

Periorbital and Orbital Infections

Ellen R. Wald, MD*

Objectives After completing this article, readers should be able to:

1. Describe the specific causes of preseptal cellulitis.
2. Discuss the management of preseptal cellulitis.
3. Know the specific manifestations of postseptal cellulitis.
4. Recognize the orbital septum as a connective tissue extension of the periosteum (or periorbita) that is reflected into the upper and lower eyelids.
5. Identify the usual signals of orbital involvement.

Introduction

Practitioners frequently have the opportunity to manage the child whose chief complaint is a “swollen eye.” Some children have trivial or self-limited disorders, but others can have sight- or life-threatening problems.

Differential Diagnosis

The noninfectious causes of swelling of or around the eye include: 1) blunt trauma (leading to the proverbial “black” eye), 2) tumor, 3) local edema, and 4) allergy. In cases of blunt trauma, the history provides the key to the diagnosis. Eyelid swelling continues to increase for 48 hours and then resolves over several days. Tumors that characteristically involve the eye include hemangiomas of the lid, ocular tumors such as retinoblastoma and choroidal melanoma, and orbital neoplasms such as neuroblastoma and rhabdomyosarcoma. Tumors usually cause a gradual onset of proptosis in the absence of inflammation. Hypoproteinemia and congestive heart failure cause eyelid swelling due to local edema. Characteristic findings are bilateral, boggy, nontender, nondiscolored soft-tissue swelling. Allergic inflammation includes angioneurotic edema or contact hypersensitivity. Superficially, these problems can resemble acute infection. However, the presence of pruritus and the absence of tenderness are helpful distinguishing characteristics.

Pathogenesis

The anatomy of the eye is important for understanding its susceptibility to spread of infection from contiguous structures. Veins that drain the orbit, the ethmoid and maxillary sinuses, and the skin of the eye and periorbital tissues (Fig. 1) represent an anastomosing and valveless network. This venous system provides opportunities for spread of infection from one anatomic site to another and predisposes to involvement of the cavernous sinus.

Figure 2 demonstrates the relationship between the eye and the paranasal sinuses. The roof of the orbit is the floor of the frontal sinus, and the floor of the orbit is the roof of the maxillary sinus. The medial wall of the orbit is formed by the frontal maxillary process, the lacrimal bone, the lamina papyracea of the ethmoid bone, and a small part of the sphenoid bone. Infection originating in the mucosa of the paranasal sinuses can spread to involve the bone (osteitis with or without subperiosteal abscess) and the intraorbital contents. The latter can occur through natural bony dehiscences in the lamina papyracea of the ethmoid or frontal bones or via foramina through which the ethmoidal arteries pass.

Figure 3 shows the position of the orbital septum. This connective tissue extension of the periosteum (or periorbita) is reflected into the upper and lower eyelids. Infection of

*Professor of Pediatrics and Otolaryngology, University of Pittsburgh School of Medicine; Chief, Division of Allergy, Immunology, and Infectious Diseases, Children’s Hospital of Pittsburgh, Pittsburgh, PA.

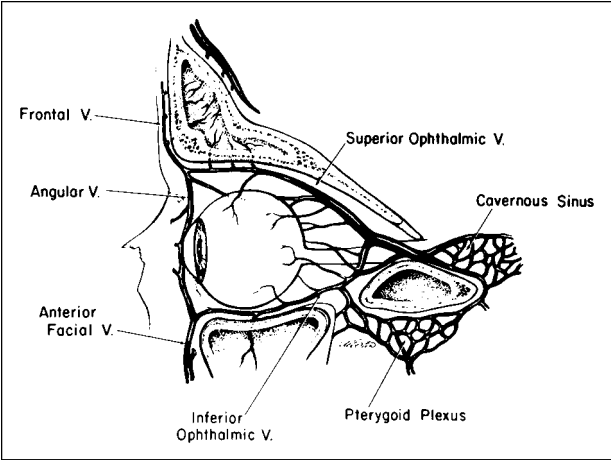


Figure 1. The valveless venous system of the orbit and its many anastomoses. Reprinted with permission from Harris (1994).

tissues anterior to the orbital septum is described as periorbital or preseptal. The septum provides a nearly impervious barrier to spread of infection to the orbit.

Infectious causes of preseptal cellulitis occur in three settings: 1) secondary to a localized infection or inflammation of the conjunctiva, eyelids, or adjacent structures (eg, conjunctivitis, hordeolum, acute chalazion, dacryocystitis, dacryoadenitis, impetigo, or traumatic bacterial cellulitis); 2) secondary to hematogenous dissemination

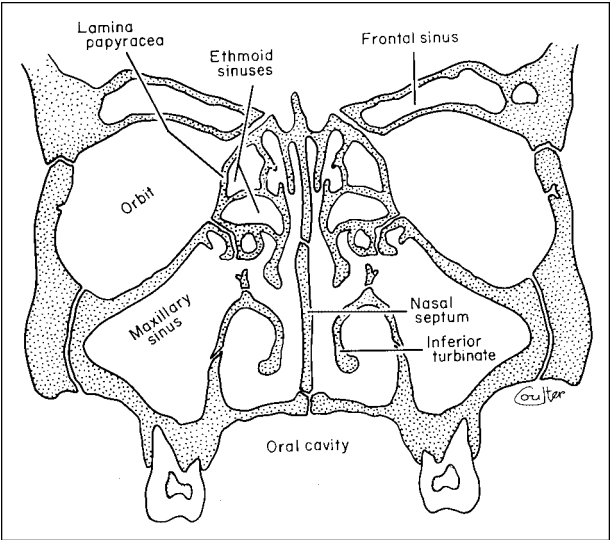


Figure 2. A schematic illustrating the relationship between the eye and the paranasal sinuses. The roof of the orbit, the medial wall, and the floor are shared by the frontal, ethmoid, and maxillary sinuses, respectively. Reprinted with permission from Shapiro et al (1982).

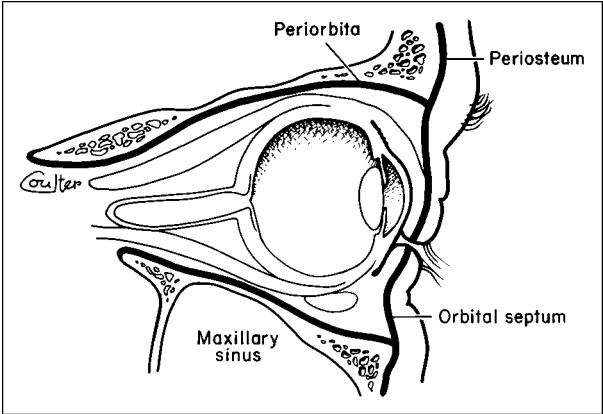


Figure 3. The orbital septum is a connective tissue extension of the periosteum that is reflected into the upper and lower lid. Reprinted with permission from Shapiro et al (1982).

of nasopharyngeal pathogens to the periorbital tissue; and 3) as a manifestation of inflammatory edema in patients who have acute sinusitis (Table). Although preseptal cellulitis or periorbital cellulitis (the terms may be used interchangeably) often is considered a “diagnosis,” the term is an inadequate diagnostic label unless accompanied by a modifier that indicates likely pathogenesis (eg, bacteremic periorbital cellulitis or periorbital cellu-

Table. Infectious Causes of Preseptal and Orbital Cellulitis

Preseptal Cellulitis

- Localized infection of the eyelid or adjacent structure
 - Conjunctivitis
 - Hordeolum
 - Chalazion
 - Dacryoadenitis
 - Dacryocystitis
 - Bacterial cellulitis (trauma)
- Hematogenous dissemination
 - Bacteremic periorbital cellulitis
- Acute sinusitis
 - Inflammatory edema

Orbital Cellulitis

- Acute sinusitis
 - Subperiosteal abscess
 - Orbital abscess
 - Orbital cellulitis
 - Cavernous sinus thrombosis
- Hematogenous dissemination
 - Endophthalmitis
- Traumatic inoculation
 - Endophthalmitis

litis due to dacryocystitis). Infections behind the septum that cause eye swelling include subperiosteal abscess, orbital abscess, orbital cellulitis, cavernous sinus thrombosis, panophthalmitis, and endophthalmitis. All of these entities can be labeled “orbital cellulitis,” but a systematic approach allows a more specific diagnosis, thereby directing management.

Preseptal Infections

Conjunctivitis

Conjunctivitis is the most common disorder of the eye for which children seek care. In most cases, the lids are crusted and thickened and the conjunctivae are hyperemic. There often is mucopurulent discharge. The usual causes of conjunctivitis in children outside of the neonatal age group but younger than 6 years of age are *Haemophilus influenzae* (nontypeable) and *Streptococcus pneumoniae*; adenovirus is common in children older than 6 years. An associated otitis media occurs in 25% of children who have bacterial conjunctivitis. Occasionally, children who have conjunctivitis exhibit diffuse swelling of the lids that may be mistaken for a more serious problem. To establish the diagnosis, a swab of the conjunctival surface should be obtained. Topical therapy with polymyxin-bacitracin, trimethoprim-polymyxin B, sodium sulfacetamide, or ofloxacin hastens resolution.

Hordeolum

An external hordeolum or styne is a bacterial infection of the glands of Zeis or Moll (sebaceous and sweat glands, respectively) associated with a hair follicle on the eyelid. In most cases, infection is localized and points to the lid margin as a pustule or inflammatory papule. The lid can be slightly swollen and erythematous around the area of involvement. These usually last a few days to a week and resolve spontaneously.

An internal hordeolum is a bacterial infection of a meibomian gland, which is a long sebaceous gland whose orifice is at the lid margin. The infection usually causes inflammation and edema of the neck of the gland, which may result in obstruction. If there is no obstruction, infection points to the lid margin. If obstruction is present, infection points to the conjunctival surface of the eye. Sometimes the swelling caused by an acute internal hordeolum is diffuse rather than localized, and a pustule is not obvious on the lid margin. To clarify the

cause, it is necessary to evert the eyelid and examine the tarsal conjunctiva. A tiny, delicate pustule is diagnostic of an internal hordeolum. The usual cause of acute internal or external hordeola is *Staphylococcus aureus*. An antibiotic ophthalmic ointment containing bacitracin can be applied to the site of infection. The primary purpose of topical therapy is to prevent spread of infection to adjacent hair follicles. Warm compresses may facilitate spontaneous drainage.

In contrast to the internal hordeolum, a chalazion manifests as a persistent (>2 wk), nontender, localized bulge or nodule (3 to 10 mm) in the lid; the overlying skin is completely normal. It is a sterile lipogranulomatous reaction. When a chalazion is large and causes local irritation, it may require incision.

“The usual cause of an external hordeolum is *Staphylococcus aureus*, for which the best treatment is bacitracin ophthalmic ointment.”

Dacryoadenitis

Dacryoadenitis is an infection of the lacrimal gland. Sudden onset of soft-tissue swelling that is maximal over the outer portion of the upper lid margin is typical. Occasionally, the eyeball is erythematous and the eyelid swollen, and the patient can have remarkable constitutional symptoms. The location of the swelling is a distinguishing characteristic (Fig. 4). When dacryoadenitis is caused by viral infection (mumps virus, Epstein-Barr virus, cytomegalovirus, coxsackievirus, echoviruses, and varicella-zoster virus), the area is only modestly tender. By contrast, when the infection is caused by bacterial agents, discomfort is prominent. In addition to *S aureus*, which is the most common cause of bacterial dacryoadenitis, other etiologic agents include streptococci, *Chlamydia trachomatis*, and occasionally *Neisseria gonorrhoeae*. If parenteral therapy is required, nafcillin at 150 mg/kg per day divided into doses every 6 hours is appropriate. Oral treatment of acute dacryoadenitis is undertaken with a semisynthetic penicillin such as dicloxacillin (100 mg/kg per day divided into four doses). For penicillin-allergic patients, cephalexin or cefadroxil (100 and 50 mg/kg per day divided into doses every 6 and 12 h, respectively) or clindamycin (40 mg/kg per day divided into doses every 6 h) can be prescribed.



Figure 4. A patient who has dacryoadenitis due to an unspecified viral infection. The nontender swelling over the lateral portion of the left upper lid evolved while an antibiotic was being administered for acute otitis media. Swelling resolved in several days without any change in medical treatment. Reprinted with permission from Wald (2003).

Treatment is continued until all signs and symptoms have disappeared.

Dacryocystitis

Dacryocystitis is a bacterial infection of the lacrimal sac. Although it is uncommon, it can occur at any age as a bacterial complication of a viral upper respiratory tract infection (URI). Delayed opening, inspissated secretions, or anatomic abnormalities lead to excessive representation of infants younger than 3 months of age among children who have dacryocystitis.

Affected patients usually have had a viral URI for several days. They then develop fever, impressive erythema, swelling, and exquisite tenderness that is most prominent in the triangular area just below and lateral to the medial canthus (Fig. 5). Pressure over the lacrimal sac



Figure 5. A 16-year-old boy who has dacryocystitis. The area beneath the medial canthus is erythematous, indurated, and exquisitely tender. Reprinted with permission from Wald (2003).

causes considerable discomfort but can result in expression of purulent material from the lacrimal puncta. Common causative organisms are gram-positive cocci. *S pneumoniae* is most common in neonates, although *S aureus*, *H influenzae*, and *S agalactiae* also have been reported. *S aureus* and *S epidermidis* are implicated most frequently in acquired dacryocystitis in the older patient. It is important to obtain material from the punctum because other organisms (including enteric gram-negative bacilli, anaerobic bacteria, and yeast) have been observed occasionally.

Most patients who have dacryocystitis require hospital admission. Often they appear ill or toxic. Because of the potential for any case of bacterial facial cellulitis to result in cavernous sinus thrombosis, therapy with parenteral antibiotics is indicated until the infection begins to subside. Nafcillin or a first-generation cephalosporin such as cefazolin (150 to 200 mg/kg per day divided into doses every 6 h) are appropriate. For penicillin-allergic patients, vancomycin or clindamycin (40 mg/kg per day divided into doses every 6 h) suffices. After substantial improvement in local findings, oral therapy can be substituted to complete a 10-day course of antimicrobials.

Preseptal Cellulitis Following Trauma

Occasionally, preseptal cellulitis results from secondary bacterial infection of sites of local skin trauma (including insect bites) or spread of infection from a focus of impetigo. Loosely bound periorbital soft tissues permit impressive swelling to accompany minor infection. The overlying skin can be bright red, with subtle textural changes, or intense swelling can lead to shininess (Fig. 6). Some patients have fever, but many are afebrile



Figure 6. A 3-year-old boy had the rapid onset of left eyelid swelling and erythema after incurring a small laceration at the lateral margin of his left eye. He had an upper respiratory tract infection for 10 days. Group A streptococci were recovered from the wound. Reprinted with permission from Wald (2003).

despite dramatic local findings. The peripheral white blood cell count varies. In these cases, cellulitis, similar to that on any other cutaneous area, is caused by *S aureus* or group A *Streptococcus*.

Patients who have bacterial cellulitis of traumatized areas rarely have bacteremia. Precise bacteriologic diagnosis is made by culturing exudate from the wound. If there is no drainage, a careful attempt at tissue aspiration is undertaken if this can be done safely (ie, at a distance far enough from the orbit so there can be no potential damage to the eye). Parenteral treatment similar to that advised for dacryocystitis is recommended for patients who have bacterial cellulitis to hasten resolution and avoid spread of infection to the cavernous sinus.

Bacteremic Periorbital Cellulitis

Bacteremic periorbital cellulitis, most often seen in infants younger than 18 months of age, is preceded by a viral URI for several days. There is a sudden increase in temperature (to higher than 102.2°F [39°C]) accompanied by the acute onset and rapid progression of eyelid swelling. Swelling usually begins in the inner canthus of the upper and lower eyelid and can obscure the eyeball within 12 hours. Periorbital tissues usually are erythematous, although if the swelling has been rapidly progressive, the area may have a violaceous discoloration. If the child can be distracted during the physical examination, periorbital tissues may not be tender early in the course of infection; the child's resistance to examination frequently leads to the erroneous impression of tenderness. Retraction or separation of the lids reveals that the globe is

placed normally and extraocular eye movements are intact. If retraction of the lids is not possible, orbital computed tomography may be necessary. The young age, high fever, and rapid progression of findings differentiate bacteremic preseptal cellulitis from other causes of swelling around the eye.

In the era before universal immunization against *H influenzae* type b, this organism was the cause of bacteremic periorbital cellulitis in approximately 80% of cases. *S pneumoniae* accounted for the remaining 20%. The substantial recent decline in the total number of cases of bacteremic periorbital cellulitis is attributable to widespread use of vaccine for *H influenzae* type b and *S pneumoniae*. A precise bacteriologic diagnosis usually is made by recovery of the organism from blood culture.

The pathogenesis of most of these infections, which usually occur during a viral URI, is hematogenous dissemination from a portal of entry in the nasopharynx. This is akin to the mechanism of most infections caused by *H influenzae* type b and some infections caused by *S pneumoniae*.

Patients who have bacteremic periorbital cellulitis often have abnormal radiographic findings of the paranasal sinuses. However, this almost certainly reflects the viral respiratory syndrome that precedes and probably predisposes to the bacteremic event rather than a clinically significant sinusitis. Bacteremic cellulitis rarely arises from the paranasal sinus cavities, as evidenced by the finding that typeable *H influenzae* organisms almost never are recovered from maxillary sinus aspirates and, likewise, are not recovered from patients who have serious local complications of paranasal sinus disease such as subperiosteal abscess. Although *S pneumoniae* can cause subperiosteal abscess in patients who have acute sinusitis, these patients rarely have bacteremia.

Treatment for suspected bacteremic periorbital cellulitis requires parenteral therapy. *S pneumoniae* is the most likely pathogen in a child who has received the *H influenzae* type b vaccine series. Cefuroxime (at 150 mg/kg per day divided into doses every 8 h) has been used successfully. Because this infection usually is bacteremic at an age when the meninges are susceptible to inoculation, it may be prudent to use an advanced-generation cephalosporin such as cefotaxime or ceftriaxone (150 and 100 mg/kg per day divided into 8- and 12-h doses, respectively). When evidence of local infection has resolved, oral antimicrobial therapy is prescribed to complete a 10-day course. Lumbar puncture should be performed if the clinical picture suggests meningitis. The addition of vancomycin (60 mg/kg per day divided into doses every 6 h) or rifampin

(20 mg/kg once daily, not to exceed 600 mg/d) is appropriate if a pleocytosis is present.

Preseptal (Periorbital) Cellulitis Caused by Inflammatory Edema of Sinusitis

Several complications of paranasal sinusitis can result in the development of swelling around the eye. The most common and least serious complication often is referred to as inflammatory edema or a sympathetic effusion, a form of preseptal cellulitis in which bacterial infection is confined to the sinuses.

Typically, the child has had a viral URI for several days when swelling is noted. Often, there is a history of intermittent early morning periorbital swelling that resolves after a few hours. On the day of presentation, the eye swelling does not resolve but progresses gradually. Surprisingly, striking degrees of erythema also can be present. Eye pain and tenderness are variable. Eyelids can be very swollen and difficult to evert, requiring the assistance of an ophthalmologist. However, there is no displacement of the globe or impairment of extraocular eye movements. Fever, if present, usually is low grade. The peripheral white blood cell count is unremarkable. Results of blood cultures always are negative. If a tissue aspirate is tested, it also is negative. Sinus radiographs show ipsilateral ethmoiditis or pansinusitis. The age of the child, gradual evolution of lid swelling, and modest temperature elevation differentiate inflammatory edema from bacteremic periorbital cellulitis.

The pathogenesis of sympathetic effusion or inflammatory edema is attributable to the venous drainage of the eyelid and surrounding structures. The inferior and superior ophthalmic veins, which drain the lower and upper lid, respectively, pass through or just next to the ethmoid sinus. When the ethmoid sinuses are congested completely, venous drainage is physically impeded, resulting in soft-tissue swelling of the eyelids that is maximal at the medial aspect of the lids. In this instance, infection is confined within the paranasal sinuses. The globe is not displaced, and there is no impairment of the extraocular muscle movements. However, inflammatory edema is part of a continuum that has more serious complications resulting from the spread of infection outside the paranasal sinuses into the orbit. Rarely, infection progresses despite optimal initial management of sympathetic effusions.

The infecting organisms in cases of inflammatory edema are the same as those that cause uncomplicated acute sinusitis (ie, *S pneumoniae*, nontypeable *H influenzae*, and *M catarrhalis*). Antibiotic therapy can be administered orally if the eyelid swelling is modest at the time of



Figure 7. A 12-year-old boy who has orbital cellulitis. He had a 5-day history of eye pain and progressive swelling of the eyelids, which were markedly erythematous. When his eyelids were retracted, anterior and lateral displacement of the globe and impairment of upward gaze were noted. Reprinted with permission from Wald (2003).

the first examination, the child does not appear toxic, and the parents are reliable. Otherwise, admission to the hospital and parenteral treatment should be undertaken. The only source of bacteriologic information is that obtainable by maxillary sinus aspiration, which usually is not performed. Appropriate agents for outpatient therapy should cover beta-lactamase-producing organisms (eg, amoxicillin/clavulanate, cefuroxime axetil, cefpodoxime proxetil, and cefdinir). Parenteral agents include cefuroxime (150 mg/kg per day divided into doses every 8 h) or ampicillin/sulbactam (200 mg/kg per day divided into doses every 6 h). The latter combination, although not approved for children younger than 12 years of age, is an attractive choice. Although not systematically evaluated, topically applied intranasal deconges-

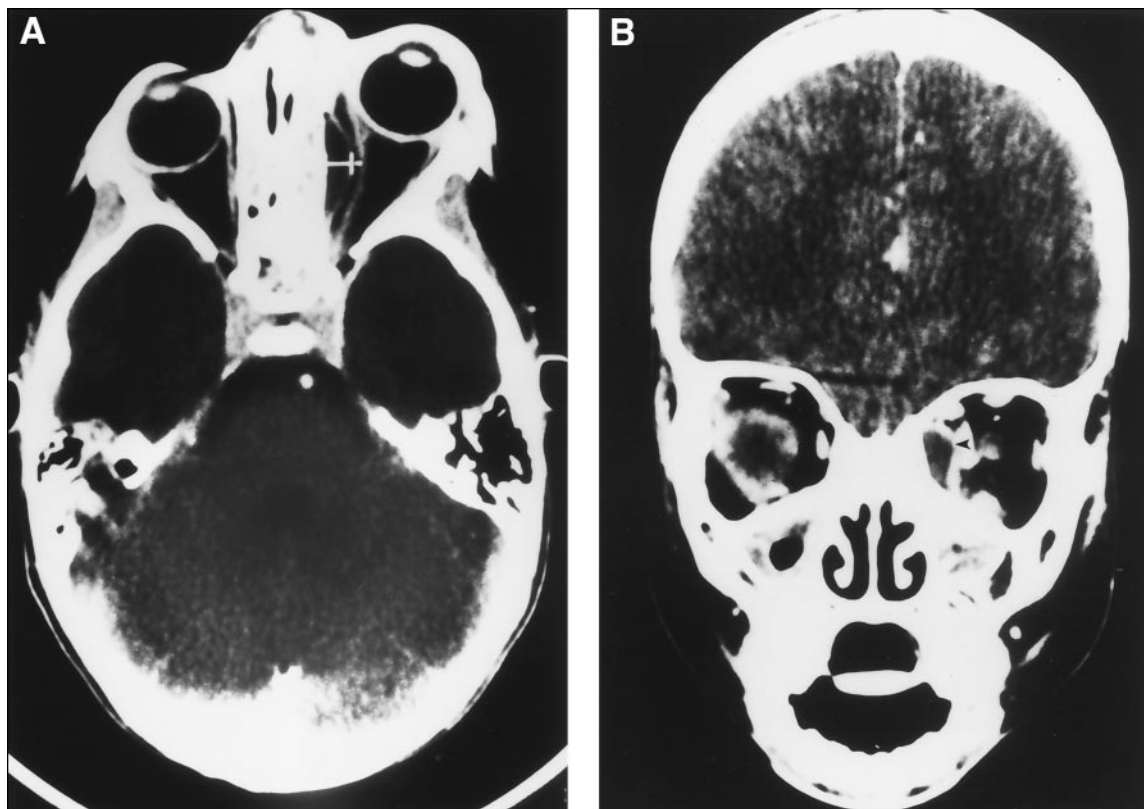


Figure 8. Axial (A) and coronal (B) computed tomography scans show a subperiosteal abscess extending from the right ethmoid sinus.

tants, such as oxymetazoline, may be helpful during the first 48 hours. After several days, when there is near normalization of the affected eye, an oral antimicrobial agent is substituted to complete a 14-day course of therapy.

Orbital Infections

The child or adolescent who has true orbital disease due to sinusitis usually has a sudden onset of erythema and swelling about the eye after several days of a viral URI (Fig. 7). Eye pain can precede swelling and often is dramatic. Fever, systemic signs, and toxicity vary. Orbital infection is suggested by proptosis (usually the globe is displaced anteriorly and downward), impairment of extraocular eye movements (most often, upward gaze), or loss of visual acuity or chemosis (edema of the bulbar conjunctiva). Fortunately, these complications are the least common cause of the “swollen eye.”

Most orbital infections involve the formation of a subperiosteal abscess. Among young children, this re-

sults from ethmoiditis and ethmoid osteitis. For the adolescent, subperiosteal abscess may be a complication of frontal sinusitis and osteitis. Rarely, orbital cellulitis evolves without subperiosteal abscess formation by direct spread from the ethmoid sinus to the orbit via natural bony dehiscences in the bones that form the medial wall of the orbit.

Imaging studies usually are performed if orbital disease is suspected to help differentiate subperiosteal abscess, orbital abscess, or orbital cellulitis as the cause of the clinical findings (Fig. 8). If there is a large, well-defined abscess, complete ophthalmoplegia, or impairment of vision, the paranasal sinuses and the abscess frequently are drained surgically. Recently, several studies have reported successful drainage of a subperiosteal abscess via endoscopy. This method, performed via an intranasal approach, avoids an external incision. In many cases of orbital infection, a well-defined abscess is not seen. Instead, inflammatory tissue is interposed between the lateral border of the ethmoid sinus and the swollen medial rectus. Usually, affected patients are managed

successfully with antimicrobial therapy alone. On occasion, the computed tomography scan can be misleading, suggesting abscess when inflammatory edema is present; accordingly, the clinical course is the ultimate guide to management.

Empiric antimicrobial therapy should be chosen that provides activity against *S aureus*, *S pyogenes*, and anaerobic bacteria of the upper respiratory tract (anaerobic cocci, *Bacteroides*, *Prevotella*, *Fusobacterium*, and *Veillonella* sp) in addition to the usual pathogens associated with acute sinusitis (ie, *S pneumoniae*, *H influenzae*, and *M catarrhalis*). Appropriate selections might include cefuroxime (150 mg/kg per day divided into doses every 8 h) or ampicillin/sulbactam (200 mg/kg per day divided into doses every 6 h). Clindamycin (40 mg/kg per day divided into doses every 6 h) or metronidazole (30 to 35 mg/kg per day divided into doses every 8 to 12 h) can be added if cefuroxime is used, when anaerobic infection is likely. If surgery is performed, Gram stain of material drained from sinuses or abscess guides consideration of additional drugs or an altered regimen. When final results of culture are available, antibiotic therapy may be changed, if appropriate. Intravenous therapy is maintained until the patient appears nearly normal. At that

time, oral antibiotic therapy can be substituted to complete a 3-week course of treatment.

Suggested Reading

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PIR Quiz

Quiz also available online at www.pedsinreview.org.

Match each of the descriptions in numbers 11 through 15 with the appropriate diagnosis in letters A through E:

11. Erythematous unilateral swelling below and lateral to medial canthus.
12. Gradually progressive unilateral proptosis without signs of inflammation.
13. Rapid unilateral erythematous swelling of the eyelids associated with impaired extraocular movements.
14. Rapid unilateral erythematous or violaceous swelling of eyelids, often accompanied by fever, but always sparing intraocular movements.
15. Sudden swelling and bruising of an eyelid, unassociated with fever, which resolves without treatment over several days.
 - A. Bacteremic periorbital cellulitis.
 - B. Blunt trauma.
 - C. Dacryocystitis.
 - D. Ocular tumor.
 - E. Orbital cellulitis.
16. A previously healthy 14-month-old boy, who has had a runny nose and cough for the past 5 days, suddenly becomes irritable, warm, and develops rapid, striking, erythematous swelling of the upper and lower right lids. His temperature in your office is 103.1°F (39.5°C). No lesions are noted on the lids. Extraocular movements are intact. He is alert, and his neck is supple. He has had all of his *H influenzae* type b immunizations as well as a single injection of pneumococcal vaccine/diphtheria conjugate. Of the following, the best choice for initial therapy is:
 - A. Oral dicloxacillin.
 - B. Oral high-dose amoxicillin.
 - C. Parenteral cefuroxime.
 - D. Parenteral nafcillin.
17. A previously healthy 4-year-old girl, who has had a runny nose and cough for the past 7 days, develops fluctuating swelling of her upper and lower right eyelids 2 days before visiting your office. She remains afebrile and nontoxic. On physical examination, you note mild swelling and erythema of the upper and lower lids, but otherwise normal findings on eye examination, including full range of extraocular movements. Selective sinus radiographs reveal a right ethmoiditis. Of the following potential pathogens, treatment is directed most appropriately at:
 - A. *Bacteroides* sp.
 - B. *Haemophilus influenzae* type b.
 - C. *Moraxella catarrhalis*.
 - D. *Staphylococcus aureus*.
 - E. *Streptococcus pyogenes*.
18. A previously healthy 14-year-old boy, who has had a runny nose and cough for 5 days, suddenly develops swelling, redness, and pain around his right eye. He has a temperature of 101.3°F (38.5°C). On physical examination, you see dramatic swelling of the right periorbital tissues and cannot verify intactness of extraocular movements. You confirm suspected orbital cellulitis with emergency computed tomography, which demonstrates a small subperiosteal abscess in the roof of the orbit adjacent to an opacified right frontal sinus. In addition to appropriate surgical drainage and pending culture results, the most appropriate parenteral antibiotic therapy should be directed at:
 - A. *Chlamydia trachomatis*.
 - B. *Haemophilus influenzae* type b.
 - C. *Neisseria gonorrhoeae*.
 - D. *Staphylococcus epidermidis*.
 - E. *Streptococcus pneumoniae*.