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# Microbiology and antibiotic therapy of subperiosteal orbital abscess in children with acute ethmoiditis

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## ABSTRACT

**Objective:** The objective of this study was to investigate the microbiological cultures and the management of acute ethmoiditis complicated by subperiosteal orbital abscess (SPOA) in a pediatric population.

**Methods:** The medical records of children under 18 years old was performed in a tertiary referral pediatric center from January 2009 to April 2017. Clinical examination, computed tomography scans, medical and surgical treatments were reviewed and compared to other studies in literature.

**Results:** One hundred and twenty-nine children were hospitalized for acute ethmoiditis. Among them, forty eight were complicated by SPOA. The mean age of these children were 7 years (range 10 months–16 years). Thirtyfour underwent surgical drainage; for the others the medical treatment was sufficient. Microbiological samples were obtained during the surgical intervention and were contributive in 91% of cases. *Streptococcus* spp was the most frequently encountered bacteria (60% of cases). We also found anaerobic bacteria (12%), and *Staphylococcus aureus* (12%). 94% of children received two intravenous antibiotics (a third-generation cephalosporin and metronidazole) for a mean duration of four days. Then the oral treatment was based on amoxicillin-clavulanate during about 8.5 days. All children were cured without sequelae.

**Conclusions:** For five years *Streptococcus milleri*, *Staphylococcus* spp and anaerobic bacteria are on the rise in acute ethmoiditis complicated by SPOA. That is why antibiotics must be adapted to these bacteria even in children under ten years old.

## 1. Introduction

During the first life decade, acute sinusitis and especially ethmoiditis frequently occur. It accounts for 21% of pediatric antibiotic prescriptions [1]. Orbital infection is the most frequent complication of ethmoiditis and can arise 91% of sinusitis complications in children [1]. The spread of infection from the ethmoid sinus to the periorbital space can occur by eroding the lamina papyracea or through the hematogenous dissemination [2,3]. Sometimes, this complication can be favored by a congenital dehiscence of the lamina papyracea. The spread of this infection can lead to a subperiosteal orbital abscess (SPOA). The progression of SPOA may result in serious complications such as cerebral abscess, cavernous sinus thrombosis and permanent visual loss [4,5].

Contrast-enhanced paranasal sinus computed tomographic scan (CT-scan) is a very useful method to diagnose and to classify orbital complications in Chandler's classification [6]. SPOA seems to represent

the most common orbital complication of sinusitis in children [7] and requires active management. The optimal management of SPOA is still controversial. Indeed, the choice of the treatment (medical treatment versus surgery) is central to the debate as well as the type of surgical approach in case of surgery. Some physicians favor immediate surgical drainage while others recommend initial medical treatment keeping surgery for non-responders [8,9]. It seems that smaller abscesses in young children [8,10–12] are suitable to medical treatment with close observation [13,14]. Oxford and McClay [2] reported that older children with SPOA were also successfully managed with medical therapy. In all cases, antibiotic therapy is necessary, first probabilistic and then adapted to the identified germ if bacteriological samples were carried out.

The main objectives of the present study were to review all children who were referred to our center for SPOA secondary to acute ethmoiditis and to assess the current bacteriology of drained SPOA. Our results were compared to those of past studies. Finally, the impact on the

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antibiotic use is discussed.

## 2. Material and methods

This retrospective study was performed in a tertiary referral pediatric center from January 2009 to April 2017. All children under 18 years old were included in the study if they presented an evident clinical ethmoiditis, with a sinus CT-scan showing a SPOA (stage III of Chandler's classification). In the CT-scan, SPOA was defined as a central low-density region with ring enhancement in the orbital region. The exclusion criteria were a chronic rhinosinusitis, and/or an intraorbital abscess on the CT-scan.

Charts were evaluated for age, gender, physical exam findings (with an oculomotor exam and a neurological assessment), CT-scans, surgical procedure, culture results, antibiotic treatment and follow up. The CT-scans were reviewed for SPOA width and length, and collection in sinuses. Our surgery indications, based on previous study [15,16], were the following ones: (1) abscess width more than 5 mm or extended to the optic nerve, (2) oculomotor disorder, (3) absence of symptoms improvement after 48–72 h of intravenous antibiotics, (4) severe clinical complications such as epidural empyema, loss of visual acuity or cavernous sinus thrombophlebitis.

The surgical therapy was recorded and separated into three categories: an external approach (EA), a transnasal endoscopic approach (TEA) and a combined external and transnasal approach (CA) to drain the SPOA. Since our department was the ENT emergency center for the Rhone department, the surgery was performed by the ENT surgeon on call who could be a fellow. The choice between the EA, TEA or the CA was decided by the surgeon on call, taking into consideration the abscess characteristics, the anatomical conditions but also his personal training and skills in pediatric transnasal endoscopic surgery.

During surgery, sinus secretions and the pus from the SPOA were systematically sampled and carried out, immediately to the laboratory, in a plastic tube containing a sterile swab. The way of detecting and identifying bacteria was based on culturing using different culture media with control of the nutrients and culture conditions (temperature, air supply, O<sub>2</sub>, light, blood, pH ...), enumeration and isolation of presumptive colonies with study of phenotypic characteristics completed if needed by genotypic characteristics. The phenotypic method included biotyping (growth requirement, environmental conditions, antibiotic resistance, cell morphology ...), and identification by mass spectrometry. Mass spectrometry is an analytical technique in which chemical compounds are ionized into charged molecules and ratio of their mass to charge ( $m/z$ ) is measured. Identification of microbes is done by either comparing the peptide mass fingerprint (PMF) of unknown organism with the PMFs contained in the database or by matching the masses of biomarkers of unknown organism with the proteome database [17]. The genotypic method used molecular techniques to identify bacteria by doing DNA or RNA analysis of the bacterium's genome. The system used in our center was the Vitek<sup>®</sup>MS system (by bioMérieux France). If the mass spectrophotometry was not contributory, a universal PCR detection method was used.

The Ethics Committee of the Hospices Civils de Lyon in France approved the study (Number 17-145) and all patients gave written informed consent.

## 3. Results

One hundred and twenty-nine children were hospitalized in our center for acute ethmoiditis between 2009 and 2017. Among them, forty eight (37%) were complicated by SPOA. The age of these children with SPOA ranged from 4 months to 16 years, with a mean age of 7 years. From these SPOA, thirty-four (71%) underwent surgical drainage. For the others, a medical treatment was sufficient. Clinical data and patient characteristics are summarized in Fig. 1.

Before surgery, each child underwent an oculomotor examination.

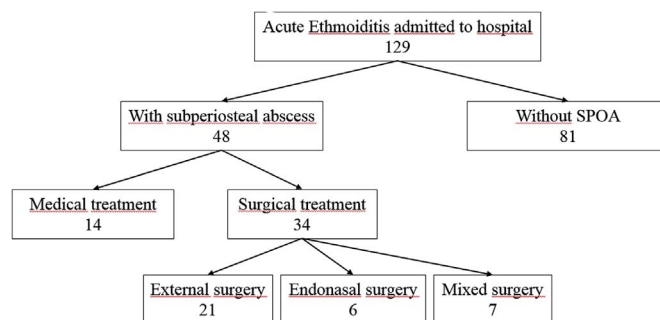


Fig. 1. Evaluation and treatment of 129 children with acute ethmoiditis.

More than 50% of children with an operated SPOA had at least one ophthalmologic trouble at the beginning. The most constant sign was ophthalmoplegia (71% cases). In 50% of cases, we recorded proptosis and/or diplopia. The mean age of operated children with an oculomotor dysfunction was nine years and six months whereas for the others without oculomotor trouble it was four years and six months.

On the CT-scan, the mean width of SPOA was 6 mm (range 3–12 mm). Twenty-one children were treated with an external approach, six with a transnasal endoscopic technique and seven with a combined approach. An example of a young child with a SPOA drained by an external approach is given in Fig. 2.

Among the operated children, seventeen (50%) had a previous antibiotic treatment before hospitalization (amoxicillin-clavulanate, or pristinamycin, or a third-generation cephalosporin, or josamycin). The average duration of this antimicrobial therapy was four days. Only two children had a sterile surgical sample despite a first medical therapy during 48 h.

### 3.1. Microbiologic cultures (Table 1)

Cultures were obtained by pus sample during the surgical intervention. Samples were contributive in 91% of cases. The most frequent encountered bacteria was *Streptococcus* spp which was found in more than 60% of cases. Furthermore, the other identified species were the anaerobic bacteria (12%), *Staphylococcus aureus* (12%) and *Haemophilus influenzae* (9%). There was only one case of methicillin-resistant *Staphylococcus aureus* (MRSA). The age of children with anaerobic cultures ranged from 3 years to 15 years. All children older than nine years had a *Streptococcus intermedius* (which belongs to milleri group) in their culture.

After surgery, thirty-two children received two intravenous antibiotics (third-generation cephalosporin and metronidazole) for a mean duration of four days. Only two children had a prolonged intravenous antimicrobial treatment. The first one had a MRSA, he received intravenous clindamycin and vancomycin during ten days. The second one had a subdural empyema which required intravenous third-generation cephalosporin and metronidazole for fifteen days. The average hospital stay was 6.5 days (range 3–16 days).

Then after hospitalization, each child had an oral antibiotic during about 8.5 days (from 7 to 15 days). The most frequently used antibiotic was amoxicillin-clavulanate (76% cases). Because of allergy, some children had pristinamycin, or clindamycin and metronidazole. All children were cured without sequelae at the end of the antibiotic treatment. Moreover we did not notice any recurrence of ethmoiditis with our follow-up. The mean follow-up length was 85.8 days after the surgery, with a range of 9 days to 5.3 years.

## 4. Discussion

Many studies have been conducted over the past decades on microbiology of SPOA complicating sinusitis. In a recent literature review

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