The Laryngoscope
Lippincott Williams & Wilkins, Inc.

Microbiology of Acute and Chronic Maxillary Sinusitis Associated with an Odontogenic Origin

Itzhak Brook, MD, MSc

Objectives: **To study the microbiology of sinusitis associated with odontogenic origin.** ***Methods:*** **Aspirates of 20 acutely and 28 chronically infected maxillary sinuses that were associated with odontogenic infection were processed for aerobic and anaerobic bacteria.** ***Results:*** **A total of 66 isolates were recovered from the 20 cases of acute sinusitis (3.3/specimen), 16 aerobic and facultatives, and 50 anaerobic. Aerobes alone were recovered in 2 (10%) specimens, anaerobes only in 10 (50%), and mixed aerobic and anaerobic bacteria in 8 (40%). The predominant aerobic were α-hemolytic streptococci (5), microaerophilic streptococci (4), and *Staphylococcus aureus* (2). The predominant anaerobes were anaerobic Gram-negative bacilli (22), *Peptostreptococcus* (12), and *Fusobacterium* spp. (9). A total of 98 isolates were recovered from the 28 cases of chronic sinusitis (3.5/patient): 21 aerobic and facultatives and 77 anaerobic. Aerobes were recovered in 3 (11%) instances, anaerobes only in 11 (39%), and mixed aerobic and anaerobic bacteria in 14 (50%). The predominant aerobes were α-hemolytic streptococci (7), microaerophilic streptococci (4), and *S. aureus* (5). The predominant anaerobes were Gram-negative bacilli (41), *Peptostreptococcus* (16), and *Fusobacterium* spp. (12). Thirteen β–lactamase-producing bacteria (BLPB) were recovered from 10 (50%) patients with acute sinusitis and 25 BLPB from 21 (75%) patients with chronic sinusitis. No correlation was found between the predisposing odontogenic conditions and the microbiological findings.** ***Conclusions:*** **These data illustrate the similar microbiology of acute and chronic maxillary sinusitis associated with odontogenic infection where anaerobic bacteria predominate in both types of infections.** ***Key Words:*** **Sinusitis, odontogenic, anaerobic bacteria.**

***Laryngoscope*, 115:823–825, 2005**

INTRODUCTION

Secondary maxillary sinusitis is a known complication of odontogenic infections of the upper jaw.[1,2] The infection may spread from the involved sinus to the central nervous system where it can cause serious complications such as subdural empyema, brain abscess, or meningitis.[1–3]

Streptococcus pneumoniae, *Haemophilus influenzae*, and *Moraxella catarrhalis* are the most common pathogens implicated in acute sinusitis,[4] whereas anaerobic bacteria can be isolated from up to 67% of patients who have chronic infection.[5,6] However, anaerobes were isolated from approximately 5% to 10% of patients with acute sinusitis, mostly from those who developed maxillary sinusitis secondary to odontogenic infection.[4]

Previous studies of the microbiology of acute and chronic maxillary sinusitis included only a small number of patients with odontogenic infection, which did not allow for a thorough assessment of the microbiology of this type of infection.[4–6] The role of anaerobic bacteria in this infection was also not well studied, although their recovery was recorded in a few cases.[2] This report describes the author's personal experience over a 30-year period of studying the aerobic and anaerobic microbiology of acute and chronic maxillary sinusitis that was associated with odontogenic infection.

MATERIALS AND METHODS

The 48 patients included in the report were studied by the author between June 1974 and June 2004. Excluded were 10 additional cases whose maxillary sinusitis showed no bacterial growth. Patients' ages ranged from 8 to 72 (mean 44.5) years; 31 were males, and 12 were children (<18 years). Included were 20 with acute and 28 with chronic sinusitis. A single sinus was involved in all instances. The teeth involved were either an upper molar or a premolar.

The odontogenic conditions associated with acute sinusitis were: pulpitis (7 cases), periodontal abscess (5), foreign body (2, including dental obturating material and embedded tooth), periapical abscess (2), root canal (2), maxillofacial surgery (1), and sinus lift surgery (1). The odontogenic conditions associated with chronic sinusitis were oro-antral fistula (8 cases), foreign body (5, including dental obturating material, embedded tooth, and radicular debris that persisted after dental extraction), dental implant

From the Department of Pediatrics, Georgetown University School of Medicine, Washington, D.C., U.S.A.

Editor's Note: This Manuscript was accepted for publication January 11, 2005.

Send Correspondence to Dr. Itzhak Brook, 4431 Albemarle St NW, DC 20016. E-mail: ib6@georgetown.edu

DOI: 10.1097/01.MLG.0000157332.17291.FC

(4), iatrogenic displacement of maxillary tooth root (4), chronic periodontitis (3), sinus lift surgery (2), and radicular cyst (2).

Antimicrobials were administered to 12 (25%) patients in the month before sample collection (5 with acute and 7 with chronic sinusitis). Only cases fulfilling the following criteria were included in the study: typical clinical symptoms of sinusitis (headache, fever, nasal drainage, etc.), positive radiographic findings, positive maxillary sinus cultures, and biopsy specimens demonstrating acute or chronic inflammation of the sinus mucosal lining, or clinical and radiologic findings compatible with sinusitis followed by clinical and radiologic improvement after surgery or antibiotics treatment. Sinusitis was considered acute if the duration of symptoms was less than 1 month, and chronic if symptoms persisted for more than 1 month.

Maxillary surgery was performed by an external approach in 6 patients or by an intranasal endoscopic approach in 42. The secretions were mucopurulent in 21 instance (9 acute and 12 chronic) and opaque in 27 (11 acute and 16 chronic). Foul smell was noted in 19 instances (5 acute and 17 chronic).

Strict asepsis was used to avoid contamination, and specimens were transported in a syringe sealed with a rubber stopper after air evacuation or in an anaerobic transport tube (Port-A-Cul, Baltimore Biological Laboratories, Cockeysville, MD). The time between specimen collection and inoculation was less than 30 minutes for syringes and less than 3 hours for the transport tube. Specimens were plated and inoculated, isolates were identified, and β-lactamase was detected as previously described.[5]

RESULTS

Acute Maxillary Sinusitis

A total of 66 isolates were recovered from the 20 cases (3.3/specimen), 16 aerobic and facultatives (0.8/specimen), and 50 anaerobic (2.5/specimen). The number of isolates per specimen varied from one to four. Aerobic and facultative organisms alone were recovered in 2 (10%) specimens, anaerobes only in 10 (50%), and mixed aerobic and anaerobic bacteria in 8 (40%). The predominant aerobic and facultatives were α-hemolytic streptococci (5), microaerophilic streptococci (4), and *Staphylococcus aureus* (2) (Table I). The predominant anaerobic bacteria were Gram-negative bacilli (22), *Peptostreptococcus* spp. (12, including 3 *Peptostreptococcus prevotii*, 2 *Peptostreptococcus micros*, and 1 *Peptostreptococcus anaerobius)*, *Fusobacterium* spp (9), and *Propionibacterium acnes* (2). Thirteen β–lactamase-producing bacteria (BLPB) were recovered from 10 (50%) specimens. No correlation was found between the predisposing odontogenic conditions and the microbiological findings.

Chronic Maxillary Sinusitis

A total of 98 isolates were recovered from the 28 cases (3.5/patient), 21 aerobic and facultatives (0.75/specimen), and 77 anaerobic (2.75/specimen). The number of isolates varied from one to five. Aerobic and facultative organisms were recovered in 3 (11%) instance, anaerobes only in 11 (39%), and mixed aerobic and anaerobic bacteria in 14 (50%). The predominant aerobic bacteria were α-hemolytic streptococci (7), *S. aureus* (5), and microaerophilic streptococci (5) (Table I). The predominant anaerobes were Gram-negative bacilli (41), *Peptostreptococcus* spp. (16, including 4 *Peptostreptococcus prevotii*, 4 *Peptostreptococcus micros*, and 2 *Peptostreptococcus anaerobius*), and *Fusobacterium* spp. (12). Twenty-five BLPB were recovered from 21 (75%) patients. These included all 5 *S. aureus* isolates, 4 of 12 (33%) of *Fusobacteria* spp., and 13 of 34 (38%) of *Prevotella* and *Porphyromonas* spp. No correlation was found between the predisposing odontogenic conditions and the microbiological findings.

TABLE I.
Bacteriology of 48 Patients with Maxillary Sinusitis with an Odontogenic Origin.

Bacteria	Number of Isolates Acute Sinusitis (n = 20)	Number of Isolates Chronic Sinusitis (n = 28)
Aerobic bacteria		
α-hemolytic streptococci	5	7
Microaerophilic streptococci	4	5
Streptococcus pneumoniae	1	
Streptococcus pyogenes	1	2
Staphylococcus aureus	2 (2)	5 (5)
Staphylococcus epidermidis	1 (1)	1 (1)
Haemophilus influenzae	1	
Klebsiella pneumoniae		1
Pseudomonas aeruginosa	1	
Subtotal aerobes	16 (3)	21 (6)
Anaerobic bacteria		
Peptostreptococcus species	12	16
Veilonella parvulla	3	2
Eubacterium species	1	2
Propionibacterium acne	2	3
Clostridium species	1	1
Fusobacterium species	2 (1)	2
Fusobacterium nucleatum	7 (2)	10 (4)
Bacteroides species	4 (1)	5
Bacteroides fragilis group		2 (2)
Prevotella melaninogenica	3 (1)	6 (2)
Prevotella oralis	3 (1)	3 (1)
Prevotella oris-buccae	3 (1)	6 (1)
Prevotella intermedia	3 (2)	12 (5)
Porphyromonas asaccharolytica	6 (1)	7 (4)
Subtotal anaerobes	50 (10)	77 (19)
Total	66 (13)	98 (25)

Number within parentheses indicates β-lactamase producers.

DISCUSSION

This study demonstrates the unique aerobic and anaerobic microbiological features of acute and chronic maxillary sinusitis that is associated with an odontogenic origin. *S. pneumoniae*, *H. influenzae*, and *M. catarrhalis*, the predominate bacteria recovered from acute maxillary sinusitis not of odontogenic origin,[4] were mostly absent in acute maxillary sinusitis that was associated with an odontogenic origin. In contrast, anaerobic bacteria predominated in both acute as well as chronic sinusitis. However, the number of both aerobic and anaerobic isolates per specimen in infected sinuses associated with odontogenic origin was similar in chronic sinusitis and acute sinusitis. A higher number of aerobic and anaerobic organisms per specimen were also found in chronic ethmoid, frontal, sphenoid, and maxillary sinusitis that were not associated with an odontogenic origin as compared with acute infections in these sinuses.[7]

The most common anaerobes isolated in this study in acute and chronic infection were *Peptostreptococcus* spp., *Fusobacterium* spp., pigmented *Prevotella*, and *Porphyromonas* spp., all members of the oropharyngeal flora.[1] These organisms also predominate in periodontal and endodontal infection.[8–10] The high recovery rate of anaerobic bacteria in maxillary sinusitis of odontogenic origin is similar to the findings in chronic maxillary, ethmoid, frontal, and sphenoid sinusitis where these organisms also predominate.[5–7]

Dental infections are generally mixed polymicrobial aerobic and anaerobic bacterial infections caused by the same families of oral organisms.[8] Because anaerobes are part of the normal oral flora and outnumber aerobic organisms by a ratio of 1:10 to 1:100 at this site,[1] it is not surprising that they predominant in odontogenic infections. There are at least 350 morphologic and biochemically distinct bacterial species that colonize the oral and dental ecologic sites.

A study that evaluated the microbiology of 32 periapical abscess highlighted the polymicrobial nature and importance of anaerobic bacteria in this infection.[9] Fifty-five anaerobic and 23 aerobic bacteria were recovered. Anaerobes only were present in 16 (50%) patients, aerobic and facultatives in 2 (6%), and mixed flora in 14 (44%). The predominant isolates were *Peptostreptococcus*, *Bacteroides*, *Prevotella*, *Porphyromonas* spp., and aerobic streptococci.

The association between periapical abscesses and sinusitis was established in a study of pus aspirate from five upper jaw abscesses and their corresponding maxillary sinusitis.[10] Polymicrobial flora was found in all instances, and anaerobes were recovered from all specimens. The predominant isolates were *Prevotella*, *Porphyromonas*, and *Peptostreptococcus* spp., and *Fusobacterium nucleatum*. Concordance in the microbiological findings between the periapical abscess and the maxillary sinus flora was found in all instances. However, *Prevotella gingivalis*, *Streptococcus sanguis*, and *Streptococcus milleri* were only recovered from the periapical abscesses.[10] This suggests that these organisms do not thrive well in the sinus cavity. However, *Peptostreptococcus*, *Prevotella*, and *Fusobacterium* spp. were isolated in both sites. These data confirm the importance of anaerobes in periapical abscesses and demonstrate their predominance in the associated maxillary sinusitis. The concordance in recovery of organisms in paired infections illustrates the dental origin of the sinusitis. The proximity of the upper molars to the floor of the maxillary sinus allows such a spread.

The higher frequent recovery of anaerobes in sinusitis associated with an odontogenic origin may be related to the poor drainage and increased intranasal pressure that develops during inflammation.[11] This can reduce the oxygen tension in the inflamed sinus[12] by decreasing the mucosal blood flow and depressing the ciliary action.[13] The lowering of the sinus cavity oxygen content and pH supports the growth of anaerobes.[14]

The association between an odontogenic condition and maxillary sinusitis warrants a thorough dental examination of patients with sinusitis. Concomitant management of the dental origin and the associated sinusitis will insure complete resolution of the infection and may prevent recurrences and complications.

Although odontogenic therapy and surgical drainage are of primary importance, antimicrobial therapy is an essential part of the management of serious odontogenic infections and their complications. Similarly, the management of sinusitis includes proper antimicrobial therapy and surgical drainage when improvement is delayed or absent.

A growing number of anaerobic Gram-negative bacilli (i.e., pigmented *Prevotella* and *Fusobacterium* spp.) have acquired resistance to penicillin through the production of the enzyme β-lactamase.[15] This has also been observed in this report, where 50% of specimens of acute and 75% of chronic sinusitis harbored BLPB.

The recovery of penicillin-resistant organisms may require the administration of antimicrobial agents effective against these organisms. These include clindamycin, cefoxitin, a carbapenem or the combination of a penicillin and a β-lactamase inhibitor, or metronidazole plus a penicillin or a macrolide.[7] The choice of antimicrobial should be guided by properly collected culture whenever possible. However, the empiric choice of antibiotics depends on the resistance patterns in a particular community or region.

BIBLIOGRAPHY

1. Finegold SM. *Anaerobic Bacteria in Human Disease*. New York: Academic Press, 1977.
2. Brook I, Friedman EM. Intracranial complications of sinusitis in children: a sequella of periapical abscess. *Ann Otol Rhinol Laryngol* 1982;91:41–43.
3. Brook I. Aerobic and anaerobic bacteriology of intracranial abscesses. *Pediatr Neurol* 1992;8:210–214.
4. Nash D, Wald E. Sinusitis. *Pediatr Rev* 2001;22:111–117.
5. Brook I. Bacteriology of chronic maxillary sinusitis in adults. *Ann Otol Rhinol Laryngol* 1989;98:426–428.
6. Nord CE. The role of anaerobic bacteria in recurrent episodes of sinusitis and tonsillitis. *Clin Infect Dis* 1995;20: 1512–1524.
7. Brook I. Microbiology and antimicrobial management of sinusitis. *Otolaryngol Clin North Am* 2004;37:253–266.
8. Brook I. Microbiology and management of endodontic infections in children. *J Clin Pediatr Dent* 2003;28:13–17.
9. Brook I, Frazier EH, Gher ME. Aerobic and anaerobic microbiology of periapical abscess. *Oral Microbiol Immunol* 1991;6:123–125.
10. Brook I, Frazier EH, Gher ME. Microbiology of periapical abscesses and associated maxillary sinusitis. *J Periodontol* 1996;67:608–610.
11. Drettner B, Lindholm CE. The borderline between acute rhinitis and sinusitis. *Acta Otolaryngol (Stockh)* 1967;64: 508–513.
12. Carenfelt C, Lundberg C. Purulent and non-purulent maxillary sinus secretions with respect to pO_2, pCO_2 and pH. *Acta Otolaryngol (Stockh)* 1977;84:138–144.
13. Aust R, Drettner B. Oxygen tension in the human maxillary sinus under normal and pathological conditions. *Acta Otolaryngol (Stockh)* 1974;78:264–269.
14. Carenfelt C. Pathogenesis of sinus empyema. *Ann Otol Rhinol Laryngol* 1979;88:16–20.
15. Brook I, Calhoun L, Yocum P. Beta-lactamase-producing isolates of Bacteroides species from children. *Antimicrob Agents Chemother* 1980;18:164–166.