Ask the parents at what age siblings had their rapid growth. This will alert the practitioner that a patient may have an earlier or later growth

Figure 2. A maxillary left central incisor was replanted at 8 years of age (A). The tooth ankylosed and at age 9 the incisal edge was about 0.75 mm in infraocclusion (B). At age 10, the incisal edge was 1.5 mm in infraocclusion (C). By age 11 the incisal edge was 2 mm in infraocclusion (D). At age 13½, the ankylosed tooth was 5 mm in infraocclusion (E). By age 16 (F) the incisal edge was 8 mm apical to the incisal of the right central at the start of orthodontic treatment (G). Because of ankylosis, surgical luxation and forced orthodontic eruption failed to move the tooth (H). The tooth was removed 9 months before debanding (I and J). The soft tissue level masks the severe alveolar ridge defect shown by a radiograph of the site (K).

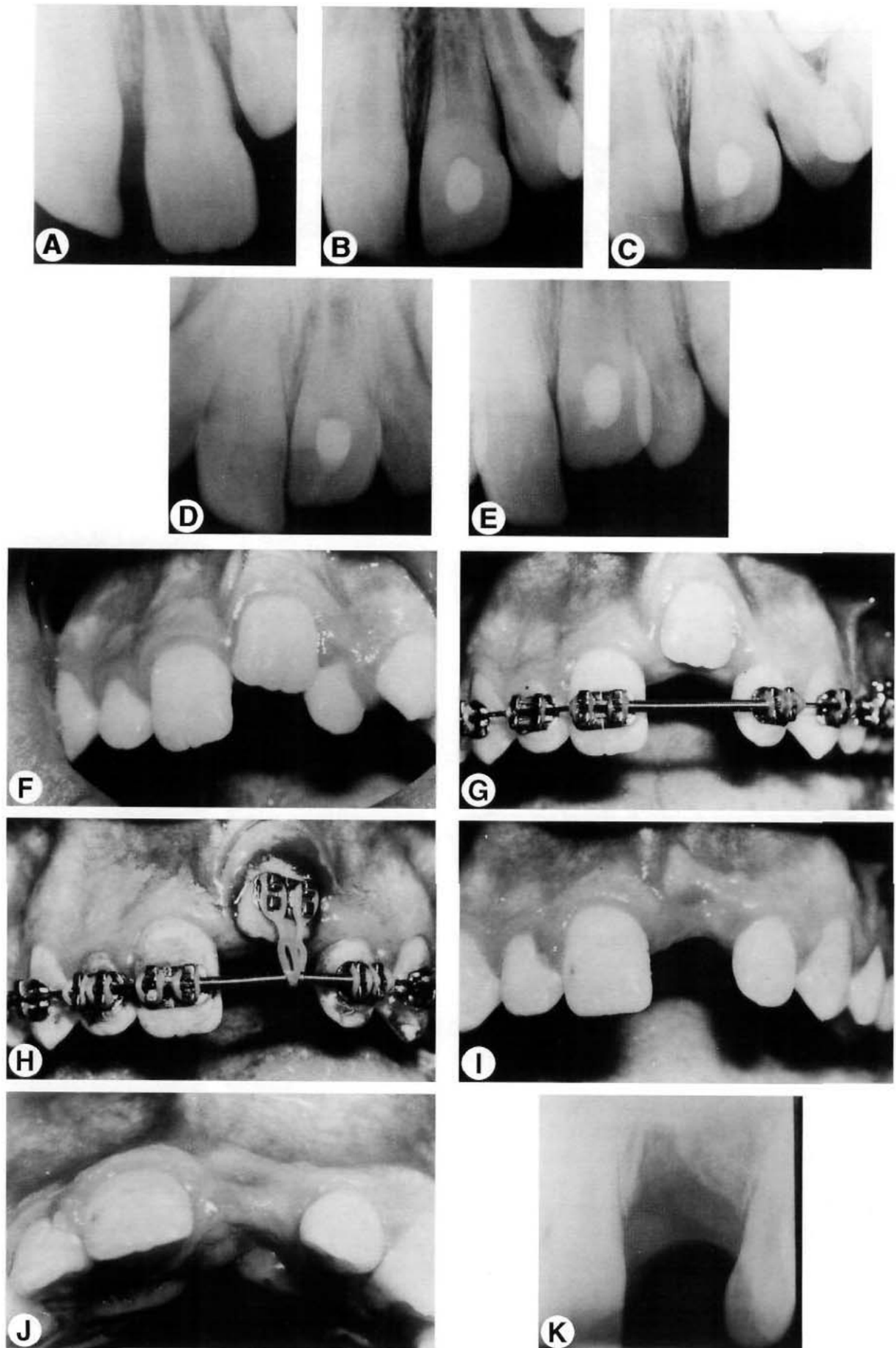


Figure 2

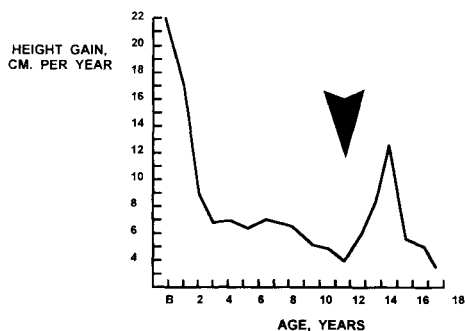


Figure 3. A time line graph showing the height gain each year from birth to age 18. The extent of an alveolar ridge defect roughly parallels the change in skeletal growth as illustrated by this graph of the growth of DeMontebeillard's son. The severity of a defect could be minimized by removing the ankylosed tooth just at the start of an adolescent growth spurt. (arrow). (Reprinted with permission from Tanner JM. *Growth at Adolescence*, ed 2. Blackwell Science, Ltd, 1962).

spurt relative to the median age of rapid growth for boys or girls.

3. Make note if beard growth is starting in boys or if breast buds are forming in girls. The start of a beard in boys or breast buds in girls indicates pubertal changes that accompany the start of adolescent rapid growth.

4. Compare the height of a male patient to that of his father or a female patient to that of her mother. The larger the discrepancy in height between child and parent, the greater the likelihood of a large change in infraposition of the tooth as rapid growth progresses. The height of older siblings may also act as a guide to the amount of growth yet to come.

5. Be aware that about 80% of growth in girls is completed by menarche. If a young woman has started her period, most jaw growth is completed and there will be little change in the level of the ankylosed tooth.

Information gathered from these questions and observations can indicate if an acceleration of adolescent growth is about to begin and the approximate amount of growth to expect. With this information, the dentist can determine the proper timing for tooth removal or determine whether the tooth should be retained, because the child has already passed most of the adolescent growth spurt.⁴

Based on this information, a clinician can take

advantage of another characteristic of ankylosed teeth. The root of an ankylosed tooth undergoes replacement resorption. Replacement resorption is the progressive resorption of the root which is then replaced by bone. To preserve the alveolar ridge, Malmgren⁵ described a method in which only the crown is removed and the ankylosed root is left in place. Because the root is resorbed and replaced by bone, the height and width of the ridge remains intact. This allows for placement of a more natural-looking restoration.

The rate of replacement resorption is extremely variable. However, about 50% of ankylosed replanted teeth are retained for 10 years.¹ If most of a child's facial growth is complete, the incisal edge of a tooth in slight infraocclusion

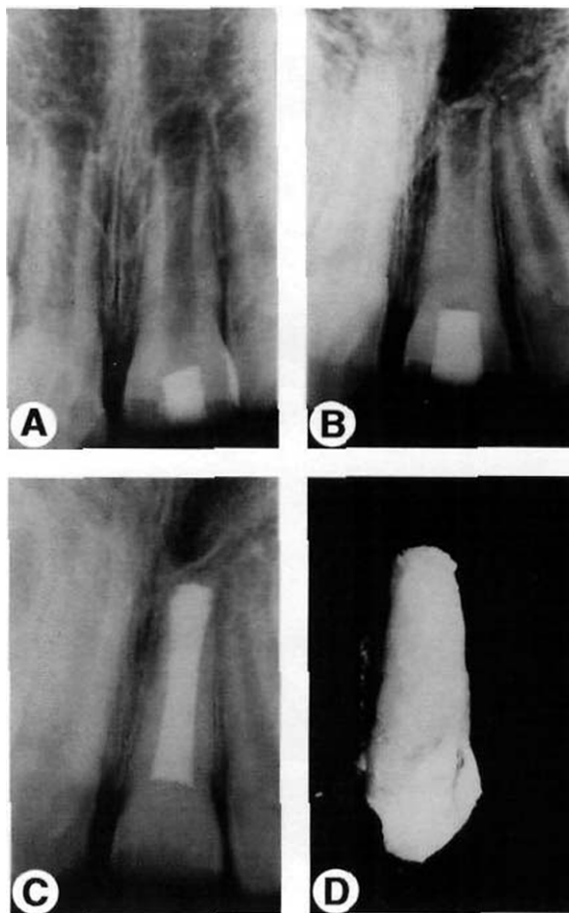


Figure 4. The left central incisor was pulpless with a wide, open apex (A). After 18 months of apexification using calcium hydroxide, a calcific barrier had formed (B), and permitted easier obturation of the root canal (C). In a different patient (D) a tooth with a successful apical barrier was extracted because of fracture.

can be restored to match the level of the adjacent teeth using composite resin bonding or laminates.

These guidelines should help the orthodontist, endodontist, and restorative dentist make an accurate estimate of the start of adolescent rapid growth. This information helps identify the best time to intervene to maximize alveolar ridge development.

Simultaneous Apexification and Active Orthodontic Movement

Pulpal necrosis in an immature tooth leads to cessation of root development. The result is a root with a large canal space and wide-open apex. This lack of apical constriction makes conventional obturation of these teeth difficult and less successful. Apexification is a method of

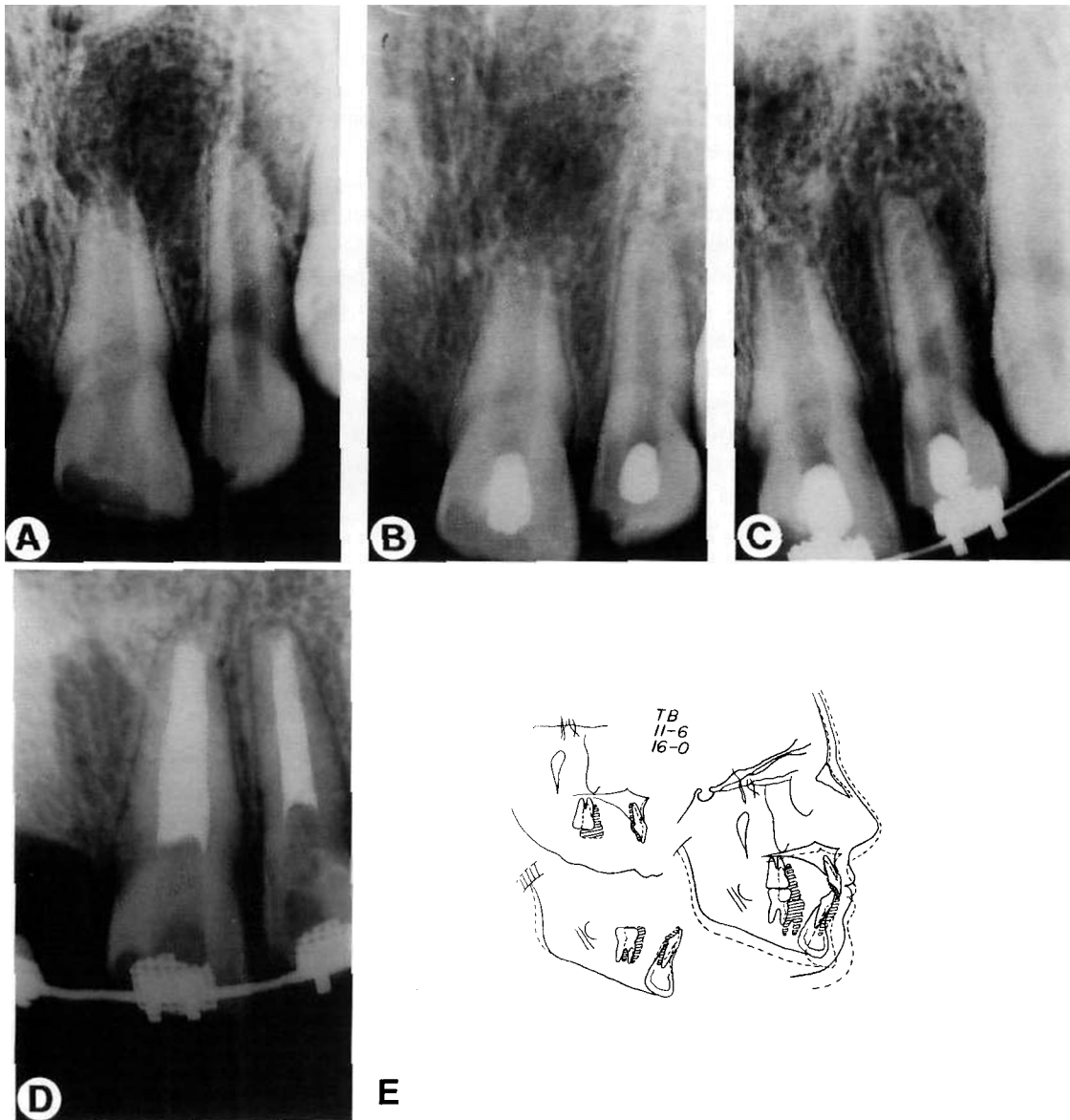


Figure 5. The maxillary central and lateral incisors were pulpless (A). After 7 months of treatment with calcium hydroxide (B) a barrier had formed on the lateral incisor. At the start of orthodontics (C), the central incisor apex had a partial barrier and at the completion of orthodontics (D and E) both teeth had complete calcific barriers despite the tooth movement.

inducing a calcified apical barrier in an incompletely formed root of a pulpless tooth. It has now become a routine endodontic procedure (Fig 4). The treatment involves the use of calcium hydroxide to fill a debrided, biomechanically prepared immature root canal. The calcium hydroxide leaches from the canal over time and needs to be replenished every 3 to 6 months. However, apexification may take between 6 to 24 months to induce formation of an apical barrier. Some patients requiring this regimen are at an age when orthodontic treatment should be initiated. By delaying the start of orthodontic treatment, the optimal time to influence orthodontic change in an area could be compromised.

Will active orthodontic movement affect formation of an apical barrier on a tooth undergoing an apexification procedure? A typical example of teeth undergoing apexification and active orthodontic movement is shown in Figure 5. An 11-year-old patient had a bicycle accident at age 10. Endodontic evaluation revealed that the maxillary left central and lateral incisors were pulpless (Fig 5). These teeth had wide open apices and a 17×15 mm periapical lesion. Apexification procedures were initiated and 7 months later the patient returned for evaluation of the teeth and replacement of the calcium hydroxide. The periapical lesion had resolved. The left lateral incisor had started to form an apical barrier. No apical barrier was evident at the apex of the central incisor. One year after starting apexification, active orthodontic movement was initiated. An endodontic evaluation at that time showed a fully formed barrier on the lateral incisor and a partially formed barrier on the central incisor. Calcium hydroxide was replenished at that time. It was replaced again 6 months later. Two years after beginning endodontic treatment both teeth had fully formed apical barriers. The canals were obturated with gutta-percha at that time. Orthodontic treatment was completed 6 months later. The preorthodontic and postorthodontic cephalometric superimposition shows that although the maxillary central incisors had moved during the apexification process, the apical barrier had formed successfully.

Anthony⁶ has reported a successful apexifica-

tion procedure during active orthodontic movement. A calcific barrier develops even with ongoing resorption and apposition during orthodontic movement. The tooth movement does not appear to inhibit or retard barrier formation. Also, a tooth undergoing simultaneous apexification and orthodontic movement does not seem to be more susceptible to apical resorption, which is similar to Spurrier's findings that endodontically treated mature incisors resorbed significantly less than vital incisors.⁷

The thin walls of an immature root undergoing apexification are more likely to fracture. Cvek⁸ has reported that the frequency of cervical root fracture is about 28% in teeth with a wide, open apex and a nearly completed root length. If teeth have a divergent apical opening and only half of the root has formed, the frequency of cervical fracture can be as high as 77%.

Even with the increased chance of fracturing, these teeth should not be arbitrarily extracted. They help to preserve the developing alveolar ridge, act as a space maintainer, and preserve the natural appearance of the site. If the tooth eventually fractures after the completion of facial growth, a permanent replacement can be more favorably placed.

References

1. Andreasen JO, Andreasen FM. Textbook and Color Atlas of Traumatic Injuries to the Teeth (ed 3). Copenhagen: Munksgaard, Mosby, 1994.
2. Graber TM, Swain BF. Orthodontics Current Principles and Techniques. St. Louis MO: Mosby, 1985.
3. Tanner JM. Growth at Adolescence (ed 2). Oxford: Blackwell Scientific, 1962.
4. Steiner DR. Timing of extraction of ankylosed teeth to maximize ridge development. *J Endodon* 1997 (in press).
5. Malmgren B, Cvek M, Lundberg M, et al. Surgical treatment of ankylosed and infrapositioned reimplanted incisors in adolescents. *Scand J Dent Res* 1984;92:391-399.
6. Anthony DR. Apexification during active orthodontic movement. *J Endodon* 1986; 12:419-421.
7. Spurrier S, Hall S, Joondeph D, et al. A comparison of apical root resorption during treatment in endodontically treated and vital teeth. *Am J Orthod Dentofac Orthop* 1990;97:130-134.
8. Cvek M. Prognosis of luxated nonvital maxillary incisions treated with calcium hydroxide and filled with gutta percha. A retrospective clinical study. *Endodon Dent Traumatol* 1992;8:45-55.