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Usha Sethuraman and Deepak Kamat

Clin Pediatr (Phila) 2009; 48; 588 originally published online Apr 8, 2009;
DOI: 10.1177/0009922809333094

Clinical Pediatrics
Volume 48 Number 6
July 2009 588-600

10.1177/0009922809333094
http://clp.sagepub.com

The Red Eye: Evaluation and Management

Usha Sethuraman, MD, and Deepak Kamat, MD, PhD

Children frequently present to primary care providers with complaints involving the eye. Examination of the eye in a child who is already terrified is challenging and requires knowledge, expertise, and the ability to perform the examination efficiently and thoroughly. The pathological processes may involve the eyelid, conjunctiva, cornea, lens, or the structures behind the eye. In this review article, we will discuss some of the ophthalmologic conditions, which are commonly managed by the pediatric primary care provider in practice.

Red Eye

"Red eye" is one of the most common complaints managed by the primary care physician. A red eye most often indicates injection of the conjunctiva and is more likely to be secondary to a benign condition such as conjunctivitis. However, some cases may herald a serious condition or life-threatening illness requiring urgent ophthalmologic referral. Pathologies of the eyelid, conjunctiva, orbit, cornea, sclera or episclera, and the uvea can also manifest as red eye.

The etiology of red eye can be infectious, traumatic, inflammatory, allergic, autoimmune, or rarely, secondary to tumors. An approach to the child with red eye should include attention to both history and physical examination, as this will help diagnose the condition. For example, the differential diagnosis may be narrowed considerably when the child complains of pain. Eye pain is common with foreign bodies, corneal abrasions, corneal ulcers, infection with herpes, or contact lens injuries or trauma.

From the Children's Hospital of Michigan, Carman and Ann Adams Department of Pediatrics, Detroit, Michigan.

Address correspondence to: Usha Sethuraman, Children's Hospital of Michigan, Carman and Ann Adams Department of Pediatrics, Department of Emergency Medicine, 3901 Beaubien Blvd., Detroit, MI 48201; e-mail: usethu@dmc.org.

Important details in the history that should be elicited include the following: duration of symptoms, changes in vision, foreign body sensation in the eye, associated pain and photophobia, history of trauma, use of contact lenses, and any eye discharge. Any child with a history of wearing contact lenses (even if not wearing one at the time of the examination) should be referred to the ophthalmologist, as a primary physician cannot assess parameters such as lens fit. Besides, the risk of permanent scarring from infections is significantly increased, especially in soft lens wearers.

The examination of the red eye should be performed after contact lenses or glasses (if the child is wearing any) are removed. During examination, care must be taken to obtain the following details: (1) Is the eye universally red, or is the redness restricted to any portion of it? (2) Is vision impaired? (3) Are the ocular movements restricted (movements are often restricted with orbital cellulitis)? (4) Are the eyelids intact and free of infections? (5) Are the pupils equal and reactive to light? and (6) Is the cornea clear? A flourescein stain and examination of the eye should be performed to rule out any corneal abrasions or tears, and when possible, a slit lamp examination should be performed. Some of the red flags for red eye include an immune-compromised host, persistent blurred vision, severe pain, ciliary flush, corneal opacification, proptosis, a pupil that does not react to direct light, reduced ocular movements, worsening signs, and no improvement despite therapy for 3 days. Some of the specific conditions that present with a red eye are discussed below.

Eyelid Disorders

As the eyelid is closely associated with the ocular surface, lesions of the eyelid can cause redness of the eye.

Blepharitis

This is an inflammation of the eyelid that is often associated with conjunctivitis and keratitis. There are 2 types of blepharitis, anterior and posterior. Anterior blepharitis affects the region at the base of the eyelashes and is usually caused by infection (staphylococcus) and dandruff. Staphylococcal blepharitis is characterized by scaling and crusting along the cilia. Chronic inflammation may be interspersed with acute exacerbations, leading to ulcerative blepharitis. Loss of eyelashes and involvement of the cornea may occur. Posterior blepharitis involves the inner (moist) surface of the lid and is caused by dysfunction of the meibomian gland or by skin conditions such as acne rosacea. Redness and crusting of eyelid margins, particularly in the morning; tearing; photophobia; itching; swollen eyelids; and redness of the eye may occur. Complications include a hordeolum, chalazion, and dry eyes.

Treatment. Both forms of blepharitis are treated by keeping the lids clean and free of crusts. Warm compresses followed by light scrubbing of the eyelid with a cotton swab dipped in a mixture of baby shampoo and water may be done. However, as this condition rarely disappears completely, this regimen may need to be followed for prolonged periods of time. For patients with staphyloccal blepharitis, a topical antibiotic such as bacitracin or erythromycin may be applied to the eyelids 1-3 times daily for 1 or more weeks, with the frequency and duration of therapy being guided by the severity of the disease. For patients with meibomian gland dysfunction, oral erythromycin may be used for young children, or doxycycline may be used in older children. A brief course of topical steroids may be helpful for severe inflammation.[1] Because many patients with blepharitis have aqueous tear deficiency, artificial tears 2 times daily may improve symptoms when used as an adjunct to medications and hygiene. Any underlying skin conditions should be treated. Severe blepharitis may need referral to an ophthalmologist.

Hordeolum

This is an acute infection of the Zeis's gland (external hordeolum or stye) or meibomian gland (internal hordeolum). *Staphylococcus aureus* or *Staphylococcus epidermidis* are the usual culprits. Spread to the neighboring tissues may lead to preseptal cellulites, and persistent hordeolum may lead to chronic inflammation resulting in a chalazion. In hordeolum externum, the infection often centers on the base of the eyelash follicle, and plucking of the eyelash often promotes healing.

Treatment. Application of warm compresses 4 times daily may be advised. Although topical antibiotics do not help with resolution of hordeolum, they may help in preventing the spread of the infection to other structures. In severe, nonresolving cases, surgical drainage may be needed.

Chalazion

This is a focal inflammatory lesion of the eyelids resulting from obstruction of the meibomian gland (internal hordeolum) (Figures 1 and 2). The meibomian glands are oil-producing glands located in the tarsal plates of both upper and lower eyelids. When plugging of the gland orifices on the eyelid margin occur, the sebum of the gland is released into the tarsus and surrounding soft tissues, which results in an inflammatory response with pain and erythema of the skin. Histologically, these lesions are characterized by chronic lipogranulomatous inflammation. They differ from hordeolum in that these are the result of gland obstruction and sterile inflammation as opposed to bacterial infection. Pain is mild or often absent. Although *Staphylococcus aureus* has been implicated in these lesions, the exact role of bacterial agents is unclear. Seborrhea, acne, and blepharitis predispose to the formation of a chalazion. Continued inflammation may lead to disfiguration of the eyelids, pyogenic granuloma, and preseptal cellulitis. Large, centrally located chalazion may result in astigmatism and visual disturbances. Diagnosis is clinical, and more than half of the cases require only conservative management.

Treatment. Warm compresses 4 times daily and topical antibiotic ointment, if there are signs of infection, may be advised. Intralesional injection of steroids may help in accelerating healing but carries the risk of hypopigmentation of the overlying skin. Large, persistent chalazion requires surgical drainage and curettage.

A recent study by Mustafa et al in children compared the efficacy of intralesional triamcinolone acetonide injection, incision, and curettage and combination of the 2.[2] The authors conclude that all 3 treatment modalities are safe and effective. Intralesional triamcinolone injection is a good procedure for

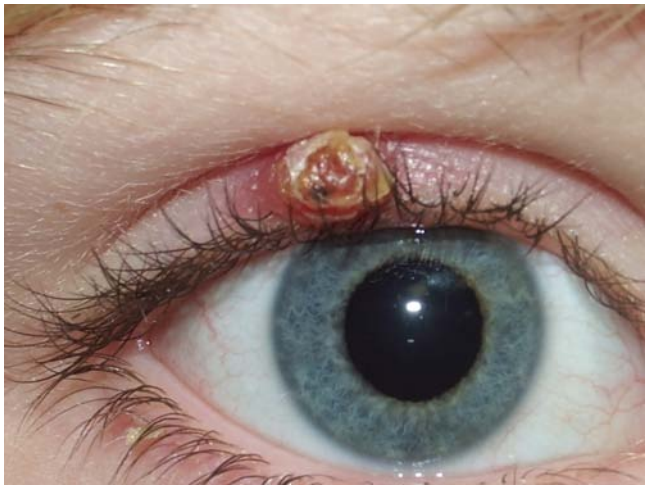

Figure 1. Chalazion with focal inflammation of the eyelid margin.

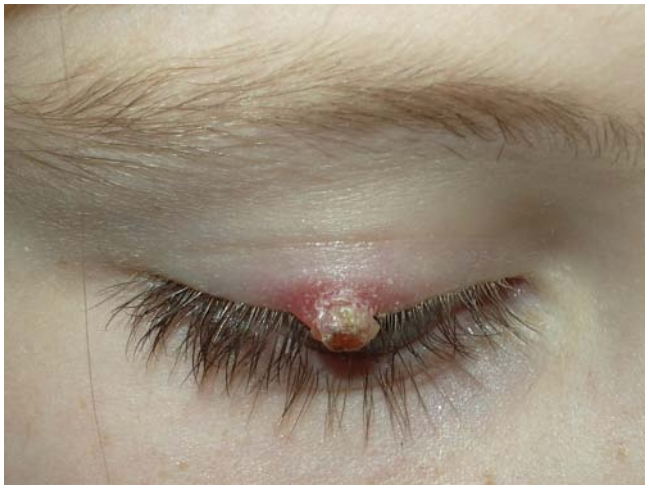

Figure 2. Externalizing chalazion with the focal inflammation of the eyelid margin.

children, patients with allergy to local anesthetics, and when the chalazion is in proximity to the lacrimal drainage system. The authors recommend incision and curettage for infected lesions and the combined treatment for large, recurrent, and multiple chalazia.

Contact Dermatitis

Contact dermatitis is the most common cause of cutaneous eyelid inflammation. Because of its thinness and frequent exposure to directly applied chemical irritants, the eyelid skin is most vulnerable to irritants. Eyelid skin may often be the only or initial presenting site for the signs of contact dermatitis. Contact dermatitis may be allergic or irritant in etiology. Patients with irritant dermatitis may present with more stinging and burning than those with allergic contact dermatitis. Allergic contact dermatitis is due to a type IV hypersensitivity reaction, whereas the irritant contact dermatitis is a result of direct toxic effect of the irritant. Examination may reveal a combination of erythema, edema, and vesiculation in patients with acute dermatitis and may be associated with scaling and desquamation in long-standing cases.

Treatment. Avoidance of the causative agent and low-dose topical steroids for 5 to 10 days is the standard treatment for these lesions.

Atopic Dermatitis

This chronic, relapsing skin condition affects about 10%-20 % of children in the United States, with eyelid involvement in about 15% of cases. Eyelids may be red, thickened, and macerated (Figure 2). This condition is commonly associated with a chronic staphylococcal blepharitis. The conjunctiva may become hyperemic and boggy, with papillary hypertrophy during an exacerbation. In severe cases of keratoconjunctivitis, cicatrization and symblepharon (adherence of bulbar and palpebral conjunctiva) formation may occur.

Treatment. Oral antihistamines and systemic or topical steroids during flare-ups may be necessary.

Disorders of the Conjunctiva: Conjunctivitis

Inflammation of the conjunctivae lining the eyelids (palpebral) and covering the exposed surface of the sclera (bulbar) that may result from infections, irritants, chemicals, and allergens.

Infectious

Viral

Viral infection is the most common cause of conjunctivitis. Most viral infections produce a mild, self-limiting conjunctivitis, but some have the potential to cause severe disability. The 2 most common

self-limiting forms of viral conjunctivitis are epidemic keratoconjunctivitis and pharyngoconjunctival fever.

Pharyngoconjuctival Fever (PCF)

This condition is characterized by fever, sore throat, and follicular conjunctivitis. It is usually caused by adenovirus 3, although occasionally it may be caused by adenovirus 4 or 7. It may be unilateral or bilateral, and corneal infiltrates are rarely seen. A few days after the onset, the cornea may show punctuate keratitis that begins as small epithelial dots that stain with fluorescein. The severity, varies and the infection may persist from a few days to 2 weeks.

Epidemic Keratoconjunctivitis (EKC)

This condition is usually bilateral and presents as inferior, palpebral follicular conjunctivitis. One third of patients develop corneal inflammation (keratitis) with subepithelial stromal infiltrates 7 to 10 days after the onset of conjunctivitis. The keratitis is a hypersensitivity reaction to the virus and not a true viral infection. Epidemic keratoconjunctivitis is usually caused by adenoviruses 8, 19, or 37.

Both PCF and EKC present with redness, tearing, serous discharge, edema of eyelids, pinpoint subconjunctival hemorrhages, severe photophobia due to corneal infiltrates, pseudomembrane formation, and palpable preauricular lymph nodes. In severe cases, scarring and symblepharon may develop. Both of these conditions are extremely contagious and usually start in one eye and then spread to the other eye within a few days.

Treatment. Primary treatment is patient education. Patients should be kept from school or work until there is no discharge and should be advised not to share utensils, clothes, and so on. Medical management includes artificial tears, cold compresses, topical vasoconstrictors (eg, naphzoline), or steroid drops. Caution must be exercised when using steroid drops, as they may worsen any bacterial corneal ulcers or herpetic disease.

When a membrane is present, it can be removed using wet cotton tipped forceps. After removal, a topical antibiotic may be placed in the eye. Antiviral drops are ineffective. However, recently cidofovir, an antiviral drug generally used for cytomegalovirus retinitis, has been shown to be efficacious in adenoviral keratoconjunctivitis. Twice daily application is recommended.

Bacterial Conjunctivitis

Although less common than viral conjunctivitis, the actual incidence of true bacterial conjunctivitis is difficult to determine. Normal conjunctiva may harbor common skin bacteria. Besides, any viral conjunctivitis may be complicated by bacterial superinfection. A recent study in a pediatric emergency department of children presenting with a red or pink eye and/or had a diagnosis of conjunctivitis, Patel et al noted that 78% had a positive conjunctival culture for bacteria.[3] Patients with bacterial conjunctivitis present with injected bulbar conjunctiva, episcleral vessels, and papillae in the palpebral conjunctiva (Figures 3 and 4), Thick, mucopurulent discharge is usually present, which causes eyelash matting and eyelid closure on waking up in the morning. A history of gluey or sticky eyelids and physical findings of mucoid or mucopurulent discharge was highly predictive of bacterial etiology.[3]

Although mild discomfort and photophobia may exist, pain is usually absent and vision is preserved. Preauricular lymphadenopathy is also less frequent. The most commonly implicated organisms are *Staphylococcus aureus, Haemophilus influenzae, Streptococcus pneumoniae,* and *Pseudomonas aeroginosa*. In Patel's study, 82% of the conjunctivitis was secondary to nontypeable H. influenzae.[3] The most common etiology in hyperacute cases are *Neisseria gonorrhoeae*. Hyperacute cases are more dangerous, as they have the propensity to penetrate the cornea. Occasional outbreaks of conjunctivitis due to *Haemophilus aegypticus* have occurred.

Treatment. Although bacterial conjunctivitis is usually self-limited, treatment probably helps shorten the duration of the infection and helps prevent person-to-person spread. Although cultures can guide management, they are expensive and often impractical and should be reserved for cases that have failed treatment. Excellent initial broad-spectrum antibiotics include a combination of polymyxin B sulfate and trimethoprim sulfate, 0.3% gentamicin, 0.5% erythromycin, and 0.3% tobramycin drops or ointments. These antibiotics are effective against both gram-negative and -positive organisms,

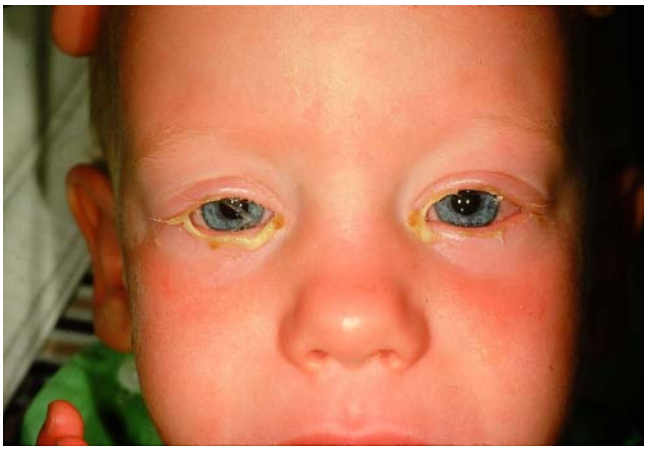

Figure 3. Bacterial conjunctivitis with bilateral eye involvement and profuse mucopurulent discharge.

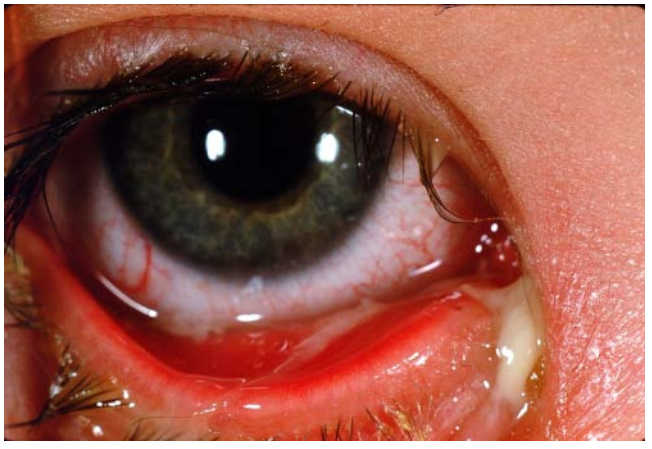

Figure 4. Bacterial conjunctivitis with thick, mucopurulent discharge and injected bulbar and palpebral conjunctivae.

however, aminoglycosides are not that effective against *Staphylococcus*. Excellent alternatives include fluoroquinolones such as ciprofloxacin and ofloxacin. Therapy for the first few days should be aggressive, and antibiotics should be instilled at least every 6 hours. Ointment may be preferable in children and in those in whom application is difficult. A recent study by Abelson et al found 1% azithromycin drops for 5 days to be safe and well tolerated in children and adults with bacterial conjunctivitis.[4] Aminoglycosides may be associated with toxicity to the corneal epithelium and may cause a reactive keratoconjunctivitis after several days of use. Fluroquinolones may be particularly indicated in children with contact lenses because of a high incidence of pseudomonas infection. Any child who is a contact lens user should be advised to remove the lenses until complete clearing of the eye and absence of discharge. If there is no significant corneal disruption, a steroid may be prescribed along with the antibiotic.

Herpes Infections

Usually associated with *Herpes simplex* virus (HSV) 2 infections. Herpetic keratoconjunctivitis may be associated with encephalitis and other systemic diseases, although it may occur as an isolated lesion. Ocular infection with HSV carries a significant risk of loss of vision. Primary HSV infection presents with conjunctivitis and enlarged preauricular nodes. In neonates, onset occurs 1 to 2 weeks after birth, and serous discharge with moderate conjunctival injection usually occurs only in 1 eye. Breakdown of the normal epithelial barrier may result in a corneal ulcer. Keratitis may be detected by a dendritic pattern in the cornea when fluorescein stain is applied to the eye. Diagnosis is confirmed by a viral culture.

Recurrent Ocular HSV

After the initial cutaneous facial infection or mucus membrane infection, the virus gains access to the sensory nerve endings and travels up the axons to the sensory ganglion. It remains sequestered in the ganglion, and recurrent ocular HSV infections occur when the virus travels down the sensory nerve and infects the cornea or eyelids. Clinical manifestations are similar to the primary HSV infection and consist of vesicles on the eyelids and conjunctivitis but may be more severe (Figure 5). It may present as symptomatic dendritic, disciform, and necrotizing forms of keratitis. In the dendritic form, branching lesions of the cornea occur, resulting in corneal ulceration and scarring. Disciform keratitis involves the cornea and is a result of the immune response to the virus. The cornea becomes anesthetized because of the sensory nerve damage, and corneal scarring can occur. Recurrent ocular HSV is always unilateral. Prompt recognition and treatment prevents blindness. Any recurrent, unilateral eye redness should raise the suspicion for herpes infection.

Figure 5. Herpetic conjunctivitis, with vesicles noted around the eye and injection of the conjunctiva.

Treatment. Topical trifluridine solution or vidarabine ointment may be used in primary cases. In a retrospective case series, Schwartz et al showed that oral acyclovir as an adjunctive to topical therapy may help in resolution of the infection in children.[5] Recurrent cases should also be treated with topical trifluridine solution. Prophylactic oral acyclovir may reduce recurrence.[6]

Parinaud's Occuloglandular Syndrome

This is a unilateral conjunctivitis associated with a nodule in the tarsal conjunctiva resulting in local swelling and ptosis, most commonly caused by cat scratch disease. The causative organism is a pleomorphic gram-negative bacillus called *Bartonella henselae*. The lid mass is associated with ipsilateral submandibular or preauricular lymph node enlargement. Rarely, optic neuritis and macular stellate neuroretinitis may occur. The patient usually gives a history of being around a kitten with or without being scratched by it. A positive skin test to cat scratch and antibody titers usually support the diagnosis. Other causes of oculoglandular syndrome include tuberculosis, *Staphylococcus aureus,* group A β-hemolytic *Streptococcus,* and tularemia.

Treatment. Some studies have shown resolution with treatment with tetracyclines, trimethoprim-sulfamethoxazole, or fluroquinolones for 2 weeks. Prognosis is excellent.

Hemorrhagic Conjunctivitis

Common causes of hemorrhagic conjunctivitis are picornaviruses such as enterovirus or coxsackievirus, but it can also be caused by adenovirus type 11. Acute hemorrhagic conjunctivits is highly contagious and usually occurs in epidemics. There is sudden development of hyperemic conjunctiva, subconjunctival hemorrhages, chemosis, lid swelling, tearing, photophobia, and pain. The symptoms last for 3-5 days and gradually resolve. Neurological complications occur rarely with certain adenoviruses and range from mild palsies to permanent flaccid paralysis. These neurological symptoms occur 2-3 weeks after the onset of conjunctivitis. Treatment is supportive with artificial tears, cold compresses, and topical decongestants. Treatment is mainly supportive.

Neonatal Conjunctivitis

Neonatal Infectious Conjunctivitis

Chlamydia trachomatis is the most common cause of infectious conjunctivitis in the neonatal period. It is acquired from the infected genital tract of the mother. It develops from a few days to several weeks after birth (usually 4-10 days after birth). Discharge is either mucopurulent or purulent and can be unilateral or bilateral. Inflamed conjunctiva, chemosis, and lid edema may occur. Diagnosis is confirmed by identifying cytoplasmic inclusion bodies in the corneal epithelial cells of conjunctival scrapings or by culture of secretions. However, the diagnostic methods of choice are the direct immunofluorescent assay using monoclonal antibody, enzyme immunoassay, or polymerase chain reaction (PCR).

Neisseria gonorrhoeae is the other cause of infectious conjunctivitis in neonates. It typically presents in the first week of life (usually within 2-4 days after birth) with marked purulent discharge, chemosis, and lid edema. Complications can be severe and may include corneal ulceration and perforation leading to blindness. Presence of gram-negative intracellular diplococci on Gram stain of the eye is presumptive evidence of this infection.

Infections with other bacteria such as *Haemophilus influenza, Staphyloccus aureus,* and *Streptococcus pneumoniae* may also occur from 2 days to 10 days

after birth. All produce inflamed conjunctivae and purulent discharge. Positive cultures are diagnostic. Conjunctivitis resulting from *Herpes simplex* may also occur from 1-2 weeks of age. Vesicles may be seen in the eyelids or conjunctivae. Diagnosis may be confirmed by PCR or culture.

Treatment. Neonates with conjunctivitis suspected to be due to *N. gonorrhoeae* should be hospitalized, a septic work up should be considered, and IV cefotaxime (ceftriaxone is avoided because of the possibility of induction of hyperbilirubinemia) should be started. If chlamydia is suspected, topical erythromycin ointment coupled with oral erythromycin therapy should be prescribed to eliminate nasal carriage of the organism. If HSV infection is suspected, the child should be hospitalized and started on topical trifluridine and intravenous acyclovir.

Neonatal Noninfectious Conjunctivitis: Chemical Conjunctivitis

This condition usually occurs within the first 24 hours after delivery and is usually caused by the instillation of silver nitrate drops. The conjunctivitis is bilateral, with a watery discharge and bulbar conjunctival injection. It generally resolves spontaneously in 3-5 days.

Noninfectious Conjunctivitis

Allergic Conjunctivitis

Patients with allergic conjunctivitis usually complain of itching and tearing of both eyes. The eyes may be injected, and the conjunctiva appears boggy (Figure 6). Serum immunoglobulin E levels may be high. Conjunctival scrapings reveal mast cells and eosinophils. Treatment should include avoiding the triggering agent, and application of antihistamine/mast cell stabilizer combination eye drops and artificial tears.

Vernal Conjunctivitis

This is a severe allergic condition that is characterized by itching, tearing, mucus production, giant papillae of the upper tarsal area, reactive ptosis, and squinting in the sun. It usually affects boys from the Mediterranean and Central and South America. Secondary keratitis occurs because of the scraping of the cornea by the giant papillae. Papillae with white centers may be found in the limbus (Horner-Trantas dots due to accumulation of eosinophils).

Figure 6. Allergic conjunctivitis with redness and bogginess of the conjunctiva. Note the mucus production.

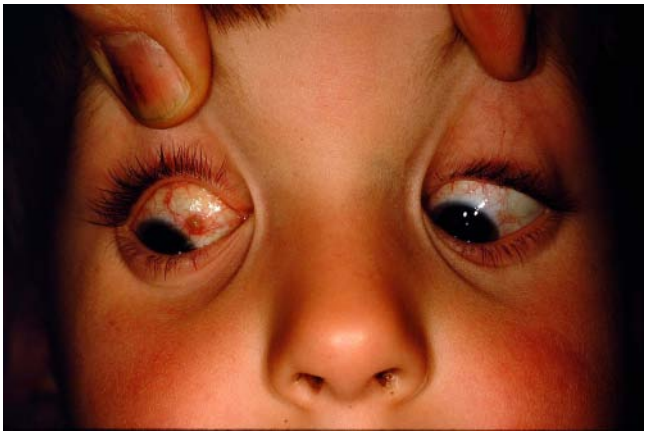

Figure 7. Phlyctenular conjunctivitis with a creamy yellow nodule on an erythematous base at the 3 o'clock position and injection of the bulbar conjunctiva.

Treatment. Eye drops containing mast cell stabilizers and antihistamines may be used.

Phlyctenular Conjunctivitis

This condition is a delayed hypersensitivity reaction to bacterial protein usually following staphyloccocal blepharitis. Tuberculosis may be a cause in areas where it is prevalent. Creamy white or yellow nodules on a base of erythema are seen around the 3 o'clock and 9 o'clock positions of the limbus (Figure 7).

Table 1. Systemic Conditions Associated with a Red Eye

Juvenile rheumatoid arthritis
Kawasaki disease
Inflammatory bowel disease
Stevens-Johnson syndrome
Vitamin A deficiency
Varicella, mumps, and measles
Collagen vascular disease
Head trauma with intracranial arteriovenous fistula

Conjunctivits Associated with Systemic Diseases

Some systemic conditions such as varicella infection, Stevens-Johnson syndrome, or Kawasaki disease may be associated with red eyes or conjunctivitis (Table 1).

Herpes zoster or *Varicella*

Varicella can rarely affect the eyes. Trifuridine may be prescribed. *Herpes zoster* may pose a serious risk in immuncompromised children, as the inflammation may involve all layers of the eye. These patients should be treated with antiviral medications.

Stevens-Johnson Syndrome

This is a type III hypersensitivity reaction associated with viruses, mycoplasma, and drugs, and it presents with fever, rash, malaise, and loss of appetite. Mucus membranes may be affected, and eye involvement may cause conjunctival injection and formation of bullae that may rupture and lead to extensive scarring.

Kawasaki Disease

This is an acute vasculitis disease of infants and children that is associated with a nonexudative conjunctivitis affecting both eyes. The diagnosis is clinical and includes a compilation of symptoms and signs that includes fever, nonexudative conjunctivitis, strawberry-appearing tongue, rash, swelling of hands and feet, and lymphadenopathy. A recent study found that neutrophilic conjunctivitis is characteristic of patients with acute Kawasaki disease and may be of value in the initial evaluation and follow-up of patients with this disease.[7]

Disorders of the Lacrymal System

Dacryoadenitis

This is an infection of the lacrimal gland that presents with sudden redness and swelling of the outer end of the upper eyelid. Etiology includes viruses (mumps, Epstein-Barr virus, cytomegalovirus, echovirus, varicella) and bacteria (*Staphylococcus aureus, Streptococcus pyogenous, Chlamydia trachomatis,* and *Neisseria gonorrhoeae*). This condition is generally treated with oral antibiotics such as dicloxacillin or clindamycin, and occasionally intravenous therapy with nafcillin may be required.

Dacryocystitis

This is a bacterial infection of the lacrimal sac that usually occurs as a result of a bacterial superinfection after a viral upper respiratory tract infection. This is generally preceded by a viral upper respiratory infection followed by fever, erythema, swelling, and tenderness in the area below and lateral to the medial canthus. Pus can be exuded from the sac when pressure is applied on the region. *Streptococcus pnemoniae* is commonly seen in neonates, whereas *S. aureus* and *S. epidermidis* are more common in older children. Most patients are toxic appearing and require parenteral antibiotics with nafcillin or clindamycin.

Congenital Glaucoma

This is a condition that is characterized by increased intraocular pressures. Normal pressure in a neonate is 10 to 15 mm Hg. The pressure is increased to greater than 30 mm Hg in congenital glaucoma. As the neonate's eye is elastic, it enlarges with corneal diameters greater than 12 mm. As the cornea enlarges, it breaks off the basement membrane, resulting in corneal edema. This process reduces vision and can result in amblyopia. The clinical presentation includes, tearing, photophobia, blepharospasm, large cornea, corneal clouding, and edema. Although rare, a red eye may be present. Most cases are bilateral. A dull red reflex may be seen with an ophthalmoscope.

Treatment. A reduction in intraocular pressures should be targeted, thus preventing optic nerve damage and reducing corneal edema. Medications

that may be used include a β-adrenergic inhibitor such as timolol and a carbonic anhydrase inhibitor such as acetazolamide. However, medical management may not always be effective, and surgery targeted at opening the outflow channels at the trabecular meshwork may be required.

Disorders of the Cornea

Keratitis

Keratitis in children may be caused by various factors. Inflammation or infection of the cornea often causes a concurrent inflammation of the conjunctiva, leading to the appearance of a red eye.

Superficial Keratitis

Superficial keratitis is usually caused by dry eyes, contact lens use, viral conjunctivitis, blepharitis, chemicals, and ultraviolet light. Complaints include eye discomfort, redness, pain, sensitivity to bright light, watering, and decreased vision. There may be a history of foreign body sensation in the eye. Characteristic clinical findings include superficial corneal epithelial defects, conjunctival inflammation, and hyperemia. Preauricular lymphadenitis may occur. Punctate lesions may be seen with flourescein eye staining, but a slit lamp examination may be necessary. Treatment should be directed to the underlying cause. An eye patch may provide symptomatic relief.

Disorders of the Sclera

The sclera is made up of thick collagen and connective tissue. The thin membrane between the sclera and conjunctiva is the episclera. Although scleritis is uncommon in children, it can occur in association with juvenile rheumatoid arthritis or infections with HSV, tuberculosis, mumps, syphilis, and varicella. Episcleritis occurs in association with certain systemic diseases including zoster, erythema multiforme, syphilis, and severe drug allergies (eg, penicillin). Episcleritis is inflammation of the episclera without the severe pain, which is common with scleritis and is characterized by an area of conjunctival injection with dilated vessels. Topical phenylephrine constricts the vessels of the conjunctiva but not of the epislcera or sclera and may be helpful in differentiating between conjunctivitis and episcleritis/scleritis. Treatment involves managing the underlying condition and use of nonsteroidal anti-inflammatory agents, cycloplegics, and topical steroids.

Disorder of the Uveal Tract: Uveitis

Uveitis is defined as an inflammation of any part of the uveal tract (iris, choroids or ciliary body, retina). Concurrent involvement of the adjacent ocular structures such as the optic nerve may occur. Specific designations are given depending on the area involved (eg. iritis for iris inflammation, cyclitis for ciliary body inflammation, or iridocyclitis when both are involved). Since all these structures share a common blood supply, inflammation may occur together. Inflammation of the anterior choroids, iris, and ciliary body is called anterior uveitis. Posterior uveitis is inflammation of the posterior choroids (choroiditis), retina (retinitis), or both (chorioretinitis). Intermediate uveitis refers to the involvement of the middle portion of the eye (retinal vessels and peripheral retina).

Uveitis is the third leading cause of blindness in this country, and about 10% of these cases occur in children. Since most uveitis in children is posterior, it is responsible for causing more blindness in children than in adults. Anterior uveitis is associated with multiple systemic disorders (Table 2).

Juvenile arthritis, particularly in girls with pauciarticular arthritis and a positive antinuclear antibody, is associated with uveitis, and hence frequent monitoring for this condition is important. It is thus important to screen for some of these diseases when treating a case of anterior uveitis.

Anterior uveitis or iridocyclitis presents with sudden onset of redness, pain, photophobia, and tearing. Visual acuity may be mildly decreased. On examination, the conjunctiva and sclera appear congested (ciliary flush), or perilimbic redness may occur. The pupil may be small and irregular with a clear cornea. Diagnosis is made with a slit lamp examination, which shows cells and protein within the aqueous chamber (aqueous flare). Keratic precipitates and adhesions between the iris and the anterior surface of the lens (posterior synechiae) may occur. Formation of anterior synechiae between the iris and the cornea may produce increased intraocular pressures and result in corneal edema.

Table 2. Some Systemic Diseases Associated with Anterior Uveitis

Juvenile arthritis
Girls: Pauciarticular with ANA +
Boys: Pauciarticular with HLA B27+
Psoriasis
Behcet disease
Kawasaki syndrome
Syphilis
Tuberculosis
Inflammatory bowel disease
Reiter's syndrome
Herpes simplex or *zoster*

The diagnosis of uveitis is often confused with that of conjunctivitis. Findings that distinguish uveitis from conjunctivitis include the watery discharge from the eye, absence of foreign body sensation, and a constricted and irregular pupil (a characteristic of uveitis).

Treatment. Early diagnosis and treatment improves prognosis. The mainstay of treatment is topical corticosteroids such as 1% prednisolone acetate. Resistant cases may require periocular steroids or rarely, oral steroids. Nonsteroidal anti-inflamatory agents may also be added to the regimen. Cycloplegic-mydriatic agents such as 1% atropine help reduce the development of synechiae.

Complications of uveitis include development of synechiae, band keratopathy, glaucoma, and cataract. In their study of 148 children with uveitis, Rosenberg et al found that 31% had 1 or more complications at the time of diagnosis, which increased to 83% by 3 years after diagnosis.[8] Anterior and intermediate uveitis had the highest risk of band keratopathy, whereas intermediate uveitis had the highest risk of cystoid macular edema. The authors conclude that uveitis is associated with numerous vision-threatening complications, which increase with the duration of the disease.

Disorders of the Orbit

Preseptal and Orbital Cellulitis

The orbital septum arises from and is continuous with the periosteum at the orbital rim, and it separates the soft tissues of the eyelid from those of the orbit. In preseptal or periorbital cellulites, the infection and inflammation are restricted to the tissues anterior to the orbital septum, whereas extension into the post-septal or orbital tissues constitutes orbital cellulitis. Other orbital infections with increasing severity include subperiosteal abscess and orbital abscess.

Preseptal cellulitis is more common than orbital cellulitis. The median age for children admitted with orbital cellulitis is 7 years. Both conditions may result from hematogenous seeding or by secondary spread from adjacent structures. Preseptal cellulitis usually results from direct inoculation near the eyelids from trauma, insect bites or any local infections (dacrocystitis, impetigo, chalazion, or hordeolum). Most cases of orbital cellulitis are caused by paranasal sinusitis, specifically ethmoid sinusitis because the orbit is separated from the ethmoid sinus by lamina papyracea, a paper-thin bone, which thus allows an easy extension of a sinus infection into the orbit. Moreover, the sinuses and orbits are drained by valveless and anastomosing veins, which makes it relatively easy for the infection to spread from one structure to another. Thus an infection originating in the paranasal sinuses can spread to involve the bones and the orbit. Moreover, the superior and inferior ophthalmic veins drain directly from the orbit into the cavernous sinuses, thus predisposing the cavernous sinuses to the spread of orbital and facial infections.

Other causes of periorbital and orbital cellulitis include: (1) hematogenous spread, including bacterial endocarditis; (2) penetrating trauma, chronic cocaine use, foreign bodies, and local surgery; and (3) maxillary odontogenic abscess as the primary sites of infection. Orbital cellulitis can follow blunt or penetrating trauma to the orbits.[9] It is important to rule out presence of orbital foreign bodies in penetrating trauma.

The infectious agents vary with the primary cause and age of the child. Harris et al noted in their study involving children less than 9 years of age that they were less likely to grow anaerobes and tend to have single organisms.[10] On the contrary, children older than 15 years had polymicrobial infections with mixed aerobes and anaerobes. The principal organisms causing orbital cellulitis are *Streptococcus pneumoniae*, nontypeable *Haemophilus influenza*, *Staphyloccus*, other streptococcal species, and non-spore-forming anaerobes. *Haemphilus influenza* is

no longer a significant pathogen causing orbital cellulitis or sinusitis. In a study of children with orbital cellulites, McKinley et al found S. *aureus* to be the most common organism, followed by streptococcal species.[11] They also found methicillin-resistant *Staphylococcus aureus* (MRSA) to represent nearly 73% of staphylococcal isolates. Only 2 of the 27 blood cultures yielded a positive result, whereas surgical aspirates yielded the highest number of positive cultures. Neonatal postseptal infections tend to form abscesses and are mostly a result of staphylococcal infections.[12] Fungal infections due to mucor and aspergillus may occur. Mucormycosis occurs mostly in diabetic ketoacidosis.

Clinical Features

Common complaints include sudden onset of fever, malaise, eye pain, and periorbital swelling, and in the case of sinusitis, associated upper respiratory symptoms. With preseptal cellulites, the erythema and swelling may extend over the superior orbital rim onto the brow, whereas this extension of erythema and swelling into the brow is not seen with orbital cellulitis. Presence of proptosis, impairment of eye movement, and impaired visual acuity are highly suggestive of postseptal involvement (Figures 8, 9, and 10). Other nonspecific findings of orbital cellulitis include pain, chemosis, conjunctival redness, and afferent pupillary defect. Most orbital cellulitis involves the formation of subperiosteal abscess. Posterior orbital cellulitis, which is a complication of sphenoethmoiditis in which visual loss occurs in the absence of other orbital symptoms, is an extremely rare disease.[13]

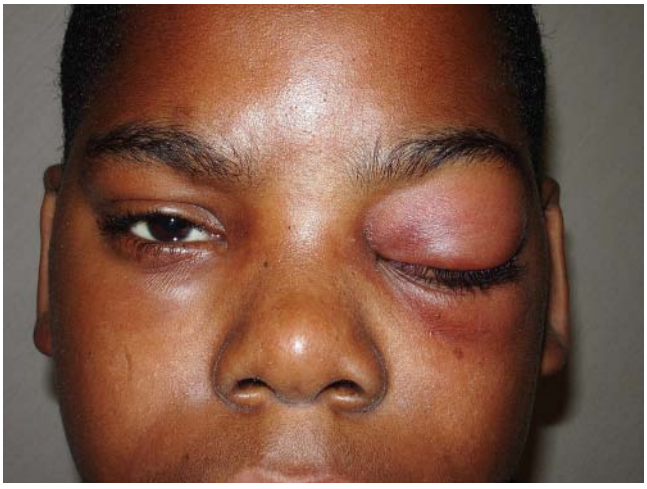

Figure 8. Orbital cellulitis with significant periorbital erythema and swelling.

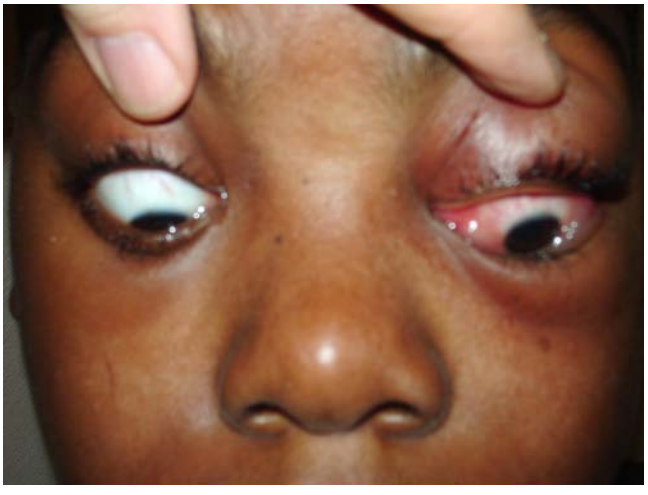

Figure 9. Orbital cellulitis with limited downward gaze, erythematous conjunctiva, and periorbital swelling.

Investigations

A complete blood count should be obtained in all cases suspected of having orbital cellulites as the white cell count is often elevated in those cases. Although blood cultures are more frequently positive in children than in adults, they still carry a low sensitivity. If the child appears toxic, a lumbar puncture should be performed. Cultures of the conjunctival sac and sinus and abscess aspirates may help in identification of the causative organism. Computerized tomogram is the most widely used modality for evaluating orbital cellulitis and allows differentiating preseptal from orbital cellulitis. A contrast-enhanced computerized tomogram with axial and coronal thin cut of the sinuses and orbits is the study of choice. A magnetic reasonance imaging is the preferred modality for diagnosing cavernous sinus thrombosis and gives further details of the soft tissues of the orbit, globe, visual pathways, and brain. Ultrasound is inadequate in visualizing the posterior aspects of the globe and thus is of limited value.

Treatment. If the child with the preseptal cellulitis is afebrile and appears nontoxic and reliability of

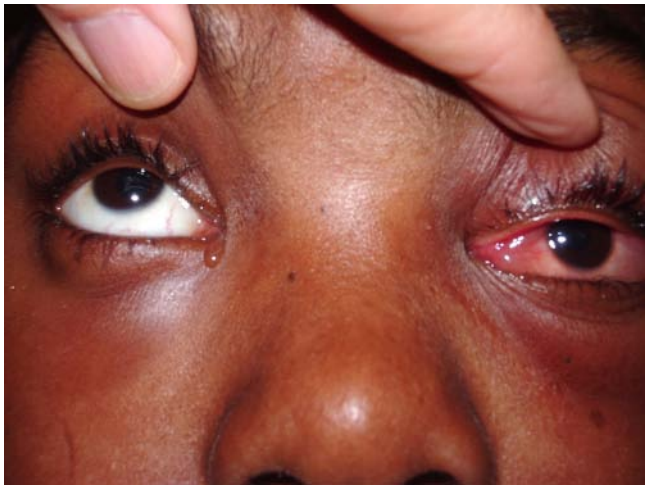

Figure 10. Orbital cellulitis demonstrating restriction of upward gaze, erythema, and periorbital swelling.

follow-up is assured, then the antibiotics may be administered orally. However, if the child looks toxic, the diagnosis is unclear, or orbital cellulitis or abscess is suspected, then hospitalization, imaging, and parenteral antibiotics are warranted. Also, preseptal cellulitis resulting from dacrocystitis in neonates mandates hospitalization and parenteral antibiotics.[12] Oral antibiotics such as amoxicillin/clavulanate or cefuroxime axetil should be used for outpatient management to cover β-lactamase producing organisms. Parenteral agents that can be used in children older than 12 years include cefuroxime or ampicillin/sulbactam. Addition of clindamycin or vancomycin in sick children should be considered in the face of recent studies showing increased MRSA. Intranasal decongestants such as oxymetazoline may be useful. Early consultation with both the ophthalmologist and the otorhinolaryngologist is important.

For orbital cellulites, antibiotics should be empirically chosen to be effective against *S. aureus, S. pyogenes*, anerobic bacteria and any pathogens such as *S. pneumoniae*, and *H. influenza,* which cause sinusitis. This list includes cefuroxime or ampicillin/sulbactam. Clindamycin or metronidazole may be added for suspected anaerobic organisms. Indications for surgery include the presence of a large abscess, ophthalmoplegia, visual acuity that is 20/60 or worse on initial exam, blindness, progression of orbital signs, and lack of improvement despite 48 hours of aggressive medical management. Some studies have reported success with drainage of the abscess with an endoscope, thus avoiding an external incision. Orbital abscess would necessitate drainage, and a cavernous sinus thrombus requires high-dose antibiotics. In their study of 9 patients with orbital cellulites, Starkey et al concluded that an initial medical management during this era of computerized tomography and vaccination is justified and avoids surgery.[14]

When the patient's condition improves, addition of oral antibiotics, for a total treatment period of 3 weeks, is warranted.

Complications. Meningitis, cavernous sinus thrombosis, and blindness are known complications of orbital cellulitis. Intracranial extensions including subdural empyema, intracerebral abscess, and extradural abscess may occur and are more commonly seen with a superior orbital abscess.[12]

Conclusion

Children presenting with a red eye to the pediatrician are a common occurrence. It is imperative that a thorough history be obtained and a systematic physical examination be performed. Once a diagnosis is made and a vision-threatening etiology has been ruled out, immediate treatment followed by close follow-up ensures healing and a good prognosis. Although most cases are benign and can be followed by the primary care physician, early referral to an ophthalmologist must be considered in certain cases to prevent severe complications.

Acknowledgment

The authors would like to thank Dr. Baker and Dr. Hartwig for their help with the figures of the different eye conditions.

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