Prevention and Management of Surgical Complications

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CHAPTER OUTLINE

This chapter discusses the variety of complications of oral surgical procedures. It is divided into two sections, intraoperative and postoperative complications. These are surgical, not medical, complications; the latter are discussed in Chapter 3.

PREVENTION OF COMPLICATIONS

It is axiomatic that the best and easiest way to manage a complication is to prevent it from happening. Prevention of surgical complications is best accomplished by a thorough preoperative assessment and comprehensive treatment plan. Only when these are routinely performed can the surgeon expect to have minimal complications. It is important to realize that even with such planning, complications occasionally occur. In situations in which the dentist has planned carefully, the complication is often expected and can be managed in a routine manner. For example, when extracting a maxillary first premolar, which has long thin roots, it is far easier to remove the buccal root than the palatal root. Therefore the surgeon uses more force toward the buccal root than toward the palatal root. If a root does fracture, it is then the buccal root rather than the palatal root, and the subsequent retrieval is easier.

Surgeons must perform surgery that is within their own ability. Surgeons must therefore carefully evaluate their training and ability before deciding to perform a specific surgical task. It is inappropriate for a dentist with limited experience in the management of impacted third

molars to undertake the surgical extraction of a deeply embedded tooth.

The incidence of operative and postoperative complications is unacceptably high in this situation. Surgeons must be cautious of unwarranted optimism, which clouds their judgment and prevents them from delivering the best possible care to the patient. The dentist must keep in mind that referral to a specialist is an option that should always be exercised if the planned surgery is beyond the dentist's own skill level. In some situations this is not only a moral obligation but also a medicolegal responsibility.

In planning a surgical procedure, the first step is always a thorough review of the patient's medical history. Several of the complications to be discussed in this chapter are caused by inadequate attention to medical histories that would have revealed the presence of a complicating factor. Patients with compromised physical status will have local surgical complications that could have been prevented had the surgeon taken a more thorough medical history.

One of the primary ways to prevent complications is by taking adequate radiographs and reviewing them carefully (see Chapter 7). The radiograph must include the entire area of surgery, including the apices of the roots of the teeth to be extracted and the local and regional anatomic structures, such as the maxillary sinus and the inferior alveolar canal. The surgeon must look for the presence of abnormal tooth root morphology. After careful examination of the radiographs, the surgeon must occasionally alter the treatment plan to prevent the complications that might be anticipated with a routine forceps (closed) extraction. Instead, the surgeon should consider surgical approaches to removing teeth in such cases.

After an adequate medical history has been taken and the radiographs have been analyzed, the surgeon must do the preoperative planning. This is not simply a preparation of a detailed surgical plan but is also a plan for managing patient anxiety and pain and postoperative recovery (instructions and modifications of normal activity for the patient). Thorough preoperative instructions and explanations for the patient are essential in preventing the majority of complications that occur in the postoperative period. If the instructions are not thoroughly explained or their importance made clear, the patient is less likely to follow them.

Finally, to keep complications at a minimum, the surgeon must always follow the basic surgical principles. There should always be clear visualization and access to the operative field, which requires adequate light, adequate soft tissue reflection (including lips, cheeks, tongue, and soft tissue flaps), and adequate suction. The teeth to be removed must have an unimpeded pathway for removal. Occasionally, bone must be removed and teeth must be sectioned to achieve this goal. Controlled force is of paramount importance; this means "finesse," not "force." The surgeon must follow the principles of asepsis, atraumatic handling of tissues, hemostasis, and thorough débridement of the wound after the surgical procedure. Violation of these principles leads to an increased incidence and severity of surgical complications.

BOX 11-1

Prevention of Soft Tissue Injuries

1. Pay strict attention to soft tissue injuries.
2. Develop adequate-sized flaps.
3. Use minimal force for retraction of soft tissue.

SOFT TISSUE INJURIES

Injuries to the soft tissue of the oral cavity are almost always the result of the surgeon's lack of adequate attention to the delicate nature of the mucosa and the use of excessive and uncontrolled force. The surgeon must continue to pay careful attention to the soft tissue while working primarily on the bone and tooth structure (Box 11-1).

Tearing Mucosal Flap

The most common soft tissue injury is the tearing of the mucosal flap during surgical extraction of a tooth. This is usually the result of an inadequately sized envelope flap, which is retracted beyond the tissue's ability to stretch (Fig. 11-1). This results in a tearing, usually at one end of the incision. Prevention of this complication is twofold: (1) create adequately sized flaps to prevent excess tension on the flap, and (2) use small amounts of retraction force on the flap. If a tear does occur in the flap, the flap should be carefully repositioned once the surgery is complete. In most patients, careful suturing of the tear results in adequate but delayed healing. If the tear is especially jagged, the surgeon may consider excising the edges of the torn flap to create a smooth flap margin for closure. This latter step should be performed with caution, because excision of excessive amounts of tissue leads to closure of the wound under tension and probable wound dehiscence.

If the area of surgery is near the apex of a tooth, an increased incidence of envelope-flap tearing exists as a result of excessive retractional forces. In this situation a release incision to create a three-cornered flap should be used to gain access to the bone.

Puncture Wound of Soft Tissue

The second soft tissue injury that occurs with some frequency is inadvertent puncturing of the soft tissue. Instruments, such as a straight elevator or periosteal elevator, may slip from the surgical field and puncture or tear into adjacent soft tissue.

Once again, this injury is the result of using uncontrolled force instead of finesse and is best prevented by the use of controlled force, with special attention given to the supporting fingers or support from the opposite hand in anticipation of slippage. If the instrument slips from the tooth or bone, the fingers thus catch the hand before injury occurs (Fig. 11-2). When a puncture wound does occur, the treatment is aimed primarily at preventing infection and allowing healing to occur, usually by secondary intention. If the wound bleeds excessively, it

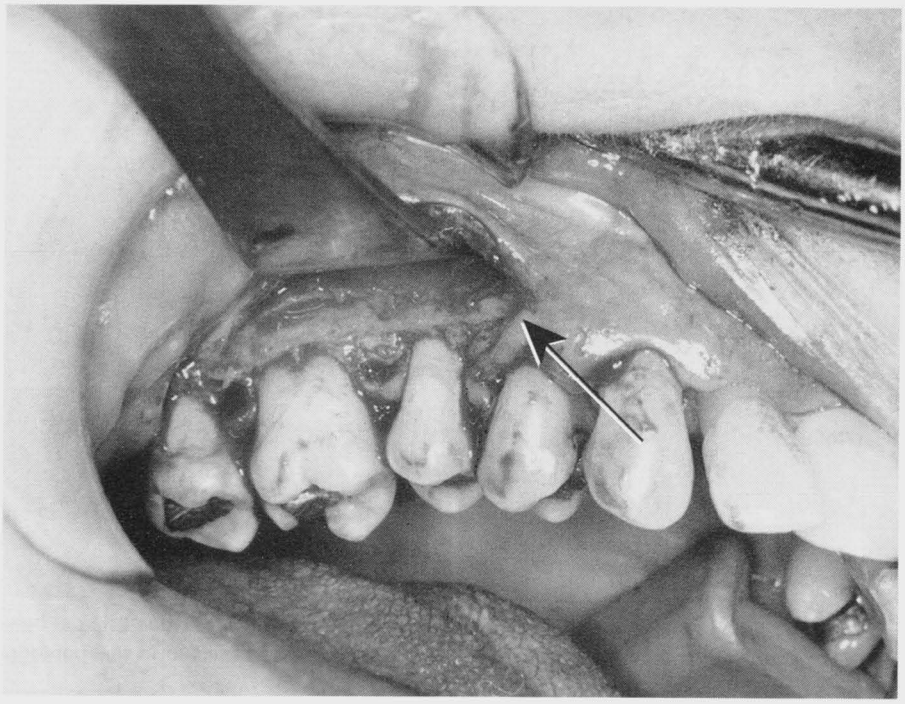

FIG. 11-1 Periosteal elevator (Seldin elevator) is used to reflect mucoperiosteal flap. Elevator placed perpendicular to bone and held in place by pushing firmly against bone, not by pushing it apically against soft tissue *(arrow)*.

should be controlled by direct pressure on the soft tissue. Once hemostasis is achieved, the wound is usually left open and not sutured, so that if a small infection were to occur, there would be an adequate pathway for drainage.

Stretch or Abrasion Injury

Abrasions or burns of the lips and corners of the mouth are usually the result of the rotating shank of the bur rubbing on the soft tissue (Fig. 11-3). When the surgeon is focused on the cutting end of the bur, the assistant should be aware of the location of the shank of the bur in relation to the cheeks and lips. If such an abrasion does develop, the dentist should advise the patient to keep it covered with Vaseline or an antibiotic ointment. It is important that the patient keeps the ointment only on the abraded area and not spread onto intact skin, because it is quite likely to result in a rash. These abrasions usually take 5 to 10 days to heal. The patient should keep the area moist with the ointment during the entire healing period to prevent eschar formation, scarring, and delayed healing, as well as to keep the area reasonably comfortable.

COMPLICATIONS WITH THE TOOTH BEING EXTRACTED

Root Fracture

The most common complication associated with the tooth being extracted is fracture of its roots. Long, curved, divergent roots that lie in dense bone are most likely to be fractured. The main method of preventing

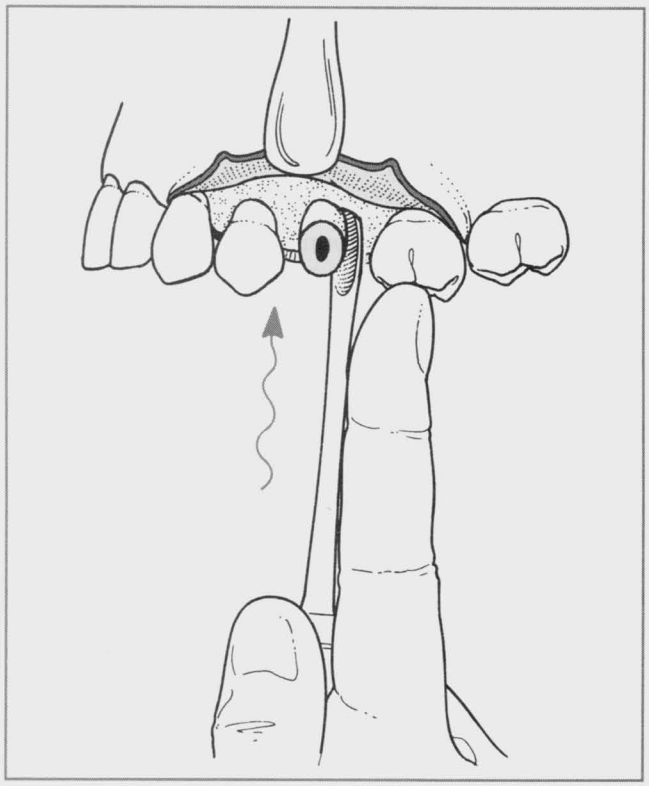

FIG. 11-2 Small straight elevator can be used as shoehorn to luxate broken root. When straight elevator is used in this position, hand must be securely supported on adjacent teeth to prevent inadvertent slippage of instrument from tooth and subsequent injury to adjacent tissue.

FIG. 11-3 **A**, Abrasion of lip as result of shank of bur rotating on soft tissue. Wound should be kept covered with antibiotic ointment. **B**, Healing should occur rapidly, as observed in this photograph taken 5 days later.

BOX 11-2

Prevention of Root and Displacement Fracture

1. Always plan for root fracture.
2. Use surgical (i.e., open) extraction if high probability of fracture.
3. Do not use strong apical force on broken root.

fracture of roots is to perform an open extraction technique and to remove bone to decrease the amount of force necessary to remove the tooth (Box 11-2). Recovery of the fractured root with a surgical approach is discussed in Chapter 8.

Root Displacement

The tooth root that is most commonly displaced into unfavorable anatomic spaces is the maxillary molar root, which is forced into the maxillary sinus. If a root of a maxillary molar is being removed, with a straight elevator being used with excess apical pressure as a wedge in the periodontal ligament space, the tooth root can be displaced into the maxillary sinus. If this occurs, the surgeon must make several assessments to prescribe the appropriate treatment. First, the surgeon must identify the size of the root lost into the sinus. It may be a root tip of several millimeters, an entire tooth root, or the entire tooth. The surgeon must next assess if there has been any infection of the tooth or periapical tissues. If the tooth is not infected, management is easier than if the tooth has been acutely infected. Finally, the surgeon must assess the preoperative condition of the maxillary sinus. For the patient who has a healthy maxillary sinus, it is easier to manage a displaced root than if the sinus has been chronically infected.

If the displaced tooth fragment is a small (2 or 3 mm) root tip and the tooth and sinus have no preexisting infection, the surgeon should make a minimal attempt at removing the root. First, a radiograph of the fractured tooth root should be taken to document its position and size. Once that has been accomplished, the surgeon should irrigate through the small opening in the socket apex and then suction the irrigating solution from the sinus via the socket. This occasionally flushes the root apex from the sinus through the socket. The surgeon should check the suction solution and confirm radiographically that the root has been removed. If this technique is not successful, no additional surgical procedure should be performed through the socket, and the root tip should be left in the sinus. The small, noninfected root tip can be left in place, because it is quite unlikely that it will cause any troublesome sequelae. Additional surgery in this situation will cause more patient morbidity than leaving the root tip *in situ*. If the root tip is left in the sinus, measures should be taken similar to those taken when leaving any root tip in place. The patient must be informed of the decision and given proper follow-up instructions.

The oroantral communication should be managed as discussed later, with a figure-of-eight suture over the socket, sinus precautions, antibiotics, and a nasal spray to prevent infection and keep the ostium open. The most likely occurrence is that the root apex will fibrose onto the sinus membrane with no subsequent problems. If the tooth root is infected or the patient has chronic sinusitis, the patient should be referred to an oral and maxillofacial surgeon for removal of the root tip.

If a large root fragment or the entire tooth is displaced into the maxillary sinus, it should be removed (Fig. 11-4).

The usual method is a Caldwell-Luc approach into the maxillary sinus in the canine fossa region and then removal of the tooth. The oral and maxillofacial surgeon (to whom the patient should be referred) performs this procedure (see Chapter 19).

Impacted maxillary third molars are occasionally displaced into the maxillary sinus (from which they are removed via a Caldwell-Luc approach) or posteriorly into the infratemporal space. During elevation of the tooth, the elevator may force the tooth posteriorly through the periosteum into the infratemporal fossa. The tooth is usually lateral to the lateral pterygoid plate and inferior to the lateral pterygoid muscle. If good access and light are available, the surgeon should make a single cautious effort to retrieve the tooth with a hemostat. The tooth is usually not visible, and blind probing will result in further displacement. If the tooth is not retrieved after a single effort, the incision should be closed and the operation stopped. The patient should be informed that the tooth has been displaced and will be removed later. Antibiotics should be given to help decrease the possibility of an infection, and routine postoperative care should be provided. During the initial healing time, fibrosis occurs and stabilizes the tooth in a rather firm position. The tooth is removed 4 to 6 weeks later by an oral and maxillofacial surgeon.

The displaced tooth lies medial to the ramus of the mandible and may interfere with wide opening of the mouth. In addition, the occurrence of a late infection is possible. Although possible, it is very unlikely that the tooth will migrate after initial fibrosis has occurred. If no mandibular restriction exists, the patient may elect not to have the tooth removed. If this decision is made, the surgeon must document that the patient understands the situation and the potential complications.

Fractured mandibular molar roots that are being removed with apical pressures may be displaced through the lingual cortical plate and into the submandibular fascial space. The lingual cortical bone over the roots of the molars becomes thinner as it progresses posteriorly. Mandibular third molars, for example, frequently have dehiscence in the overlying lingual bone and may be actually sitting in the submandibular space preoperatively. Even small amounts of apical pressure result in displacement of the root into that space. Prevention of displacement into the submandibular space is primarily achieved by avoiding all apical pressures when removing the mandibular roots.

Pennant-shaped elevators, such as the Cryer, are used to elevate the broken tooth root. If the root disappears during the root removal, the dentist should make a single effort to remove it. The index finger of the left hand is inserted onto the lingual aspect of the floor of the mouth in an attempt to place pressure against the lingual aspect of the mandible and force the root back into the socket. If this works, the surgeon may be able to tease the root out of the socket with a root tip pick. If this effort is not successful on the initial attempt, the dentist should abandon the procedure and refer the patient to an oral and maxillofacial surgeon. The usual, definitive procedure of removing such a root tip is to reflect a soft tissue flap on the lingual aspect of the mandible and gently dissect the overlying mucoperiosteum until the root tip can be found. As with teeth that are displaced into the maxillary sinus, if the root fragment is small and was not infected preoperatively, the oral and maxillofacial surgeon may elect to leave the root in its position, because surgical retrieval of the root may be an extensive procedure.

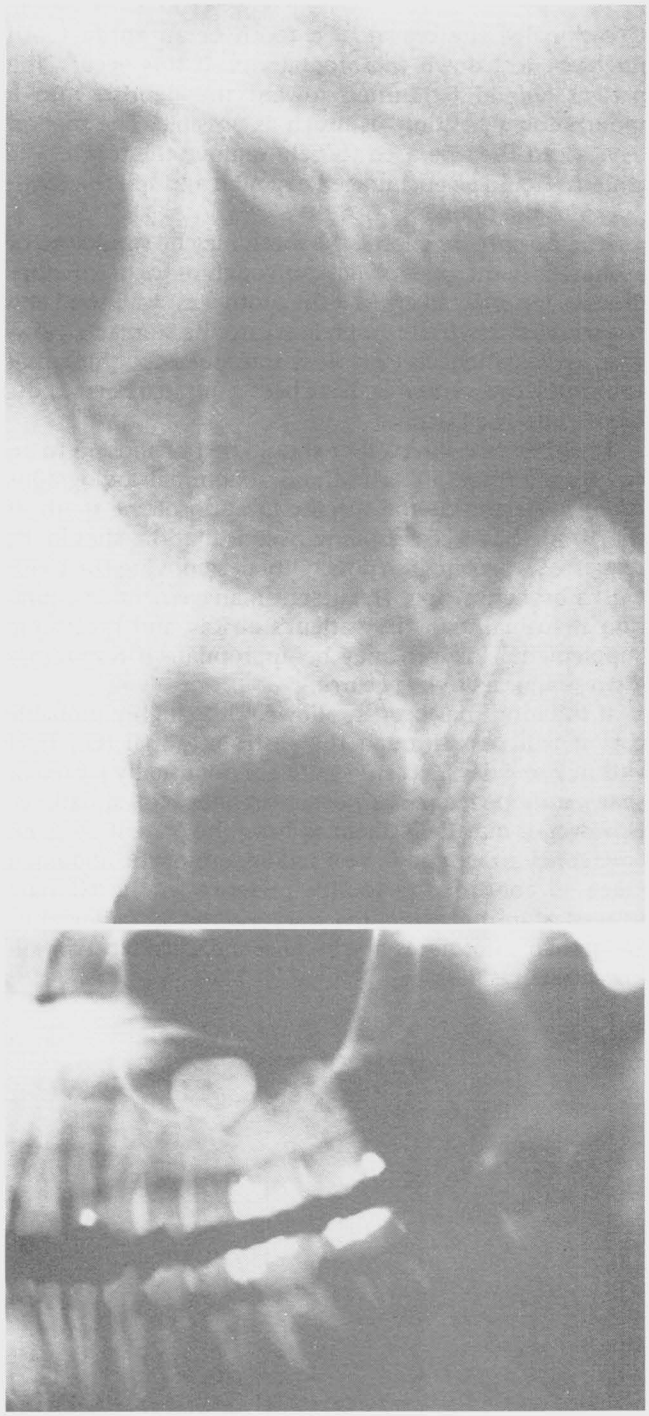

FIG. 11-4 **A,** Large root fragment displaced into maxillary sinus. Fragment should be removed with Caldwell-Luc approach. **B,** Tooth in maxillary sinus is maxillary third molar that was displaced into sinus during elevation of tooth. This tooth must be removed from sinus, probably via a Caldwell-Luc approach.

Tooth Lost into Oropharynx

Occasionally, the crown of a tooth or an entire tooth might be lost down the oropharynx. If this occurs, the patient should be turned toward the dentist, into a mouth-down position, as much as possible. The suction device can then be used to help remove the tooth. The patient should be encouraged to cough and spit the tooth out onto the floor.

In spite of these efforts, the tooth may be swallowed or aspirated. If the patient has no coughing or respiratory distress, it is most likely that the tooth was swallowed and has traveled down the esophagus into the stomach. However, if the patient has a violent episode of coughing that continues, the tooth may have been aspirated beyond the larynx into the trachea.

In either case the patient should be transported to an emergency room and chest and abdominal radiographs taken to determine the specific location of the tooth. If the tooth has been aspirated, consultation should be requested regarding the possibility of removing the tooth with a bronchoscope. The urgent management of aspiration is to maintain the patient's airway and breathing. Supplemental oxygen may be appropriate if respiratory distress appears to be occurring.

If the tooth has been swallowed, it is highly probable that it will pass through the gastrointestinal (GI) tract within 2 to 4 days. Because teeth are not usually jagged or sharp, unimpeded passage occurs in almost all situations. However, it may be prudent to have the patient go to an emergency room and have a radiograph of the abdomen taken to confirm the tooth's presence in the GI tract instead of in the respiratory tract. Follow-up radiographs are probably not necessary, because the usual fate of swallowed teeth is passage.

INJURIES TO ADJACENT TEETH

When the dentist extracts a tooth, the focus of attention is on that particular tooth and the application of forces to luxate and deliver it. When the surgeon's total attention is thus focused, likelihood of injury to the adjacent teeth increases. The surgeon should mentally step back from time to time to survey the entire surgical field to prevent injury to adjacent teeth.

Fracture of Adjacent Restoration

The most common injury to adjacent teeth is the inadvertent fracture of either a restoration or a severely carious tooth while the surgeon is attempting to luxate the tooth to be removed with an elevator (Fig. 11-5). If a large restoration exists, the surgeon should warn the patient preoperatively about the possibility of fracturing it during the extraction. Prevention of such a fracture is primarily achieved by avoiding application of instrumentation and force on the restoration (Box 11-3). This means that the straight elevator should be used with great caution or not used at all to luxate the tooth before extraction. If a

BOX 11-3

Prevention of Injury to Adjacent Teeth

1. Recognize potential to fracture large restoration.
2. Warn patient preoperatively.
3. Employ judicious use of elevators.
4. Ask assistant to warn surgeon of pressure on adjacent teeth.

FIG. 11-5 Mandibular first molar. If it is to be removed, surgeon must take care not to fracture amalgam in second premolar with elevators or forceps.

restoration is dislodged or fractured, the surgeon should make sure that the displaced restoration is removed from the mouth and does not fall into the empty tooth socket. Once the surgical procedure has been completed, the injured tooth should be treated by placement of a temporary restoration. The patient should be informed that the fracture has occurred and that a replacement restoration must be placed (see Chapter 12).

Teeth in the opposite arch may also be injured as a result of uncontrolled tractional forces. This usually occurs when buccolingual forces inadequately mobilize a tooth and excessive tractional forces are used. The tooth suddenly releases from the socket, and the forceps strikes against the teeth of the opposite arch and chips or fractures a cusp. This is more likely to occur with extraction of lower teeth, because these teeth may require more vertical tractional forces for their delivery, especially when using the no. 23 (cowhorn) forceps. Prevention of this type of injury can be accomplished by several methods. First and primary, the surgeon should avoid the use of excessive tractional forces. The tooth should be adequately luxated with apical, buccolingual, and rotational forces to minimize the need for tractional forces.

Even when this is done, however, occasionally a tooth releases unexpectedly. The surgeon or assistant should protect the teeth of the opposite arch by simply holding a finger or suction tip against them to absorb the blow should the forceps be released in that direction. If such an injury occurs, the tooth should be smoothed or restored as necessary to keep the patient comfortable until a permanent restoration can be constructed.

Luxation of Adjacent Teeth

Inappropriate use of the extraction instruments may luxate the adjacent tooth. This is prevented by judicious use of force with elevators and forceps. If the tooth to be extracted is crowded and has overlapping adjacent teeth, such as is commonly seen in the mandibular incisor region, thin, narrow forceps such as the no. 286 forceps, may be useful for the extraction (Fig. 11-6). Forceps with broader beaks should be avoided, because it will cause injury and luxation of the adjacent teeth.

If an adjacent tooth is luxated or partially avulsed, the treatment goal is to reposition the tooth into its appropriate position and stabilize it so that adequate healing occurs. This usually requires that the tooth simply be repositioned in the tooth socket and left alone.

The occlusion should be checked to ensure that the tooth has not been displaced into a hypererupted and traumatic occlusion. Occasionally, the luxated tooth is very mobile. If this is the case, the tooth should be stabilized with the least possible rigid fixation to maintain the tooth in its position. A simple silk suture that crosses the occlusal table and is sutured to the adjacent gingiva is usually sufficient. Rigid fixation with circumdental wires and arch bars results in increased chances for external root resorption and ankylosis of the tooth; therefore it should usually be avoided (see Chapter 23).

Extraction of Wrong Teeth

A complication that every dentist believes can never happen—but happens surprisingly often—is extraction of the wrong tooth. This should never occur if appropriate attention is given to the planning and execution of the surgical procedure.

This problem may be the result of inadequate attention to the preoperative assessment. If the tooth to be extracted is grossly carious, it is less likely that the wrong tooth will be removed. The wrong tooth is most commonly extracted when the dentist is asked to remove teeth for orthodontic purposes, especially from patients who are in mixed dentition stages and whose orthodon-

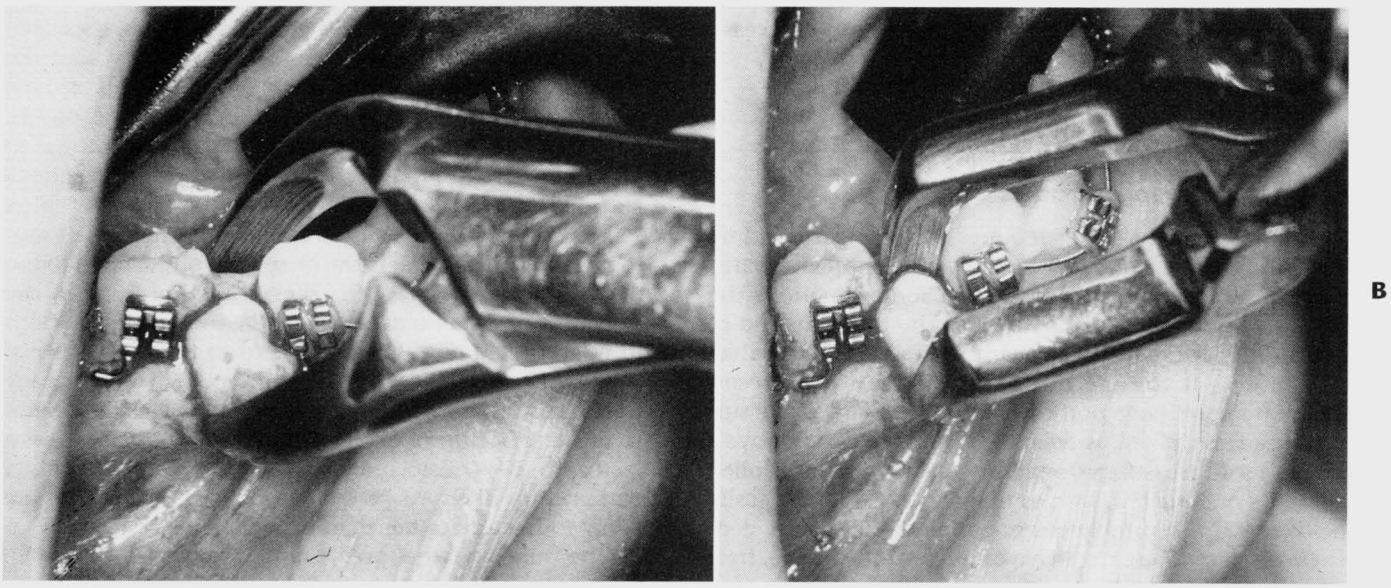

FIG. 11-6 **A,** No. 151 forceps, too wide to grasp premolar to be extracted without luxating adjacent teeth. **B,** Maxillary root forceps, which can be adapted easily to tooth for extraction.

BOX 11-4

Prevention of Extraction of Wrong Teeth

1. Focus attention on procedure.
2. Enlist patient and assistant to ensure correct tooth is being removed.
3. Check, then recheck, to confirm correct tooth.

tists have asked for unusual extractions. Careful preoperative planning and clinical assessment of which tooth is to be removed before the forceps is applied is the main method of preventing this complication (Box 11-4).

If the wrong tooth is extracted and the dentist realizes this error immediately, the tooth should be replaced immediately into the tooth socket. If the extraction is for orthodontic purposes, the dentist should contact the orthodontist immediately and discuss whether or not the tooth that was removed can substitute for the tooth that should have been removed. If the orthodontist believes the original tooth must be removed, the correct extraction should be deferred for 4 or 5 weeks, until the fate of the replanted tooth can be assessed. If the wrongfully extracted tooth has regained its attachment to the alveolar process, then the originally planned extraction can proceed. The surgeon should not extract the contralateral tooth until a definite alternative treatment plan is made.

If the surgeon does not recognize that the wrong tooth was extracted until the patient returns for a postoperative visit, little can be done to correct the problem. Replantation of the extracted tooth after it has dried cannot be successfully accomplished.

When the wrong tooth is extracted, it is important to inform the patient, the patient's parents (if the patient is a minor), and any other dentist involved with the patient's care, such as the orthodontist. In some situations the orthodontist may be able to adjust the treatment plan so that extraction of the wrong tooth necessitates only a minor adjustment.

INJURIES TO OSSEOUS STRUCTURES

Fracture of Alveolar Process

The extraction of a tooth requires that the surrounding alveolar bone be expanded to allow an unimpeded pathway for tooth removal. However, in some situations the bone fractures and is removed with the tooth instead of expanding. The most likely cause of fracture of the alveolar process is the use of excessive force with forceps, which fractures large portions of cortical plate. If the surgeon realizes that excessive force is necessary to remove a tooth, a soft tissue flap should be elevated and controlled amounts of bone removed so that the tooth can be easily delivered. If this principle is not adhered to and the dentist continues to use excessive or uncontrolled force, fracture of the bone will probably occur.

The most likely places for bony fracture are the buccal cortical plate over the maxillary canine, the buccal cortical plate over the maxillary molars (especially the first molar), the portions of the floor of the maxillary sinus associated with maxillary molars, the maxillary tuberosity, and the labial bone on mandibular incisors (Fig. 11-7). All of these bony injuries are caused by excessive force from the forceps.

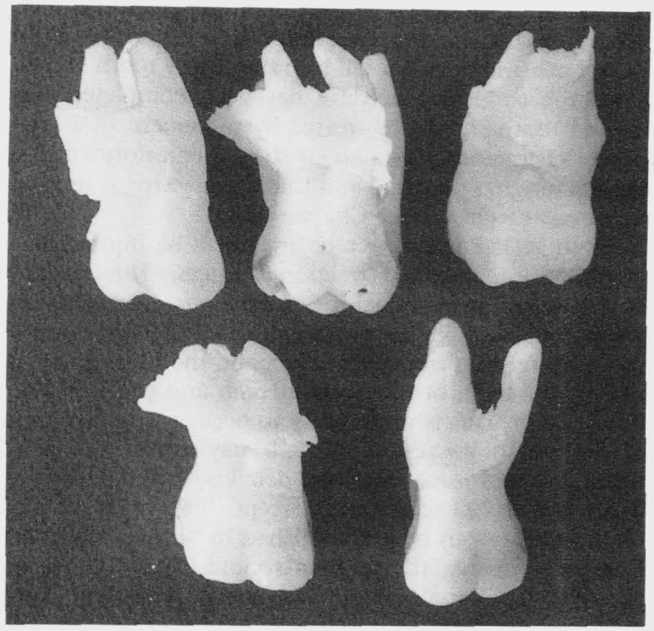

FIG. 11-7 Forceps extraction of these teeth resulted in removal of bone and tooth instead of just tooth.

BOX 11-5

Prevention of Fracture of Alveolar Process

1. Conduct thorough preoperative clinical and radiographic examination.
2. Do not use excessive force.
3. Use surgical (i.e., open) extraction technique to reduce force required.

The primary method of preventing these fractures is to perform a careful preoperative examination of the alveolar process, both clinically and radiographically (Box 11-5). Surgeons should inspect the root form of the tooth to be removed and assess the proximity of the roots to the maxillary sinus (Fig. 11-8). They should also check the thickness of the buccal cortical plate overlying the tooth to be extracted (Fig. 11-9). If the roots diverge widely, if they lie close to the sinus, or if the patient has a heavy buccal cortical bone, surgeons must take special measures to prevent fracturing excessive portions of bone. Age is a factor to be considered, because the bones of older patients are likely to be less elastic and therefore more likely to fracture rather than expand.

The surgeon who preoperatively determines that a high probability exists for bone fracture should consider performing the extraction by the surgical technique. Using this method the surgeon can remove a smaller,

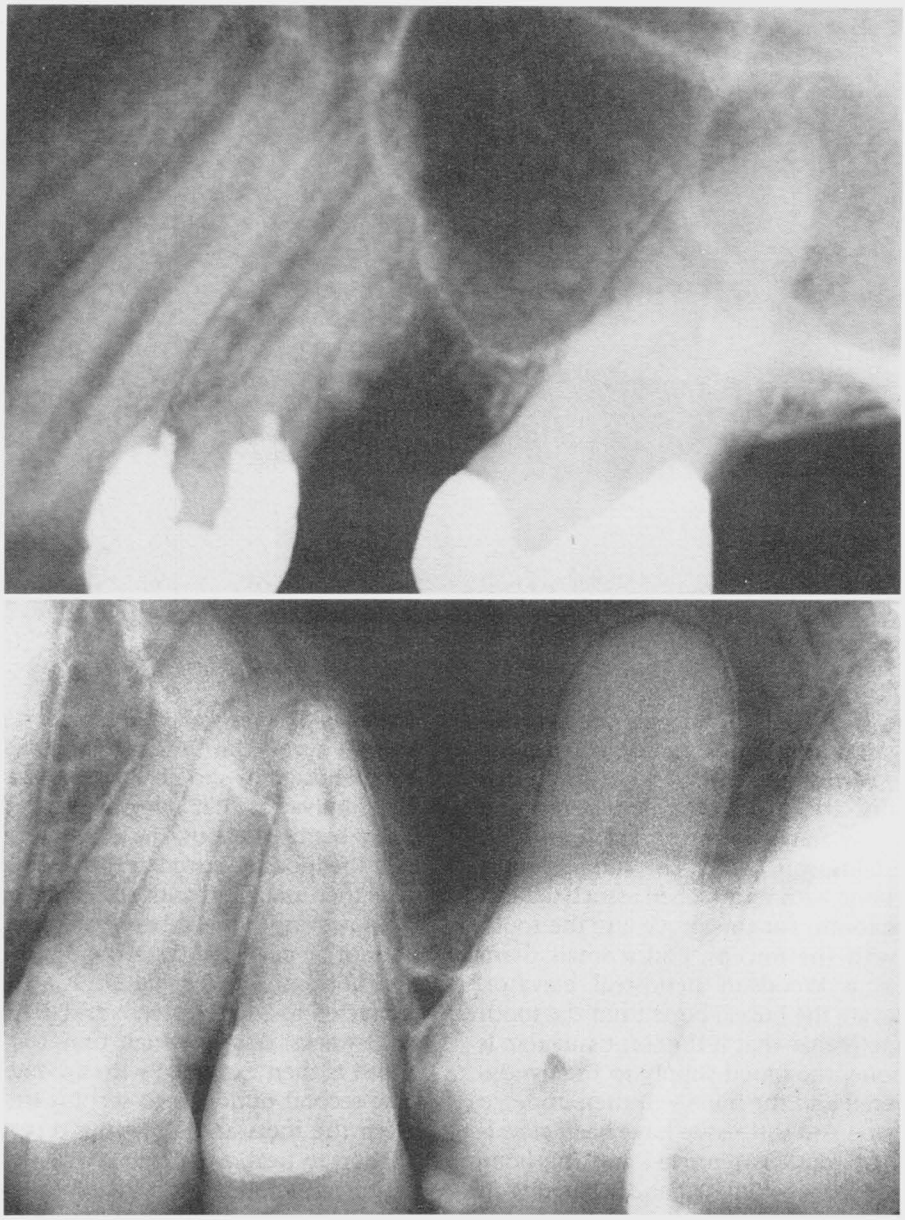

FIG. 11-8 **A,** Floor of sinus associated with roots of teeth. If extraction is required, tooth should be removed surgically. **B,** Maxillary molar teeth immediately adjacent to sinus present increased danger of sinus exposure.

more controlled amount of bone, which results in more rapid healing and a more ideal ridge form for prosthetic reconstruction.

When the maxillary molar lies close to the maxillary sinus, surgical exposure of the tooth, with sectioning of the tooth roots into two or three portions, will prevent the removal of a portion of the maxillary sinus floor. This prevents the formation of a chronic oroantral fistula, which requires secondary procedures to close.

In summary, prevention of fractures of large portions of the cortical plate depends on preoperative radiographic and clinical assessment, avoidance of the use of excessive amounts of uncontrolled force, and the early decision to perform an open extraction with removal of controlled amounts of bone and sectioning of multirooted teeth. During a forceps extraction, if the appropriate amount of tooth mobilization does not occur early, then the wise and prudent dentist will alter the treatment plan to the surgical technique instead of pursuing the closed method.

Management of fractures of the alveolar bone takes several different routes, depending on the type and severity of the fracture: If the bone has been completely removed from the tooth socket along with the tooth, it should *not* be replaced. The surgeon should simply make sure that the soft tissue has been replaced and repositioned over the remaining bone to prevent delayed healing. The surgeon must also smooth any sharp edges that may have been caused by the fracture. If such sharp edges of bone exist, the surgeon should reflect a small amount of soft tissue and use a bone file to round off the sharp edges.

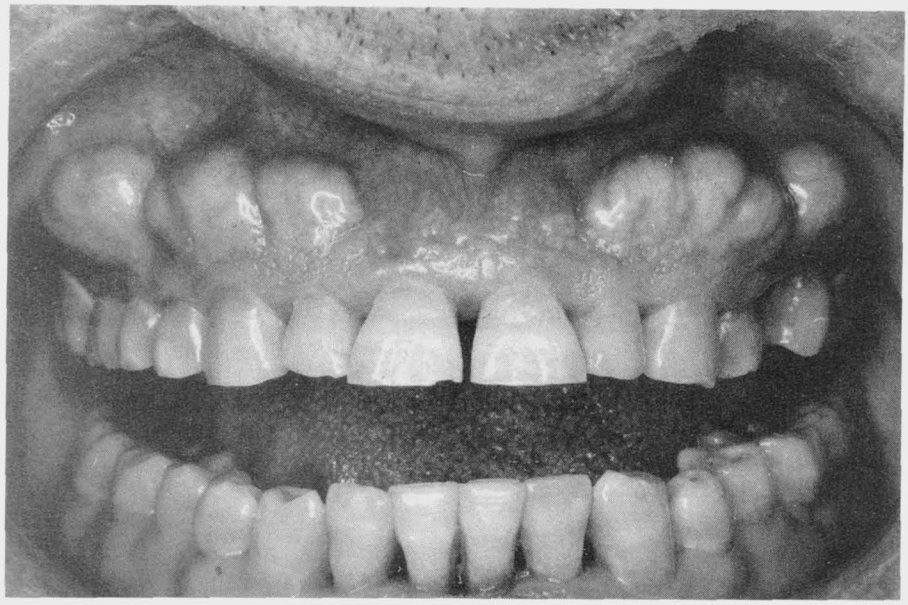

FIG. 11-9 Patient with heavy buccal cortical plate who requires open extraction.

The surgeon who has been supporting the alveolar process with the fingers during the extraction will feel the fracture of the buccal cortical plate when it occurs. At this time the bone remains attached to the periosteum and will heal if it can be separated from the tooth and left attached to the overlying soft tissue. The surgeon must carefully dissect the bone with its attached associated soft tissue away from the tooth. For this procedure the tooth must be stabilized with the forceps, and a small sharp instrument, such as a Woodson periosteal elevator, should be used to elevate the buccal bone from the tooth root. It is important to realize that if the soft tissue flap is reflected from the bone, the blood supply to the overlying bone will be severed and the bone will then undergo necrosis. Once the bone and soft tissue have been elevated from the tooth, the tooth is removed and the bone and soft tissue flap are reapproximated and secured with sutures. When treated in this fashion, it is highly probable that the bone will heal in a more favorable ridge form for prosthetic reconstruction than if the bone had been removed along with the tooth. Therefore it is worth the special effort to dissect the bone from the tooth.

Fracture of Maxillary Tuberosity

Fracture of a large section of bone in the maxillary tuberosity area is a situation of special concern. The maxillary tuberosity is especially important for the construction of a stable retentive maxillary denture. If a large portion of this tuberosity is removed along with the maxillary tooth, denture stability may be compromised. The fracture of the maxillary tuberosity most commonly results from extraction of an erupted maxillary third molar or from a second molar if it happens to be the last tooth in the arch (Fig. 11-10).

If this type of fracture occurs during an extraction, treatment is similar to that just discussed for other bony fractures. The surgeon using finger support for the alveolar process during the fracture (if the bone remains attached to the periosteum) should take extreme measures to ensure the survival of that bony segment. If at all possible the bony segment should be dissected away from the tooth and the tooth removed in the usual fashion. The tuberosity is then stabilized with sutures as previously indicated.

However, if the tuberosity is excessively mobile and cannot be dissected from the tooth, the surgeon has several options. The first option is to splint the tooth being extracted to adjacent teeth and defer the extraction for 6 to 8 weeks, during which time the bone will heal. The tooth is then extracted with an open surgical technique. The second option is to section the crown of the tooth from the roots and allow the tuberosity and tooth root section to heal. After 6 to 8 weeks the surgeon can reenter the area and remove the tooth roots in the usual fashion. If the maxillary molar tooth is infected, these two techniques should be used with caution.

If the maxillary tuberosity is completely separated from the soft tissue, the usual steps are to smooth the sharp edges of the remaining bone and to replace and suture the remaining soft tissue. The surgeon must carefully check for an oroantral communication and treat as necessary.

Fractures of the maxillary tuberosity should be viewed as a serious complication. The major therapeutic goal of management is to maintain the fractured bone in place and to provide the best possible environment for healing. This may be a situation that can best be handled by referral to an oral and maxillofacial surgeon.

INJURIES TO ADJACENT STRUCTURES

During the process of tooth extraction, it is possible to injure adjacent tissues. The prudent surgeon preoperatively evaluates all adjacent anatomic areas and designs a surgical procedure to prevent injury to these tissues.

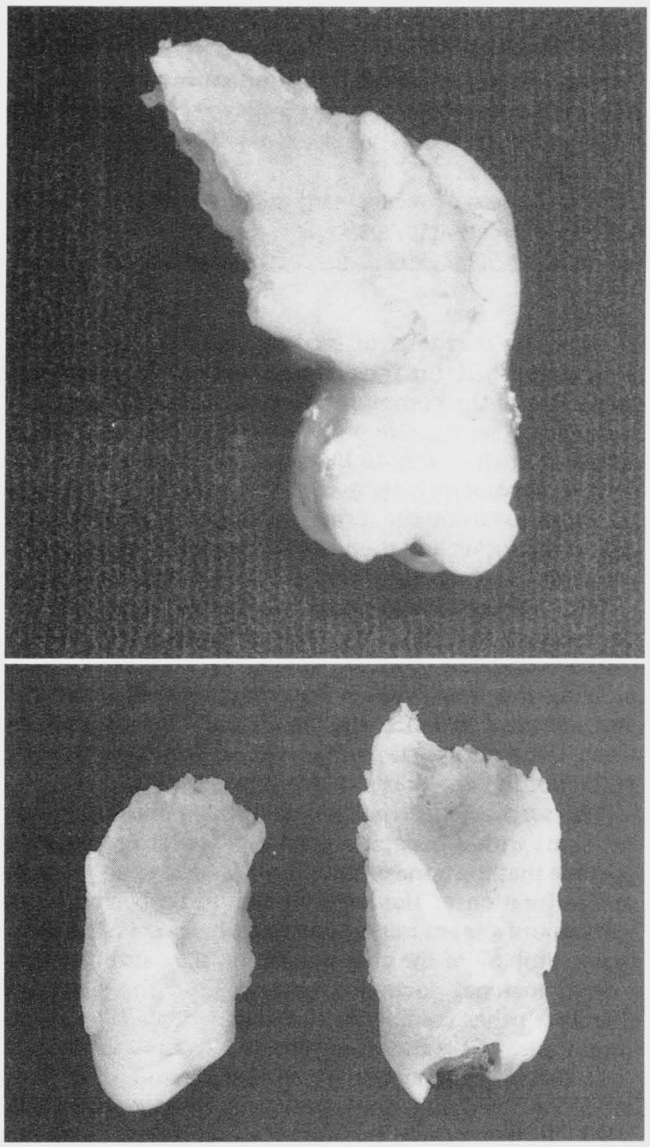

FIG. 11-10 Tuberosity removed with maxillary second molar, which eliminates important prosthetic retention area and exposes maxillary sinus. **A,** Buccal view of bone removed with tooth. **B,** Superior view, looking onto sinus floor, which was removed with tooth.

Injury to Regional Nerves

The branches of the fifth cranial nerve, which provide innervation to the mucosa and skin, are the structures most likely to be injured during extraction. The most frequently involved specific branches are the mental nerve, the lingual nerve, the buccal nerve, and the nasopalatine nerve. The nasopalatine and buccal nerves are frequently sectioned during the creation of flaps for removal of impacted teeth. The area of sensory innervation of these two nerves is relatively small, and reinnervation of the affected area usually occurs rapidly. Therefore the nasopalatine and long buccal nerves can be surgically sectioned without sequelae or complications.

Surgical removal of mandibular premolar roots or impacted mandibular premolars and periapical surgery in the area of the mental nerve and mental foramen must be performed with great care. If the mental nerve is injured, the patient will have an anesthesia or paresthesia of the lip and chin. If the injury is the result of flap reflection or simple manipulation, the altered sensation usually disappears in a few weeks to a few months. If the mental nerve is sectioned at its exit from the mental foramen or torn along its course, it is likely that mental nerve function will not return, and the patient will have a permanent state of anesthesia. If surgery is to be performed in the area of the mental nerve or the mental foramen, it is imperative that surgeons have a keen awareness of the potential morbidity from injury to this nerve (Box 11-6). If surgeons have any question concerning their ability to perform the indicated surgical procedure, they should refer the patient to an oral and maxillofacial surgeon. If a three-corner flap is to be used in the area of the mental nerve, the vertical releasing incision must be placed far enough anterior to avoid severing any portion of the mental nerve. Rarely is it advisable to make the vertical releasing incision at the interdental papilla between the canine and first premolar.

BOX 11-6

Prevention of Nerve Injury

1. Be aware of nerve anatomy in surgical area.
2. Avoid making incisions or affecting periosteum in nerve area.

The lingual nerve is anatomically located directly against the lingual aspect of the mandible in the retromolar pad region. The lingual nerve rarely regenerates if it is severely traumatized. Incisions made in the retromolar pad region of the mandible should be placed to avoid severing this nerve. Therefore incisions made for surgical exposure of impacted third molars or of bony areas in the posterior molar region should be made well to the buccal aspect of the mandible. Prevention of injury to the lingual nerve is of paramount importance for controlling this difficult complication.

Finally, the inferior alveolar nerve may be traumatized along the course of its intrabony canal. The most common place of injury is the area of the mandibular third molar. Removal of impacted third molars may crush or sharply injure the nerve in its canal. This complication is common enough during the extraction of third molars that it is important to inform patients on a routine basis that it is a possibility. The surgeon must then take every precaution possible to avoid injuring the nerve during the extraction.

Injury to Temporomandibular Joint

Another major structure that can be traumatized during an extraction procedure in the mandible is the temporomandibular joint (TMJ). Removal of mandibular molar teeth frequently requires the application of a substantial amount of force. If the jaw is inadequately supported during the extraction, the patient may experience pain in this region. Controlled force and adequate support of the jaw prevents this. The use of a bite block on the contralateral

BOX 11-7

Prevention of Injury to Temporomandibular Joint

1. Support mandible during extraction.
2. Do not open mouth too widely.

BOX 11-8

Prevention of Oroantral Communications

1. Conduct thorough preoperative radiographic examination.
2. Use surgical extraction early and section roots.
3. Avoid excess apical pressure.

side may provide adequate balance of forces so that injury and pain do not occur (Box 11-7). The surgeon must also support the jaw as described earlier. If the patient complains of pain in the TMJ immediately after the extraction procedure, the surgeon should recommend the use of moist heat, rest for the jaw, a soft diet, and 1000 mg of aspirin every 4 hours for several days. Patients who cannot tolerate aspirin should be given an aspirin substitute, such as other NSAIDs or acetaminophen.

OROANTRAL COMMUNICATIONS

Removal of maxillary molars occasionally results in communication between the oral cavity and the maxillary sinus. If the maxillary sinus is large, if no bone exists between the roots of the teeth and the maxillary sinus, and if the roots of the tooth are widely divergent, then it is increasingly probable that a portion of the bony floor of the sinus will be removed with the tooth. If this complication occurs, appropriate measures are necessary to prevent a variety of sequelae. The two sequelae of most concern are postoperative maxillary sinusitis and formation of a chronic oroantral fistula. The probability that either of these two sequelae will occur is related to the size of the oroantral communication and the management of the exposure.

As with all complications, prevention is the easiest and most efficient method of managing the situation. Preoperative radiographs must be carefully evaluated for the tooth-sinus relationship whenever maxillary molars are to be extracted. If the sinus floor seems to be very close to the tooth roots and the tooth roots are widely divergent, the surgeon should avoid a closed forceps extraction and perform a surgical removal with sectioning of tooth roots (see Fig. 11-8). Large amounts of force should be avoided in the removal of such maxillary molars (Box 11-8).

Diagnosis of the oroantral communication can be made in several ways: The first is to examine the tooth once it is removed. If a section of bone is adhered to the root ends of the tooth, the surgeon can be relatively certain that a communication between the sinus and mouth exists. If a small amount of bone or no bone adheres to the molars, a communication may exist anyway. To confirm the presence of a communication, the best technique is to use the nose-blowing test. Pinching the nostrils together occludes the patient's nose, and the patient is asked to blow gently through the nose while the surgeon observes the area of the tooth extraction. If a communication exists, there will be passage of air through the tooth socket and bubbling of blood in the socket area.

After the diagnosis of oroantral communication has been established, the surgeon must determine the approximate size of the communication, because the treatment will depend on the size of the opening. If the communication is small (2 mm in diameter or less), no additional surgical treatment is necessary. The surgeon should take measures to ensure the formation of a high-quality blood clot in the socket and then advise the patient to take sinus precautions to prevent dislodgment of the blood clot.

Sinus precautions are aimed at preventing increases or decreases in the maxillary sinus air pressure that would dislodge the clot. Patients should be advised to avoid blowing the nose, violent sneezing, sucking on straws, and smoking. Patients who smoke and who cannot stop (even temporarily) should be advised to smoke in small puffs, not in deep drags, to avoid pressure changes.

The surgeon must not probe through the socket into the sinus with a periapical curette or a root tip pick. It is possible that the bone of the sinus has been removed without perforation of the sinus lining. To probe the socket with an instrument might unnecessarily lacerate the membrane. Probing of the communication may also introduce foreign material, including bacteria, into the sinus and thereby further complicate the situation. Probing of the communication is therefore absolutely contraindicated.

If the opening between the mouth and sinus is of moderate size (2 to 6 mm), additional measures should be taken. To help ensure the maintenance of the blood clot in the area, a figure-of-eight suture should be placed over the tooth socket (Fig. 11-11). The patient should also be told to follow sinus precautions. Finally, the patient should be prescribed several medications to help lessen the possibility that maxillary sinusitis will occur. Antibiotics, usually penicillin or clindamycin, should be prescribed for 5 days. In addition, a decongestant nasal spray should be prescribed to shrink the nasal mucosa to keep the ostium of the sinus patent. As long as the ostium is patent and normal sinus drainage can occur, sinusitis and sinus infection are less likely. An oral decongestant is also sometimes recommended.

If the sinus opening is large (7 mm or larger), the dentist should consider closing the sinus communication with a flap procedure. This usually requires that the patient be referred to an oral and maxillofacial surgeon, because flap development and closure of a sinus opening are somewhat complex procedures that require skill and experience.

The most commonly used flap is a buccal flap. This technique mobilizes buccal soft tissue to cover the opening and provide for a primary closure. This technique should be performed as soon as possible, preferably on

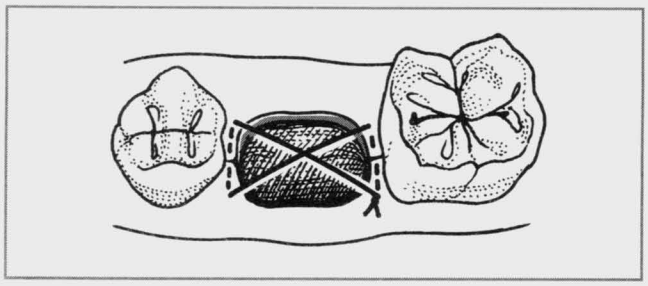

FIG. 11-11 A figure-of-eight stitch is usually performed to help maintain piece of oxidized cellulose in tooth socket.

the same day in which the opening occurred. The same sinus precautions and medications are usually required (see Chapter 19).

The recommendations just described hold true for patients who have no preexisting sinus disease. If a communication does occur, it is important that the dentist inquire specifically about a history of sinusitis and sinus infections. If the patient has a history of chronic sinus disease, even small oroantral communications will heal poorly and may result in permanent oroantral communication. Therefore creation of an oroantral communication in patients with chronic sinusitis is cause for referral to an oral and maxillofacial surgeon for definitive care (see Chapter 19).

The majority of oroantral communications treated in the methods just recommended will heal uneventfully. Patients should be followed up carefully for several weeks to ensure that this has occurred. Even patients who return within a few days with a small communication usually heal spontaneously if no maxillary sinusitis exists. These patients should be followed up closely and referred to an oral and maxillofacial surgeon if the communication persists for longer than 2 weeks. Closure of oroantral fistulae is important because air, water, food, and bacteria go from the oral cavity into the sinus, often causing a chronic sinusitis condition. Additionally, if the patient is wearing a full maxillary denture, suction is not as strong; therefore retention of the denture is compromised.

POSTOPERATIVE BLEEDING

Extraction of teeth is a surgical procedure that presents a severe challenge to the body's hemostatic mechanism. Several reasons exist for this challenge: First, the tissues of the mouth and jaws are highly vascular. Second, the extraction of a tooth leaves an open wound, with both soft tissue and bone open, which allows additional oozing and bleeding. Third, it is almost impossible to apply dressing material with enough pressure and sealing to prevent additional bleeding during surgery. Fourth, patients tend to play with the area of surgery with their tongues and occasionally dislodge blood clots, which initiates secondary bleeding. The tongue may also cause secondary bleeding by creating small negative pressures that suction the blood clot from the socket. Finally, salivary enzymes may lyse the blood clot before it has organized and before the ingrowth of granulation tissue.

BOX 11-9

Prevention of Postoperative Bleeding

1. Obtain history of bleeding.
2. Use atraumatic surgical technique.
3. Obtain good hemostasis at surgery.
4. Provide excellent patient instructions.

As with all complications, prevention of bleeding is the best way to manage this problem (Box 11-9). One of the prime factors in preventing bleeding is the taking of a thorough history from the patient regarding this specific potential problem. Several questions should be asked of the patient concerning any history of bleeding. If affirmative answers to any of these questions are given, the surgeon should take special efforts to control bleeding.

The first question that patients should be asked is if they have ever had a problem with bleeding in the past. The surgeon should inquire about bleeding after previous tooth extractions or previous surgery (such as a tonsillectomy) and persistent bleeding after accidental lacerations. The surgeon must listen carefully to the patient's answers to these questions, because the patient's idea of "persistent" may actually be normal. For example, it is quite normal for a socket to ooze small amounts of blood for the first 12 to 24 hours after extraction. However, if a patient relates a history of bleeding that persisted for more than 1 day or that required special attention from the dentist, then the surgeon's degree of suspicion should be substantially elevated.

The surgeon should inquire about any family history of bleeding. If anyone in the patient's family has or had a history of prolonged bleeding, further inquiry about its cause should be pursued. Most congenital bleeding disorders are familial, inherited characteristics. These congenital disorders vary from very mild to very profound, the latter requiring substantial efforts to control.

The patient should next be asked about any medications currently being taken that might interfere with coagulation. Drugs such as anticoagulants may cause prolonged bleeding after extraction. Patients receiving anticancer chemotherapy or who are alcoholics may also tend to bleed.

The patient who has a known or suspected coagulopathy should be evaluated by laboratory testing before surgery is performed to determine the severity of the disorder. It is usually advisable to enlist the aid of a hematologist if the patient has a familial coagulation disorder.

The means to measure the status of intentional anticoagulation is to use the International Normalized Ratio (INR). This value takes into account both the patient's prothrombin time (PT) and the control. Normal anticoagulated status for most medical indications will have an INR of 2.0 to 3.0. It is reasonable to perform extractions on patients who have an INR of 2.5 or less without reducing the anticoagulant dose. With special precautions, it is reasonably safe to do minor amounts of surgery in patients with an INR of up to 3.0, if special local hemostatic measures are taken.

Primary control of bleeding during routine surgery depends on gaining control of all factors that may prolong bleeding. Surgery should be as atraumatic as possible, with clean incisions and gentle management of the soft tissue. Care should be taken not to crush the soft tissue, because crushed tissue tends to ooze for long periods. Sharp bony spicules should be smoothed or removed. All granulation tissue should be curetted from the periapical region of the socket and from around the necks of adjacent teeth and soft tissue flaps. This should be deferred when anatomic restrictions, such as the sinus or inferior alveolar canal, are present (Fig. 11-12). The wound should be carefully inspected for the presence of any specific bleeding arteries. If such arteries exist in the soft tissue, they should be controlled with direct pressure or, if pressure fails, by clamping the artery with a hemostat and ligating it with a resorbable suture. For most oral surgical procedures, direct pressure over the soft tissue bleeding area for 5 minutes results in complete control.

The surgeon should also check for bleeding from the bone. Occasionally, a small, isolated vessel bleeds from a bony foramen. If this occurs, the foramen can be crushed with the closed ends of the hemostat, thereby occluding the bleeding vessel. Once these measures have been accomplished, the bleeding socket is covered with a damp gauze sponge that has been folded to fit directly into the area from which the tooth was extracted. The patient bites down firmly on this gauze for at least 30 minutes. The surgeon should not dismiss the patient from the office until hemostasis has been achieved. This requires that the surgeon check the patient's extraction socket about 15 minutes after the completion of surgery. The patient should open the mouth widely, the gauze should be removed, and the area should be inspected carefully for any persistent oozing. Initial control should have been achieved. New damp gauze is then folded and placed into position, and the patient is told to leave it in place for an additional 30 minutes.

If bleeding persists but careful inspection of the socket reveals that it is not of an arterial origin, the surgeon should take additional measures to achieve hemostasis. Several different materials can be placed in the socket to help gain hemostasis (Fig. 11-13). The most commonly used and the least expensive is the absorbable gelatin sponge (e.g., Gelfoam). This material is placed in the extraction socket and held in place with a figure eight suture placed over the socket. The absorbable gelatin sponge forms a scaffold for the formation of a blood clot, and the suture helps maintain the sponge in position during the coagulation process. A gauze pack is then placed over the top of the socket and is held with pressure.

A second material that can be used to control bleeding is oxidized regenerated cellulose (e.g., Surgicel). This material promotes coagulation better than the absorbable gelatin sponge, because it can be packed into the socket under pressure. The gelatin sponge becomes very friable when wet and cannot be packed into a bleeding socket. When the cellulose is packed into the socket, it almost always causes delayed healing of the socket. Therefore packing the socket with cellulose is reserved for more persistent bleeding.

If the surgeon has special concerns about the patient's ability to clot, a liquid preparation of topical thrombin (prepared from bovine thrombin) can be saturated onto a gelatin sponge and inserted into the tooth socket. The thrombin bypasses all steps in the coagulation cascade and helps to convert fibrinogen to fibrin enzymatically, which forms a clot. The sponge with the topical thrombin is secured in place with a figure-eight suture. A gauze pack is placed over the extraction site in the usual fashion.

A final material that can be used to help control a bleeding socket is collagen. Collagen promotes platelet aggregation and thereby helps accelerate blood coagulation. Collagen is currently available in several different forms. Microfibular collagen (e.g., Avitene) is available as a fibular material that is loose and fluffy but can be

FIG. 11-12 Granuloma of second premolar. Surgeon should not curette periapically around this second premolar to remove granuloma because risk for sinus perforation is high.

packed into a tooth socket and held in by suturing and gauze packs, as with the other materials. A more highly cross-linked collagen is supplied as a plug (e.g., Collaplug) or as a tape (e.g., Collatape). These materials are more readily packed into a socket (Fig. 11-14) and are easier to use. They are also more expensive.

Even after primary hemostasis has been achieved, patients occasionally call the dentist with bleeding from the extraction site, referred to as secondary bleeding. The patient should be told to rinse the mouth gently with very cold water, then place appropriate-sized gauze over the area and bite firmly. The patient should sit quietly for 30 minutes, biting firmly on the gauze. If the bleeding persists, the patient should repeat the cold rinse and bite down on a damp tea bag. The tannin in the tea will frequently help stop the bleeding. If neither of these techniques is successful, the patient should return to the dentist.

The surgeon must have an orderly, planned regimen to control this secondary bleeding. The patient should be positioned in the dental chair, and all blood, saliva, and fluids should be suctioned from the mouth. Such patients will frequently have large "liver clots" in their mouth, which must be removed. The surgeon should visualize the bleeding site carefully with good light to determine the precise source of bleeding. If it is clearly seen to be a generalized oozing, the bleeding site is covered with a folded, damp gauze sponge held in place with firm pressure by the surgeon's finger for at least 5 minutes.

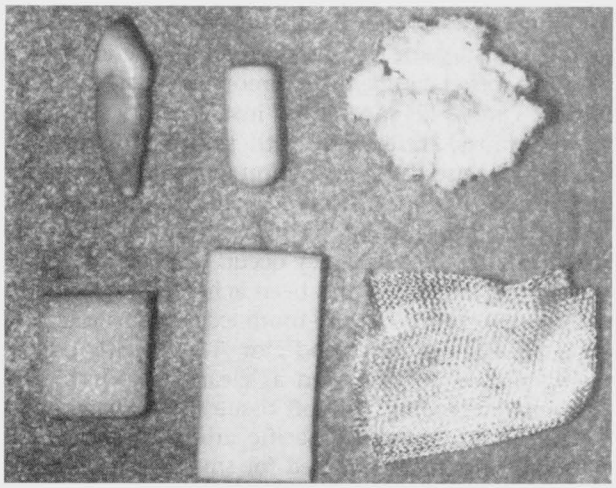

FIG. 11-13 Material that can be used in a bleeding socket. Clockwise from the canine tooth: collagen plug, microfibular collagen, regenerated oxidized cellulose, collagen tape, and absorbable gelatin sponge.

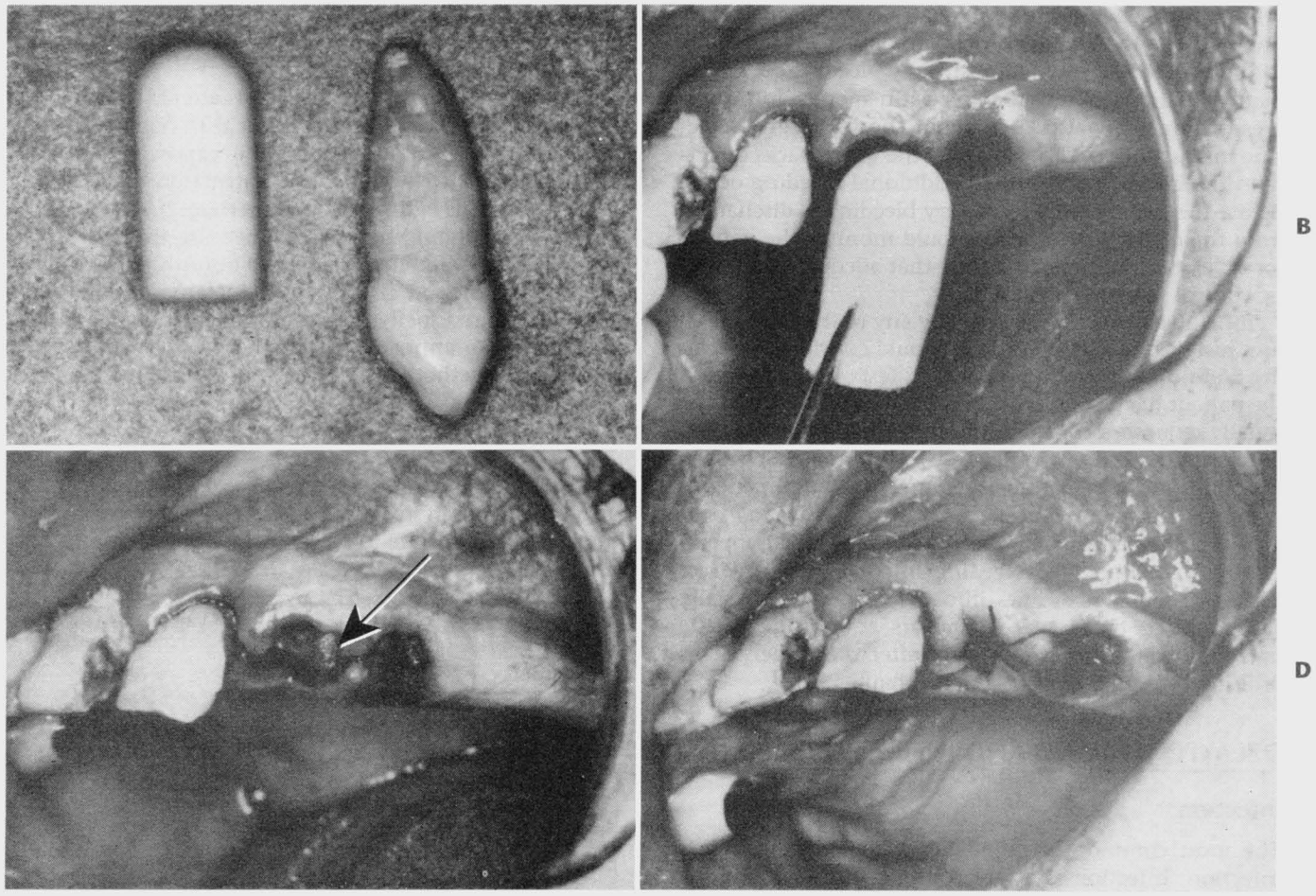

FIG. 11-14 **A,** Collagen shaped into the form of a plug is similar in size to the root of a maxillary canine. **B** and **C,** The collagen plug is placed into the socket with cotton pliers *(arrow)*. **D,** A figure-eight suture is placed over the socket to maintain the collagen in the socket.

This measure is sufficient to control most bleeding. The reason for the bleeding is usually some secondary trauma that is potentiated by the patient's continuing to suck on the area or to spit blood from the mouth instead of continuing to apply pressure with a gauze sponge.

If 5 minutes of this treatment does not control the bleeding, the surgeon must administer a local anesthetic so that the socket can be treated more aggressively. Block techniques are to be encouraged instead of local infiltration techniques. Infiltration with solutions containing epinephrine cause vasoconstriction and may control the bleeding temporarily. However, when the effects of the epinephrine dissipate, rebound hemorrhage with recurrent bothersome bleeding may occur.

Once local anesthesia has been achieved, the surgeon should gently curette out the tooth extraction socket and suction all areas of old blood clot. The specific area of bleeding should be identified as clearly as possible. As with primary bleeding, the soft tissue should be checked for diffuse oozing versus specific artery bleeding. The bone tissue should be checked for small nutrient artery bleeding or general oozing. The same measures described for control of primary bleeding should be used. The surgeon must then decide if a hemostatic agent should be inserted into the bony socket. The use of an absorbable gelatin sponge with topical thrombin held in position with a figure-of-eight stitch and reinforced with application of firm pressure from a small, damp gauze pack is standard for local control of secondary bleeding. This technique works well in almost every bleeding socket. In many situations an absorbable gelatin sponge and gauze pressure are adequate. The patient should be given specific instructions on how to apply the gauze packs directly to the bleeding site should additional bleeding occur. Before the patient with secondary bleeding is discharged from the office, the surgeon should monitor the patient for at least 30 minutes to ensure that adequate hemostatic control has been achieved.

If hemostasis is not achieved by any of the local measures just discussed, the surgeon should consider performing additional laboratory screening tests to determine if the patient has a profound hemostatic defect. The dentist usually requests a consultation from a hematologist, who orders the typical screening tests. Abnormal test results will prompt the hematologist to investigate the patient's hemostatic system further.

A final hemostatic complication relates to intraoperative and postoperative bleeding into the adjacent soft tissues. Blood that escapes into tissue spaces, especially subcutaneous tissue spaces, appears as bruising of the overlying soft tissue 2 to 5 days after the surgery. This bruising is termed *ecchymosis* (see Chapter 10).

DELAYED HEALING AND INFECTION

Infection

The most common cause of delayed wound healing is infection. Infection is a rare complication after routine dental extraction and is primarily seen after oral surgery that involves the reflection of soft tissue flaps and bone removal. Careful asepsis and thorough wound débridement after surgery can best achieve prevention of infection after surgical flap procedures. This means that the area of bone removal under the flap must be copiously irrigated with saline and that all foreign debris must be removed with a curette. Some patients are predisposed to postoperative wound infections and should be given perioperative prophylactic antibiotics (see Chapter 15).

Wound Dehiscence

Another problem of delayed healing is wound dehiscence (Box 11-10). If a soft tissue flap is replaced and sutured without an adequate bony foundation, the unsupported soft tissue flap often sags and separates along the line of incision. A second cause of dehiscence is suturing the wound under tension. If the soft tissue flap is sutured under tension, the sutures cause ischemia of the flap margin with subsequent tissue necrosis, which allows the suture to pull through the flap margin and results in wound dehiscence. Therefore sutures should always be placed in tissue without tension and tied loosely enough to prevent blanching of the tissue.

A common area of exposed bone after tooth extraction is the internal oblique ridge. After extraction of the first and second molar, during the initial healing, the lingual flap becomes stretched over the internal oblique (mylohyoid) ridge. Occasionally, the bone will perforate through the thin mucosa, causing a sharp projection of bone in the area.

The two major treatment options are (1) to leave the projection alone, or (2) to smooth it with bone file. If the area is left to heal untreated, the exposed bone will slough off in 2 to 4 weeks. If the irritation of the sharp bone is low, this is the preferred method. If a bone file is used, *no* flap should be elevated, because this will result in an increased amount of exposed bone. The file is used only to smooth off the sharp projections of the bone. This procedure usually requires local anesthesia. Patients who are quite annoyed by the sharp bone will usually choose this method.

Dry Socket

Dry socket or alveolar osteitis is delayed healing but is not associated with an infection. This postoperative complication causes moderate-to-severe pain but is without the usual signs and symptoms of infection, such as fever, swelling, and erythema. The term *dry socket* describes the appearance of the tooth extraction socket when the pain

BOX 11-10

Prevention of Wound Dehiscence

1. Use aseptic technique.
2. Perform atraumatic surgery.
3. Close incision over intact bone.
4. Suture without tension.

begins. In the usual clinical course, pain develops on the third or fourth day after removal of the tooth. On examination the tooth socket appears to be empty, with a partially or completely lost blood clot, and the bony surfaces of the socket are exposed. The exposed bone is extremely sensitive and is the source of the pain. The dull, aching pain is moderate to severe, usually throbs, and frequently radiates to the patient's ear. The area of the socket has a bad odor, and the patient frequently complains of a bad taste.

The cause of alveolar osteitis is not absolutely clear, but it appears to be the result of high levels of fibrinolytic activity in and around the tooth extraction socket. This fibrinolytic activity results in lysis of the blood clot and subsequent exposure of the bone. The fibrinolytic activity may be the result of subclinical infections, inflammation of the marrow space of the bone, or other factors. The occurrence of a dry socket after a routine tooth extraction is relatively rare (2% of extractions), but it is quite frequent after the removal of impacted mandibular third molars (20% of extractions).

Prevention of the dry socket syndrome requires that the surgeon minimize trauma and bacterial contamination in the area of surgery. The surgeon should perform atraumatic surgery with clean incisions and soft tissue reflection. After the surgical procedure, the wound should be thoroughly débrided and irrigated with large quantities of saline. Small amounts of antibiotics (e.g., tetracycline) placed in the socket alone or on a gelatin sponge may help to decrease the incidence of dry socket in mandibular third molars. The incidence of dry socket can also be decreased by preoperative and postoperative rinses with antimicrobial mouth rinses, such as chlorhexidine. Well-controlled studies indicate that the incidence of dry socket after impacted mandibular third molar surgery can be reduced by up to 50%.

The treatment of alveolar osteitis is dictated by the single therapeutic goal of relieving the patient's pain during the period of healing. If the patient receives no treatment, no sequela other than continued pain exists (treatment does not hasten healing).

Treatment is straightforward and consists of gentle irrigation and insertion of a medicated dressing. First, the tooth socket is gently irrigated with saline. The socket should not be curetted down to bare bone, because this increases both the amount of exposed bone and the pain. Usually the entire blood clot is not lysed, and the part that is intact should be retained. The socket is carefully suctioned of all excess saline, and a small strip of iodoform gauze soaked with the medication is inserted into the socket. The medication contains the following principal ingredients: eugenol, which obtunds the pain from the bone tissue; a topical anesthetic, such as benzocaine; and a carrying vehicle, such as balsam of Peru. The medication can be made by the surgeon's pharmacist or can be obtained as a commercial preparation from dental supply houses.

The medicated gauze is gently inserted into the socket, and the patient usually experiences profound relief from pain within 5 minutes. The dressing is changed every day or every other day for the next 3 to 6 days, depending on the severity of the pain. The socket is gently irrigated with saline at each dressing change. Once the patient's pain decreases, the dressing should not be replaced, because it acts as a foreign body and further prolongs wound healing.

FRACTURES OF THE MANDIBLE

Fracture of the mandible during extraction is a rare complication; it is associated almost exclusively with the surgical removal of impacted third molars. A mandibular fracture is usually the result of the application of a force exceeding that needed to remove a tooth and often occurs during the use of dental elevators. However, when lower third molars are deeply impacted, even small amounts of force may cause a fracture. Fractures may also occur during removal of impacted teeth from a severely atrophic mandible. Should such a fracture occur, it must be treated by the usual methods used for jaw fractures. The fracture must be adequately reduced and stabilized with intermaxillary fixation. Usually this means that the patient should be referred to an oral and maxillofacial surgeon for definitive care.

SUMMARY

Prevention of complications should be a major goal of the surgeon. Skillful management of complications when they do occur is the *sine qua non* of the wise and mature surgeon.

The surgeon who anticipates a high probability of an unusual specific complication should inform the patient and explain the anticipated management and sequelae. Notation of this should be made in the informed consent that the patient signs.

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