

## Bacteriology of chronic maxillary sinusitis associated with nasal polyposis

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Aspirates from 48 chronically inflamed maxillary sinuses from patients who had nasal polyposis were processed for aerobic and anaerobic bacteria. Bacterial growth was present in 46 (96 %) specimens. Aerobic or facultative bacteria were present in 6 (13 %) specimens, anaerobic bacteria alone in 18 (39 %), and mixed aerobic and anaerobic bacteria in 22 (48 %). There were 110 bacterial isolates (2.4 per specimen). Thirty-nine of the isolates were aerobic or facultative organisms (0.85 per specimen). The predominant aerobic or facultative organisms were: *Staphylococcus aureus*, microaerophilic streptococci, *Haemophilus influenzae* and *Moraxella catarrhalis*. Seventy-one anaerobes were isolated (1.5 per specimen), *Peptostreptococcus* spp., *Prevotella* spp., *Porphyromonas asaccharolytica* and *Fusobacterium* spp. being predominant. These findings illustrate for the first time the presence of polymicrobial aerobic–anaerobic flora in patients with chronic maxillary sinusitis who had nasal polyposis.

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## INTRODUCTION

The microbiology of chronic maxillary sinusitis is polymicrobial, consisting of aerobic and anaerobic bacteria (Frederick & Braude, 1974; Su *et al.*, 1983; Brook, 1989; Karma *et al.*, 1979; Nord, 1995). The recovery rate of anaerobic bacteria varied in these studies from 25 to 56 %. When adequate methods are used, anaerobes can be recovered in more than half of all cases (Nord, 1995). The prevalence of isolation of *Staphylococcus aureus* and Gram-negative aerobic rods including *Pseudomonas aeruginosa* also varied and ranged from 1 to 29 % (Frederick & Braude, 1974; Su *et al.*, 1983; Brook, 1989; Karma *et al.*, 1979; Palva *et al.*, 1962; Catlin *et al.*, 1965), and 0–15 % (Frederick & Braude, 1974; Su *et al.*, 1983; Brook, 1989; Karma *et al.*, 1979; Palva *et al.*, 1962), respectively.

Chronic sinusitis is suspected of being caused by impaired paranasal sinus ventilation and drainage disorders due to a blockage of the ostiomeatal complex in the middle nasal meatus (Gwaltney *et al.*, 1995). Nasal polyps can obstruct the sinus ostia and cause acute, recurrent or chronic sinusitis.

Several studies have shown that in the majority of cases of chronic sinusitis in which nasal polyps are present, bacterial cultures are negative. Even PCR techniques have failed to demonstrate bacterial infection in most cases (Bucholtz *et al.*, 2002). Hamilos *et al.* (1993), who obtained antral cultures from 12 subjects with chronic maxillary sinusitis with nasal

polyps, isolated organisms from only three patients. However, none of these studies employed methods that were adequate for the recovery of anaerobic bacteria.

This retrospective study summarizes our experience in recovery of micro-organisms in adults with chronic maxillary sinusitis who had nasal polyposis.

## METHODS

The study included 48 patients: 31 men and 17 women. Their ages ranged from 18 to 71 years (mean age 34 years). All patients had bilateral obstructive or subobstructive chronic hyperplastic sinusitis with nasal polyposis, had failed medical therapy, and required endoscopic polypectomy. Cultures of sinus contents were done by meatal antrostomy.

Sinusitis was judged to be present if the radiographic studies showed mucosal thickening and either an air–fluid level or complete opacification of the maxillary sinus. Occipitomental (Water's view), lateral, oblique and verticomeatal or computed tomography views were obtained. The degree of mucosal thickening was evaluated by noting the nearest distance between the air–mucosal interface and the lateral part of the sinus wall. Mucosal thickening was defined as a mucosal width of 5 mm or more. Patients had at least one of the following complaints: facial pain, frontal headache, purulent nasal discharge, fever or malaise. None had aspirin intolerance or cystic fibrosis. Chronic sinusitis was defined based on clinical records as an infection of at least 12 weeks' duration (Benninger *et al.*, 2003).

Specimens were obtained using sinus puncture either through the inferior meatus or by a canine fossa approach that was done after disinfection of the oral mucosa with povidone-iodine. Specimens were transported to the laboratory in a syringe sealed with a rubber stopper after evacuation of the air in the syringe. The time between the collection

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Abbreviation: BLPB,  $\beta$ -lactamase-producing bacteria.

of materials and the inoculation of the specimen generally did not exceed 30 min; however, the exact time needed for transportation was not recorded.

Specimens were inoculated onto 5% sheep's blood, chocolate and MacConkey's agar plates for aerobic and facultative organisms. The plates were incubated at 37 °C aerobically (MacConkey agar) or under 5% carbon dioxide (5% sheep's blood and chocolate agars) and examined at 24 and 48 h. For anaerobes, the material was plated onto prereduced vitamin K<sub>1</sub>-enriched *Brucella* blood agar, an anaerobic blood agar plate containing kanamycin sulfate and vancomycin hydrochloride, an anaerobic blood plate containing colistin sulfate and nalidixic acid, and an enriched thioglycolate broth (containing haemin and vitamin K<sub>1</sub>) (Summanen *et al.*, 1993). The anaerobic plates and thioglycolate broth were incubated in jars (GasPak) and examined at 48 and 96 h.

Anaerobes were identified by techniques previously described (Summanen *et al.*, 1993). Aerobic bacteria were identified using conventional methods (Murray *et al.*, 1999).  $\beta$ -Lactamase activity was determined for all isolates using the chromogenic cephalosporin analogue 87/312 method (O'Callaghan *et al.*, 1972).

Included in the study were only those patients whose medical records were available for review. An additional eight patients were not included in the final analysis because their records were not available. Patients' records were reviewed and the following medical history was recorded and correlated with microbiological results: allergic rhinitis (found in five patients), asthma (in four), use of systemic antibiotics within the previous 6 weeks (in 21) and within the previous 3 months (in all), use of systemic (in five) or topical (in seven) steroids within the previous 6 weeks, and previous sinus surgery (in two). Statistical significance in the prevalence of recovery of bacteria was calculated by the chi-square test using Yates's correction.

## RESULTS

Bacterial growth was present in 46 (96%) specimens. Aerobic or facultative bacteria were present in 6 (13%) of the culture-positive specimens, anaerobic bacteria alone in 18 (39%), and mixed aerobic and anaerobic bacteria in 22 (48%). There were 110 individual bacterial isolates recovered from the 46 specimens (2.4 per specimen) (Table 1). Thirty-nine of the isolates were aerobic or facultative organisms (0.85 per specimen). The predominant aerobic or facultative organisms were *S. aureus*, microaerophilic streptococci, *Haemophilus influenzae* and *Moraxella catarrhalis*. There were 71 anaerobes isolated (1.5 per specimen). The predominant anaerobes were *Peptostreptococcus* spp., *Prevotella* spp., *Porphyromonas asaccharolytica* and *Fusobacterium* spp.

Thirty-three  $\beta$ -lactamase-producing bacteria (BLPB) were isolated from 25 patients (54%) (Table 1). These included all *S. aureus*, *M. catarrhalis* and *Bacteroides fragilis* group isolates, 10 of 22 (45%) *Prevotella* spp., one of two (50%) *Pseudomonas aeruginosa*, three of five (80%) *H. influenzae/parainfluenzae*, three of six (50%) *Fusobacterium* spp. and one of five (27%) *Porphyromonas* spp.

The correlation between clinical and medical history revealed no differences related to allergic rhinitis, asthma, use of systemic or topical steroids within the previous 6 weeks, or previous sinus surgery. The use of systemic antibiotics within

**Table 1.** Bacteriology of 46 patients with chronic maxillary sinusitis who had nasal polyposis

Bacteria	No. of isolates*
<b>Aerobic bacteria</b>	
<i><math>\alpha</math></i> -Haemolytic streptococcus	6
Microaerophilic streptococci	5
<i>Streptococcus pneumoniae</i>	3
<i>Streptococcus pyogenes</i>	3
Group B streptococcus	1
<i>Staphylococcus aureus</i>	7 (7)
<i>Staphylococcus epidermidis</i>	1 (1)
<i>Moraxella catarrhalis</i>	4 (4)
<i>Haemophilus influenzae</i>	4 (2)
<i>Haemophilus parainfluenzae</i>	1 (1)
<i>Klebsiella pneumoniae</i>	1 (0)
<i>Escherichia coli</i>	1 (1)
<i>Pseudomonas aeruginosa</i>	2 (1)
<b>Subtotal aerobes</b>	<b>39 (17)</b>
<b>Anaerobic bacteria</b>	
<i>Peptostreptococcus</i> spp.	23
<i>Veillonella parvula</i>	3
<i>Eubacterium</i> spp.	2
<i>Propionibacterium acnes</i>	2
<i>Propionibacterium avidum</i>	1
<i>Clostridium</i> spp.	1
<i>Fusobacterium</i> spp.	2 (1)
<i>Fusobacterium nucleatum</i>	4 (2)
<i>Bacteroides</i> spp.	4
<i>Bacteroides fragilis</i> group	2 (2)
<i>Prevotella melaninogenica</i>	10 (5)
<i>Prevotella oralis</i>	3 (1)
<i>Prevotella oris-buccae</i>	3 (1)
<i>Prevotella intermedia</i>	6 (3)
<i>Porphyromonas asaccharolytica</i>	5 (1)
<b>Subtotal anaerobes</b>	<b>71 (16)</b>
<b>Total</b>	<b>110 (33)</b>

\*The number within parentheses indicates  $\beta$ -lactamase producers.

the previous 3 months correlated with the recovery of BLPB. Of the 21 patients that received systemic antibiotics within the previous 6 weeks, BLPB were recovered from 17, as compared to 8 BLPB that were isolated from the 25 patients that did not receive systemic antibiotics within the previous 6 weeks ( $P < 0.001$ ).

## DISCUSSION

This report confirms findings from previous studies that demonstrate the predominance of anaerobic organisms (pigmented *Prevotella* and *Porphyromonas*, *Fusobacterium* and *Peptostreptococcus* spp.) in chronic maxillary sinusitis (Bachert *et al.*, 2001). It is the first time that such flora has been isolated from the maxillary sinus of patients with chronic sinusitis with polyposis. The lack of recovery of

these organisms in previous studies, and the inability to isolate any bacteria from most of the specimens recovered from patients with chronic maxillary sinusitis who had nasal polyposis, may be attributed to the lack of employment of methods adequate for the recovery of these organisms.

Colonization with enterotoxin-forming staphylococci, whose products act as superantigens and cause local polyclonal IgE formation, has recently been described as a possible pathological mechanism in bilateral eosinophilic nasal polyposis with associated asthma and aspirin sensitivity (Bachert *et al.*, 2001). The presence of enterotoxin-specific IgE antibodies in the tissue is accompanied by relatively severe eosinophil inflammation. Although we isolated *S. aureus* from 7 of 46 (15 %) of our patients, it was not the most predominant isolate and was mixed with other flora in five instances. We did not, however, test for enterotoxin production in our *S. aureus* isolates.

Isolates that produced  $\beta$ -lactamase were recovered from over half of the patients and their finding was associated with treatment with systemic antibiotics within the previous 6 weeks. Receipt of antimicrobial agents including  $\beta$ -lactams within the previous 6 weeks is a known cause of selection for these organisms (Brook & Gober, 1999).

The frequent involvement of anaerobes in chronic sinusitis is probably related to the poor drainage and increased intranasal pressure that develops during inflammation (Drettner & Lindholm, 1967). This can reduce the oxygen tension in the inflamed sinus (Carenfelt & Lundberg, 1977) by decreasing the mucosal blood flow (Aust & Drettner, 1974) and depressing ciliary action (Carenfelt, 1979). The lowering of the oxygen content and pH of the sinus cavity supports the growth of anaerobic organisms by providing them with an optimal oxidation–reduction potential. It is apparent from our data that nasal polyps can induce similar anoxic conditions by obstructing the sinus ostia and causing chronic sinusitis.

Our finding suggests that the microbiology of the maxillary sinus of patients with chronic sinusitis with polyposis is not different from that in patients who develop chronic sinusitis without this condition. Obtaining a culture of the maxillary sinus in such patients may be of particular importance, so that appropriate antimicrobial therapy directed at their specific pathogens could be administered. Further studies are warranted to elucidate the therapeutic effect of antimicrobial therapy directed at the aerobic and anaerobic organisms isolated from the chronically inflamed sinuses.

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