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A Surveillance Study of Bacteriologic Profile in Rhinosinusitis

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ABSTRACT

Objective: To review the types of bacteria found in rhinosinusitis and the prevalence of a beta-lactamase producing organism in a tertiary care hospital during the year 2004 and compared with our previous reports.

Methods: Charts of patients who underwent endoscopic sinus surgery or maxillary antral puncture or endoscopic-guided culture at the Rhinology & Allergy Division, Department of Otolaryngology and the Department of Microbiology, Siriraj Hospital from January 2004 to December 2004 were reviewed. Information regarding the patient's age, site of specimens, culture and sensitivity results were obtained.

Results: There were 162 specimens and 29 bacterial species isolated. There were 50.4% positive aerobic cultures, gram-negative bacteria were more common than gram-positive bacteria (68.5% vs 31.5%). Common aerobes were *Pseudomonas aeruginosa* (16.2%), non-fermentative gram negative rod : NF-GNR (10.8%), Coagulase- negative *Staphylococcus aureus* : CNS (9.9%) and *Klebsiella pneumoniae* (9.9%). The most common anaerobes were *Peptostreptococcus* sp., *Bacteroides fragilis* and *Fusobacterium* sp.

Conclusion: Contrary to our previous studies, gram negative organisms play a more important role than gram positive organisms. The causative pathogens of rhinosinusitis should be studied continuously because rapid progress in the development of new antimicrobial agents has a significant impact on their bacteriologic profile.

Keywords: Bacteriological study; rhinosinusitis

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Rhinosinusitis is a common disease in clinical practice. The incidence in the United States is 14.7% in the general population[1]. The cost of over-the counter medications for rhinosinusitis is two billion dollars annually and accounts for 25 million physician visits each year[2,3]. The etiology of bacterial rhinosinusitis may be rhinogenic or odontogenic. When treating rhinosinusitis, physicians should select the appropriate antibiotic according to the most common offending organisms in his/her community.

The gold standard for obtaining reliable specimens for culture is the maxillary antral aspiration. This technique requires certain skill, patient cooperation and time. Less invasive techniques for obtaining sinus specimen for culture including nasal and nasopharyngeal swabs are unreliable due to possible contamination by secondary bacterial overgrowth in the nose[4]. However, in the endoscopic era, the proper specimen for culture from the sinus via endoscopic-guided swab/aspiration has been proven to have a good correlation with the antral aspiration[5,6]. Another method is to get the mucosa from the diseased sinus sent for bacterial culture. Comparing with the pus in the sinus, the sinus mucosa yielded a higher rate of bacterial growth[7].

Previously we have reported our bacteriologic profile in three different periods i.e. during 1974-78, 1979 and 1999-2000[8,9]. The objective of this study is to follow up the prevalence of individual bacterial species from rhinosinusitis patients in comparison with the previous studies in our hospital which is a tertiary care and teaching center in Thailand.

MATERIALS AND METHODS

This study is a retrospective review of bacterial culture and a sensitivity test of rhinosinusitis patients who underwent endoscopic sinus surgery or maxillary antral puncture or endoscopic-guided culture at the Rhinology & Allergy

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TABLE 1. Microbiological study of rhinosinusitis.

	Maxillary	Ethmoid	Sphenoid	Total
Number of specimens	114	27	21	162
Positive	54.4%	44.4%	52.4%	50.6%
Gram +ve	24	3	8	35
Gram -ve	54	11	11	76

Note: Each specimen can be cultured-positive for both gram +ve and Gram-ve

Division, Department of Otolaryngology and the Department of Microbiology, Siriraj Hospital between January 2004 and December 2004.

The indications for obtaining specimens for culture or operation are according to the standard recommendations and guidelines[10]. Antibiotics were withheld one week prior to the operations. A total of 162 patients (80 males and 82 females) were included in this study. The mean age was 47 +/- 18.2 years (range 10-86 years).

The specimens for bacteriological study were collected by 1. maxillary antral aspiration using sterile technique, or 2. endoscopic-guided middle meatus swab/aspiration, or 3. sinus tissue culture during endoscopic sinus surgery. For anaerobic culture, the specimens were transferred immedia-tely on a blood agar plate, and put into Gaspak anaerobic jars. All specimens were sent to the microbiology laboratory within 2 hours. Microorganisms were isolated and identified according to standard bacteriological methods and the antibiotic susceptibility was performed by the disk diffusion technique as recommended by the Clinical Laboratory Standards Institute (CLSI)[11]. Each bacterial inoculums was prepared by suspending 4-5 isolated colonies from pure culture in a peptone broth and the suspension was adjusted equal to the turbidity of McFarland standard solution No.0.5. The diameter of the inhibition zone around each antimicrobial disk after incubation on agar plates at 35°C for 18-24 hours was measured to the zone diameter interpretive standards as recommended by the CLSI. Beta-lactamase enzyme was detected by a rapid test for hydrolysis of nitrocefin solution[12]. A positive reaction occurs when the color of the solution changes from yellow to red within 5 minutes of the procedure carried out at room temperature.

RESULTS

Altogether 162 specimens were collected and sent to the laboratory. Most of the specimens were taken from the operation room from chronic sinusitis cases. Aerobic cultures were positive in 50.6% (82 of the total 162 specimens): the 95% confident interval = 43.0-58.2 (Table 1). Gram positive bacteria were found in 35 specimens and gram negative bacteria were found in 76 specimens. The rate of cultured-positive and the bacteriological profiles were compared with our previous study in Table 2. The rate of cultured-positive profiles was statistically significantly different from the study in 2000 (95% CI). Maxillary, ethmoid and sphenoid sinuses were found positive cultured as 54.4%, 44.4% and 52.4% respectively. The most common aerobes isolated were *P.aeruginosa* (16.2%), non-fermentative gram negative rod (NF-GNR, 10.8%), Coagulase negative *Staphylococcus* (CNS, 9.9%) and *Klebsiella pneumoniae* (9.9%). Only 2.7% and 0.9% were positive for *H. influenzae* and *M.catarrhalis* respectively (Table 3). Due to the limited number of *H. Influenzae* and *M.catarrhalis* isolated from our specimens, the incidence of the beta lactamase producing strain of all specimens from respiratory infection in our hospital (55.1% for *H.influenzae* and 97.3% for *M. catarrhalis*) was shown instead. Prevalence of each type of aerobic bacteria isolated from each sinus was shown in Table 4.

Forty three specimens were sent for anaerobic culture, 9% (4/43) were positive for anaerobic only and 13.95 % (6/43) were positive for mixed aerobic and anaerobic organisms (Table 5). The most common anaerobes were *Peptostreptococcus* (4 specimens : 30.8%), *Bacteroides fragilis* (3 specimens : 23.1%) and *Fusobacterium* (2 specimens : 15.45%).

TABLE 2. The rate of cultured-positive and the bacteriologic profile of rhinosinusitis during different period.

	Specimens	No. of cultured-positive	%	95% CI	Gram-positive	Gram-negative
1974-1978	40	16	40.0	26.4-55.4	55.6% (10/18)	44.4% (8/18)
1979	20	14	70.0	48.1-85.5	75% (18/24)	25% (6/24)
2000	91	71	78.0*	68.5-85.3	39.2% (29/74)	60.8% (45/74)
Present study	162	82	50.6	43.0-58.2	31.5% (35/111)	68.5% (76/111)

* Statistically significant at 95% confident interval

TABLE 3. Prevalence of aerobic bacteria isolated.

Specimens : N = 111	
P. aeruginosa	16.2%
NF-GNR	10.8%
CNS (Coagulase negative staphylococci)	9.9%
K. pneumoniae	9.9%
S. aureus	9.0%
H. parainfluenzae	7.2%
Viridans Streptococci	6.3%
E. coli	3.6%
H. influenzae	2.7%
M. catarrhalis	0.9%

* Only Top-10 aerobic bacteria isolated were shown.

TABLE 4. Prevalence of aerobic bacteria isolated from each sinus.

Maxillary		Ethmoid		Sphenoid	
Total = 78	%	Total = 14	%	Total = 19	%
NF-GNR	15.0	*K. pneumoniae*	26.6	*P. aeruginosa*	26.3
P. aeruginosa	13.8	CNS	20.0	*S. aureus*	26.3
CNS	10.0	*P. aeruginosa*	13.3	*K. pneumoniae*	5.2
K. pneumoniae	7.5	*H. parainfluenzae*	13.3	Viridans Streptococci	5.2
H. parainfluenzae	7.5	*E. coli*	6.6	*H. influenzae*	5.2
Viridans Streptococci	7.5			*E. coli*	5.2
S. aureus	6.2				
H. influenzae	2.5				
E. coli	2.5				
M. catarrhalis	1.3				

NF-GNR = Non-fermentative gram negative rod, CNS = Coagulase negative staph.

TABLE 5. Anaerobic cultures in rhinosinusitis.

	Maxillary	Ethmoid	Sphenoid	Total
Total	33	8	2	43
% positive	24.2	25.0	0.0	23.3
Anaerobes only	2	2	0	4
Mixed	6	0	0	6
Aerobes only	0	0	0	0

DISCUSSION

The percentage of positive aerobic cultures in this study is 50.6 % (95% CI = 43.0-58.2). The positive rate differs significantly from our previous study (71% positive rate with 95%CI = 68.5-85.3)[9]. But the positive rate dose not reach the statistical significance for our studies during 1974-1978 and in 1979[8]. The positive rate depends on: 1. patient factors such as type of rhinosinusitis, duration of infection, antibiotics used, associated diseases; and 2. technical factors such as method of obtaining specimens from sinuses, delivery process and microbiologic identification process. Jiang RS, et al. (2000) study the rate of positive culture in sinusitis with or without secretion seen in middle meatus and found 44-53% positive in middle meatus without secretion and 51-70% in middle meatus with secretion[13]. The rate of positive culture (50%) may increase by improving: 1) the handling process of specimens to the laboratory such as the excessive dryness of specimens or 2) a short period of time from the out-patient department to the microbiology department. In this study, the specimens came from the operating room and outpatient section which are not in the same building as the lab. Direct comparison of positive cultures between studies is also not appropriate due to different sources of specimens. Karma P, et al. (1979) found the sinus mucosa yielded the highest rate of bacterial growth compared with pus in the sinus.[7] On the contrary, Winther B, et al. (1996) found the cultures of small pieces of mucosa obtained at the time of surgery have a greater problem with contamination.[14] Further prospective study may be beneficial for comparing the results of tissue culture and direct pus culture.

The predominant aerobic bacteria in this study were *P.aeruginosa*, NF-GNR and CNS. Gold and Tami (1997) found gram negative organisms are rarely implicated in chronic rhinosinusitis except in immunocompromized patients[6]. This study correlates with the study of Bolger in 1994, who reported CNS, *S.aureus* and *Pseudomonas* as predominant organisms[15]. The high rate of gram negative bacilli and *Pseudomonas* in this study may be explained by the fact that the majority of the cases were chronic cases which needed surgery[5]. It is possible that gram negative infections are found frequently in the refractory cases[6].

The role of CNS in rhinosinusitis remains controversial. Some authors consider CNS as contaminant but its role as a pathogen in other body sites has been reported[16]. In this study, CNS grows 9.9% and is comparable to other reports (0-8%).[7, 17-20] Even the maxillary sinus tap which is considered a gold standard because it eleminates the chance of contamination from nasal flora, grows CNS for 6.9%. Then, CNS may play a role as pathogen in rhinosinusitis. Moreover, the semi-quantitative culturing method will guide the physician to consider CNS as a contaminant or a pathogen. Correlation of positive culture result with the patient's clinical features such as sinusitis symptoms or endoscopic finding will be another parameter to support the role of CNS in sinusitis patients.

Comparing with our previous study during 1974-78 and 1979, the majority of causative organisms changed from gram positive to gram negative bacteria (68.5%). The incidence of beta-lactamase producing strains in our hospital is high (55% of *H.influenzae* and 97% of *M.catarrhalis*), but comparable with the study of Gwaltney JM, et al.[21] Thus, the second-line antibiotics such as beta-lactamase inhibitor or newer-generation quinolone should be recommended in chronic cases.

The prevalence of anaerobic bacteria in our study in 1986 was 28.6%.[8] This study, showed the overall positive rate of anaerobe is 23.25%. When the sites of infected sinuses are taken into consideration, the ethmoid sinus had 25% positive, and the maxillary sinus had 24.24% anaerobic culture. Some studies reported that the prevalence of anaerobe was as high as 90%.[19-20] The question remaining for debate is whether the routine anaerobic culture should be done in every case of rhinosinusitis. Considering the high cost and limited accessibility of anaerobic culture together with the low rate of resistance to antibiotics, anaerobic culture should not yet be recommended as routine.

The drawback of this study is being a retrospective chart review. Most of the cases are chronic rhinosinusitis or acute exacerbation of chronic rhinosinusitis which need surgical treatment. However, it is relevant to our daily practice in dealing with the refractory cases. Maxillary sinus puncture/aspiration, which is considered the gold-standard for identifying causative organisms of rhinosinusitis is invasive, difficult to perform and not acceptable by most patients. So there is a need for other methods to provide some clues. It is true that surveillance study of pathogenic bacteria in bacterial rhinosinusitis is rare.[22] Routine collection would at least provide a monitoring system of the bacterial pattern in rhinosinusitis in that locality which would facilitate more appropriate antimicrobial selection for the treatment of rhinosinusitis. Nevertheless, a prospective multicenter study of bacteriology of rhinosinusitis patients is being performed in our country, so there will be more useful data in this aspect in the future.

CONCLUSION

The common organisms of rhinosinusitis in our hospital are *P.aeruginosa*, NF-GFR and CNS. The emerging role of gram negative bacteria as a cause of rhinosinusitis should be recognized, and a surveillance study of common responsible bacteriology should be done continuously.

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REFERENCES

1. Kaliner MA. Rhinosinusitis-the role of the allergist in diagnosis and treatment. ACI International 1998; 10: 141-8.
2. William JW Jr, Holleman DR, Samsa GP, Simel DL. Randomized controlled trial of 3 vs 10 days of trimetroprim/sulfamethoxazole for acute maxillary sinusitis. JAMA 1995; 273: 1015-21.
3. Kennedy DW. Sinus Disease: Guide to First Line Management. Darien.

Connecticut Health Communication, Inc; 1994: 10.
4. Myelsson A, Brorson JE. The correlation between bacterial findings in the nose and maxillary sinus in acute maxillary sinusitis. Laryngoscope 1973; 83: 2003-11.
5. Nadel DM, Lanza DC, Kennedy DW. Endoscopically guided cultures in chronic sinusitis. Am J Rhinol 1998; 12: 233-41.
6. Gold SM, Tami TA. Role of middle meatus aspiration culture in the diagnosis of chronic sinusitis. Laryngoscope 1997; 107: 1586-89.
7. Karma P, Jokipii L, Sipila P, Luotonen J, Jokipii AMM. Bacteria in chronic maxillary sinusitis. Arch Otolaryngol 1979; 105: 386-90.
8. Bunnag C, Dhiraputra C, Santivijai C, Moenlamai K, Youngrod T. Bacteriological findings in chronic maxillary sinusitis. Otolaryngol Head Neck Surg 1986; 1: 21-9.
9. Jareoncharsri P, Bunng C, Tunsuriyawong P, Voraprayoon S, Srifuengfung S, Dhiraputra C, et al. Bacteriologic Profile of Acute and Chronic Maxillary Sinusitis. J Infect Dis Antimicrob Agents 2001; 18: 96-102.
10. Fokkens W, Lund V, Bachert C, Clement P, Helllings P, Holmstrom M, et al. European Position Paper on Rhinosinusitis and Nasal Polyps, 2005: 1-87.
11. CLSI. Performance standards for antimicrobial susceptibility testing; Fifteenth informational supplement. CLSI document 2005; M100-S15. The Clinical and Laboratory Standards Institute, USA.
12. O'Callaghan CH, Morris A, Kirby SM, Shingler AH. Novel method for detection of beta-lactamase by using chromogenic cephalosporin substrate. Antimicrob Agents Chemother 1972; 1: 283-8.
13. Jiang RS, Su MC, Jiao CY, Lin JF. Bacteriology of chronic sinusitis in relation to middle meatal secretion. Am J Rhinol 2000; 20: 173-6.
14. Winther B, Vickery CL, Gross CW, Hendley JO. Microbiology of the maxillary sinus in adults with chronic sinus disease. Am J Rhinol 1996; 10: 347-50.
15. Bolger WE. Gram negative sinusitis: An emerging clinical entity. Am J Rhinol 1994; 8: 279-84.
16. Hsu J, Lanza DC, Kennedy DW. Antimicrobial resistance in bacterial chronic sinusitis. Presented at the American Rhinologic Society Spring Meeting, 1995.
17. Su WY, Lie C, Hung SY, Tsai WF. Bacteriological study in chronic maxillary sinusitis. Laryngoscope 1983; 93: 931-34.
18. Palva T, Gronroos JA, Palva A. Bacteriology and pathology of chronic maxillary sinusitis. Acta Otolaryngol 1962; 54: 159-75.
19. Frederick J, Braude AI. Anaerobic infection of the paranasal sinuses. NEJM 1974; 290: 135-7.
20. Brook I. Bacteriology of chronic maxillary sinusitis in adults. Ann Otol Rhinol Laryngol 1989; 98: 426-8.
21. Gwaltney JM, Scheld WM, Sande MA, Sydner A. The microbial therapy of adults with acute community-acquired sinusitis: A fifteen-year experience at the university of Virginia and review of other selected study. J Allergy Clin Immunol 1992; 20: 457-61.
22. Benninger MS, Payne SC, Ferguson BJ, Hadley JA, Ahmad N. Endoscopically directed middle meatal cultures versus maxillary sinus taps in acute bacterial maxillary rhinosinusitis : A meta-analysis. Otolaryngol Head Neck Surg 2006; 134: 3-9.