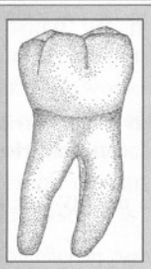
CHAPTER 3



Endodontic Emergency Treatment

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Approximately 90% of patients requesting treatment for the relief of pain to a dental office have pulpal and/or periapical disease and thus are candidates for endodontic therapy. This fact was originally reported by Mitchell and Tarplee and then reaffirmed by Hasler and Mitchell in an exhaustive study of 1628 patients with toothaches. Not all these people will receive endodontic treatment. Some of the involved teeth may not be treatable or restorable, whereas some of the patients may not be interested in saving the affected tooth or be able to afford the required treatment. However, 90% of those calling the office for relief may be potential endodontic patients.

Despite this impressive information, if one examines dental publications or programs for dental society meetings, articles or presentations on endodontic emergency treatment are conspicuous by their absence. At the time of the writing of this edition, infection control, esthetics, implants, and practice management seem to have a huge segment of the postdoctoral information market. However, knowing how to treat successfully and adequately 90% of those requiring pain relief represents a huge segment of problems to be solved in any dental office.

In addition to the pain experienced by the patient, the need for endodontic emergency treatment usually has some upsetting effect on the practitioner. Time must be taken from another scheduled patient to dispense the needed relief. Being conscientious, the dentist wishes to spend any necessary time that is required to get the patient out of pain yet wishes to disrupt the normal schedule only minimally.

This chapter will discuss the methods essential in making a rapid yet accurate diagnosis of pulpal and periapical pain, the kinds of emergency treatment needed to relieve pain, and the correct procedures to follow to gain a successful endodontic result.

EFFECTS OF EMERGENCY TREATMENT

Flare-ups Even with the Best Therapy

There is often some embarrassment felt by dentists when one of their patients requires emergency treatment. They may believe that the painful episode could have been prevented or that it was caused by their past dental work. This feeling should be dispelled because a flare-up may occur sometimes with the best therapy, and a particular exacerbation may not be directly associated with recent treatment.

An excellent example of this situation is a patient requiring replacement of an old and inadequate restoration for a tooth with a chronic pulpitis. Because the pulp had been in a quiet state, the operator was unaware of the true condition. As a result of cavity preparation, impressions, temporarization, and restoration placement, the chronic pulpitis was converted to an acute situation, and pain developed. However, the tooth has received a better restoration as a result of treatment. Although the major source of pulpal irritation may have occurred many years earlier when the previous work was performed, the present treatment might be erroneously blamed as the major source of the problem.

It is impractical to remove every deep restoration to examine the underlying tooth structure, particularly when there is no clinical or radiographic evidence of damage. Teeth with fillings or bases in proximity to the pulp may be difficult to evaluate with available diagnostic aids. Also, the response to pulp injury varies with individuals. The pulps of some patients may have an excellent recovery after extensive operative procedures, whereas in others pulp tissue will remain in a permanently damaged state after less complex treatment, even if all the normally used pulpal protective agents and devices are utilized.

Emergencies in Cases under Construction

During the course of tooth preparation, pulp exposure or irreversible damage may occur without the operator's realizing the situation. In excavating the last vestiges of decay or preparing abutments for parallelism, a wafer-thin wall of dentin may remain that is sufficient to protect the pulp to withstand the procedures that follow. A pulp exposure may occur in a tooth with chronic pulpitis or pulp necrosis, and thus no bleeding occurs to alert the dentist. Within a day or two of such an occurrence, the patient probably suffers a serious toothache, and an endodontic emergency has developed. This type of pain is much more severe than the sensitivity to thermal changes normally associated with many operative procedures.

Method for Reaching New Patients

As stated earlier, programs on practice management are very popular at present. Intensive courses are given on how to attract and then retain new patients into a dental practice. Such programs are often given by various combinations of psychologists, time and money management experts, and marketing analysts.

In my opinion, efficient and effective endodontic treatment is one of the best ways to attract and retain new patients into a specific practice. A patient coming into a dental office for the first time, in pain and in jeopardy of losing a tooth, is in a very vulnerable position.

If applicable, at the time of the emergency appointment the dentist should suggest that endodontic therapy might be employed to retain the involved tooth. If the necessary treatment is administered and the pain is relieved, patients are impressed with the dentist's interest in their oral health, as shown by preventing an extraction and by the effectiveness of the treatment. In these circumstances, it would not be unusual for the patient, prompted by the excellence of the emergency treatment, to make further appointments for evaluation of dental problems and needed therapy.

Sometimes the need for endodontic emergency treatment may be considered to be beneficial for both the patient and the dentist. Some potential patients avoid dental treatment for various reasons, most often fear, but are forced to seek relief due to pain. If treated by a caring person, with skill and effectiveness, such a patient can be won over, proper treatment can be gained for any and all dental problems present, and the patient can be on the way to dental health.

Demonstration of Continued Interest in Past Patients

In addition to reaching new patients, effective emergency treatment reassures the patient already within the practice that the dentist is maintaining a continued interest. If an emergency befalls a patient during the interim period between checkup appointments, the necessary treatment must be promptly provided. The patient's feelings about the need for an emergency appointment may not coincide with a true emergency as far as the dentist is concerned. However, if patients are not obliged in what they consider their time of need, they have every right to be upset. Recurrence of procrastination in these circumstances may lead to the loss of patients so handled.

Self-Satisfaction

In addition to the relief that the patient feels after successful emergency treatment, the dentist feels a definite amount of self-satisfaction. The patient came in with a serious problem, consisting of pain and the threat of tooth loss. By correct endodontic emergency treatment, the pain is relieved, yet the endangered tooth is to be retained. The hero of this drama is the dispenser of this excellent treatment, and the dentist has every right to feel proud of the work.

INITIAL THERAPY FOR "HOT" TEETH

Initial therapy for "hot" teeth refers to what needs to be done to give relief from pain at the first appointment for a tooth with pulpal or periapical involvement. Further portions of this chapter will discuss the needed emergency treatment for a tooth for which endodontic therapy had already been started and for traumatic injuries.

Two types of emergency treatment will be described and are listed in Table 3-1; choosing one or the other depends on the time available for administering therapy. If little time is available and the emergency treatment must be dispensed while seeing the patient in pain between normally scheduled patients, a specific regimen will be presented. However, if a full appointment is available without time constraints, a longer treatment session will be described. In all circumstances, the suggested therapy is designed to get the patient out of pain and retain the relief of pain for a reasonable amount of time—until the patient can be fit into the regular schedule again. Getting the patient out of pain for a short while, only to be seen again in pain very soon, is counterproductive.

Need for Making Diagnosis

Before any endodontic treatment is performed, of either routine or emergency nature, an accurate diagnosis must be made to determine what is wrong. A classification of pulpal and periapical disease is made because each major category of clinical condition requires slightly different treatment. If an indifferent attempt is made in diagnosis and the wrong condition is thought to be present, an



TABLE 3-1 Emergency Treatment for "Hot" Teeth

Diagnostic Tests		*Condition of Periapical Tissues According to Radiograph*	*Clinical Condition*	*Treatment, Minimal or Considerable Amount of Time Available*	*Medicament*	*Open/Close*
Pulp Vitality	*Percussion*					
+	0	Normal	Acute pulpitis	Minimal amount of time:		
				Single-rooted tooth—pulpectomy	None	Close
				Multirooted tooth—pulpotomy	Formocresol	Close
				Considerable amount of time:		
				Single-rooted tooth—pulpectomy and canal preparation	None	Close
				Multirooted tooth—pulpectomy	None	Close
+	+	Normal to slight thickening to small radiolucency	Acute pulpitis with acute apical periodontitis	Minimal amount of time:		
				Nonmolar—pulpectomy	None	Close!
				Molar—pulpectomy of largest canal	CMCP	Close!
				Considerable amount of time		
				Nonmolar—pulpectomy and canal preparation	None	Close!
				Molar—pulpectomy	None	Close!
0	0	Radiolucency	Pulp necrosis	Canal debridement	None	Close
0	+	Small to large radiolucency, may be diffuse	Acute periapical abscess	Minimal amount of time:		
				Not most reliable treatment		
				Incision and drainage, preferably through tooth; otherwise through tissue	Often systemic antibiotics	Open
				Second appointment, canal debridement	None	Open
				Third appointment, irrigate and dry, **do not file**	None or sulfa point	Close
				Considerable amount of time:		
				Better treatment than above Open through tooth and let drain until exudation stops; mild preparation; treat as described in Fig. 3-11	None	Close

incorrect method of therapy will be initiated. This is particularly serious in emergency treatment because a minimal amount of time is available due to the press of other patients, and the patient in pain may have an increase in symptoms if the wrong treatment is provided.

Fortunately the conditions that require emergency endodontic treatment may be divided into four major categories, each requiring different handling for relief of pain but all based on making only two clinical determinations. The four conditions are acute pulpitis, acute pulpitis with apical periodontitis, pulp necrosis, and acute periapical abscess. Any acute condition may have been converted from a chronic inflammation or may be the initial inflammatory lesion. The exact pathogenicity is really not too important at the time of the emergency treatment because the major objective is to relieve the pain rather than decide what conditions preceded it.

Table 3-1 summarizes the emergency treatment required for initial endodontic therapy for patients in pain. After a diagnosis is made, on the basis of response to pulp testing and percussion, the needed treatment, medication, and closing of the access preparation are listed.

Types of Diagnostic Aids Needed

According to Table 3-1, three clinical determinations are required before instituting endodontic emergency treatment: (1) determine the presence or absence of pulp vitality, (2) analyze the reaction of the offending tooth to percussion, and (3) evaluate the radiograph.

As discussed in Chapter 2, the thermal tests for reaction to heat and cold and the electric pulp tester are the most reliable diagnostic aids for determining pulp vitality. The test cavity may be employed if question still exists. For cold, using either ice sticks or ethyl chloride spray is best. Either hot gutta-percha or rubber wheeling on metal restorations is used for heat.

In some cases no diagnostic aid is needed to establish that the pulp is vital, but merely questioning of the patient is sufficient. If the patient supplies the facts that changes in temperature either increase or decrease pain, the pulp is considered to have vitality.

Percussion is an important test because it determines whether inflammation has extended to the periapical tissues. The test, also described in Chapter 2, is best performed by lightly tapping the teeth with the butt end of a mirror handle.

Radiographs are critically important in all stages of endodontic therapy, particularly in deciding on the correct emergency treatment when minimal time is available to gain pain relief. The presence or absence of a periapical lesion, or even a thickening of the periodontal ligament, may dictate different therapy. As discussed in Chapter 2 and as seen in Figures 3-1, 3-3, 3-9, and 3-10, each of these conditions requires individual analysis as related to other clinical symptomatology to arrive at the correct form of treatment.

Acute Pulpitis. For a diagnosis of acute pulpitis to be made, the pain must be coming from a vital pulp in a tooth without tenderness to percussion. These two determinations establish that the inflammation has not yet reached the apical portions of the root canal and probably is confined to the coronal pulp. Radiographically there is no change from normal in the periapical tissues because the inflammation has not reached that area. However, some cause of coronal pulp inflammation, such as deep caries, extensive restoration, trauma, or pulp capping, must be shown (Figure 3-1).

Accordingly, when minimal time is available, in a posterior tooth the correct emergency treatment is a pulpotomy. Local anesthetic is administered and the correct access cavity prepared (Chapter 4). By means of spoon excavator and large round bur, the coronal portion of the pulp is removed, leaving vital tissue inside the pulp canals (Figure 3-2, *A*). A cotton pellet is moistened with formocresol and placed over the canal orifices for 1 minute. This pellet is discarded; a new pellet very lightly dampened with formocresol is placed in the chamber (Figure 3-2, *B*), and the access cavity is closed with zinc oxide–eugenol (ZOE), accelerated with zinc acetate crystals (Figure 3-2, *C*). The patient is then given another appointment for completion of the endodontic treatment.

Only a pulpotomy need be performed at the emergency appointment for acute pulpitis because the pulp in the roots probably has remained in a relatively normal condition. After removal of the tissue in the chamber, the site of inflammation precipitating a painful response is gone. The action of the formocresol is to fix the noninflamed tissue left in the root until subsequent treatment thoroughly debrides the canal contents. Because formocresol is caustic, its action must be kept within the pulp canals. As long as vital tissue remains between the drug and the periapical tissues, there is little chance of periapical damage. Therefore neither of the cotton pellets used within the chamber is to be saturated with formocresol; if a complete pulpectomy is performed at the



FIGURE 3-1 Radiograph reveals large carious lesion with probable pulp exposure but no deviation from normal in periapical tissues.

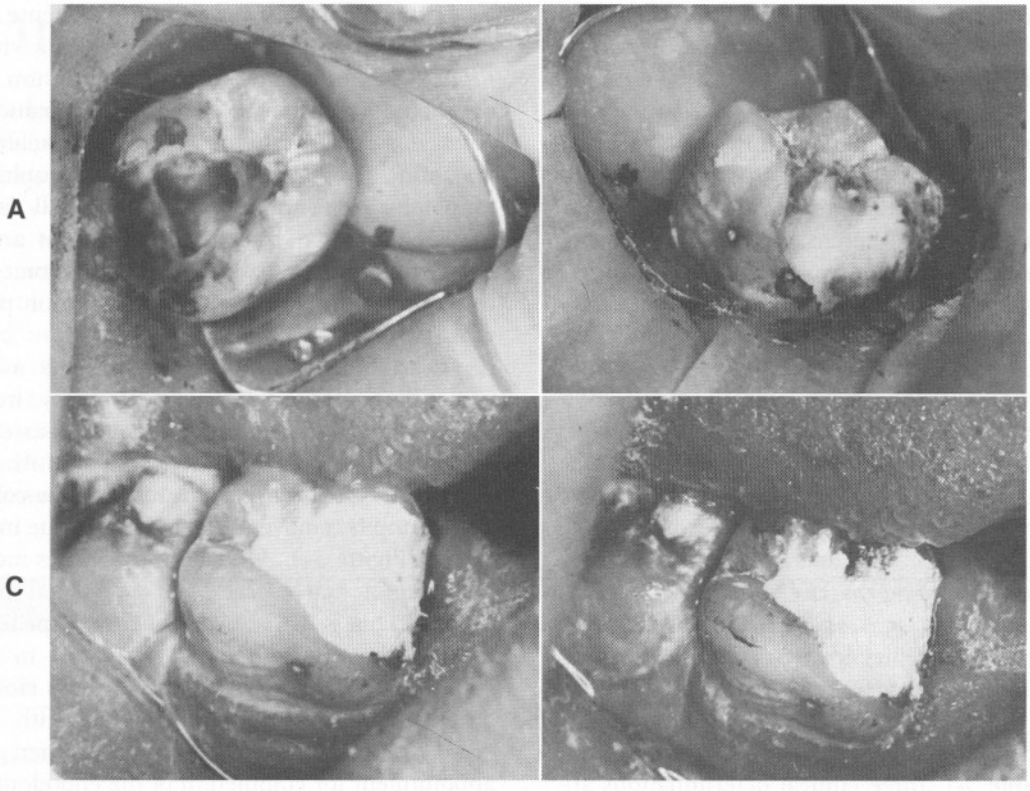


FIGURE 3-2 **A,** Coronal pulp is removed, leaving vital tissue within canals. **B,** Cotton pellet dampened with formocresol is placed over canal orifices. **C,** Preparation is closed with zinc oxide–eugenol (ZOE). **D,** Marking paper indicates that no high spots exist on temporary restoration, which might cause dislodgement. The patient may now be released.

emergency appointment, an alternative medication should be used.

In single-rooted teeth, it is just as easy to remove the pulp totally as to perform a pulpotomy at the emergency treatment for acute pulpitis. Accordingly, this procedure is followed if sufficient time and canal width allow for complete pulpectomy. With the entire pulp removed, a cotton pellet with no drug is sealed in as before with ZOE.

After the temporary seal is placed, occlusion should be checked with marking paper to ascertain that no high spots exist (Figure 3-2, *D*). Supraocclusion might cause a pericementitis. This would complicate the next phases of endodontic therapy because the healing of periapical tissue is the objective of any endodontic treatment. Also, if the temporary seal is too high, portions of the ZOE might break out, opening the access preparation to the contaminants of saliva. Because one of the important factors in treating an acute pulpitis is to keep the tooth sealed between appointments, loss of the temporary filling would be undesirable.

When considerable time is available at the emergency visit, more treatment may be afforded. In multirooted teeth a complete pulpectomy may be performed rather than merely a pulpotomy. The removal of the entire pulp will ensure that the pain that brought the patient to the dental office will be eliminated. With the entire pulp removed, no medicament is necessary, and the access is closed with a dry, sterile cotton pellet and ZOE.

For single-rooted teeth with more time available, the pulpectomy is performed, and then the working length is calculated (Chapter 6), followed by initiation of canal preparation. Again, no medicament is needed, and the access is closed as with multirooted teeth.

Acute Pulpitis with Apical Periodontitis. The most difficult emergency condition to treat is acute pulpitis with apical periodontitis. This is particularly true in mandibular molars, where an insufficiency in depth of anesthesia is not an uncommon problem. Considerable time is usually required for the emergency treatment of this condition because the inflamed tissue that must be removed is in the apical portion of the root canal.

The diagnosis of acute pulpitis with apical periodontitis is usually simple to make. The patient is aware of the tooth's tenderness to percussion and may request that the dentist not tap that particular member of the arch during the oral examination. In the most typical classic situation, heat causes the intense pain, whereas cold relieves. Some patients may actually come to the dental office with a glass of ice water that they have been taking periodically to keep the pain to a minimal level of intensity. Sensitivity to both heat and cold is not unusual.

Therefore the determinations of tooth vitality and tenderness to percussion are obvious.

A radiograph of a tooth with acute apical periodontitis may show a small periapical radiolucency, exhibit a thickening of the periodontal ligament space, or appear normal (Figure 3-3). In a multirooted tooth, one root may show one radiographic condition, whereas another root may demonstrate a different situation.

Heavy dosage of local anesthetic is administered, with two Carpules being required for most posterior teeth. The correct access cavity is prepared (Chapter 4). In some cases when the pulp has been severely inflamed for a considerable time, the patient may complain of sensitivity to access preparation, even after good signs of paresthesia have been obtained, increasing in intensity as the pulp is approached. When this occurs, the proper approach is to be sympathetic about the patient's pain, explain that the severe inflammation has prevented the anesthetic from attaining full effectiveness, and request the patient to endure a few more minutes of discomfort until anesthetic can be applied directly to the irritated tissue. When water spray is used to complete the access preparation, its cooling effect may make approach to the pulp more endurable.

Once a hole in the roof of the chamber has been opened, anesthetic is applied directly to the vital pulp (Figure 3-4), and generally no further pain will be experienced.

Best therapy for the condition is a complete pulpectomy, and this should be performed in nonmolar teeth in all cases and in molar teeth when sufficient time is available. The inflamed tissue in an acute pulpitis with acute apical periodontitis is found in the apical portion of the canal(s). If only a pulpotomy is performed, the patient probably will not gain relief from pain. It is the pulp near the apex that must be removed.

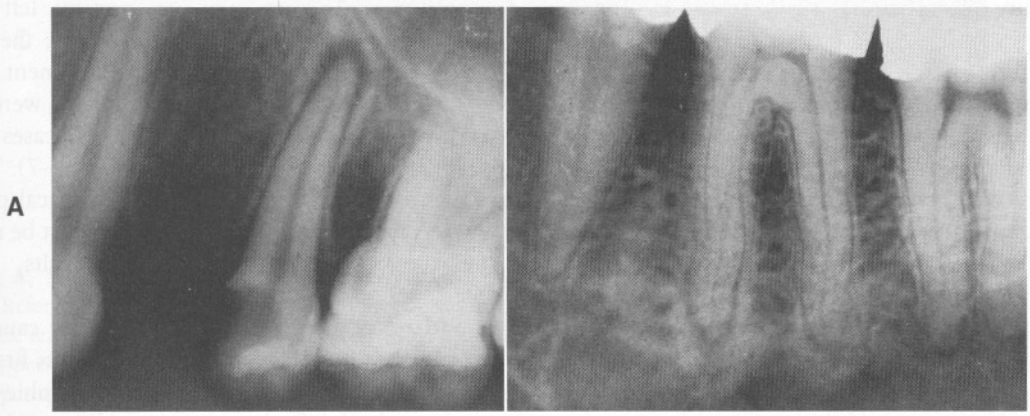


FIGURE 3-3 **A,** Radiograph reveals small radiolucency around apex of maxillary second bicuspid. **B,** Radiograph shows thickening of periodontal ligament space on mesial root, but no apparent change adjacent to distal root of the mandibular first molar. Radiopacity around both roots indicates presence of pulpoperiapical osteosclerosis. Both teeth were tender to percussion and had vital pulp tissue. Diagnosis of acute pulpitis with apical periodontitis was made for each.

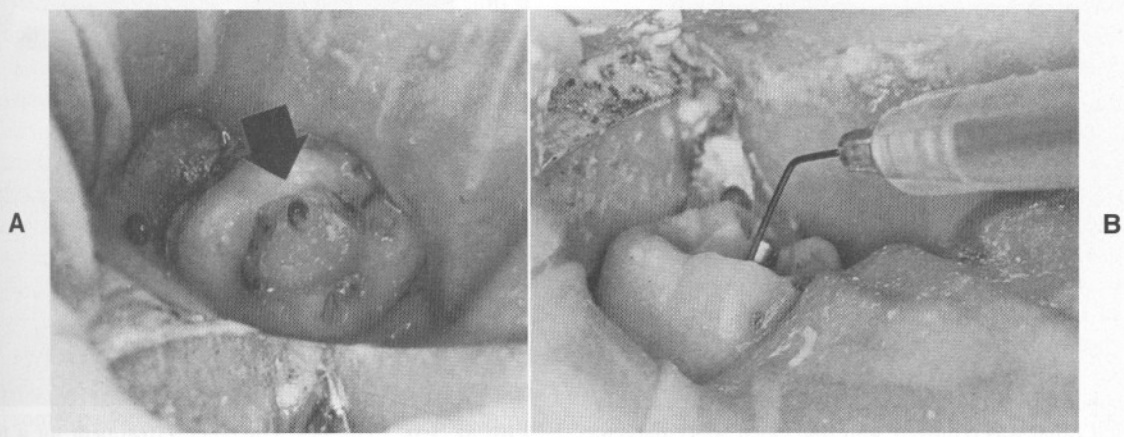


FIGURE 3-4 **Direct injection into pulp. A,** Small hole is drilled through roof of chamber *(arrow)*. Entire roof must not be removed because the intrapulpal injection will not be effective. **B,** Injection solution is forcibly injected into pulp through the small hole in roof of chamber.

Although complete pulpectomy is feasible in nonmolar teeth in minimal time, this is rarely possible if a molar is causing the problem. Therefore it is permissible in this condition for a complete pulpectomy to be performed on the largest canal only in the molar tooth, that is, the palatal canal of a maxillary molar or the distal canal of a mandibular molar (Figure 3-5). This will involve the taking of a radiograph and removal of bulk tissue, but this procedure still requires much less time than a complete pulpectomy and usually is effective.

Generally the single-canal pulpectomy for molar teeth works well to gain relief because it is the largest canal that usually houses the tissue carrying the pain in an acute pulpitis with acute apical periodontitis. However, in a low percentage of cases the inflamed tissue causing the pain will be in the undebrided smaller canals. In that instance, not only will pain relief not be obtained, but the pain might intensify. The patient should be called the next day after the emergency treatment to verify that the condition has been alleviated. If not, another appointment must be scheduled quickly, and then all the remaining pulp is removed.

If sufficient time exists, the complete pulpectomy is preferable for molar teeth with this condition. Care must be exercised to ensure that all canals have been located and debrided. This means that radiographs with files in place (Figure 3-6) must be taken and evaluated. The second distal canal of a mandibular molar or a second canal in a maxillary second bicuspid may house sufficient pulp tissue to cause a continued painful condition if undiscovered and hence uncleaned. The access cavity is closed with a sterile cotton pellet and ZOE, accelerated with zinc acetate crystals, and the occlusion is checked. For some erroneous reason, many practitioners believe that any tooth that is tender to percussion before treatment should be left open at an emergency appointment to gain pain relief. Nothing could be further from the truth. Although it is true that leaving open a tooth that has a condition of acute pulpitis with apical periodontitis will diminish the pain response initially, such relief will be merely transitory. Unless the apical tissue is removed, pain must return, and after the tooth has been open, the inflamed tissues will be further irritated by the ingress of contaminants from the oral fluids.

Even though some relief may have been gained, the later treatment will have been greatly complicated. In one study, Weine et al investigated the total number of appointments needed to complete treatment after teeth with vital pulps had been left open at the emergency appointment. When such teeth were left open, 5.11 appointments were needed to complete therapy and 25 out of 81 cases exacerbated during treatment. However, in teeth kept closed, 3.31 appointments were needed to complete therapy and only 11 of 144 cases exacerbated during the course of treatment (Figure 3-7). Therefore, in the condition of acute pulpitis with apical periodontitis, all the pulp tissue within the canals must be removed and the access cavity sealed to gain best results.

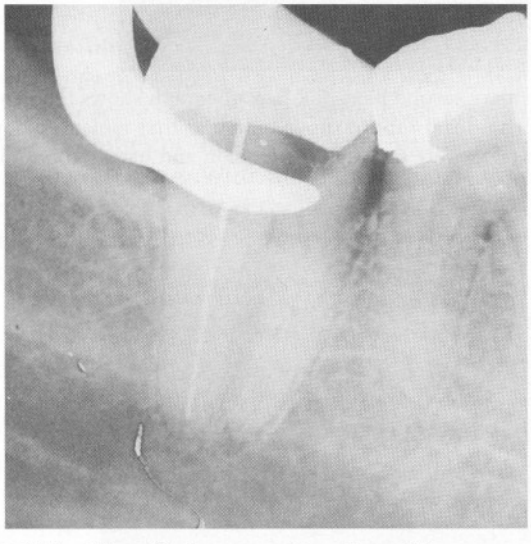


FIGURE 3-5 Mandibular second molar with preoperative symptoms of tenderness to percussion, severe pain, and a vital pulp, indicating an acute pulpitis with acute apical periodontitis. Because minimal time was available for the emergency appointment, a pulpotomy was performed, the pulp from the distal canal was removed, and that canal was enlarged. The patient was free of pain that evening. Had more time been available, a complete pulpectomy would have been the treatment of choice.

Pulp Necrosis. Pulp necrosis rarely causes an emergency procedure. Usually the condition is first discovered through periapical films during radiographic examination or through the findings of a swelling or distention of periapical tissue during digital examination. However, the patient may notice a swelling and request emergency

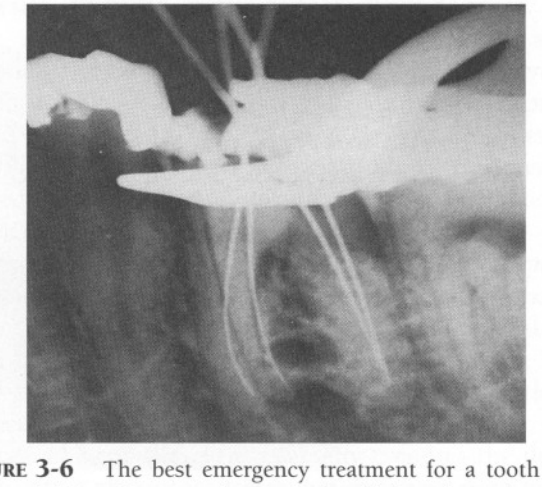


FIGURE 3-6 The best emergency treatment for a tooth with acute pulpitis and acute apical periodontitis is to have the entire pulp removed. In mandibular molars, the possibility of tissue remaining in a second distal canal must be managed.

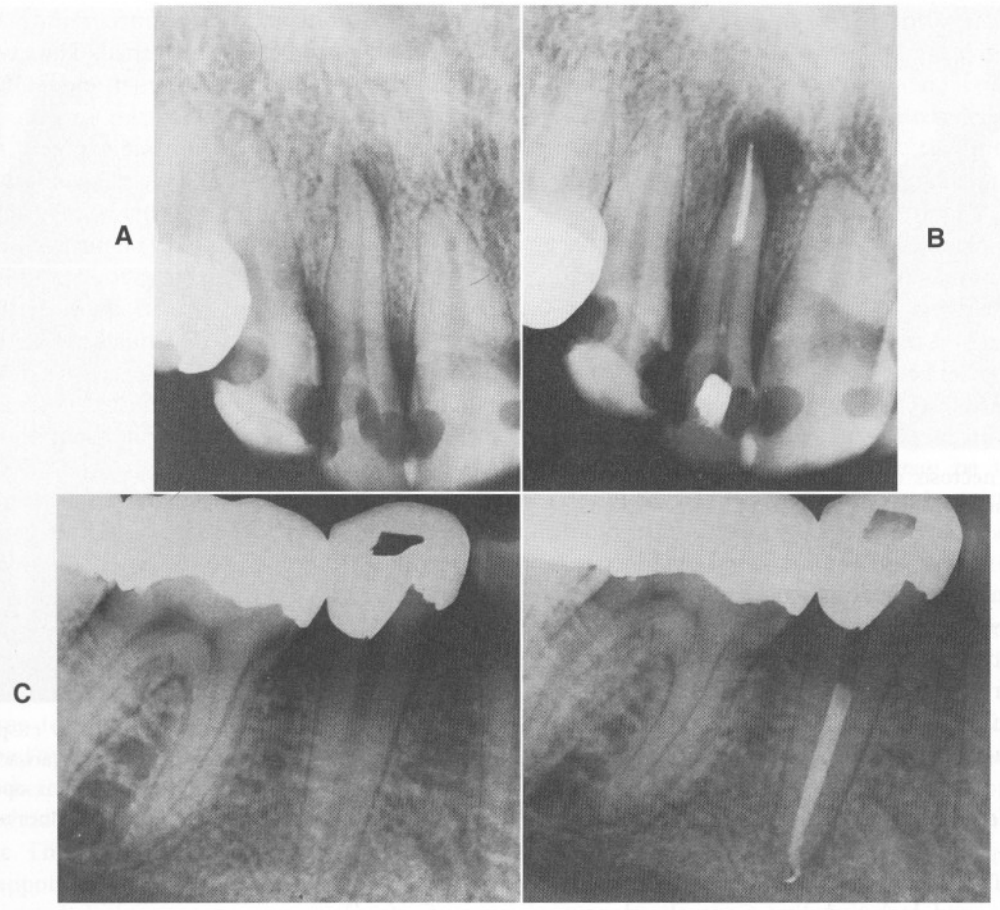


FIGURE 3-7 **A,** Maxillary lateral incisor was referred for treatment after having been left open at the emergency treatment appointment. Referring dentist reported that pulp had been vital; but because some periapical damage was seen on radiograph and the tooth had been tender to percussion, it was decided to keep the access open. **B,** After six appointments and two intratreatment exacerbations, periapical surgery was performed. **C,** Mandibular second bicuspid referred for treatment after being left open at an emergency appointment. Tooth had been tender to percussion, but pulp was vital. **D,** Seven appointments were required to complete the case, and the tooth exacerbated twice. Both these teeth would have been much easier to treat if the access cavities had been kept closed.

treatment. Even though a true emergency does not exist, a patient with this problem must not be kept waiting more than a day or two. The area might become acute and a severe condition result. The patient may worry excessively about the situation and attempt to incise the area or use local phlogistic agents (Figure 3-8).

The radiograph usually reveals a radiolucency ranging from a definite thickening of the periodontal ligament space to a large periapical lesion (Figure 3-9). If the apex of the root is close to the buccal plate or protrudes through it, no periapical change may be evident. The tooth is not sensitive to percussion, or is only mildly sensitive, and does not respond to pulp vitality tests.

The proper treatment for pulp necrosis is canal debridement. No anesthetic is necessary in most instances, although some patients may insist that one be administered despite explanations by the dentist that the pulpal nerve tissues are no longer responsive. In some cases there are still enough pain receptors to cause discomfort during

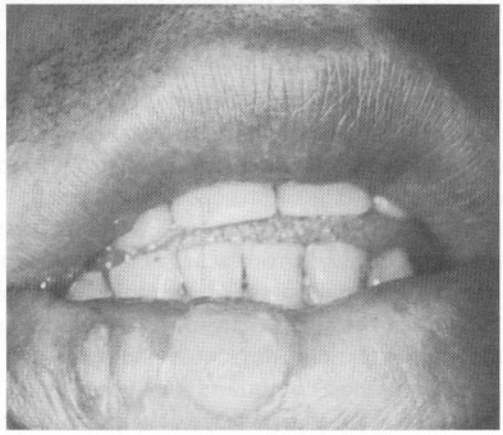


FIGURE 3-8 Aspirin burn. Patient placed a tablet on a chronic draining sinus tract in mandibular areas and held it in place with his lip.

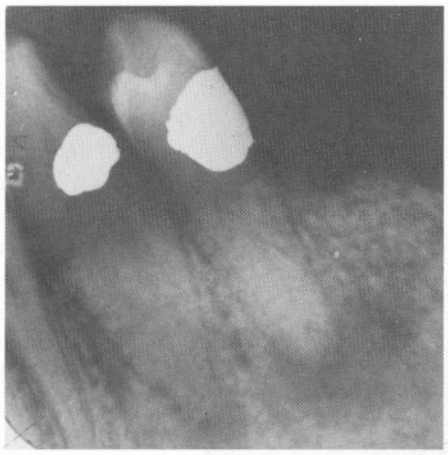


FIGURE 3-9 Pulp necrosis of mandibular cuspid with small periapical radiolucency and first bicuspid with a larger lesion.

the procedure, and anesthetic may be required. The correct access cavity is prepared and the tooth length determined. Sufficient canal enlargement with heavy irrigation (Chapter 5) is performed to permit removal of the necrotic pulp tissue, a pellet of cotton is placed in the chamber, and the access is sealed with ZOE.

Acute Periapical Abscess. The diagnosis of acute periapical abscess is obvious. The patient has a large diffuse swelling; the responsible tooth is tender to percussion, is mobile, and lacks vitality. Generalized pain may be absent despite the discomfort of the swelling. In many patients, pain is present before the swelling occurs as the toxic products build up pressure. Once the bone is perforated and there is room for the exudate to expand through the soft tissues, pain may be relieved and certainly is lessened.

Radiographs for acute periapical abscess range from no periapical change, when the inflammation is rapid, to definite radiolucency (see Figures 3-10, *A*, and 3-11, *A*). In the latter case the acute abscess may develop from a chronic lesion, whereas in the former the abscess is acute before it has had a chance to destroy sufficient periapical tissue for radiographic visualization.

Whenever possible, the acute periapical abscess should be incised and drained through the root canal space, even if this requires damage to an existing restoration (Figure 3-10). The indications for an incision and drainage (I and D) through the tissue are few but are discussed in this chapter. The correct access cavity is prepared, always using the highest-speed handpiece available to minimize the vibrations that are so painful in this condition. If the patient still experiences painful vibrations, stick impression compound may be softened by hot tap water and tightly placed across the labial surfaces of the abscessed tooth and the teeth adjacent. Cool water makes the compound solidify and acts as a splint to lessen the vibrations.

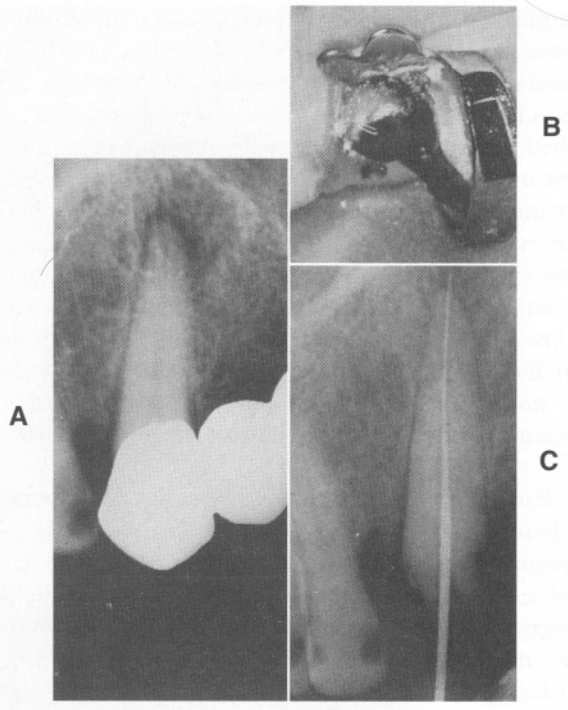


FIGURE 3-10 **A,** Radiograph of maxillary cuspid with small periapical lesion and clinical symptoms of an acute periapical abscess. **B,** After removal of bridge, canal is opened to allow bloody exudate to discharge. **C,** If drainage does not occur, apex is enlarged with a size 25 or 30 file.

Local infiltration anesthetic should not be administered in the distended area because of the pain caused by injection, the chance for dissemination of virulent organisms, and the ineffectiveness of such anesthesia. Block anesthesia usually is effective, however, and may be administered when the patient remains uncomfortable during the initial phases of the emergency treatment.

In many cases, drainage will occur immediately on removing the pulp chamber roof, with a bloody and/or purulent exudate discharging through the access opening (see Figure 3-10, *B*).

Aspiration using any mild suction device will further aid in establishing drainage through the canal. A wide-gauge needle placed in the saliva ejector will give sufficient negative pressure to establish and maintain exudation in many cases. Other teeth may appear to be dry within the canal, and one might suspect that a noncausative tooth has been erroneously opened or that all the exudate had been discharged through the tissue. This is not correct. What has happened is that the apical constriction is preventing the inflammatory products from draining through the tooth.

To relieve this problem, the apical constriction is purposely violated and enlarged to a minimum of a size 25 or 30 instrument, to allow for exudate drainage through the tooth (see Figure 3-10, *C*). Such a procedure usually results in gaining the desired drainage. Again, negative

pressure aids in continuing the exudation. If drainage does not occur after the use of a size 30 through the apex, do not continue attempting to widen the apex further. If drainage does not result with the size 30, going to sizes as big as 70 or 80 will be equally ineffective and cause potential harm for the completion of treatment.

When sufficient drainage has resulted and if the patient is afebrile, no antibiotic coverage is needed. If the patient is febrile and minimal drainage has occurred, an antibiotic should be prescribed (Chapter 17). When the patient is febrile and drainage has been gained or when minimal drainage has resulted with an afebrile patient, an individualized evaluation must be made to decide whether an antibiotic is needed. It may be well to remain in contact with the patient for the next 24 hours; then only if the symptoms persist should an antibiotic be prescribed.

For many years, after establishment of drainage, the patient was dismissed with the access cavity left open. In most patients, the swelling continued to subside and the symptoms decreased acceptably. The patient was reappointed for further therapy, as will be discussed later, and although some exacerbations did occur, the treatment generally came to a successful conclusion even though four to six total appointments were required.

Recently there has been an alteration in the most desirable method for treating an acute periapical abscess with drainage. This regimen allowed for drainage, but the emergency appointment ended with the access cavity closed. To accomplish this, it was necessary for the dentist to have an extra chair available because the patient had to be allowed to sit with the tooth draining for as long as an hour or even more. Also, the dentist had to have sufficient time available to check on the patient to observe the stages of draining and then be able to do some canal preparation before closing the tooth. For best therapy, it was necessary for a dental assistant to remain with the draining emergency patient while the doctor was in another operatory treating a different patient.

The drainage follows a very predictable pattern, starting with pus of a yellowish, whitish, or greenish color mixed with blood. Gradually the pus decreases, and primarily blood drains. Finally the blood flow decreases, and only a clear serum exudation emerges. The sight of the serous fluid indicates that the forceful exudation has dissipated, and this may take from 15 minutes to well over an hour to occur.

At this point a film with files in place is taken and the correct working length calculated. The canal is enlarged several sizes and then may be closed with a sterile cotton pellet and ZOE. The patient is reappointed from 2 to 5 days later, and therapy is continued. In some cases the patient may have further problems and must be seen the next day. Usually I attempt to allow for more drainage and then reclose one more time. If flare-ups persist, the canal probably is best left open with adjunctive antibiotic treatment.

There are several advantages for this type of therapy. With the tooth kept closed, no new type of microorganism systems are introduced into the infected periapical tissues than were present at the initial opening. This is very significant in teeth with multicanaled systems where ribbon-shaped anastomoses exist going from canal to canal. There is no problem attempting to reclose a tooth left open, and the total number of appointments decreases (Figure 3-11). Neither food nor debris is packed into an open canal. The single major disadvantage is that a very long and sometimes inconvenient initial appointment is needed to start the program.

If it is not possible to allow the time for closing such a tooth, the long-used method of drainage through the canal and access left open may be utilized. Once the drainage has been gained, there is no attempt to close the tooth, thus allowing any further exudation to exit in the interim between appointments; the patient is rescheduled 3 to 7 days later. At that time the canals are enlarged to approximately one size smaller than the estimated final width. Again each canal is left open. The patient is next seen 2 to 7 days later. After the rubber dam is applied, the canals are heavily irrigated, aspirated, and dried with absorbent points. Broaches may be used to remove any debris that has lodged within the tooth, but no files or reamers may be employed.

As suggested by Frank et al, paper points with a sulfonamide powder may be used for intracanal medicament. Sulfanilamide or sulfathiazole powder is obtainable in any pharmacy. A sterile paper point is dampened by dipping into sterile distilled water. The sulfonamide is fluffed in its container by shaking, and the point is inserted. The powder adheres to the dampened point, and one point is placed in each dried root canal. A dry sterile pellet of cotton is placed in the chamber and the access sealed with ZOE. If the patient's medical history indicates an allergy to sulfonamides, that medication is not sealed, but a sterile pellet of cotton is substituted.

The timing for sealing of the access cavity after treatment of an acute periapical abscess requires further discussion. As may be noted in Table 3-1, this condition is the only one that may involve leaving the tooth open as part of the emergency treatment. Clinical experience has shown that when a tooth has been left open, if the access is sealed for the first time at the same appointment in which canal enlargement is performed, some exacerbations will occur. To avoid this, the following rules are made governing closure in cases that have been left open for drainage:

If you file, don't close.
If you close, don't file.

This statement has been misquoted by many dentists and taken out of context for the last few years. Leaving teeth open after filing is done for teeth that have already been left open to discharge an active exudate. If a tooth is

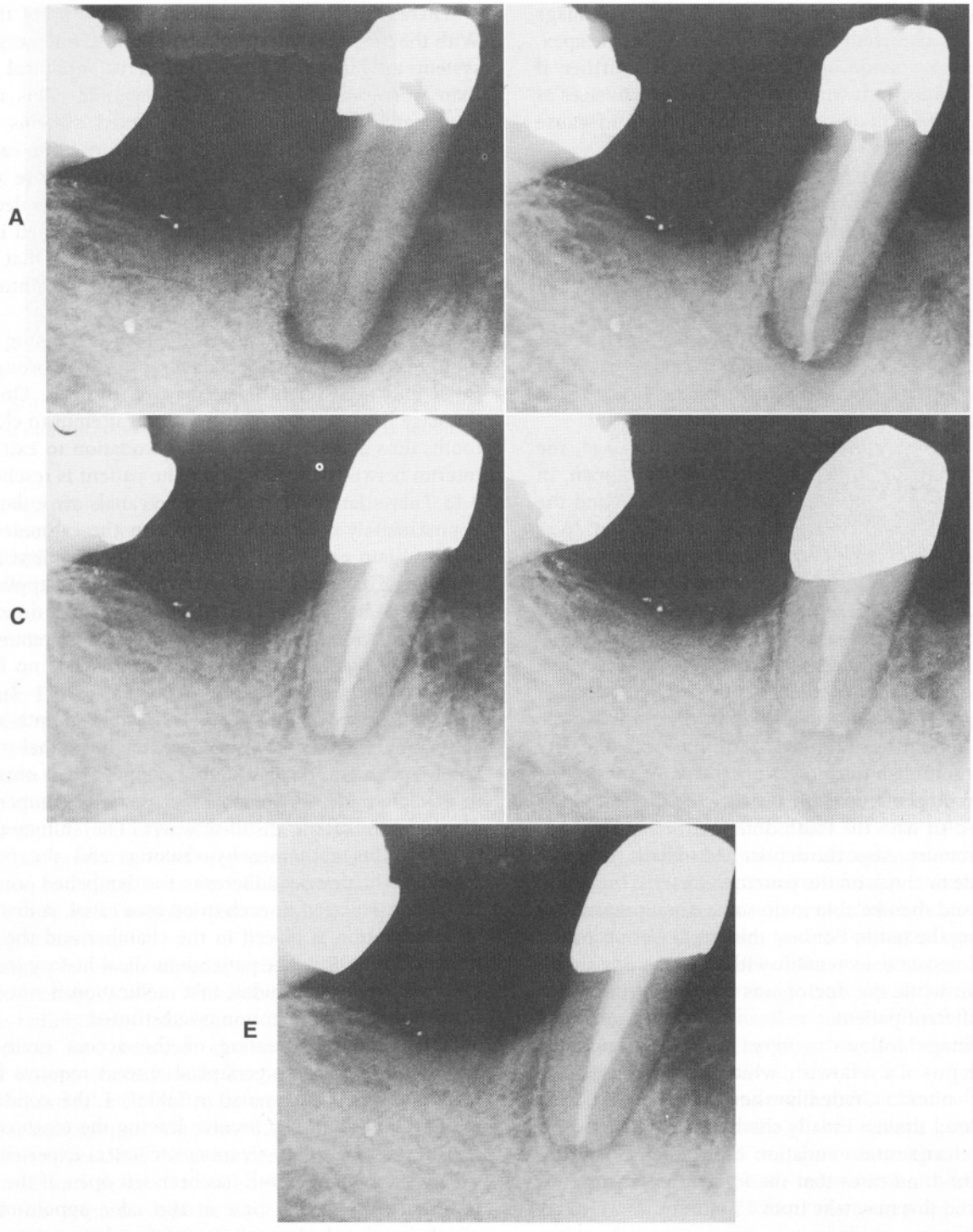


FIGURE 3-11 Tooth with an acute periapical abscess, closed after emergency treatment. A, Preoperative radiograph of mandibular second bicuspid with periapical lesion, tenderness to percussion, swelling, mobility, and nonvital pulp. When the tooth was opened, a heavy exudate drained, similar to Figure 3-10, *B*. After 30 minutes, the drainage decreased and a clear fluid emanated. A measurement length was calculated, the canal was enlarged, and the tooth was closed because all exudation had ceased. No antibiotic was prescribed, but all pain and symptoms decreased markedly. **B,** Canal preparation was completed at a second appointment 3 days later, and the canal was filled with laterally condensed gutta-percha 1 week later. **C,** Nine months later. **D,** Eighteen months after original treatment, lesion is healed. The tooth is an abutment for a removable partial denture. (Because of change in angulation, tooth appears to be shorter in this view.) **E,** Eight years after original treatment, perfect healing is affirmed. (Restoration by Dr. Stanley Martin, formerly of Chicago.)

closed, it should be kept closed throughout treatment if possible. Leave teeth open only when that is the only choice.

During canal enlargement of an opened tooth, mass contaminants from the microorganisms and debris within the canal are inoculated into the periapical areas, even when the instruments are confined to the interior of the canal. Closing at the same appointment does not allow for the venting of the elements and products of inflammation, thereby causing a high percentage of flare-ups. When the tooth is closed after only the irrigating and drying of the canals, few irritants are pushed through into the irritable periapical tissues, and the medication placed aids the body in producing a healthy reaction.

Culturing the Exudate

Whether or not one utilizes culturing in one's endodontic technique, taking a culture of the exudate during an acute periapical abscess or a recrudescent abscess is a wise idea. It takes only a few minutes to perform, and its information when an antibiotic is needed to control a recalcitrant case is invaluable. The culture should not be taken of the initial portion of the exudate when considerable purulence discharges because the majority of the microorganisms at that time are dead and thus incapable of reproduction. However, when the exudate starts to change from yellowish to a reddish hue, the culture sample may be taken with a sterile paper point or sterile cotton swab. At that time, viable microorganisms will be picked up to produce a positive growth.

If the patient has few or no problems after the emergency appointment, the culture may be discarded. However, if the symptoms remain, become worse, or recur, the culture should be sent to a laboratory for antibiotic sensitivity testing (Chapter 13).

Irrigants Used in Treating Acute Abscesses

The constituents and uses for the intracanal irrigants are listed in Chapter 5. When an acute abscess is being treated, it is suggested that the irrigants normally used during canal preparation be altered somewhat to provide important functions not usually required.

At the emergency appointment the preferred irrigant in the initial stages of inducing drainage should be warm sterile water or saline. The sodium hypochlorite normally used has a tendency to clump the exudate, which might cause plugging of the apical constriction and halt the drainage. When patency through the apex is maintained, sodium hypochlorite may be used if further canal preparation is to be performed at the emergency appointment.

When the patient returns after having a tooth left open for the appointment when the access will be closed without filing, another adjustment is recommended. The preferred irrigants are the alternating use of sodium hypochlorite and hydrogen peroxide. These two solutions cause foaming when used together and will aid in the bubbling out of any debris that might be packed in the canal. This reduces the need for files or reamers to clean an open canal when it is necessary to close a case without canal preparation. To prevent buildup of nascent oxygen, the sodium hypochlorite must always be the final irrigant used, until all foaming has stopped. This must be done before sealing of the access cavity.

Drainage Through the Tissue and Bone

The presence of a post and core crown, sectioned silver point, or heavily calcified canal prevents obtaining intracanal drainage after an acute periapical abscess. Therefore the drainage must be accomplished through the apical tissue and frequently apical bone by a process of trephination (defined as cutting a hole in the bone) or artificial fistulation (artifistulation for short). When it is possible to obtain drainage through the canal, trephination should not be used, even if it would take less time. With the nidus of infection remaining undisturbed within the canal, the relief will be short lived and the tissue in the area of incision unnecessarily damaged.

Artifistulation or trephination should not be performed until the swelling is sufficiently localized to permit adequate drainage following incision. If the swelling is diffuse, antibiotic coverage is prescribed along with hot mouth rinses. Once the area is fluctuant and localized, incision and drainage procedures may be instituted.

For artifistulation a stab incision is made just below the most dependent point of the swelling with a no. 11 scalpel. Usually a heavy purulent exudate is obtained immediately. The apical bone is probed with an endodontic explorer to locate a perforation, which may be enlarged with a spoon excavator or endodontic file to ensure venting of the apical area.

The incision is not closed but is purposely left open to allow for any further drainage. To accomplish this, a strip of rubber dam material (20 by 20 mm) is cut to resemble the letter *H* or rolled into a tube and disinfected by dipping into a suitable chemical solution. One half of the dam drain is placed underneath the flap, with the wings allowed to extend underneath the tissue. A suture is placed to attach the isthmus to the unretracted edge of the flap. An antibiotic is prescribed, and the patient is then scheduled for another appointment 4 to 7 days later.

Only if artifistulation fails to give sufficient drainage and pressure remains within the periapical bone should trephination be utilized. The flap should be increased in size to allow for visualization of the apical bone. By using a fissure bur in the airotor with water spray, the periapical bone is removed until the tip of the root is uncovered and the necessary drainage obtained. The H or tube drain is placed, an antibiotic prescribed, and the patient rescheduled for 4 to 7 days later (Figure 3-12).

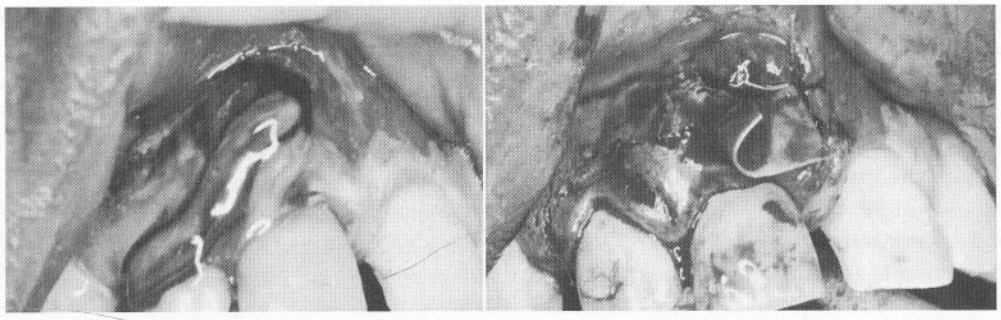


FIGURE 3-12 Incision and drainage through the tissue. The patient was referred for treatment of the right central incisor, which had been left open by the referring dentist for the previous 5 days. Now swelling has worsened, raising the lip. A size 30 file was passed through the apex attempting to reinstitute drainage through the tooth, but no discharge could be obtained. **A,** With no. 11 scalpel blade, a stab incision was made into the dependent area of swelling, resulting in a heavy purulent discharge. **B,** A rubber dam segment was rolled into a tube and sutured to place to prevent premature closure of tissue. The lingual access was closed 2 days later and the drain removed 5 days after the incision. No further problem was encountered in treatment.

At the subsequent appointment the drain is removed and an apicoectomy performed (Chapter 9). During this operation the tissue along the lines of incision is removed so more normal areas are in contact when the site is sutured after apical surgery.

EMERGENCY TREATMENT OF TRAUMATIC INJURIES—FRACTURES

Emergency endodontic treatment may be required as a result of traumatic injury: a crown fracture, root fracture, luxation, or avulsion. As a result of sports or horseplay, the anterior teeth of young boys, ages 7 through 14 years, are the most frequently involved. However, impact injuries to the dentition as a result of an automobile accident, household mishaps, assault, or other traumatic event may result in an endodontic emergency for patients of any sex or age on any tooth.

Emergency treatment may be complicated by local edema, bleeding, or other consequences of the accident. Frequently the patients involved have had few or no previous dental problems, having enjoyed excellent dental health until the mishap, but may now be faced with a serious situation. In most impact injuries a temporary paresthesia of the nerves to the pulp occurs as a result of the trauma. Therefore there may be no way to evaluate the condition of the injured pulp accurately by using diagnostic aids. As has been stressed in the discussion of diagnosis and treatment planning, an accurate assessment of what is wrong should be made before any treatment is performed.

Still, the patient with a traumatic injury requires emergency treatment to guard against discomfort that might develop and to enhance the chances for the success of any therapy that may be required in the future.

Crown Fracture Without Pulp Exposure

A patient may be brought in for emergency treatment of a fractured tooth that has no direct pulp exposure. The injury may have produced a fracture deep into the dentin or may have merely chipped a small portion of enamel. In the latter case, smoothing the jagged edge with a sandpaper disk and rubber wheel will prevent irritation to the tongue and lips.

However, exposure of dentin requires more definitive treatment. A thin mixture of ZOE is placed over the exposed dentin. Then a celluloid crown is festooned, filled with a thick mix of ZOE accelerated with zinc acetate crystals, and cemented into place. These celluloid crowns often become dislodged, and a more permanent type of covering may be needed after a relatively short time. If the initial dressing stays in place for merely a few weeks, the sedative effect may greatly aid in the recuperation of the pulp, and its function will be served.

The fractured tooth should be checked with radiographs and pulp testing before any extensive permanent restoration is placed. Adjacent teeth should be similarly examined because it is not unusual for the pulp of a fractured tooth to recover, whereas the pulp of a neighboring tooth that was seemingly unaffected by the injury becomes necrotic. The reason for such occurrences is that the fracture dissipates the force of a blow, whereas the effect of the blow to the adjacent whole tooth is received at the periapical area and may sever or seriously damage the apical nerve and blood vessels.

Crown Fracture with Vital Pulp Exposure

The presence or absence of apical closure must be determined by radiograph because emergency therapy differs for these two entities. If closure has taken place, the

emergency treatment is identical to that previously listed in Table 3-1 as treatment for acute pulpitis, which is the condition present. The canal is broached and the pulp removed in anterior teeth and a pulpotomy performed on posterior teeth, suitable medication is placed, and the access is closed. For a fractured anterior tooth with pulp exposure, a lingual opening is unnecessary, but the exposure through the incisal is widened with a tapered fissure bur, and direct access to the apex is available. The patient is given another appointment for the completion of endodontic therapy.

If apical closure has not yet taken place, a formocresol pulpotomy is performed to keep the apical pulp tissue unimpeded in its function of completing apexogenesis (Chapter 14). Pulpotomy is preferred to pulp capping, even if the exposure is of minimal size. In fractured teeth it is always a problem to retain the temporary crowns or dressings. If a pulp capping is to be performed and the temporary seal is lost or dislodged, the underlying pulp will become contaminated and require redressing. Worse yet, the pulp may become necrotic because of the invasion of microorganisms, and the apex may cease developing. The pulpotomy dressing is placed deeply enough into the canal so that it will be unaffected if the crown covering becomes loosened.

At periodic intervals, 3 to 6 months, radiographs are taken to evaluate the degree of apical development. Once apical development has been completed, routine endodontic treatment may be instituted (Chapter 14).

Crown Fracture with Necrotic Pulp Exposure

After crown fracture into the pulp chamber, it may be determined that the pulp tissue is nonvital. This condition may occur as a result of an earlier accident, caries, or deep restoration or by a severing of the pulpal blood vessels in the most recent traumatic incident. It is interesting that certain children are highly accident prone and may suffer repeated injuries to teeth and jaws (see later discussion).

Emergency treatment follows the pattern shown in Table 3-1. The condition present is diagnosed as either an acute periapical abscess or pulp necrosis, as determined by the clinical symptoms and the response to vitality and percussion tests. The presence or absence of apical closure does not have any effect on the emergency treatment but will have important bearing on the therapy that will follow. If apical closure has taken place, routine endodontic treatment will be performed. If the apex has not developed, apexification procedures will be instituted after cessation of acute symptoms (see Chapter 14).

Horizontal Root Fracture

Horizontal root fracture does not always mean that endodontic therapy will be necessary. Although the dentin and cementum have been cleaved, the pulp tissue may have been stretched by the injury but still may retain its integrity in a recoverable state. If little or no mobility is present, no emergency therapy is indicated. The area should be reevaluated periodically by radiographs and pulp vitality testing. When definite mobility is present, some type of stabilization is required. This is needed to reappose the fractured segments in the hope that the pulp has retained vitality and that any fractured alveolar bone will heal to retain the loosened tooth (Figure 3-13). Stabilization may be afforded by orthodontic wire, arch bars, acrylic and wire combination, or any other satisfactory method. The method for treating horizontal root fractures will be discussed in Chapters 8 and 9.

EMERGENCY TREATMENT OF TRAUMATIC INJURIES—AVULSED TEETH

The replacement of a tooth that has been removed from the alveolar socket, either intentionally or by trauma, is called replantation. As an emergency procedure to replace a tooth avulsed due to an accident, it is spectacular but unfortunately has a rather low long-range success ratio compared with routine endodontic therapy. However, one must consider that the avulsed tooth represents a foreign body when it is replaced and is therefore subjected to all the functions of the body that may be employed to counteract such intruders. Replantation success should not be compared with other types of endodontic therapy in which the treated tooth remains in its alveolar housing and is benefited by the periodontal attachment. Rather, it should be viewed as a last-ditch, heroic attempt to retain alveolar bone and tooth-to-tooth relationships for a period of time. The resorption that so frequently follows the procedure takes some time to cause tooth mobility (Figure 3-14). Once this occurs, a temporary removable prosthesis, followed by a fixed partial denture, may be constructed at the convenience of the dentist and the patient. Shortly after the accident, it might have been difficult to prepare adjacent teeth as fixed partial denture abutments because of the large size of the pulp commonly found in youngsters. In the period while the replant was in place, even though in a resorbing condition, precious time has been gained to allow for diminution of the pulp canal size of abutments. Construction of such appliances immediately following the traumatic injury is considerably more complex.

Newer Philosophies of Replantation

For many years, endodontists were advised to enlarge and fill the root canal of an avulsed tooth before replantation. This procedure has been replaced in the last 15 years by the method originally suggested by Andreasen, based on clinical and experimental research. An extensive bibliography for the subject of replantation appears at the end of this chapter.

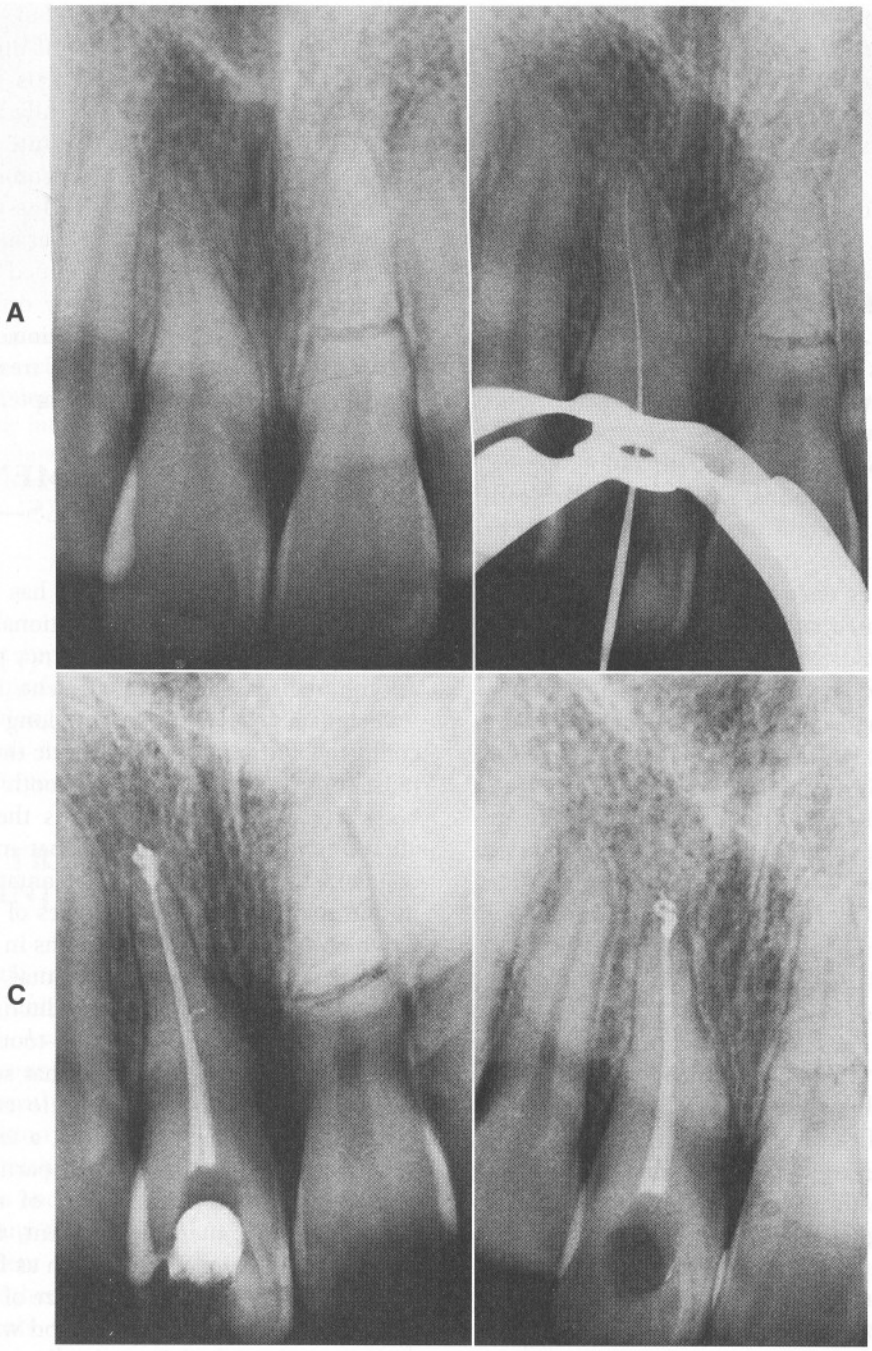


FIGURE 3-13 **A,** Patient was referred for treatment of central incisor to left (no. 8), which was tender to percussion and sensitive to hot and cold. Central incisor to right (no. 9) was not mobile and was symptom free. Both teeth had vital pulps. Patient was involved in an automobile accident 3 months earlier. **B,** File in place for no. 8. **C,** Canal filling for no. 8. Symptoms all subsided after canal preparation. Note lateral canal exiting to site at the same level as fracture of no. 9. Still no symptoms on 9. **D,** Eighteen months later, no. 9 still remains vital and symptom free.

It had been observed that a relatively good success rate was achieved when patients, or someone else present at the scene of the accident, replanted the avulsed tooth immediately after the trauma compared with replantation by a dentist, despite the absence of canal filling, sterility, or stabilization. Practitioners and researchers began to realize that when the time out of the mouth was minimized, the outlook for the avulsed tooth improved dramatically. Further studies, mainly by Andreasen and his colleagues in Scandinavia, Joe Camp of the United States, and Trope and his associates at the University of North Carolina, verified that the longer the period between the traumatic extraction and the reinsertion, the greater is the chance for failure. Therefore the technique for replantation that follows assumes that the avulsed tooth is located quickly after the incident and may be

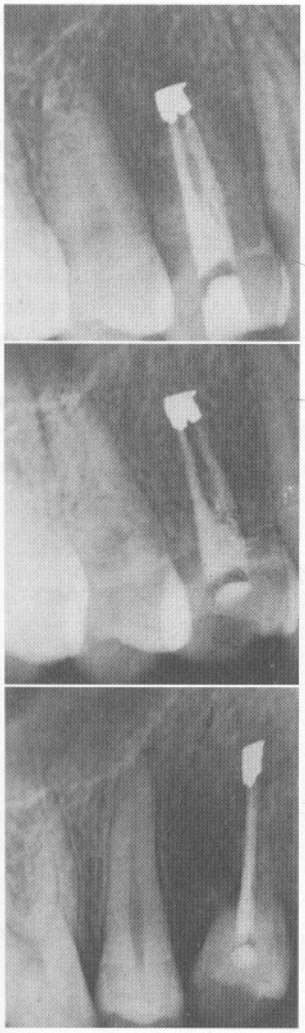


FIGURE 3-14 **A,** Tooth replanted with apical amalgam plug and gutta-percha canal fillings. **B** and **C,** Five years postoperatively, root has resorbed almost completely, leaving only canal fillings in place. Crown of tooth is still tight!

replanted at the site of injury or that the tooth will be taken quickly to the dental office, hopefully in a suitable transport media, where a dentist is able to replant it.

It has been reported that immature teeth that are rapidly replanted without pulp extirpation may require no further endodontic treatment, other than stabilization. The open apex allows for a replacement and/or repair of the severed pulpal vessels, and root resorption is diminished.

A study by Sherman indicated that the presence of the original periodontal ligament on the root surface of replanted teeth improved the prospect for secondary cementum deposition and root resorption repair. When the original periodontal ligament was scraped and the tooth replanted with absorbable surgical sponge, root resorption was more extensive and progressive, and a greater degree of ankylosis took place compared with the nonscraped replants.

Technique

Much credit for improvement of treatment for this problem must go to Andreasen and his coworkers, Camp, Trope and his colleagues, and others who reported on studies with avulsions and replantations. Their investigations have been valuable in designing the most ideal combination of treatment modalities. At present, some controversy still surrounds the best method for treatment, and alternative techniques are being suggested and investigated constantly. Five specific areas of treatment must be considered, and various combinations of therapy are available.

The method of treatment suggested here follows closely the recommendations by Andreasen. Because of the many studies that he performed over long periods, evaluating treatment modalities where only a single variable was altered, I believe that his theories are the most reliable. However, even then I have made slight modifications in a few areas. In these cases, I have included the treatment methods of Andreasen as well, whenever they differ from mine.

The reader should be warned that although the treatment schedule suggested here has been used successfully in many cases, it is still subject to further research and evaluation, which may lead to future changes.

Suggested Treatment of the Avulsed Tooth.

Part I: Emergency Treatment at the Site of Injury.

1. Best results occur if the tooth is replanted as soon as possible after the avulsion. The parent, playground supervisor, gym teacher, or responsible adult present who can replace the tooth as quickly as possible will be doing a great favor to the patient. If someone calls you and states that a tooth has been knocked out, try to have a responsible adult replace the tooth in its socket. Even if the tooth has been badly contaminated by being found in mud or animal fecal matter, it should be replanted without sterilization or scrubbing with soap or detergent. The tooth may be rinsed under running tap water until it appears that foreign matter has been washed away, but no tissue clinging to the root surface should be scraped.
2. After rinsing, if necessary, the tooth should be firmly and directly reinserted into the socket, handling the crown only. The family dentist, or nearest practitioner, should be telephoned and the patient taken to the dentist's office as soon as possible. A small towel may be placed in contact with the biting edges (incisal edges) of the replanted and the adjacent teeth, and firm pressure applied to keep the tooth in its socket on the trip to the dental office.
3. If it is impossible to reinsert the tooth, it is best that the tooth be placed in a suitable transport medium (see following discussion) and brought to the dental office.

Part II: Emergency Treatment at the Dental Office.

1. When the patient arrives at your office, put the tooth in a glass of saline (a pinch of salt in a glass of water produces 0.7% salinity). Take a health history, examine the area, and take radiographs as thoroughly but as quickly as possible. If the tooth has been replaced, and seems in an acceptable position, splint as described in step 3, following.
2. If the tooth has not been replanted, do not curette or attempt to sterilize either the root surface or the socket. Handle the tooth at all times with a sponge soaked in saline, grasping the crown only. Wipe away gross debris gently from the root surface with the wet sponge. Irrigate the socket with saline. Do not make an access cavity, do not cut off any of the root tip, and do not perform an apical fenestration. Measure the tooth length and record it on the patient's chart.
3. As soon as possible, implant the tooth firmly into the socket with the sponge. Radiograph to check the position (Figure 3-15, *A*). Splint with a soft arch wire (Figure 3-15, *B;* see also Figure 3-16) and an acid-etch or similar system. A soft diet is advised (no apples, ribs, sandwiches, or chewy or hard candy). Dairy products, soft ice cream or ice milk, and well-done hamburgers are acceptable foods.

Part III: Completion of Endodontic Treatment.

1. One week after replantation, prepare the access cavity, perform canal debridement and preparation

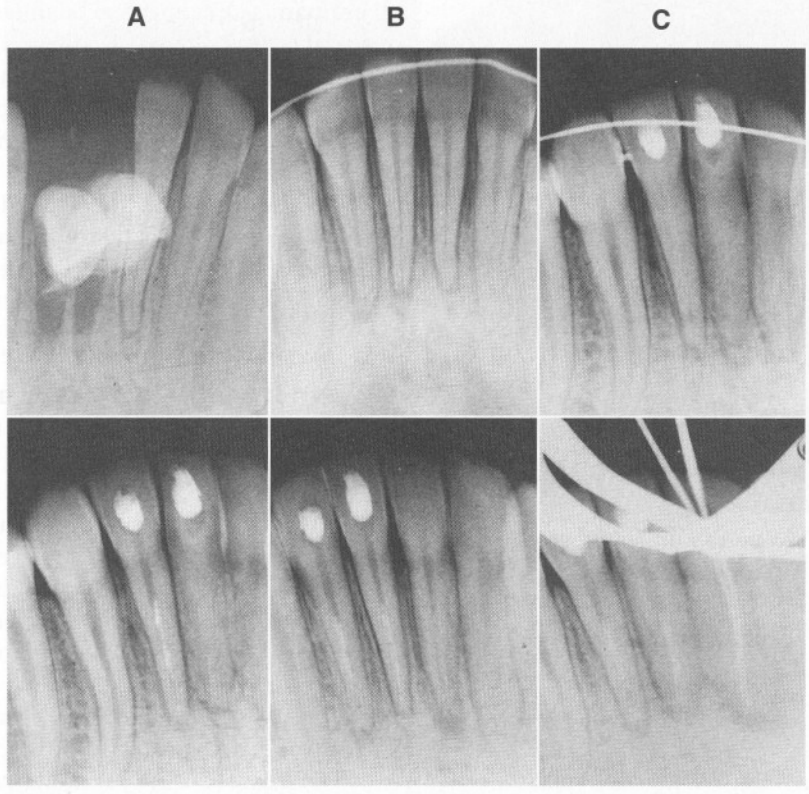


FIGURE 3-15 Treatment of avulsed teeth with minimal extraoral time, long-term evaluation. A, Patient was a 13-year-old girl injured by a swing that had backed up prematurely when she was not looking, knocking the crowns of the mandibular right central and lateral incisors totally to the lingual, forcing the apices out of their sockets to a position where the root tips were completely visualized pushing the lower lip forward. Several other areas of trauma were apparent, including bruises on both lips, fractured root tips on three mandibular incisors, and multiple sites of bleeding in the mouth. The mother brought her to my office within 60 minutes of the accident, where this film was taken. **B,** I was able to realign the teeth and replace them in their sockets. Even though the vessels to the apices were completely severed and the pulps devitalized, no attempt was made to handle, clean, or initiate endodontic treatment on the teeth. An acid etch soft arch wire splint was placed (see Figure 3-16). One week later, access cavities were prepared in the replanted incisors, the pulps extirpated, and canal preparation performed. Both teeth had figure-eight types of canal shape and were enlarged as Type II canals (Chapter 4). The splint was removed, but the teeth seemed to be very mobile. Therefore, I put the splint on again, using an acid etch attachment system. **C,** An additional week later, 2 weeks after replantation, the accesses were reopened, mild preparation was performed, and calcium hydroxide paste was placed. The splint was removed and left off for the rest of therapy. **D,** The lateral incisor had a brief period of soreness, so the tooth was opened, mildly enlarged with heavy irrigation, and reclosed with calcium hydroxide paste. **E,** After 4 months, the two treated teeth were firm and were prepared for completion of treatment. This film revealed a lesion at the apex of the left central incisor. Electric and temperature tests gave no response. **F,** The pulp was necrotic on opening. As expected, this tooth had a similar canal configuration (Type II) to the others.

Continued

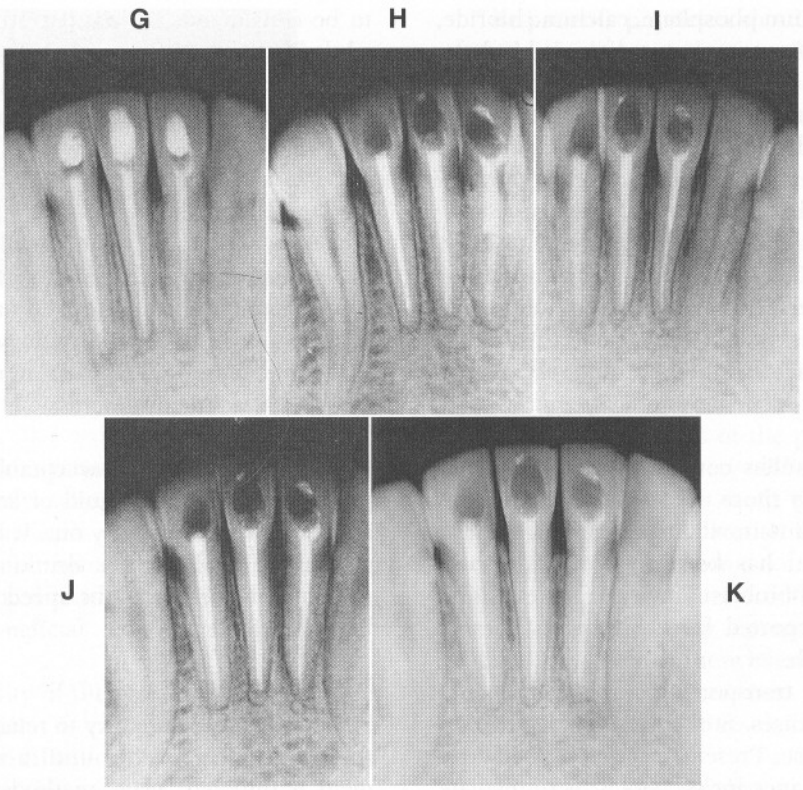


FIGURE 3-15 cont'd G, The teeth were filled with laterally condensed gutta-percha with Wach's paste as sealer. **H** and **I,** Films taken 2 years after treatment indicated total periapical healing and no signs of lateral resorption. For the left central incisor, the lingual portion of the canal did not fill totally, but the canal appears to be sealed both apically and coronally to that site. **J,** Three years after treatment, excellent healing still. **K,** Seventeen years later, 20 years after original treatment, all three treated teeth look excellent. Previously fractured root tips are in proximity to the teeth and absolutely no sign of resorption or radiolucent lesions are present.

using the previously recorded tooth length, and place a ZOE temporary filling in the access. Teeth with undeveloped apices may be watched without pulp extirpation because some of these pulps may revitalize sufficiently for continued apical development. If pulp necrosis develops later, canal debridement and apexification procedures may be undertaken (Chapter 14). To prevent ankylosis, remove the splint at the conclusion of this appointment. The soft diet must be continued.

2. Two weeks after replantation (1 week after canal preparation), place calcium hydroxide paste in the canal to inhibit and reduce external resorption (Figure 3-15, *C*). If the paste is placed too soon, before the periodontal ligament is regenerated, it may cause increased resorption. Recall monthly (Figure 3-15, *D-F*).
3. After the periodontal ligament and the apex have reformed radiographically, which takes 3 to 6 months, reopen the tooth. Refresh the canal walls with mild preparation and fill with gutta-percha and sealer (Figure 3-15, *G*; see also Chapter 7). Recall initially at 1 month, then at 3-month intervals. External resorption usually occurs in the first year or not at all (Figure 3-15, *H-J*).

Use of Transport Medium

As mentioned in Part I, Step 3, if the avulsed tooth cannot be replanted at the time and site of the accident, it becomes incumbent to transport the tooth to the dentist in a manner that will be conducive to a successful reattachment. To accomplish this, a suitable transport medium must be selected.

For many years it was common for an avulsed tooth to be brought to the dental office wrapped in a tissue paper. This led to a drying out of the tooth and any remaining periodontal ligament, drastically decreasing chances for success. Information was made available to the public that this choice was poor, and for a while, the preferred transporting method was to wrap the tooth in a wet tea bag. This was better; the tooth was kept moistened, but water was not the best liquid for transport.

Hank's Balanced Salt Solution (HBSS). HBSS is a very favorable transport medium for the avulsed tooth. A retrospective study reported by Krasner and Person (Krasner is the originator for the use of this product in endodontics) indicated that the solution was highly successful when used in 85.3% of replantation cases. HBSS contains sodium chloride, glucose, potassium chloride,

sodium bicarbonate, sodium phosphate, calcium chloride, magnesium chloride, and magnesium sulfate. It has been used in the past as a tissue culture support for mammalian tissues, has demonstrated the ability to preserve and reconstitute the cells of the periodontal ligament, and has a shelf life of 2 years.

Krasner has developed an avulsed tooth storage system, named the Emergency Tooth Preserving System* (ETPS), which contains HBSS, a net for holding the tooth atraumatically, and a container for bringing the submerged tooth to the dentist. This system is available to schools, gymnasiums, park district fieldhouses, and other sites where tooth trauma may occur.

Via Span. Recent studies comparing HBSS to other transport systems, usually those used to transport organs for transplantation or maintain vitality of fibroblasts, have been reported. Via Span† has been shown to decrease resorption and maintain fibroblast vitality. Trope et al, and Ashkenazi et al, have reported favorably on its use for transporting avulsed teeth.

Unquestionably, these transporting systems are valuable in treating avulsion cases. Still, I have some reservations concerning their use. Present information strongly indicates that the best chance for success is by immediate replantation at the site of trauma. The transporting system should be used only when such a procedure is not possible.

In the suggestions for use of the ETPS, soaking of the tooth in a transport system before reinsertion is suggested in certain cases. I believe that this is acceptable if the tooth has been allowed to dry out, but if the tooth has been handled properly and is moist, it is better to keep the extraoral time to a minimum and replant as soon as possible without soaking.

Saliva. In my opinion the patient's own saliva is the best transport medium for an avulsed tooth. Favorable reports on using it have been published, and the logic for its use and its availability are obvious. After trauma to the face and jaws, youngsters generally drool saliva and blood constantly. Often a child comes to the dental office after any trauma to the mouth with a dishrag or hand towel around his or her neck to absorb this constant flow. There is no problem collecting several inches of saliva, tinged with blood, in a cup or small juice glass and then dropping the tooth into this very biologically acceptable liquid.

Also, it has been suggested that when the tooth cannot be replanted at the site of injury and acceptable transport media are not present, it be placed in the patient's mouth or under the tongue. This method has received favorable reports. In such cases the transport medium being used successfully is saliva. If such a method for transporting is to be considered, the patient must be an older child or adult. If the child is young, is unreliable, or has a severe gag reflex, there is too great a chance for swallowing the tooth on the trip to the dentist's office.

Milk. Andreasen favors milk over saliva as a transport medium. Many accidents that cause an avulsion occur related to athletics: on a baseball field, football field, playground, or gym. Except for when an accident happens in the home, milk is not readily available, whereas saliva is always present. Also, milk may contain many antigens that could act negatively from an immunologic standpoint on the reattachment process.

Water. If no other acceptable transport medium is present, water is the liquid of last resort, as opposed to allowing the tooth to dry out. It is readily available, even at athletic fields, where drinking fountains are always present, and decreases the speed with which periodontal ligament tissue will die.

Stabilization

Stabilization is mandatory to retain the replanted tooth in the desired relationship until a new periodontal attachment is initiated. Many methods of splinting have been utilized, but most have had definite disadvantages because of bulkiness, possibility of loss, irritation of gingival tissues, prevention of normal oral hygiene, and interference with subsequent endodontic procedures.

Adhesive cements have been introduced that bind directly to enamel and have been widely used in orthodontics. Heiman et al discuss a procedure for using an adhesive system designed expressly for stabilizing avulsed teeth. The method is rapid and effective, and it circumvents all the problems mentioned that were encountered with other splinting techniques. The teeth to be incorporated in the splint—normally at least two or three teeth, both mesial and distal to the replant—are cleansed by pumicing with a fluoride prophylaxis paste. The teeth are rinsed, dried by air spray, and kept dry with cotton roll placement. A cotton pellet dampened with two drops of the surface-treating agent is applied to the labial enamel surface of each tooth in the splint and kept in contact for 1 minute; it is then rinsed off and the teeth dried. A strip of heavy-gauge rectangular orthodontic wire (0.0215 by 0.028 inch) is measured, cut, heat treated, and contoured to approximate contact with the teeth in the area that has been surface treated. The ends of the wire are bent around the most distal teeth in the splint and held with carding wax.

The powder and liquid components are mixed according to the manufacturer's recommendations until a smooth mass is obtained. The cement is applied to the teeth and wire, but because of the rapid set, only two or three teeth may be involved with a single mix. The carding wax is removed after the cement has set, and the wire ends

* Biological Rescus Products, Inc., Conshohocken, PA 19482.

† DuPont Pharmaceuticals, Wilmington, DE.

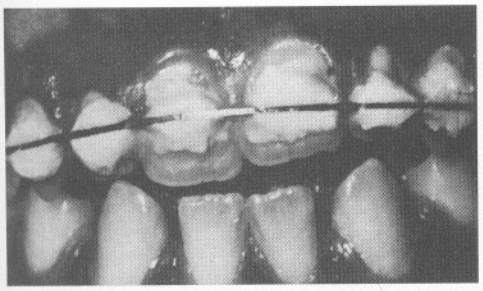


FIGURE 3-16 Stabilization afforded a replanted central incisor by adhesive system. Note absence of impingement on gingival tissues. (Courtesy Dr. Gerald Heiman, Glenview, Ill.)

and excess cement are trimmed and smoothed with sandpaper disks and rubber wheels to prevent irritation to the gingiva and inner surfaces of the lips (Figure 3-16). Such a splint allows for some movement and some occlusion for the replanted tooth or teeth. This has been found to be more beneficial than those splints that afforded total rigidity.

After sufficient stability of the replant has been gained by reattachment, the splint is easily removed by cutting through the cement with a bur to free the wire and flicking off the adhesive with a scaler.

Andreasen suggests that the splint be removed 1 week after replantation. (Formerly it was suggested that the splint remain for 4 to 8 weeks.) He believes that keeping the splint in place too long leads to ankylosis or inflammatory resorption because the periodontal ligament is not kept in function. It is difficult to remove the splint this early, with the tooth still exhibiting a degree of mobility, and not experience mental reservations about this course of therapy. However, Andreasen has followed cases for long periods and maintains the advisability of early splint removal.

In certain cases, after removing the splint in 1 week, I have found that the replant is still extremely mobile. Despite Andreasen's warnings, I generally replace the splint and keep it in the mouth for an additional 1 week. Generally removal at that time denotes improvement.

Postoperative Instructions and Systemic Treatment

In addition to advice concerning the soft diet, several other instructions must be given after the replantation procedure. In most of my cases I did not prescribe antibiotics. However, Andreasen has reported that systemic antibiotics strongly contribute to replantation success. When one considers the potential contamination that might befall the root during the avulsion, it does seem logical to prescribe antimicrobial agents for the initial few days after the replantation. Currently I do prescribe antibiotics adjunctively unless I am certain that the avulsion and extraoral period were such that no serious contamination could occur.

The patient's physician should be consulted very soon after the replantation concerning the need for an antitetanus booster. Differing views concerning the frequency of these inoculations exist, so it is important to have the medical records reviewed to make the correct decision.

Mild postoperative swelling is normal, and severe pain rarely results from the dental treatment. Mild analgesics should be prescribed for 1 to 4 days. When the adhesive system splint is used, normal oral hygiene may be followed.

Replantation After an Extended Extraoral Period

There is no question that rapid reinsertion of the avulsed tooth enhances success of the procedure. In some cases, however, it becomes very difficult to replace the tooth quickly. Sometimes the tooth is not found until several hours to several days later. It may be that the accident occurs in an area far from a convenient dental office. The trauma may be so extensive that the tooth avulsion was a relatively minor injury compared with other damage (Figure 3-17). When these events do occur, if at all possible, even though the treatment was delayed, considering the benefits that might result from therapy, replantation should be attempted.

Some have suggested that when the tooth has not been replaced within several hours, it is acceptable to perform endodontic treatment before replantation. I do not agree. The sooner that the tooth is returned to its environment, with the least extraoral manipulation, the better it will be. The pulp tissue may be removed several days later and treatment continued as described earlier in part III.

If the tooth has been allowed to dry out during the extraoral period, according to Mattson et al, soaking in a pH-balanced solution, such as HBSS, will wash off undesirable adhesions to the root surface and may reconstitute depleted cellular metabolites. A soaking of 30 minutes is suggested and would seem to be a logical procedure to follow. Treatment is continued as suggested.

Typical Posttreatment Sequelae

After completion of routine endodontic therapy, the patient should be seen at regular 6-month intervals, at which time radiographs are taken. It is hoped the treated tooth or teeth will be doing well (see Figure 3-15, *H-J*), but one of two undesirable conditions may occur to replanted teeth: root resorption (see Figures 3-14 and 3-17) or ankylosis.

Resorption is initially seen radiographically on the lateral surfaces of the root, in irregular bays. As it becomes more extensive, most of the root structure may be replaced by bone, and only the canal filling material remains behind to indicate the earlier treatment. Even though extensive root resorption occurs, the crown may remain relatively tight (see Figure 3-14).

Ankylosis is certainly preferable to resorption. Although the tooth fails to undergo passive eruption with

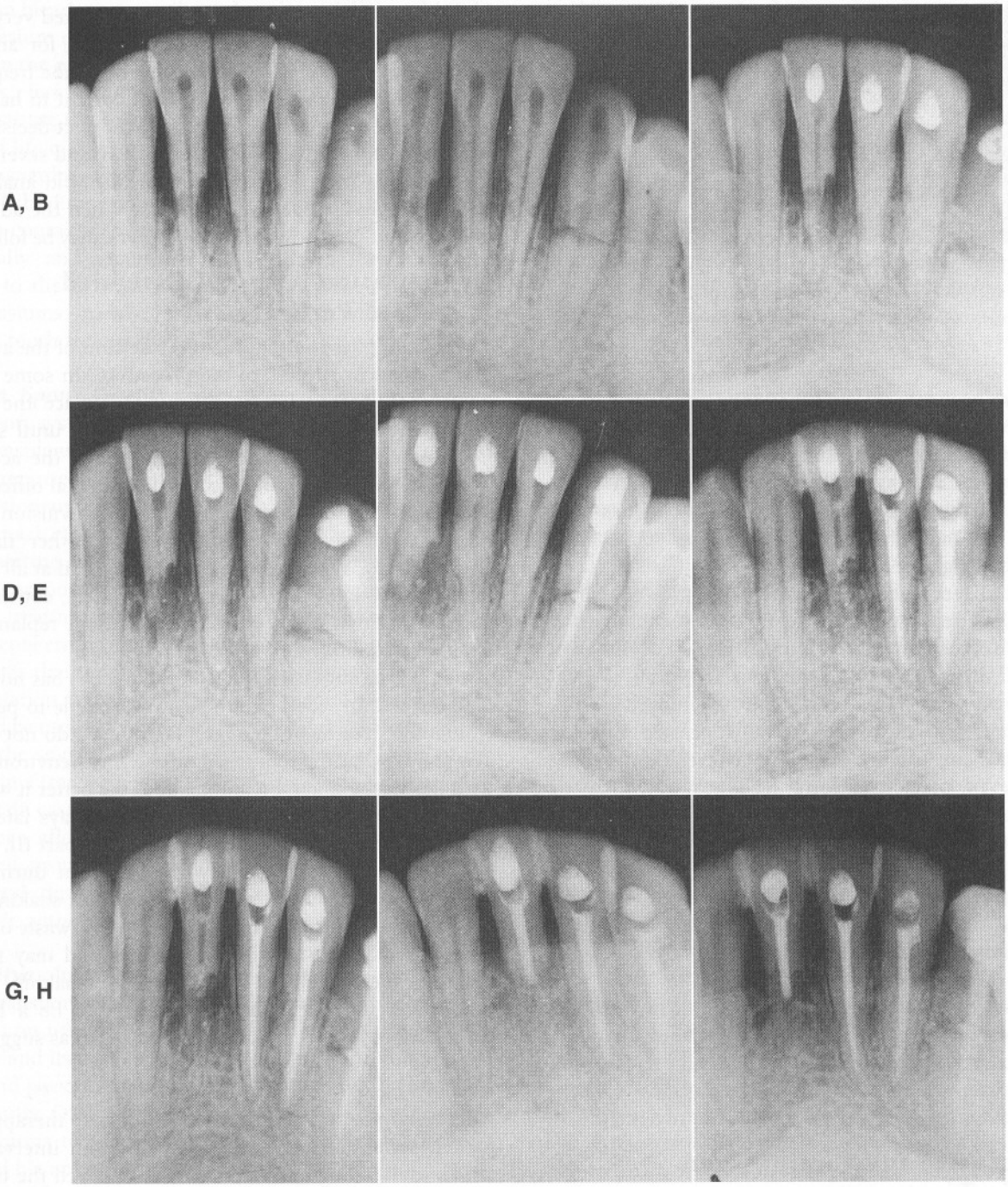


FIGURE 3-17 Very long-term evaluation of severe trauma, including replantations and a midroot fracture. The patient was an 18-year-old male involved in a serious accident when a car with a drunken driver drove off an overpass and fell on top of his car. The young man was unconscious and injured so seriously that it was anticipated that he would expire. Three mandibular teeth were knocked out and located on the floor of his vehicle, but nothing was done to replace them because of the grave outlook. Three days later, he was making a miraculous recovery and had awakened. An oral surgeon from the hospital staff was called in to replace the teeth and perform other intra- and extraoral procedures caused by the accident. The patient continued to recover and left the hospital after several weeks. After 8 weeks he went to the oral surgeon, who referred him to me for continuation of treatment. **A** and **B,** My preoperative radiographs of the anterior mandibular teeth, taken several weeks later, 3 months after the accident. The mandibular left cuspid (no. 22) had a midroot fracture, and the oral surgeon had extirpated the pulp from the coronal portion after preparing access. The mandibular left lateral (no. 23) and central (no. 24) incisors and the right central incisor (no. 25) had access cavities prepared and the pulps extirpated. All four teeth had been left open for almost 3 months. Tooth no. 25 and the crown of no. 22 were mobile, but no. 23 and no. 24 were fairly tight. Much debris was in the pulp canals, and the tissue around the teeth was still inflamed and tender to the touch. Severe sites of resorption were associated with no. 25 and the fracture line of no. 22. Several sites of resorption were noted on no. 23 and no. 24, but none were as severe as seen on no. 25.

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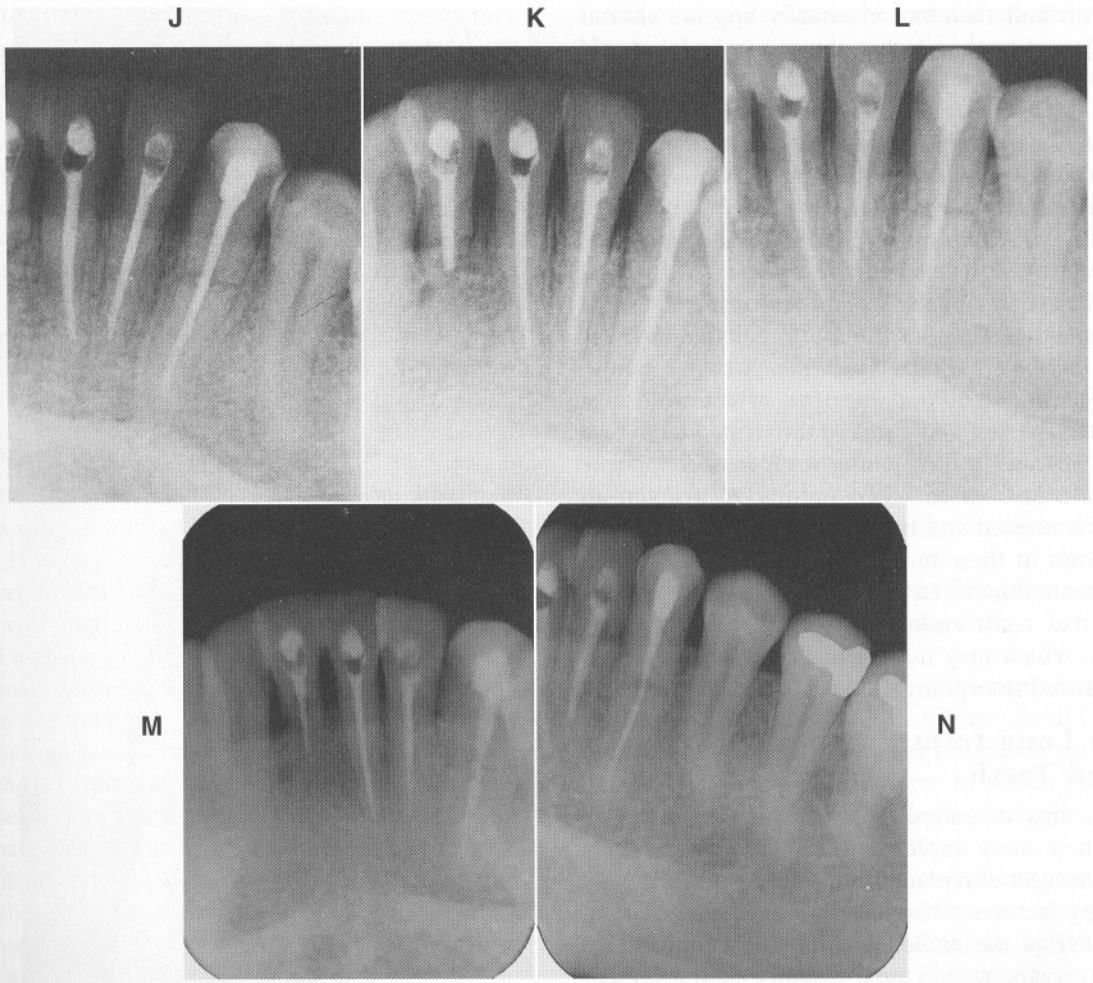


FIGURE 3-17 Cont'd **C,** Radiograph taken 3 months later, 6 months after the replantations. The remaining pulp had been removed from no. 22, the entire canal prepared, and calcium hydroxide paste placed past the fracture line. Teeth no. 23, no. 24, and no. 25 were all treated identically, with canal preparation accompanied by heavy irrigation and placement of calcium hydroxide paste. All access cavities were closed with a cotton pellet and ZOE. On this film it can be seen that the bays of resorption on no. 25 at the gingival line have increased considerably. **D,** Three months later, 9 months after replantation, no. 25 looks much worse and has increased mobility, and the resorption seems to have cut through the root, with the root tip still visible apical to the activity. The other three teeth are now tight. I had changed the calcium hydroxide paste twice on no. 25 but had not needed to do so on the others. **E,** Three months later, 12 months after replantation. Tooth no. 22 has been filled with laterally condensed gutta-percha and Sealapex as sealer. It is firm and comfortable. The bays of resorption on no. 23 and no. 24 seem to be reversing, and these teeth are also firm and comfortable. Tooth no. 25, however, continues to resorb and is mobile and sore despite several more canal cleanings and placement of paste. **F,** Three months later, 15 months after replantation. Teeth no. 23 and no. 24 have been filled with laterally condensed gutta-percha and Wach's paste as sealer and are firm and comfortable. Continued resorption is apparent on no. 25, and the root tip is now seen separated from the remainder of the tooth. Because of continued mobility of this tooth, bonding has been used to splint it to the adjacent teeth. **G,** Three months later, 18 months after replantation. It was now possible to probe the apex of no. 25 from the gingivolingual, although the tooth was acceptably tight from the bonding. I feared that the tooth would start to decay within the canal, so I recleaned the canal and filled it with laterally condensed gutta-percha and Wach's paste. I felt that the tooth would not last much longer but believed that it was now functioning as a pontic and might be able to stay this way for a little more time and put off replacement for awhile. **H,** Radiograph taken after canal filling, indicating the gutta-percha at approximately the radiographic tip of the root. **I** and **J,** Radiographs taken 24 months after replantation. Teeth no. 22, no. 23, and no. 24 are comfortable and firm with resorptive bays reformed. Tooth no. 25 appears to be getting longer! One cannot tell if the firmness is due to the splinting or slightly increased root length. **K** and **L,** Radiographs taken 36 months after replantation. Continued healthy appearance of no. 22, no. 23, and no. 24, with no new resorption visible. Tooth no. 25 continues to be getting longer, with root surface visible approximately 3 mm from the gutta-percha. **M** and **N,** Nineteen years after original treatment, it appears that a callus has formed around the fracture of no. 22, and the tooth is very tight. Teeth no. 23 and no. 24 are tight with external resorption well healed, although a small area of resorption is seen in the apical one third of no. 23. Tooth no. 25 is still tight, probably due to the bonding (which had been replaced twice), and the canal cannot be probed either from labial or lingual. An area of resorption is noted near the middle of the gutta-percha. Several small problems are still present that need attention, but it is remarkable how well the area of trauma has responded to the treatment rendered. This is particularly true when considering the long extraoral time and the failure to place the replanted teeth in the appropriate transfer media.