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High risk and low prevalence diseases: Orbital cellulitis

Jessica Pelletier [a], Alex Koyfman [b], Brit Long [c,*]

[a] Department of Emergency Medicine, Washington University School of Medicine, St. Louis, MO, USA
[b] Department of Emergency Medicine, UT Southwestern, Dallas, TX, USA
[c] SAUSHEC, Department of Emergency Medicine, Brooke Army Medical Center, Fort Sam Houston, TX, USA

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ABSTRACT

Introduction: Orbital cellulitis is an uncommon but serious condition that carries with it a potential for significant morbidity.
Objective: This review highlights the pearls and pitfalls of orbital cellulitis, including presentation, diagnosis, and management in the emergency department (ED) based on current evidence.
Discussion: Orbital cellulitis refers to infection of the globe and surrounding soft tissues posterior to the orbital septum. Orbital cellulitis is typically caused by local spread from sinusitis but can also be caused by local trauma or dental infection. It is more common in pediatric patients compared to adults. Emergency clinicians should first assess for and manage other critical, sight-threatening complications such as orbital compartment syndrome (OCS). Following this assessment, a focused eye examination is necessary. Though orbital cellulitis is primarily a clinical diagnosis, computed tomography (CT) of the brain and orbits with and without contrast is critical for evaluation of complications such as abscess or intracranial extension. Magnetic resonance imaging (MRI) of the brain and orbits with and without contrast should be performed in cases of suspected orbital cellulitis in which CT is non-diagnostic. While point-of-care ultrasound (POCUS) may be useful in differentiating preseptal from orbital cellulitis, it cannot exclude intracranial extension of infection. Management includes early administration of broad-spectrum antibiotics and ophthalmology consultation. The use of steroids is controversial. In cases of intracranial extension of infection (e.g., cavernous sinus thrombosis, abscess, or meningitis), neurosurgery should be consulted.
Conclusion: An understanding of orbital cellulitis can assist emergency clinicians in diagnosing and managing this sight-threatening infectious process.

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1. Introduction

This article series addresses high risk and low prevalence diseases that are encountered in the emergency department (ED). Much of the primary literature evaluating these conditions is not emergency medicine focused. By their very nature, many of these disease states and clinical presentations have little useful evidence available to guide the emergency physician in diagnosis and management. The format of each article defines the disease or clinical presentation to be reviewed, provides an overview of the extent of what we currently understand, and finally discusses pearls and pitfalls using a question and answer format. This article will discuss orbital cellulitis. This condition's low prevalence but high morbidity, as well as its variable atypical patient presentations and challenging diagnosis, makes it a high risk and low prevalence disease.

1.1. Definition

Orbital cellulitis refers to inflammation of the globe contents and surrounding soft tissues posterior to the orbital septum, typically involving an infectious process [1,2]. This disease process falls into Group 2 of the Chandler classification, a system utilized to describe severity of infections of the eye and surrounding tissues (Table 1) [1]. Increasing group number implies increasing severity of infection [1]. Jain et al. proposed simplifying periorbital infections into three groups by severity (Table 1) [1]. The Chandler classification was originally based on clinical examination findings, but in the current era, computed tomography (CT) with intravenous (IV) contrast plays an important role in differentiating the degree of periorbital infection [3]. Regardless of the classification system used, preseptal cellulitis is a superficial infection whereas orbital cellulitis represents a serious, vision-threatening disease process; therefore, it is essential to differentiate these distinct pathological entities.

* Corresponding author at: 3551 Roger Brooke Dr, Fort Sam Houston, TX 78234, USA.
E-mail address: brit.long@yahoo.com (B. Long).

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Table 1
Chandler [1] and Jain [4] classification systems for periorbital infections.

Chandler	Jain
Group 1 - Preseptal cellulitis	Preseptal cellulitis
Group 2 - Orbital cellulitis	Orbital cellulitis (with or without intracranial complications)
Group 3 - Subperiosteal abscess	Orbital abscess (with or without intracranial complications)
Group 4 - Intraorbital abscess	• Intraorbital abscess
Group 5 - Cavernous sinus thrombosis	• Subperiosteal abscess

1.2. Pathophysiology

The ocular globe sits within the bony cavity of the orbit, which is lined by periosteum (periorbita), a fibrous membrane (Fig. 1) [1]. This periorbita is the only true barrier between the orbit and the thin-walled ethmoid sinus [1]. The periorbita forms a reflection and merges with the tarsal plate to form the orbital septum [1]. The orbital septum maintains the globe, periorbital fat, and extraocular muscles within the orbit [1]. The superior and inferior orbital veins drain directly into the cavernous sinus, and the inferior orbital valves do not contain valves [1].

Sinusitis is the most common cause of orbital cellulitis. The ethmoid sinus is the only developed sinus at birth, and thus orbital cellulitis is typically caused by ethmoid sinusitis in children younger than seven years [3]. Bacteria can spread through the thin medial wall of the orbit (lamina papyracea), which contains perforations for blood vessels and nerves and natural fenestrations [5]. There can also be retrograde travel of bacteria via the venous system [1,3,6]. The frontal, maxillary, and sphenoid sinuses develop later in childhood, and sinusitis in these areas contribute to orbital cellulitis in older children and adults [7].

Direct involvement of the optic nerve or orbital compartment syndrome (OCS) secondary to infection and subsequent compression of the optic nerve may lead to visual defects, altered color vision, or a relative afferent pupillary defect (RAPD) [8]. Focal consolidation of infection between the periorbita and the bones of the orbit results in subperiosteal abscess [1]. This most commonly occurs medially, and abscess may extend outside of the subperiosteal space and into the orbit [8]. The absence of valves in the venous system draining the eye allows for infection to track from the orbit to the cavernous sinus or even the brain, producing meningitis or intracranial abscesses [1].

Haemophilus influenzae type B (HIB) caused the majority of orbital cellulitis cases prior to the introduction of the HIB vaccine, and this species was also highly associated with bacteremia [9-11]. However, HIB causes only 3.5% of cases in the current era [10]. The most common causative organisms in orbital cellulitis in the current era include gram-positive cocci [12], typically *Staphylococcus aureus* followed by *Streptococcus* species [13]. Methicillin-resistant *Staphylococcus aureus* (MRSA) is increasingly prevalent in cases of orbital cellulitis, causing 5–6.5% of total cases and as high as 73% of *Staphylococcus* cases [13-15]. Gram-negative and anaerobic organisms are also implicated in orbital cellulitis, with anaerobes increasingly prevalent when dental infections are the underlying source [10,15]. Anaerobic infections are more common in older children than in younger children, likely due to the narrowing of sinus ostia [16,17]. Fungal etiologies such as mucormycosis and *Aspergillus* may occur in immunocompromised patients, including those with human immunodeficiency virus (HIV) and neutropenia [18].

1.3. Epidemiology

Orbital cellulitis is primarily a pediatric disease, with an incidence of 1.6 per 100,000 in children, compared to 0.1 per 100,000 in adults [19]. Ethmoid sinusitis is the underlying cause of orbital cellulitis in 43% to

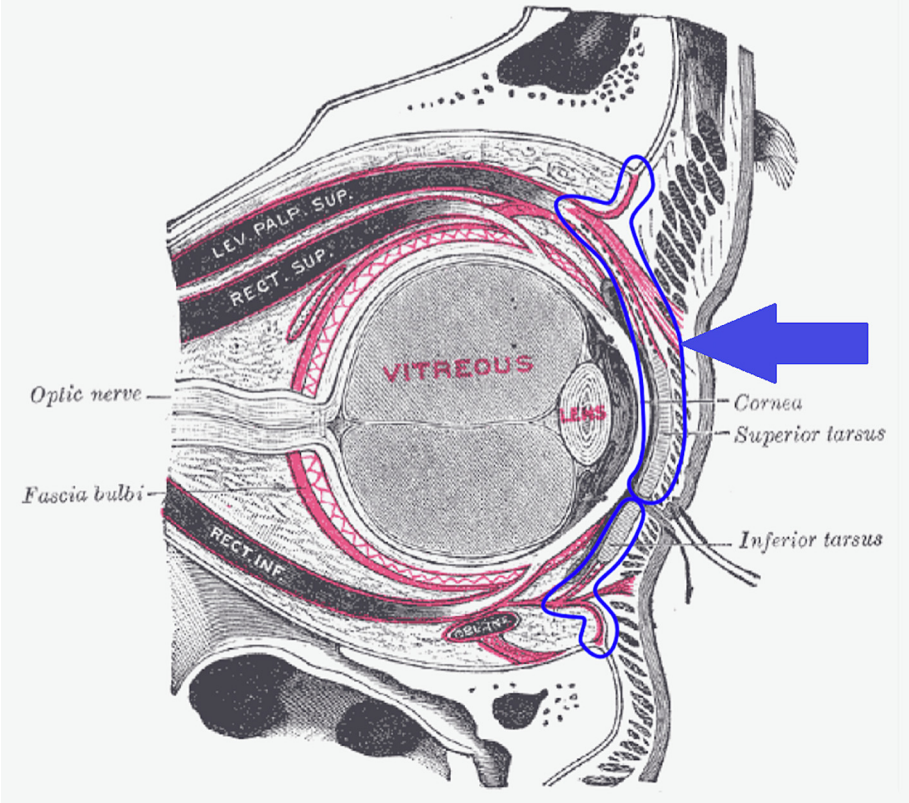

Fig. 1. Anatomy of the eye, including the orbital septum (outlined and indicated by the arrow). Open-access image reference: Häggström, Mikael (2014). "Medical gallery of Mikael Häggström 2014". *Wiki Journal of Medicine***1** (2). 10.15347/wjm/2014.008. ISSN 2002-4436.

100% of pediatric cases [10,20-27]. Greater than one sinus is found to be involved in 38% of cases, and pansinusitis has been observed in 15.7% of children [17,27,28]. The sinus etiology differs in adults, with 50% having some form of sinusitis and 11% demonstrating infection in greater than one sinus [17,28]. Frontal sinusitis is a more common etiology for orbital cellulitis in adults compared to children [29-31]. Between 1.5 and 5.6% of sinusitis cases progress to orbital cellulitis [32,33].

Trauma is a less common cause of orbital cellulitis (compared to preseptal cellulitis, in which trauma and bacteremia are the most common causes) [24,27,34]. There is a male prevalence of orbital cellulitis in low- and middle-income countries, possibly due to the higher propensity for work-related injuries in these regions [35-37]. There are mixed data from industrialized countries, but several studies suggest a male predominance [38,39]. Dacryocystitis and dental infections are other potential causes for orbital cellulitis [24,40,41]. Some studies have identified seasonality of orbital cellulitis, with cases occurring more frequently in the winter and early spring (overlapping with the peak timing of rhinosinusitis) [28,37]. Other causes include ophthalmic surgery, peribulbar anesthesia, and endogenous seeding from bacteremia [31,42,43].

The prognosis of orbital cellulitis when treated with early antibiotic therapy in the current era is overall favorable. This is in stark contrast to its morbidity in the past. In the pre-antibiotic era, the mortality rate from intracranial complications (e.g., cavernous sinus thrombosis, intracranial abscess) was 19%, 20% lost vision in the affected eye, and 13% had reduced visual acuity [44]. In a retrospective chart review conducted from 1978 to 1988, 4/159 patients suffered from permanent blindness [45]. In the current era with appropriate therapy, the overall rate of vision loss for patients with orbital cellulitis approaches 0%, though 3–11% can experience vision changes [17]. If orbital cellulitis progresses to endophthalmitis, there is a higher risk for poor visual outcomes [46]. The mortality rate associated with orbital cellulitis approximates 1–2%, but it may be as high as 40% in patients with intracranial abscess [47]. Unfortunately, patients with orbital cellulitis in low- and middle-income countries tend to seek care later in the course of disease and hence are more likely to experience complications [37].

2. Discussion

2.1. Presentation

Orbital cellulitis typically presents with a painful, red eye. Up to 95.9% of patients have eyelid swelling, and 77.7% have eyelid erythema [13]. Several other pathologies may present with similar symptoms, and thus the clinician should evaluate for "red flags" that distinguish orbital cellulitis from more benign causes of the painful, red eye (i.e., preseptal cellulitis). These red flags include pain with eye movements, restricted eye movements, photophobia, diplopia that resolves when the affected eye is closed, decreased visual acuity, decreased color vision, RAPD, and proptosis (Fig. 2) [8,48]. Decreased visual acuity with elevated intraocular pressure (IOP), with or without a RAPD, suggests OCS, a vision-threatening emergency [8]. Fever is common in orbital cellulitis (70.9% of cases in a pediatric retrospective cohort study) [13]. While fever may occur with preseptal cellulitis, it is more strongly associated with orbital cellulitis [48]. Headache, facial pain, and other symptoms of sinusitis such as rhinorrhea may be present given the close association of orbital cellulitis with sinusitis [4].

It is critically important to distinguish preseptal from orbital cellulitis, given that the management of these diseases differs markedly. Visual acuity may be subjectively reduced in preseptal cellulitis due to swelling of the infected lids, but this should resolve with lid retraction [8]. Color vision and visual fields should be unaffected in preseptal cellulitis [8]. Other major clinical findings in orbital cellulitis that should not be present in preseptal cellulitis include pupillary abnormalities, altered extraocular movements, and proptosis [8].

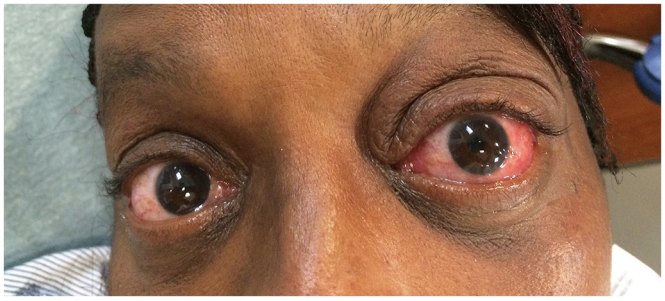

Fig. 2. Proptosis of the left eye. This is a classic clinical sign seen in orbital cellulitis. Open-access image obtained from: https://wikem.org/wiki/File:Proptosis_2014-10-28_12-32.jpg#filelinks

2.2. ED evaluation

Orbital cellulitis is primarily a clinical diagnosis, but the condition is confirmed based on imaging [46,49]. History should include any precipitating trauma, recent dental infections or procedures, visual symptoms (e.g., pain, visual changes), and systemic signs and symptoms of infection (e.g., fevers, chills, rigors) [49]. Inflammatory markers such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) may be elevated in both preseptal and orbital cellulitis [24]. Leukocytosis may be present, with a sensitivity of 19–33% in orbital cellulitis [24,27,29]. Blood cultures should be obtained, but their yield may be as low as 3% [27]. CT imaging of the brain and orbits with and without IV contrast is the imaging modality of choice in the ED setting to evaluate for the presence of an abscess or intracranial extension (Figs. 3 and 4) [3,49]. CT should be performed if the patient has signs and symptoms of intracranial involvement (e.g., headache, meningismus, high fever, vomiting, focal neurologic deficits, altered mental status) [50-52]. Lumbar puncture should be performed in these cases if CT reveals no evidence of elevated intracranial pressure or space-occupying lesion and the patient does not have other contraindications such as neurologic examination abnormalities [49].

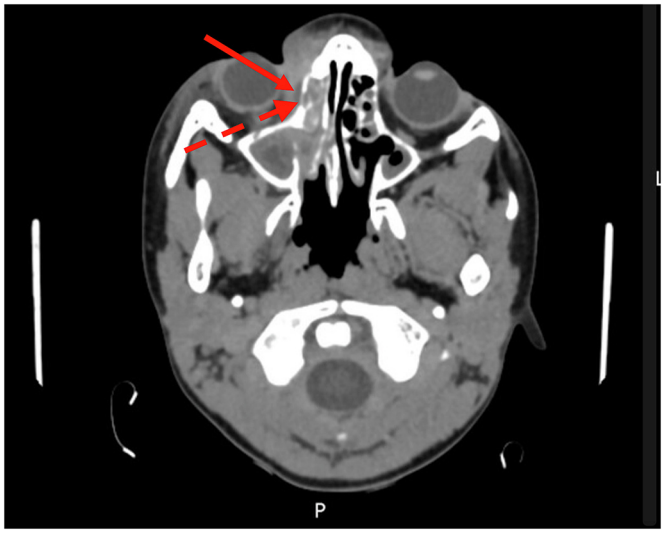

Fig. 3. Orbital cellulitis on CT. Significant infection and inflammation of the right orbit are noted at the medial aspect with defects in the lamina papyracea (dashed arrow) and extension of infection from the right ethmoid sinusitis and resultant small sub-periosteal abscess (solid arrow). No intracranial extension. Case courtesy of Anil Geetha Virupakshappa, Radiopaedia.org, rID: 152015. Obtained from https://radiopaedia.org/cases/orbital-cellulitis-5?lang=us

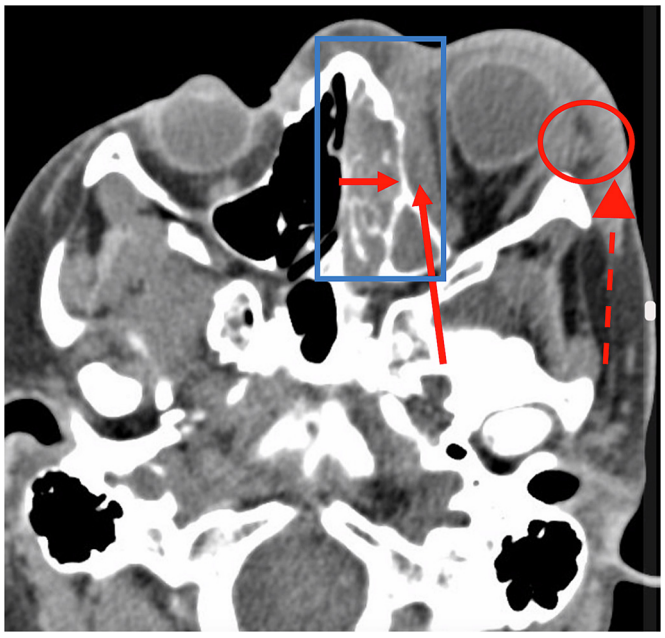

Fig. 4. Orbital cellulitis on CT. Left-sided pre-septal soft tissue swelling and subcutaneous inflammatory change (dashed arrow). Thin elliptical subperiosteal collection in the left medial extraconal space (space within the orbit that is not occupied by the globe or extraocular muscles) adjacent to the lamina papyracea (long solid arrow). Irregularity of the lamina without frank destruction (short solid arrow). Extraconal soft-tissue-fluid attenuation abnormality in the superolateral of the left orbit causing proptosis and inferior displacement of the globe (circled). The left ethmoidal sinuses are opacified with fluid (square). Case courtesy of Ian Bickle, Radiopaedia.org, rID: 57825. Obtained from https://radiopaedia.org/cases/orbital-cellulitis-with-subperiosteal-collection?lang=us

2.3. ED management

Specialist consultation and early administration of antibiotics for patients with orbital cellulitis are the central tenets of ED management, and many patients will improve with antibiotics alone. Antibiotics should be selected that cover *Staphylococcus* (including MRSA) and *Streptococcus* species, as well as anaerobes [7,53]. Examples of appropriate antibiotic combinations include vancomycin in addition to piperacillin-tazobactam, ampicillin-sulbactam, or a third-generation cephalosporin (e.g., ceftriaxone or cefotaxime) plus metronidazole [53]. If there is evidence of OCS, including resistance to retropulsion, eyelids that are held tight against the globe, vision changes, proptosis, and elevated IOP, lateral canthotomy and cantholysis is recommended to prevent irreversible vision loss [54,55]. Ophthalmology should be consulted in suspected cases of orbital cellulitis, as well as the ear, nose, and throat (ENT) or neurosurgery specialist if there is evidence of infectious extension intracranially [56]. Use of steroids is controversial and should only be administered in conjunction with specialist consultation [13,48,57].

3. Pearls and pitfalls

3.1. What are the utility, and limitations, of the history and physical examination?

Though orbital cellulitis can be a clinical diagnosis [49], history and physical examination alone may not be as accurate as imaging at predicting orbital cellulitis. In a retrospective study of 43 patients with orbital complications of sinusitis, the predictive accuracy for diagnosing orbital cellulitis was 82% for history and physical examination, compared to 91% for CT [58]. In a retrospective chart review of 76 patients with orbital cellulitis, there was no significant difference in physical examination findings by age [59]. A retrospective study found the most common clinical signs in pediatric patients with orbital cellulitis were restricted ocular movements, proptosis, and chemosis; the presence of one or more of these clinical signs or temperature of greater than 100.4 degrees Fahrenheit was 76% sensitive and 76% specific for orbital cellulitis [60]. RAPD was rare and was only found in patients who had one of the three most common clinical signs [60]. Another pediatric retrospective study found eyelid swelling to be the most common presenting sign/symptom, followed by fever, eye pain, injection, proptosis, altered extraocular movements, headache, and cough [27].

Several findings on physical examination suggest a more advanced course of disease and intracranial involvement. Extensive inflammatory changes of the orbit (such as conjunctival injection) or non-axial proptosis (movement of the globe away from the abscess location as opposed to antero-posterior proptosis) may indicate the presence of subperiosteal abscess [16,45,61]. Severe visual acuity deficits with proptosis should raise concern for intraorbital abscess [6]. Table 2 lists signs and symptoms of orbital cellulitis.

3.2. What are key differences between pediatric and adult populations?

The higher prevalence of orbital cellulitis in children compared to adults is likely secondary to the underdeveloped immune system in childhood and involvement of the ethmoid sinus, which shares the thin medial wall of the orbit. This thin wall has perforations for blood vessels and nerves and natural fenestrations [24]. Sinusitis is the most common progenitor of orbital cellulitis in both adults and children, though frontal sinusitis is a more common cause in adults compared to children [24,29]. Diabetes may be present in up to 10% of adults with orbital cellulitis based on retrospective data [62], and adults are more likely to have polymicrobial infections compared to pediatric patients [2,7,24].

A retrospective study including 27 children and adults with orbital cellulitis found less seasonal variability for orbital cellulitis in adults compared to children and a greater frequency of surgical intervention in adults [24]. The authors theorized that the increased need for operative management in adults is likely due to more delayed presentation [24]. In a retrospective study of 93 adults and children with preseptal or orbital cellulitis, 36.7% of children versus 20% of adults underwent surgery [35]. These authors did not differentiate what percentage of those totals included patients with preseptal versus orbital cellulitis [35]. Other studies have demonstrated greater infection severity in adults and higher rates of subperiosteal abscess [32,45,63].

3.3. What is the utility of laboratory evaluation?

Laboratory evaluation can assist in evaluating for orbital cellulitis but should not be used to definitively rule in or rule out the diagnosis.

Table 2
Predictive value of signs and symptoms in the diagnosis of orbital cellulitis [13,18,24,35,48].

Sign/Symptom	Prevalence in orbital cellulitis population
Eyelid swelling	89.7–100%
Periorbital erythema	79.2%
Eyelid erythema	77.7–100%
Eye movement restriction	65–100%
Eye pain	61.5–62.5%
Chemosis	51.9–75%
Nasal congestion	43.6%
Fever	37–70.9%
Pain with eye movement	33.3–55.0%
Photophobia	20.8%
Headache	18.5%
Purulent eye discharge	16.7%
Diplopia	14.8%
RAPD	10%
Proptosis	8.3–46.2%
Decreased visual acuity	8.3–20.5%

A 2006 retrospective study found CRP was more frequently elevated in those with orbital cellulitis compared to preseptal cellulitis (78.6% vs. 50.0%) [24]. Another retrospective study of pediatric patients with orbital cellulitis identified CRP elevation in 60% of cases [64]. ESR was elevated in 7.4% of orbital cellulitis patients compared with 3.0% of those with preseptal cellulitis, and leukocytosis was present in 18.5% of orbital cellulitis cases compared with 7.5% of preseptal cellulitis cases [24]. A retrospective study of pediatric patients with orbital cellulitis found that CRP was 7.7 +/− 8.0 mg/dL, and absolute neutrophil count (ANC) was 10.1 +/− 5.2 K/μL [13]. A retrospective study of 49 children with orbital complications of sinusitis found that a white blood cell count greater than 11,100/μL independently predicted subperiosteal or orbital abscess [65]. While more robust data are needed, elevation of CRP, ESR, white blood cell count, or ANC may suggest orbital cellulitis but cannot distinguish between orbital and preseptal cellulitis.

Blood cultures are rarely positive in patients with orbital cellulitis and are even less likely to be positive in adults compared to children [4,26,27,66-68]. Sinus aspiration or culture of intraorbital abscess contents (when available) are the most reliable methods for organism isolation [15]. However, these are not recommended on a routine basis and are not within the scope of emergency clinicians [15]. External swabs of ocular discharge or nasal cavity may occasionally yield the source of infection but are less specific than blood cultures [4]. Positive swab or blood cultures obtained in the ED may help tailor antibiotic therapy in the hospital [53].

3.4. What are the utility and limitations of imaging?

CT of the brain and orbits with and without IV contrast is the recommended imaging modality for the diagnosis of orbital cellulitis and to evaluate for progressing infection or involvement of the cavernous sinus and intracranial compartment [8,69]. Imaging is also recommended if the diagnosis of preseptal versus orbital cellulitis is unclear based on history and examination [8]. Indications to obtain CT in a patient with suspected orbital cellulitis are demonstrated in Table 3. CT may demonstrate infiltration of the orbital fat, sinusitis, extraocular muscle enhancement, intracranial involvement, and subperiosteal abscess [8,13,24,69]. CT identified a subperiosteal abscess in 52.7% of orbital cellulitis patients in one retrospective cohort study of 220 children [13]. In a retrospective study including 20 children with orbital cellulitis who underwent CT imaging, eight were found to have orbital abscess [24]. In another retrospective review of pediatric patients with preseptal and orbital cellulitis, the diagnosis of orbital cellulitis was confirmed in 38 patients via CT imaging; two patients with unclear orbital involvement based on history and physical examination were concluded to have only preseptal involvement using CT [27]. Approximately 32% of the patients with orbital cellulitis were noted to have a subperiosteal abscess, and 11% had intraorbital abscesses [27]. Four children underwent surgical drainage based on CT [27]. Although there are no prospective data comparing CT to clinical diagnosis alone or CT to MRI at this time, the present data suggest that CT frequently changes management and should therefore be obtained in patients with orbital cellulitis.

In cases where CT imaging is non-diagnostic and there remains clinical suspicion for orbital cellulitis, MRI of the brain and orbits with and without contrast should be performed [69]. One report details the case of an eight-year-old male presenting to the ED with signs and symptoms of left orbital cellulitis whose CT demonstrated no evidence of acute abnormalities; however, MRI of the brain and orbits with and without contrast identified irregularity of the inferior rectus muscle and fat stranding within the orbit [69]. Another report discusses the case of a negative CT but positive MRI in a 14-year-old with orbital cellulitis [70]. If CT is negative but clinical concern for orbital cellulitis is present, especially if the patient is early in the course of the disease, MRI with and without contrast is recommended [69].

MRI is superior in detecting soft tissue abnormalities compared to CT, even when gadolinium contrast is not used [71]. However, gadolinium contrast provides improved resolution of abscesses and inflammation [71]. Diffusion-weighted imaging (DWI) can be considered for patients who cannot receive gadolinium due to renal insufficiency or allergy [72]. A prospective study of 15 patients with orbital cellulitis identified numerous complications including optic neuritis/perineuritis, bony destruction, and intracranial involvement using MRI of the brain and orbits with and without contrast [71]. The authors of this study recommend MRI as the imaging test of choice in orbital cellulitis given its increased sensitivity for detecting subtle inflammatory changes; however, they did not publish data comparing the results of CT imaging to MRI [71]. There is a distinct advantage with MRI in pediatric orbital cellulitis cases given the lack of radiation [71]. However, MRI can be difficult to obtain in the ED setting, and MRI requires greater time and resources. Until wide accessibility and more rapid methods for obtaining MRI become realistic in the ED, it is appropriate for emergency clinicians to pursue CT first followed by MRI if CT is non-diagnostic. For pediatric patients, MRI remains the test of choice, though this may necessitate sedation or transfer of the patient [71].

While the data remain inconclusive, one prospective observational study and several case reports describe the use of ultrasound in the diagnosis of orbital cellulitis (Fig. 5) [73-75]. In a prospective observational study, 122 children presenting to an ophthalmologic emergency center underwent posterior segment B scan ultrasound to examine the posterior segment for retinal or vitreous detachment, abnormalities of the extraocular muscles, and lesions within the orbit [73]. Approximately 4% of children were found to have orbital cellulitis [73]. No details were provided as to whether this finding on ultrasound was confirmed with CT or MRI imaging [73]. In two case reports, patients presenting to the ED with signs and symptoms of orbital cellulitis underwent point-of-care ultrasound (POCUS), demonstrating orbital edema and thickening and echogenic intraorbital fatty tissue [74,75]. In both cases, orbital cellulitis was subsequently confirmed on CT [74,75]. While robust data are lacking, it may be reasonable to pursue

Table 3
Indications for CT in the evaluation of orbital cellulitis.

- Decreased or double vision
- Eye movement limitations
- Pain with eye movements
- Proptosis
- Relative afferent pupillary defect
- Signs and symptoms of CNS involvement

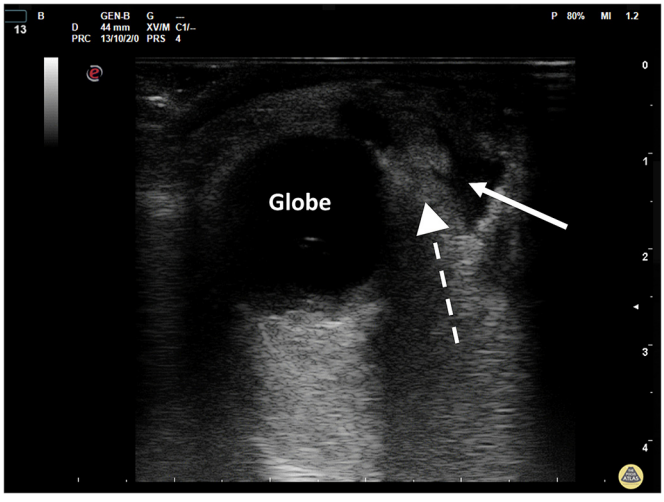

Fig. 5. POCUS demonstrating orbital cellulitis (dashed arrow) with abscess (solid arrow). Obtained from https://www.thepocusatlas.com/ocular-atlas.

Table 4
Recommended antibiotic regimens for orbital cellulitis in adults and children [53,76-82].

Population	Adult	Pediatric
First-line regimens	• Vancomycin IV AND • Piperacillin-tazobactam IV, ampicillin-sulbactam IV, ticarcillin--clavulanate IV, or third-generation cephalosporin IV (e.g., ceftriaxone or cefotaxime) plus metronidazole IV	• Ampicillin-sulbactam IV[a] • Third-generation cephalosporin plus metronidazole IV[a] • Third-generation cephalosporin IV plus clindamycin IV[b] • Meropenem IV plus vancomycin IV
Second-line regimens	• Fluoroquinolone IV plus vancomycin IV • Fluoroquinolone PO plus clindamycin PO[c] • Amoxicillin-clavulanate PO[c]	• Fluoroquinolone IV plus vancomycin IV • Fluoroquinolone PO plus clindamycin PO[c] • Amoxicillin-clavulanate PO[c]

IV – intravenous; PO – per os.
[a] Strongly consider the addition of MRSA coverage depending on local prevalence rates.
[b] Ensure resistance rates are low based on local antibiogram data before selecting this agent.
[c] PO antibiotics are not recommended in severe cases of orbital cellulitis, particularly if Chandler group 3–5.

POCUS in the ED if there is high suspicion for orbital cellulitis and there will be any delay to more definitive imaging.

3.5. What are the core tenets of management for orbital cellulitis?

The key components of management in the ED setting include broad-spectrum antibiotics and specialist consultation. There are currently no practice guidelines directing the standardized management of orbital cellulitis [13], as no randomized controlled studies have determined the ideal antibiotic regimen for this condition [53]. Antibiotics should be selected that cover anaerobes, *Staphylococcus* (including MRSA), and *Streptococcus* species [7,53]. A retrospective study of children ages 0–21 years with orbital cellulitis found wide practice variability in terms of antibiotic treatment regimens [13]. The majority of the cohort received greater than one antibiotic (two medications in 36.5% and three in 24.5%) [13]. The most commonly used antibiotic included ampicillin/sulbactam (79.5%), and 60.9% received vancomycin for coverage of MRSA [13]. Another retrospective case series of pediatric patients found that the most common antibiotic combinations on admission included a cephalosporin with clindamycin and cefotaxime with cloxacillin [27].

Vancomycin in addition to piperacillin-tazobactam, ampicillin-sulbactam, ticarcillin-clavulanate, or a third-generation cephalosporin (e.g., ceftriaxone or cefotaxime) plus metronidazole provide adequate coverage for common organisms causing orbital cellulitis [53]. For patients allergic to penicillin, a fluoroquinolone may be used in combination with vancomycin [53]. Clindamycin may be used rather than vancomycin for MRSA coverage depending upon local resistance patterns [53]. Table 4 lists several antibiotic regimens for orbital cellulitis.

The use of corticosteroids for orbital cellulitis is controversial. A meta-analysis including eight studies and 477 patients found no difference in operative intervention rates for those receiving steroids, but hospital length of stay (LOS) was shorter in the steroid group (standard mean difference = −2.92 days, 95% confidence interval [CI] −5.65 to −0.19) [83]. Most of the patients in the included studies were children [83]. A 2021 Cochrane systematic review found no significant difference between hospital LOS, preservation of visual acuity, level of pain on day three, or duration of IV antibiotics [84]. However, they could not evaluate the adult subgroup separately, and the certainty of the evidence was low [84]. Until randomized controlled trials become available, corticosteroids should only be administered to patients with orbital cellulitis at the direction of the ophthalmology specialist.

Orbital cellulitis is a much less common cause of OCS than trauma with retrobulbar hemorrhage, though it is a possible complication of

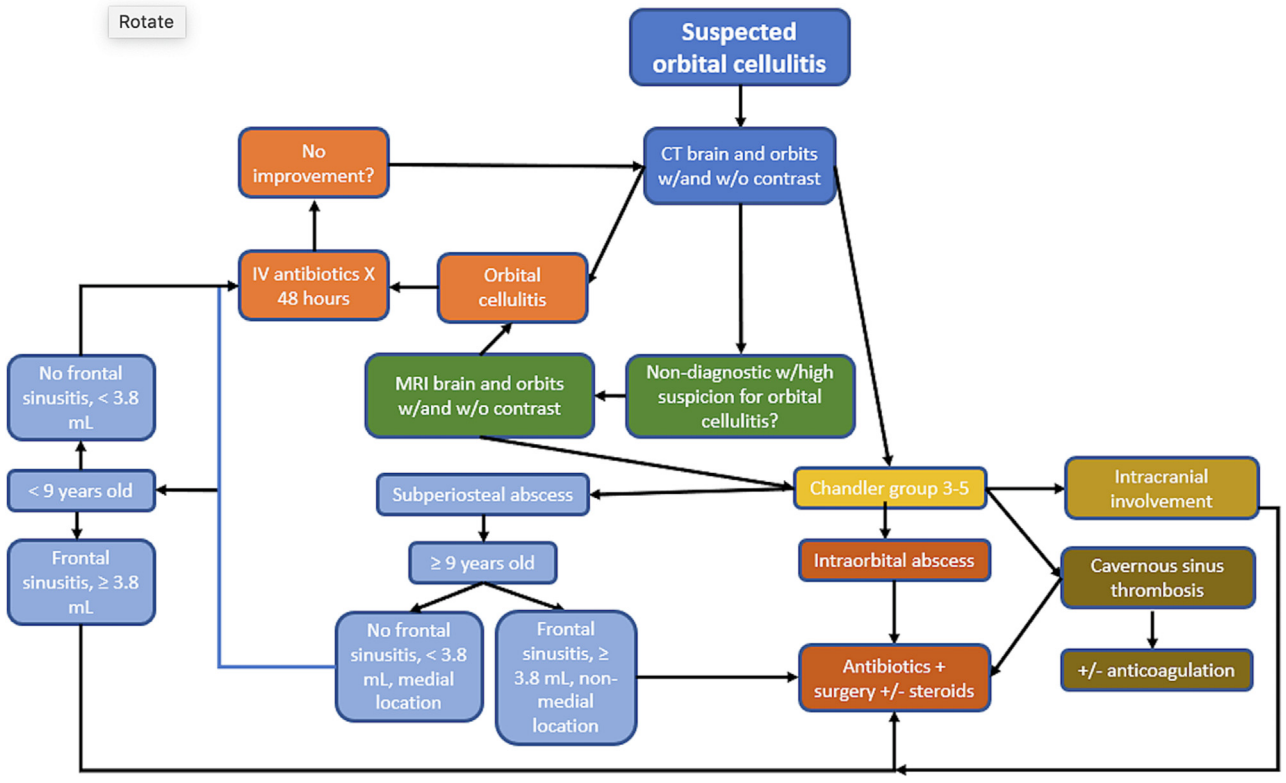

Fig. 6. Management algorithm for orbital cellulitis and its complications [105].

Table 5
Orbital cellulitis pearls.

- Orbital cellulitis is due to inflammation of the globe contents and surrounding soft tissues posterior to the orbital septum; the most common underlying cause is sinusitis.
- Pain with eye movements, restricted eye movements, photophobia, diplopia that resolves when the affected eye is closed, decreased visual acuity, decreased color vision, RAPD, or proptosis should raise concern for orbital cellulitis.
- Laboratory evaluation should not be used to differentiate orbital from preseptal cellulitis.
- Blood cultures are unlikely to be positive but should be obtained in systemically ill patients.
- POCUS may identify signs of orbital cellulitis in patients for whom CT is delayed.
- CT of the brain and orbits with and without contrast should be obtained in all patients with suspected orbital cellulitis to evaluate for abscesses or intracranial extension that may warrant surgical intervention.
- MRI of the brain and orbits with and without contrast (or DWI if contrast is contraindicated) should be obtained for patients with non-diagnostic CT but there remains high clinical suspicion for orbital cellulitis.
- Treatment includes administration of antibiotics covering *Staphylococcus*, *Streptococcus*, and anaerobes, as well as early ophthalmology consultation.
- Orbital cellulitis may cause orbital compartment syndrome, which requires lateral canthotomy and cantholysis.

orbital cellulitis [85]. Patients with orbital cellulitis who present with clinical evidence of OCS require immediate lateral canthotomy and cantholysis, ideally within two hours of recognition to maximize visual outcomes [86,87]. Patients may require further surgical reduction of IOP, and thus ophthalmology must be consulted immediately for patients with OCS [87]. OCS is a clinical diagnosis and does not require imaging for confirmation [86]. Decreased vision is the most common patient complaint in OCS [85,88], with eye pain only occurring in 15% of cases [86,89]. Physical examination may reveal decreased visual acuity, RAPD, proptosis, ophthalmoplegia, resistance of the globe to retropulsion, eyelids that are held tight against the globe and cannot be lifted, and elevated IOP [89].

The majority of patients with orbital cellulitis will recover with medical management alone (60–100%) [27,32,57,58,76,90-92]. Older age and diplopia on presentation are risk factors for requiring surgery [92]. Indications for surgical intervention include large subperiosteal abscess, orbital abscess, and intracranial abscess [32,38,93-95]. One study found a subperiosteal abscess 1.2 cm in diameter or more was associated with need for surgical intervention [93]. A retrospective study of 101 pediatric patients with orbital cellulitis found that the likelihood of needing surgery was 12% for patients with a subperiosteal abscess less than 3.8 cm but rose to 71% once the diameter exceeded 3.8 cm [38]. Based on the current data, patients with subperiosteal/intraorbital abscess or intracranial involvement are more likely to require surgical intervention [95]. Cavernous sinus thrombosis is typically managed medically, though many of these patients will need endoscopic sinus surgery in order to address the underlying cause of the cavernous sinus thrombosis [96-99]. Though anticoagulation in cavernous sinus thrombosis remains controversial, there may be a mortality benefit; the decision to start anticoagulation should be discussed with ophthalmology and neurosurgery [100-104].

Fig. 6 provides an approach to management of orbital cellulitis and its complications, and Table 5 provides pearls and pitfalls concerning the evaluation and management of orbital cellulitis.

4. Conclusion

Orbital cellulitis is a rare but potentially dangerous diagnosis due to its risk of vision loss and potential complications of subperiosteal abscess, intraorbital abscess, cavernous sinus thrombosis, and intracranial extension. Orbital cellulitis can be difficult to distinguish from preseptal cellulitis, a more benign diagnosis which typically requires only oral antibiotics. Clinical signs and symptoms that should raise concern for orbital cellulitis include painful or restricted eye movements, photophobia, diplopia when the affected eye is open, decreased visual acuity or color vision, RAPD, or proptosis. Though the diagnosis can often be made clinically, CT of the brain and orbits with and without contrast (followed by MRI of the brain and orbits with and without contrast if non-diagnostic) should be used to confirm the diagnosis of orbital cellulitis and rule out complications. ED management includes administration of broad-spectrum IV antibiotics, ophthalmology consultation, lateral canthotomy and cantholysis if there is concomitant OCS, and neurosurgery consultation for cases with intracranial extension.

CRediT authorship contribution statement

Jessica Pelletier: Writing – review & editing, Writing – original draft, Visualization, Resources, Conceptualization. **Alex Koyfman:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Conceptualization. **Brit Long:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Conceptualization.

Declaration of Competing Interest

None.

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