As a general rule, surgical treatment is indicated for those patients with chronic sinusitis who do not respond to medical therapy. The advent of biochemotherapy and of a better understanding of sinus and intranasal physiology has been instrumental in a reduction of the frequency with which sinus surgery must be undertaken.

Routine indications for sinus surgery are:

1. Intracranial extension of infections such as meningitis, subdural abscess, or brain abscess.
2. Persistent pain and/or purulent discharge which has not been responded to conservative therapy.
3. Necrosis of the sinus wall as shown by fistula formation.
4. Mucocele or pyocele formation.
5. Orbital cellulitis or retrobulbar neuritis.
6. Venous sinus thrombosis.

The objective of surgical treatment of a sinus is either to (1) provide free and easy drainage from the sinus into the nose (while at the same time not interfering with intranasal physiology); or (2) eliminate the sinus (obliteration). Before resorting to any of the radical sinus procedures it is most often preferable to perform simple intranasal operations in order to establish better drainage. Such operations as submucous resection of the nasal septum, removal of nasal polyps, resection of the anterior half of the middle turbinate, intranasal antrostomy, and intranasal ethmoidectomy are often sufficient to effect a cure.

Complications of Sinus Disease

Orbital Manifestations of Sinus Disease

The paranasal sinuses might also be referred to as the paraorbital sinuses, for the orbit is surrounded (except laterally) by these sinuses. The first indication of sinus disease is often manifested by orbital symptoms.

Orbital Pain. Generalized headache is not a usual manifestation of sinus disease, whereas pain in or above the orbit is a common symptom of this malady.

Pain in the eye may be the presenting complaint in a patient with acute maxillary sinusitis. Orbital pain is a less common complaint associated with chronic maxillary sinusitis. Benign and malignant tumors which extend through the roof of the antrum may cause orbital pain.
Acute frontal sinusitis frequently produces orbital pain. Pain elicited by palpation of the floor of the frontal sinus just posterior to the medial aspect of the supraorbital rim is indicative of such infection. Orbital pain is increased if the infection extends into the orbit, either directly through the floor of the frontal sinus or by phlebitis. Chronic frontal sinusitis and benign and malignant tumors may, if they extend into or in the direction of the orbit, also produce orbital pain.

Orbital pain is an early manifestation of acute ethmoiditis. This is, of course, increased with the onset of orbital cellulitis or abscess. Chronic ethmoiditis does not usually produce orbital pain unless the disease extends in the direction of the orbit. Benign and malignant tumors of the ethmoid may produce orbital pain.

Acute and chronic sphenoiditis produce pain which the patient describes as being behind the eye(s). Extension of disease beyond the confines of the sphenoid sinus, whether the disease be inflammatory or neoplastic, may produce severe retrobulbar pain.

**Exophthalmos.** Exophthalmos is a protrusion of the eyeball from the orbit. It is usually a manifestation of a disease other than of sinus origin.

Acute and chronic maxillary sinusitis are rarely complicated by exophthalmos unless infection has extended by means of phlebitis into the retrobulbar space. Cystic lesions of the maxillary sinus include mucocele, dentigerous cyst, dermoid cyst, and cystadenoma. Any of these lesions may expand so as to destroy the roof of the antrum and extend into the orbit, thus producing exophthalmos. The pressure exerted in the direction of the orbit may also cause a ptosis of the upper lid which is produced by a restriction of elevation of the upper lid. Epiphora may accompany this proptosis. Diplopia results from the upward displacement of the orbital contents. On occasion, the lesion may be palpated posterior to the infraorbital rim. Malignant lesions of the maxillary sinus which occur high in the sinus will cause early destruction of the roof of the antrum and extend into the orbit, producing exophthalmos. Malignant lesions which have their origins elsewhere in the antrum may also extend into the orbit. In these cases the prognosis is poor because, as a rule, the disease has also spread in other directions such as through the posterior wall of the antrum into the pharyngomaxillary fossa. A fracture of the maxilla rarely produces exophthalmos, but exophthalmos does occur, however, in association with certain tripod fractures.

Acute and chronic ethmoiditis may produce exophthalmos as a result of extension of infection through the lamina papyracea. This will be discussed under the headings "Orbital Cellulitis and Abscess" and "Cavernous Sinus Thrombosis." Tumors of the ethmoid sinuses are not common. They extend in the direction of least resistance, which is the lamina papyracea, thus causing outward and lateral displacement of the orbital contents. The most common benign lesions of the ethmoid sinus are mucoceles, osteomas, papillomas, and fibromas. Primary carcinoma of the ethmoid is unusual. A fracture of the ethmoid labyrinth and lamina papyracea may cause a degree of proptosis following nose-blowing. The subcutaneous emphysema of the lids is indicative of fracture.

Acute or chronic frontal sinusitis may extend into the orbit by way of the floor of the frontal sinus with resultant cellulitis and orbital abscess attended with proptosis. Other diseases of a frontal sinus may penetrate through the orbital roof and cause displacement of
the orbital contents in an outward and downward direction. The upper lid may be involved in an inflammatory process, or a mass may be palpated between the upper lid and the supraorbital rim. The two most common tumors of the frontal sinus causing displacement of the orbital contents are mucocele and osteoma. The progression of downward and outward displacement of the orbital contents by either of these lesions can be very slow and insidious. The displacement can also have a rapid onset if the mucocele becomes infected (pyocele) or if the osteoma becomes complicated by acute frontal sinusitis. Other benign lesions and malignant lesions of the frontal sinuses are rare, but, when present, they also may produce exophthalmos by extension through the floor of the frontal sinus.

Acute and chronic sphenoiditis, cystic (mucocele) and solid benign tumors, and primary or secondary carcinomas of the sphenoid sinus may extend into the retrobulbar area and produce exophthalmos simply by occupying space or by interfering with the venous return from the orbit. These conditions are usually also accompanied by interference with the nerves and blood vessels entering the orbit as manifested by visual defects and extraocular muscular dysfunction. There have been numerous reports of metastatic lesions of the sphenoid sinuses with orbital complications. These malignant lesions may arise in the nasal cavity, nasopharynx, other sinuses, intracranial spaces (pituitary), and distant points, such as the bowel, or kidney.

**Enophthalmos.** Enophthalmos is a recession of the eyeball into the orbit. It may result from contracture following orbital cellulitis, orbital and sinus operations, orbital injuries, and fractures of the orbital walls.

The blow-out fracture is a relatively common cause of enophthalmos. This is a fracture of the floor of the orbit with prolapse of the orbital contents into the antrum. There may be also a fracture and medial displacement of the lamina papyracea with prolapse of the orbital contents into the ethmoid labyrinth. Varying degrees of interference with ocular motility may accompany these fractures when the extraocular muscles (especially inferior rectus and inferior oblique) are trapped between the bony fragments. This situation requires immediate surgical intervention.

Two cases of enophthalmos resulting from mucocele of the maxillary antrum have been reported (Montgomery, 1964). The pathogenesis is not absolutely clear. It is assumed that the mucocele expands, destroying the roof of the antrum by pressure, and that the enophthalmos occurs with subsequent rupture and partial evacuation of the mucocele.

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**Lid Swelling.** Inflammatory edema of the eyelids may occur with acute maxillary, ethmoid, or frontal sinusitis. This edema is soft with no point of tenderness or localization such as that found in acute meibomian gland infection. Ocular motility and vision are not affected. If the inflammatory process extends into the orbit from the sinuses, this inflammatory edema may become more severe as orbital cellulitis progresses. As a general rule, the upper lid is more swollen with frontal than with ethmoid or maxillary sinusitis. Both upper and lower lids are swollen with ethmoiditis, and the lower lid may be more swollen than the upper with extension of infection from the maxillary sinus.

**Mass in the Orbit.** A mass palpated in the orbit may be the first sign of sinus disease. A mass in the region of the infraorbital rim may represent extension of disease from the maxillary sinus. The most common diseases of the antrum producing a mass behind the infraorbital rim are carcinoma, mucocele, and osteoma of the maxillary sinus. A mass medial to the inner canthus may indicate a disease in the ethmoid sinuses, the most common being carcinoma, mucocele, and osteoma. A mass behind the supraorbital rim may indicate disease extending through the floor of the frontal sinus; the lesions most commonly responsible are mucocele, pyocele, osteoma, chronic inflammatory process, recurrent or persistent disease following the Lynch frontal sinus procedure (which entails removal of the floor of the frontal sinus), and carcinoma of the frontal sinus.

**Epiphora.** A prolonged inflammatory process of the nasal mucosa is said to cause epiphora, either by stenosis of the nasal lacrimal duct or by obstruction of the orifice in the inferior meatus. It is also within the realm of possibility that an inflammatory process could extend from the ethmoid sinuses to the lacrimal sac. Epiphora may also accompany exophthalmos of sinus origin.

**Orbital Cellulitis and Abscess.** An inflammatory process may extend from any of the paranasal sinuses into the orbit by direct extension through the bony wall or by way of the venous circulation. At first there is an inflammatory edema of the lid(s). As the disease progresses, there is exophthalmos, chemosis of the conjunctiva, and progressive immobility of the eye. There also may be some interference with the vision. At this point the patient is usually quite ill and has a high fever and severe pain. X rays of the sinuses should be taken to determine the origin of infection. Although the ethmoid sinus is most common the site of origin, the infection may stem from any of the other sinuses. Treatment should be vigorous because of the danger of extension of the infection into the intracranial spaces, producing such complications as meningitis and cavernous sinus thrombosis.

It is often difficult to determine whether or not an orbital abscess is present unless obvious fluctuation can be palpated. As a general rule, if the condition is not responding to intensive therapy, an exploratory operation should be performed in which the orbit is approached through a frontoethmoidectomy incision. The orbital periosteum is carefully elevated posteriorly, superiorly, and laterally. Since many orbital abscesses are extensions from a chronic ethmoiditis or acute exacerbation thereof, a point of breakthrough may be found in the lamina papyracea. In such cases, it is wise to perform an external ethmoidectomy.
simultaneously with exploration of the orbit and drainage of the orbital abscess. If an abscess is found, it should be drained for at least four days.

**Cavernous Sinus Thrombosis.** Cavernous sinus thrombosis can be a fatal disease, even when all modern therapeutic tools are utilized. It is sometimes difficult to differentiate between cavernous sinus thrombosis and orbital cellulitis or abscess. In addition to the signs for orbital cellulitis described above, a dilation of the retinal veins and edema of the optic disk may be found with cavernous sinus thrombosis. Intermittent rises of temperature to 104° or 105°F following a chill should make one suspicious of this complication. A blood culture and examination of the spinal fluid are indicated. The physician should be on the lookout for signs of meningitis.

**Involvement of Optic Nerve.** Approximately 15% of cases of retrobulbar neuritis are said to be caused by sinus disease. This is not surprising since the optic nerve may be in close relationship to the sphenoid, ethmoid, and maxillary sinuses, depending on their degree of pneumatization. The inflammatory process may spread directly through the sinus wall or by phlebitis. The loss of vision may be of sudden or gradual onset. The therapy consists in administration of antibiotics and specific surgery of the involved sinus. Benign and malignant tumors of the sinuses, as well as of the pituitary gland, can cause blindness or defects in the visual fields.

**Superior Orbital Fissure Syndrome.** The third, fourth, and sixth cranial nerves, the first division of the fifth cranial nerve, the ophthalmic vein, and sympathetic nerves from the cavernous plexus may become involved in disease of the sphenoid sinus. The lateral wall of this sinus, if well pneumatized, is in very close proximity to the superior orbital fissure. An acute or chronic inflammatory process may extend from the sphenoid sinus to this region. Cystic lesions, such as a mucocele or a craniopharyngioma, benign neoplasms, and primary or secondary malignant disease of the sphenoid sinus may be complicated by a superior orbital fissure syndrome. Any or all of the structures passing through the superior orbital fissure may be affected by the disease processes. The sixth cranial nerve is usually implicated first, with subsequent involvement of the third, fourth, and fifth nerves. As the disease progresses the fifth cranial nerve is affected, as manifested by pain in the eye and forehead. This is followed by exophthalmos and, finally, total ophthalmoplegia. X rays of the sinuses should include laminography of the sphenoid sinuses. Treatment consists in immediate exploration by means of the transethmoid approach to the sphenoid sinus.

**Osteomyelitis of the Frontal Bone**

**Etiology.** In the great majority of the reported cases of osteomyelitis of the frontal bone the organism recovered is the Staphylococcus aureus. The streptococcus, pneumococcus, and anaerobic streptococcus are found in a few instances. The degree of involvement depends to a certain extent upon the virulence of the organism and the resistance of immunity of the patient to the particular bacteria present.

In children the origin of osteomyelitis of the frontal bone is almost always hematogenous; in adults the disease is more likely to result from trauma during an episode of acute frontal sinusitis. The majority of the patients are under 30 years of age. The disease
is more common in females than in males and in many instances follows swimming. Chronic infection of the sinuses, especially an acute exacerbation of the infection, may predispose to osteomyelitis. Trauma in the region of the frontal sinus or an operation upon the frontal sinus frequently precedes the advent of the osteomyelitis.

**Symptoms.** The clinical course may be acute or chronic.

In the acute fulminating type, fever, headache, and edema of the upper eyelid on the affected side are present. The soft, doughy swelling (Pott's puffy tumor) or pericranial abscess is pathognomonic of osteomyelitis of the underlying bone. This type frequently follows swimming. Spread to the intracranial structures is not unusual. As a rule, however, osteomyelitis is a slowly progressive disease, even in the acute stage.

The chronic localized form of frontal bone osteomyelitis, without perforation of the internal table, is usually characterized by an insidious onset, a low-grade fever, local pain or tenderness, doughy swelling of the forehead, general malaise, and, occasionally, chills. Fistulas may form, and sequestra may separate from the bone during cyclic exacerbations.

**Diagnosis.** The diagnosis is made by means of roentgenogram combined with the signs and symptoms of fluctuating swellings, advancing edema, persistent low-grade temperature, leukocytosis, and pain and headache with cyclic exacerbation.

According to Mosher and Judd, the edema of the soft tissue of the forehead is the first sign of infection of the periosteum and the medulla of the frontal bone. This edema, in the past, was a practical guide to the extent of bone to be removed. X rays do not show positive change until necrosis is present and this is not apparent until 7 to 10 days after forehead edema appears. If antibiotics have been administered the clinical correlation just described does not hold true, for the edema of the forehead is no longer an index of the degree of osteomyelitis and, in fact, may not be present.

**Treatment.** Antibiotics, selected in accordance with bacteriologic sensitivity tests, should be given intravenously in large doses. Any localized abscess should be drained. If x rays show that the frontal sinus(es) contains pus, a trephine operation of the frontal sinus(es) should be carried out, both for inspection of the interior of the sinus(es) and to obtain purulent secretions for culture and antibiotic sensitivity tests. Usually the antibiotic of choice is penicillin. This should be administered intravenously and local therapy, such as application of heat, nasal spray, and systemic decongestants, should be instituted.

If there is not rapid reversal of the osteomyelitic process or if there is any question regarding involvement of the posterior wall of the frontal sinus, surgical intervention in the early course of therapy is indicated. If, on the other hand, the patient continues to show improvement, manifested both clinically and radiologically, the antibiotic therapy is continued for approximately 10 days.

After the osteomyelitis has been controlled by surgical drainage and antibiotic therapy, attention should then be directed more specifically to the frontal sinuses. If there is any question of persistent or chronic frontal sinusitis, a bilateral osteoplastic adipose obliteration operation should be carried out. A more conservative approach is contraindicated, for a
complication such as an extradural abscess could subsequently result. At the time of the osteoplastic operation any diseased bone is removed, and the sinus(es) is obliterated by insertion of subcutaneous abdominal adipose tissue. Antibiotic therapy is continued for at least 10 days following this operation.

The radical procedures which were most often necessary in the past for the treatment of osteomyelitis of the frontal bone are, for the most part, no longer necessary, if the proper antibiotics are administered in adequate doses. The operations advocated by Mosher and Judd are now procedures of the past.

On occasion it is necessary to remove a portion of devitalized bone. The resulting defect can be repaired by using an autogenous osseous autograft or a plastic implant. Since regeneration of bone is often a very slow process, this reconstructive procedure should not be attempted for many months following removal of the devitalized bone.

### Osteomyelitis of the Superior Maxilla

Acute osteomyelitis of the superior maxilla is usually secondary to an infection of dental origin. In infants, it is occasionally secondary to a buccal infection. Involvement of the dental sac follows with extension of the necrotic process to the walls of the maxillary antrum, resulting in a purulent discharge into the nose and mouth. Lederer believes that the associated acute osteomyelitis is a result of the venous infection. He bases his opinion upon carefully studied serial sections from an infant in whom a nasal infection and sinusitis were found to be the primary cause of the osteomyelitis of the maxilla.

Osteomyelitis of the maxilla in nurslings and infants may occur from the first week following birth up to the ninth month. The highest incidence is during the first three weeks. The portal of entry and the manner of spreading of the primary infection may vary.

As shown by Lederer a sinusitis may produce a periostitis and osteitis with a fistulous tract formation which extends in any one of three ways: (1) to the facial surface with swelling of the soft parts of the cheek, breaking down of Bichat’s pad, and abscess formation; (2) to the palatine and alveolar process with a fistula into the roof of the mouth; (3) to the zygomatic process with a necrosis of the zygomatic arch and extension into the pterygoid fossa with abscess formation. Extension along the fascial planes to the mandibular foramen may occur. An ethmoiditis may result in a periostitis, osteitis, and periorbital cellulitis which may extend in one or both of two ways: (1) thrombophlebitis of the venous channels, with extension to the cavernous sinus and the production of a thrombosis; (2) a periorbital abscess, with an occasional complicating external fistula.

**Symptoms.** The signs and symptoms are those of a sinusitis accompanied by marked swelling and chemosis of the cheek. Exophthalmos with limitation of movement of the eye may be present.

The first or septicemic stage may last for about 10 days with the formation of fistulas in the infraorbital regions, palate, and, in rare instances, into the nose. This is followed by a chronic indolent stage with persistent fistulas and sequestration of dead bone. This second
stage is not seen if antibiotics, proper drainage, and local therapy are instituted early in the course of the disease.

**Treatment.** Treatment consists of administration of large doses of specific antibiotics, surgical establishment of free drainage, and local application of heat. On occasion there is considerable loss of bone from osteomyelitis of the superior maxilla and a resultant large oroantral fistula, which can be repaired by using the various techniques outlined in Chapter 6.

**Osteomyelitis of the Sphenoid Bone**

Osteomyelitis of the sphenoid bone is quite rare. Many of the reported cases have been associated with osteomyelitis of the base of the skull or secondary to an infection of the petrous portion of the temporal bone. Eagleton attributes the rarity of infection of the base of the sphenoid to the preponderance of red cellular bone marrow found throughout life in this bone.

The organisms usually recovered are beta hemolytic streptococcus and Staphylococcus aureus. The early symptoms consist in a rather profuse postnasal discharge and a deep-seated headache either described as being in the center of the head or behind the eyes, which on occasion radiates to the temporal or occipital regions. Infection may spread laterally to the retrobulbar region, producing any of the various manifestations described in this chapter under the heading "Superior Orbital Fissure Syndrome."

Later, as the body of the sphenoid becomes more extensively invaded, symptoms of sepsis ensue, although the temperature may be low and the toxemia not marked. The retroorbital and temporal pain becomes especially severe. There may be, at this time, bacterial invasion of the meninges and blood stream. Cavernous sinus thrombosis, brain abscess, encephalitis, and intercranial hemorrhage may result.

**Treatment.** Osteomyelitis of the sphenoid bone is frequently not diagnosed until severe complications, which can be fatal, have developed. Careful x-ray examination of the sphenoid bone, including laminography, is imperative. The patient should also be followed closely by an ophthalmologist and neurologist. Treatment is essentially that of antibiotic therapy and surgical drainage.

**Intracranial Complications of Sinus Disease**

The modern otolaryngologist should be constantly on the lookout for intracranial complications of sinus disease. Most of these complications are readily apparent by their clinical manifestations. On the other hand, others have a slow, insidious onset which makes the diagnosis quite difficult.

The possible intracranial complications from disease of the nasal passages and sinuses are meningitis, extradural and subdural abscess, dural fistula, the various types of brain abscesses, and septic thrombosis of the cavernous or superior longitudinal sinus (the other venous sinuses are rarely involved in infections of the nasal sinuses). Meningitis which has its origin from sinusitis is more frequently observed than thrombosis of the venous sinuses.
Intracranial complications are more apt to result from acute infections of the sinuses than from chronic infections. These complications are more common in males than in females (4 to 1).

All infected sinuses may give rise to an intracranial complication, but an extension from a maxillary sinusitis is rare. Courville and Rosenvold state that a maxillary sinusitis of dental origin is more apt to provoke intracranial suppurative lesions than is maxillary sinusitis of any other type.

Infections from the nose or sinuses may invade the intracranial structures (1) after trauma; (2) through congenital dehiscences or nonclosure of fetal defects; (3) by a direct pathway through the sinus wall; (4) along the sheaths of the olfactory nerves; (5) by way of the communicating veins; (6) by means of septic thrombi along the diploetic veins with a retrograde thrombophlebitis or peripheritis to the cavernous sinus; (7) by way of the angular or ethmoid veins to the cavernous sinus; or (8) by way of the orbit. There has been some question as to the possibility of a direct extension of an infection of the sinuses to the intracranial structures by way of the lymphatic vessels.

Temporal lobe abscesses most commonly originate from infection in the temporal bone and lateral dural sinus. A temporal lobe abscess can originate from the sphenoid sinus or indirectly from the other sinuses by way of the cavernous sinus. Frontal lobe abscesses may complicate acute or chronic frontal sinusitis or tumors of the frontal sinus (such as osteoma), following surgical treatment of frontal or ethmoid sinus or trauma to the forehead.

**Frontal Sinus Pneumocele**

A pneumocele (pneumatocoele) is a collection of air, under pressure, in the tissues. The air usually escapes from a defect in the bony wall of the frontal sinus and collects adjacent to the sinus. If the defect is on the forehead, an external pneumocele results. If the defect is in the posterior wall of the frontal sinus, an internal or intracranial pneumocele is present.

A pneumocele may follow fracture, trauma, operation, congenital cleft, dehiscence, or necrosis of the bone. The latter may be due to syphilis, osteomyelitis, or sinusitis. Cases have been reported as secondary to, or associated with, an osteoma of the frontal sinus.

The sinus mucous membrane or frontal periosteum is intact over the bony defect, so that a ballooning of the mucosa or periosteum occurs; this forms an air sac when under pressure from blowing the nose, coughing, or sneezing. A pneumocele may occur in connection with a mucocele of the frontal sinus if air takes the place of the fluid contents and there is a connection from the nasal cavity to a defect in the mucocele.

In addition to the external and internal pneumoceles, a third type, characterized by an excessive dilation of the sinus (pneumosinus dilatans), may occur. Dilation of the sinus is usually associated with acromegaly or localized osteitis, or follows fractures in the region of the sinuses. Enlargement of the sinus is more apt to result if the bone changes occur before the sinuses are fully developed. Any of the sinuses may be involved on one or both sides. The exact mechanism by which the dilation occurs is not understood.