Microbiology of Intracranial Abscesses and Their Associated Sinusitis

Itzhak Brook, MD, MSc

**Objective:** To evaluate the organisms recovered from infected sinuses and associated intracranial abscesses (IAs).

**Design:** Retrospective review of findings from aspirate of pus from 10 infected sinuses and their corresponding IAs.

**Setting:** Academic medical center.

**Patients:** Ten patients diagnosed as having sinusitis (age range, 7-58 years).

**Main Outcome Measure:** Aerobic and anaerobic bacteria findings from infected sinuses and IAs.

**Results:** Polymicrobial flora was found in 9 sinuses and 8 IAs. Anaerobes were isolated from all sinuses and 9 IAs. A total of 26 isolates (2.6 isolates per specimen) were recovered from the sinuses: 19 anaerobic, 6 aerobic or facultative, and 1 microaerophilic; 17 isolates were found in the IAs (1.7 isolates per site): 13 anaerobic, 2 aerobic or facultative, and 2 microaerophilic. The predominant anaerobes were *Fusobacterium* species (in 5 corresponding sinuses and abscesses, 1 in a sinus only, and 1 in an IA only), *Prevotella* species (in 3 corresponding sinuses and abscesses), *Peptostreptococcus* species (in 2 corresponding sinuses and abscesses, and 4 in a sinus only), *Staphylococcus aureus*, *Haemophilus influenzae* type b, microaerophilic streptococci, and *Bacteroides ureolyticus* (in 1 corresponding sinus and abscess each). *Streptococcus pneumoniae* was recovered 2 times, only from a sinus. α-Hemolytic streptococci and β-hemolytic streptococci group F were each isolated once from the sinus. Concordance in the microbiological findings between the sinus and the IA was found in all instances. However, certain organisms were present at only one or the other site.

**Conclusion:** These data illustrate the concordance in the recovery of organisms from infected sinuses and their associated IA and confirm the importance of anaerobic bacteria in sinusitis and IA.


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**METHODS**

The 10 patients included in the present report were observed between June 1977 and June 2003. Their ages ranged from 7 to 58 years, and 6 were male (Table). Antimicrobial agents were given to 3 patients prior to drainage: amoxicillin to patients 2 and 14, erythromycin to patient 9.

Cultures of sinuses and IAs were obtained during surgery using aseptically performed puncture and aspiration prior to surgical drainage. The material was collected either by syringe that was immediately sealed and transported to the laboratory within 30 minutes or by a swab that was dipped into the pus and introduced into an anaerobic transport system (Port-A-Cul; BBL Microbiology Systems, Cockeysville, Md) and generally transported to the laboratory within 2 hours.

Anaerobic bacteria material was plated onto 1 of the following: (1) prereduced *Brucella* blood agar enriched with phytodaidone (vitamin K₁); (2) anaerobic blood agar containing colistin and nalidixic acid; or (3) enriched thioglycolate broth (containing hemin and vitamin K₁). It was then incubated inside GasPak jars (BBL Microbiology Systems) and exam-
Table. Bacteriology and Clinical Features of Sinusitis and Associated Intracranial Abscesses in 10 Patients

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Diagnoses</th>
<th>Sinus Cavity</th>
<th>Intracranial Abscess</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/33</td>
<td>Ethmoid and frontal sinusitis, brain abscess</td>
<td>Prevotella intermedia (βL +)</td>
<td>Prevotella intermedia (βL +) Fusobacterium nucleatum</td>
</tr>
<tr>
<td>2/F/42</td>
<td>Frontal and maxillary sinusitis, subdural empyema</td>
<td>Fusobacterium nucleatum (βL +)</td>
<td>Fusobacterium nucleatum (βL +) Fusobacterium nucleatum micros</td>
</tr>
<tr>
<td>3/M/31</td>
<td>Frontal sinusitis, brain abscess</td>
<td>Peptostreptococcus anaerobius</td>
<td>Peptostreptococcus anaerobius</td>
</tr>
<tr>
<td>4/F/48</td>
<td>Pansinusitis, brain abscess</td>
<td>Peptostreptococcus intermedius Streptococcus pneumoniae</td>
<td>Fusobacterium nucleatum</td>
</tr>
<tr>
<td>5/F/40</td>
<td>Sphenoid sinusitis, brain abscess</td>
<td>Staphylococcus aureus (βL +)</td>
<td>Staphylococcus aureus (βL +)</td>
</tr>
<tr>
<td>6/M/58</td>
<td>Ethmoid and frontal sinusitis, subdural empyema</td>
<td>Peptostreptococcus species</td>
<td>Fusobacterium nucleatum (βL +) Veillonella parvula</td>
</tr>
<tr>
<td>7/M/14</td>
<td>Ethmoid and frontal sinusitis, subdural empyema</td>
<td>Prevotella intermedia</td>
<td>Prevotella intermedia Fusobacterium nucleatum Magnus Veillonella parvula</td>
</tr>
<tr>
<td>8/M/13</td>
<td>Maxillary sinusitis, subdural empyema</td>
<td>Microaerophilic streptococci</td>
<td>Microaerophilic streptococci Fusobacterium necrophorum</td>
</tr>
<tr>
<td>9/M/7</td>
<td>Frontal sinusitis, frontal lobe brain abscess, subdural empyema</td>
<td>Fusobacterium nucleatum</td>
<td>Fusobacterium nucleatum</td>
</tr>
<tr>
<td>10/F/15</td>
<td>Frontal sinusitis, subdural empyema</td>
<td>Bacteroides ureolyticus β-hemolytic streptococci group F</td>
<td>Bacteroides ureolyticus Microaerophilic streptococci</td>
</tr>
</tbody>
</table>

Abbreviation: βL +, β-lactamase producer.

RESULTS

Polymicrobial flora was found in 9 sinuses and 8 IAs, and the number of isolates ranged from 1 to 4. Anaerobic bacteria were isolated from all sinuses and 9 IAs (Table). These anaerobes (including microaerophilic streptococci) were the sole bacterial isolates in 5 sinuses (patients 2, 6, 7, 8, and 9) and 7 IAs (patients 1, 2, 4, 6, 7, 8, and 9). Concordance in the microbiological findings between the sinus and the IA was found in all instances. However, certain organisms were present only at one site and not at the other sites.

A total of 26 isolates (2.6 isolates per specimen) were recovered from the sinuses: 19 anaerobic, 6 aerobic or facultative, and 1 microaerophilic; 17 isolates were found in the IAs (1.7 isolates per site): 13 anaerobic, 2 aerobic or facultative, and 2 microaerophilic. The predominant anaerobic isolates were Fusobacterium species (in 5 corresponding sinuses and abscesses, 1 in a sinus only, and 1 in an IA only); Prevotella species (in 3 corresponding sinuses and abscesses); Peptostreptococcus species (in 2 corresponding sinuses and abscesses and 4 in a sinus only); and Staphylococcus aureus, Haemophilus influenzae type b, microaerophilic streptococci, and Bacteroides ureolyticus (in 1 corresponding sinus and abscess each). Streptococcus pneumoniae was recovered 2 times from a sinus only. α-Hemolytic streptococci and β-hemolytic streptococci group F were each isolated once from a sinus.

Twelve β-lactamase–producing organisms were present in 6 sinuses and 6 IAs. These were Fusobacterium nucleatum (4 isolates), Prevotella species (4), S aureus (2), and H influenzae type b (2).

COMMENT

This study illustrates the importance of anaerobic bacteria in IAs and their predominance in the associated sinusitis-affected sinus.8 Our findings confirm the observation of Herrmann and Forsen,13 who recovered aerobic and anaerobic polymicrobial flora from 2 infected sinuses and their associated intracranial complication sites. Anaerobic bacteria were previously recovered from chronically infected sinuses.7,8 Although several aerobic bacteria such as Streptococcus species, S aureus, and H influ-
enzae were isolated in several instances, the recovery of mainly anaerobic bacteria from all of our patients suggests the chronic nature of their infection.

Anaerobic and microaerophilic cocci and gram-negative and gram-positive anaerobic bacilli are the most important isolates recovered from brain abscesses. These include Bacteroides, Prevotella, Fusobacterium, and Clostridium species.3-5,13-16 The variations in collection techniques, culturing for strict anaerobes, and improper specimen handling to prevent contamination may account for differences between studies in the final organism identification.

Certain organisms such as S pneumoniae and Peptostreptococcus species were only or mainly present at the sinus and not the IA. The lower number of organisms per specimen recovered from IAs than from sinuses (1.7 vs 2.6 isolates per specimen) suggests that not all the bacteria present in the sinus cavity are able to reach the intracranial space or participate in the IA.

Past studies have not found significant correlation between sinus cultures and IAs.9-11 However, most of the sinus cultures were done using an endoscopic method, which can lead to contamination of specimens, and methods adequate for the recovery of anaerobic bacteria were not used.

Although surgical drainage is of primary importance, administration of antimicrobial therapy is an essential part of the treatment of patients with sinusitis and IA and other related complications. A growing number of anaerobic gram-negative bacilli (eg, pigmented Prevotella and Fusobacterium species) have acquired resistance to penicillin through the production of the enzyme β-lactamase.17 This has also been observed in the present report, where 6 each of the sinuses and IAs contained such organisms.

The isolation of polymicrobial aerobic and anaerobic flora in most of our patients suggests their important role in sinusitis and the associated IA. However, further prospective studies are warranted that include larger numbers of patients to evaluate the concurrent prevalence of these organisms in sinusitis and the associated IAs.

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Correspondence: Itzhak Brook, MD, MSc, 4431 Albe- marle St NW, Washington, DC 20016 (ib6@georgetown.edu).

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REFERENCES
