Surgery of the Upper Respiratory System

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Chapter 3: Surgery of the Ethmoid and Sphenoid Sinuses

Ethmoidectomy

Surgical Anatomy

The ethmoid bone is situated in the anterior cranium between the two orbits and the upper half of the nasal cavities. The lower two thirds of the lateral nasal wall is the medial wall of the maxillary sinus. The ethmoid bone appears to consist of crossed vertical and horizontal plates with the bony capsule of the labyrinthine cells attached to the inferior and lateral portion of the horizontal plate. The vertical plate rises slightly over the horizontal to form the crista galli, while the inferior vertical portion forms the perpendicular plate of the nasal septum. The ethmoid bone articulates anteriorly with the frontal bone, posteriorly with the sphenoid bone, and inferiorly with the quadrangular septal cartilage and perpendicular plate of the vomer bone. The horizontal plate of the ethmoid bone, adjacent to the midline, is perforated by many foramina for the passage of the olfactory nerve endings. The cribriform plate (lamina cribrosa) articulates with the frontal bone laterally and anteriorly. Posteriorly, it is in contact with the sphenoid bone.

The ethmoid cells lie between the upper third of the lateral nasal wall and the medial wall of the orbit. The number of cells varies according to the size of the cells. The attachment of the middle turbinate roughly divides the ethmoid cells into anterior and posterior groups. Thus, the ostia of the anterior ethmoid cells communicate with the middle meatus, while those of the posterior ethmoid cells communicate with the superior meatus.

The ethmoid labyrinth is pyramidal in shape; it is wider posteriorly than anteriorly and wider above than below. The anterior width of the labyrinth is 0.5 to 1 cm. The posterior width is approximately 1.5 cm. The anteroposterior dimension, or length of the labyrinth, is 4 to 5 cm. The height is 2 to 2.5 cm.

The lacrimal bone forms the lateral wall of the anterior ethmoid cells, and the os planum (lamina papyracea) forms the lateral wall of the posterior ethmoid cells. As a general rule, the outer half of the front face of the sphenoid sinus is the posterior limit of the ethmoid labyrinth.

The cribriform plate is the roof of the olfactory slit in the anterior superior nasal cavity. It is attached to the roof of the ethmoid labyrinth, which in turn joins the orbital plate of the frontal bone. The plane of the cribriform plate and roof of the ethmoid labyrinth correspond to a horizontal plane at the level of the pupils. The superior prolongation of the attachment of the middle turbinate, which forms the superolateral nasal wall, is the division between the cribriform plate and the roof of the ethmoid labyrinth.

The anterior half of the ethmoid labyrinth is made up of cells which are overlaid medially by the upper anterior part of the middle turbinate (the agger nasi cells, lacrimal cells,
infundibular cells, and cells of the ethmoid bulla). The posterior half of the ethmoid labyrinth is made up of cells which are overlaid medially by the upper extension of the attachment of the middle turbinate and the superior turbinate. The most important surgical relationships of the anterior ethmoid cells are: (1) the lacrimal bone, (2) the floor of the frontal sinus, (3) the semilunar hiatus, (4) the unciform groove, (5) the nasofrontal orifice, and (6) the ostium of the antrum. The most important relationships of the posterior ethmoid cells are: (1) the outer half of the front wall of the sphenoid sinus, (2) the posterior half of the inner wall of the orbit (lamina papyracea), and (3) the optic nerve. The thickness of bone between the optic nerve and the posterior ethmoid cells varies between 1 mm and 5 mm. On occasion, the nerve may mound into the posterior ethmoid cells.

There are common extensions of both the anterior and posterior ethmoid cells. The anterior cells may extend anteriorly, upward and outward, to the inside of the ascending process of the maxilla, making a cell series with the frontal sinus (the fronto-ethmoidal cell), and medially into the turbinate, producing a cellular turbinate. The common extensions of the posterior ethmoid cells are over, or to the side of, the sphenoid sinus posteriorly, and into the antrum and the pterygoid process inferiorly.

The arterial blood supply of the ethmoid cells is through the lateral branches of the sphenopalatine artery and the anterior and posterior ethmoid arteries. The ethmoid sinus thus receives blood from both the external and internal carotid systems. The venous drainage is by way of the ophthalmic vein or pterygoid plexus. The lymphatic vessels related to the ethmoid sinuses are few in number. Most of these pass directly to the nasal mucosa.

Intranasal Ethmoidectomy

Indications. Intranasal surgery of the ethmoid labyrinth is quite effective when indicated, but has been neglected by many otolaryngologists. Chronic polypoid ethmoiditis, with or without nasal polyps, is a positive indication for this type of operation. The eradication of chronic ethmoid infection is often sufficient to bring about a cure of chronic frontal and sphenoid infection. Even though the external ethmoidectomy provides a safer and a more thorough method of approaching the entire ethmoid labyrinth, a skillfully performed intranasal ethmoidectomy is perfectly adequate to bring about resolution of chronic polypoid ethmoiditis.

Technique of Surgery. Since the intranasal ethmoidectomy is used for the treatment of chronic polypoid ethmoid sinusitis, which almost invariably involves both ethmoid labyrinths, it is usually a bilateral procedure.

A submucous resection of the nasal septum facilitates the intranasal ethmoidectomy and is performed as a routine part of this operation by many surgeons. Each nasal cavity is packed with cotton strips impregnated with 1:1000 epinephrine solution. This assists in hemostasis and in providing a better view of the area to be operated upon. Polyps projecting into the nasal cavities are removed.

The patient is placed in a position of slight extension so that the middle meatus and anterior ethmoid region may be seen. The bulla and infundibulum can also be viewed unless the anatomic relationships have been distorted by disease. A sharp curette is used for
penetration into the anterior ethmoid labyrinth in the region of the bulla. Sharp, angulated, looped curettes are employed to remove the anterior ethmoid cells; if the bleeding is troublesome, the anterior ethmoid labyrinth is packed with epinephrine-impregnated gauze strips. The anterior ethmoid cells on the contralateral side are then removed in like manner.

The anterior one half or two thirds of the middle turbinate must be removed in order to gain access to the posterior ethmoid cells. The attachment of the middle turbinate is cut with turbinate scissors (or straight or slightly curved scissors). The turbinate is then transected, at the desired location, with a wire snare or a right-angled scissors. If bleeding is profuse, epinephrine-impregnated gauze strips are inserted for its control.

The posterior ethmoid cells lie behind the attachment of the middle turbinate. At times, the middle turbinate cannot be recognized as such, having been chewed away during repeated intranasal polypectomies. In such cases, the posterior ethmoid cells must be dissected with extreme care. On occasion, after the middle turbinate or a portion thereof has been removed, the attachment cannot be identified because of destruction by disease. In such cases, the relative position of the posterior ethmoid cells can be fairly well judged, since the anterior portion of the turbinate has just been removed. A ring curette is inserted into the posterior ethmoid cells. By gentle curettage and with a knowledge of the approximate dimensions of the area, the limits of the posterior ethmoid cells can be precisely outlined. Debris (bone, polyps, etc) is best removed with either Brownie or Takahashi forceps. Bleeding may be profuse at this point. It is well to remember that it can be controlled by repeated packing accompanied by patience. The posterior limit of the ethmoid labyrinth is the anterior wall of the sphenoid sinus. If indicated, the sphenoid sinus can be entered, diseased tissue removed, and a portion of the anterior wall resected in order to establish drainage. The close relationship of the optic canal to the lateral aspect of the posterior ethmoid cells must be clearly kept in mind during this dissection.

**Packing.** Bleeding is usually well controlled by the time all ethmoid cells have been removed. On the other hand, there is a somewhat significant incidence of postoperative epistaxis following intranasal ethmoidectomy. Some surgeons prefer not to use packing until bleeding becomes apparent. Others pack the ethmoid area routinely. A favorite packing is 1-inch iodoform gauze impregnated with aureomycin ointment. Approximately 24 inches of this packing are inserted into each ethmoid defect and held in place by a finger-cot packing inserted into each nasal cavity.

**Postoperative Care.** The finger-cot packing is removed on the first postoperative day. The ethmoid packing remains in place for from 3 to 5 days. Systemic antibiotic therapy, as prescribed by laboratory sensitivity tests, is usually instituted following intranasal ethmoidectomy.

Usually the patient can be discharged from the hospital on the fifth or sixth postoperative day. The intranasal spaces are not disturbed during the first postoperative week except for possible gentle cleansing executed with suction or forceps. A medicated oily spray may be used during the first few postoperative weeks in order to soften the crusts. It is most important that the patient be examined two weeks following this operation in order that any intranasal synechiae which may have formed will be detected and treated. When synechiae are present they are anesthetized with topical anesthesia and disrupted. A small piece of
double-faced Telfa gauze can be inserted to prevent their re-formation. The patient will experience dryness and repeated crust formation for a number of weeks following the intranasal ethmoidectomy. If he is warned of this, he will be more ready to accept the discomfort as due to the normal process of healing.

External Ethmoidectomy

**Indications.** External ethmoidectomy is indicated for those patients with acute ethmoiditis who do not respond to antibiotic therapy and have redness, swelling, and fluctuation over the ethmoid sinuses, as well as chronic ethmoid infection. Extension of the purulent infection into the orbital cavity with a resultant orbital abscess is also an indication for this operation. Mucocele, pyocele, and tumors of the ethmoid must be approached by way of the external role. The external ethmoidectomy also provides the route for external frontal sinus surgery (the Lynch procedure) and an approach to the sphenoid sinus and to the pituitary gland.

**Technique of Surgery.** The entire face is washed with antiseptic solution and drapes are placed from above the eyebrows to below the nose. Some surgeons prefer to cover one eye. In order to protect the cornea from injury, the upper and lower eyelids are sewn together with a single No. 5-0 silk or plastic suture placed through the tarsal plates. After infiltration with 2% procaine to which epinephrine solution has been added, a 1- to 1.5-inch curved incision is made half way between the inner canthus and the anterior aspect of the nasal dorsum. This incision is carefully extended through skin, subcutaneous tissues, and periosteum. If the angular vessels can be identified and ligated, much troublesome bleeding will be prevented. Before dealing with the periosteum, it is best to control all bleeding by either ligation or cauterization. There are a number of self-retaining retractors which have been devised to separate the incision. Most are bulky and cumbersome. Two or three chromic catgut sutures (No. 2-0), placed subcutaneously along the skin margins and weighted with heavy hemostats, usually provide excellent exposure. To protect the eyelids, a folded 4- x 4-inch sponge or eye pad is placed under these sutures as they extend laterally. The periosteum is elevated anteriorly and posteriorly over the ascending process of the maxillary bone. A square-ended periosteal elevator or chisel is best suited for this dissection until the anterior lacrimal crest is encountered. A small curved-end periosteal elevator is used to elevate the periosteum from the anterior lacrimal crest and the lacrimal sac from its fossa, and to expose the posterior lacrimal crest. By using a large, thin, rounded periosteal elevator, the periosteum is then readily elevated from the remainder of the lacrimal bone and the lamina papyracea. The anterior and posterior ethmoid vessels are encountered as the periosteum is elevated from the lamina papyracea. These vessels are cauterized and transected. It is usually not necessary to ligate them. If they are inadvertently ruptured before cauterization, bleeding is readily controlled by applying packing for a short period. It must be kept in mind that the anteroposterior ethmoid arteries are important landmarks. They are invariably found in the suture line between the frontal bone and the lamina papyracea and mark the plane of the roof of the ethmoid and cribiform plate. The lacrimal sac and orbital periosteum are retracted laterally with an orbital retractor, providing a good view of the nasal bone, ascending process of the maxilla, lacrimal bone, lamina papyracea, ethmoid vessels, and nasolacrimal foramen.

The anterior ethmoid labyrinth is entered by removing the thin lacrimal bone just behind the posterior lacrimal crest with a sharp curette. This opening is enlarged with various-
sized Kerrison bone-biting forceps. In order to obtain wide exposure of the later nasal mucous membrane wall, it is necessary to remove the lacrimal bone, a portion of the lamina papyracea, the ascending process of the maxilla, and sometimes a portion of the nasal bone. The anterior ethmoid cells are readily encountered and removed with Brownie or Takahashi forceps. The nasal mucosa is incised superiorly, anteriorly, and inferiorly as a "U" shaped flap and reflected laterally. This gives an excellent view of the anterior tip of the middle turbinate and the upper extension of its attachment which forms the lateral wall of the superior nasal cavity and the medial wall of the ethmoid labyrinth.

The attachment of the middle turbinate is severed by placing one blade of the turbinate scissors in the ethmoid labyrinth and the other in the superior nasal cavity. The posterior attachment of the middle turbinate is transected with a wire snare and the turbinate is removed. With Takahashi forceps, the upper extension of the attachment of the middle turbinate is carefully removed to the level of the roof of the anterior ethmoid cells. By so doing, the anterior aspect of the olfactory slit comes into view. Using, as guides, the unresected portion of the lamina papyracea, the roof of the ethmoid, and the upper extension of the attachment of the middle turbinate, the remainder of the ethmoid cells are readily removed with curettes and forceps. This done, the entire upper half of the nasal septum, the olfactory slit, the roof of the ethmoid, and the anterior face of the sphenoid sinus are entirely exposed.

Packing. The ethmoid labyrinth is packed by way of the operative field with 1-inch iodoform gauze that is impregnated with aureomycin ointment. One intranasal finger-cot pack is inserted to support the iodoform packing. A layer of Gelfoam is placed over the anterior aspect of the gauze packing in the medial wall of the orbit to prevent adherence of the packing to either the bone margins or the periosteum. The periosteum and subcutaneous layers are sutured with No. 4-0 catgut. The skin incision is sutured with No. 5-0 silk or plastic thread, either an interrupted or a subcuticular running stitch being used.

Dressing. A moderate-pressure dressing will prevent troublesome postoperative edema and ecchymosis about the eye. A small strip of Telfa gauze is placed over the incision. An eye pad is covered with three or four fluffed 4- x 4-inch gauze sponges. The skin of the forehead and lateral cheek is painted with tincture of benzoin. The dressing is secured in place with three 6-inch strips of 2-inch elastic adhesive. This is covered with a conforming gauze bandage. The finger-cot packing is removed 24 hours after completion of the operation; all dressings are removed 24 hours later. The iodoform packing is removed between the third and fifth postoperative day.

Dacryocystorhinostomy

Anatomy

The superior and inferior puncta are situated at the apex of the papillae. The papillae are found on the posteromedial aspect of the lids, about 4 mm lateral to the inner canthus. The puncta are about 0.3 mm in diameter and point in a posterosuperior and posteroinferior direction respectively.
The canaliculi pass from the puncta to the lacrimal sac and are about 10 mm in length. The course of the canaliculi is at first vertical (2 mm superiorly or inferiorly and then 8 mm horizontally). In most cases the canaliculi join to form the common canaliculus just before entering the lacrimal sac. The common canaliculus enters the lacrimal sac at a point 3 mm from its apex.

The lacrimal sac is about 12 mm in height and 5 mm in diameter. Its size roughly corresponds to the outline of the lacrimal fossa. The nasolacrimal duct is simply a continuation of the lacrimal sac in an inferior and slightly posterior direction. It is approximately 20 mm in length and 3 mm in diameter and empties into the anterior aspect of the inferior meatus of the nose. The most common site obstruction is in the upper portion of the duct.

**Indications for Dacryocystorhinostomy**

As a general rule, dacryocystorhinostomy is indicated in patients with chronic stenosis of the nasolacrimal duct when manifestations (epiphora, repeated infections, mucocele) are of sufficient severity to be annoying. A fistula from the lacrimal sac to the surface is certainly an indication. Age is not a contraindication, and the operation may be performed on children as well as elderly persons. On the other hand, in older individuals in poor health and with minimal infection and only moderate epiphora the operation can be deferred. Definite contraindications are the presence of acute dacryocystitis, carcinoma or tuberculosis of the lacrimal sac, or a severe chronic dacryocystitis that has repeatedly failed to respond to surgical treatment (a dacryocystectomy is indicated for the latter condition).

Many patients who are presented for consideration of dacryocystorhinostomy have had repeated probings and irrigations of the nasolacrimal system, both for diagnosis and treatment.

**Diagnosis**

Patency of the nasolacrimal system can be tested by probing and by application of fluorescein to the eye. X-ray examination is employed to determine the site of stenosis and whether or not a fistula is present, and to demonstrate the general anatomy of the system.

**Technique for Probing the Nasolacrimal System.** In order to probe the nasolacrimal ducts of infants and children, a general anesthetic is necessary. For adults, a topical agent, such as 2% Pontocaine, applied directly to the punctum with a cotton swab, may be used.

The lower lid is slightly everted and a punctum dilator is inserted, in a vertical direction, for approximately 2 mm. This will allow a #0 or #1 lacrimal probe to enter the canaliculus. The probe is passed inferiorly for 1 or 2 mm and then turned to a 90-degree horizontal medial direction. As the probe reaches the medial wall of the lacrimal sac, it will encounter the solid obstruction of the lacrimal fossa. It is again redirected so that it becomes vertical, and thus enters the nasolacrimal duct.

**Fluorescein Test.** A simple test to determine the patency of the nasolacrimal system consists in placing a drop of fluorescein in the eye. After a few minutes the mucous membrane of the floor of the nose and of the nasopharynx will have a yellow tinge if the
system is patent. A piece of cotton placed in the inferior meatus and subsequently observed under ultraviolet illumination is an even more accurate method of obtaining the endpoint in this test.

**X-ray Examination of the Nasolacrimal System.** The punctum is dilated as described for probing the nasolacrimal system. A more satisfactory outline of the lacrimal sac will be obtained if the sac is irrigated with normal saline solution and then evacuated by pressure over the sac prior to injection of contrast medium. Pantopaque, or Lipiodol, is injected into the canaliculus with a 2-cc syringe and a lacrimal cannula. Anteroposterior and lateral x rays are taken immediately.

**Technique of Dacryocystorhinostomy**

**Anesthesia.** General anesthesia is preferable for the operation unless there is some contraindication to its use.

The technique for local anesthesia is as follows:

1. Premedication, consisting of Nembutal, Demerol, and atropine, is given.

2. Intranasal packing (4% cocaine-impregnated cotton strips) is placed in the superior nasal cavity to anesthetize the mucous membrane innervated by the anterior ethmoid nerves and to reduce the size of the middle turbinate. This packing is also placed posteriorly to anesthetize the distribution of the sphenopalatine nerve.

3. With a 27-gauge needle, 2 cc of procaine with epinephrine (1:100,000) are infiltrated along the line of incision.

A needle is inserted 1 cm above the inner canthus, to a depth of 3 cm, while being kept in contact with bone medially, to anesthetize the nasociliary branch of the ophthalmic nerve (2 cc of the procaine-epinephrine solution are used).

The infraorbital foramen can usually be palpated. A needle is inserted below this level and directed upward to locate the foramen. Two cubic centimeters of solution are injected just inside the foramen to anesthetize the infraorbital nerve.

The eyelids are sutured with #5-0 plastic or silk material. One suture through the center of each tarsal plate is usually sufficient.

**Incision.** The incision for a dacryocystorhinostomy is identical to that for an external ethmoidectomy, ie, a 2- to 3-cm, vertical, slightly curved incision, half-way between the inner canthus and the midline of the nasal dorsum. Some surgeons prefer to start the incision 3 mm medial to, and 3 mm above, the inner canthus. The upper half of the incision is vertical, while the lower half curves laterally along Langer's lines. Skin hooks are used for retraction while the skin is undermined along the incision. The incision is then carried in layers through the peristeum. The subcutaneous and periosteal layers are elevated as a unit, both medially and laterally so as to expose the anterior lacrimal crest, the ascending process of the maxilla, and a portion of the nasal bone.
Troublesome vessels are either cauterized or ligated. Insulated suction tips are of value here when cautery is used. The medial palpebral ligament is avoided by careful elevation of the periosteum.

For retraction, two or three #00 chromic catgut sutures are placed through the subcutaneous and periosteal layers on each side of the incision. A square-edged periosteal elevator or chisel is the instrument of choice for the initial elevation of the periosteum. After the anterior lacrimal crest has been exposed, a small, sharp, curved-end periosteal elevator is used to elevate the periosteum away from the posterior aspect of this crest, as well as from the lacrimal fossa and the posterior lacrimal crest. A smooth orbital retractor is then inserted, reflecting the lacrimal sac laterally; the periosteum is then readily elevated from the anterior aspect of the lamina papyracea. It is important that the inferior aspect of the sac and the beginning of the nasolacrimal duct are freed and retracted laterally.

A curette is used to provide entrance into the ethmoid labyrinth just behind the posterior lacrimal crest. A few anterior ethmoid cells will be encountered and should be removed. The opening is enlarged with various-sized Kerrison forceps. In order to properly expose the mucous membrane of the upper lateral nasal wall, it is essential to make a bony fenestra at least 2 cm in diameter. To accomplish this, a small portion of the anterior aspect of the lamina papyracea, the anterior and the posterior lacrimal crests, the lacrimal fossa, and a portion of the ascending process of the maxilla and of the nasal bones must be removed. Anterior ethmoid cells in this area can be easily removed with Brownie or Takahashi forceps. The identity of the lateral wall mucous membrane is ascertained by inserting a cotton applicator stick, or periosteal elevator, intranasally and testing to determine whether or not the nasal mucosa bulges laterally.

**Mucosal Anastomosis.** There are many variations of technique for constructing mucosal flaps in order to prevent recurrent stenosis. The "I"-shaped incision, both in the nasal mucous membrane and on the medial wall of the sac, seems to be most popular.

A vertical incision is made in the center of the medial wall of the lacrimal sac with a knife (#11 blade) and scissors, along with small skin hooks or grasping forceps. Horizontal incisions are made at each end of the vertical incision, completing the "I" incision and thus fashioning an anteriorly and posteriorly based flap. A similar incision producing identical flaps is made in the lateral nasal mucous membrane wall. It is almost never necessary to remove the anterior tip of the middle turbinate.

The posterior flaps are sutured together with two or three #4-0 chromic catgut sutures. Relaxation of the traction sutures will facilitate the suturing of the anterior flaps. The subcutaneous layers are approximated with a #4-0 catgut sutures. The skin incision is closed with interrupted stitches of #5-0 suture material or a continuous subcuticular suture. The dressing is identical to that described for the external ethmoid operation. Intranasal packing is usually not necessary. The dressing is removed at the end of 24 or 48 hours, at which time the patient may be discharged from the hospital.

An alternate and somewhat simpler technique is that involving the construction of posteriorly based mucosal flaps from both the medial wall of the lacrimal sac and the lateral
wall of the nose. The anterior margins of these flaps are easily approximated with #4-0 chromic catgut suture material on a small non-cutting curved needle.

Some surgeons prefer to remove the medial wall of the lacrimal sac and the mucous membrane of the lateral nasal wall without attempting to fashion mucosal flaps. Prior to making the vertical incision in the lacrimal sac, a lacrimal probe is inserted into the sac by way of the inferior canaliculus. This tents the medial wall of the lacrimal sac, allowing for positive identification of the sac and facilitating removal of the medial wall of the lacrimal sac. This is the ideal technique for surgeons not skilled in constructing and suture mucosal flaps. It enjoys nearly as good results as those procedures in which lacrimal sac mucosa is sutured to nasal mucosa.

**Surgical Treatment of Malignant Exophthalmos**

Malignant exophthalmos is of endocrine origin. The exophthalmos produced by increase in the orbital contents is due mainly to an increased bulk of the extraocular muscles and orbital adipose tissue. As proptosis increases the eyelids become unable to cover the globes adequately, thus corneal ulceration may ensue. Also, with increasing proptosis, there is impairment of the venous return from the orbit, which results in chemosis and edema of the conjunctiva and eyelids. With the fullness of the eyelids, epiphora becomes a problem. Diplopia and finally ophthalmoplegia occur with progression of the disease. The circulatory embarrassment of the retina results in papilledema and, finally, a loss of vision.

**Indications for Surgical Treatment**

An indication for immediate operation is an impending loss of vision and/or ophthalmoplegia. Severe exophthalmos with complicating corneal exposure, chemosis of the conjunctiva and lids, and unsightly appearance due to increasing exophthalmos are also indications for surgical treatment.

**Techniques in Surgical Treatment**

**Naffzigger Technique.** This operation consists in creating two frontal flaps by means of which the orbital roof is exposed and removed as far back as the optic foramen. The optic foramen may be decompressed if edema of the nerve is noted during the operative procedure. The superior orbital rim is preserved in order to maintain the contour of the forehead. The nasal sinuses are not entered. The direction of expansion of the orbital contents is into the anterior cranial fossa. The dura, lateral to the frontal sinuses, and the anterior cranial fossa are exposed. It is obvious that careful study of the preoperative x-ray films is necessary in order to determine the degree of lateral extension of both the ethmoid and frontal sinuses. If the frontal sinus is entered the hazard of complicating frontal sinusitis and/or mucocele formation is increased. On occasion the Naffziger operation is impractical because of lateral extension of the frontal sinus. Sometimes, following this operation, the pulsations of the cerebral vessels are transmitted to the eye and are notable.

**Sewall's Method.** Sewall, in 1926, utilized the paranasal sinuses to decompress the orbit in the treatment of malignant exophthalmos. The Sewall decompression consists of a complete ethmoidectomy and removal of the entire floor of the frontal sinus. This operation
is less disfiguring and formidable than the Naffziger procedure. An actual, rather than potential, space is created. There is no subjective or objective evidence of pulsations of the orbit following the operation.

**Hirsch Technique.** This operation consists in removal of the orbital floor. The maxillary sinus is entered by the Caldwell-Luc approach. Its roof is removed on both sides of the infraorbital nerve. A narrow bony ridge is left in place for support of the infraorbital nerve. The periorbital fascia is incised. Orbital fat than prolapses into the maxillary sinus. A portion of this adipose tissue can be removed. A large fenestration is made in the nasoantral wall of the inferior meatus. Hirsch indicates that this operation is a simple procedure, leaving no external scar and attended with minimal danger of infection. A fairly large potential space for decompression is provided with an orbital recession of from 3 to 7 mm depending on the size of the maxillary sinus.

**Swift or Kronlein Operation.** The lateral wall of the orbit is removed by way of an incision over the lateral orbital rim. The bony defect is covered with orbital peristeme and temporalis muscle. This procedure provides limited space for decompression, although many satisfactory recessions have been secured by its use. There is an external scar and absence of the lateral orbital rim exposes the orbit to injury.

**Combined Technique (Walsh-Ogura).** In this procedure, both the floor and medial walls of the orbit are removed. The maxillary sinus is entered by way of the Caldwell-Luc incision. As much of the anterior wall of the antrum as possible is removed for exposure. The ethmoid sinuses are entered through the transantral route. As complete an ethmoidectomy as possible is carried out with removal of the lamina papyracea. Both the anterior and the posterior cells of the ethmoid sinuses are removed, exposing the anterior wall of the sphenoid sinus. The floor of the orbit is removed by using various rongeurs. The infraorbital nerve is preserved. Several anteroposterior incisions are made in the orbital periosteum. The orbital fat herniates into both the ethmoid and maxillary sinuses. A large nasoantral window is fashioned, and the gingivobuccal incision is closed.

This certainly is a more formidable operation for severe exophthalmos than those previously described. As with the Sewall operation there is a risk of post-operative emphysema, but this is not a severe complication and it can be avoided by the patient's refraining from nose blowing, sneezing, etc. When performing the combined ethmoid and antral decompression, it is probably wise for one not experienced with the transantral ethmoidectomy to use both the external ethmoidectomy and Caldwell-Luc incisions.

**Sphenoidotomy**

**Surgical Anatomy**

The sphenoid sinus is situated posterior to both the upper nasal cavity and the ethmoid labyrinth. The site of the ostium is variable according to the degree and direction of sinus pneumatization. Usually the ostium is found in the spheno-ethmoidal recess which is located above and behind the posterior aspect of the middle turbinate and just lateral to the nasal septum. The sinus may be contained entirely within the body of the sphenoid bone or may extend into the pterygoid process, rostrum of the sphenoid, greater wing of the sphenoid, or
basilar process of the occipital bone. Whereas the posterior aspect of the nasal septum is usually in the midline, the intersphenoidal septum is rarely so. On occasion, the intersphenoidal septum is oblique and can even be horizontal.

The sphenoid sinus has a number of important anatomic relations with which the surgeon must be very familiar. An easily recognized superolateral ridge formed by the optic canal into the sphenoid sinus is quite often present. Other structures which may indent the lateral wall are the carotid artery and the maxillary nerve. A ridge on the floor of the sphenoid sinus may represent the vidian canal. The posterior superior wall of the sphenoid sinus is almost invariably in close contact with the sella turcica. This is especially true when the anterior and posterior clinoid processes are pneumatized.

There are a number of important structures to be found in a sagittal plane through the sella turcica. These include the cavernous, the internal carotid artery, all three divisions of the trigeminal nerve, and the third, fourth, and sixth motor nerves to the orbit. The intracranial relation of the sphenoid sinus and its association with the ethmoid sinuses must be familiar to the surgeon who is operating in the vicinity of the sphenoid sinus and sella turcica.

**Intranasal Surgery of the Sphenoid Sinus**

**Irrigation of the Sphenoid Sinus.** On occasion, irrigation of the sphenoid sinus is indicated for diagnosis and treatment of subacute and chronic sphenoid sinusitis. The sphenoid ostium can usually be seen after reducing the size of the turbinates with intranasal cotton packing impregnated with 4% cocaine solution. The mucous membrane over the anterior wall of the sphenoid sinus should also be treated with 4% cocaine solution to produce anesthesia and effect decongestion of edematous mucous membrane in the region of the sphenoid sinus ostium. The site of the ostium is variable as are the direction and degree of sinus pneumatization. The sphenoid cannula is 10 cm in length and slightly curved at its tip. It is introduced along the roof of the nasal cavity, adjacent to the nasal septum in the direction of the posterior tip of the middle turbinate, making approximately a 30-degree angle with the floor of the nose. If the sphenoid sinus cannot be viewed directly, it is located by gentle manipulation. As soon as the sinus has been entered, aspiration is used to determine the presence of fluid. The sinus is then slowly irrigated with warm saline solution.

If cannulation of the sphenoid ostium is not possible, a Hajek sphenoid hook with a Trumbel guard is introduced into the sphenoid sinus just lateral to the nasal septum at the level of the posterior tip of the middle turbinate. Hajek forceps are used to enlarge this opening. The sphenoid sinusotomy should be made as inferior on the anterior wall of the sphenoid sinus as is possible. The purpose of the intranasal sphenoidotomy is to obtain material for culture and antibiotic sensitivity tests and also to effect drainage. In addition to antibiotic therapy, the follow-up care should include use of nasal decongestants.

**External Sphenoidotomy**

**Diagnosis of Sphenoid Disease.** The one symptom typical of sphenoid disease is constant headache described as severe and located in the center of the head. The pain may radiate to the suboccipital region or penetrate deep behind the eye. Other symptoms of
sphenoid disease are the result of its extension to surrounding structure rather than emanating from the sinus itself. The important neighbors of the sphenoid sinus are:

- Dura mater.
- Pituitary gland.
- Cavernous sinus.
- Internal carotid artery.
- Pterygoid canal.
- Abducens nerve.
- Optic nerve chiasma.
- Oculomotor nerve.
- Ophthalmic nerve.
- Trochlear nerve.
- Maxillary nerve.
- Sphenopalatine nerve.
- Ophthalmic artery.

X rays should include routine sinus views plus laminograms. Usually sagittal plane laminograms are sufficient. At times it is impossible to differentiate radiologically between infection and tumor of the sphenoid sinus or to determine whether the lesion originates in the sinus or is an extension from a neighboring area.

Lesions involving the sphenoid sinus are:

- Infection, acute and chronic.
- Polypoid sinusitis.
- Mucocele or pyocele.
- Fracture.
- Aneurysm.
- Cholesteatoma.
- Eosinophilic granuloma.
- Primary tumors:
  - Squamous cell carcinoma.
  - Adenocarcinoma.
  - Cylindroma.
  - Giant cell tumors.
  - Sarcoma.
- Secondary invaders:
  - Craniopharyngioma.
  - Chordoma.
  - Pituitary tumor.
  - Nasopharyngeal angiofibroma.
  - Meningioma.
  - Adamantinoma.
  - Malignant lesions from the maxillary and ethmoid sinuses.
  - Metastatic tumors such as adenocarcinoma and thyroid carcinoma.

Exploratory sphenoidotomy is in order when there is clinical or radiological evidence of sphenoid disease which has not responded to conservative therapy. Too many lesions of the sphenoid sinus are missed. The sphenoid sinus is approached by the tranethmoid route when chronic inflammatory, benign, and malignant lesions are to be treated. The malignant lesions are approached to obtain biopsy specimens and to establish adequate drainage and decompression.

**Technique of Operation.** A complete ethmoidectomy is carried out as has been described. It is essential that the posterior aspect of the lamina papyracea, anterior and posterior ethmoid foramina, roof of the ethmoid, and olfactory slit be identified.

The ostium of the sphenoid sinus is usually quite large and can be readily recognized. The front face of the sphenoid sinus is entered by using a sharp curette and the anterior wall is removed with various side-biting bone forceps. Diseased tissue is removed from the sinus. When treating chronic inflammatory disease, it is best to remove only sufficient amount of
anterior wall to provide adequate drainage. A wide-open sphenoid sinus can, on occasion, cause a very troublesome headache.

The intranasal packing and postoperative care are identical to those procedures outlined under "External Ethmoidectomy."

**Hypophysectomy**

The transsphenoid approach to the pituitary gland is attended with lower morbidity and mortality rates than is the anterior craniotomy route. It provides less chance for injury to the optic chiasm. Postoperative complications, such as seizures, extradural hematoma, brain damage, and cerebral edema, are rare. The convalescent period is usually quite short.

There are a number of routes and modifications for the transsphenoidal hypophysectomy.

**Type of Procedures**

**Trans-septal-sphenoidal Hypophysectomy.** This operation was pioneered by Oscar Hirsch in 1910. Cushing later used a sublabial modification of this route. Heck and associates were the first in this country to use the transseptal approach for the treatment of advanced carcinoma of the breast. The main objection to this route is that it provides a long narrow approach. Two instruments cannot be used simultaneously, and the dissecting microscope cannot be employed. It is, however, still employed by many surgeons, because it is a direct midline dissection.

**Transantro-ethmoidosphenoidal Hypophysectomy.** Hamberger and associates used this approach in a large series of patients with remarkable success. For most surgeons, however, this is a long oblique to the hypophyseal fossa. It also has the disadvantage of an increased hazard of postoperative infection, for the oral route in some patients traverses a potentially septic area.

**Transnasal Osteoplastic Hypophysectomy.** Macbeth and Hall have devised a unique direct midline approach using an osteoplastic skin flap based at the root of the nose. The only disadvantage of this procedure is that it leaves undesirable scarring of the nasal bridge. Those who perform this operation point out that this is not a factor when treating patients with advanced carcinoma of the breast.

**Transethmoidosphenoidal Hypophysectomy.** This technique for hypophysectomy has been used since the turn of the century. Chiari, in 1912, described this method for the removal of a pituitary adenoma. A few of the otolaryngologists who deserve credit for improving the techniques for this approach are Bateman, James, and Nager, who have used this operation because it provides the shortest route to the hypophysis that affords a wide field, permitting easy manipulation of instruments and use of more than one instrument simultaneously. One instrument may be inserted by way of the nasal cavity and another by way of the operative field. The advent of the surgical microscope has also increased the popularity of the transethmoidosphenoidal hypophysectomy.
The transthyroidosphenoidal approach has been used for removal of solid and cystic pituitary tumors, and hypophysectomy for palliative therapy in patients with advanced breast carcinoma, patients with diabetic retinopathy, and those with advanced prostatic carcinoma. Cystic tumors can easily be marsupialized. Solid tumors can be resected and/or decompressed. Most authors, Riskaer and Bateman, for example, report 60% to 80% transient remissions when employing hypophysectomy in treating patients having generalized metastases from carcinoma of the breast.

Hypophysectomy for metastatic carcinoma of the breast is a palliative operation. The transsphenoidal hypophysectomy is the ideal operation, for it is minimal in nature and more acceptable to a patient with terminal disease than are other procedures. Best results can be expected in those patients in the premenopausal group who have had a good response to castration and in postmenopausal patients who have responded well to estrogenic or androgenic hormone therapy.

Painful bony metastatic lesions respond best to hypophysectomy. Skin and pulmonary metastases often regress. The operation is not advised for liver or brain metastases.

Patients with breast carcinomatosis, who have been so weak that they could hardly turn in bed, have had dramatic results following hypophysectomy. In 65% of patients with diabetic retinopathy treated by hypophysectomy there has been improvement in vision or cessation of progression of the disease.

Preoperative Management in Transthyroidosphenoidal Hypophysectomy

A team consisting of a neurologist, ophthalmologist, endocrinologist, and surgeon is essential for the proper management of the patient during the preoperative and postoperative periods. A rhinologist who attempts a hypophysectomy without the assistance of these specialties is only inviting disaster. If neurologic and endocrinologic work-ups have not been carried out prior to the patient's admission to the hospital, the patient should be admitted several days prior to surgery so that these may be executed.

The neurologist's careful survey, in the patient with a pituitary tumor, should include radioactive scanning, pneumoencephalogram, and arteriograms. The endocrinologist determines the preoperative endocrine balance and prescribes the necessary hormones during the preoperative endocrine balance and prescribes the necessary hormones during the preoperative, operative, and postoperative periods. Patients with bony metastases from carcinoma of the breast should be thoroughly investigated for blood dyscrasia. A complete ophthalmologic examination should also be made prior to operation. A careful examination of the nasal cavities and the nasopharyngeal space is important to rule out the possibility of sepsis and other disease and also to orient the surgeon as to the exact anatomy of the nasal septum.

Preoperative X rays (Sinus Series)

Complete sinus x rays are taken to rule out the possibility of septic or other sinus disease. The lateral view will demonstrate the size and relationship of the sella turcica. This
view, however, is misleading as to the exact pneumatization of the sphenoid sinuses because of the densities cast by the greater wings of the sphenoid bone.

Lateral planograms of the sphenoid sinuses will give a detailed anatomy of these structures and also show their relationship to the sella turcica.

A submental vertical view will show the lateral extent of the sphenoid sinuses and the position of the sphenoid septum which is most often not in the midline.

**Operative Technique**

The anatomy of the sphenoid and sella turcica should be reviewed.

The objectives of this operation are: (1) to obtain a wide field so that a surgical microscope can be used to illuminate and outline the posterior wall of the sphenoid sinus properly (when this is accomplished, more than one instrument can be used simultaneously); (2) to define the midline with accuracy at all times during the procedure; (3) to control all bleeding and cerebrospinal fluid leakage at the completion of the operation.

An external ethmoidectomy is carried out. It is most important that the patient's head be secured in a supine position with the aid of sandbags. After the ethmoidectomy has been performed, incisions for construction of a septal mucosal flap are made. The purpose of the mucosal flap is to reduce the incidence of postoperative hemorrhage, cerebrospinal rhinorrhea, and meningitis.

A vertical incision is made through the mucosa of the nasal septum at a point approximately half-way between the nasal orifice and the anterior wall of the sphenoid. Since this incision determines the length of the septal mucosal flap, it may be varied according to the demands of the pneumatization of the sphenoid sinus. Mucosal incisions are then carried posteriorly from the superior and inferior end of the vertical incision. The superior incision extends along the nasal septum just inferior to the cribriform plate to the front face of the sphenoid sinus. It is carried laterally across the superior aspect of the front face of the sphenoid sinus and then inferiorly. The inferior septal incision is carried posteriorly to the front face of the sphenoid sinus in the region of the sphenoid rostrum. The mucosal flap is carefully elevated and reflected into the nasopharynx until the hypophysectomy has been completed.

The right sphenoid sinus is entered, and the entire anterior wall is removed. The bony nasal septum is usually left intact as an accurate guide to the midline. However, a small portion of the posterior nasal septum may be removed for a wider exposure without destroying the septum's usefulness as a midline guide.

The dissecting microscope is employed for the remainder of the operation. The bulge of the sella turcica can be seen on the posterior wall of the sphenoid sinus. The midline is again checked by using the posterior aspect of the nasal septum as a guide. If the anatomic relationships are doubtful, x rays may be taken with a portable machine, metallic probes or lead-shot attached to suture material being used as pointers. This step becomes increasingly necessary as the number of patients operated upon increases. A small opening is made in the
posterior wall of the sphenoid sinus (anterior wall of the sella turcica) with a curette or a rotating bur. This is enlarged by using various rongeurs. It is important to remove the entire anterior wall of the sella turcica in order to define accurately the limits of the hypophyseal fossa. Either a vertical or a cruciate incision is made in the dura; the pituitary gland or tumor thereof is then removed by using suction and various dissectors.

Following the completion of the pituitary surgery, the fossa is packed with Gelfoam saturated with thrombin solution if there is any bleeding or spinal fluid leakage. Fascia or adipose tissue may also be used to control bleeding or leakage. The septal mucosal flap is elevated from the nasopharynx and reflected into the sphenoid sinus. The flap is placed over the defect in the posterior wall of the sphenoid sinus, covered with a layer of Gelfoam, and then packed in place with iodoform gauze treated with petroleum jelly. When dealing with a cystic tumor, the septal mucosal flap is reflected into the hypophyseal fossa rather than used to cover the defect. This is done to ensure marsupialization of the cyst. The end of the iodoform gauze is placed in the nasal cavity so that it can be easily removed on the fifth postoperative day. The external ethmoid incision is closed subcutaneously with #4-0 chromic catgut; a #5-0 Dermalene is used for the subcuticular sutures. A dry external pressure dressing is applied over the eye and lateral nasal bridge.

**Postoperative Treatment**

Cortisone and other supportive hormonal therapy are prescribed by the endocrinologist. Hydrocortisone (100 mg on the average) is administered the evening before the operation, with the preoperative medication, during the operation, and postoperatively. The amount is variable and must be adjusted in accordance with the patient's basic hormonal balance. As a general rule, partial or complete removal of the pituitary gland is not as disturbing to the general glandular metabolism as one would suppose. Symptoms of thyroid insufficiency are not common and usually do not appear until one to three months postoperatively. One and one-half grain of thyroid extract or 0.1 and 0.2 mg of Thyroxin is administered daily when indicated.

Occasionally, estrogens or androgens are necessary following hypophysectomy. Sex hormones are withheld from cancer patients. Three hundred milligrams of Depo-testosterone are administered every month to maintain potential improved strength and well-being in male patients. In female patients, the administration of estrogens is of similar value.

The use of prophylactic antibiotic therapy is questionable. Six hundred thousand units of procaine penicillin may be administered intramuscularly twice a day. Diabetes insipidus may occur. This is easily controlled by administering vasopressin (Pitressin) in oil. The fluid intake and output chart will demonstrate the onset of diabetes insipidus. Disturbances in the metabolism of glucose will be demonstrated by sugar in the urine and abnormal quantities of sugar in the blood.

The pressure dressing over the eye and lateral nasal bridge is removed on the second postoperative day, and the patient is allowed full activity at this time. The iodoform-gauze packing and subcuticular sutures are removed on the fifth postoperative day. The patient is discharged from the hospital on the sixth or seventh postoperative day.
Postoperative Complication

Hemorrhage. The potential hazard of hemorrhage from the ethmoidal artery, sphenopalatine artery, and dural sinuses is fairly well eliminated by the use of the septal mucosal flap and the iodoform-gauze pack treated with petroleum jelly.

Cerebrospinal Fluid Rhinorrhea. Leakage of spinal fluid may occur in the immediate postoperative period or several weeks later. The patient complains of lightheadedness, headache, and soaking of his pillow and clothing from the cerebrospinal fluid rhinorrhea. This, for the most part, is self-limiting, but on occasion can be a very troublesome complication. The septal mucosal flap, used to cover the posterior wall of the sphenoid sinus, seems to eliminate this complication.

Meningitis. It would seem that meningitis would be a fairly common complication, since the hypophyseal fossa has been exposed to the upper respiratory tract. It is, however, surprisingly rare, although its occurrence has been reported in the immediate postoperative period or weeks and months later. The septal mucosal flap may be the barrier needed to prevent this complication.

Damage to the Eye. Bateman states: "It has been suspected that wide exposure of the sphenoid through an orbital incision would be likely to cause blindness because of stretching of the optical nerve. This has not been reported."

Intracranial Hemorrhage. Subarachnoid hemorrhage has on occasion been reported and has been attributed to anatomic anomalies and misdirected surgery.

Case Reports

Four case reports are presented to exemplify the advantages of the septal mucosal flap. The first two cases demonstrate complications which can occur when a defect in the posterior wall of the sphenoid sinus is not covered. The septal mucosal flap was used in the third and fourth cases and has been used in all subsequent cases to date.

Case I. A 52-year-old right-handed construction inspector was first examined on October 1, 1957. A history of intermittent right epistaxis, decreased visual acuity on the left side, and intermittent right-sided occipital headaches was obtained. The patient had noted a decrease in his sexual desires during the past year, but there had been no change in his body hair. He had also noted increasing nervousness.

The past history was negative except for a right petrosal nerve section in 1947 as treatment of tic douloureux.

X rays of the sinuses showed an old surgical defect in the right temporal fossa. The sinuses were entirely within normal limits. The sella turcica was enlarged.

Ophthalmologic examination demonstrated normal globes. The pupils were round and reacted normally to light. Extraocular motion was within normal limits. There was not nystagmus. Examination of the fundi showed no abnormality. The corneal reflexes were active
and equal. The visual acuity in the right eye was 20/30 and in the left eye 3/200. There was a visual defect on the left involving the entire field with the exception of a portion of the upper medial field. There was an upper temporal quadrant defect on the right side.

A general neurologic examination showed all reactions to be within normal limits. On lumbar puncture the initial spinal fluid pressure was 280 mm and the final pressure, 220 mm. Spinal fluid studies demonstrated no abnormality except for a protein content of 180 mg%. The basal metabolic rate was -14. Encephalograms demonstrated many α and β frequencies at less than 50 µ and poorly defined τ and δ frequencies at 50 µ or less. Most of the activity was normal. Arteriograms were within normal limits except for evidence of an enlarged sella turcica. A pneumoencephalogram demonstrated a moderately dilated ventricular system; there was a very good delineation of a large mass occupying the sella turcica and projecting into the sphenoid sinus.

A diagnosis of pituitary tumor was established and, after consultation, radiation therapy was recommended. Biopsy study of the pituitary region was not made. Radiation therapy was begun on February 8, 1958. By February 18, a total dose of 1500 r had been administered. The patient had almost no vision in the left eye and decreasing visual activity in the right eye. His headaches had become unbearable. On February 19, a transethmoido-sphenoidal hypophysectomy was performed with the patient under general endotracheal anesthesia. The sphenoid sinus was found to be well pneumatized. The anterior wall of the sella turcica could be seen bulging into the sphenoid sinus. The tumor was removed with hypophyseal forceps and aspiration.

Postoperatively, the patient's headaches disappeared, and his visual acuity and field defect gradually improved. By February 26, his visual fields were within normal limits, and his vision was 20/20 on the right and 20/30 on the left. The final pathologic diagnosis was chromophobe pituitary adenoma. Radiation therapy was reinstituted as soon as the visual fields were normal. A total dose of 4000 r was administered.

On March 21, the patient was readmitted to the hospital after having had an upper respiratory infection for a week and severe occipital headaches, nausea, vomiting, and chills for 24 hours. His meningitis responded dramatically to high doses of penicillin, chloramphenicol (Chloromycetin), and sulfadiazine. The patient was discharged from the hospital on March 29. He has remained well since this admission and has had no endocrine disturbance.

Comment. This case demonstrates a fairly rapidly expanding pituitary chromophobe adenoma resulting in visual field defects. The additional swelling produced an ophthalmologic emergency. Removal of the tumor by the transethmoidosphenoidal approach resulted in a dramatic improvement in the patient's vision. Meningitis occurred one month postoperatively. This might have been prevented if an adequate barrier had been established between the hypophyseal fossa and the upper respiratory tract.

Case II. A 45-year-old white-haired lady was first examined at the Massachusetts General Hospital in April of 1960. She was described as a typical acromegalic with large hands, feet, and facial features. Her voice was deep and coarse. Her complaints were limited
to intermittent headache and pain in the eyes, without visual difficulties, of several years' duration.

A thorough ophthalmologic examination revealed no ocular involvement. X rays of the skull showed a marked expansion of the sella turcica which measured $22 \times 26$ mm. A pneumoencephalogram demonstrated that the intrasellar tumor displaced the chiasmatic and interpeduncular cisterns superiorly. There was a slight concave indentation of the anterior portion of the third ventricle, indicating pressure from a suprasellar extension of the tumor. Cerebrospinal fluid studies showed no evidence of increased intracranial pressure. The total protein in the cerebrospinal fluid was 72 mg%. Studies indicated a slight hypopituitarism.

Because of the size of the pituitary tumor and the suprasellar extension, it was decided to institute radiation therapy. A total of 4500 r was administered from April 22 to May 16.

The patient was readmitted to the hospital on November 15, 1960, complaining of failing vision of four months' duration. Ophthalmologic work-up showed a bitemporal hemianopia and decreased in the right eye (to 20/50). The fundi were normal.

On November 23 the patient was prepared for a transethmoidosphenoidal hypophysectomy. During anesthesia induction, intubation by either the oral or nasal route was impossible because of the presence of tremendous macroglossia. A tracheotomy was rapidly performed, and the anesthetic was administered through the incision into the trachea. The sphenoid area was explored, but the patient's general condition did not allow sufficient time for either adequate decompression or removal of the tumor. There was no postoperative improvement in the visual fields. A cerebrospinal fluid rhinorrhea persistent until December 6.

On March 20, 1961, the patient was readmitted to the hospital for a second attempt at hypophysectomy. The tracheotomy incision was reopened prior to anesthesia induction. The pituitary tumor was resected and a good decompression of the area was accomplished. A septal mucosal flap was used to cover the defect in the posterior wall of the sphenoid sinus. The postoperative course was uneventful. The visual fields gradually improved. The patient has remained well while receiving some supportive endocrine therapy.

**Comment.** This was our first attempt to intubate a patient with marked macroglossia. A rapidly performed tracheotomy rectified the situation. A troublesome cerebrospinal fluid rhinorrhea followed the first attempt at hypophysectomy, in which neither adequate decompression of the area nor removal of the tumor were accomplished. The operation was successfully undertaken at a later date. A septal mucosal flap was used to cover the defect in the posterior wall of the sphenoid sinus to prevent the recurrence of the cerebrospinal fluid rhinorrhea.

**Case III.** A 59-year-old white, obese caterer was admitted to the hospital on July 4, 1961, with the chief complaint, "I can't walk downstairs." For the past eight years, she had been struggling unsuccessfully to wear bifocals. Two years prior to this hospital admission, her family doctor found that her lateral vision was blurred. X rays of the skull were taken because the patient had severe headaches. These demonstrated an enlargement of the sella turcica. The past history was otherwise not significant.
General physical examination revealed no abnormality except for obesity and a blood pressure of 190/110. Complete neurologic examination yielded findings within normal limits.

The pressure and dynamics of the spinal fluid were normal. The spinal fluid protein content was 64 mg%. The complete blood cell count gave normal values. The electroencephalogram and the blood studies, which included those for determination of protein-bound iodine, blood urea nitrogen, fasting blood sugar, and calcium content, showed no abnormality. The x rays of the skull demonstrated marked enlargement of the sella turcica. The posterior clinoid processes were destroyed. The pineal body was calcified and in the midline. The pneumoencephalogram demonstrated a pituitary tumor of 3.5-cm diameter. The electrocardiogram showed no abnormality.

Ophthalmologic examinations demonstrated a complete bitemporal hemianopia. The globes were white and in normal position. The extraocular motion was normal. The pupils were equal (4 mm) and reacted well to light. There was no nystagmus or red lens diplopia. The fundi were normal. The visual acuity was 20/30 in both eyes.

On July 13, a transethmoidosphenoidal hypophysectomy was performed. The sphenoid sinus was found to be normal except for an anterior convexity of the posterior wall. The substance of the tumor mass was soft and granular. The tumor was easily removed with hypophyseal forceps and suction. A posterior septal mucosal flap was used to cover the defect in the posterior wall of the sphenoid sinus.

The postoperative course was uneventful except for epistaxis of brief duration occurring on the eighth day. The patient was discharged on the twelfth postoperative day. Her headache was absent. She noted a definite improvement in her vision. Her visual fields were normal one month postoperatively. Hydrocortisone was administered for four months following the operation. The final diagnosis was chromophobe pituitary adenoma.

Case IV. A 61-year-old salesman was admitted to the Massachusetts General Hospital on November 27, 1961, with a six months’ history of intermittent blurring of vision while reading, and occasional diplopia. During the two months prior to admission these symptoms increased in frequency, and the patient had the feeling that "things were closing in" on him. He also complained of bitemporal headaches which were readily relieved by taking aspirin.

On examination a definite left temporal field defect to a 3-mm white object and a similar but less apparent defect in the right temporal field were noted. There was no defect on finger confrontation. The red glass test revealed a variable diplopia. It was crossed on forward gaze, homonymous on looking to the right, and not present on looking to the left. The optic disks were normal and other cranial nerves intact. The reflexes were active and equal. The motor nerves and sensation were normal.

As demonstrated by x rays of the skull, the pituitary fossa was enlarged and the dorsum sellae and the right anterior clinoid process were eroded.

An electroencephalogram showed no abnormality. The spinal fluid protein content was 90 mg%. The pneumoencephalogram gave evidence of a suprasellar expansion of an intrasellar mass. Routine blood and endocrine studies yielded values within normal limits.
Radiation therapy (total of 4000 r) was delivered to the sellar region from December 4, 1961, to January 8, 1962.

There was no improvement in the patients' symptoms after the radiation therapy. He admitted to a mild loss of energy, decreased libido and potency, and increasing constipation. Repeated field examinations indicated an increasing bitemporal hemianopia.

On May 29, the patient was admitted to the Massachusetts Eye and Ear Infirmary. X rays showed the sella turcica to measure 18 mm in its anteroposterior dimension and the posterior clinoid processes to be decalcified. A neuromedical and endocrine evaluation revealed no changes since the previous hospital admission other than the increasing defects in the visual fields.

On June 1, a transethmoidosphenoidal hypophysectomy was performed from the right side. The fluid center of a dark-brown tumor was aspirated. The lesion was then removed, but its capsule was left in place. The dural incision was covered with a septal mucous membrane flap. This was covered with Gelfoam and packed in place with petrolatum-impregnated iodoform gauze. Cortisone therapy was given both pre- and postoperatively. The pathologic diagnosis was "chromophobe adenoma."

Examination of the visual fields made three days postoperatively showed no improvement. The subcuticular sutures were removed on the fourth postoperative day. The patient was discharged from the hospital on June 7, 1962. His visual fields were normal on June 15.

Comment. Cases III and IV demonstrate a rapid return to normal visual fields and relief of other symptoms produced by pituitary tumors. In both of the patients the septal mucosal flap was used to cover the defect in the posterior wall of the sphenoid sinus. The postoperative courses were short and benign.