Chapter 54: Surgical Management of Infectious and Inflammatory Disease

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History

Acute sinusitis

Acute sinusitis may occur without previous sinus disease or as an intensificiation in the course of chronic sinusitis.

In the previously normal patient, acute sinusitis is characterized by accentuation of an illness that begins as a viral upper respiratory infection (URI) or acute allergic hypersensitivity. In this form the patient will typically indicate a prolongation and worsening of the symptoms of URI or allergy that have gone beyond the usual 5- to 7-day time course. Headache or facial pain is a common complaint. Additional symptoms inclue nasal congestion, postnasal drainage, fatigue, and sometimes dysequilibrium.

Chronic sinusitis

Chronic sinusitis may be arbitrarily defined as an infection lasting at least 4 weeks and accompanied by the appropriate symptoms, radiographic changes, and physical findings. Cheek pressure and periorbital pressure are the most common symptoms but are less prominent than in acute sinusitis. The most common systemic symptom is fatigue, whereas fever and myalgia are uncommon. The patient will often complain of thick postnasal discharge. Another common presentation of chronic sinusitis is that of recurrent acute sinusitis with seemingly normal or near-normal periods in between but of relatively short duration.

In the course of the initial evaluation, it is imperative to evaluate the possible contributing role of other factors. One should (1) question the patient carefully about the possibility of inhalant allergies, either seasonal or perennial; (2) determine if the patient smokes tobacco or works in an environment where there is exposure to noxious agents; (3) question the patient about the possible use of recreational drugs, in particular cocaine; (4) determine if the patient has been using nasal sprays or other self-medications. Any of these contributing factors will require additional management maneuvers.

Physical Examination

Acute sinusitis

The patient with acute sinusitis may often demonstrate little in the way of obvious clinical findings. The presence of sinus tenderness is of assistance in the examination, but its absence does not rule out sinusitis. Likewise, purulent discharge from the middle or superior meatus assists in the diagnosis, but its absence is common in an acutely obstructed sinus. Application of topical nasal decongestant will allow marked improvement in visualization of the middle meatus, where inflamed mucosa, mucopurulent debris, and anatomic obstructions including polyps may be recognized. The examiner should additionally observe the nasal septum for evidence of physical obstruction of the involved drainage pathway.

Chronic sinusitis

In the most common situation, the history will generally be that of an acute process that fails to resolve completely but rather continues to smolder. The second most common presentation as mentioned is that of recurrent episoes of acute sinusitis separated by a few weeks or a few months of seemingly normal nasal and sinus function. In either case the patient will often complain of low-grade facial and periorbital pain and pressure. Tenderness over the involved sinuses is usually not prominent, particularly in the absence of a complication. Anterior rhinoscopy may well be normal but more commonly reveals erythematous, edematous nasal mucosa. There will generally be a modest postnasal drainage. Nasal endoscopy will virtually invariably reveal abnormalities in the middle meatus. One may see marked swelling, purulent discharge from the anterior ethmoid sinuses, or small polyps in the middle meatus. Purulent discharge from the other sinuses may also be evident depending on the degree of swelling in the middle meatus and the extent of the disease.

Imaging

When the clinical diagnosis of acute sinusitis is obvious no imaging studies are necessary unless a complication is apparent or is of concern to the clinician. Imaging may begin with transillumination, which unfortunately is often misleading because of the anatomic variability of the sinuses. It may, however, be helpful in conjunction with x-ray films or computed tomography (CT) scans as a tool for follow-up in the evolution of acute sinusitis. Standard four-view radiographs may demonstrate air-fluid levels or opacification of the sinuses but provide no information to influence the selection of treatment in the typical patient with acute sinusitis. Computerized axial tomography (CAT) provides a dramatic improvement in visualization of the sinus anatomy in both acute and chronic situations. In the instance of acute disease the only indication for CT scan is when a complication is considered or in the instance of planned surgical drainage for severe acute disease. CT scan without contrast is the current imaging method of choice for chronic sinusitis. When an intracranial complication is of concern, the CT scan should be ordered with coronal and axial views and with intravenous contrast. Magnetic resonance imaging (MRI) provides excellent detail of soft tissue changes in the sinuses and adjacent structures but may be overly sensitive to mucosal changes. It is not a first-line modality even in the management of complicated acute sinusitis in light of the substantial expense and patient discomfort involved.

Laboratory Studies

In the typical case of acute sinusitis it is usually necessary to obtain laboratory studies. In particular, cultures from the nasopharynx or middle meatus are generally inaccurate and unnecessary. The microbiology of acute sinusitis is well documented, and selection of appropriate treatment in the usual instance may be guided by this information and the expense of a culture avoided. Studies of blood samples are unnecessary unless the patient has a history of additional medical problems such as diabetes or an immune disorder or if history and physical examination suggest that the patient has an atypical form of acute or chronic sinusitis (see below).

Spectrum of Disorers

Infection

Acute sinusitis

Viral infection. Approximately 50% of acute sinus infections are negative for culture and presumably are viral in etiology. However, the initial viral infection may become secondarily involved with respiratory pathogens.

Bacterial infection. The range of bacteria involved in acute sinusitis includes the typical respiratory pathogens: *Streptococcus pyogenes, Streptococcus pneumoniae, Staphylococcus aureus,* and *Haemophilus influenzae.* This group of pathogens is effectively treated with amoxicillin or, in the penicillin-allergic patient, with sulfaisoxazole or a second-generation cephalosporin.

Fungal infection. Acute sinusitis in the diabetic or immunocompromised patient may be a manifestation of mucormycosis. In the setting of an immunocompromised host the presence of black or necrotic debris in the nasal vault should initiate consideration of rhinocerebral mucormycosis. In this instance a tissue specimen for microscopic examination should be obtained (cultures are positive in only 20% of cases). The identification of nonseptate hyphae indicates the presence of mucormycosis. The pathogenesis of this infection involves direct invasion of blood vessels and progressive avascular necrosis of tissue, which causes local hypoxia and acidosis and favors further fungal proliferation. When this disease is being considered, complete evaluation with imaging using CT and possibly MRI is appropriate since invasion of the orbit and subsequently the brain is common. Management is centered around systemic antifungal agents, control of the underlying cause of acidosis, and urgent surgical intervention with resection of all involved tissues. This may include resection of the skull base or the orbital contents in an effort to contain the progression of this fulminant disease. Hyperbaric oxygen has also been used in some centers with promising results.

Chronic sinusitis

The bacteriology of chronic sinusitis is quite different from that of acute sinusitis. Numerous studies in the past few decades have shown that anaerobic bacteria are of significance in chronic sinusitis. This was first convincingly demonstrated by Frederic and Braude (1974). Earlier investigators had hinted at this problem, but these studies were done when anaerobic cultures were less reliable (Urdal and Berdal, 1949). It is now well established that cultures of purulent material within the nasal cavity are unreliable with only a 50% correlation with cultures taken directly from the involved sinus. In general, the predominant anaerobes are the streptococci and *Bacteroides* species. The most common aerobes in this setting are streptococci, *Staphylococcus aureus,* and *Haemophilus influenzae.* The most common fungal disease in the otherwise healthy patient is aspergillosis, which may be manifest as a contaminant or as an allergic fungal sinusitis but rarely as an invasive organism.

Immunologic sinusitis

Allergic sinusitis. One of the most common presentations of acute sinusitis occurs during an acute allergic episode and is characterized by fever, headache, and postnasal discharge. In this setting, physical examination will reveal marked nasal congestion with edematous nasal mucosa and watery nasal discharge. A clinical diagnosis of sinusitis may be entertained when allergic symptoms have intensified, have lasted beyond 7 to 10 days, and have failed to respond to management with systemic antihistamines and topical nasal decongestants. In this setting the use of systemic glucocorticoids is often dramatic in effecting resolution of the symptoms. Prednisone, 20 mg daily for 5 days and then 10 mg daily for 5 days, in conjunction with standard antibiotics (amoxicillin or sulfaisoxazole) will often be effective. In both acute nonallergic sinusitis and acute allergic sinusitis a treatment duration of 3 to 4 weeks is often necessary. One of the most common causes of failed treatment for acute sinusitis is an inadequate period of antibiotic management.

Autoimmune and neoplastic disease. On rare occasion, acute sinusitis may be the presenting symptom of systemic disease. When acute sinusitis fails to respond to standard management, acute systemic disorders including Wegener's granulomatosis, lymphoproliferative disorders, immune deficiency, and neoplastic obstruction must be considered. In this setting, evaluation would include complete blood count, sedimentation rate, fasting blood sugar, consideration of an HIV titer, and antineutrophil cytoplasmic antibody titer. Additionally, if the sinusitis is unilateral, careful evaluation of the osteomeatal complex and biopsy of any abnormal granulation tissue or mucosa will assist in establishing the diagnosis of obstructing neoplasm. In this setting an early evaluation with CT scan is appropriate.

Wegener's granulomatosis

Wegener's granulomatosis is a systemic necrotizing vasculitis that manifests primarily in the upper respiratory tract, the lower respiratory tract, and the kidneys. Its cause is unknown, but it is thought to involve a hypersensitivity reaction, perhaps to unknown inhaled antigens. The disease typically produces slowly progressive ulceration and destruction of the nose and paranasal sinuses, pulmonary granulomas and vasculitis, and focal segmental glomerulonephritis with rapidly progressing renal failure. Ninety to ninety-five percent of patients present with signs and symptoms of respiratory tract involvement (Wyngaarden and Smith, 1988). These include increasing nasal obstruction, purulent nasal discharge, cough, sinus pain, hemoptysis, nasal mucosal ulceration, and saddle-nose deformity. Constitutional symptoms, including weakness, malaise, arthralgia, weight loss, and fever, are almost always present. Examination typically reveals an ill-appearing patient with diffuse, bilateral mucosal destruction. Removal of large, thick crusts typically exposes friable nasal mucosa and septal perforation. Ocular involvement occurs in 60% of patients (Wyngaarden and Smith, 1988) and can range from a mild conjunctivitis to scleritis, uveitis, dacrocystitis, proptosis, retinal vasculitis, optic nerve vasculitis, and blindness. Otologic involvement can include unilateral serous otitis media and a conductive hearing loss, suppurative otitis media with thickened or perforated tympanic membrane, bilateral sensorineural hearing loss, and a red, swollen, tender pinna (Govett and Amedee, 1990). Laryngotracheal involvement commonly includes the subglottis and trachea, presenting with hoarseness, stridor, dyspnea, and sore throat (Govett and Amedee, 1990). Early oral lesions involve the gingiva and may progress to involve the

periodontium with resulting loss of teeth.

Definitive diagnosis is established if there is a clinical disease in two of the three usually involved systems (upper respiratory tract, lower respiratory tract, and kidneys). Tissue biopsy should show disease in at least one of the two clinically affected systems, with lung tissue providing the highest diagnostic yield (Wyngaarden and Smith, 1988). Chest x-ray findings include nodular infiltrates and may be present in asymptomatic individuals. Laboratory abnormalities include an elevated erythrocyte sedimentation rate (ESR), a positive test for rheumatoid factor, anemia, and neutrophil leukocytosis in addition to an elevated antineutrophil cytoplasmic antibody titer.

Wegener's granulomatosis must be distinguished from other disorders that produce destructive lesions of the facial midline, including polymorphic reticulosis, idiopathic midline destructive disease, and nasal lymphoma. This differential diagnosis is fully discussed in the following section on midline granuloma. Other diseases to be considered in the differential diagnosis of Wegener's granulomatosis include Goodpasture's syndrome, sarcoidosis, and chronic infectious disease. Goodpasture's syndrome can mimic the clinical picture of Wegener's granulomatosis in the lungs and kidneys but has no upper respiratory involvement. Sarcoidosis can cause nasal obstruction, crusting, and discharge, but lesions are not necrotic. Infectious agents such as tuberculosis, syphilis, *Coccidioides*, and *Sporothrix schenckii* can mimic Wegener's clinically and hence must be ruled out with tissue stains and culture for AFB and fungi, PPD placement, and VDRL.

The treatment of choice for Wegener's granulomatosis is cytotoxic agents combined corticosteroids (Andrassy and Rasmussen, 1989). Cyclophosphamide has emerged as the treatment of choice although controlled clinical trials have not been performed (Fauci et al, 1983). Cyclophosphamide is typically continued for 1 year after remission is obtained; Fauci et al recommend that the criterior for remission be a stable, normal ESR. The use of oral corticosteroids is advised in fulminant cases although the details of drug administration, for example, dose and schedule, are controversial. Typically, the corticosteroids are tapered off once fulminant disease is stabilized. In one case study (Locht and Lindstrom, 1989) plasmapheresis and oral trimethoprim-sulamethoxazole were used as adjunctive therapy in a patient refractory to cyclophosphamide and corticosteroids alone.

Patients who have been treated for Wegener's granulomatosis must be monitored carefully for clinical signs of relapse. One prospective study (Tervaert et al, 1990) recommends using antineutrophil cytoplasmic antibody titers as a way to monitor relapse.

The prognosis for patients with Wegener's granulomatosis has improved from a 93% mortality rate at 2 years if untreated (Walton, 1958) to remissions in 90% of patients who have an early iagnosis and prompt treatment with cyclophosphamide and corticosteroids (Govett and Amedee, 1990).

Midline granuloma

The term *midline granuloma* is generic and refers to a group of disorders that produce destructive lesions of the midline of the head and neck. A review of the literature quickly reveals a set of confused, redundant terminology and a lack of consensus on the classification

and diagnosis of the individual disorders that make up "midline granuloma". This is due, in part, to the fact that diagnostic technologies such as immunohistochemistry and molecular cytogenetic studies have only recently become available to sort out the many similar disorders.

Table 54-1 provides a comparison between the following four disorders: idiopathic midline destructive disease, Wegener's granulomatosis, polymorphic reticulosis, and nasal lymphoma. Despite the "neatness" of Table 54-1, it is important to regognize that there is debate about many aspects of the classification scheme as shown. For example, the entire subject of hematopoietic neoplasms that present as midline destructive lesions is an area of intense research and debate (O'Connor and Robinson, 1987; Pickens and Modica, 1989). There is also debate as to whether lymphomatoid granulomatosis is the same disease as polymorphic reticulosis since they are identical histologically or whether they are different since the former tends to spare the upper airway; apparently most investigators believe they are the same disease (Costa and Delacretas, 1986; O'Connor and Robinson, 1987; Pickens and Modica, 1989). Treatment for the non-Wegener's midline destructive diseases is primarily based on radiation supplemented with chemotherapy if systemic disease is indicated. Idiopathic midline destructive disease is by definition localized and will require only high-dose local irradiation. Polymorphic reticulosis and nasal lymphoma may be part of a broader systemic disorder, in which case chemotherapy assumes a more significant role in the management.

There are several other disorders that can present with crusting, ulcerative lesions of the upper respiratory tract such as infectious agents including *Staphylococcus, Streptococcus, Leishmania,* tuberculosis, syphilis, leprosy, actinomycosis, blastomycosis, candidiasis, rhinosporidosis, histoplasmosis, cryptococcosis, and mucormycosis (O'Connor and Robinson, 1987). The workup for destructive midline lesions must therefore include appropriate cultures and stains of biopsy tissue for fungal agents, acid-fast bacillus (AFB), and bacteria. Also indicated is placement of a PPD and VDRL serology. In addition, it is important to keep in mind that superinfections may complicate any of the diseases previously discussed as "midline granuloma". Other diseases in the differential diagnosis include necrotizing sialometaplasia (O'Connor and Robinson, 1987), sarcoidosis, ulcerative squamous cell carcinoma, and pyogenic granuloma; these can be distinguished on the basis of microscopic tissue examination.

Intensive care unit sinusitis

The otolaryngologist - head and neck surgeon may be consulted in the ICU when a patient is evaluated for a fever of unknown origin and the CT scan demonstrates opacified paranasal sinuses. Often the patient has multiple potential sources for sepsis, in particular pulmonary infection, venous access sites, or sites of previous surgery or trauma. In this setting isolation of sinusitis as a cause of sepsis is difficult. Physical examination may reveal purulent drainage from the nose that should be cultured, but often this finding is not evident. When the maxillary sinuses are opacified, it is reasonable to perform a canine fossa puncture; the aspirate may be processed with Gram stain and culture. The nasal mucosa should be aggressively decongested using oxymetazoline spray for 15 to 20 minutes before aspiration and the canine fossa anesthetized with injected lidocaine (Xylocaine). A 14- or 16-gauge needle is used to penetrate the canine fossa, and the antral contents may be aspirated for

Gram stain and culture. The sinus is then irrigated with sterile saline solution in an attempt to clear the osteomeatal obstruction. Frequently these patients are intubated with nasotracheal or nasogastric tubes. If purulent sinusitis is identified, the tubes should be converted to the oral route, allowing improved management of the nasal mucosa. The finding of an opacified sinus in conjunction with the presence of a transnasal tube is extremely common in the ICU and does not constitute a need for intervention unless infection is demonstrated. The diagnosis of ICU sinusitis should be reserved until Gram stain and culture results clearly demonstrate an organism that is consistent with the organism identified by blood culture as the source of the septic picture. In our experience it is common for the sinuses to be opacified in the ICU but uncommon for there to be a direct correlation between culture material from the sinus and from the blood. Far more frequently these patients have sepsis from a pulmonary or an intraabdominal source. When sinusitis is the source of sepsis the organism is usually nosocomial (polymicrobial and often gram-negative organisms). The other factor complicating decision making in this condition is the presence of pansinus opacification. In this setting selection of an appropriate sinus drainage procedure is a significant clinical challenge. In most instances repeat irrigation of the maxillary sinuses, nasal decongestion, removal of tubes, and the use of IV antibiotics will bring resolution. On rare occasions an isolated sinus may appear to be the source of sepsis and direct surgical drainage appropriate to that sinus may effect clinical improvement.

Management

Acute sinus infection

Acute maxillary sinusitis

Infant. A variant of acute maxillary sinusitis may occur in the neonatal period. In this setting an acute facial cellulitis occurs with progressive erythema, swelling, tenderness, and edema in the region of the cheek and eyelid. The infection is typically *Staphylococcus aureus* and may be related to an infected maternal nipple. Treatment is based on aggressive antibiotic therapy and consideration of incision and drainage via the canine fossa. The infection can progress to an osteomyelitis of the facial bones and must be treated with extreme respect.

Adult. Acute maxillary sinusitis in the adult usually occurs as a progression from upper respiratory infection or exacerbation of allergic rhinitis. The symptoms of severe pain and pressure may be experienced in the cheek, the teeth, or the eye. As mentioned previously, physical examination may otherwise be unremarkable. Treatment includes maximal decongestion of the nasal mucosa using topical agents and antimicrobial therapy. Sinus irrigation is contraindicated since the meatus is usually obstructed and penetration of the canine fossa or the lateral nasal wall may initiate spread of the disease into the perifacial soft tissues. However, if after a 7- to 10-day trial of appropriate antibacterials the patient continues to have severe symptoms, a drainage procedure is appropriate. Sinus irrigation should be attempted and may reconstitute adequate drainage. If irrigation fails, an anterior ethmoidectomy and middle meatus antrostomy or an interior meatus antrostomy provide substantial improvement.

Acute ethmoiditis

The vast majority of sinusitis begins as an acute anterior ethmoiditis that responds to antimicrobial therapy. Acute ethmoid sinusitis does not require drainage unless a complication evolves. (See discussion of orbital cellulitis and orbital abscess.)

Acute frontal sinusitis

The hallmark of acute frontal sinusitis is severe supraorbital or retroorbital pain during the course of an acute sinus infection. This illness may be fulminant and appears to be particularly common in young patients. There may be an antecedent history of swimming and diving without a significant history of acute sinusitis. The history can be brief (24 to 48 hours). The physical examination may indicate puffiness and tenderness in the supraorbital region of the involved sinus but may be quite unrevealing. Intranasal examination may or may not demonstrate erythema and/or purulent discharge in the middle meatus. In the patient with significant frontal headache, consideration of CT scan with contrast may be appropriate, since it is not uncommon for acute frontal sinusitis to proceed to epidural abscess rapidly during the course of the infection. These patients must be hospitalized and given high-dose intravenous antibiotics to cover respiratory pathogens, including *Staphylococcus aureus.* The nasal passage should be actively decongested with topical spray used frequently and the patient closely observed for neurologic changes. A decision regarding surgical drainage must be considered at the outset and may be performed with the patient under local or general anesthesia. Before undertaking trephination, a CT scan is appropriate. The frontal trephination operation provides good access to the frontal sinus with an uncomplicated route. After removing the floor of the medial aspect of the sinus with a drill, purulent material is aspirated and cultured and a thin Silastic tube left in place for the purposes of irrigation. Gentle irrigation is carried out on a daily basis for 5 days or until drainage is obvious through the nasal frontal duct into the nasal passage. If the CT scan appears favorable, intranasal endoscopic ethmoidectomy is an alternative procedure where removal of the anterior ethmoidal cells and decompression of the nasal frontal duct may provide not only acute drainage but also correction of the anatomic abnormality that may have precipitated frontal sinusitis (Kennedy and Zinreich, 1982). This operation is difficult in the presence of acutely inflamed tissue, and it should only be performed by an individual with substantial prior experience in endoscopic techniques. A secondary ethmoidectomy after resolution of the acute frontal sinusitis is an equally appropriate alternative.

Acute sphenoid sinusitis

In contrast to the majority of other acute sinus infections, acute sphenoid sinusitis is often an infection with *Staphylococcus aureus*. The presenting symptoms are typically headache and retroorbital pain. There may be additional symptoms indicating inflammatory involvement of cranial nerves II through VI. The most difficult aspect of acute sphenoid sinusitis is making the initial diagnosis. The otolaryngologist may see these patients acutely but also may often be asked to see the patient after the illness has evolved to one of the significant intracranial complications. The patient should be evaluated with drect coronal CT scan, preferably with contrast. Numerous unusual lesions may masquerade as sphenoid sinusitis. In particular, vascular anomalies or lesions involving the cavernous sinus and internal carotid artery must be consiered (Holt et al, 1984). In the uncomplicated instance

once the diagnosis is established, the patient should be hospitalized and given IV antibiotics including coverage for *Staphylococcus aureus.* After 24 to 48 hours if substantial resolution of pain and systemic illness is not achieve, the sphenoid sinus should be drained. Sphenoidotomy may be accomplished directly through the nasal passage, through the ethmoid labyrinth, or via transeptal sphenoidotomy. If transnasal and transsinus routes are not feasible, an external ethmoidectomy will allow direct access to the sphenoid.

Chronic sinusitis

On the initial evaluation of the patient with chronic sinusitis it may be difficult to determine the exact cause of the persistence of the infection. It may be merely a matter of incomplete treatment with an appropriate antibiotic. There may be actual physical obstruction to the sinus outflow, making resolution difficult or impossible. Physical obstructions may vary from edematous mucosa obstructing a sinus, to chronic scar tissue obstructing a sinus, to sinus ostia of inadequate size, to obstruction by septal deflections or turbinate abnormalities such as a concha bullosa or a paradoxically bent middle turbinate. Less frequent causes of obstruction leading to chronic sinusitis include the following: mucoceles, osteomas, prior facial trauma, ciliary dysfunction, and cystic fibrosis. Of increasing importance in this setting are patients with previously unrecognized IgG subclass deficiencies or other relatively mild immunologic deficiencies. IgA deficiencies may also lead to chronic sinusitis.

Patients with severe immunologic deficiencies are generally recognized in childhood. Acquired immune deficiencies generally occur in patients who are immunosuppressed on a pharmacologic basis for treatment of another more serious disease. In the patient who fails to respond to adequate treatment and who seems to have no other abnormalities one should consider AIDS. Primary ciliary deficiencies are generally recognized in childhood and are readily apparent.

If the basis of the chronic sinusitis appears to be inadequate initial treatment, one should consider a prolonged course of a high dose of a broad-spectrum antibiotic that covers anaerobic organisms and *Staphylococcus aureus* as well. This may require that the patient take a significant dose for as long as 4 weeks but often will bring resolution. Potential choices of antibiotics include amoxicillin plus clavulanic acid, or Ceficlor with Flagyl. Additional agents such as antihistamines, decongestants, and steroids are frequently used but are not scientifically established as effective.

Chronic maxillary sinusitis

Should prolonged antibiotics fail to resolve the problem, invasive maneuvers will be needed. Irrigation of the maxillary sinus may serve two purposes: a culture can be obtained directly from the sinus while the sinus is irrigated free of the purulent material within it. There are few contraindications to maxillary sinus irrigation. A canine fossa puncture should not be done in a child with unerupted teeth. An intranasal puncture should be undertaken with some discretion in patients with bleeding disorders or who have been taking significant doses of aspirin or other nonsteroidal antiinflammatory drugs. A canine fossa puncture in an adult may be done very readily in the office with minimum morbidity. The canine fossa should be anesthetized with 1% lidocaine with 1:100.000 epinephrine. It should be borne in mind that this will not anesthetize the inflamed mucus within the sinus so the actual puncture will still

be painful and the patient should be forewarned. One may insert the trocar directly through the canine fossa with a controlled rotating motion, with care being taken to not direct the trocar toward the orbit. Once the sinus is entered, a culture should always be taken and a gram-stained specimen should be obtained. The sinus may then be irrigated with either saline or an antibiotic solution such as a povidone-iodine (Betadine) solution.

One may also enter the maxillary sinus from an intranasal approach through either the inferior or the middle meatus. If the inferior meatus is chosen, one must be careful to be posterior enough to avoid the nasolacrimal duct. Anesthesia should first be obtained by placing cottonoids, cotton, or gauze soaked in 1% lidocaine with 1:100.000 epinephrine in the inferior meatus under the inferior turbinate, following the injection of the inferior turbinate itself with a small amount of the same solution. Following the attainment of adequate anesthesia and vasoconstriction, the sinus is entered with the antral troacar after slight in-fracturing of the inferior turbinate. The troacar should be directe laterally or slightly inferiorly but not toward the orbit. Again, once the sinus is entered, a culture should be taken and the sinus irrigate. This may produce a modest amount of hemorrhage. If one elects to enter the sinus through the middle meatus it should be attempted as close to the natural ostium as possible. Since this may be difficult to determine in an office setting with inflamed nasal mucosa, the sinus is most safely entered through the fontanelle immediately above the inferior turbinate just inferior to the bulla ethmoidalis or slightly more posterior.

If the disease process fails to respond to antrostomy and irrigation, a definitive procedure is indicated. Careful evaluation of coronal CT scans without contrast will almost invariably show disease of the anterior ethmoids or osteomeatal complex. If this is the case it is now well established that definitive intervention should address this area. This should take the form of at least an anterior ethmoidectomy coupled with a middle meatal antrostomy. It is unusual for a patient to need a classic Calwell-Luc operation. An occasional patient may need a canine fossa puncture to aspirate retention cysts or to do a biopsy of material in the sinus but rarely is it indicated to remove the entire lining of the sinus for inflammatory disease.

Chronic ethmoid sinusitis

Disease of the ethmoid sinus is not amenable to aspiration and irrigation. When disease fails to respond to medical management, an exenteration is needed. The amount of intervention will depend on the extent of the disease. If the CT scan shows only anterior ethmoid involvement, than only that area need be approached. If there is opacification of all ethmoid air cells, a complete ethmoidectomy should be performed. There are three basic approaches to the ethmoids: intranasal, transantral, and external. The intranasal approach may be done with various aids. Regardless of whether one uses an endoscope, a microscope, or a headlight, visualization as well as thorough knowledge of the anatomy is imperative. The microscope offers the ability to use both hands simultaneously. It has the disadvantage of not allowing visualization around corners. The endoscopes limit the operator to instrumentation with a single hand but allow excellent visualization both directly ahead and at various angles. One can work in the ethmoid and sphenoid sinuses and expose the nasofrontal duct and maxillary sinus. The procedure can also be done with merely a headlight, but this lacks both magnification of the field and the ability to look at angles.

In addition, the ethmoid sinuses can be approached via the maxillary sinus as can the sphenoid. This approach allows excellent visualization of the floor of the orbit, and one can follow it medially and superiorly as it becomes the lamina papyracea. The disadvantage is the requirement of sublabial incision and the Calwell-Luc approach.

Ethmoid disease can also be approached externally. An incision is made approximately midway between the medial canthus and the nasal dorsum down to periosteum. The periosteum is then elevated off the nasal bones and the lamina papyracea and the ethmoid sinus entered directly just behind the posterior lacrimal crest. A complete ethmoidectomy can be performed via this approach. The advantage of this approach is excellent visualization. The major disadvantage, however, is that it removes the lamina papyracea, thus eliminating a bony partition that if maintained could continue to act as a barrier to protect the eye from future sinus disease. In addition, this requires a facial incision, although this incision generally heals quite well.

Chronic frontal sinusitis

In the case of chronic frontal sinusitis, there are two basic approaches: (1) mucosa-preserving techniques and (2) mucosa-eliminating techniques. Mucosa-preserving techniques may be performed either intranasally or externally. The intranasal approach is typically done with endoscopes and involves anterior ethmoidectomy followed by careful exenteration of the frontal recess air cells to expose the nasofrontal orifice. Generally in this setting the orifice is of adequate size and nothing further need be done. If needed, however, the access to the duct can be enlarged by removing bone anteriorly with either specially angled Kerrison rongeurs or a drill. This approach may also be used for medially located frontal mucoceles or the more typical frontoethmoid mucocele. Typically the mucocele is bulging through the floor of the frontal sinus into the ethmoids, and removal of this bone can be easily accomplished, leaving a very wide opening into the frontal sinus.

There are two types of external mucosa-preserving techniques. Both involve an approach beginning with an external ethmoidectomy. This is followed either by removal of a large part of the medial floor of the frontal sinus, the so-called Lynch procedure, or by enlarging the nasofrontal duct and attempting to reconstruct it with a mucosal flap, the so-called Boyden procedure. The major disadvantages of these approaches are the requirement of an external incision and the fact that the soft tissues of the orbit will tend to collapse medially in the postoperative period, obstructing the nasofrontal duct once the stent is removed. Despite this tendency the procedure is successful approximately 70% of the time.

The mucosa-eliminating procedure are of three basic types. The first is the osteoplastic flap coupled with obliteration of the frontal sinus. This involves creating an anterior bone flap fractured inferiorly, allowing access to the frontal sinus. The mucosa of the entire sinus is then removed first with an elevator and then with a drill to eliminate all remnants of mucosa. Following this, the nasofrontal ducts are plugged and then covered with fascia and the frontal sinus obliterated with fat, usually from either the abdomen or the thigh but occasionally from the submental area.

Another approach is the frontal sinus anterior ablation, the so-called Riedel procedure. This is rarely done today but may be indicated for severe frontal chronic sinusitis with

osteomyelitis of the anterior table. In this case, the anterior table bone is removed. Then the mucosa is removed, including the nasofrontal duct, and the forehead skin is allowed to collapse back against the posterior table. Following a period of 6 to 12 months during which there should be no evidence of residual infection, the anterior table may be reconstructed. A more contemporary approach, however, is to discard the anterior table, remove all of the frontal sinus mucosa, obliterate the nasofrontal duct, then reconstruct the anterior table with a pericranial bone graft, and obliterate the sinus with fat. On rare occasions, posterior wall ablation may also be indicated. The two most common reasons for this procedure are infections involving the posterior table leading to either epidural or subdural abscesses or severe trauma causing comminution of the posterior table. In either case, the posterior table bone is removed, the mucosa is removed from the remaining parts of the sinus, the nasofrontal ducts are plugged, and the brain is allowed to prolapse forward against the posterior part of the anterior table. This is the so-called cranialization procedure and is usually performed in conjunction with a neurosurgeon.

Chronic sphenoid sinusitis

Chronic sphenoid sinusitis rarely occurs in isolation and is more typically found with pansinusitis or at least disease of the entire ethmoid sinus. In either case the sphenoid sinus may be approached in one of three basic ways. The first is transnasal, and the second is transethmoid. The transethmoid approach may be done either intranasally or externally. The third approach is transantral.

If there is isolated sphenoid sinus disease with normal ethmoid sinuses, the transnasal approach should be considered first. The sphenoid sinus may be entered safely between the posterior end of the middle turbinate and the nasal septum. If there is ethmoid disease the sphenoid may be approached by doing first a complete ethmoidectomy. The same approach may be used through an external ethmodectomy, but this offers few if any advantages over the two previously described approaches.

When thorough, thoughtful nonoperative management fails, more aggressive intervention is indicated. For each sinus that may be involved, a number of choices are available. This allows the contemporary sinus surgeon to tailor the approach to best fit the disease and the patient. It should be remembered, however, that no single approach is invariably successful and long follow-up may be required to detect failure.

Complications

Facial cellulitis

For a discussion of facial cellulitis, see the discussion of maxillary sinusitis of infants.

Orbital cellulitis/abscess

Orbital cellulitis and abscess are usually complications of ethmoid sinusitics. They may also occur as a primary event resulting from infection of the lids and orbital adnexa. In this instance a "preseptal" cellulitis will occur. There will be edema of the lids and periorbital soft tissues without evidence of significant chemosis, proptosis, or limitation of ocular movement.

Preseptal cellulitis may be treated as a localized process, but sinus radiographs are essential to rule out associated sinus disease.

In the more common setting periorbital cellulitis will occur with chemosis and associated limitation of ocular movement and proptosis. Orbital cellulitis and abscess if untreated may progress to ophthalmoplegia and blindness. The causal organism is almost always a respiratory pathogen and cultures may be positive in the abscess cavity and in the blood. When suspicion of orbital cellulitis or abscess exists, a CT scan is appropriate to evaluate both the anatomy and the progression of the disease. Subperiosteal abscess when identified is an absolute indication for surgical drainage. The patient should be hospitalized and given high-dose intravenous antibiotics, such as ampicillin, 200 mg/day, and chloramphenicol, 600 mg TID. The indications for surgical drainage include and abscess demonstrate on CT scan, progression of disease (ophthalmoplegia, decreased vision) for more than 24 hours, or lack of resolution on antibiotic therapy after 48 to 72 hours. Surgery should be performed via an ethmoidectomy with incision of the orbital periosteum to allow complete drainage of the orbit (Schramm et al, 1982).

Osteomyelitis

Acute frontal sinus infection may progress to involve the bone and soft tissues of the skull (Pott's puffy tumor). This rapidly progressing infection is typified by diffuse brawny edema of the brow and is usually seen as a complication of acute frontal sinusitis. Treatment includes drainage of the acutely infected frontal sinus and long-term intravenous antibiotics. Resection of infected bone should be considered if the infection does not respond to intravenous antibiotics.

Epidural abscess

Epidural abscess is typically a complication of acute frontal sinusitis and is pathologically caused by direct extension of the disease through the sinus wall via thrombosed venous channels to the epidural space. It is typically associated with a severe headache and may be accompanied by fever, stiff neck, and obtundation. The clinical suspicion is confirmed using a CT scan with contrast. A lumbar puncture should be considered after consultation with a neurologic surgeon. Drainage may be accomplished in cases with favorable anatomy via a frontal trephination with removal of the posterior wall. If the anatomy is not favorable, epidural abscess may require craniotomy for drainage.

Venous sinus thrombosis

Cavernous sinus thrombosis may occur as a complication of acute ethmoid or sphenoid sinusitis. It is manifested by high spiking fever, numbness in the first or second division of the trigeminal nerve, or ophthalmoplegia and pulsatile proptosis with retinal venous engorgement. Treatment consists of high-dose intravenous antibiotics and wide drainage of the ethmoid and sphenoid sinuses using surgical access either externally or intranasally. The use of anticoagulants in this setting is controversial.

Intracerebral abscess

Intracerebral abscess in the evolution of sinusitis is difficult to diagnose since the primary symptoms is headache, which may be masked by the sinus symptoms. Brain abscess must be considered when sinusitis is complicated by drowsiness, confusion, nausea and vomiting, or seizures. The patient must be examined for papilledema and other evidence of cranial neuropathy as a result of increased intracranial pressure. A moderate temperature elevation (101°F to 102°F) may be present although the patient may be afebrile. Other symptoms such as hemiparesis and seizures draw attention to the CNS more rapidly. Evaluation must be performed in conjunction with a neurologic surgeon and will include CT scan and lumbar puncture. Management includes high-dose antibiotics and drainage of the involved sinus. The brain abscess itself may resolve with medical management, but surgical drainage using either CT-guided needle aspiration or direct excision of the abscess may be considered.

Meningitis

Acute meningitis can be a complication of sinusitis and may occur at any age. In the neonatal group meningitis usually relates to exposure to organisms during elivery and is characterized by hospital-associated gram-negative rods. Soon thereafter meningitis is more typically related to respiratory pathogens and may well be a complication of sinusitis. Clinically the patient may present with classic symptoms of fever, headache, and stiff neck or more advanced CNS illness including coma. CT scan and lumbar puncture are appropriate in this setting, and rapid institution of high-dose antibiotics is critical. Sinus drainage should be considered after meningitis is brought under control with antibiotic management and only if the sinuses are felt to be the primary source of the infection (Neu and Garvey, 1976).