Periorbital and orbital infections in children

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Bacterial infections of the periorbital and orbital tissues range in severity from minor to life-threatening. Preseptal (periorbital) cellulitis is more common than orbital cellulitis and occurs quite frequently in children. A history of antecedent trauma or upper respiratory tract infection is present in more than half of all cases. Evaluation by computed tomography scans is an indispensable part of the diagnostic procedure. All cultures should be obtained before institution of antibiotic therapy. Initial therapy should begin with administration of broad-spectrum antibiotics with adjustments made in response to positive culture results. Response to antibiotics is usually prompt and the incidence of complications is low. If clinical improvement is slow, surgery should be performed early in the course of the disease to minimize the potential for significant complications such as cavernous sinus thrombosis.

(Key words: Periorbital cellulitis, orbital cellulitis, orbital septum, subperiosteal abscess, cavernous sinus thrombosis)

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Periorbital infections are common in children and usually resolve promptly with appropriate therapy. Orbital infections are less common in this population and are frequently associated with serious complications. We review the classification, etiology, diagnosis, and therapy of these infections. A thorough understanding of their pathophysiology will help to avoid the potential morbidity associated with these conditions.

Anatomy

The anatomic development of the sinuses in children may play a part in the relative frequency of periorbital and orbital infections. The ethmoid sinuses are proportionally normal at birth, whereas the maxillary sinuses are small and poorly formed. The frontal sinuses are not formed at all at birth.¹ Congenital dehiscences of the orbital walls are common in newborn infants.² These factors may predispose the child to an increased risk of periorbital infection.

As the child grows, the orbital cavity becomes separated from the sinuses by thin bony plates. An example is the lamina papyracea, an extremely thin segment of bone that forms a portion of the medial wall of the orbit and the lateral wall of the ethmoid sinus. The venous system of the orbit and the paranasal sinuses have free communications through valveless channels. No lymphatic system exists within the orbit. These factors make the spread of infection relatively easy within the periorbital tissues.

The orbital periosteum, also known as the

Figure 1. Cross section of orbit. Note relationship of orbital septum to preseptal and postseptal (orbital) lamellae.

periorbital, is a thin tissue barrier lining the orbital walls. The periorbital acts as an obstacle to the spread of infection into or out of the orbit. The orbital septum is a fibrous tissue structure extending from each eyelid's tarsal plate to the orbital periosteum (Fig 1). This fascial plane separates the anterior eyelid lamella from the posterior lamella, or orbit contents. The septum provides a barrier to the spread of infection from one lamella to the other.

Classification

These infections are classified by a system established by Smith and Spencer³ and later modified by Chandler and colleagues⁴ according to the location of the infection with particular reference to the orbital septum. Classification is as follows:

- Class I. Periorbital or preseptal cellulitis is the most common pediatric adnexal infection in this class. One study reported 94% of children with orbital or periorbital infections as having preseptal cellulitis. Preseptal cellulitis is confined to the anterior lamellar tissues. Lid edema and erythema may be mild or severe (Fig 2). Typically, the globe remains uninvolved, with normal function and vision.
- Class II. Orbital cellulitis results from extension of infection through the septum into the orbital fat and other tissues. Manifestations of this infection include proptosis, limitation of retropulsion, impaired or painful motility, and periocular pain. Visual acuity may be impaired late in the course of orbital cellulitis, and septicemia may become apparent.
- Class III. Subperiosteal abscess may occur if pus collects between the periosteum and the orbital wall. Medial wall involvement (Fig 3) is most common, causing globe displacement inferiorly or laterally. Symptoms may be mild at first, or they may become severe and resemble orbital cellulitis.
- Class IV. Orbital abscess occurs when pus accumulates within orbital tissue. The infectious process may become localized and encapsulated, unlike orbital cellulitis which infiltrates the tissues diffusely. Proptosis, chemosis, ophthalmoplegia, and visual impairment are generally associated with this infection.
- Class V. Cavernous sinus thrombosis results from extension of the orbital infection to the intracranial space. Headache, nausea, vomiting, fever, pupillary dilation, and other severe systemic symptoms herald cavernous sinus thrombosis (CST). Optic nerve edema

Figure 2. Left: Preseptal cellulitis with complete ptosis. Right: Note marked periorbital swelling of upper eyelid as well as brow.

and involvement of the ophthalmic and maxillary branches of the trigeminal nerve may occur. It is interesting to note that tenderness and pain on extraocular motion may be absent with CST.

Etiology

Upper respiratory tract infections, sinusitis, and conjunctivitis may predispose a patient to preseptal cellulitis. However, this infection typically results from traumatic inoculation of infectious agents into tissues. Nasolacrimal duct obstruction and dacryocystitis may cause preseptal cellulitis in newborn infants. Posttraumatic infections are usually caused by *Staphylococcus* species or *Streptococcus* species, whereas *Haemophilus influenzae* or *Pneumococcus* species are responsible for most postrespiratory or sinus infections.^{5,6}

Orbital cellulitis and the other postseptal infections are usually caused by *Staphylococcus aureus*, *Streptococcus pneumoniae*, *H influenzae*, *Propionibacterium*, or anaerobic agents. Because of a lack of antibodies to the capsular antigens, children younger than 3 years are particularly susceptible to *H influenzae*. Extension of infection from the paranasal sinuses as well as facial infection and dental infection may cause most cases of orbital cellulitis. Trauma or perioperative factors may predispose to orbital cellulitis, as may lacrimal, systemic, or intraocular infection.

Orbital fungal infections are uncommon in children. A steady, indolent course of orbital swelling in children, with vomiting or diarrhea and dehydration, may indicate mucormycosis. Immunocompromised patients may also be predisposed to fungal infections.

Localization of infection within the periosteal space can result in a subperiosteal abscess; if the process extends to the tissues within the orbit, an orbital abscess may develop. Migration of infection intracranially will increase the likelihood of CST.

Diagnosis

Suspicion of a periorbital or orbital infection should prompt a thorough investigation. Immediate recognition and therapy are important in preventing the spread of infection and

Figure 3. Computed tomography scan demonstrates subperiosteal abscess along medial orbital wall. Note involvement of ethmoid sinus.

Figure 4. Top: Computed tomography scan shows marked soft tissue involvement with early postseptal spread of infection. Bottom: Coronal view of same patient.

the potential morbidity associated with these infections. Obtaining a thorough patient history is important to identify the onset and duration of symptoms, predisposing factors, and the medical condition of the patient.

Physical examination may reveal a child or

Figure 5. Left: Left orbital cellulitis in 2-year-old patient Right: Clinical improvement after antibiotics had been administered intravenously for 2 days.

young adult with a relatively sudden onset of unilateral chemosis, lid swelling, erythema, and proptosis. Ocular motility may be reduced or painful. Visual acuity and intraocular pressure must be recorded. Fundus evaluation will reveal the status of the optic nerve and the retina. Systemic evaluation may show pyrexia, malaise, irritability, or other signs of meningeal inflammation.

Conjunctival scrapings and cultures along with nasopharyngeal cultures may be obtained but are not mandatory because the results rarely correlate with blood and abscess cultures.⁷ If taken, blood agar and chocolate agar should be included as inoculum media. A complete blood cell count may reveal leukocytosis; blood cultures should be obtained in all cases.

Radiologic evaluation helps to assess the location and extent of the infection. Because in most instances sinus studies of children are difficult to interpret, computed tomograms (CT) of the orbits should be obtained (Fig 4). In the future, magnetic resonance imaging may play a part in the evaluation of periorbital infection. However, high contrast orbital CT remains the sine qua non at this time. Ultrasonography is useful in evaluating the orbit for abscesses or foreign bodies, but lesions adjacent to the globe or at the orbital apex may be difficult to interpret.

A strong suspicion of preseptal or orbital cellulitis requires the immediate hospitalization of the patient. Prompt recognition, thorough evaluation, and appropriate therapy prevent exacerbation of the infection and the onset of potentially deadly complications such as meningitis, cavernous sinus thrombosis, or brain abscess. The most common ocular complication is partial or complete loss of vision as a result of CST, septic optic neuritis, occlusion of the

ocular blood supply, or sustained high intraocular pressure. Once vision is lost, the process is usually irreversible.

Although proptosis is a major sign of orbital cellulitis, it is not unique to this type of infection. A study conducted by the Toronto Hospital for Sick Children separated proptosis into five major etiologic categories. Periorbital infections fell under inflammatory causes, along with sinus infections, and accounted for more than 30% of the children in the study. Hyperthyroidism was named as a common cause under metabolic and systemic diseases, and neoplastic causes included rhabdomyosarcoma and optic nerve glioma. Orbital hemorrhage secondary to trauma was a major cause of vascular proptosis. Developmental anomalies, such as craniostenosis, were grouped in a final etiologic category.⁸

Therapy

All cultures should be obtained before institution of antibiotics. The rapidity with which preseptal infections can spread should prompt an aggressive approach to antibiotic therapy. Empiric therapy with intravenous antibiotics should begin as soon as possible. More definitive therapy may be instituted as cultures identify the offending organism.⁹

Broad-spectrum coverage with cefuroxime, 200 mg/kg of body weight, may be instituted in three divided doses per day.¹⁰ Nafcillin sodium may also be given intravenously at a daily dose of 200 mg/kg of body weight if desired. Clindamycin or vancomycin hydrochloride may be substituted if the patient is allergic to penicillin.

The clinical response to antibiotic therapy may take up to 72 hours. Chandler and colleagues⁴ stated that more serious infections should show a reversal of fever within 8 hours

with aggressive intravenous antibiotics; otherwise, surgical intervention may be considered. If the patient improves, intravenous antibiotics should be maintained for a minimum of 7 to 10 days (Fig 5). The patient may then be discharged and given 10 days of oral amoxicillin/clavulanate potassium, cefadroxil, or other broad-spectrum cephalosporins. The patient is then followed up closely for several weeks to monitor for recurrence.

Surgery is indicated when clinical deterioration occurs, or if a foreign body can be shown to be the cause of the infection.¹¹ Intravenous antibiotics will not penetrate sufficiently into an orbital or subperiosteal abscess. In this case, surgery is mandatory. Up to 50% of more serious infections may require drainage of the sinuses, subperiosteal space, or orbits in addition to intravenously administered antibiotics.⁵ The antibiotics should be continued for 10 to 14 days after surgery. The possibility of osteomyelitis or a retained foreign body must be considered if recurrence or exacerbation of symptoms occurs.¹²

Summary

Bacterial infection of the periorbital or orbital tissues is a common clinical entity in children. The severity of the infection can range from mild to life-threatening; therefore, aggressive workup and therapy are paramount. Orbital and periorbital infections may be classified into groups based on location in tissues, with the orbital septum and orbital periosteum as distinguishing factors.

Preseptal cellulitis is common in the younger age groups and is typically caused by trauma or by upper respiratory tract infection. Orbital cellulitis, subperiosteal abscess, orbital abscess, and cavernous sinus thrombosis are less common but potentially more severe infections. Aggressive therapy is critical to prevent serious and often life-threatening concomitant complications.

Computed tomography scanning of the orbits is required for the diagnosis and classification of the infection and provides a basis on

which to begin therapy. Conjunctival and nasopharyngeal cultures can be obtained, but blood cultures are more helpful. Cultures and Gram staining of visible pus may be beneficial.

Broad-spectrum antibiotics are necessary for a prompt clinical response. As organisms are cultured, therapy may be adjusted according to sensitivities. Clinical improvement should be apparent soon after initiation of antibiotic therapy; otherwise, surgical intervention may be indicated. Surgical drainage of the infected tissues may be required to provide complete resolution. Prompt recognition, thorough evaluation, and appropriate therapy are necessary to prevent exacerbation of the infection and the onset of potentially deadly complications such as meningitis, cavernous sinus thrombosis, or brain abscess.

References

1. Duke-Elder S, Cooke C: Normal and abnormal development: Embryology, in Duke-Elder S (ed): *System in Ophthalmology Part 2: Congenital Deformities*. St Louis, The CV Mosby Co, 1963, vol 3, pp 827-976.
2. MacDonald D, Schneider K, Della Rocca RC: Childhood disorders of the orbit and ocular adnexa, in *Ophthalmic Plastic and Reconstructive Surgery*. St Louis, CV Mosby Co, 1987, vol 1, pp 331-332.
3. Smith AT, Spencer JT: Orbital complications resulting from lesions of the sinuses. *Ann Otol Rhinol Laryngol* 1948;57:5-27.
4. Chandler JR, Langenbrunner DJ, Stevens ER: The pathogenesis of orbital complications in acute sinusitis. *Laryngoscope* 1970;80:1414-1428.
5. Spires JR, Smith RJH: Bacterial infections of the orbital and periorbital tissues in children. *Laryngoscope* 1986;96:763-767.
6. Israele V, Nelson JD: Periorbital and orbital cellulitis. *Pediatr Infect Dis J* 1987;6:404-410.
7. Watters EC, Wallar PH, Hiles DA, et al: Evaluation of orbital cellulitis and results of treatment. *Arch Ophthalmol* 1976;94:785-788.
8. Crawford JS: Diseases of the orbit, in Toronto Hospital for Sick Children Department of Ophthalmology: *The Eyes in Children*. New York, Grune & Stratton Inc, 1983, pp 361-394.
9. Jackson K, Baker SR: Periorbital cellulitis. *Head Neck Surg* 1987;9:227-243.
10. Nelson JD: Cefuroxime: A cephalosporin with unique applicability to pediatric practice. *Pediatr Infect Dis J* 1983;2:394-396.
11. Schramm VL, Curtin HD, Kennerdell JS: Evaluation of orbital cellulitis and results of treatment. *Laryngoscope* 1982;92:732-738.
12. Rootman J, Robertson W, Lapoint JS: Inflammatory diseases, in Rootman J (ed): *Diseases of the Orbit*. Philadelphia, JB Lippincott Co, pp 143-159.