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Zuzanna Bielska, Piotr Kwast, *Lidia Zawadzka-Głos

Microbiological etiology of complicated acute rhinosinusitis requiring surgical treatment in children

Etiologia mikrobiologiczna powikłanego ostrego zapalenia zatok przynosowych wymagającego leczenia zabiegowego u dzieci

Department of Pediatric Otolaryngology, Medical University of Warsaw, Poland
Head of Department: Associate Professor Lidia Zawadzka-Głos, MD, PhD

Keywords

microbiology, acute sinusitis, surgery, pediatric laryngology

Summary

Introduction. Rhinosinusitis is a very common disease. Viral infections are usually mild and self-limiting. Only 0.5-2% of all acute sinusitis cases have a bacterial etiology and only a small percentage of them develop complications that require appropriate treatment. The surgical procedure allows precise collection of material for microbiological examination and then the identification of the pathogen causing the infections.
Aim. The aim of the study was to evaluate patients and especially the microbiological etiology of acute bacterial rhinosinusitis undergoing surgical treatment because of complications.
Material and methods. The retrospective analysis included 30 pediatric patients hospitalized in the years 2018-2022 at the Department of Pediatric Otolaryngology of the Medical University of Warsaw due to complicated bacterial rhinosinusitis requiring surgical treatment. The analysis included the age and sex of the patients, the indication for surgical treatment, the results of microbiological tests collected during the surgical procedure and the course of treatment.
Results. The study included 21 boys (70.0%) and 9 girls (30.0%) aged from 11 months to 14 years (average age 7.5 years). The following complications were found in 21 (70.0%) of 30 operated patients: inflammatory eyelid edema (23.3%), orbital cellulitis (16.7%), subperiosteal abscess of the orbit (23.3%) and Pott's tumor (6.7%). 16 different pathogens were isolated as a result of culture of material collected during surgery. The presence of one pathogen was confirmed in 18 patients (60.0%), in 10 patients (33.3%) two or more pathogens were detected, while in two children (6.7%) the microbiological test result was negative. The most frequently isolated pathogens were *Staphylococcus aureus* and *Streptococcus pyogenes*. Both *S. aureus* and *S. pyogenes* were found in 5 patients and in one case both pathogens were present in the culture. *Haemophilus influenzae* was confirmed in 4 patients (13.3%), one of them was also diagnosed with *Moraxella catarrhalis*. *Streptococcus pneumoniae* was isolated in two children (6.7%). All patients received wide-spectrum intravenous empirical antibiotics, most often, it was a combination of ceftriaxone (40.0%) or cefuroxime (20.0%) with clindamycin.
Conclusions. In the studied group of patients from the Department of Pediatric Otolaryngology of the Medical University of Warsaw in 2018-2022 with diagnosed bacterial rhinosinusitis requiring surgical treatment, the most frequently isolated pathogen was *Staphylococcus aureus* and *Streptococcus pyogenes*. Infections of *Haemophilus influenzae*, *Streptococcus pneumoniae* or *Moraxella catarrhalis* occurred much less often.

Słowa kluczowe

mikrobiologia, ostre zapalenie zatok przynosowych, operacja, laryngologia dziecięca

Streszczenie

Wstęp. Zapalenie błony śluzowej nosa i zatok przynosowych jest bardzo częstą jednostką chorobową. Infekcje wywołane przez wirusy mają zazwyczaj charakter łagodny i samoograniczający. Jedynie 0,5-2% wszystkich ostrych zapaleń zatok posiadają etiologię bakteryjną i niewielka część z nich przebiega z rozwinięciem powikłań, które wymagają odpowiedniego leczenia. Postępowanie zabiegowe pozwala na precyzyjne pobranie materiału do badania mikrobiologicznego, a tym samym na identyfikację patogenu powodującego infekcję.

Cel pracy. Celem pracy była ocena pediatrycznych pacjentów z ostrym bakteryjnym zapaleniem zatok przynosowych poddawanych leczeniu zabiegowemu ze szczególnym uwzględnieniem etiologii mikrobiologicznej powikłanego ostrego bakteryjnego zapalenia zatok przynosowych.

Materiał i metody. Analizą retrospektywną objęto 30 pacjentów hospitalizowanych w latach 2018-2022 w Klinice Otolaryngologii Dziecięcej Warszawskiego Uniwersytetu Medycznego z powodu powikłanego bakteryjnego zapalenia zatok przynosowych wymagającego leczenia operacyjnego. Analizie poddano wiek i płeć pacjentów, wskazanie do leczenia operacyjnego, wyniki badań mikrobiologicznych pobranych podczas zabiegu oraz przebieg leczenia.

Wyniki. Do badania włączono 21 chłopców (70,0%) oraz 9 dziewcząt (30,0%) w wieku od 11 miesięcy do 14 lat (średnia wieku 7,5 roku). U 21 (70,0%) z 30 operowanych pacjentów stwierdzono następujące powikłania: zapalny obrzęk powiek (23,3%), zapalenie tkanek miękkich oczodołu (16,7%), ropień podokostnowy oczodołu (23,3%) oraz guz Potta (6,7%). W wyniku hodowli materiału pobranego podczas zabiegu operacyjnego wyizolowano 16 różnych patogenów. U 18 pacjentów (60,0%) stwierdzono obecność jednego patogenu, u 10 (33,3%) dwa lub więcej patogeny, natomiast u dwójki dzieci (6,7%) wynik badania mikrobiologicznego był ujemny. Najczęściej izolowanymi patogenami były *Staphylococcus aureus* i *Streptococcus pyogenes*. Etiologię *S. aureus* stwierdzono u 5 pacjentów, *S. pyogenes* także u 5 dzieci, dodatkowo w jednym przypadku w posiewie obecne były oba wyżej wymienione patogeny. *Haemophilus influenzae* potwierdzono u 4 pacjentów (13,3%), u jednego z nich dodatkowo wykryto *Moraxella catarrhalis*; *Streptococcus pneumoniae* wyizolowano u dwójki dzieci (6,7%). Wszyscy pacjenci otrzymali szerokospektralną dożylną antybiotykoterapię empiryczną, najczęściej było to połączenie ceftriaksonu (40,0%) lub cefuroksymu (20,0%) z klindamycyną.

Wnioski. W badanej grupie pacjentów Kliniki Otolaryngologii Dziecięcej Warszawskiego Uniwersytetu Medycznego w latach 2018-2022 z rozpoznanym bakteryjnym zapaleniem zatok przynosowych wymagającym leczenia zabiegowego, najczęściej izolowanymi patogenami były *Staphylococcus aureus* oraz *Streptococcus pyogenes*. Infekcja o etiologii *Haemophilus influenzae*, *Streptococcus pneumoniae* czy *Moraxella catarrhalis* występowała zdecydowanie rzadziej.

Introduction

Rhinosinusitis is a very common disease occurring in the practice of physicians, pediatricians and pediatric laryngologists.

European Position Paper on Rhinosinusitis and Nasal Polyps from 2020 (EPOS 2020) define acute rhinosinusitis (ARS) in children as the sudden onset of two or more of the following symptoms: nasal blockage, nasal discharge (anterior or posterior nasal drip) or cough (daytime or nighttime) persisting for no more than 12 weeks (1). The authors of EPOS 2020 suggested division into three different forms of ARS: acute viral rhinosinusitis (common cold), post-viral acute rhinosinusitis and acute bacterial rhinosinusitis. It is estimated that school children may suffer from 7 to 10 colds per year, which is the most common form of ARS. Infections caused by viruses are usually mild and self-limiting, and antibiotic treatment is not recommended.

According to the literature only about 0.5-2% of all acute sinus infections have bacterial etiology. The diagnosis of acute bacterial rhinosinusitis requires the presence of at least 3 of 5 symptoms: change in discharge color, severe facial pain, fever, raised CRP/ESR or 'double' sickening.

Most cases of bacterial ARS can be treated conservatively with empirical antibiotics; moreover only a small percentage of bacterial infections develop complications.

It is extremely important to quickly apply effective treatment, including wide-spectrum intravenous antibiotics and often surgical treatment. The surgical procedure allows precise collection of material for microbiological examination and then the identification of the pathogen causing the infection. It also enables modification of empirical antibiotic therapy based on the antibiogram result when it is necessary.

Described group of patients consists of children who underwent surgical treatment because of complications

caused by bacterial acute rhinosinusitis. Identification of a group with this particular criteria allows for a reliable analysis of microbiological etiology based on the culture results of material collected during surgery.

Aim

The aim of the study was to evaluate patients and especially the microbiological etiology of acute bacterial rhinosinusitis undergoing surgical treatment because of complications.

Material and methods

The retrospective analysis included 30 patients hospitalized in the years 2018-2022 at the Department of Pediatric Otolaryngology of the Medical University of Warsaw due to complicated bacterial rhinosinusitis requiring surgical treatment.

The inclusion criteria for the study group were: diagnosis of complicated bacterial acute rhinosinusitis requiring surgical treatment, age below 18 years and absence of chronic inflammatory process in the paranasal sinuses. The indication for surgical intervention was the presence of an abscess in the orbit or frontal area (Pott's tumor) on physical examination or imaging or lack of clinical improvement within 24-48 hours from the beginning of empiric antibiotic therapy. Material for microbiological examination was collected from each patient during the procedure.

The analysis included the age and sex of the patients, the indication for surgical treatment, the results of microbiological tests and the course of treatment.

Results

The study included 21 boys (70.0%) and 9 girls (30.0%) aged from 11 months to 14 years (average age 7.5 years). The age range of the study group is shown in figure 1.

The following complications were found in 21 (70.0%) of 30 operated patients: inflammatory eyelid edema (23.3%), orbital cellulitis (16.7%), subperiosteal abscess of the orbit (23.3%) and Pott's tumor (6.7%) (fig. 2). Remaining children had no improvement within 24-48 hours of conservative treatment. In addition three patients had sepsis, probably caused by ARS.

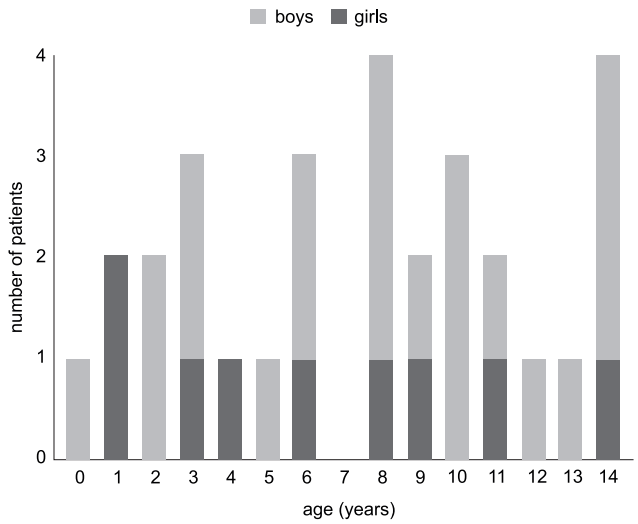

Fig. 1. Age rage of the study group of patients

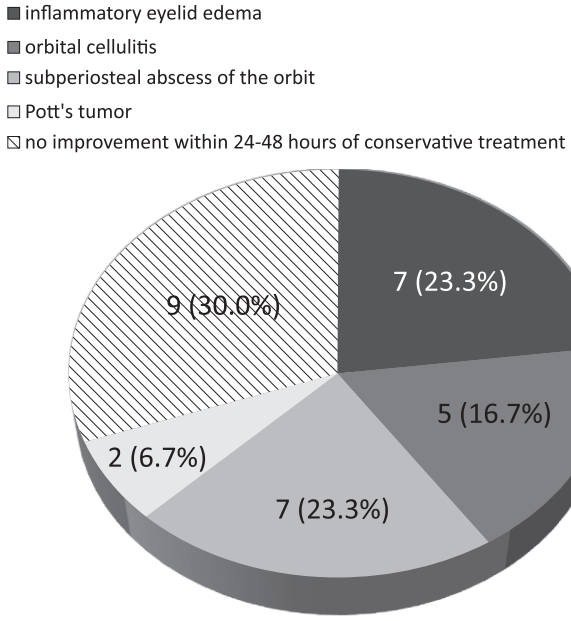

Fig. 2. Indications for surgical treatment

During the treatment process, 29 of 30 patients required only one surgical procedure, apart from one patient who was operated three times: two functional endoscopic sinus surgery (FESS) and external ethmoidectomy with orbital drainage. 11 (36.7%) patients underwent FESS procedure. Moreover 3 patients (10.0%) had FESS and a Beck's puncture (external drainage of the frontal sinus). Just maxillary sinus puncture was performed in 9 (30.0%) patients, 3 (10.0%) patients had Beck's puncture combined with puncture of the maxillary sinus. One patient (3.3%) underwent just Beck's puncture. Two patients (6.7%) were qualified for external ethmoidectomy with orbital drainage. Procedures performed in the study group are presented schematically in figure 3.

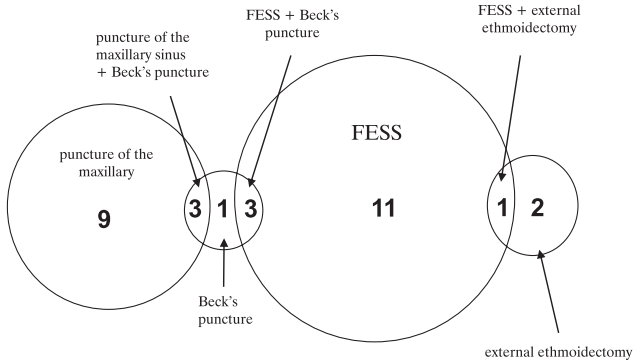

Fig. 3. Graphical presentation of the types and number of procedures performed in the study group

Sixteen different pathogens were isolated as a result of culture of material collected during surgery. The presence of one pathogen was confirmed in 18 patients (60.0%), in 10 patients (33.3%) two or more pathogens were detected, while in two children (6.7%) the microbiological test result was negative.

The most frequently isolated pathogens were *Staphylococcus aureus* and *Streptococcus pyogenes*. Both *S. aureus* and *S. pyogenes* were found in 5 patients and in one case both pathogens were present in the culture. Other staphylococcal species were present in 7 patients (23.3%). *Streptococcus intermedius* was isolated in 4 children (13.3%).

Tab. 1. Particular bacteria within a whole group of pathogens

Isolated pathogen	Number of cases	Percent (%)
Staphylococcus aureus MS	6	15.38
Streptococcus pyogenes	6	15.38
Staphylococcus spp. (pasteuri, hominis, warneri)	5	12.82
Staphylococcus epidermidis	4	10.26
Streptococcus intermedius	4	10.26
Haemophilus influenzae	4	10.26
Streptococcus pneumoniae PSSP	2	5.13
Streptococcus oralis	2	5.13
Moraxella catarrhalis	1	2.56
Prevotella melaninogenica	1	2.56
Dolosigranulum pigrum	1	2.56
Corynebacterium pseudodiphtheriticum	1	2.56
Eikenella corrodens	1	2.56
Bacillus cereus	1	2.56

Haemophilus influenzae was confirmed in 4 patients (13.3%), one of them was also diagnosed with *Moraxella catarrhalis*. *Streptococcus pneumoniae* was isolated in two children (6.7%). *Streptococcus pyogenes* was found to be the etiology in 3 out of 7 patients (42.9%) with a complication like subperiosteal abscess of orbit. Bacterial strains with antibiotic resistance mechanisms were isolated in 4 cases (13.3%). There were two cases of beta-lactamase-producing *Haemophilus influenzae*, methicillin-resistant *Staphylococcus epidermidis* and *Staphylococcus aureus* MLSBI (inducible clindamycin resistance).

Particular pathogens and the results of microbiological tests are presented in table 1. The results of cultures in patients with bacterial co-infection are presented in table 2.

All patients, in addition to surgical treatment, received wide-spectrum intravenous empirical antibiotics; 4 children (13.3%) required treatment modifications based on the microbiological test results. Two intravenous antibiotics were administered in the majority, i.e. 21 children (70.0%). Most often, it was a combination of ceftriaxone (40.0%) or cefuroxime (20.0%) with clindamycin.

The duration of hospitalization at the Department of Pediatric Otolaryngology of the Medical University of Warsaw in the study group ranged from 2 to 23 days. The median hospitalization time in the entire group was 11 days.

Discussion

Acute rhinosinusitis (ARS) is a disease in which antibiotics are commonly overused. This is due to the fact that the clinical course of bacterial infections and more severe viral infections is often difficult to distinguish. The increasing antibiotic resistance of bacteria in recent years forces clinicians to be more cautious and careful when using antibiotics in ARS treatment.

Tab. 2. Summary of cases with bacterial co-infection including age, sex, clinical form and identified pathogens

Age (years)	Sex	Clinical form	Pathogen 1	Pathogen 2	Pathogen 3
10	M	orbital cellulitis pansinusitis	*Staphylococcus aureus*	*Streptococcus pyogenes*	
13	M	acute frontal and maxillary sinusitis, upper eyelid abscess	*Staphylococcus aureus*	*Streptococcus intermedius*	
8	M	pansinusitis, sepsis	*Staphylococcus aureus*	*Prevotella melaninogenica*	
9	M	acute maxillary sinusitis	*Staphylococcus warneri*	*Streptococcus oralis*	
10	M	orbital cellulitis, pansinusitis	*Staphylococcus warneri*	*Staphylococcus epidermidis*	*Staphylococcus pasteuri*
10	M	subperiosteal abscess of the orbit	*Staphylococcus hominis*	*Streptococcus oralis*	
11	K	subperiosteal abscess of the orbit	*Haemophilus influenzae* BLNAR	*Staphylococcus epidermidis*	
3	M	acute sphenoid sinusitis, polyp of sphenoid sinus	*Haemophilus influenzae*	*Moraxella catarrhalis*	
8	M	Pott's tumor, eyelid edema	*Streptococcus intermedius*	*Eikenella corrodens*	
1	K	subperiosteal abscess of the orbit	*Dolosigranulum pigrum*	*Corynebacterium pseudodiphtheriticum*	

Analyzing the microbiological etiology of acute bacterial sinusitis makes many challenges to researchers, potentially limiting the value of the obtained data. In many cases, obtaining reliable material for bacteriological tests is very difficult or even impossible. A nasal swab is not considered reliable for isolating the pathogen responsible for a current acute infection (1). This is due to the contamination of the sample by the rich bacterial flora of the upper respiratory tract. Among the methods available in patients treated entirely conservatively, only a swab from the middle nasal meatus taken under endoscopic control has a high compliance of 82%, compared to an aspirate taken from the maxillary sinus (2). This procedure is very difficult to perform in children and therefore not useful in this group of patients. Performing diagnostic puncture of the maxillary sinus or taking a swab under endoscopic control during sedation is not currently recommended as a standard of conservative treatment for patients with bacterial ARS.

Careful and reliable collection of microbiological material is possible during surgery, therefore only in a certain part of patients, especially those who have developed complications of rhinosinusitis. In the group of pediatric patients not undergoing surgical treatment there are significant limitations to reliable analysis.

According to the literature, bacterial acute rhinosinusitis accounts for only 1% of all paranasal sinus infections and most cases can be treated conservatively. According to reports, in patients hospitalized due to bacterial ARS, complications occur in approximately 3-20%, and they concern male patients and children much more often (1, 3, 4). It is seen in our study group, which was dominated by boys.

The decision to perform surgery in all cases should be made individually, taking into consideration clinical indications, medical staff experience, urgency of the procedure and response to conservative treatment. Current literature often indicates good effects of conservative treatment of smaller abscesses and the possibility of delaying surgical intervention (1).

According to the literature, the most common pathogens causing bacterial ARS are *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Moraxella catarrhalis* (1, 5-9). However, according to the literature, in the case of complicated infections, including those requiring surgical treatment, the microbiological etiology is different (10). In these cases, the culture results most often reveal the presence of: *Staphylococcus aureus* (6, 11-13) and *Streptococcus pyogenes* (7, 12, 13). Additionally, the polymicrobial etiology should be considered, which may be present in 29-55% of patients (11, 12, 14).

In the study group of patients, the most common pathogens were *Staphylococcus aureus* (20.0%) and *Streptococcus pyogenes* (20.0%), two or more pathogens were identified in 10 children (33.3%). Moreover, the most common microbiological etiology in patients with subperiosteal abscess of the orbit was *Streptococcus pyogenes* (42.9%), while bacterial co-infection was found in 3 patients (42.9%). Our results are similar to the analysis of McCoy et al. (15). In other publications (16, 17), the presence of *Staphylococcus aureus* and *Streptococcus anginosus* group is predominated.

The presence of *Haemophilus influenzae* was confirmed in 4 patients (13.3%), in one of them *Moraxella catarrhalis* was additionally detected. *Streptococcus pneumoniae* was isolated in two children (6.7%), these results are similar to reports in the literature (8).

Antibiotic resistance mechanisms were detected in two strains of *Haemophilus influenzae*. These were *Haemophilus influenzae* BLPACR (β-lactamase positive, ampicilin-clavulanate resistant) and *Haemophilus influenzae* BLNAR (β-lactamase negative, ampicilin resistant) The increase in the presence of beta lactamase-producing pathogens in recent years, especially *Haemophilus influenzae* in the case of ARS is confirmed by Brook (8).

According to other reports (18), an increase in resistance of *Streptococcus pneumoniae* strains is also observed, which we did not find in our data. Hamill et al. in their work (19) point to a significant relationship between complicated ARS caused by *Staphylococcus aureus* MRSA and a worse prognosis. Furthermore, Brook (13) emphasize the increased participation of *S. aureus*, including MRSA, in the microbiological etiology of subperiosteal abscesses of the orbit in children in the course of ARS. In our group, MRSA was not isolated in any patient, but the most severe clinical course was observed in an 8-year-old girl, in whom *Staphylococcus epidermidis* MRCNS (methicillin-resistant coagulase-negative *Staphylococcus*) was detected. This child was operated on three times during one hospitalization lasting 21 days.

The results obtained in our study are similar with data from other patient populations available in the literature. They confirm that in the group of children requiring surgical treatment due to complicated ARS, the etiology is different and often complex compared to the group of patients with uncomplicated AP. Moreover, bacterial strains with antibiotic resistance mechanisms are quite common in complicated ARS.

Conclusions

In the studied group of patients from the Department of Pediatric Otolaryngology of the Medical University of Warsaw in 2018-2022 with diagnosed bacterial rhinosinusitis requiring surgical treatment, the most frequently isolated pathogen was *Staphylococcus aureus* and *Streptococcus pyogenes*. Infections of *Haemophilus influenzae*, *Streptococcus pneumoniae* or *Moraxella catarrhalis* occurred much less often.

Conflict of interest
Konflikt interesów

None
Brak konfliktu interesów

Correspondence
Adres do korespondencji

*Lidia Zawadzka-Głos
Klinika Otolaryngologii Dziecięcej
Warszawski Uniwersytet Medyczny
ul. Żwirki i Wigury 63A, 02-091 Warszawa
tel.: +48 (22) 317-97-21
laryngologia.dsk@uckwum.pl

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