ORIGINAL STUDY

Acute bacterial rhinosinusitis: new aspects regarding bacterial spectrum and microbiologic diagnosis

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ABSTRACT

BACKGROUND. In most cases, the etiology of acute rhinosinusitis (ARS) is viral, but 0.5 – 2% of them can be complicated by bacterial infection. Traditionally, the microbiologic spectrum of ABRS include: Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, but, in the past years, there is a lack of studies regarding this issue in our country. For the microbiological diagnosis of acute bacterial rhinosinusitis (ABRS), one can use 2 sampling techniques: from the middle meatus, under direct endoscopic control (EDMM), and by maxillary sinus tap (MST) through the canine fossa.
OBJECTIVE. The aim of the study was to identify the bacterial spectrum in patients diagnosed with ABRS and to establish the sensitivity and specificity of the sampling techniques described.
MATERIAL AND METHODS. We performed a prospective study on 40 adult patients with microbiologically confirmed ABRS from a lot of 52 patients clinically diagnosed with ARS. Cultures were sampled by EDMM in all patients; in 19 patients, samples were taken both by EDMM and MST.
RESULTS. A total of 21 types of pathogen bacteria were isolated. Results indicate changes in the percentages of the "classic trio" in favour of other germs, other species of streptococci in particular. Concerning the culture sampling, the results from EDMM compared with those from MST showed a correlation over 90%.
CONCLUSION. Study results demonstrate some changes of the bacteriologic spectrum in ABRS in this geographic area. Although MST is considered the gold standard for sampling, EDMM is also an accurate choice for microbiological diagnosis.
KEYWORDS: ABRS, microbiologic diagnosis, EDMM, MST.

INTRODUCTION

Rhinosinusitis is defined as an inflammation of the nose and the paranasal sinuses, characterised by two or more symptoms that can be classified in major and minor. The major symptoms are nasal obstruction or congestion and nasal discharge (anterior/posterior nasal drip). The other symptoms refer to facial pressure/pain and reduction/loss of smell. Although acute or chronic rhinosinusitis may be diagnosed only on clinical grounds, using the mentioned symptoms or signs, the condition can be confirmed endoscopically (oedema/mucosal obstruction in the middle meatus, mucopurulent discharge from the middle meatus, nasal polyps) or by imaging signs (mucosal changes in the ostiomeatal complex and the sinuses)[1].

Regarding the duration of the disease, rhinosinusitis can be classified in acute and chronic. Acute rhinosinusitis (ARS) refers to less than 12-week duration of the symptoms mentioned above.

Prevalence rates of ARS vary between 6 and 15% according to EPOS 2012.

ARS is most frequently associated with upper respiratory viral infection, complicated by bacterial infection in 0.5 – 2% of cases. The viruses causing upper respiratory conditions are: rhinoviruses responsible for 30-70% of them, coronaviruses (7-18%), influenza A and B, adenoviruses, parainfluenza viruses, respiratory syncytial viruses, enteroviruses[2].

The most common pathogenic organisms in ABRS are *Streptococcus pneumoniae* (20-45%), *Haemophylus influenzae* (22-35%), *Morraxella catarrhalis* (20-28%)[3]. Also, recent data suggests the fact that *Staphylococcus aureus* represents in 10% of cases the pathogenic bacterial strain[4].

Nowadays, it is mentioned by some authors, including Brook, that the vaccination program with heptavalent conjugate pneumococcal vaccine determined a number of changes in the microbiological spectrum; respectively, the decreasing prevalence of *Streptococcus*

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pneumoniae by 11% and the increasing of *Haemophilus influenzae* by 6%[5].

Concerning the ABRS' diagnosis, in most cases (uncomplicated ABRS), it is a clinical one – anamnesis, physical exam. Allowing the visualization of the middle meatus through nasal endoscopy certifies the diagnosis.

Microbiologic confirmation is usually not necessary in uncomplicated rhinosinusitis; it is recommended in persistent symptoms after a correct maximal treatment, in immune-compromised patients or in rhinosinusitis with complications. Even if the "gold standard" for the microbiological diagnosis is the sinus aspiration, it is not routinely recommended, being a relatively invasive procedure, sometimes difficult to perform, but especially hard to be accepted by the patient. Usually, another sampling technique is used - prelevation from the middle meatus, under endoscopic control. Some other studies[6-9] showed an accuracy of 87% of endoscopically directed middle meatal cultures when compared with maxillary sinus taps.

Imaging (CT scan) can be used to confirm the diagnosis and it is recommended in complicated rhinosinusitis or when surgery is being considered.

Based on the idea that microbiology of ABRS showed some changes (due to treatment failures, resistant cases or quick recurrence after treatment), we noticed that, in the past years, there is a lack of studies regarding this issue in our country. Thereby, the aim of our study was to identify the bacterial spectrum in patients diagnosed with ABRS.

Another objective was to compare the two types of sample techniques used for microbiological diagnosis – MST and EDMM.

MATERIAL AND METHODS

This prospective clinical study was performed between November 2011 and November 2012 on 52 adult patients diagnosed with ABRS. From 52 patients clinically diagnosed with ABRS, 40 had also microbiologic confirmation (positive cultures).

The main inclusion criteria refer to adult patients (male or female, over 18 years old) diagnosed with moderate to severe ABRS (according to clinical criteria from EPOS 2012) – the presence of 2 or more of the following symptoms: nasal blockage, anterior/post nasal drip, facial pain/pressure, reduction/loss of smell. Symptoms have to last at least 10 days or worsen after 5 days. Clinical criteria were confirmed endoscopically – congestion, oedema and purulent drip in the middle meatus.

We excluded from the study imunocompromised patients, patients with nosocomial infections (nosocomial sinus infections or infections following or associated with naso-tracheal intubation); patients with chronic rhinosinusitis or complicated rhinosinusitis, with nasal polyps, nasal anatomic abnormalities, with history of sinus surgery; patients with antibiotic treatment within the previous week; patients with cystic fibrosis, with concurrent infections and/or neoplasm or positive history for drugs and alcohol abuse. Also, those patients with the inability to comply with the protocol requirements were excluded.

Study protocol included 3 visits.

The first visit consisted in patients' informed consent signature for study participation, Visual Analogue Scale (VAS) filling, clinical exam, endoscopic assessment and sample prelevation from the middle meatus, under direct endoscopic control (EDMM) and by maxillary sinus tap through the canine fossa (MST).

The clinical assessment of ABRS included: nasal blockage/obstruction/congestion, nasal discharge (anterior/posterior nasal drip), facial pain/pressure, reduction or loss of smell. Only patients with 2 or more symptoms, one of which was nasal blockage/obstruction/congestion or nasal discharge, were accepted.

Clinical exam and nasal endoscopy revealed mucosal congestion/edema, anterior/posterior discharge and the absence of nasal polyps.

To evaluate the overall severity of the rhinosinusitis, the patients indicated on a 10 cm VAS how disturbing the symptoms are. Based on the VAS score, the ABRS was classified as mild (VAS 0-3) or moderate to severe (VAS 3-10). Only patients with VAS from 3 to 10 were included in the study.

All subjects were sampled by EDMM. MST through the canine fossa was used as an additional sampling technique (MST being the traditional "gold standard" diagnostic test). The MST was collected from consenting patients, using the standard technique by puncture through the anterior wall of the maxillary sinus ipsilateral to the side where EDMM was performed. The procedure was performed under local anaesthesia. In case no secretions were obtained, a saline washing through the needle was performed. 19 patients accepted both sampling techniques. All the samples were referred to the microbiological laboratory no later than 1 hour after collection.

At the second visit, the interpretation of microbiological results and the establishment of the appropriate antibiotic treatment according to the antibiogram were performed.

During the third visit, the patients were reassessed by clinical examination, VAS filling, nasal endoscopy and sampling to confirm clinical and microbiological healing (these data are part of a clinical trial whose results obtained in the third visit are not covered by the object of this article). Only EDMM sampling was used, when applicable (secretion in the

middle meatus). The MST procedure was not performed at this visit. Samples were referred to the microbiologically laboratory no later than 1 hour after collection.

RESULTS

52 patients, 27 women and 13 men (male:female ratio=2.08:1), clinically diagnosed with ABRS, participated to our study. Patients' ages varied from 20 to 79 years old.

Forty specimens (76.92%) were culture-positive and 12 (23.08%) culture-negative.

A total of 21 types of pathogen bacteria were isolated. (Table 1)

Concerning the distribution of the 21 types of bacteria, 15.5% of them were Streptococcus pneumoniae, 5.63% - Moraxella cattarhalis, 11.27% - Haemophilus influenzae, 1.41% - Haemophilus aphrophilus, 23.94% - other species of Streptococcus (constellatus, anginosus, group A, pyogenes, coagulase-positive), 4.23% - Pseudomonas (aeruginosa, mendocina), 8.44% - Prevotella (oralis, intermediaries, buccae), 1.41% -

Table 1
Types of bacteria in ABRS

Nr.	Bacteria	Number	Frequency	Type
1	Streptococcus pneumoniae	11	15.50%	Gram +
2	Moraxella cattarhalis	4	5.63%	Gram -, aerobic
3	Haemophilus influenzae	8	11.27%	Gram -, fclt. anaerobic
4	Staphilococcus aureus	11	15.50%	Gram +
5	Streptococcus constellatus	11	15.50%	Gram +
6	Streptococcus anginosus	3	4.23%	Gram +
7	Streptococcus group A	1	1.41%	Gram +
8	Streptococcus pyogenes	1	1.41%	Gram +
9	Streptococcus coagulase-positive	1	1.41%	Gram +
10	Pseudomonas mendocina	1	1.41%	Gram -, anaerobic
11	Pseudomonas aeruginosa	2	2.82%	Gram -, anaerobic
12	Prevotella oralis	1	1.41%	Gram -
13	Prevotella intermediaris	1	1.41%	Gram -
14	Prevotella buccae	4	5.62%	Gram -
15	Propionibacterium acnes	1	1.41%	Gram +
16	Porphyromonas gingivalis	1	1.41%	Gram -, anaerobic
17	Fusobacterium nucleatum	4	5.62%	Gram -, anaerobic
18	Fusobacterium necrophorum	1	1.41%	Gram -, anaerobic
19	Corynebacterium pseudotuberculosis	2	2.82%	Gram +
20	Corynebacterium macginleyi	1	1.41%	Gram +
21	Haemophilus aphrophilus	1	1.41%	Gram -, aerobic

Propionibacterium acnes, 1.41% - Porphyromonas gingivalis, 7.03% - Fusobacterium (nucleatum, necrophorum), 4.23% - Corynebacterium (pseudotuberculosis, macginleyi).

Thus, Streptococcus pneumoniae and other species of Streptococcus represented 49.44% of the microbes, Moraxella cattarhalis – 5.63%, Haemophilus (influenzae, aphrophilus) - 12.68%, anaerobic bacteria 11.27% and other types of bacteria represented 16.89% (Chart 1).

Polymicrobial cultures were found in 17 patients (42.5%). The number of isolates per specimen varied from one to five – 24 patients (representing 60%) had monomicrobial cultures, 11 patients (27.5%) 2 pathogens, 3 patients with 3 pathogens in cultures, 1 patient (2.5%) with 4 pathogenic species and 1 patient (2.5%) with positive culture for 5 species of bacteria.

Regarding the culture sampling, the results from EDMM compared with those from MST showed a correlation over 91.15%. Benninger communicates an accuracy of 87% of the EDMM when compared with MST in acute maxillary sinus infection[9].

DISCUSSIONS

It is well known that the most common organisms responsible for ABRS are *Streptococcus pneumoniae, Haemophilus infuenzae, Moraxella cattarhalis* and *Staphylococcus aureus*[1]. Also, other streptococcal species and anaerobic bacteria are involved in ABRS[10-12]. The most frequently reported anaerobes include *Peptostreptococcus, Prevotella, Fusobacterium, Propionibacterium* and *Bacteroides.*

In our study, 71 (50 by EDMM, 19 by MST) cultures were obtained. From these, 40 (76.92%) were culture-positive, with a total of 21 types of bacteria isolated.

The "infernal trio" - *Streptococcus pneumoniae, Haemophilus infuenzae, Moraxella cattarhalis* – was involved in 32.4% of cases.

Concerning the frequency of *Streptococcus pneumoniae,* recent studies report even smaller isolation rates, ranging from 2.6% to 11.9%[13]. A study from 2009 on paediatric population reported even total absence of *Streptococcus pneumoniae* from cultures[14].

In our study, *Staphylococcus aureus* was isolated in 15.5% of cases. Literature communicates a frequency of *Staphylococcus aureus* that reaches up to 10%[3]. Important to be mentioned is the fact that all 11 positive cultures of *Staphylococcus aureus* were sampled from the middle meatus. 7 of them were found in polymicrobial cultures. In 2 cases, both sampling techniques were used and Staphylococcus *aureus* was not confirmed by MST. Our results are in accordance with the general acceptance of this organism as a major pathogen[14]. Also, we cannot pass over the suspicion of sample's contamination, given the 2 uncertified cases aforementioned.

Haemophilus influenzae's frequency was 11.27%. Previous studies report large variations, between 2.8% - 26%[15-20].

Moraxella cattarhalis was positive in 4 cultures (5.63%). Brook and Gober report a frequency of 13% - 14% in their study in 2007[21]. Nevertheless, Olwoch reported in his study performed on 163 patients a 0.4% rate for *Moraxella cattarhalis*[14].

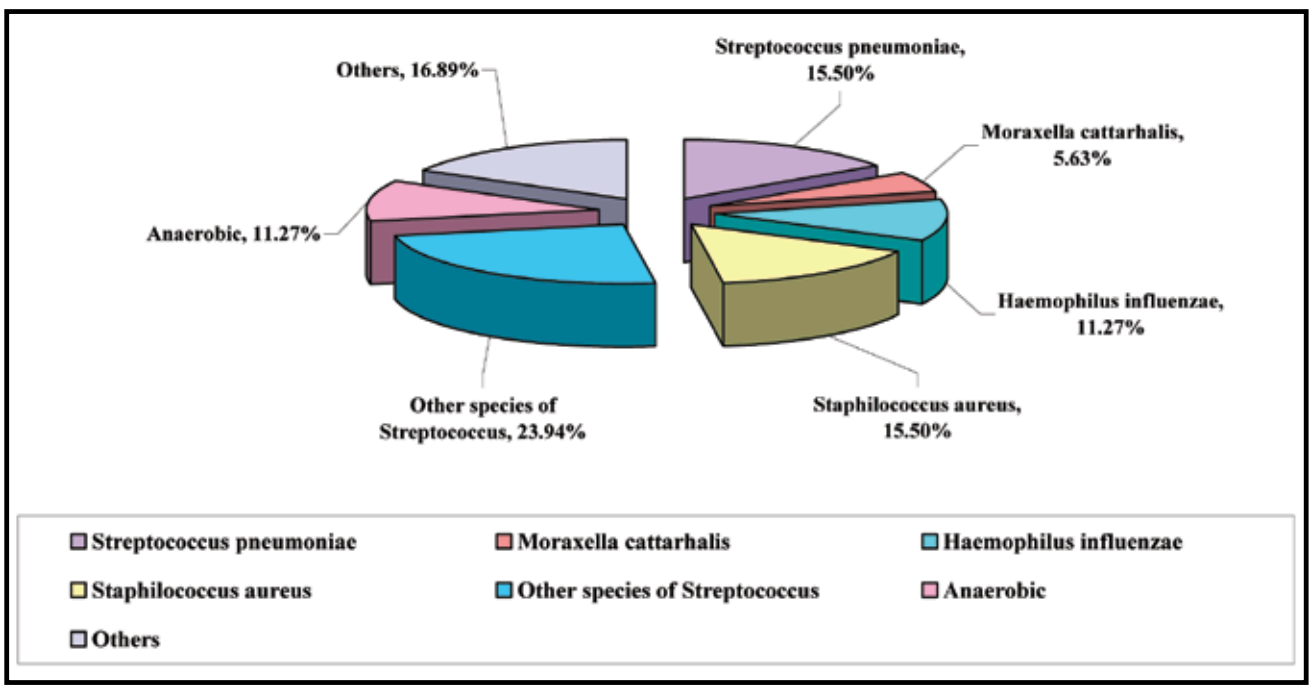

Chart 1. Bacterial spectrum in ABRS

In 23.94% of cases, different types of streptococci were isolated (*Streptococcus constellatus, Streptococcus anginosus, Streptococcus group A, Streptococcus pyogenes, Streptococcus coagulase-positive*). So, our study proves that this group of oral streptococci has its role as important pathogens in ABRS.

Anaerobic bacteria isolated from our 40 cultures were *Prevotella* species (8.44%), *Fusobacterium* species (7.03%), *Porphyromonas gingivalis* (1.41%), *Pseudomonas aeruginosa* and *mendocina* (4.23%), representing a total of 11.27% (16 isolates) of pathogenic organisms involved in ABRS. In his study on 26 cases of acute ethmoidal rhinosinusitis, Brook found 10 anaerobes (representing 12.7%). The predominant anaerobes in his study were: 4 *Peptostreptococcus* spp. and 3 *Propionibacterium acnes* 3, *1* isolate of *Fusobacterium spp.*, 2 isolates of *Prevotella intermedia*[22].

In 17 patients, representing 42.5% of our cases, polymicrobial cultures were found; in 7 of them, *Staphylococcus aureus* was present (EDMM sampled). This fact could support the decreasing host defences mechanisms and the superinfection theory in patients with ABRS[3].

Concerning the comparison between EDMM and MST regarding the isolated bacteria, we found that results overlap for the two techniques in 91.15% of cases. Given the percentage, we can conclude that EDMM is also an accurate choice for microbiological diagnosis. Also, Benninger reported in his study a sensitivity of 80.9%, a specificity of 90.5% for EDMM in comparison with MST for known pathogenic bacteria for ABRS[9].

Given the results, one can find a number of explanations for the changes in the microbial spectrum in our country. First, in Romania's vaccination program, the pneumococcal and the anti-Haemophilus influeanzae vaccines were added, which leaded to a decrease in their frequency in what concerns the etiopathogenesis of ABRS.

Also, a series of mistakes regarding ARS' treatment influenced over time the structure of the bacterial spectrum. A tendency to treat viral ARS with antibiotic (medical prescription or self indication) can be observed, in the absence of clinical criteria for ABRS and without initially prescribing an appropriate treatment according to the guidelines. Also, the common mistakes in ABRS treatment cannot be overlooked: administration of antibiotic over a period of less than 7 days. Incomplete treatment of chronic rhinosinusitis can lead to recurrent episodes of ARS – in which case, polymicrobial cultures (specific to CRS and ARS) are found.

Another important factor influencing the bacterial spectrum is dental pathology. In Romania, one can talk about a superficial approach of dental treatment, due to educational and economic factors. This is why pathogens frequently involved in this area are now found in acute or chronic rhinosinusitis.

CONCLUSIONS

Acute rhinosinusitis is a significant health problem worldwide, which is initiated as a viral infection of the upper respiratory tract, followed, in some cases, by bacterial or fungal superinfection.

Streptococcus pneumoniae, Haemophilus influenzae and *Morraxella catarrhalis* are still the most common pathogenic organisms in acute bacterial rhinosinusitis in adults, but nowadays the frequencies of their involvement are decreasing. Until now, *Staphylococcus aureus* has been often considered as a contaminant, but recent studies suggest that *Staphylococcus aureus* is a true pathogen in about 10% of cases of acute bacterial rhinosinusitis in adults. Also, other species of oral streptococci are implicated in almost 1/3 of ABRS.

Concerning the bacteriological diagnosis, although MST represents the "gold standard", there are studies that demonstrate the fact that EDMM is an easier to accept, less painful and less money consuming technique. Thus, it is considered to be an accurate choice for microbiological diagnosis.

In conclusion, ARS is a frequent condition clinically diagnosed, which only in case of bacterial superinfection (ABRS) should be treated with antibiotic. In most cases, clinical criteria provide the correct diagnosis. The correct antibiotic treatment should be prescribed applying the knowledge regarding specific ABRS' microbiology. Only in drug resistance ABRS sampling is needed. In this case, EDMM can be used with satisfactory results.

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