Preseptal and orbital cellulitis in children: a review

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Introduction

Orbital cellulitis predominantly affects children. This disease is potentially sight and life threatening and requires prompt recognition, investigations and treatment. An understanding of the anatomical features of the orbit its adnexa and neighbouring paranasal sinuses is essential in the evaluation and management of inflammations of the orbit. In this review the current aetiological factors, the clinical presentation, the differential diagnosis, complications, investigations and management of orbital cellulitis are presented.

Applied anatomy

The orbit is a quadrilateral pyramid surrounding the eye and its soft tissues. The orbital septum is a layer of fascia, which is attached to the orbital rim and the tarsal plates in the upper and lower eyelids. The septum forms a barrier between the deep orbital soft tissue and the superficial structures. Inflammation limited by the septum causes preseptal cellulitis anteriorly and orbital cellulitis posterior to the septum (Figure 1).

The paranasal sinuses are the commonest source of infection for orbital cellulitis. The ethmoidal sinuses are situated nasally and are separated from the medial orbit by a thin wall called the lamina papyracea. The floor of the orbit forms the roof of the maxillary sinus and the roof orbit forms the floor of the frontal sinus. The ethmoidal sinuses are well developed at birth the maxillary sinus develops within the first 2 years but is not well developed till 6 years of age and the frontal sinuses start developing in the 6th year of life. Hence orbital cellulitis secondary to sinusitis is almost exclusively due to ethmoidal sinusitis in the first 5 years of life and secondary to ethmoidal, maxillary and frontal sinusitis in children over 7 years. The ostia of the sinuses are relatively large compared to the size of the sinuses during early development. As the sinuses enlarge with age the ostia remain the same size allowing poor drainage during inflammations of the sinuses. Natural dehiscences may exist in the medial wall and the roof of the orbit promoting spread of infection from the sinuses into the orbit.

The orbit is lined loosely by peristeum, which limits the spread of inflammation to the orbit. Nerves and blood vessels from the sinuses, which are potential avenues for spread of inflammation to the orbit, perforate this lining.

The rich venous plexus in the orbit communicates with the facial veins anteriorly, the sinuses that surround the orbit and the cavernous sinus posteriorly. In young children diploic veins may directly communicate with the anterior cranial fossa through the roof of the orbit. The orbital veins are without valves facilitating a two-way spread of infections.

Definitions

Preseptal cellulitis: this is an inflammatory disease of the orbit limited to the space anterior to the orbital septum. It is characterized by erythema and swelling of the eyelids. The visual acuity, ocular movements are normal. It represents the mild end of the spectrum of orbital inflammation. In young children the intense oedema of the lids may sometimes preclude examination of the eye making the distinction between orbital cellulitis difficult.

Orbital cellulitis: this is an inflammatory disease of the superficial and deep structures of the orbit. It is characterized by lid oedema and erythema, chemosis of the conjunctiva, restricted ocular motility and proptosis.

Periorbital cellulitis: this term has been used to indicate inflammation around the orbit to encompass both preseptal and orbital cellulitis. However it is also used interchangeably to indicate preseptal cellulitis. It has been suggested that this term is best avoided due to confusion of the pathology it indicates.

Pott’s Puffy tumour: both preseptal and orbital cellulitis has been described with this condition. Most reports describe an orbital cellulitis with a subperiosteal abscess as a result of frontal sinusitis. It may be associated with osteomyelitis of the frontal bone and intracranial spread of infection.

Classification

Initial classifications of infective orbital cellulitis predated current imaging techniques. A modification of Chandler’s classification still favoured by some clinicians includes five groups (Table 1). Uzcategui et al. attempted to correlate the groups with computerized tomography findings. The weakness of this classification suggests the disease evolving through stages, however clinical presentation does not follow a temporal sequence of stages. In addition this classification does not include intracranial abscesses, which are more commonly reported than cavernous sinus thrombosis in children.

A practical classification suggested by Jain and Rubin (Table 2) is useful both from a prognostic, diagnostic and therapeutic perspective and is easily adapted into clinical practice. It is generally thought that preseptal disease is milder and not associated with intracranial complications, however Reynolds et al. have reported four cases of intracranial complications with preseptal disease. It is hence important that each case is assessed and monitored thoroughly for complications.
**Epidemiology**

Infections causing inflammation of the orbital tissues are common. There are no reports on the incidence of orbital inflammation, however preseptal cellulitis is more common that orbital cellulitis. Preseptal cellulitis has been reported in 84–87% of cases. Children with preseptal cellulitis are usually younger than 5 years of age and those with orbital cellulitis present at a mean age of 7 years. Earlier reports have indicated a slightly higher prevalence of orbital cellulitis. This may be in part due to better imaging techniques that allow a clearer distinction between preseptal and orbital cellulitis or earlier treatment.

**Clinical features**

The child may present with an upper respiratory tract infection with lid swelling and erythema. They may be febrile and have an obvious source of skin infection like an infected insect bite, impetigo or erysipelas. Insect bites on their own without infection may cause an allergic swelling of the eyelids on both sides; the child is usually well and the swelling settles within 48 h. They may present with pain and swelling around the orbit with or without pyrexia.

Preseptal cellulitis is distinguished from orbital cellulitis by being localized anterior to the orbital septum with lid oedema and erythema. The visual acuity, ocular movements are normal. Occasionally the lids may be shut tight with swelling and it may be difficult to rule out underlying orbital involvement (Figure 2a). An ophthalmologist may use retractors to examine the globe and CT scanning may be necessary to rule out orbital involvement (Figure 2b).

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**Chandler’s classification system**

- Group 1: inflammatory oedema — preseptal cellulitis
- Group 2: orbital cellulitis
- Group 3: subperiosteal abscess
- Group 4: orbital abscess
- Group 5: cavernous sinus thrombosis.

**Table 1**

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**Jain and Rubin classification**

1. Preseptal cellulitis
2. Orbital cellulitis (with or without intracranial complications)
3. Orbital abscess (with or without intracranial complications)
   - (i) Intraorbital abscess — which may arise from a collection of purulent material from orbital cellulitis
   - (ii) Subperiosteal abscess, which may lead to infection of orbital soft tissue.

**Table 2**
Orbital cellulitis in addition to the features of preseptal cellulitis may have chemosis of the conjunctiva, limited extraocular movements with diplopia and proptosis (Figure 3a and b). The child with orbital cellulitis is systemically unwell. Excessive lethargy drowsiness with neurological signs and epilepsy may herald the onset of intracranial complications.

Aetiology
The bacterial infections of the orbit are caused through three routes.

1. Direct infection of the orbit
Superficial trauma to the skin including infected insect bites and eyebrow piercing may lead to preseptal cellulitis. Trauma to the orbit with or without retained foreign bodies is associated with orbital cellulitis. Fractures of the orbit, sometimes undiagnosed can present with either preseptal or orbital cellulitis.

2. Extension from neighbouring regions
Spread from the paranasal sinuses is the most common cause of orbital and some cases of preseptal cellulitis. This may be either through direct spread through naturally occurring dehiscences in the bones lining the medial wall of the orbit, through a process of infective thrombophlebitis or through the communication of valve less veins of the orbit and the sinuses. The ethmoid sinuses are the most common source of infection. Dacryocystitis and infections of the皮肤 may lead to preseptal cellulitis. Odontogenic and middle ear infections have been reported to cause inflammation of the orbit. Inflammation and infection of the lacrimal gland or globe (endophthalmitis) may rarely lead to orbital cellulitis. Surgical procedures on the eye for

Figure 2 a Left eye preseptal cellulitis, spreading over the cheek with oedema of right upper lid. Skin ink markings delineate the extent of cellulitis. b Axial CT scan with line diagram demonstrating inflammation limited to the anterior preseptal space.
strabismus, glaucoma and retinal detachment have been reported to cause orbital cellulitis. Trauma to the oral mucosa is has been complicated with preseptal cellulitis.

3. Haematogenous
Rarely the orbit may be inflamed as a result of a blood born infection. Children without sinus disease may have an upper respiratory tract infection associated with preseptal cellulitis.

Microbiology
Bacteria most commonly cause infective cellulitis, though florid adenoviral conjunctivitis may be associated with preseptal cellulitis. Dacryocystitis, herpes simplex or varicella zoster infections of the skin around the orbit may also be associated with preseptal cellulitis. Rarely infections of the orbit with yeasts or filamentous fungi may be seen in patients who are immunocompromised or have diabetic ketoacidosis.

Bacteria may be aerobic or anaerobic organisms. Currently the commonest forms of bacteria causing septal and orbital cellulitis are *Staphylococcus* and *Streptomyces* species though many others have been reported (Table 3).

Culture from the orbital abscess or paranasal sinuses may be negative but this does not rule out an infective cause. Blood cultures may reveal a bacteraemia with a negative culture from the orbit or sinuses. *Haemophilus influenza* was a frequent cause of cellulitis in era prior to Hib vaccination compared to after. Polymicrobial infections have been reported in older children with subperiosteal abscesses.

Investigations
Preseptal cellulitis: a detailed history and general systemic examination to look for the source of infection should be carried out. The child should have the temperature recorded and a thorough examination of the eyes should be undertaken. If the visual acuity, pupillary examination, ocular movements are normal with no chemosis or proptosis; a full blood count, erythrocyte sedimentation rate and C reactive protein tests are done. Cultures should be taken from an obvious site of infection on the skin or conjunctiva. Where an ocular examination cannot be carried out because of tense oedema of the lids a computerized tomography scan or magnetic resonance scan is necessary.

Orbital cellulitis: in the addition to the above investigations all children with orbital cellulitis requires imaging of the orbits, paranasal sinuses and brain. Blood cultures and cultures of purulent material drained are necessary. Apart from clostridia species gas in the orbit, seen on imaging can signify infection with aerobic gram negative gas forming enterobacteria (*Proteus* species, *Klebsiella* species and *Escherichia coli*) and anaerobic...
Bacterial isolates from orbital cellulitis (abscesses), ocular surface or blood

1. *Staphylococcus aureus*, *Staphylococcus epidermidis*
2. *Streptococci pneumoniae, Streptococci pyogenes, Streptococci sanguinis, Streptococci fecalis, Streptococci mitis*
3. Diphtheroids
4. *Haemophilus influenza*
5. *Escherchia coli*
6. *Moraxella catarrhalis*
7. *Neisseria sp*
8. *Bacillus thuringiensis*
9. *Arcanobacterium haemolyticum*
10. *Pseudomonas aeruginosa*
11. *Pasteurella multocida*
12. Atypical Mycobacteria and *Mycobacterium tuberculosis*
13. *Fusobacterium necrophorum*

Preseptal: a well child with mild preseptal cellulitis, where it is possible to examine the eye which is unaffected and the child is afebrile may be treated with oral antibiotics and nonsteroidal anti-inflammatory drugs with regular daily clinic review (Table 4). In children who appear unwell or where the eye cannot be examined as a result of lid oedema or those with severe preseptal cellulitis where an assessment cannot be completed due to limited cooperation of the child need to be admitted to hospital and treated with a combination of intravenous antibiotics till the signs of lid erythema and oedema resolve to allow a complete eye examination, which is usually a period of 2–3 days. The child is then treated with oral antibiotics and nonsteroidal anti-inflammatory drugs for a week (Table 5). Surgical intervention is required for lid abscesses or a lacrimal sac abscess.

Orbital: children with postseptal disease need hospital admission and treatment with a combination of intravenous antibiotics covering for both aerobic and anaerobic organisms (Table 6). The duration of intravenous treatment will depend on the clinical response to treatment. In children who respond to treatment the duration is usually 1–2 weeks of intravenous treatment followed by oral antibiotics for 1 week. The presence of an abscess in the orbit may need surgical intervention in the event of no response to intravenous antibiotics. However in children less than 7 years with a small medial subperiosteal abscess that does not displace the globe can be treated with intravenous antibiotics alone.

Superior orbital abscesses and those that displace the globe need open surgical drainage of the abscess and sinuses involved (Figure 3c). Some reports suggest that medial wall abscesses may be treated endoscopically. A drain is left in situ and withdrawn daily over 7 days. The purulent material is sent for culture and sensitivity and the antibiotics adjusted if necessary. Intravenous antibiotics are continued postoperatively till the drain is removed.

It is important that intravenous antibiotics are not stopped prematurely due to difficulty with venous access; a long line or a central line may be required.

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**Protocol for management of preseptal cellulitis (mild)**

**Diagnosis:** preseptal cellulitis — mild

Clinical features
- Swelling of lids
- Erythema
- Pain

Paediatric assessment
- Afebrile
- Systemic examination normal

Ophthalmology assessment
- Inflammation limited to eyelids
- Visual acuity — normal
- Pupil reflexes — normal
- Ocular movements — normal
- Exophthalmometry — normal

Investigations
- Full blood count
- ESR, CRP

Treatment — out patient
- Oral cefotaxime and flucloxacillin

Monitor
- Daily — temperature
- Swelling marked out with skin marker pen or photography

Ophthalmology assessment

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Table 3

Table 4
In the presence of intracranial disease a 6-week course of intravenous antibiotics are required. Routine lumbar puncture is not helpful in the analysis of intracranial spread and should be discouraged. Nasal decongestants and nonsteroidal anti-inflammatory drugs should be administered together with the antibiotics. Lack of progressive improvement with treatment should trigger repeat imaging of the child with a CT or MRI scan. Re-evaluation of the antibiotics regimen with the microbiology results and further surgical intervention for a new or residual collection within the orbit may be required.

### Protocol for management of preseptal cellulitis (severe)

**Diagnosis**: preseptal cellulitis — severe

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>Paediatric assessment</th>
<th>Investigations</th>
<th>Ophthalmology assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swelling of lids</td>
<td>Febrile</td>
<td>Full blood count — ↑ white cell count</td>
<td>Inflammation limited to eyelids</td>
</tr>
<tr>
<td>Erythema</td>
<td>Systemic examination normal</td>
<td>ESR ↑, CRP ↑</td>
<td>Anterior segment exam normal — using lid retractors if possible</td>
</tr>
<tr>
<td>Pain</td>
<td></td>
<td>CT scan — preseptal</td>
<td>Tight lid oedema precludes further examination</td>
</tr>
<tr>
<td>Febrile</td>
<td></td>
<td></td>
<td>ENT assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Normal</td>
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</tbody>
</table>

Table 5

In the presence of intracranial disease a 6-week course of intravenous antibiotics are required. Routine lumbar puncture is not helpful in the analysis of intracranial spread and should be discouraged. Nasal decongestants and nonsteroidal anti-inflammatory drugs should be administered together with the antibiotics.

### Protocol for management of orbital cellulitis

**Diagnosis**: orbital cellulitis

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>Paediatric assessment</th>
<th>Investigations</th>
<th>Ophthalmology assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swelling of lids</td>
<td>Febrile</td>
<td>Full blood count — ↑ white cell count</td>
<td>Visual acuity — normal</td>
</tr>
<tr>
<td>Erythema</td>
<td>Systemic examination normal but unwell child</td>
<td>ESR, ↑ CRP — ↑</td>
<td>Pupil exam normal</td>
</tr>
<tr>
<td>Pain</td>
<td></td>
<td>Blood culture</td>
<td>Inflammation of eyelids and</td>
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<tr>
<td>Febrile</td>
<td></td>
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<td>Chemosis of conjunctiva</td>
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<td></td>
<td>proptosis</td>
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<tr>
<td>Limited ocular movements</td>
<td></td>
<td></td>
<td>Limited eye movements</td>
</tr>
<tr>
<td>Proptosis</td>
<td></td>
<td></td>
<td>Tight lid oedema may preclude detailed examination</td>
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</tbody>
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Table 6
A combination of broad spectrum antibiotics covering for both gram positive and gram negative organisms is required for preseptal cellulitis with the addition of anaerobic cover for orbital cellulitis. A third generation cephalosporin (ceftriaxone or cefotaxime) covers both gram positive and gram negative organisms, however as they are less sensitive to beta lactamase producing *Staphylococcus aureus* which is covered with the addition of fluloxacinillin. Metronidazole is used in orbital cellulitis to cover for anaerobic bacteria. The use of clindamycin is recommended in the presence of infections that involve the bone with osteomyelitis or those individuals who are allergic to cephalosporins and penicillins.

### Complications of preseptal and orbital cellulitis

**A. Ocular or orbital complications**

(i) Preseptal complications

(a) Scarring of lids with ectropion
(b) Necrotizing fasciitis
(c) Ptosis

(ii) Related proptosis

(a) Exposure keratopathy
(b) Corneal ulceration and opacification

(iii) Related to increased intraorbital pressure.

(a) Compressive optic neuropathy
(b) Central retinal artery occlusion
(c) Extraocular motility defects
(d) Globe perforation
(e) Neurotrophic keratitis
(f) Sustained increased intraocular pressure leading to optic atrophy.

(iv) Related to septic thrombophlebitis and local spread.

(a) Optic neuropathy
(b) Retinal vein occlusions
(c) Septic uveitis or retinitis
(d) Exudative retinal detachment

**B. Intracranial complications**

(i) Extra axial abscesses — extradural and subdural and brain abscesses

(ii) Cavernous sinus thrombosis

(iii) Meningitis

### Choice of antibiotics

Local protocols for the use of antibiotics in preseptal and orbital cellulitis should be developed in discussion with microbiologists. A combination of broad spectrum antibiotics covering for both

### Differential diagnosis of orbital cellulitis in children

**A. Idiopathic nonsuppurative inflammation of the orbit**

(i) Nonspecific orbital inflammatory disease

(ii) Inflammatory thyroid eye disease (rarely seen in children)

(iii) Wegner’s granulomatosis

(iv) Sarcoid related inflammatory disease

**B. Benign and neoplastic disease**

(i) Retinoblastoma and its treatment

(ii) Lymphoma

(iii) Lymphangioma

(iv) Eosinophilic granuloma (histiocytosis)

(v) Rhabdomyosarcoma

(vi) Leukaemic deposits

(vii) Dermoid cyst

**C. Systemic disease**

(i) Kawasaki disease

(ii) Sickle cell anaemia

### Complications

The complications of inflammations around the orbit are related to either late presentation, failure of adequate or appropriate medical or surgical treatment. However complications are also seen despite early appropriate and aggressive medical and surgical intervention due to virulence of the organism or where there is an underlying immuno-compromised individual. The morbidity of the complications is related either to the eye or soft tissue in the orbit or to the spread of the infection intracranially (Table 7). Visual loss, blindness and death complicating orbital cellulitis are still reported with current appropriate management. It is to be noted that serious intracranial complications have been reported with both preseptal and orbital cellulitis.

### Differential diagnosis

Inflammatory disease of the orbit is commonly due to infections in children. There is however a list of conditions that needs to be considered in the differential diagnosis and this can be divided into categories listed in Table 8.

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**FURTHER READING**

Practice points

- Prompt multidisciplinary assessment and appropriate treatment of a child with either preseptal or orbital cellulitis.
- CT scans may be needed to differentiate between preseptal and orbital cellulitis.
- Oral antibiotics must not prematurely replace intravenous antibiotics administered until signs of infection are controlled.
- Prompt drainage of a superior orbital abscess or one displacing the globe.
- Regular assessment for signs of intracranial spread of infection.