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Bacteriology of chronic purulent secretions in chronic rhinosinusitis

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Abstract

The aim of this work was to study the bacterial flora of purulent secretions during chronic rhinosinusitis. We studied a total of 533 patients divided into two groups. The control population consisted of 139 adults (> 16 years) of both sexes seen in the community or hospitalized for less than 72 hours for non-rhinological conditions. The rhinosinusitis group consisted of 394 patients referred to the ENT clinic with chronic rhinosinusitis. All the patients with rhinosinusitis had had a post-nasal discharge for at least three months, associated with purulent or mucopurulent secretions originating from the involved sinus cavity. All samples were obtained endonasally under endoscopic guidance from the sinus ostium or from the sinus cavity during surgery. Cultures were positive in 81.3 per cent of the control subjects and 83.1 per cent of the patients with rhinosinusitis.

Corynebacteria, coagulase-negative staphylococci, propionibacteria and peptostreptococci were the main commensal organisms, while *Haemophilus influenzae*, streptococci, *Streptococcus pneumoniae*, *Prevotella* spp and *Fusobacterium* spp were probable causative pathogens. Anaerobes were isolated from approximately 25 per cent of the patients in the rhinosinusitis group. Betalactamase producers represented 27.5 per cent of *H. influenzae* and 28 per cent of *Prevotella* spp isolates. Diminished susceptibility to penicillin was found in 13 per cent of *S. pneumoniae* isolates. The amoxycillin-clavulanate combination was the most active oral antibiotic tested against the pathogenic species in vitro.

Key words: Rhinitis; Paranasal sinus diseases; Infection; Bacteriology

Introduction

The bacteriology of chronic rhinosinusitis is now well documented, although the interpretation of the results is controversial (Brook, 1981; Loch *et al.*, 1990; Van Cauwenberge *et al.*, 1993; Brook *et al.*, 1994; Hartog *et al.*, 1995; Gwaltney, 1995). Sinus puncture remains the gold standard for sampling secretions in the sinus cavities (Axelson and Brorson, 1973; Erkan *et al.*, 1994). The aim of this work was to identify the bacterial species present in nasal secretions of patients with chronic post-nasal discharge (more than three months); patients with acute rhinosinusitis and exacerbations of chronic rhinosinusitis were ineligible (Lund and Kennedy, 1995; Rowe-Jones and Mackay, 1995). Samples were obtained by swabbing the nasal part close to the area of the ostium (three swabs) under endoscopic guidance in both the control and rhinosinusitis groups. Two samples were taken from 75 patients, one in the area close to the ostium and the other in the sinus cavity during surgery or after puncture. Samples were examined for white cells and were Gram stained and cultured aerobically and anaerobically. Using this method we studied the validity of the endoscopic endonasal sampling technique and determined, by comparison with the control group, the bacterial species responsible for chronic rhinosinusitis.

Patients and methods

Patients

Five hundred and thirty-three patients over 17 years of age were enrolled in the study after being informed of the sampling method and giving their consent. There were two groups of patients:

(1) a control group consisting of 139 patients with no history of chronic rhinosinusitis and no rhinologic infections for at least three months. None of these patients had received systemic or local antibiotic

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therapy in the two weeks before sampling and none had received topical or systemic steroids in the three months before sampling.

(2) a rhinosinusitis group consisting of 394 patients complaining of a post-nasal discharge for at least three months. Purulent secretions originating from the ostium were found on endoscopic examination, and an opacity was seen in the involved sinus cavity by standard or computed tomographic (CT) radiography. Fourteen of these patients had received systemic antibiotics in the week before the sampling.

Samples

In every case, three endonasal samples were taken under endoscopic control (rigid optic, 0° or 30° lens, 4 or 2.7 mm diameter) to avoid contamination from the nasal vestible. Secretions were sampled in the area close to the ostium of the involved sinus cavity, as follows: middle meatus, n = 479; frontal recess, n = 47; and spheno-ethmoidal recess, n = 17.

The three swabs (Calgiswab* type 1, Spectrum Laboratories, Inc.) were immediately placed in transport medium (TGV Anaer, Diagnostics Pasteur) and rapidly taken to the laboratory. Three smears were prepared from another swab for direct examination.

Double sampling was carried out in 75 cases in the rhinosinusitis group, one as described above (three swabs) and the other (by aspiration) taken directly from the involved sinus cavity during surgery or after puncture. The decision for a double sample was not randomized, it was taken if there were in the same patient enough secretions in the area close to the ostium and in the sinus cavity.

Laboratory methods

All samples were subjected to Gram staining and direct examination; white cells were assessed semi-quantitatively (none, few, many, abundant).

Aerobic and anaerobic bacteria were identified and isolated as follows. Samples were inoculated onto Columbia blood agar and chocolate agar for aerobes, and on non-selective Columbia blood agar for anaerobes. Nalidixic acid-colistin-nystatin agar or neomycin-vancomycin agar was used to selectively isolate Gram negative anaerobes. Anaerobic cultures were incubated at 35°C in an anaerobic atmosphere in either jars or anaerobic chambers for up to five days, and were examined every 48 hours. Nitrocefin disks (Cefinase BioMérieux*) were used to detect betalactamase production. The threshold bacterial count was 10^4 CFU/ml. Antibiotic susceptibility was determined by a classical disk-diffusion test, except for anaerobes, for which ATB-ANA Bio Mérieux kit was used. Results for erythromycin and amoxycillin, alone or combined with 2 mg/l clavulanic acid are presented below.

TABLE I
CULTURE POSITIVITY

Chronic rhinosinusitis n = 394		Control n = 139	
Positive	Sterile	Positive	Sterile
n = 327 83%	n = 67 17%	n = 113 81.3%	n = 26 18.7%

Statistical analysis

Data were analysed using the Epi-Info computer data base (version 5, Centers for Disease Control and Prevention, Atlanta, GA). Fisher's two-tailed exact test and Student's *t*-test were used to test for the significance of association.

Results

Five hundred and thirty-three patients were studied. There was no difference between the control group and the rhinosinusitis group regarding age (42 *vs* 45 years) or sex (57.7 per cent men, *vs* 53 per cent). The percentage of sterile samples was also similar in the two groups (17.9 per cent *vs* 18.7 per cent, respectively) (Table I). The maxillary sinus was most frequently involved (378 patients); involvement was bilateral in 139 cases and was associated with ethmoidal involvement in 127 cases. The other sites of involvement were frontal unilateral in 47 cases, frontal bilateral in 17 cases, and sphenoidal in 17 cases.

Species identified

Cultures were positive in 83.1 per cent of cases in the rhinosinusitis group and in 81.3 per cent of cases in the control group. In the rhinosinusitis group, one organism was isolated from 158 patients, and two from 93 patients; more than two bacteria were isolated from the remaining 77 patients; mixed aerobic-anaerobic infections were found in 81 cases (Table II).

White cell counts

Only seven of the control samples contained abundant or very abundant white cells, compared to 132 of the samples in the rhinosinusitis group (Table III).

TABLE II
NUMBER OF PATIENTS WITH BACTERIAL ISOLATES

	Sinusitis group n = 394		Control group n = 139	
Sterile	67		26	
Strict aerobes				
one species	144		55	
two species	61	226	28	90
more than 2 species	21		7	
Strict anaerobes				
one species	14		4	
two species	4	20	0	4
more than 2 species	2		0	
Mixed cultures				
one aerobe and anaerobe	28	81	9	19
miscellaneous	53		10	

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TABLE III
SEMIQUANTITATIVE WHITE CELL COUNTS

White cells	Control	Chronic rhinosinusitis
None	87 (64%)	113 (29.5%)
Few	42 (31.1%)	138 (36%)
Many	5 (3.7%)	103 (26.8%)
Abundant	1 (0.74%)	29 (9.5%)
Total number of patients	135	383

*Results for respectively 4 and 11 patients were not available.

TABLE V
RESULTS OF THE DOUBLE SAMPLES

Pathogens in the two samples:	
• identical	29
• different	5
Commensal in both samples	8
Commensal in one sample/sterile	3
Both samples sterile	8
False positivity	7
False negativity	5

Species isolated (Table IV)

Coagulase-negative staphylococci, corynebacteria and propionibacteria were predominant in the control group. *Staphylococcus aureus*, *H. influenzae*, streptococci, pneumococci, *Prevotella* and *Fusobacterium* spp were isolated in the rhinosinusitis group and were significantly associated with chronic rhinorrhoea. Strict anaerobes were isolated in 101 of the patients with rhinosinusitis (25.9 per cent) and were mainly *Propionibacterium*, *Prevotella*, *Peptostreptococcus* and *Fusobacterium*. Betalactamase producers represented respectively 87.0 per cent, 27.5 per cent, 42.9 per cent and 28 per cent of *S. aureus*, *H. influenzae*, *Moraxella catarrhalis* and *Prevotella* isolates.

Thirteen per cent of pneumococci showed diminished susceptibility to penicillin, while 28 per cent of these strains were resistant to macrolides. The antibiotics susceptibility of the isolates is shown in Table VI.

Double samples

Seventy-five double samples (nose and sinus) were obtained. In 48 cases the results of the two samples were in agreement (one or more identical pathogens: 29 cases; commensal species in both samples in eight cases; both samples sterile eight cases). In another five cases a pathogen was isolated from the sinus while the nose sample was sterile or yielded a commensal, and the reverse was observed in seven cases (Table V). Different pathogens were found in the two samples in five cases. A total of 47 pathogens were isolated from the two sites.

Discussion

The bacteria involved in chronic rhinosinusitis have been widely studied (Su *et al.*, 1983; Van Cauwenberge *et al.*, 1993; Brook *et al.*, 1994; Hartog *et al.*, 1995; Suzuki *et al.*, 1996). The aim of this study was to analyse the flora in secretions of patients with a post-nasal discharge lasting at least three months. Endoscopy was used in all cases to identify the precise sinus cavity involved, and a CT scan was used routinely to confirm the endoscopic findings. The maxillary sinus was the most frequent site of involvement in this population, as in other studies (Loch *et al.*, 1990; Gwaltney, 1995). Abnormalities of the anterior ethmoid were found in one-third of patients. CT scan is more sensitive than standard radiography for investigation of the sinuses, especially the ethmoidal cavities (Davidson *et al.*, 1989). Few authors have used CT to assess chronic rhinosinusitis (Su *et al.*, 1983; Almadori *et al.*, 1986; Brook *et al.*, 1994; Erkan *et al.*, 1994; Hartog *et al.*, 1995), meaning that the extent of involvement is probably underestimated in most studies. Nevertheless in the present study, the low rate of involvement of the ethmoid cavities is probably due to the fact that the analysis of the radiological examination has not been focused on this point which certainly has underestimated the real number of patients for whom the ethmoid cavities were infected. Secretions were collected via the nostrils with endoscopic control, close to the ostium of the infected cavity. This is a controversial method for collecting nasosinus secretions (Savolainen *et al.*, 1987; Brook *et al.*, 1994; Gwaltney, 1995), as direct puncture or peri-operative sampling remains the gold standard in bacteriological studies. Sample contamination by the nasal flora is the main drawback of this method (Savolainen *et al.*, 1987; Jousimies-Somer *et al.*, 1989). We attempted to overcome this problem by including a control group of patients hospitalized for reasons other than ENT infections, in order to assess the normal flora of the middle meatus (Klossek *et al.*, 1996). The isolation of *Streptococcus* spp, *H. influenzae*, *S.*

TABLE IV
SPECIES ISOLATED FROM ENDONASAL SAMPLES

Species	Chronic rhinosinusitis	Control	*p*
	Aerobes n = 482	Aerobes n = 160	
Staphylococcus aureus	90 (18.6 %)	19 (11.9 %)	0.03
Streptococcus viridans	48 (10 %)	6 (3.7 %)	0.01
Haemophilus influenzae	43 (8.9 %)	2 (1.2 %)	0.001
Streptococcus pneumoniae	38 (7.9 %)	2 (1.2 %)	0.003
Coagulase-negative staph.	115 (23.9 %)	74 (46.2 %)	0.001
Corynebacterium spp	32 (6.6 %)	34 (21.2 %)	0.001
Anaerobes	Anaerobes n = 159	Anaerobes n = 29	
Prevotella spp	29 (18.2 %)	0 (0 %)	0.002
Fusobacterium spp	14 (8.8 %)	0 (0 %)	0.03
Priopionibacterium spp	51 (32.1 %)	18 (62.1 %)	N S

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TABLE VI
SUSCEPTIBILITY OF THE SPECIES ISOLATED IN THE RHINOSINUSITIS GROUP

Species	Antibiotics	Amoxycillin	Amoxycillin clavularic acid	Erythromycin
S. aureus	n = 90	21 %	96 %	79 %
H. influenzase	n = 43	74 %	100 %	37 %
Streptococcus viridans	n = 48	95 %	95 %	65 %
S. pneumoniae	n = 38	87 %	86 %	72 %
Enterobacteriaceae	n = 41	29 %	63 %	ND
Fusobacterium spp	n = 14	100 %	100 %	60 %
Prevotella spp	n = 29	72 %	100 %	95 %
Anaerobes	n = 188	91 %	99 %	82 %

pneumoniae, *Prevotella* spp, *Fusobacterium* spp and *S. aureus* was significantly associated with chronic rhinorrhoea. These results are similar to those of previous studies based on sinus sampling by direct puncture (Su *et al.*, 1983; Van Cauwenberge *et al.*, 1993; Brook *et al.*, 1994).

In 65 cases we obtained double samples from the middle meatus and the corresponding maxillary sinus to validate the samples taken from the area close to the ostium. The results of the two samples agreed in 48 cases. In five cases a pathogen was isolated from the sinus and a commensal (or no species) was isolated from the nose (false negativity). In seven cases we recovered a pathogen from the nose and a commensal (or no species) from the sinus (false positivity).

The normal flora of the middle meatus contained both aerobes and anaerobes. These organisms may correspond either to the nasal flora itself, or to organisms expelled from the sinus cavities to the nasal fossae by mucociliary transport.

Our results are similar to those of Brook (1981), who used direct puncture to study the normal flora of the maxillary sinus and found that it was predominantly anaerobic. However, the study population was not composed of strictly healthy subjects, as the patients had nasal disorders. In contrast, Sobin *et al.* (1992), in a study of a healthy population, found no bacteria in samples obtained by direct puncture through the inferior meatus. These results clearly illustrate the differences observed between one study and another, even when similar sampling methods are used. Almadori *et al.* (1986) also compared isolates from nasal and sinus samples and found a significant difference in anaerobic species when the sample was a biopsy specimen of the sinus mucosa. Our results are in keeping with those of the latter study. Savolainen *et al.* (1987) assessed the predictive value of nasal sampling according to the purulence of secretions. A good match was found in 91 per cent of 247 samples. In another study the same author (Savolainen *et al.*, 1989) analysed 270 samples and found that a pathogen was almost always present when the patient had purulent secretions, a finding confirmed by Jousimies-Somer *et al.* (1988). In our study only seven patients had a pathogen in the sinuses when the nose contained either a commensal or no detectable bacteria. The reliability of this endonasal sampling method with endoscopic guidance can be estimated at about 80 per cent. The antibiotic susceptibility of the isolates, including anaerobes, is reported in Table VI. The high rate of betalactamase production among *S. aureus* and *H. influenzae* in this study is in accordance with recent data on the sensitivity of these bacteria in France (Dabernat and Delmars, 1996). Only 13 per cent of the pneumococcal isolates were resistant to penicillin, a proportion far lower than that reported in pneumococcal otitis media. This difference may be due to the fact that we only selected patients with at least a three-month history of chronic rhinorrhoea, without exacerbations of chronic rhinosinusitis. Van Cauwenberge *et al.* (1993) reported a higher proportion of *H. influenzae*, probably because he included patients with acute rhinosinusitis. Our results are similar to those of Hartog (1995), who found few mixed or polymicrobial cultures (104/397) when samples were obtained by direct puncture.

In conclusion, this study documents the bacterial epidemiology in patients with chronic rhinorrhoea (>three months) and no ongoing exacerbation of chronic rhinosinusitis. The isolates were different from those generally found in acute rhinosinusitis or exacerbations of chronic rhinosinusitis, particularly with regard to anaerobic species. These data should prove useful in choosing an antibacterial regimen, as they suggest that the agent chosen should cover both aerobes and anaerobes (although it remains to be proven that the isolates are capable of causing rhinosinusitis). The amoxycillin-clavulanate combination had the best efficacy *in vitro*. Endonasal endoscopic sampling appears to be a suitable first-line method for aetiological investigation of chronic rhinosinusitis, provided it is carried out under strict conditions. The estimated reliability of this approach is about 80 per cent. However, some bacteria isolated from nasal secretions were not found in the sinus mucosa (Lundberg and Engquist, 1984).

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