Antrotomy

Indications. In maxillary sinusitis, nasoantral irrigations are indicated only after adequate conservative management has failed to effect a cure or in order to obtain material for culture. An adequate trial of conservative therapy is the treatment of choice whether the sinusitis be acute, subacute, or chronic. The appropriate antibiotics are administered along with the use of local and systemic nasal decongestants. If this therapy is properly instituted, nasoantral irrigations are rarely indicated. If medical therapy is not successful, the surgeon should resort to more definite procedures, in an attempt to establish adequate drainage and remove diseased tissue from the sinus.

Technique of Irrigation. There are two routes for irrigating the maxillary sinus: (1) by way of the natural ostium, and (2) through the inferior meatus. The arguments against the natural route are that irreparable damage to the ciliated respiratory epithelium in the region of the natural ostium is a possibility, and anatomic variations may render this technique extremely difficult or impossible.

Most otolaryngologists prefer to irrigate the maxillary sinus by way of the inferior meatus. For this procedure, the inferior meatus is anesthetized by packing with cotton strips impregnated with 4% cocaine or 2% Pontocaine. Epinephrine (1:1000) or ephedrine (1%) may be added to the Pontocaine. These cotton strips should remain in place for approximately 15 minutes. A straight Lichtwitz needle with a Wolf thumb rest is the instrument of choice for the nasoantral puncture. This is inserted through the nasoantral wall of the inferior meatus, approximately 1 cm behind the anterior tip of the inferior turbinate, and directed toward the lateral canthus. At this point, it is most important not to traverse the sinus cavity completely and enter either the superior or lateral sinus walls. Aspirating before irrigation is essential. Either secretions or air is obtained if the tip of the needle is in the sinus cavity. If the tip is in the sinus cavity and neither secretion nor air is aspirated, then the antrum is filled with a solid material such as that due to polypoid mucosisitis or to a neoplasm.

The sinus is irrigated with warm normal saline solution. It is not necessary to inject air following this irrigation. There have been some reports of air embolism following injection of air into the maxillary sinus. It the irrigating solution containing the material washed out from the sinus is collected in a black basin, all purulent secretions and debris will be prominent, while the sanguineous material will be invisible and not upsetting to the patient.

Antrostomy (Intranasal Fenestration of the Nasoantral Wall)

A well-constructed nasoantral window is sufficient to cure a chronic purulent maxillary sinusitis, providing the antrum is not filled with polypoid disease and there is no bone necrosis or dental complication. Over the years it has been repeatedly demonstrated that a small nasoantral window closes rapidly and is thus ineffective. A large window is essential.
**Technique.** The intranasal antrostomy should be performed as an in-patient procedure so that the surgeon proceed with a radical antrum operation, if indicated, after fenestrating the nasoantral wall of the inferior meatus. Many surgeons perform a radical antrum operation routinely in preference to an intranasal antrostomy. The latter procedure effects a cure in less than 90% of patients, thus necessitating an additional hospitalization and operative procedure for those patients in whom the antrostomy fails to effect a cure.

For the intranasal antrostomy, cotton strips, impregnated with a topical anesthetic agent, are placed in the inferior meatus, medial to and above the inferior turbinate. It is best to leave these packs in place for 15 minutes, even when operating with a patient under general anesthesia, because shrinkage of the mucous membrane affords better visualization of the inferior meatus and better hemostasis that could otherwise be obtained. The topical anesthesia also supplements the general anesthesia.

The inferior turbinate is fractured medially and superiorly with a smooth-edged, flat instrument such as a large periosteal elevator or a tonsil dissector. No portion of the inferior turbinate is removed. The nasoantral wall of the inferior meatus is broken through with a punch or sharp curved hemostat. This opening is first enlarged anteriorly with a Kerrison bone-biting forceps and then posteriorly with side-biting ring forceps. The diameter of the fenestration should be 1.5 to 2 cm. It is obviously important to remove the nasoantral wall down to the level of the floor of the nasal cavity in order to facilitate drainage from the sinus. When the fenestration is of sufficient size, the sinus cavity can be inspected for disease by direct vision. If irreversible disease is found, it is best to enter the antrum by way of the canine fossa and carry out a radical antrum operation.

Usually, it is not necessary to insert packing following the antrostomy. On the other hand, if bleeding is troublesome, the window may be packed with 1-inch petrolatum-impregnated iodoform gauze. The packing is removed on the first or second postoperative day.

**External Surgery of the Maxillary Sinus**

**The Caldwell-Luc Operation**

**Indications.** The indications for the Caldwell-Luc procedure are (1) intractable infection; (2) failure of resolution of a chronic infection following intranasal antrostomy; (3) polypoid tissue filling the antrum; (4) antrochoanal polyp, or cystic disease of the antrum; (5) osteonecrosis; (6) suspicion of maxillary sinus neoplasm; (7) dental cysts; (8) presence of foreign bodies; (9) fractures of the maxilla; (10) the presence of an oroantral fistula.

**Technique of Operation.** *Anesthesia.* The Caldwell-Luc operation may be performed with the patient under either general or local anesthesia. If local anesthesia is employed, cotton strips impregnated with a topical anesthetic and vasoconstrictor are placed both above and below the inferior turbinate. Two per cent Xylocaine or procaine with added epinephrine is injected along the gingivobuccal sulcus in the region of the canine fossa. The injection is continued superiorly so as to include the infraorbital nerve.
Incision. A horizontal incision is made in the gingivobuccal sulcus well above the roots of the teeth. The incision extends from the level of the lateral incisor to the second molar and through the mucous membrane and periosteum. The periosteum over the canine fossa is then elevated to the level of the infraorbital canal. The infraorbital nerve is identified and carefully preserved. The best way to avoid injury to this nerve is to positively identify it. An atraumatic method of elevating the periosteum is to place a bit of gauze ahead of a chisel to provide blunt dissection. Gentle retraction throughout the procedure will also reduce the chance for trauma to the infraorbital nerve as well as to the other soft tissues of the cheek. Two retractors are used to elevate the periosteum. These are placed in a superior medial and superior lateral direction in order to avoid the infraorbital nerve.

Fenestrating the Canine Fossa. The best way to fenestrate the anterior wall of the antrum is with use of a curette or a rotating bur. If a rotating bur is not available, a square window may be made with a sharp chisel. The four sides of this window are first scored by light tapping in order to avoid fracture. A sharp gouge is another instrument that may be used to fenestrate the anterior wall. Whichever instrument is employed, a fracture must be avoided, for this may extend to, and injure, the infraorbital nerve or a tooth root.

The opening in the anterior wall is enlarged with either a bur or a Kerrison bone-cutting forceps. Troublesome bleeding may occur from the bone margin. This can be controlled by squeezing tightly with the Kerrison forceps but not hard enough to cut through the bone. It is well to enlarge the sinus opening to a size that will admit the fifth digit. The entire contents of the antrum can then be viewed.

Cysts and benign tumors can be removed with various elevators and forceps, injury to the normal mucosa being avoided. Removal of the entire mucous membrane lining of the antrum is rarely necessary. However, when the lining seems irreversibly diseased it can be easily removed by first elevating it with a curved blunt dissector and then using various elevators, curettes, and tissue forceps for removal. Dissection in the region of the roof of the antrum must be conducted with care, for the infraorbital nerve may not have a bony covering in this region.

The Nasoantral Window. A curved, sharp hemostat is inserted intranasally into the inferior meatus and, by gentle pressure, an opening is made in the anterior aspect of the nasoantral wall. The fenestra is enlarged in an anterior direction with Kerrison forceps and posteriorly with a side-biting forceps. This dissection is much more easily carried out by way of the Caldwell-Luc opening in contrast to the intranasal route. The nasoantral window should be at least 1.5 cm in diameter and should include intranasal mucous membrane, sinus mucosa, and the bony nasoantral wall. Many surgeons hold the opinion that the various mucosal flaps devised for formation of the nasoantral window are not only unnecessary but can, by becoming displaced, close the fenestra.

The Denker modification of the radical antrum operation is preferred by some surgeons. The opening in the anterior sinus wall is enlarged in a medial direction, thus removing the inferior portion of the ascending process of the maxilla. The anterior half of the lateral nasal wall inferior to the inferior turbinate is resected to serve as the nasoantral communication. The end results of the Caldwell-Luc and Denker operations are quite similar.
Before packing, the sinus cavity is carefully inspected for retained sponges. If there is no bleeding, packing is unnecessary. Petrolatum- or aureomycin ointment-impregnated 1-inch iodoform gauze packing may be inserted into the sinus by way of the nasoantral fenestra in order to control persistent bleeding. The incision in the gingivobuccal sulcus is closed with one or two catgut sutures. Some surgeons prefer not to suture this incision, stating that there is much less postoperative edema if it is not closed.

Postoperative Care. An ice pack over the cheek during the first 24 postoperative hours is essential to prevent edema, hematoma, and discomfort and should be obtained for the patient while he is still in the recovery room. The intrasinus and intranasal packing should be removed at the end of one or two postoperative days. If purulent secretions were encountered in the sinus, the postoperative administration of antibiotics is of value. The antibiotics may be altered according to culture and sensitivity tests.

Caldwell-Luc operation - technical details

The upper lip is retracted superiorly in a direction away from the infraorbital nerve. Stretching the nerve can cause anesthesia of the upper lip and side of the nose. The endotracheal tube is directed towards the contralateral angle of the mouth. The pharynx is packed both to assist with a closed system of anesthesia and to prevent blood from entering the pharynx. An incision is made about 5 mm above the gum margin. It should be slightly "U" shaped, especially when the patient wears an upper denture. The periosteum has been elevated superiorly, exposing the bony front face of the maxillary sinus, known as the canine fossa. Again, note that the retraction is in a direction away from the infraorbital nerve, which can be seen as it leaves the infraorbital foramen. Bleeding is controlled by packing with epinephrine impregnated gauze strips or by cautery. A gauze strip pushed ahead of a chisel assists with the elevation of the periosteum.

Caldwell-Luc operation - methods for entering antrum

There are several methods for entering the antrum by way of the anterior wall.

A curette can be used if the wall is thin. A cutting "rose" bur can be used both for entrance into the antrum and for removal of the antrum's anterior wall. When a sharp chisel is used, all four sides must be scored with the chisel prior to penetrating into the antrum. This is essential to prevent fracture and possible injury to the infraorbital nerve. The anterior wall of the sinus is being removed with a Kerrison forceps. Troublesome bleeding may occur from the cut edge of bone. This can be controlled by squeezing the bone edge tightly with the Kerrison forceps but not hard enough to cut through. Sufficient amount of anterior wall has now been resected, so that the diseased area can be removed effectively and a nasoantral fenestration fashioned.

Caldwell-Luc operation - construction of nasoantral window

Diseased tissue is removed from the antrum with curettes and blunt cupped forceps. If the mucosal lining of the antrum is to be removed, it is first elevated with a blunt curved dissector. Dissection should be conducted with care in the region of the roof, for the infraorbital nerve may not have a bony covering. To construct the nasoantral window, a
A curved hemostat is passed into the nasal cavity along the floor and then directly lateralward beneath the inferior turbinate. The tip of the hemostat is moved from side to side in order to enlarge the opening sufficiently to admit a small Kerrison or Hajek forceps.

The nasoantral fenestration is enlarged in an anterior direction with Kerrison forceps and posteriorly with ring forceps. The bony and membranous layers are removed simultaneously, exposing the inferior turbinate. There are a number of techniques for the construction of a flap from the medial wall of the antrum to be reflected laterally. These are somewhat difficult to fashion and have a tendency to resume their anatomic position, thus closing the fenestra.

**Oroantral Fistula**

**Diagnosis.** The number of upper premolars and molars in intimate contact with the floor of the maxillary sinus is dependent upon the size of the sinus. The sinus may be separated from the roots of these teeth by a thin layer of bone, or there may be an absence of bone. On occasion the roots may extend into the maxillary sinus. An oroantral fistula may occur following the extraction of a non-diseased tooth. There are two predisposing factors to oroantral fistulas: the close proximity of premolar and molar roots to the sinus floor, and the presence of either an apical abscess or a maxillary sinusitis with poor drainage at the time of an upper molar or premolar extraction. An oroantral fistula may be secondary to a compound maxillary fracture, neoplasm of the antrum (especially after radiation therapy), or following a radical antrum operation.

The symptoms of an oroantral fistula, if of recent origin, are blood in the nasal cavity, and an escape of air from the fistulous tooth socket. Liquids taken into the mouth may escape through the nostril. If infection is present it usually is manifested within one or two days following the extraction of the tooth. Pain over the maxillary sinus and a profuse odoriferous nasal discharge are characteristic. The patient complains of foul taste. Purulent discharge can be seen exuding from the extraction site. This discharge may increase when the patient holds his nose and increases the internal pressure. The patient may have difficulty in developing a negative intraoral pressure such as when drinking through a straw.

The diagnosis is made from the history, signs and symptoms, x rays of the sinuses, and probing of the fistulous tract with a small-caliber lacrimal probe.

**Indications for Surgical Procedure.** The surgical procedure is determined by:

1. The size of the fistula.
2. The presence or absence of adjacent teeth.
3. Previous unsuccessful attempts for closure.
4. Severity of the associated maxillary sinusitis.
5. Epithelialization of the fistulous tract.

On occasion an oromaxillary fistula may occur following the extraction of a non-diseased tooth. This usually heals rapidly after local repair, administration of antibiotics, and prohibiting the patient from nose-blowing. If a tooth root is broken off during extraction and found to lie within the antrum but submucosally, it is best left alone if there is no infection.
If infection is present, antibiotic therapy plus irrigation may result in resolution of the inferior and healing. Otherwise a more radical procedure is necessary both to remove the foreign body and to close the oroantral fistula.

**Repair of Fistula When Teeth Are Present.** If the fistula is small and teeth are present it is closed by using a combination of gingival and palatal incisions adjacent to the teeth. Antibiotic therapy is instituted several days before operation. The patient is prepared for operation as outlined for the Caldwell-Luc procedure. The incision is made near the gingival margin. The periosteum is elevated over the anterior wall of the maxillary sinus. The antrum is entered and a Caldwell-Luc operation is carried out, making certain that a large oroantral window is fashioned. It is most important to obtain a culture so that sensitivity tests can be performed. All granulation tissue and diseased bone are curetted from both the sinus and oral orifices of the fistula. An incision is made on the palatal side of the alveolar ridge. A counter incision is made over the hard palate; this incision may extend beyond the junction of the hard and soft palate if necessary. The bipedicled flap thus created is elevated so that it may be advanced laterally in order to obtain tension-free approximation of the flaps. The flaps are securely sutured over the fistula with mattress sutures. The antrum is firmly packed with 1-inch aureomycin-ointment impregnated iodoform gauze.

Postoperatively the patient is maintained on antibiotics. The iodoform packing is removed on the fifth postoperative day by way of the nasoantral window. If the suture material used is #3-0 silk rather than chromic catgut it is removed on the tenth postoperative day. The patient is warned against nose-blowing until healing is complete.

**Procedure in Edentulous Patient.** If the fistula is small or of moderate size, there are no teeth present in the adjacent alveolar ridge, a gingivobuccal "U" flap is used to repair the defect. The "U" flap is elevated and a Caldwell-Luc operation is carried out. The lateral wall of the fistulous tract is completely removed from the alveolar ridge to the antrum. Adjacent bone is also removed laterally so that the "U" flap may be placed in contact with the entire surface of the trough thus created. The "U" flap is then secured in place with #3-0 chromic catgut or silk suture material.

**Procedure for Large or Persistent Oroantral Fistula.** There are numerous surgical procedures for the correction of a persistent or large oroantral fistula. Probably the simplest and the most successful method is that of providing a posteriorly based palatal flap combined with a buccal flap. It may be necessary to remove adjacent teeth if they are in close proximity to the fistula. In preparing the palatal flap it is important to be cognizant of the location of the greater palatal foramen and artery. The location of the greater palatal foramen is approximately 0.5 cm medial to the last molar tooth. The lateral wall of the fistulous tract is removed in a manner similar to that previously described. A more extensive resection of the alveolar ridge may also be necessary. The palatal flap is then advanced laterally so that it may be sutured to the gingivobuccal flap without tension.

A connective tissue flap derived from the area above the gingivobuccal flap may be reflected inferiorly into a large oroantral fistula. This is sometimes necessary in conjunction with the palatal and buccal flap to close a very large oroantral fistula.
Indications. Any patient with persistent bilateral nasal obstruction due to engorgement of the turbinates and nasal mucous membrane who has not responded to intensive conservative management may be a candidate for unilateral or bilateral vidian nerve section. The candidates are patients who have either had negative or nonspecific responses to skin sensitivity tests, have no complicating bacterial infection, and do not have local and blood eosinophilia. Before subjecting patients to the operation, emotional and endocrine factors as well as physical agents such as heat, cold, and local irritants should be considered as factors responsible for engorgement of the turbinates and nasal mucous membrane.

The surgeon must make a careful differentiation between the patient with rhinorrhea which is secondary to cholinergic effects of the parasympathetic fibers of the vidian nerve as opposed to the “blocked stuffy nose without rhinorrhea” which will usually not be improved after section of the vidian nerve. It should be emphasized that sectioning of the vidian nerve should be reserved only for patients in whom conservative measures have failed.

Anatomy of the Pterygomaxillary Fossa. The pterygomaxillary fossa is bound:

1. Anteriorly, by the infratemporal surface of the maxilla (posterior wall of the maxillary sinus.
2. Superiorly, by the undersurface of the sphenoid bone and the orbital process of the palatine bone.
3. Medially, by the perpendicular plate of the palatal bone.
4. Posteriorly, by the base of the pterygoid process and part of the anterior surface of the greater wing of the sphenoid bone.

The pterygomaxillary fossa contains the third division of the internal maxillary artery, the accompanying veins, the vidian nerve, the sphenopalatine ganglion, and the second division of the trigeminal nerve. The spaces between these structures are filled with adipose tissue.

The openings into the pterygomaxillary fossa are as follows:

1. The inferior orbital fissure is the communication between the pterygomaxillary fossa and the orbit.
2. The pterygomaxillary fissure is located laterally at the junction of the second and third division of the internal maxillary artery.
3. The sphenopalatine foramen is found close to the posterior tip of the middle turbinate. The sphenopalatine artery and nerves are distributed to the septum and the lateral wall of the nose through this foramen.
4. The foramen rotundum is readily identified in the posterior superior wall of the pterygomaxillary fossa. The second division of the trigeminal nerve enters the fossa by way of the foramen rotundum.
5. The vidian canal is a funnel-shaped opening on the posterior wall situated medial and slightly inferior to the foramen rotundum. A 7- to 10-mm wide vertical crest of bone separates the foramen rotundum from the vidian canal. The vidian canal is often difficult to
view because of its close proximity to the medial wall of the antrum (lateral wall of the nasal cavity). The vidian nerve exits from this canal to join the overlying sphenopalatine ganglion.

6. The pharyngeal canal is an opening into the lateral aspect of the roof of the choanae. The pharyngeal branches of the sphenopalatine ganglion and the pharyngeal branches of the sphenopalatine ganglion and the pharyngeal branches of the internal maxillary artery reach the nasopharynx by way of this canal.

7. The posterior palatine canal, found in the floor of the pterygomaxillary fossa, provides passage for the descending palatine nerves and the greater palatine artery.

**Anatomy of the Vidian Nerve.** The vidian nerve is made up of both sympathetic and parasympathetic fibers. The sympathetic innervation arises from the cervical ganglion of the carotid plexus. The parasympathetic innervation originates in the superior salivatory nucleus and accompanies the facial nerve to the geniculate ganglion. Here the parasympathetic fibers separate from the facial nerve to form the greater superficial petrosal nerve, which exits from the temporal bone through the hiatus facialis on the anterior surface of its petrous portion. Shortly thereafter the greater superficial petrosal nerve joins the sympathetic fibers from the carotid plexus to form the vidian nerve.

The vidian nerve joins the overlying sphenopalatine ganglion shortly after its exist from the vidian canal. It proceeds to provide the parasympathetic and sympathetic nerve supply of the nasal cavities.

**Technique of Vidian Nerve Section.** The procedure may be performed with the patient under either general or local anesthesia. When local anesthesia is the choice, 2% Xylocaine with 1:100,000 epinephrine is injected into the gingivobuccal sulcus and around the infraorbital nerve.

A curved needle is inserted 2 cm into the greater palatine foramen and 2 cc of the same local anesthetic agent previously used are slowly injected into the canal and pterygomaxillary fossa.

A Caldwell-Luc incision is employed. The periosteum is elevated from the anterior wall of the antrum in the region of the canine fossa. A curette, chisel, or rotating bur is used for entry into the antrum. As much of the anterior wall of the antrum is removed as is possible without damaging the infraorbital nerve. Removal can be accomplished with Kerrison forceps, but is best done with a rotating bur. A cocaine pack is placed in the antrum for a few minutes to further anesthetize the antral mucosa and to decrease bleeding. A mucosal flap based laterally or inferiorly, is elevated from the posterior wall of the antrum. A self-retaining retractor is applied to elevate the upper lip and periosteum.

The surgical microscope, with a 300-mm lens, should be used during the remaining dissection. The thin posterior wall is broken through with a curette or small chisel. The periosteum is carefully separated from the posterior sinus wall, which, in turn, is removed with Hajek bone-cutting forceps. It is important to extend this bony dissection as far medially as is possible, for the vidian canal is often found directly posterior to the medial wall of the antrum. There are a number of small blood vessels directly underneath the periosteum covering the pterygomaxillary fossa. It is best, therefore, to use electrocoagulation when
making the cruciate incision to open this periosteum. The four flaps thus created are easily elevated, exposing the underlying adipose tissue.

Pulsations of the internal carotid artery can often be seen, giving the surgeon some indication as to the location of this artery. Adipose tissue is carefully removed with dissectors, alligator and cup forceps, and suction tips, all especially designed for this purpose. As soon as the main artery is identified, it is elevated with an artery hook so that its branches may be more readily dissected free.

The sphenopalatine ganglion is often quite difficult to see because of the overlying internal maxillary artery. The artery may also interfere with the dissection in a medial and inferior direction to the vidian canal. In such cases it is ligated and sectioned medial to the origin of the infraorbital artery. Once the sectioned artery is reflected medially, the rounded vertical bony ridge which separates the foramen rotundum from the vidian canal can be identified. The rather large, funnel-shaped vidian canal is found medial and slightly inferior to the foramen rotundum, nearly in direct line with the medial wall of the antrum.

The sphenopalatine ganglion is held forward with a right-angle hook, and the emerging vidian nerve is seen. The vidian nerve is sectioned with a small sickle knife or a small curette. Bone wax or Oxygauze is packed into the vidian foramen. I have abandoned the use of cautery in this area. The posterior antral wall mucosal flap is placed over the pterygomaxillary fossa and covered with a layer of Gelfoam. A Caldwell-Luc operation is completed.

**Postoperative Care.** The postoperative care is similar to that after a Caldwell-Luc procedure or ligation of the internal maxillary artery. Following the section of a vidian nerve, absence of lacrimation may give temporary discomfort. This is alleviated by methyl cellulose eye drops.

It should be noted that Gergely (1935) states that one-third of the cases of unilateral sectioning of the vidian nerve show bilateral improvement. This usually becomes apparent approximately two weeks after the operation, and thus a contralateral operation should be delayed for at least one month.

**Maxillectomy**

Maxillectomy is the treatment of choice for a carcinoma confined to the antrum. Unfortunately, these cases are few and far between, for carcinoma in the maxillary sinus usually extends beyond the confines of the sinus to produce signs and symptoms which bring the disease to the attention of the patient.

As a general rule, inferiorly located carcinoma of the maxillary sinus has the best chance for cure. If the lesion has broken through the anterior wall of the sinus, everything under the cutaneous cheek must be removed, and, on occasion, the skin of the cheek must be included with the resected specimen. If the carcinoma has broken through the roof of the antrum, the orbital contents must be resected with maxilla. If the tumor invades the anterior ethmoid cells, the nasal septum and entire ethmoid labyrinth, including the roof of the labyrinth and the cribriform plate, must be removed. Tumors which extend through the
posterior wall of the antrum into the posterior ethmoid cells, sphenoid sinus, or apex of the orbit have a poor prognosis even with preoperative or postoperative radiation therapy. If the carcinoma extends into the frontal sinus, the frontal bone in this area should be resected.

If the disease extends beyond the confines of the antrum and the site of extension can be accurately outlined, preoperative radiation therapy should be instituted. The advantage here is that a larger dose of radiation can be given with less chance of tumor spread by the surgical procedure, and there will be fewer postoperative complications. Postoperative radiation therapy is given when the site of extension is discovered at the time of the operation. In such cases, a radiotherapist can administer the radiation more accurately than would have been possible prior to the operation, but the amount must be limited because of almost certain injury and breakdown of surrounding normal tissues.

Is a maxillectomy ever done when there is no chance for cure? Yes, it is undertaken to remove disease tissue and the products of palliative radiation therapy when such complications as bone sequestration, severe odor, uncontrollable pain, and trismus result from this therapy.

Preoperative Management. Permission for removal of the orbit must be obtained preoperatively in all cases, for an unsuspected extension of disease is not uncommon. The surgeon may choose to begin antibiotic therapy before the operation, especially if the carcinoma is accompanied by secondary infection. Anteroposterior and lateral planograms of the maxillary sinus are often most helpful in determining the extent of the disease. It is preferable to obtain upper and lower dental impressions before the maxillectomy rather than during the immediate postoperative period. If this is not possible, the impression can be taken either immediately after the operation or following removal of the packing. The patient's blood is crossmatched with at least 1500 cc of whole blood, which should be in readiness at the time of the operation. In the past, ligation of one or both external carotid arteries has been a prelude to maxillectomy. For the most part, this has been abandoned, and hemorrhage is controlled and blood replaced as the problem is encountered.

Since the incidence of carcinoma of the maxillary sinus is high among persons of the older age group, a careful preoperative evaluation of the patient's general health is essential.

Anesthesia. Hypotensive anesthesia facilitates this extensive and bloody surgical procedure; however, only about 50% of patients with carcinoma of the maxillary sinus can fulfill the necessary qualifications for hypotensive anesthesia, which requires that the systolic blood pressure be maintained at 60 mm and even slightly lower if the patient is young and healthy. A cuffed endotracheal tube should be inserted through the nasal cavity opposite to the side being operated upon. Pharyngeal packing is inserted to prevent blood from entering the esophagus or trachea. The anesthetic agent of choice is one which allows the surgeon to use cautery and epinephrine solution simultaneously.

Maxillectomy with Orbital Exenteration

The patient is placed on the operating table in the supine position. His head is elevated above the level of the thorax in order to reduce venous pressure. Maxillectomy is a difficult, bloody, and high-risk operation. Heavy equipment is necessary.
The anatomic parts to be removed are: the orbital contents, the floor and medial wall of the orbit, the malar bone, a portion of the zygomatic arch, the antrum, the ethmoid sinuses, the anterior wall of the sphenoid sinus, the pterygoid plate, the hard palate, and the nasal septum if the ethmoid or nasal cavity is involved with the tumor.

**Incisions.** The eyelids are sewed together with #5-0 silk or polyethylene suture material. The incision begins over the lateral aspect of the nasal dorsum, just above the level of the inner canthus. It is made directly to the bone. It is extended down over the nasal bone midway between the lateral nasal crease and the dorsum of the nose, around the ala and the nasal labial crease, to the midline under the columella. Cross hatching of the incision is carried out in order to ensure a more accurate closure. A vertical midline incision is carried out in order to ensure a more accurate closure. A vertical midline incision is used to split the upper lip. The upper lip is compressed with a finger and thumb on each side while the lip-splitting incision is made. As pressure is released the superior labial and lateral nasal branches of the external maxillary artery are easily identified and ligated.

The incisions above and below the eyelid margin are made approximately 2 mm away from the tarsal plates. They rejoin lateral to the external canthus and extend laterally an additional 2 cm. Some surgeons advocate preservation of the lids so that a prosthesis may be worn. The cosmesis attending this operation is not entirely satisfactory and preservation of the lids is often not advisable, because the orbital defect is needed for long-term inspection and the detection of recurrent disease.

An incision is made along the entire length of the gingivobuccal sulcus and posteriorly around the maxillary tuberosity. If teeth are present, the median incisor on the side of the maxillectomy is removed.

Either of two methods is used to approach the hard palate. If the lesion extends to, or involves, the hard palate, then the mucous membrane over the hard palate must be removed with the specimen. In such cases a midline incision is made from the anterior midline alveolar ridge to the junction of the hard and soft palates. An incision is then made along the posterior rim of the hard palate. This connects with the gingivobuccal incision which has been extended around the maxillary tuberosity.

If the hard palate is not involved, the mucosal incision is made along the palatal side of the alveolar ridge parallel to the gingivobuccal incision. This connects with the gingivobuccal incision around the posterior aspect of the maxillary tuberosity. A mucous membrane flap is elevated, exposing the hard palate on the side upon which the maxillectomy is being performed.

**Elevation of the Facial Flap.** The nasal cavity is entered inferiorly after the upper lip has been reflected laterally. An electrocautery knife is useful here. This incision is extended laterally and then superiorly in the pyriform aperture to a point on the inferior margin of the nasal skeleton at the junction between the nasal bone and the ascending process of the maxilla. The periosteum is elevated over the nasal bone and ascending process of the maxilla to the level of the nasal process of the frontal bone, while the nose is retracted to the opposite side.
Elevation of the facial flap is continued in a subcutaneous plane. The skin of the lids is elevated superficial to the orbicularis oculi muscle. (On the other hand, if the tumor does not extend to this region, the orbicularis oculi muscle may be preserved with the facial flap to give a better cosmetic result.) The buccinator muscle is preserved with the facial flap. All other facial muscles attached to the anterior wall of the antrum must be transected. The buccinator can be followed easily, for its fibers are continuous with those of the orbicularis oris muscle and run in a posterior direction. That portion of the buccinator muscle which attaches to the maxilla is transected. Elevation of the flap is continued posteriorly to the anterior aspect of the zygomatic arch and to the lateral aspect of the malar bone.

**Orbit.** As has been mentioned, the skin of the upper lid is usually elevated to include the orbicularis oculi muscle unless there is extension of disease into the orbit. The superior orbital rim is identified. The periosteum is incised along the superior orbital rim and also on the medial and lateral orbital rims, to the level of the inner and external canthi. Elevation of the periosteum is begun superiorly, and the contents of the orbit are dissected inferiorly. The optic nerve and vessels are transected with curved scissors. Troublesome bleeding can be controlled with packing left in place for a short time.

**Malar Bone.** The inferior orbital fissure is identified. A long, curved hemostat is inserted under the malar bone and up and out through the inferior orbital fissure. This hemostat is used to grasp one end of a Gigli saw, which is pulled through and used to transect the malar bone. The malar bone can also be incised with a Stryker saw. On occasion it may be necessary to remove the superior and lateral bony walls of the orbit, thus exposing the dura.

**Zygomatic Arch.** After detaching the anterior attachment of the masseter muscle, the zygomatic arch is transected with either a Gigli or a Stryker saw.

**Hard Palate.** The simplest way to transect the hard palate is with a 2-cm osteotome. The transection may be accomplished by inserting a Gigli saw into the nasal cavity and out at the junction of the hard and soft palates. The saw is grasped by a curved hemostat inserted through the incision at the junction of the hard and soft palates. When sawing, it is necessary to pull slightly toward the opposite side so that the saw will approximate the midline. Troublesome bleeding may occur from the greater palatine artery, but this can be controlled by packing or by inserting a cautery tip into the greater palatine foramen. In order to decrease the amount of bleeding, the electrocautery knife can be employed on the buccal and nasal sides of the hard palate prior to using the osteotome or Gigli saw.

**Ethmoid.** The upper nasal cavity is entered by one of two methods. A 1-cm osteotome is placed between the nasal bone and the ascending process of the maxilla. The osteoma is inserted to the level of the nasal process of the frontal bone. This is approximately at the level of the inner canthus, cribriform plate, roof of the ethmoid labyrinth, anterior and posterior ethmoid arteries, and the suture line between the orbital process of the frontal bone and the lamina papyracea. The exposure also can be accomplished by removing the ascending process of the maxilla with a rongeur.

The periosteum is elevated laterally, exposing the lacrimal sac and lamina papyracea. The anterior and posterior ethmoid arteries are identified and cauterized. The anterior and
posterior ethmoid foramen accurately identify the level of the cribriform plate and roof of the ethmoid sinuses. An osteotome is used to transect the specimen just below the roof of the ethmoid sinuses. This osteotome is extended posteriorly to the depth of the posterior ethmoid artery. If the disease involves the ethmoid sinuses, their bony roof and cribriform plate should be removed, thus exposing the dura. In such cases, cerebrospinal fluid leakage usually occurs. Repair is made with a split-thickness skin graft or a mucosal flap from the septum. When the ethmoid sinuses are grossly involved, it is also advisable to resect the nasal septum.

**Posterior Dissection.** The masseter muscle is detached from the maxilla. There are two methods to handle the posterior dissection. If the posterior wall of the antrum remains intact, an osteotome is inserted between the maxilla and the pterygoid process. Most often it is impossible to determine whether or not the posterior wall of the antrum is involved with the tumor and thus an alternate method must be used. The pterygoid muscles are detached from the medial and lateral pterygoid plates. A large curved osteotome is placed behind the pterygoid plates, and the pterygoid process is transected near its origin from the remainder of the sphenoid bone. Brisk bleeding from the internal maxillary artery may be encountered in this area.

**Specimen Removal.** After the pterygoid processes have been freed the specimen is attached only by the posterior and medial aspect of the bony orbit and the pterygomaxillary fossa. A heavy pair of scissors is placed behind the pterygoid plates and then wherever the specimen remains intact. As soon as the specimen is removed, a large hot-pack is inserted into the cavity. Time can now be taken for examination of the specimen to determine the extent of the disease. The packing is removed and the internal maxillary artery is ligated. The remaining portions of the ethmoid labyrinth, the anterior wall of the sphenoid sinus, and other areas where there could be possible extension of the disease are resected.

**Skin Grafting.** A 0.0015- to 0.0018-inch thickness skin graft is obtained from the medial aspect of the thigh, a nonhair-bearing area. All areas void of mucous membrane are grafted. One graft is used to line the orbit, roof of the ethmoid sinuses, and the cribriform area. A second graft extends from the anterior wall of the sphenoid sinus to the anterior skin incision, thus lining the skin flap. This graft is sutured to the gingivobuccal incision inferiorly and subcutaneously anteriorly. Chromic catgut (#4-0) is used for suturing the skin graft. Overlapping portions of the graft can be trimmed, postoperatively, after the packing has been removed. As a general rule these grafts take very well and it is not necessary to suture them carefully in place. The entire skin-grafted cavity is lined with a layer of absorbable gelatin material, so that when the gauze packing is removed the skin graft will not be pulled away. The defect (cavity) is packed with aureomycin ointment-impregnated iodoform gauze. This packing is held in place with a temporary prosthesis or by bridging #00 chromic catgut or #3-0 Dermalene sutures from the midline to the gingivobuccal incision.

**Skin Closure.** Using the cross-hatchings as a guide, the flap is replaced subcutaneously with #3-0 chromic catgut sutures. The mucous membrane is sutured with #4-0 chromic catgut. Dermal suture material (#5-0) is used for the skin closure. A light dressing is placed over the orbit, face, and side of the nose. A nasogastric feeding tube is inserted by way of the nasal cavity opposite the operated side. This remains in place for approximately 4 days or until the patient is able to feed himself properly. If there is any sign of impending
respiratory obstruction, or a radical neck dissection has been carried out with the maxillectomy, a tracheotomy should be performed.

**Postoperative Care.** The packing is removed between the seventh and tenth postoperative day. An impression for a temporary prosthesis is made at this time, if this was not done immediately after the operation. Moist cotton packing can be used temporarily to fill the defect. This is changed several times a day, especially after each meal. The cavity should be carefully cleaned each day with hydrogen peroxide solution and irrigated with warm saline solution. Excessive skin that has been grafted is trimmed. A permanent dental prosthesis is made four to six weeks postoperatively when all healing has taken place.

As a general rule a dental prosthesis is preferable to a reconstructed palate because this provides for easier inspection of the cavity, and recurrent disease can be identified at an early date. If the mucous membrane and periosteum of the hard palate have been preserved, the defect in the palate may be eliminated. When the hard palate is reconstructed, the resultant skin-lined cavity, which produces much debris, may result in a crusting and an odor problem. There are three methods for constructing the palate: (1) by using a pedicled flap consisting of the entire forehead based on one temporal artery (this is tunneled in through the cheek); (2) by using a cervical pedicled skin flap which is pulled up and through the cheek; or (3) by swinging the nasal septum, which has been incised anteriorly, superiorly, and posteriorly and hinged inferiorly, laterally to cover the palatal defect.

**Maxillectomy with Preservation of the Orbit**

A medial and lateral tarsorrhaphy should be performed prior to making the maxillectomy incision. This is done to prevent edema and ectropion of the lower lid postoperatively. The rhinotomy and the upper lip, gingivobuccal, and palatal incisions are made as described previously. The horizontal incision under the eye extends across the lower lid within 2 to 3 cm from the tarsal places. The lower lid is elevated in a plane above the orbicularis oculi muscle. The flap is elevated, preserving the orbicularis oculi and buccinator muscles. The entire front face of the maxilla, ascending process, inferior orbital rim, zygomatic arch, and malar bone are exposed.

A periosteal incision is made along the inferior orbital rim. The periosteum is elevated from the floor and lower medial and lateral walls of the orbit. A curved hemostat is inserted under the malar bone, the tip presenting in the inferior orbital fissure in order to grasp one end of a Gigli saw, which is used to transect the malar bone. If the floor of the orbit is to be preserved, the orbital periosteum is not elevated from it.

The remainder of the operation is as has been described for maxillectomy with orbital exenteration. The ethmoid is usually transected at slightly lower level. The remainder of the ethmoid cells are carefully removed after the specimen has been resected.

There are two methods to obtain support for the orbit if the bony floor has been removed.

1. The temporalis muscle is detached from the coronoid process of the mandible. It is slung under the orbital periosteum and sutured in the region of the inner canthus. The
temporalis muscle, as well as the remainder of the maxillectomy defect, is covered with a split-thickness skin graft.

2. An alternate, but not quite as effective, method to support the orbit is that of suturing a sling of skin graft under the orbital periosteum. As the graft becomes attached to the periosteum and contracts, it supplies a good support to the orbit.

It is best not to disturb the tarsorrhaphy incision for several weeks in order to prevent edema and ectropion of the lower lid. The remainder of the postoperative care is as has been outlined for maxillectomy with orbital exenteration.

**Partial Maxillectomy**

For very low lesions of the maxilla, such as those of the alveolar ridge and hard palate, a partial maxillectomy can be accomplished by using the gingivobuccal and palatal incisions only.