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Evidence-Based Management of Orbital Complications of Rhinosinusitis in Children

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Abstract

Purpose of Review The purpose of this review is to assess recent evidence regarding orbital complications of rhinosinusitis in children and discuss the implications of these findings on current management protocols and clinical practice.

Recent Findings The evidence base for this topic is level 4 and 5, based on case series and expert opinion. There are some cohort studies investigating the public health aspects and microbiology of the disease which guides empirical antibiotic prescribing.

Summary The management of periorbital complications of rhinosinusitis in children is based on low levels of evidence. Expert consensus recommends expeditious cross-sectional imaging with appropriate intravenous antibiotic usage penetrating the blood brain barrier and selective surgical drainage which can be sight saving. There is some evidence to support conservative management of small subperiosteal abscesses. Surgical drainage via endoscopic, open or hybrid technique depends on individual patient circumstances and skill set of the available surgical team. However, the key tenet of all treatment options remains that clinicians should manage expeditiously to avoid visual loss.

Keywords Orbital cellulitis · Periorbital abscess · Subperiosteal abscess · Orbital disease · Paranasal sinus disease · Paediatric rhinosinusitis

Introduction

The child presenting with a hot, red, swollen eyelid, may be suffering from a broad array of conditions. In these cases, many will be benign and self-limiting such as dermatitis or topical allergy. In some infective cases, such as dacrocystitis, blepharitis, herpes simplex or zoster, topical eye drops and supportive care will be sufficient to address the condition. The consequences of underdiagnosing a child who rather than these more straightforward to manage conditions has an orbital abscess or tumour are significant. Orbital complications of rhinosinusitis in children should be treated as an emergency as they may result in visual loss, intracranial spread of infection, or rarely mortality if their course is left unchecked. A clear history, including detail time course of recent illness or exposure, examination and appropriate imaging are key to successfully managing all these conditions.

Orbital complications of rhinosinusitis can be divided into two classes by their relation to a band of fibrous tissue arising from the orbital rims and inserting into the posterior aspects of the eyelids, the orbital septum. Inflammation, infection and abscess formation anterior to the septum are referred to as "pre-septal or periorbital cellulitis," and "post-septal or orbital cellulitis" when involving tissue posterior to the septum. In effect, the septum acts as the anterior boundary of the orbit and as such pre-septal disease may expand freely whilst post-septal disease is expanding within a finite space. This expansion in volume results in a rising intra-orbital pressure, with resulting raised intraocular pressure or an "orbital compartment syndrome" [1]. The proptosis of the globe within the orbit will result in direct stretching of the optic nerve, but may also result in vascular events; either or both of which may lead to blindness if not rapidly corrected.

Post-septal disease in children is most commonly caused by spread from concurrent ethmoidal sinusitis. It is less common for the source of infection to be the maxillary or frontal

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sinus, as although adjacent to the orbit, these sinuses develop later in childhood. In contrast to this, pre-septal conditions are frequently more akin to a cutaneous cellulitis or abscess, caused by an insect bite or trauma.

Orbital infections were classified by Chandler to reflect this pre- and post-septal differentiation and also the venous drainage of the orbit and overlying skin to the cavernous sinus [2] (Table 1).

Materials and Methods

Search Strategy

The primary search for this review was conducted in September 2017 using the MEDLINE database, via the PubMed search engine. Free text searches were performed for "Complications of Rhinosinusitis," +/− "In children." The results of this search were added to by a MeSH term search for "Orbital Cellulitis and/or Paranasal Sinus Disease or Sinusitis," and the same secondary terms when "Orbital Cellulitis" was replaced with, "Orbital Disease."

The titles and abstracts for articles published between 1 January 2012 and 31 December 2017 were reviewed for relevance. The forward dating of the end of the search window was to allow 3 months for electronic ahead of paper publication. The included papers and their reference lists were scrutinized to identify further papers of potential interest.

Inclusion Criteria

The inclusion criteria for the articles within the review window were the article was primarily published in English, provided case series of more than five patients, or addressed any of the key areas of controversy relating to the management of the orbital complications of rhinosinusitis. The age of the patients involved was not considered at this stage.

Papers on the prevalence, risk factors and microbiology were considered initially, followed by those relating to the investigation and management of orbital complications of rhinosinusitis in children.

Results

The initial free text searches yielded a total of 62 papers, whilst the MeSH searches yielded 24 and 195 results respectively. These were narrowed down in the review process to 18 papers, which on scrutinizing their reference lists increased to 19 papers.

There were no randomized control trials and as such the following review is based on cohort studies, case series and expert opinion.

Prevalence and Risk Factors

The prevalence of orbital complications in the paediatric population has been assessed in the USA using the Kids' Inpatient Database (KID). In the year 2000, the incidence was 7.38 children per 100,000 (0.007%) and 6.05 per 100,000 (0.006%) in 2009 [3]. A population of 616 children and adults, known to a department with symptoms of chronic rhinosinusitis, had an incidence of orbital complications of sinusitis of 5.8% (36/616) [4]. Where similar studies have focused on purely paediatric cases, they have demonstrated an incidence of orbital complications in acute rhinosinusitis as high as 36 per 100,000 (0.036%), reflecting 171 cases of pre-septal cellulitis in 213 admissions [5]. All three studies identified a slight male preponderance, and the latter identified that children under 2 are twice as likely to be hospitalized as a result of their condition.

The falling incidence in the United States has been associated with an increase in the mean and median age of presentation (mean 4.77–6.07), whilst the public health burden of the disease remains significant. The children treated accounted for 18,293 (95% CI 16378–20,209) hospital days in 2009, with an estimated cost of US$10 million [3]. The individual cost of care was US$20,748 ± 23,549 for patients with complications of acute sinusitis, reflecting both the relatively high number of days spent in hospital and also the potential necessity for surgical intervention and prolonged hospital stay [6].

Children from lower socioeconomic classes have been considered at greater risk of orbital complications from acute rhinosinusitis, due to lesser levels of preventative care and later presentation for management. Emergency admission databases have been cross-referenced with insurance and median income level (by postal area) and

Table 1 Chandler classification of orbital cellulitis

I	Inflammatory oedema (pre-septal)	Eyelid swelling without proptosis, ophthalmoplegia or loss of vision
II	Orbital cellulitis (post-septal)	Inflammation of the orbital fat
III	Subperioesteal abscess	Pus collection elevating the periosteum off the bony orbit
IV	Orbital abscess	Pus collection within the orbit
V	Cavernous sinus thrombosis	May have bilateral neurological symptoms

demonstrated children from the highest income groups were more likely to have a complication of acute sinusitis [7]. In addressing the issue in this manner, there is a failure to consider variation of parental income within a postal area, and thus socioeconomic class is decided for children in particularly broad strokes. The issue of disease severity by socioeconomic class was not addressed.

Assessment

Clinical assessment remains the mainstay and guide for both further investigation and decision making regarding the management of children with orbital complications of rhinosinusitis. Children may present with or without preceding upper respiratory or nasal signs or symptoms. They may indeed present without any history of risk factors for the condition. Proptosis, ophthalmoplegia and loss of visual acuity, in addition to erythema, oedema and pain are all suggestive of post-septal disease. Rhinological symptoms may include unilateral, discoloured nasal discharge, purulent material in the nasal cavity/middle meatus and localized pain. The presence of pyrexia points towards an infective cause but cannot alone rule out the possibility of a neoplastic cause for eyelid swelling and erythema. In all case series reviewed, multidisciplinary care of orbital complications in children was advised. In particular the input of Otorhinolaryngology and Ophthalmology for assessment and management were considered key aspects of care. The potential for intracranial spread of disease warrants a basic neurological assessment. Localized headache, meningism, falling or altered consciousness level, focal neurological change and behavioural or mood change warrant early and urgent referral to Neurosurgery and would all warrant further radiological investigation.

Pathology and Microbiology

Orbital complications of sinus disease arise as a result of infectious [8], neoplastic, inflammatory and post-traumatic conditions. Direct pressure, invasion or penetrating trauma laterally from the sinuses all carry risk to the orbital structures. The subsequent loss of integrity of the periorbital fascia and lamina papyracea also leave the contents of the orbit more prone to infectious complications of sinus disease. Infectious, either pre-septal or post-septal cellulitis or abscess formation, is most common [9]. The anatomy of the sinuses has been shown not to act as a risk factor for the development of post-septal cellulitis [10]; however, the presence of ethmoidal sinus disease on CT scan is near ubiquitous to patients with post-septal cellulitis [11]. The method of transmission is potentially haematological via emissary veins (devoid of valves) crossing the lamina papyracea. Direct spread through osteitis has been reported in up to 55% of patients treated surgically, where the lamina papyracea has been submitted for histological examination. The presence of preceding chronic sinus disease also raises the incidence of orbital complications of acute episodes of rhinosinusitis [12].

The flora of the nasal cavity includes respiratory commensals, and most acute bacterial rhinosinusitis infections are considered secondary to viral upper respiratory tract infection [13]. Where specimens have been sampled from acutely infected sinuses and, the responsible pathogens are similar to those found in community acquired pneumonia *(S Pneumoniae*, *H Influenzae*, *Moraxella catarrhalis and Staph Aureus)* [14]. However, in the same study, during complicated acute rhinosinusitis the presence of *S. anginosus* and *S. aureus* were most common. In keeping with this finding, and the shifting nature of microbial prevalence and resistance, some authors indicate a growing relevance of *S Aureus* and its methicillin resistant variant [15].

Investigation

Initial or baseline investigations are commented on but not clearly analysed in detail. It is common place for baseline blood tests to be performed and whilst it is of note that white cell count is significantly higher in children suffering from post-septal rather than pre-septal conditions [16]; there is little in baseline bloods to alter management plans but rather monitor clinical progress.

It has previously been discussed that blood cultures have been reported to be of varying use clinically, and that cultures from an abscess cavity or sinonasal mucopus proved more useful. In the review time frame, few papers have reflected upon the efficacy of these cultures, focusing instead on the prevalence of different pathogens [1].

Contrast enhanced CT scanning of the sinuses and orbits is the predominant imaging modality in orbital cellulitis. There remains controversy over the timing of scans; however, there appear to be two categories into which children undergoing imaging fall. The first, and more common, where children have failed to improve during medical management having been admitted with normal visual acuity and the second group of patients presenting with severe symptoms undergo scanning at the point of admission to hospital. In particular, this group may include those children suffering significant sepsis, neurological symptoms or loss of visual acuity. Loss of visual acuity is a key indicator, but the index of suspicion and inclination to perform early imaging would be greatly increased by other post-septal signs, such as conjunctival hyperaemia/chemosis, reduced ocular motility, pain on eye movements or proptosis. In the case of impaired visual acuity and clear concurrent sinusitis, the question arises as to the necessity for imaging, which could well delay potentially vision preserving surgery to decompress the abscess and hence the orbit. There

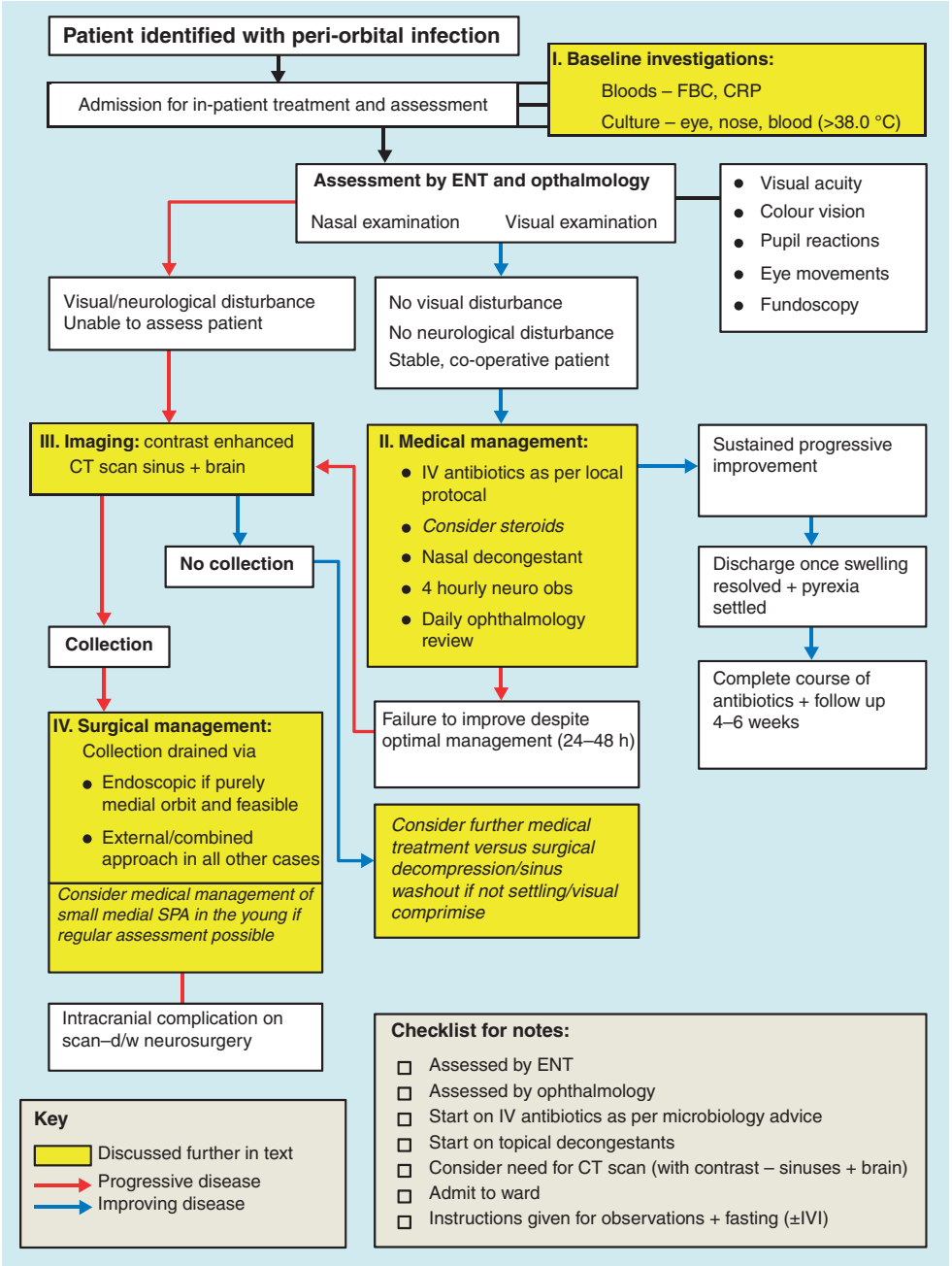

Fig. 1 Assessment and treatment plan

is little evidence or discussion in the literature to support not scanning, despite the obvious concerns about exposing children to radiation.

Patients undergoing MRI scanning were being investigated for intracranial or further orbital conditions in the case series reviewed. This is in keeping with earlier literature although it is interesting that only two papers mentioned MRI as a modality of investigation [9, 17], which may be suggestive of an inherent bias towards orbital rather than intracranial complications of rhinosinusitis in our initial search.

Management

The initial use of antibiotics in pre- and post-septal disease is uncontroversial both historically and in current literature, as many of these patients will display signs of sepsis at the time of admission to hospital. As we have already discussed, pathogens associated with sinonasal disease are akin to those seen in community acquired pneumonia. However, the increased presence of staphylococci in abscess cultures from patients with orbital disease, warrants the use of broad spectrum antibiotics [14]. It is our opinion that the choice of antibiotic

would ideally be related to both the local knowledge of common organisms and necessity for broader spectrum treatment than that recommended in uncomplicated acute rhinosinusitis. Whilst not mentioned in the articles reviewed, it also seems prudent that duration of antibiotics is based on clinical assessment rather than didactic prescribing.

The prolonged or sole use of antibiotics in the treatment of post-septal disease where abscess formation has occurred (Chandler III) is more controversial. The argument for the conservative treatment of small, medially placed subperiosteal abscesses highlights the evidence for resolution in these cases, with avoidance of general anaesthetic and improved cosmesis (assuming an external surgical approach) [17, 18]. In an earlier review of this topic, larger abscesses, non-medial position, presence of other complications (intracranial), increasing age, proptosis, gas in the orbit and concurrent dental infection were considered as factors reducing the efficacy of conservative therapy [1]. These factors are in addition to any sign or symptom of altered sight (loss of acuity, colour vision, proptosis or ophthalmoplegia) which would mandate surgical decompression of the orbit. As a result, medical treatment should not be carried out in an outpatient setting or indeed any setting where regular and frequent assessment by both an Otorhinolaryngologist and Ophthalmologist is not easily accessible.

Surgical drainage is therefore reserved for those who do not respond to medical therapy or those who present with visual or neurological symptoms with abscess. Localization of abscess by CT scan allows for surgical planning, and consideration of endoscopic or open approaches to post-septal abscess. The traditional approach, via a Lynch-Howarth incision and elevation of the orbital periosteum to expose the abscess cavity and adjacent lamina papyracea results in a facial scar. It does however allow for rapid and reliable decompression, easy superior and inferior extension, and is a useful adjunct in cases of severe rhinosinusitis where heavy bleeding from inflamed mucosa may result in difficulty draining the abscess through an endoscopic approach in a young child, or complex anatomy where a combined approach may prove useful. Despite this several authors have published series operating solely through the endoscopic approach [17, 19]. In one series, varying extents of endoscopic dissection are discussed, all of which achieve adequate drainage [18].

A transcaruncalar approach for drainage of medial periorbital collections is a more recent alternative to the external approach and carries with it little in the way of cosmetic consequences [20]. The initial dissection through a conjunctival incision and subsequent dissection between the lacrimal sac and medial rectus muscle leads to the periorbita and thus to a surgical exposure similar to that achieved via Lynch-Howarth incision. Despite the cosmetic benefits, there is little discussion of its use in the recent literature or comparison with the more traditional approaches. The application of a transcaruncular approach may also be limited by presence or absence of ophthalmology support in hospitals with ENT emergency services.

It is important that decisions regarding drainage technique and extent of endoscopic dissection are made on an individual patient by patient basis and that surgeons make decisions in keeping with their training and experience regarding their choice of approach. In endoscopic and combined approaches, the use of a drain is counter intuitive as the abscess will drain medially into the sinus cavity. However, we found no discussion or evidence of a change in practice regarding post-operative use of drains.

Conclusion

There are key areas within the management of orbital complications of rhinosinusitis that remain unanswered by randomized control trial. The high stakes regarding the potential consequences of inaction or delayed treatment in a child presenting with ophthalmoplegia and proptosis obviates the state of clinical equipoise, which is necessary for the design of a randomized controlled trial (RCT). Expert opinion and large case series will continue to be key in refining management. This position has not changed a great deal during the time period of this review. Indeed, many of the papers we have discussed reflect the assessment and treatment plan (Fig. 1) based on the West of Scotland paper from 2011 [1]. The variability of pathogen and virulence in particular is an area in which the benefit of local audit and protocol are important to inform the initial treatment of orbital complications of rhinosinusitis. Local guidelines for management of these children should be in place to decrease the incidence of complications from orbital cellulitis [21].

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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