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Orbital complications of acute sinusitis

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In the pre-antibiotic era, orbital complications of acute sinusitis were not infrequent, often leading to severe patient morbidity, including blindness. Today, treatment of orbital complications consists primarily of systemic antibiotic therapy with surgical intervention reserved for large or medically unresponsive orbital or subperiosteal abscesses. Staging systems have been created to assist physicians in management and prognosis of such complications, but do not replace clinical acumen. Although powerful antibiotics have decreased the morbidity associated with orbital complications of acute sinusitis, the physician should remain aware of potential complications and ready to escalate treatment when necessary.

Introduction

Acute rhinosinusitis is the most common causes of severe orbital infections, responsible for 60%-80% of such cases.[1-4] Prior to antibiotic therapy, complications of sinusitis would often result in serious patient morbidity, including blindness in up to 20% of cases.[5] Sinus-related orbital complications can occur in all age groups, but are most common in the pediatric population.[2,6,7] The peak incidence of such complications is between 5 and 10 years of age. Yet, the likelihood of requiring surgical intervention is greater in the older child and adult populations.[8]

Pathophysiology

The proximity of the orbit to the sinonasal cavity facilitates the spread of infection between these 2 anatomic regions. The orbit is bounded medially by the ethmoid sinus, inferiorly by the maxillary sinus, posteriorly by the sphenoid sinus, and superiorly by the frontal sinus. Orbital complications are most often associated with infections of the ethmoid sinuses, followed by the maxillary, frontal, and sphenoid sinuses in that order.[1,3,8,9]

Infections involving the orbit occur by 2 proposed mechanisms:

(1) *Direct extension* of infection from the sinuses to the orbit can occur through a congenital dehiscence, open suture line or foramina, or by erosion of the lamina papyracea.[10-12] For example, an ethmoid cavity infection may extend through the medial orbital wall; infection of the frontal sinus may extend into the superior orbit; or maxillary sinusitis may break through the orbital floor.
(2) *Retrograde thrombophlebitis* through a valveless system of veins in the skin of the face, maxillary sinus, and nasal cavity can spread infection to the orbit and predispose the patient to involvement of the cavernous sinus.[10,13]

Inflammation within the orbit can lead to either temporary or permanent loss of vision in a relatively rapid fashion. Therefore, patients who are being evaluated for

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orbital infections secondary to rhinosinusitis should have visual acuity checks performed at regular intervals. Despite appropriate antibiotic and surgical intervention, there remains an up to a 10% incidence of permanent blindness with orbital complications of sinusitis.[3,9,14]

There are several proposed mechanisms by which orbital infections can lead to blindness. The first mechanism is ischemic optic neuropathy secondary to compression of the branches of the central and ophthalmic arteries leading to loss of perfusion to the optic nerve and retina.[14-16] Unless circulation to the central retinal artery is restored within 100 minutes, permanent blindness can result.[17] The next cause of blindness is compressive optic neuropathy secondary to direct pressure on the optic nerve itself. This pathology is most commonly associated with ethmoiditis. Patients typically present with visual loss and an afferent pupillary defect. Lastly, inflammatory optic neuropathy can result from reactive damage to the optic nerve secondary to an adjacent infection.

Diagnostic evaluation

Evaluation of a possible orbital infection should include a thorough history and physical exam focusing on the time course of the symptoms, history of trauma, changes in vision and color perception, and pain with eye motion. Early stage infections of the orbit typically present with periorbital edema and erythema. Suspected infections of the orbit or periorbita must first be differentiated from other etiologies of periorbital edema including allergy, local irritation, tumor, blunt trauma, or recent surgery. In cases of prior blunt trauma, the history and clinical course typically reveal the etiology as edema continues to increase for 48-72 hours and then slowly resolves over the following days. Early stage infectious etiologies include acute rhinosinusitis, acute dacryocystitis, and odontogenic sinusitis.

The physical exam should include a thorough ophthalmological evaluation including visual acuity testing, intraocular pressure monitoring, pupillary responses, and an assessment of extraocular motions. The ability to distinguish color can be used as a guide to assess disease progression as increasing ocular pressures cause a loss of red or green perception prior to any changes in visual acuity. Changes in pupillary reflexes will be noted once a significant visual loss has occurred.

Given that the primary etiology behind orbital infections is sinusitis, nasal endoscopy should be performed to assess the nasal cavity. The evaluating otolaryngologist should note any mucosal erythema or edema, polyps, purulent drainage, fungal debris, or evidence of masses or tumor. If purulent debris is noted, culture, gram stain, and sensitivities should be performed for aerobic and anaerobic species.

Imaging studies

Computed tomography (CT) scanning can be highly informative in the staging of orbital complications of sinusitis. CT is the exam of choice given its availability, short exam duration and ability to accurately assess the anatomy of the orbit, sinuses, and surrounding soft tissues. If appropriate, the scan can be utilized for intraoperative image guidance if endoscopic sinus surgery is performed. This exam requires thin slice scans of the face and sinuses with coronal and axial images, bone and soft tissue windows with intravenous (IV) contrast to determine the extent of the infection in and outside of the sinus cavities. Typically, CT scanning is unnecessary for the evaluation of preseptal cellulitis.[16,18] Many authors advocate for CT imaging if a patient fails to show improvement on 24-48 hours of broad spectrum IV antibiotics, when clinical evidence of periorbital infection is present (ie, exophthalmos, extraocular motion restriction, change in visual acuity or color perception) or in pediatric patients as the disease progression can be particularly aggressive in younger children. CT imaging with IV contrast can correctly stage orbital complications in the majority of cases and correlates with surgical findings in 84% of the cases.[19] It is also the best study for differentiating a subperiosteal abscess from an orbital abscess.[20] If an intracranial component to the infection is suspected, magnetic resonance imaging (MRI) can be helpful but should not be used as a routine component of the diagnostic workup. Cavernous sinus thrombosis (CST) can be detected on a contrast-enhanced CT scan when absent enhancement of the cavernous sinus is noted compared to the contralateral side. MRI can be helpful in assessing CST, especially given the incidence of associated intracranial complications. Once the initial diagnosis has been made, serial CT scans may be useful to monitor disease response and progression.

Classification and clinical presentation

In 1936, Hubert[21] published an anatomical classification system of orbital infections that was later modified by Chandler et al[1] in 1970. The anatomic classification scheme can be helpful in determining both prognosis and treatment.

Class 1

Preseptal cellulitis—involves inflammation and edema of the eyelid anterior to the orbital septum without any involvement of the orbital soft tissue posterior to the orbital septum (Figure 1).[22] This inflammatory edema is thought to be secondary to impaired venous drainage.[5] Preseptal cellulitis is the earliest and most benign orbital complication, and is also the most common. It compromises over 80% of the orbital complications from acute rhinosinusitis in most large series.[2,10,21,23]

On physical exam there may be edematous, tender eyelids with associated erythema that is confined anterior to the orbital septum. The patient may be febrile upon presentation. Proptosis should not be present in preseptal

Figure 1 A 11-year-old male who presented with a 2-day history of progressive orbital and facial swelling despite oral antibiotic therapy. This axial CT of the sinuses shows bilateral preseptal cellulitis (arrows) with associated ethmoid sinusitis. He was treated with intravenous antibiotics and taken to the operating suite for bilateral endoscopic ethmoidectomy. Intraoperative cultures grew methicillin-sensitive *Staphylococcus aureus* and *Enterococcus faecalis*. Following surgery and culture-directed intravenous antibiotic therapy he returned to his normal state of health.

cellulitis, but may be an early clinical sign in more advanced infections including orbital cellulitis, subperiosteal, and orbital abscess.

Class 2

Orbital cellulitis (postseptal)—involves inflammation and edema of the orbital contents posterior to the orbital septum without abscess formation (Figure 2).

Patients tend to present with orbital pain in over 80% of the cases.[4] On physical examination, proptosis and chemosis are typically present and can progress to ophthalmoplegia in severe cases. Preseptal cellulitis may progress to orbital cellulitis by extending posteriorly through the orbital septum.[14,18,24] Any changes in vision or extraocular mobility are signs of postseptal involvement.[25]

Figure 2 An adult male who presented with 5 days of facial pain, pressure, and nasal congestion and 2 days of worsening orbital pain with eye movement. This axial CT of the sinuses shows right-sided orbital cellulitis without abscess formation (small arrows) and inflamed right medial rectus muscle (large arrow) with adjacent right-sided ethmoid and sphenoid sinusitis. He was placed on broad spectrum intravenous antibiotic therapy and improved over 7 days without sequelae.

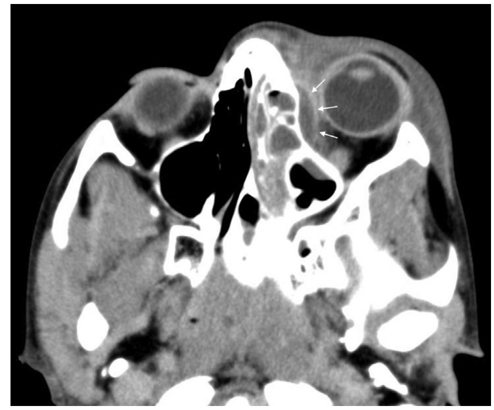

Figure 3 A 13-year-old male who presented with a 2-day history of fatigue, fevers, chills, worsening nasal congestion, and a 1-day history of left orbital swelling, double vision, and severe orbital pain. An axial CT with contrast enhancement shows a subperiosteal abscess (arrows) of the left medial orbit with rim enhancement. Note the adjacent left ethmoid and maxillary sinusitis. He was placed on broad spectrum intravenous antibiotics and taken to the operating room for left endoscopic sinus surgery with drainage of the subperiosteal abscess. Cultures grew normal respiratory flora. He improved and was discharged home without sequelae 48 hours after surgery.

Class 3

Subperiosteal abscess—is a purulent fluid collection between the orbital periosteum and the bony orbital wall, which typically forms between the medial orbital periosteum and the lamina papyracea (Figure 3). A collection in this location will displace the orbital contents inferiolaterally. Medial orbital wall subperiosteal abscesses are most common while more superiorly located subperiosteal abscesses, while less typical, are more prevalent in older children and teenagers.

Orbital subperiosteal abscesses may present without associated preseptal or orbital cellulitis and minimal symptomatology other than the pressure and nasal congestion of the associated acute rhinosinusitis. If an abscess is small, the extraocular mobility and vision typically remain intact but as the abscess enlarges, chemosis, decreased extraocular motion, and diminished visual acuity may develop.

Class 4

Orbital abscess—occurs when a purulent collection forms within the orbital tissue. This collection can be located between the orbital periosteum and the extraocular musculature (extraconal) or within the extraocular muscle cone (intraconal) (Figure 4). An orbital abscess typically occurs secondary to progression of orbital cellulitis or extravasation of a subperiosteal abscess.

Orbital abscesses are difficult to clinically differentiate from orbital cellulitis although patients are more likely to appear toxic with severe ophthalmoplegia, proptosis, and globe displacement. They also tend to have decreased

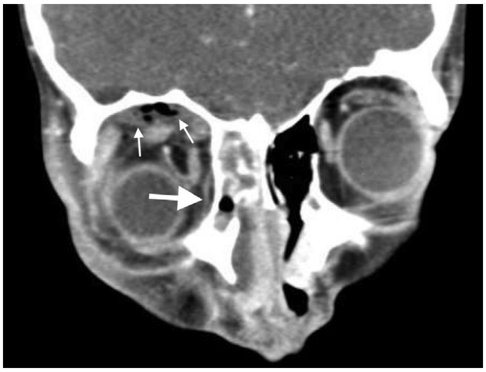

Figure 4 A 11-year-old male patient with a history of recurrent acute sinusitis who presented with a 2-day history of rapidly worsening nasal congestion, fever, orbital pain, and tearing. A coronal CT demonstrated a right extraconal superior orbital abscess with associated emphysema (small arrows), a small right medial subperiosteal abscess (large arrow), and adjacent ethmoid sinusitis. Upon admission, he was taken to the operating room for a superior orbitotomy to drain the superior abscess and endoscopic ethmoidectomy with maxillary antrostomy. Intraoperative cultures grew *Streptococcus anginosus* and *Eikenella corrodens*. Despite culture-directed antibiotics, his progress stalled and he returned to the operating room 5 days later for revision endoscopic sinus surgery with drainage of the right medial orbital subperiosteal abscess. He was discharged from the hospital 4 days later and returned to his normal state of health after completing outpatient intravenous antibiotic therapy.

extraocular mobility. If infection extends posteriorly to the orbital apex, decreased visual acuity may be present. Intracranial extension should be suspected with mental status changes, spiking fevers, and contralateral nerve palsy.

Class 5

Cavernous sinus thrombosis (CST)—typically occurs via retrograde thrombophlebitis or direct extension along the ophthalmic vein from infection of the ethmoid or sphenoid sinuses.[26,27] CST is a potentially fatal intracranial complication of acute rhinosinusitis. The cavernous sinus lies adjacent to the sphenoid sinus and collects venous blood from the face, orbit, and sphenoid mucosa. Once in the ipsilateral cavernous sinus is involved, the infection can extend through the intercavernous sinus to the contralateral side and into the dural sinuses.[26,28]

Early signs and symptoms of CST include headache, fever, photophobia, diplopia, and periorbital edema.[28] Headache is the most common early symptom of CST and may precede fever and orbital signs. The headache is often sharp in character, rapidly progressive in severity, and located in the distributions of the unilateral distributions of the first (V1) and second (V2) distributions of the trigeminal nerve. Periorbital edema may be seen early in the clinical course followed by severe and rapidly progressive chemosis, ophthalmoplegia, or cranial nerve palsy with associated diplopia, proptosis, decreased visual acuity, epiphora, and retinal engorgement.[27,29] Ophthalmoplegia and diplopia occur due to inflammation of cranial nerves III, IV, and VI as they travel through the cavernous sinus. In cases of CST cause by sphenoid sinusitis, lateral gaze (abducens nerve) palsy may present prior to complete ophthalmoplegia due to its medial course within the cavernous sinus. Ptosis, mydriasis, and ophthalmoplegia occur with inflammation and dysfunction of cranial nerve III, which contributes parasympathetic innervation to sphincter of the iris and innervates the levator palpebrae superioris. Unilateral hypesthesia or facial pain may occur with inflammation of V1 and V2 as they travel through the cavernous sinus. Fever and changes in mental status may be seen. The hallmark finding of CST is bilateral ocular symptoms[8,30] although unilateral ocular symptoms with fever should warrant suspicion of CST.[31]

Medical therapy

Medical management with intravenous (IV) antibiotic treatment is central to the treatment paradigm for patients with orbital complications from acute rhinosinusitis, whether or not surgical intervention is also required. Medical management alone, without surgical therapy, is reserved for preseptal cellulitis, orbital cellulitis without impaired vision, and subperiosteal abscess in young pediatric patients meeting certain criteria. Bacteremia is uncommon but can be seen in the pediatric population.[9,25,32,33]

Common pathogens

Selection of antibiotic therapy is dependent on patient age and suspected infectious organism, as well as the extent of complications. Patients who present with orbital complications of acute rhinosinusitis have often received antibiotic therapy before a culture being obtained. Infections, particularly in older children and adults, are usually polymicrobial, with a mix of aerobic and anaerobic organisms. Children under 9 years of age are more likely to have monomicrobial aerobic infections. *Staphylococcus aureus* and streptococci species, such as group A beta-hemolytic streptococci (ie, *Streptococcus pyogenes*) and *Streptococcus anginosus*, are the most common microorganisms identified in this population.[34] Methicillin-resistant *Staphylococcus aureus* (MRSA) is becoming an increasingly common pathogen.[35] Although *Streptococcus pneumoniae* was more common in the past,[36] its prevalence has decreased owing to the advent of a commonly administered vaccine against this organism. Anaerobes may also be isolated in these orbital infections with oral flora and odontogenic organisms as a source.[37]

Medical management

Antibiotic management should cover the most common organisms noted above. In addition to antibiotic therapy, medical management of complicated acute sinusitis includes high-volume nasal saline irrigations and topical decongestant sprays. Because of the potential morbidity of orbital infections, vancomycin is often used as a first-line agent in these patients; however, ceftriaxone, cefotaxime, ampicillin-sulbactam, and piperacillin-tazobactam may be acceptable alternatives, depending on the clinical presentation. In cases where anaerobic infection is suspected because of possible odontogenic origin or the presence of gas in an abscess on imaging studies, antibiotic coverage may need to be broadened with the addition of metronidazole. If methicillin-sensitive *Staphylococcus aureus* (MSSA) is recovered in cultures, vancomycin can be switched to nafcillin or oxacillin. Patients are usually kept on intravenous antibiotic therapy until there has been substantial clinical improvement and an absence of fever for at least 24 hours. Clindamycin or sulfamethoxazole or trimethoprim plus amoxicillin, amoxicillin-clavulanate, cefpodoxime, or cefdinir are usually recommended as an oral regimen if definitive culture data are not available.

Surgical therapy

While medical therapy is sufficient for treatment of many patients with orbital infections from acute rhinosinusitis, particularly those with Class 1 or 2 disease, surgical treatment is often necessary in patients with advanced diseased, particularly if an orbital abscess or visual compromise are present.

Subperiosteal abscess: deciding if surgery is necessary

Subperiosteal abscess of the medial orbital wall in patients with ethmoiditis may be surgically drained with endoscopic anterior ethmoidectomy and removal of a portion of the lamina papyracea. Emergent drainage is required if vision is compromised.

In younger children, nonsurgical treatment may be appropriate in certain circumstances. Garcia and Harris[38] have advocated for the use of specific criteria to consider nonsurgical management in patients less than 9 years of age. These criteria include absence of visual compromise, small or moderate medial abscess (less than 10 mm), absent intracranial or frontal sinus involvement, and no expectation of anaerobic infection (no gas in the abscess or suspicion for odontogenic origin). The age cutoff was established based on data demonstrating that children under 9 years of age were more likely to have negative or single aerobe cultures, and most responded to medical management, whereas complications associated with subperiosteal abscess, as well as anaerobic and polymicrobial infections, were associated with older children and adults.[39] In a series of 37 pediatric patients treated according to these guidelines, 27 of 29 children (93%) who met the above criteria for medical management experienced complete resolution of their infection, while 2 required surgical intervention.[38] If patients do not improve within 48-72 hours, worsen, or show signs of visual compromise, they should be brought to the operating room even if originally triaged to medical management.

In neonates and infants, subperiosteal abscess is extremely rare. A recent review found only 11 cases of subperiosteal abscess in infants in the literature, 9 of which were drained through either open or endoscopic approaches, and 1 of which ruptured spontaneously.[40] There was 1 death of a patient whose abscess did not rupture spontaneously and was not surgically managed; therefore, the authors advised surgical management for infants. More aggressive treatment of orbital infections in this age group may reflect the more complex microbiology associated with neonatal infections.

Subperiosteal abscess drainage: surgical technique

For patients requiring surgical drainage, the surgical approach depends on the location of the abscess and extent of disease. For medial or inferiorly based subperiosteal abscesses, an endoscopic approach is generally appropriate. Superomedial abscesses can sometimes be amenable to endoscopic drainage, whereas superolateral orbital abscesses require an external approach and are more commonly associated with frontal, rather than ethmoid, sinusitis.

The endoscopic approach for drainage of a medial subperiosteal orbital abscess utilizes a surgical set up and instrumentation similar to that used for standard endoscopic sinus surgery. The procedure is performed under general anesthesia. An image-guidance system is registered at the start of the procedure, so as to be available during surgery if needed. The nasal tissues are decongested with topical oxymetazoline and injected with 1% lidocaine with 1:100,000 epinephrine. Because of the presence of an acute infection, it is common for the sinus mucosa to be more edematous and the surgical field to be bloodier than for routine sinus surgery.

At the start of surgery, the middle turbinate is medialized for better access to the lateral nasal wall. A maxillary antrostomy is then performed with removal of the uncinate process and identification of the natural ostium. The ostium is enlarged in a posterior direction to allow for visualization of the posterior and superior maxillary walls. The superior wall corresponds to the level of the orbital floor.

Next, the ethmoid bulla is opened and its bony fragments removed. The basal lamella is then entered inferomedially and the posterior ethmoids opened. Once the ethmoid roof has been identified, the surgeon dissects from a posterior-to-anterior direction to remove remaining ethmoid partitions along the skull base and medial orbital wall.

The lamina papyracea should be well exposed at this point. It is entered by applying gentle pressure with a small periosteal elevator or spoon to crack the thin bone of the lamina. The created bony fragments are elevated and removed. For a subperiosteal abscess, removal of the lamina will lead to decompression of the abscess. Complete removal of the lamina papyracea is not necessary, so long as the abscess has been completely decompressed and drained.[41] Cultures should be taken from the abscess cavity. Palpation of the eye externally should reveal decompression and reduction of proptosis if present. If no pus is decompressed with removal of the lamina papyracea, the diagnosis of subperiosteal abscess should be called into question, and orbital abscess considered. In that scenario, the underlying periorbita should be incised for decompression of a possible orbital abscess.[42] Nasal packing should be avoided if possible to allow for maximal decompression and drainage of the abscess site.

For patients with an orbital abscess or orbital cellulitis without abscess, but with concerning features such as loss of visual acuity or lack of improvement with antibiotic treatment, incision of the periorbita may be necessary for abscess drainage or decompression. The endoscopic approach is effective for drainage of a medial orbital abscess. For abscesses located in other regions of the orbit, an orbitotomy performed through an external or transconjunctival approach is usually necessary.

Treatment results

Preseptal cellulitis is typically successfully treated with medical management. In a retrospective review of 48 pediatric patients with preseptal cellulitis, 100% of infections resolved with 3-4 days of parental antibiotics followed by oral antibiotic therapy.[43] Orbital cellulitis, on the other hand, often requires surgical intervention. In a series of 20 pediatric patients admitted with orbital cellulitis, 65% required operative intervention while the remaining 35% responded well to medical treatment. All patients in this series recovered without functional deficit or sequelae.[44] Fortunately, in the antibiotic era, CST is rare and there are few studies looking at clinical outcomes. In a review of 9 pediatric cases of CST secondary to acute rhinosinusitis, all patients underwent endoscopic sinus surgery with 4 undergoing an orbitotomy due to orbital cellulitis. All 4 of these patients with orbital cellulitis had a permanent decrease in visual acuity; only 1 patient without orbital cellulitis suffered from decreased vision postoperatively.[45]

Conclusion

Orbital complications of acute sinusitis require urgent evaluation and treatment. Ophthalmologic consultation is required for any patient with a postseptal infection. In select cases, a trial of medical therapy is initiated, and surgery is performed if the patient fails to improve clinically. Patients with visual compromise require immediate surgical management. Subperiosteal abscesses located medially along the orbit can often be drained endoscopically, while superiorly located abscesses may require an open approach for access. While severe orbital complications of acute rhinosinusitis are rare in the antibiotic era, high clinical suspicion and prompt intervention are important to reduce the morbidity and mortality associated with these serious infections.

Disclosure

The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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