Management of periorbital and orbital cellulitis

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Abstract
Swelling of the tissues surrounding the eye is a relatively common presentation in paediatric practice. Many of the mild, pre-septal cases of periorbital inflammation and infection are caused by insect bites, trauma and conjunctivitis. Frequently infection spreads from the ethmoid sinuses and invades orbital tissues. The distinction between pre-septal and orbital involvement can be difficult based on clinical examination only, and the research base supporting management of periorbital and orbital cellulitis is limited. This review addresses the role of investigations and the multi-disciplinary approach needed in order to establish accurate diagnosis, appropriate treatment and prevention of serious complications including blindness and venous sinus thrombosis.

Keywords acute sinusitis; computed tomography; orbital cellulitis; periorbital cellulitis; pre-septal cellulitis; venous sinus thrombosis

Introduction
Periorbital cellulitis is an umbrella term for infections of the tissues around the eye and represents a continuum of severity resulting from a number of causes rather than a well-defined disease entity.

Management of children with periorbital infections often involves input from ophthalmology and ear, nose and throat (ENT) specialists. This in itself, and the lack of evidence base for the management of children with periorbital infections pose a number of challenges. This review attempts to present a pragmatic approach to this relatively common paediatric problem.

Epidemiology and definitions
Very little reliable data are available on the incidence of periorbital and orbital cellulitis. Based on local and published audit figures, a paediatric emergency department seeing 20,000 children per annum is likely to admit one child per month for inpatient management. A similar number will be treated as outpatients.

Before introduction of a vaccine in 1985, Haemophilus influenzae was the most common pathogen to cause periorbital or orbital cellulitis, an infection often associated with CNS infection. Since then there has been a change in the microbiological spectrum, with the most common culture positive cases now being due to Staphylococcus aureus and streptococcus species.

Whilst periorbital cellulitis occurs at all ages, children under 10 years are most commonly affected, including rare neonatal cases.

The terminology used to classify periorbital infection refers to anatomical extent of the disease rather than aetiology and is summarized in Figure 1.

Infection of the structures behind the orbital septum is called orbital cellulitis and is considered by some to be a different entity altogether. In clinical practice the distinction between the two can cause considerable diagnostic difficulty, and the authors make no excuses for using the term periorbital cellulitis synonymously for both.

Severe complications of periorbital cellulitis are rare if the diagnosis is made early and treatment started appropriately; these include visual impairment, orbital and intracranial abscess formation and venous sinus thrombosis.

Clinical presentation and diagnostic pitfalls
Five categories are commonly used to classify periorbital and orbital infection. These do not necessarily represent a progression of symptoms due to the various underlying causes of periorbital infections.

Pre-septal cellulitis (which corresponds to type 1 of the Chandler classification) is limited to the tissues anterior to the orbital septum of the upper eyelid, which is an extension of the periosteum of the frontal bone and fuses with the tarsal plates of the eyelids. Unless breached, this structure seems to be an effective barrier to further expansion of infection, which explains why the majority of cases of pre-septal cellulitis are due to an obvious local cause, e.g. dacryocystitis, sty, chalazion, or due to infection stemming from breaches of the skin barrier such as insect bites, infected varicella lesions and minor trauma, to name the most common.

Orbital cellulitis, on the other hand, generally spreads from an infection of the paranasal sinuses. Whilst pre-septal disease can expand in an unrestricted fashion into the surrounding facial tissues, the impact of inflammatory and infectious processes in the confined space of the orbit can be more difficult to assess and has the potential for lasting damage. The most important structure is the optic nerve which carries neuronal signals from the retina to the optic chiasm and thus is essential in mediating the sense of sight. Damage to the optic nerve can occur through direct pressure, optic neuritis or vasculitis. Damage to the vessels within the orbit can also result in ischaemia. This can cause irreversible visual loss or even total blindness in the involved orbit. Intracranial spread of the infection can cause sagittal sinus thrombosis, meningitis and encephalitis which can lead to death.
As far as clinical signs are concerned, proptosis, conjunctival injection and limitation of extraocular movements are highly suggestive of an intraorbital process. Unfortunately, absence of these features does not exclude the presence of intraorbital infection, and depending on the child’s age and degree of eyelid swelling, a clinical assessment can be unreliable if not impossible. The child with systemic features, such as a high fever and neurological compromise, is at high risk of having severe disease with intracranial involvement. Although bacteria are the most common cause of orbital infection, viral, parasitic and fungal infections have also been reported. The latter are most common in immunocompromised individuals, and early detection of such infections is imperative as they can be associated with a high mortality.

Differential diagnoses of periorbital cellulitis also include autoimmune disease including thyroid eye disease, as well as trauma and neoplasms; these are all very rare in children but should be borne in mind if there is no response to treatment.

**Investigations**

Blood tests do not provide any diagnostic value per se but are commonly performed and may be useful in monitoring response to treatment. Although more severe disease increases the likelihood of leucocytosis and raised inflammatory markers, the negative predictive value of an absence of abnormal parameters is not sufficiently good to be relied upon. Blood tests are also poor indicators of the location and extent of infection. A number of studies have confirmed that blood tests do not help to differentiate between pre-septal cellulitis, intraorbital abscess and orbital cellulitis. Positive blood cultures are found in no more than a third of cases and seem to have very little bearing on the crucial early management.

In the presence of ophthalmological signs such as proptosis, reduced visual acuity and colour vision, ophthalmoplegia and/or diplopia, urgent imaging should be acquired. Radiological investigations have a role in assessing potential complications arising from orbital cellulitis, namely presence of an abscess and involvement of the orbital structures, paranasal sinuses and intracranial structures. Imaging will help to define the exact location and extent of the problem and aid in planning for subsequent treatment. The question is when to request imaging as it may involve significant exposure to radiation, and younger children will possibly also require sedation.

In the absence of any systemic features and presence of mild eyelid swelling only, reliable assessment of the normal range of eye movement, acuity and colour vision can be made, and there is no indication for immediate radiological assessment. An unwell child, inability to make a reliable clinical assessment and clinical suspicion of orbital involvement warrant a high definition computed tomography (CT) scan taken in coronal and axial planes. This will delineate any bony defect.

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**Figure 1** Chandler classification of periorbital infection.

**Type 1**
Pre-septal cellulitis: Inflammation does not extend beyond the orbital septum

**Type 2**
Post-septal/orbital cellulitis: Inflammation extends into the orbital tissues, with no abscess formation

**Type 3**
Subperiosteal abscess: Abscess forms deep to the periosteum of the orbit

**Type 4**
Orbital abscess: Abscess forms within the orbit, with breach of the periosteum

**Type 5**
Cavernous sinus thrombosis

**Orbital septum**
- Inflammation, no pus
- Inflammation, pus/abscess
within the orbit and sinuses (often a breach of the paper-thin lamina papyracea separating the medial orbital wall from the anterior ethmoid sinuses (Figure 2)), and will demonstrate the presence of a subperiosteal or orbital abscess. It will also confirm the presence of pus in the sinuses. Due to its inability to provide bony definition, Magnetic Resonance Imaging (MRI) is inferior to CT in assessing and planning the surgical management of local complications of orbital sinusitis. However, MRI is better than CT in assessing intracranial complications and distinguishing pre-septal from post-septal disease.

Given the difficulties in determining extent and severity of periorbital cellulitis based on clinical examination alone, further investigations and involvement of ophthalmologists and ENT surgeons is usually called for in all but the mildest cases, i.e. clinical suspicion of Chandler grade 2 and above.

Ophthalmology review

It is important to liaise closely with the ophthalmologist for all patients needing admission, in order to allow for a fuller ocular assessment and reach a consensus opinion on who needs to be scanned urgently and who can wait. An urgent ophthalmology review must be requested for all cases of orbital cellulitis.

The main ocular symptoms and signs are reduced vision, orbital pain, lid swelling, chemosis and proptosis which may be axial or non-axial, pain on eye movements and possible diplopia. The patient may not necessarily complain of diplopia.
if swelling of the lids has occluded the visual axis of the affected eye.

It is important for the doctor seeing a child with periorbital cellulitis to assess the following:

- can the lids be opened?
- is the conjunctiva involved (hyperaemia, chemosis, discharge)?
- if possible obtain visual acuities for each eye. This should be treated as a game with the child being asked to see as many letters/characters as possible. The more they can see with each eye, the higher the score. Some mobile phone applications exist for assessing visual acuity of children, however the accuracy of these apps has not been fully assessed.
- are the extraocular movements grossly normal? This can be assessed by moving a toy or object of interest in the main positions of gaze. It is most important to assess how well the affected eye adducts (movement towards the nose) and elevates, as these are often the first to be restricted in cases of orbital cellulitis.
- are the pupillary responses normal? It is important to try and look for a relative afferent pupillary defect (RAPD) through using the swinging light torch test.
- Ishihara colour plates can be used in age appropriate children (those who are verbal) to assess optic nerve function.
- it is also important to try and visualize the optic disc for signs of swelling.
- how well is the patient systemically?

The presence of any of the above ocular signs is an indication of orbital cellulitis and would necessitate immediate admission and treatment with intravenous antibiotics as well as imaging. Close monitoring may be necessary in such patients, with hourly checks of optic nerve function, including visual acuities, pupillary response and colour vision. This is not always possible in the very young child, however specialized tests in the orthoptic department to assess vision and eye movements can be carried out, but this may not be available in the emergency situation.

The role for intravenous steroids in cases where optic nerve involvement is suspected remains controversial and there is no strong evidence base to support it. Instruction should be given to the ward staff to starve the patient, and the ophthalmologist will assess the patient and liaise with an orbital and ENT surgeon regarding the need for abscess drainage or possible emergency orbital decompression.

ENT review

An ENT surgeon should be involved in the clinical assessment of a child who fits categories Chandler 2 and upwards. The nose should be examined to assess for the presence of mucus. In a co-operative child, a more detailed assessment can be made endoscopically, and a swab taken for bacteriological analysis.

Whether to treat subperiosteal abscess medically or surgically is an area of controversy in the literature. The decision to operate should be made in the absence of improvement with intravenous antibiotics, and on the basis of the eye, namely reduction in visual acuity, colour vision, ophthalmoplegia and/or proptosis.

Surgical treatment should address the underlying rhinosinusitis and its associated complication(s). Drainage of a subperiosteal or orbital abscess is performed externally or endoscopically. The latter approach is technically more difficult in paediatric cases, especially with inflammation and bleeding, and is usually reserved for experienced endoscopic surgeons. It is avoided in the presence of intracranial complications, frontal bone osteomyelitis (Pott's puffy tumour) or orbital complications with acute visual compromise. The sinuses should be drained and irrigated endoscopically.

Surgical treatment of intracranial complications should involve collaboration with a neurosurgeon. Intracranial complications are more likely in the presence of frontal rhinosinusitis than the other sinuses, and external trephine drainage of the frontal sinus should be performed. Any intracranial abscess should be drained.

Pott’s puffy tumour necessitates abscess drainage and removal of the infected bone, followed by 6 weeks of antibiotic treatment.

Medical treatment

Antibiotic treatment is the mainstay of medical management of periorbital infections. The following recommendations should be regarded as a rough guide only and we would advise obtaining local microbiology advice before commencing ‘blind’ antibiotic treatment of periorbital infections.

Mild, pre-septal infections will often respond very well to oral treatment covering both staphylococci and streptococci as a priority, given the typical pre-septal route of infection which involves breaching the skin barrier. Parenteral treatment with once daily intravenous ceftriaxone for ambulatory patients is commonly used in paediatric emergency departments and assessment units. At least once daily review and robust safety netting are advised for any patient discharged home on antibiotic treatment, and escalation of management to imaging and review of antibiotic therapy may be required if there is clinical deterioration or no improvement within 24–48 h.

Any infection suspected or with the potential to affect post-septal tissues will require treatment with intravenous antibiotics with broad spectrum cover including anaerobes from the outset. The duration of treatment will vary and depend on clinical response, the extent of the infection and presence of complications. Usually a treatment course would be for 10–14 days.

There is currently no evidence to support the routine use of nasal decongestants or oral steroids. An overview of the approach to the child with periorbital swelling is outlined in Figure 3.

Surgical treatment

The primary aim of surgery is drainage of the subperiosteal or intraorbital abscess. This can be performed under general anaesthetic, either externally or endoscopically.

In the external approach, a curvilinear incision is made halfway between the medial canthus of the eye and the nasion of the nose. Dissection proceeds along the periosteum. The anterior ethmoidal artery will be identified and ligated. As dissection continues, the abscess cavity is encountered, the pus drained, and the cavity irrigated. A hole should be made in the lamina papyracea to drain the abscess cavity medially into the anterior
ethmoid sinuses. A corrugated drain is usually placed into the cavity, to drain any residual blood and pus, and brought out externally through the skin incision. The drain prevents the abscess from re-collecting, and is usually removed on the ward 24–48 h later.

In the endoscopic approach there is no scar, and the operation is performed entirely through the nasal cavity. In the presence of acute inflammation and bleeding, access can be difficult. This approach is usually reserved for a more experienced endoscopic surgeon, typically a rhinologist. The lamina papyracea is breached to enable the subperiosteal or intraorbital abscess to drain into the nose, and subsequent irrigation to be performed. Provided a sufficiently large hole is fashioned, it is not usually necessary to insert a drain.

In both the above approaches, there is a risk of blindness in an already inflamed orbit, due to pressure from retraction, too vigorous irrigation, or haemorrhage into the orbit. The surgeon should therefore be prepared to undertake a lateral canthotomy if haemorrhage occurs, to release the intraorbital pressure on the optic nerve.

The secondary aim of surgery is to open up and washout the sinuses. The anterior ethmoid sinuses will have already been opened by draining the abscess. The ostia (drainage channels) of the maxillary sinuses should be widened endoscopically, and irrigated through an infra-meatal antrostomy.

Follow-up and prognosis

Review of children discharged home from hospital is particularly important in the early stages of the illness in order to assess response to treatment. Review in hospital or by the child’s General Practitioner should be arranged within 24–48 h. Follow-up after inpatient treatment will depend on the extent of the infection, complications and treatment modalities and will be guided by the relevant teams involved in the patient’s care.

If treated promptly, the prognosis for return of normal vision following orbital cellulitis +/− abscess is excellent, and patients can usually be discharged within a few days following surgery. Follow-up is advised for any patient who underwent surgical treatment, to exclude early complications. Residual or recurrent disease and intracranial sepsis are possible, and usually equate to inadequate surgical drainage. There is a small risk of diplopia following surgery which usually resolves. Late complications include residual visual defect (diplopia, reduced acuity), scarring or webbing from an external drainage approach, and enophthalmos.
For frontal sinus involvement, an elective ventilation or frontal sinus obliteration procedure can be considered, to prevent recurrence of sinusitis.

Uncomplicated, pre-septal cellulitis which is responding to treatment does not require long term follow-up.

FURTHER READING


Practice points

- Clinical assessment of periorbital cellulitis is challenging except in the mildest of cases
- In the majority of cases of mild pre-septal cellulitis (Chandler classification type 1) oral antibiotic treatment will be sufficient to achieve full resolution
- An early detection of extent and severity of infection is required to prevent long-term morbidity
- Proptosis, conjunctival injection, decreased optic nerve function and impaired extraocular movements are red flags
- Management typically requires multi-disciplinary input
- CT scanning should include sinuses, orbita and intracranial structures
- Antibiotic treatment is broad spectrum including anaerobes