Chapter 8 – Anterior Antrostomy: The Caldwell-Luc Operation

David E. Eibling,
Eugene N. Myers

Open surgical access to the maxillary sinus was once a common procedure frequently undertaken for a variety of indications. Open approaches for the management of chronic infection, for excision or biopsy of masses, or for access to the spaces medial, superior, and posterior to the sinus were part of every otolaryngologist's repertoire. Open transantral approaches to the pterygopalatine space for internal maxillary artery ligation or vidian neurectomy, to the orbital floor for repair of fractures and for orbital decompression, and even to the posterior ethmoid and sphenoid sinuses and pituitary were routine and commonly encountered in most training programs.[1]

Over the past 2 decades, endoscopic approaches have replaced traditional open procedures, so residents who trained in the 1990s and thereafter may never have been afforded the opportunity to perform an open maxillary sinus procedure other than as part of a maxillectomy or for the treatment of midfacial fractures. An understanding of the procedure is, however, valuable because there are occasional situations in which an open approach may be preferable to an endoscopic one.

Anterior antrostomy is known as the *Caldwell-Luc procedure* after the two surgeons, one American and the other French, who independently described the approach to the antrum through the canine fossa more than a century ago. The history of these two physicians is interesting and is recounted by McBeth, who discusses not only their contributions but also how they came to be connected with the fledgling specialty of otorhinolaryngology.[2] Caldwell was born in Vermont and practiced in New York City; he published his report on anterior antrostomy in 1893 in the *New York Medical Journal*. Luc, unaware of Caldwell's report (these events obviously predate MEDLINE), reported his procedure in 1897. Luc was French and studied otolaryngology in Vienna under the tutelage of Politzer. He practiced in Paris and was a cofounder and editor of the *International Archives of Otorhinolaryngology*, established in 1889. Luc has been called the “father of French rhinology,” and both these physicians did much to help establish the specialty of otorhinolaryngology.[2,3]

Both physicians emphasized the need for “counterdrainage” into the nose; Caldwell described the inferior meatal route and Luc, enlargement of the natural ostium in the middle meatus. It is interesting to note that controversy regarding techniques to ensure adequate sinus drainage and aeration continues to this day.

ANATOMY

The anatomy of the maxillary sinus is easily visualized on a coronal computed tomography (CT) scan of the normal sinuses (Fig. 8-1A). Congenital hypoplasia is not uncommon and is also easily identified on CT (Fig. 8-1B). The roof of the maxillary sinus is the floor of the orbit anterior to the infraorbital fissure. Medially and posteriorly, the orbital floor is composed of the ethmoid sinuses. The floor of the maxillary sinus is the maxillary alveolus and it is inferior to the level of the floor of the nose in adults. The alveolar bone atrophies in edentulous patients such that the floor of the sinus may lie significantly below the level of the nasal floor. Anteriorly, the anterior wall of the maxilla extends laterally to the zygomatic buttress. The medial wall of the sinus is the lateral wall of the nose, and the natural-draining ostium is located in the midportion of the superior aspect of the medial wall. The sinus drains into the middle meatus through the infundibulum posterior to the uncinate process and anterior to the ethmoid bulla, a narrow crevice easily seen on fine-cut coronal CT scans.

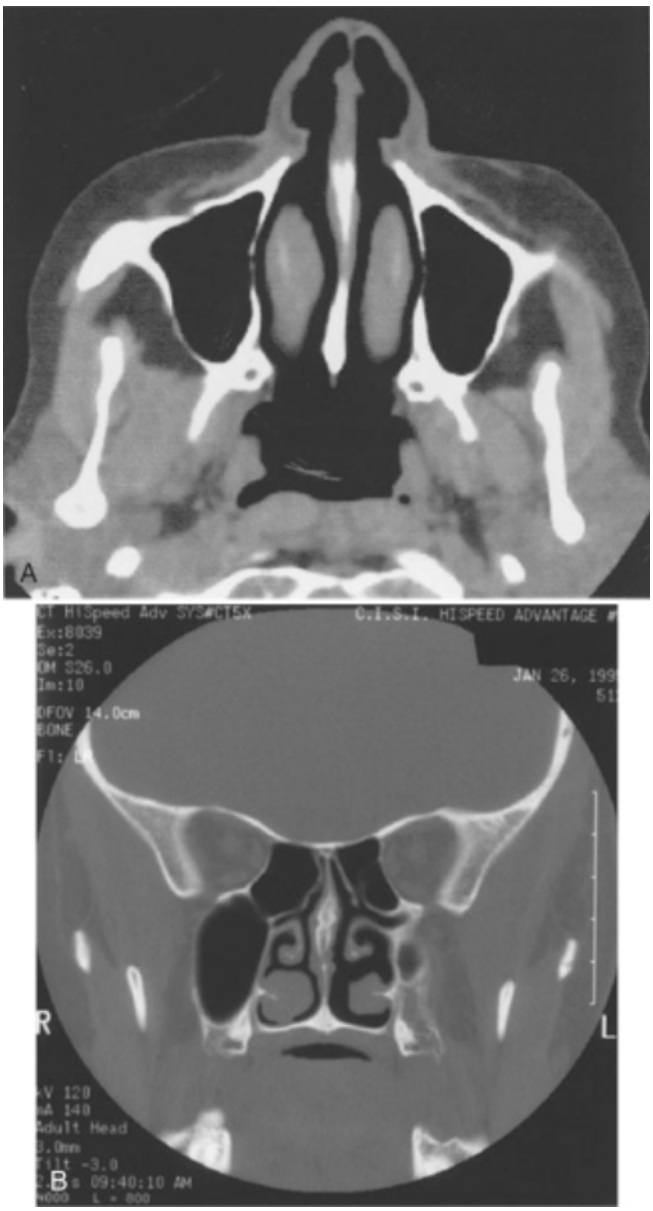

Figure 8-1 **A**, Computed tomography (CT) scan demonstrating normal anatomy. **B**, Hypoplastic sinus (left maxillary) demonstrated by a coronal CT scan.

The inferior turbinate is attached in an oblique line along the wall below the level of the ostium, and the nasolacrimal duct traverses the thicker bone at the junction of the medial and anterior walls before it opens below the inferior turbinate.

The maxillary sinus is lined with ciliated columnar epithelium, and beating of the cilia is organized in such a fashion to move secretions toward the natural ostium (Fig. 8-2). Appreciation of this normal centripetal mucociliary flow is key to an understanding of sinus physiology.

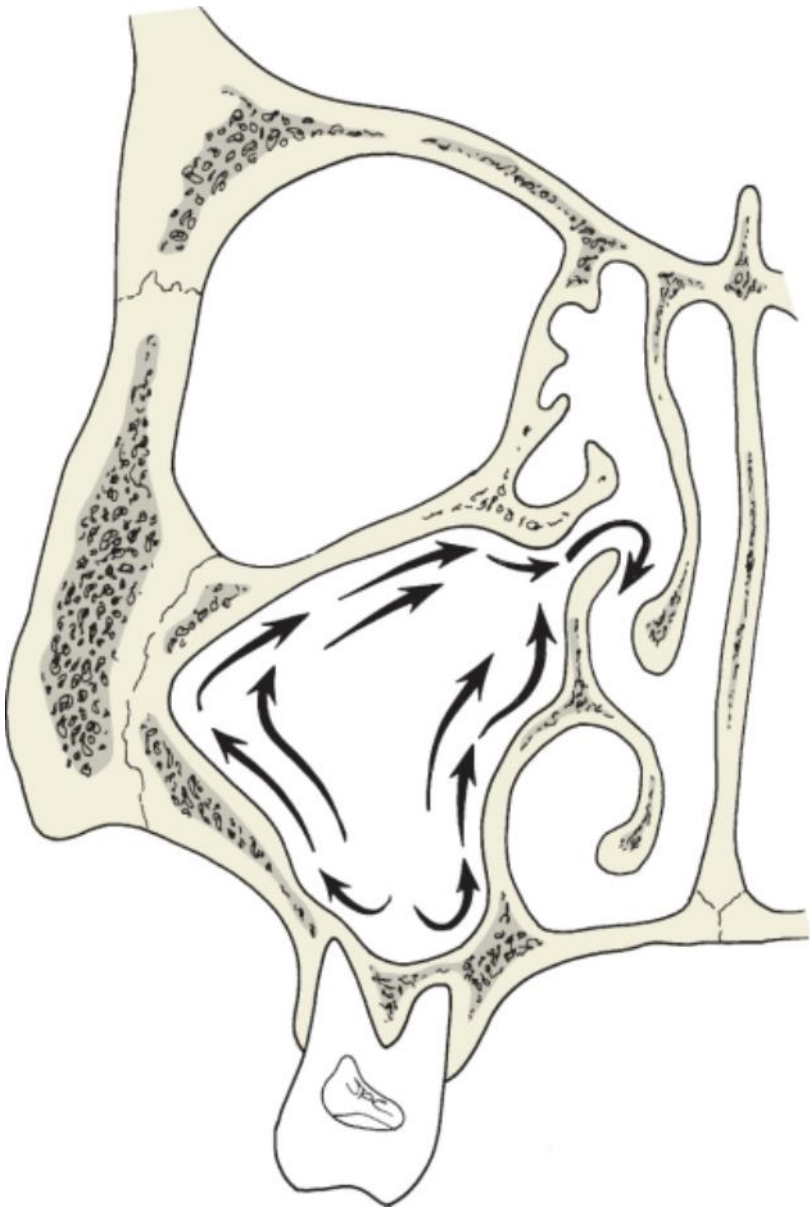

Figure 8-2 Flow of mucus is directed by the cilia toward the natural ostium; hence drainage is not facilitated by an inferior meatal antrostomy.

The internal maxillary artery is the blood supply to the sinus mucosa through its branches the posterosuperior alveolar, infraorbital, and descending palatine arteries, as well as through the mucosal lining of the natural ostium on the medial wall. The nerve supply is derived from the second division of the trigeminalnerve. The infraorbital neurovascular bundle travels through a groove in the orbital floor and then a bony canal in the roof of the sinus. This canal can be dehiscent and result in referred pain from pathology in the sinus affecting the nerve. It exits into the soft tissue of the cheek through a foramen located approximately 5 mm below the anterior midportion of the inferior orbital rim. Care must be taken when elevating the periosteum from the anterior wall of the sinus to avoid injury to the infraorbital nerve as it exits this canal. The bony walls of the maxillary sinus are thin medially, posteriorly, superiorly, and anteriorly. Thicker bone is located in the zygomatic buttress, within the maxillary alveolus, adjacent to the floor of the nose, posteriorly along the descending palatine canal, and along the inferior orbital rim. These regions of thicker bone are critical fixation points for the treatment of midfacial fractures. A shallow depression on the anterior wall of the maxilla superolateral to the root of the canine tooth, inferior to the infraorbital nerve foramen, and medial to the zygomatic buttress is termed the *canine fossa* (Fig. 8-3). This bone is relatively thin and can generally be easily punctured to provide access for diagnostic and therapeutic sinus puncture, as well as trocar puncture for insertion of sinus endoscopes.

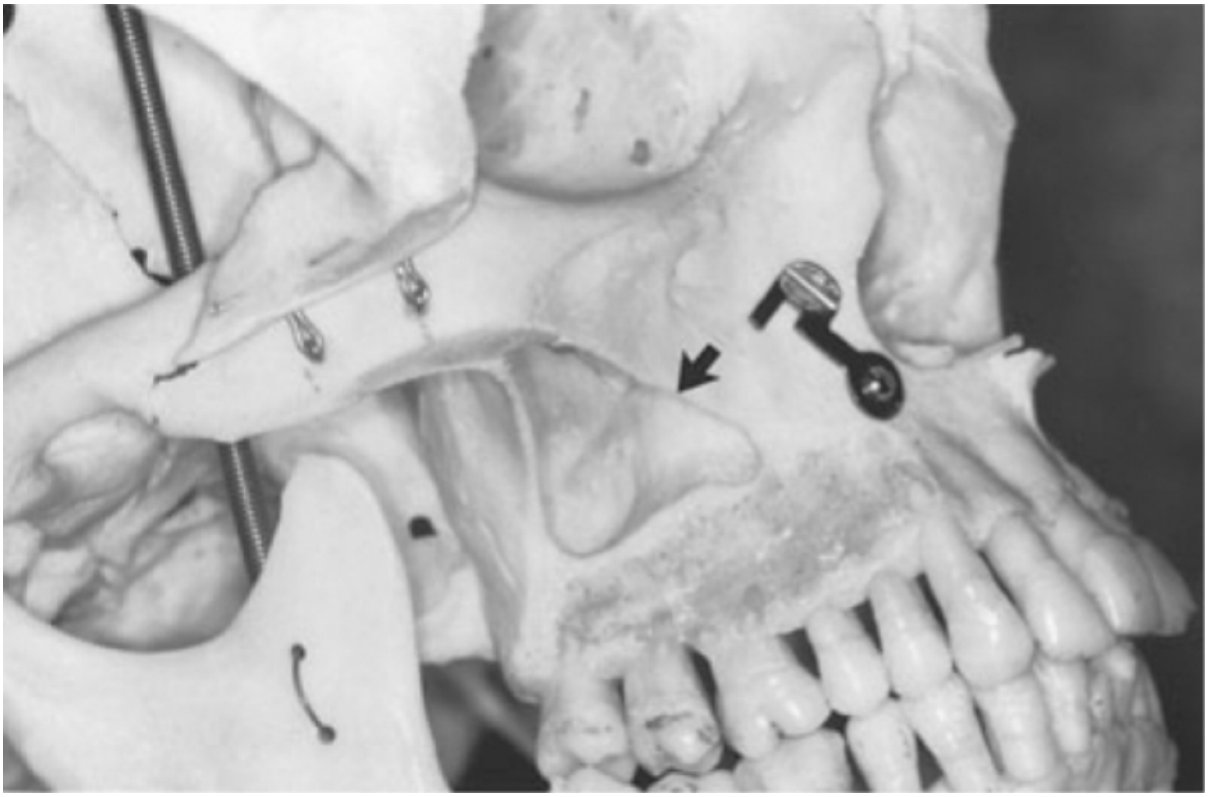

Figure 8-3 The bone in this region is quite thin and easily perforated. The *arrow* indicates the canine fossa.

PATIENT SELECTION

Table 8-1 includes the historical indications for anterior antrostomy. It should be noted, however, that in the past 20 years, anterior antrostomy has essentially been replaced by endoscopic approaches for the initial surgical management of chronic sinusitis, biopsy of masses, management of oral-antral fistulas, and removal of antral-choanal polyps, as well as for approaches to the orbital floor and the pterygopalatine fossa. The most likely indications encountered by an otolaryngologist today will be for management of complex midfacial trauma, for removal of foreign bodies (Fig. 8-4), for lesions that are not amenable to endoscopic excision, or as an approach to lesions of the pterygoid region.[4]

Table 8-1 -- HISTORICAL INDICATIONS FOR I ANTERIOR ANTROSTOMY[*]

Inflammatory disease
Chronic maxillary sinusitis
Antral-choanal polyp
Fungal sinusitis
Neoplastic disease
Biopsy of maxillary sinus tumors
Excision of benign dental tumors
Staging of palate carcinoma
Access to the pterygopalatine space
Initial step in medial maxillectomy
Access to the orbital floor for orbital decompression
Access to the orbital floor for repair of zygomaticomaxillary complex fractures
Closure of oral-antral fistulas

* Anterior antrostomy has been replaced by endoscopic techniques for most of these indications.

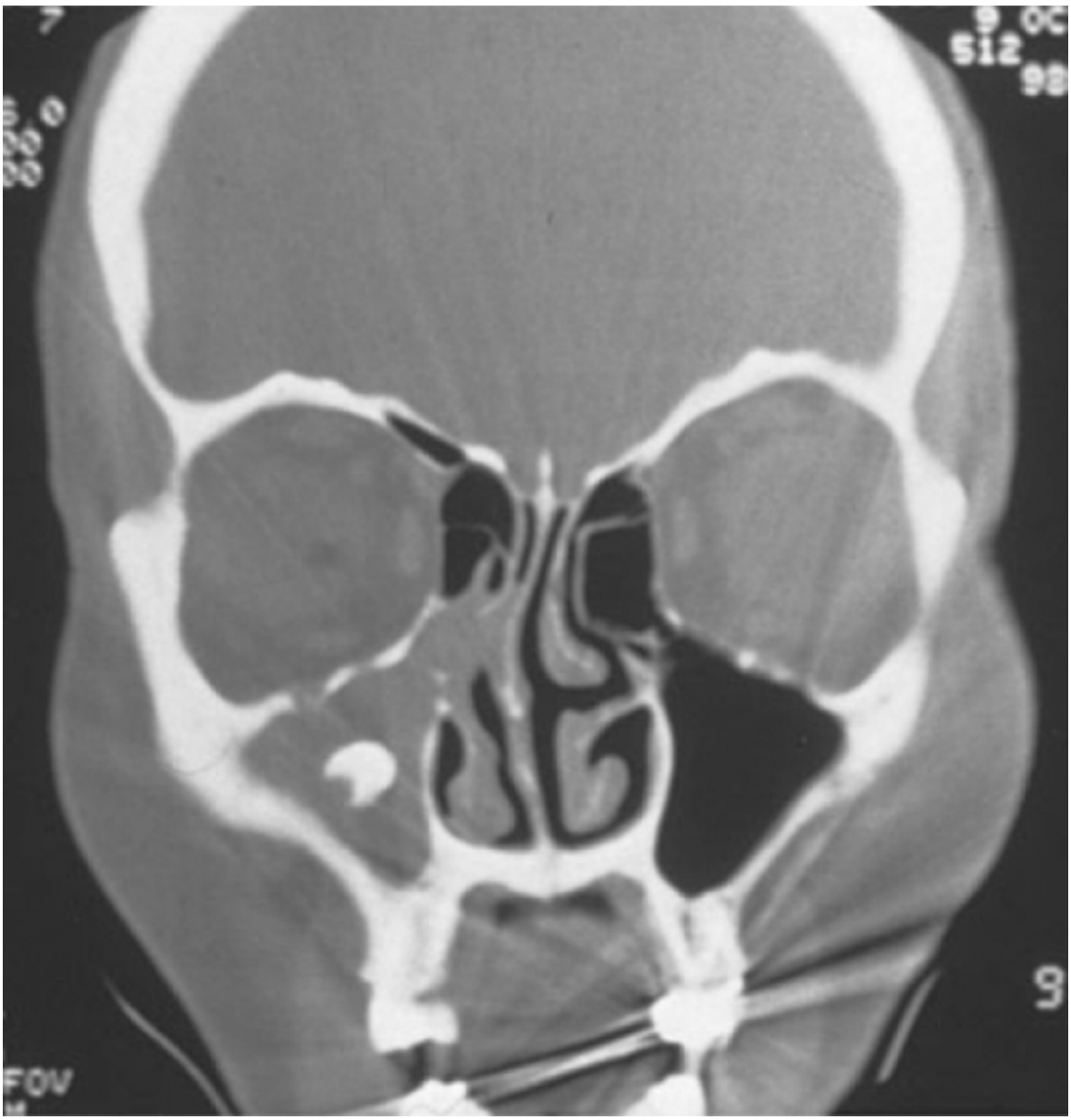

Figure 8-4 Coronal computed tomography scan of a patient with chronic sinusitis of many years' duration that resulted in the formation of a calcified foreign body ("sinolith"). Treatment required anterior antrostomy for visualization and removal of the sinolith.

Imaging is standard in all diagnostic evaluations of the maxillary sinuses. Plain radiographs of the sinuses are no longer used for the evaluation of sinus disease because far superior modalities are available at only an incremental increase in cost. CT scans are now standard because they provide much more detailed images of the nose and sinuses. Axial scans are commonly available at the time of referral; however, CT scans should be obtained in the coronal plane in essentially all cases inwhich surgical management is being contemplated. Coronal cuts provide improved visualization of the orbital floor, maxillary alveolus, and sinus outflow tract anatomy not visible on axial views and can be obtained either by reconstruction or by direct coronal acquisition (Fig. 8-5). Other imaging modalities such as magnetic resonance imaging (MRI) may be required occasionally to further evaluate the consistency of the sinus contents. It must be noted that the critical bone detail required for sinus evaluation is not provided by MRI; hence, the availability of MRI does not obviate the requirement for coronal CT scanning. MRI is useful in distinguishing between soft tissue and mucus in the sinuses.

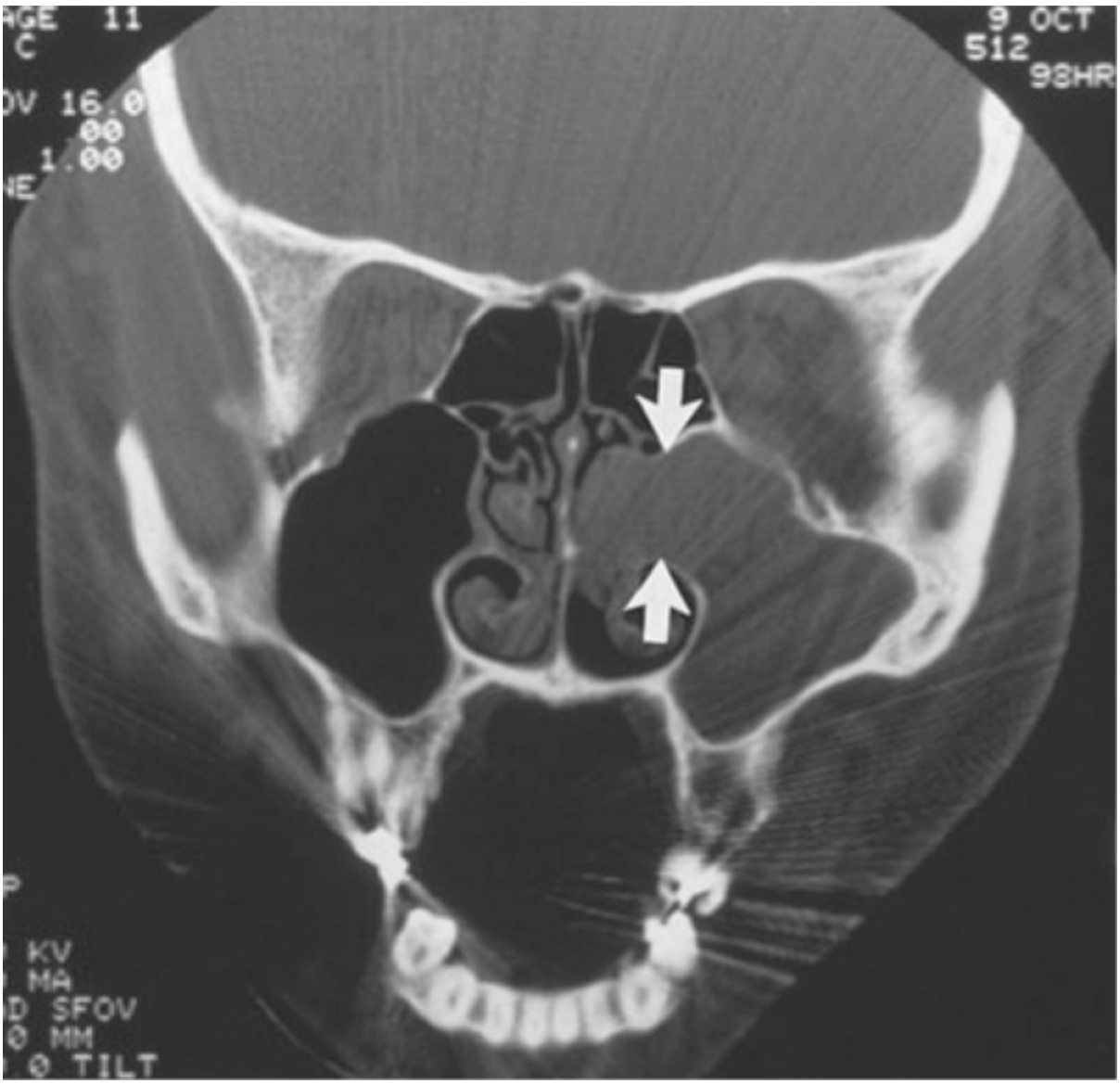

Figure 8-5 Coronal computed tomography scan through the maxillary sinus in a patient with an antral-choanal polyp. Note expansion of the natural ostium *(arrows)* by the polyp.

Controversy regarding the management of diseased mucosa was prevalent a decade ago. The success of minimally invasive sinus surgery has now conclusively demonstrated that with adequate aeration and drainage, diseased mucosa will normalize so that removal is not required. The primary indication for anterior antrostomy was chronic sinusitis with total mucosal extirpation, but removal is no longer considered necessary.

PREOPERATIVE PLANNING

Patient selection is the most difficult portion of the preoperative preparation and, in most cases, will consist of patients with diseases or conditions deemed not suitable for endoscopic management. Perioperative prophylactic antibiotics are not routinely administered, nor are steroids, except in the unusual case in which an anterior antrostomy is planned for the management of chronic hyperplastic sinusitis with polyposis and steroid-dependent asthma.

Bleeding can be a significant problem in patients with coagulopathies. Patients with bleeding disorders must be identified and appropriate steps taken to correct the abnormality before surgery. Patients who have been taking aspirin, warfarin (Coumadin), or similar medications should discontinue taking them and similar drugs several days or even weeks before surgery.

Occasionally, surgery will be necessary in immunocompromised and coagulopathic patients. In these circumstances, adequate quantities of platelets, fresh frozen plasma, and other blood products must be available if their use is anticipated. Decisions regarding surgery in these patients are often complex, but it must be remembered that uncontrolled infection in immunocompromised patients can be rapidly fatal. One such entity is

invasive fungal sinusitis. The surgeon must have a low threshold for operative intervention in these patients because angioinvasion will rapidly progress to necrosis of significant amounts of tissue. These patients often exhibit only minor bleeding at the time of the procedure because of the angio-occlusive nature of the fungal hyphae.

Not only must preoperative counseling include the usual risks of bleeding, infection, and other problems, but mention should also be made of the high potential for numbness of the midface and upper lip, which is a consequence of injury or traction on the infraorbital nerve during retraction of the soft tissue of the face to provide exposure. Discussion regarding postoperative ecchymosis, facial edema, the value of elevation of the head, and dietary recommendations is also helpful to the patient.

TECHNIQUE

The procedure may be performed with the patient under either local or general anesthesia. It is more commonly performed under general anesthesia, although adequate blockade of the sinus mucosa can be obtained by injecting the posterosuperior alveolar nerve, as well as the descending palatine foramen. Lidocaine (Xylocaine) with epinephrine 1:1,000,000 is injected directly into the buccogingival sulcus approximately 5 minutes before the beginning of the procedure to assist with hemostasis. Decongestion of the nasal mucosa with oxymetazoline (Afrin) or 0.25% phenylephrine (Neo-Synephrine) is used in patients in whom associated intranasal surgery is planned in conjunction with the antrostomy.

The upper lip is retracted and the incision is made such that approximately 0.5 cm of free buccogingival mucosa is preserved for later closure (Fig. 8-6). In edentulous patients the incision should be made over the attached gingiva rather than the buccogingival sulcus to permit early wearing of dentures. Early wearing of dentures by patients who have undergone a standard buccogingival incision, particularly in cases in which there is infraorbital nerve anesthesia, can result in suture line disruption because of pressure of the buccal flange of the denture, as well as the subsequent development of a chronic oral-antral fistula. Dissection is carried down to the anterior wall of the maxilla via electrocautery. With a wide periosteal elevator, the periosteum is elevated from the anterior wall of the maxilla as far as the infraorbital nerve (Fig. 8-7). Elevation is difficult over the attached gingiva in edentulous patients but easier once the dissection progresses superiorly to the alveolus. Care is taken to avoid injury to the infraorbital nerve as it exits the infraorbital foramen (Fig. 8-8). The canine fossa is easily identified at this stage, and a mallet and osteotome are used to enter the maxillary sinus. The opening is enlarged with Kerrison rongeurs to gain as much exposure as necessary for the planned procedure (Fig. 8-9). Care is taken to avoid injury to the neurovascular supply to the tooth roots, the infraorbital nerve, and the soft tissue anterior to the maxilla. The mucosa is then opened and the planned procedure is performed. Brisk bleeding from the edges of the mucosa or bone can be controlled with electrocautery, bone wax, or temporary packing with 0.25% phenylephrine- or oxymetazoline-soaked material.

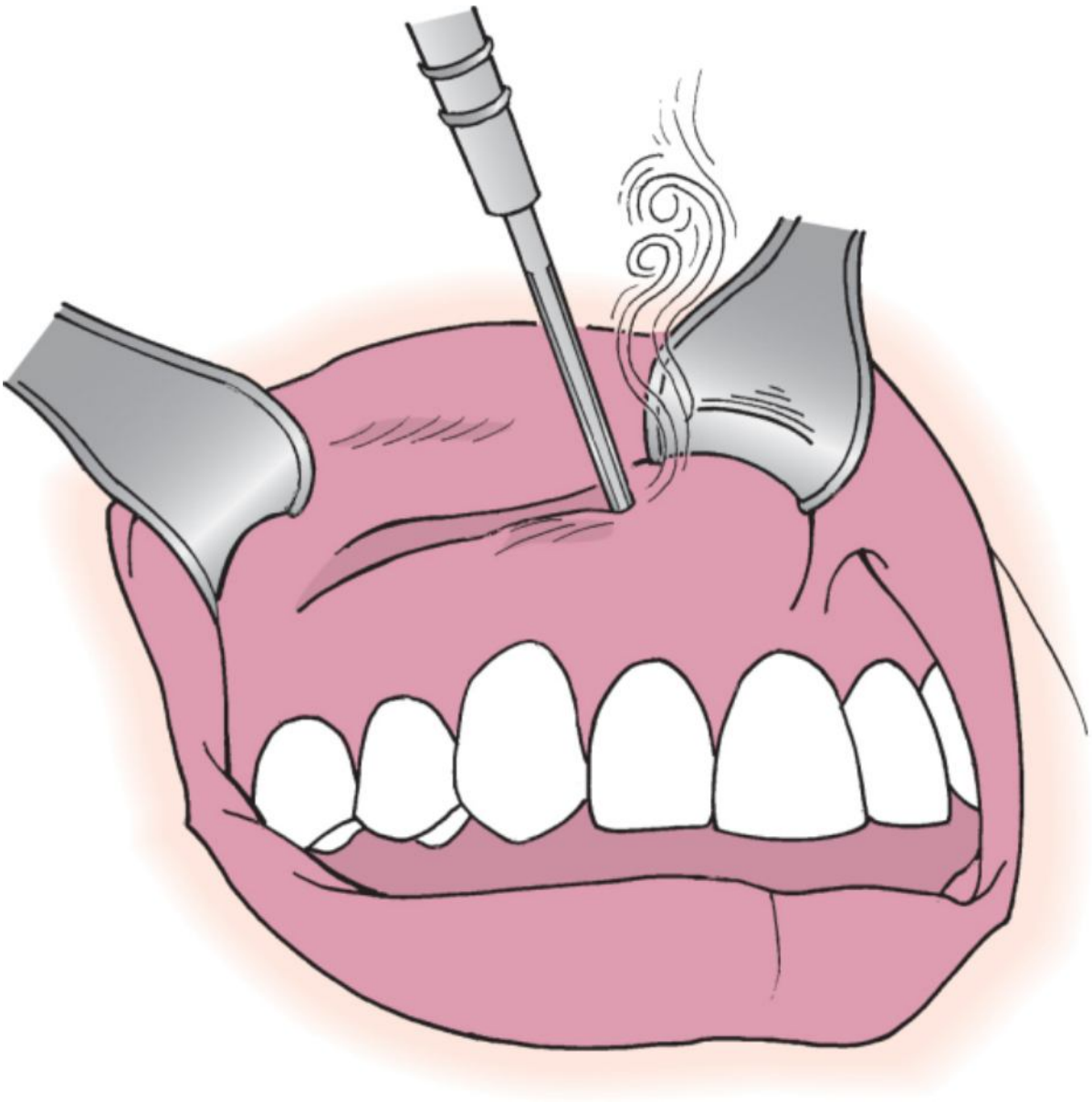

Figure 8-6 The incision is made in the buccogingival sulcus. In edentulous patients, the incision is made over the gingiva to permit earlier wearing of dentures.

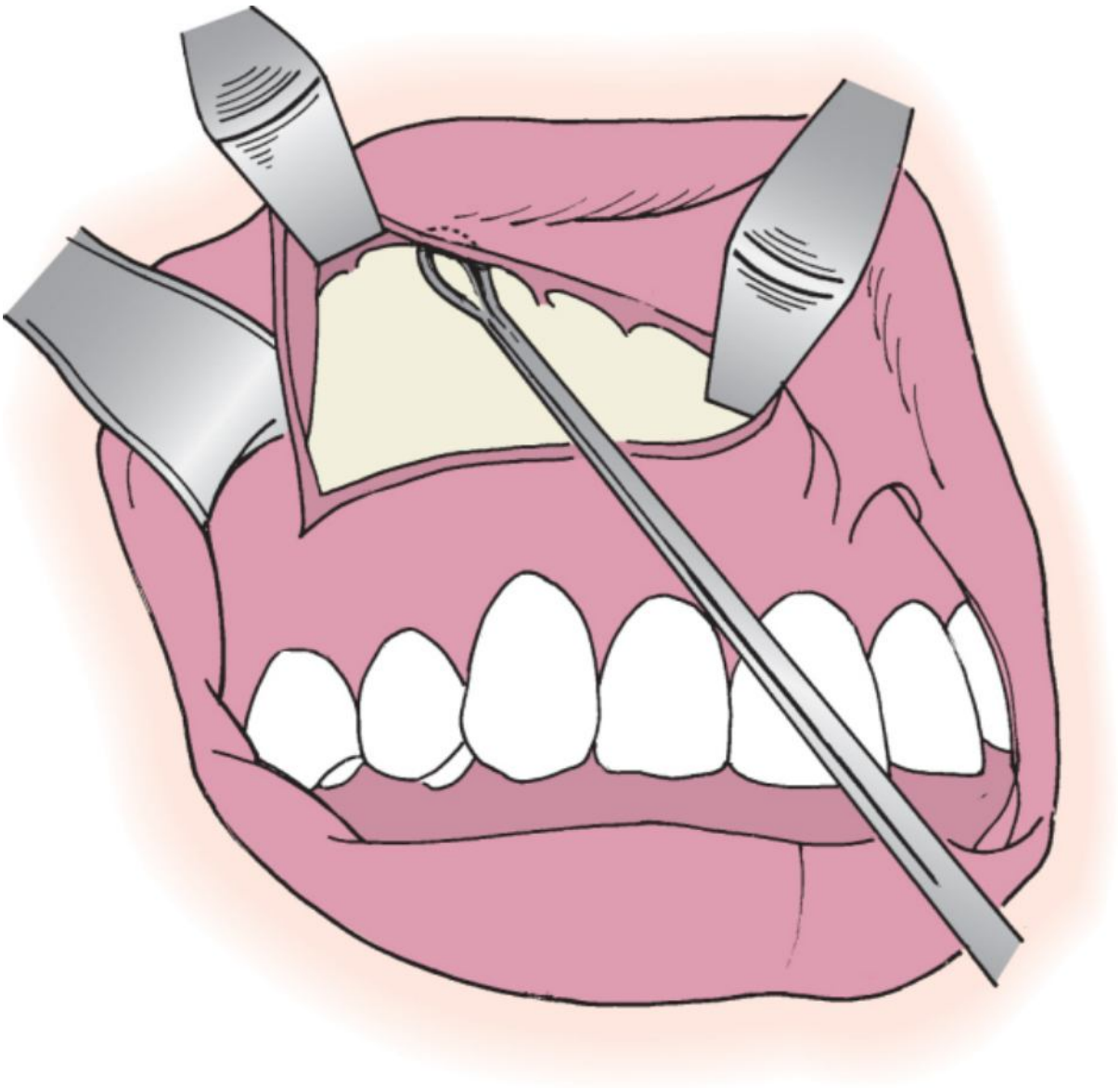

Figure 8-7 Exposure of the canine fossa. Care is taken to avoid undue trauma or stretching of the infraorbital nerve.

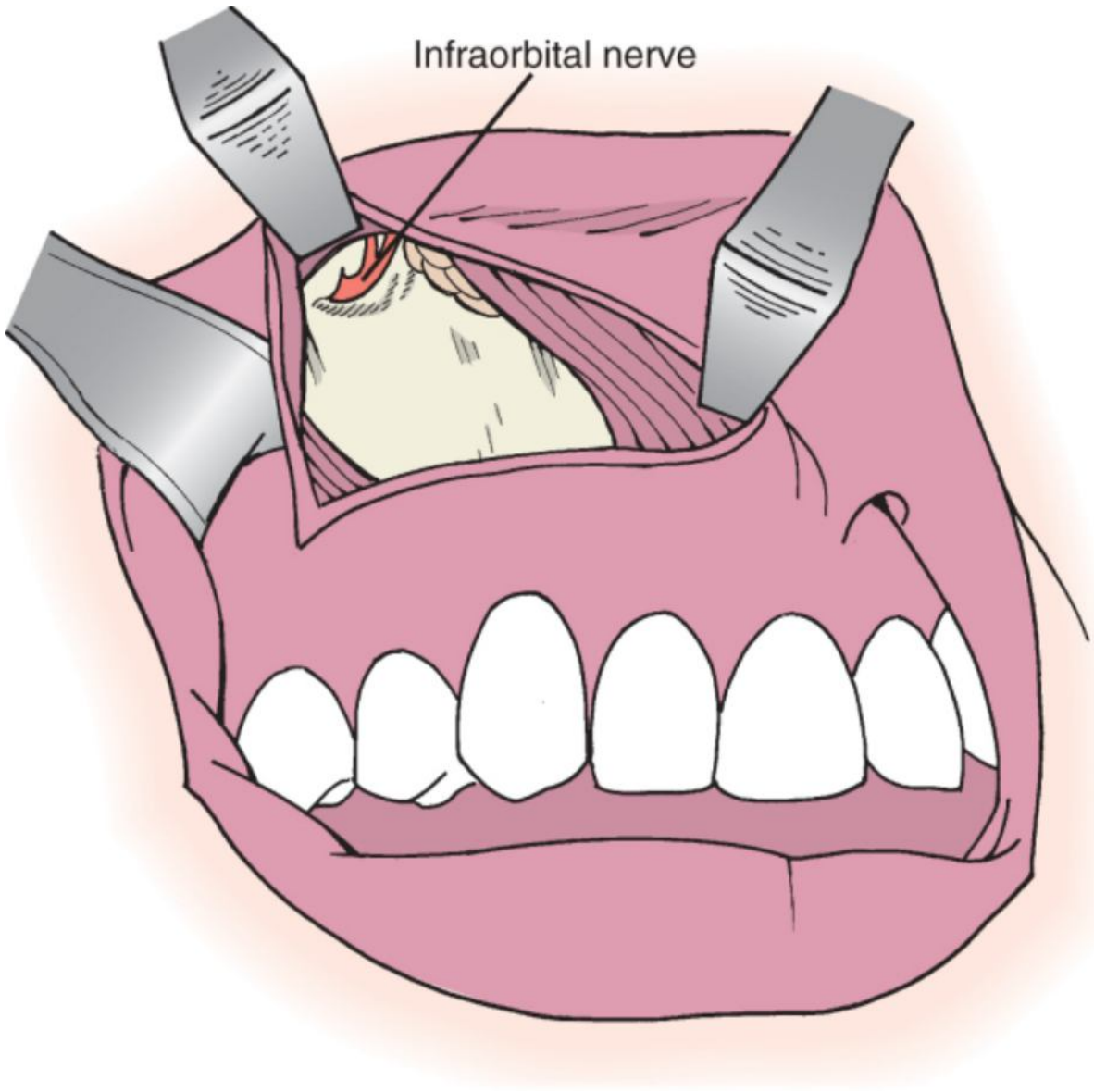

Figure 8-8 The infraorbital nerve is identified at the point where it exits the infraorbital foramen and is preserved.

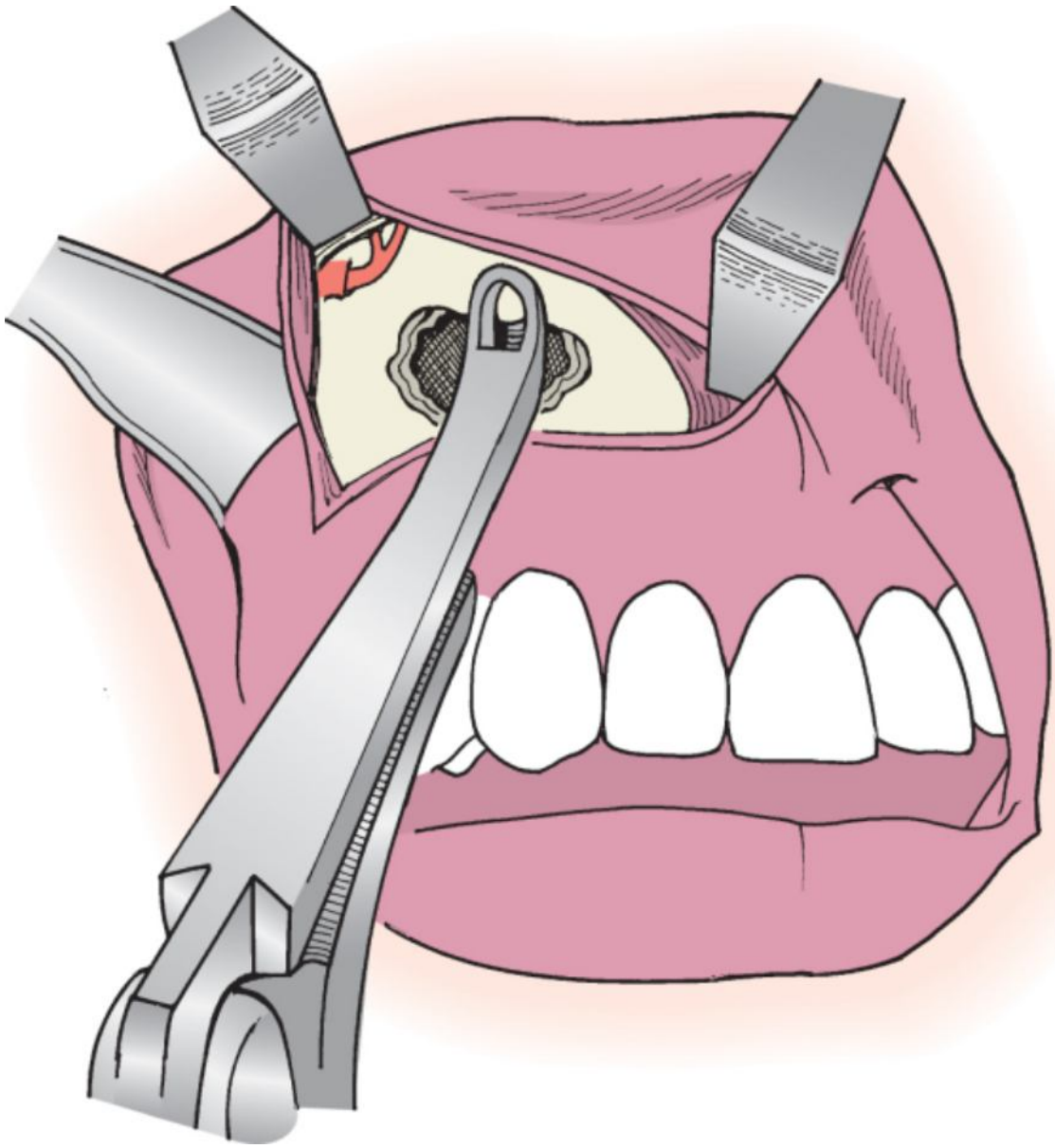

Figure 8-9 Opening the sinus with a Kerrison rongeur.

If the antrostomy is being carried out for removal of an antrochoanal polyp, all the mucosa is undermined and left attached at the widened natural ostium. The antrochoanal polyp is then approached through the oral cavity and nasopharynx. It may be necessary to retract the soft palate to visualize the polyp. Traction is placed on the polyp. A sharp elevator should be used to undermine any residual mucosa that might be tethering the polyp to the natural ostium. Once the mucosa has been freed, continuous traction will remove the antrochoanal polyp and all the mucosa of the maxillary antrum in one specimen to prevent recurrence.[1]

A nasoantral window is formed to provide drainage, aeration, and a natural way to remove packing from the antrum should it be necessary. The bone of the inferior meatus is visualized through the antrostomy. This bone is quite thin and, with pressure from a periosteal elevator, can be fractured and then removed piecemeal until a large window is formed (Fig. 8-10). It is helpful to insert a curved hemostat into the inferior meatus to push the mucosa toward the maxillary antrum. Electrocauteryis used to make an inferiorly based flap of this mucosa, which is then draped into the medial wall of the sinus. This flap is subsequently placed into the maxillary antrum to facilitate the healing process.

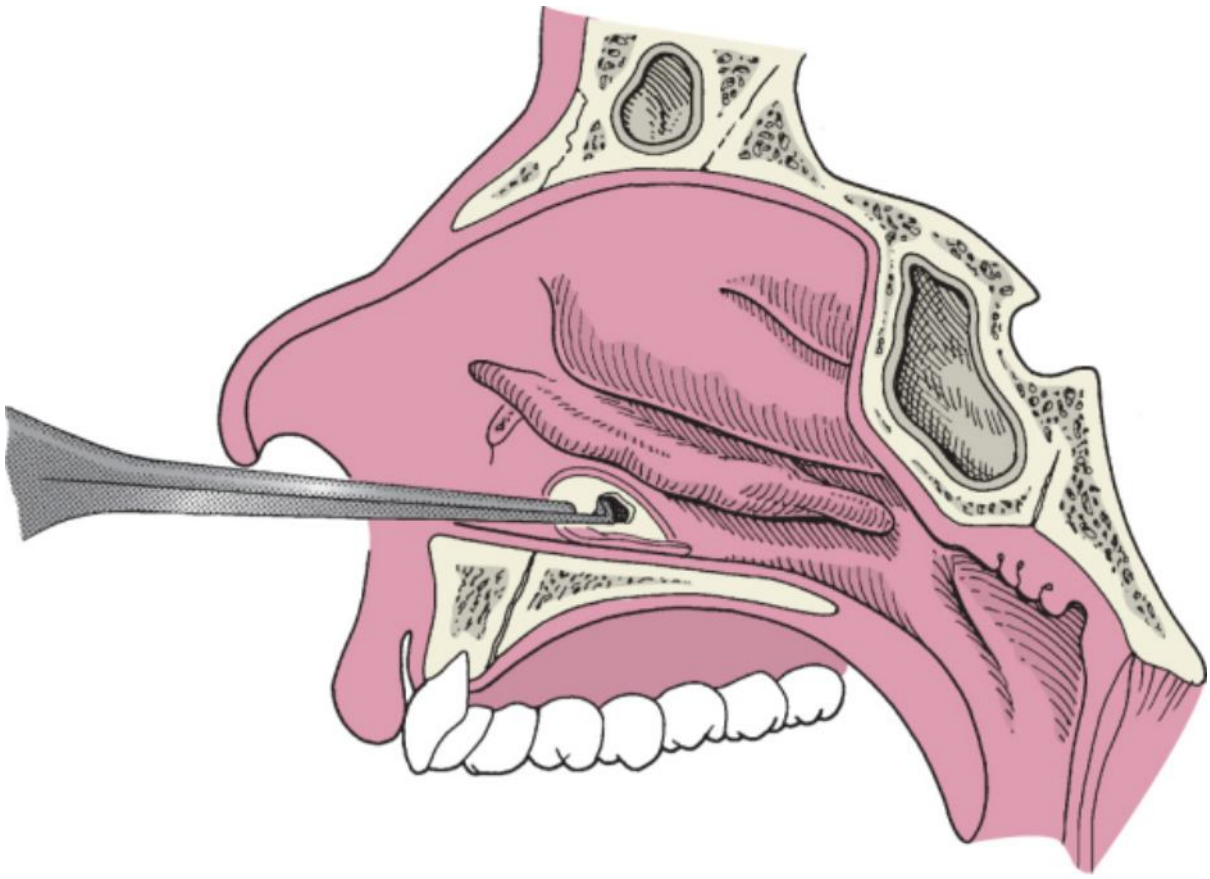

Figure 8-10 Creation of a window in the inferior meatus.

Hemostasis can usually be achieved by cautery alone, unless extensive removal of mucosa is performed, in which case packing may be required. The wall of the antrum is lined with pledgets of compressed Gelfoam or a similar hemostatic substance. Petrolatum (Vaseline) gauze impregnated with bacitracin is used to loosely pack the antrum, and the end of the pack is brought out into the nose via the nasoantral window. Care must be taken to ensure that the packing is layered in such a way that it can be easily removed through the antrostomy. A suture on the end of the packing identifies it for later removal, a particularly valuable step if the nose is packed as well. The incision is closed with absorbable sutures and care taken to ensure that the mucosal edges are accurately approximated to prevent the occurrence of an oral-antral fistula. If packing is used, care must be taken to ensure that it is not caught by the suture or on a bone spicule.

POSTOPERATIVE CARE

The packing can be removed on the second or third day, depending on the hematologic status of the patient, as well as the disease process. It is critical that *all* packing be removed because “lost packing” is a foreign body that may result in chronic infection and additional surgery will be required. Routine cleansing through the nasal antral window can be performed in patients who require it. Some patients may benefit from irrigation through a catheter placed in the sinus and secured with a suture for several days. Patients should be advised to not wear an upper denture for 7 to 10 days to allow time for healing of the buccogingival incision because the trauma of wearing dentures too soon can lead to an oral-antral fistula.

Most patients will experience some temporary hypoesthesia in the distribution of the infraorbital nerve as a result of retraction on the nerve during the procedure. This usually resolves within 4 to 6 weeks. Some patients will also experience numbness of their canine and premolar teeth as a consequence of bone removal because branches of the superior alveolar nerve pass through the inferior anterior maxillary wall. Avoiding excessive removal of inferior bone in dentate patients can help minimize this sequela.

PEARLS

- Anterior antrostomy (Caldwell-Luc operation) remains a very useful procedure for treating patients with facial fractures and foreign bodies in the maxillary antrum.
- Maxillary antrostomy is the first step in performing medial maxillectomy for benign tumors of the paranasal sinuses.

- Anterior antrostomy is very important in the closure of an oroantral fistula.
- After the gingivobuccal sulcus incision is made, caution must be exercised when elevating the soft tissues off the anterior wall of the antrum to avoid injury to the infraorbital nerve.
- An antrostomy must always be made in the inferior meatus if an anterior antrostomy is performed to provide drainage of secretions during the healing process.

PITFALLS

- Failure to create adequate nasal drainage may result in the accumulation of blood and secretions within the sinus.
- Intraoperative injury to the floor of the orbit may lead to orbital emphysema.
- Injury to the infraorbital nerve will produce permanent hypoesthesia of the cheek, lip, and nasal ala.
- Injury to the neurovascular supply to the tooth roots because of aggressive removal of bone from the anterior wall of the antrum can result in loss of tooth vitality.
- Failure to obtain adequate hemostasis at the time of surgery may lead to postoperative bleeding, particularly in coagulopathic patients.