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Correlation of middle meatus and ethmoid sinus microbiology in patients with chronic sinusitis*

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SUMMARY

Empirical antibiotics constitute the cornerstone of medical therapy for chronic sinusitis due to difficulties of obtaining cultures from the paranasal sinuses. Indirect isolation of the pathogenic microorganisms outside the paranasal sinuses with a non-invasive method may enable administration of specific antibiotics. In this prospective study, we obtained cultures from the middle meatus and ethmoid sinuses of 193 sides from 127 patients who had undergone FESS for chronic sinusitis with a method that minimizes the risk of nasal contamination. The same bacterial species were isolated from both the ethmoid sinus and middle meatus in 59.3% of the cultures. There was no bacterial growth in either site in 32.3% of the cultures. The overall correlation rate of middle meatus and ethmoid sinus cultures was estimated to be 91.6%. In conclusion, middle meatal cultures can be used for the isolation of pathogenic microorganisms indirectly, while administration of specific antibiotics can be possible according to the results of these cultures.

Key words: chronic sinusitis, middle meatus, ethmoid sinus

INTRODUCTION

Chronic sinusitis is among the most frequent diseases in the world. Antibiotics constitute the cornerstone of the current medical therapy for this disease. It is difficult and sometimes impossible to obtain cultures from the paranasal sinuses in the office, and frequently large spectrum, empirical antibiotics are preferred. Inappropriate use of large spectrum antibiotics may lead to an increased bacterial resistance and virulence.

The middle meatus has gained importance with the progress of functional endoscopic sinus surgery (FESS). It was suggested that the ethmoid sinuses play a key role in the pathogenesis of sinusitis (Stammberger, 1990). If the microbiology of middle meatus correlates to that of the ethmoid sinus, it would be possible to identify the pathogenic agent indirectly, to start specific antibiotics and to demonstrate the eradication of the microorganism microbiologically. Since the middle meatus can be reached easily even in the office, an invasive procedure is not needed to obtain a culture.

In this study, we used a technique that minimizes the risk of contamination while obtaining middle meatus and ethmoid sinus cultures and investigated the correlation of middle meatus and ethmoid sinus microbiology of patients who underwent FESS for chronic sinusitis.

MATERIALS AND METHODS

One hundred twenty seven patients who underwent FESS for chronic sinusitis were included in this study. Their ages ranged between 18 and 57 years with a mean of 32.6. Fifty-two of the patients were female and 75 were male. The patients had symptoms for at least 12 weeks prior to their first admission to the hospital. The diagnosis of chronic sinusitis was based on history, otolaryngological examination and plain sinus X-rays. Patients received amoxicilline and clavulanic acid, cefaclor or cefuroxime axetil for four weeks in addition to topical decongestants for one week. Patients who had persistent symptoms and had findings suggestive of chronic sinusitis on physical examination were ordered a paranasal computed tomography and FESS was planned. The patients did not use antibiotics within 2 weeks prior to the surgery. All patients had partial or total opacification in their ethmoid sinuses in their paranasal sinus CT. Patients with gross or micro (endoscopic) nasal polyps were not included in the study. Approval was given by the local Institutional Review Board and informed consent was obtained from all of the patients.

Chronic sinusitis was apparent in 193 sides of 127 patients. Following premedication, patients were taken into the operating room. Cottonoids with 2% lidocaine and 1:10000 adrena-

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line were inserted into both nasal cavities and were removed after 5 minutes. Both vestibules were cleansed with a povidon-iodine solution and after one minute, excess solution was wiped dry. The cannula with the cotton tipped rod inside that had been prepared and sterilized previously was placed into the middle meatus with the help of the 0 degree rigid endoscope. The cotton tipped rod was pushed out of the cannula and rubbed against the middle meatus and pulled back into the cannula. Later it was taken out of the nose. Following uncinectomy and opening of the ethmoid bulla, the same method was used to obtain a microbiological specimen of the ethmoid air cells. A total of 386 samples were obtained from 193 sides. Samples were inoculated into semi-liquid thioglycollate (PITMAN) broth and sent to the microbiology laboratory. All samples were inoculated within 30 minutes at the maximum.

All specimens were inoculated onto EMB (eosine-methylene blue) agar and sheep blood agar (colombia blood agar base + 5% defibrinated sheep blood agar) and incubated in normal atmosphere at 37°C for 24 to 48 hours. Samples were further plated onto 5% sheep blood agar and horse blood chocolate agar with 300mg/L bacitracin and incubated in 5% CO_2 at 37°C for 24-48 hours. For anaerobic microorganisms, specimens were inoculated onto CDC anaerobe blood agar with kanamycine and vancomycine and incubated in a Gas-Pak anaerobic jar for 48-92 hours at 35°C. The specimens were also inoculated into thioglycollate broth and incubated at 35°C for 4-7 days.

The microorganisms were isolated and identified by the methods defined in the Manual of Clinical Microbiology (D'Amato et al., 1991).

RESULTS

Bacterial growth was observed in 251 of 386 samples (65%). In 81 sides, no bacterial growth was observed in either the middle meatus or the ethmoid (32.3%). In 149 sides, the same type of bacterial growth was observed in both sites (59.3%). In 13 sides, there was bacterial growth in the middle meatus, but no growth in the ethmoid (5.2%); this was accepted as a false positive result. In 4 sides, there was growth in the ethmoid but no growth in the middle meatus (1.6%) and this was accepted as a false negative result. The correlation of middle meatal and ethmoid sinus microbiology was estimated to be 91.6% (Table 1).

Table 1. Correlation of middle meatus and ethmoid sinus microbiology.

	n	%
The same bacteria in ethmoid and middle meatus (a)	149/251	59.3
No growth in either middle meatus or ethmoid (b)	81/251	32.3
Different bacterial growth in middle meatus and ethmoid	3/251	1.2
Bacterial growth in middle meatus, no growth in ethmoid, (false positive)	13/251	5.2
Bacterial growth in ethmoid, no growth in middle meatus, (false negative)	4/251	1.6
Correlation of middle meatus and ethmoid sinus microbiology (a+b)	230/251	91.6

Both in the middle meatus and ethmoid sinus, the most frequently encountered microorganism was *Staphylococcus aureus* followed by *Bacteroides spp.* Multibacterial growth in both the middle meatus and ethmoid sinus was evident in 21 sides (42 sites) (10.9%). Anaerobes alone or together with aerobes were isolated in 31.2% of ethmoid sinuses and in 22.4% of the middle meatal cultures. Bacterial growth in the ethmoid sinus and middle meatus are shown in Table 2.

Table 2. The number of the bacterial isolates in the middle meatus and the ethmoid sinus.

	Middle meatus	Ethmoid sinus
Aerobic or facultative anaerobic bacteria		
Gram positive		
Staphylococcus aureus	32	26
Staphylococcus epidermidis	8	6
Streptococcus pyogenes	7	7
a-hemolytic Streptococcus	13	9
Streptococcus pneumoniae	7	9
Gram negative		
Haemophylus influenzae	8	8
Haemophylus parainfluenza	7	7
Moraxella (Branhamella) catarhalis	3	3
Escherichia coli	9	13
Klebsiella pneumoniae	3	3
Citrobacter diversus	3	3
Anaerobic bacteria		
Gram positive		
Peptostreptococcus spp.	9	9
Peptococcus spp.	9	7
Gram negative		
Bacteroides spp.	19	16
Total	137	126

DISCUSSION

The preferred treatment method of infectious diseases is the administration of a specific antimicrobial agent following the identification of the pathogenic microorganism. However, obtaining a culture is sometimes technically difficult or requires an invasive procedure, as is the case in the paranasal sinuses. This is why broad-spectrum empirical antibiotics directed at the most common pathogenic microorganisms are preferred for the treatment of chronic sinusitis. In fact, inappropriate use of empirical antibiotics may lead to an increased bacterial resistance and virulence.

Klossek et al. (1996) and Gordts et al. (2000) have studied the bacteriology of the middle meatus in healthy adults and have reported similar results. Coagulase negative *Staphylococcus* was the most common bacterial isolate in both studies and was isolated in 50% of the cultures by Klossek et al. while this percentage was 35% in the report of Gordts et al.. *Corynobacteria* was the second most common isolate in both studies (20%) while the most common anaerobic isolate was *Propionibacterium spp.*

Despite the similarity of the results of aforementioned studies, the types of bacteria isolated from the patients with chronic sinusitis differ widely. For example, the isolation rate of anaerobic bacteria was reported between 0-100% (Brook and Yocum, 1995; Doyle and Woodham, 1991; Jiang et al., 1997; Muntz and Lusk, 1991; Orobello et al., 1991; Şfiener et al., 1996; van Cauwenberge et al., 1993). The variation of results may be related to some factors as the patients' age, duration of the disease, differences in the sampling technique, site of specimen collection, specimen transport method, inoculation media, and previous antibiotic therapy. The difference of the results of microbiological studies puts forward the importance of specific antibiotic therapy for every patient. A simple and noninvasive method for microbiological sampling is the main requirement for this goal.

Can the pathogenic bacteria of chronic sinusitis be identified indirectly elsewhere except the paranasal sinuses? It has been reported that the cultures that were obtained from the nose, oropharynx or nasopharynx did not correlate with the maxillary sinus cultures when chronic sinusitis is considered. Şfiener et al. (1996) reported the correlation of maxillary sinus cultures with the nasopharynx as 57%, with the nose as 53% and with the throat as 40%. Orobello et al. (1991) reported the correlation of nasopharyngeal and ethmoid sinus cultures as 40%.

Since maxillary, anterior ethmoid, and frontal sinuses drain into the middle meatus, microbiological specimens obtained from the middle meatus may be correlated to the paranasal sinus microbiology. Gold and Tami (1997) studied the correlation of middle meatal and maxillary sinus aspiration cultures for only aerobes in 18 adults with chronic sinusitis. The most prevalent microorganism was *Staphylococcus aureus*. The middle meatus and maxillary sinus cultures were correlated in 85.7% of the patients. *Streptococcus viridans* or coagulase negative *Staphylococcus* was isolated in 25.8% of cultures from the middle meatus and 28.5% of cultures from the maxillary sinus. These results may be suggestive of nasal contamination. In addition, aspiration culture may not be appropriate for patients with chronic sinusitis because the presence of pus in the middle meatus is not an universal characteristic of the disease.

Orobello et al. (1991) compared the microbiology of ethmoid/maxillary sinus and middle meatus in 39 pediatric patients. They found a correlation rate of ethmoid sinus and middle meatus cultures of 80%, and maxillary sinus and middle meatal cultures of 83%. The authors suggested direct endoscopic culture of the middle meatus for diagnosis of ethmoid and maxillary sinus infections especially in children. They used swabs to culture the middle meatus and avoided carefully the contamination from the vestibule and anterior aspect of the nose. Unfortunately, as the authors have already stated, the predominance of *Staphylococcus epidermidis, Streptococcus viridans* and normal respiratory flora in low concentration suggests contamination of nearly all of the specimens in their study.

The results of both studies suggest a high correlation rate between the middle meatal and ethmoid and/or maxillary sinus cultures but nasal contamination seems to be the major problem of transnasal sampling.

Several authors used different methods to minimize contamination from the vestibule while obtaining ethmoidal specimens. Obtaining cultures in sterile conditions and using a sterile nasal speculum did not eliminate nasal contamination in previous studies (Gold and Tami, 1997; Jiang et al., 1997; Orobello et al., 1991). We modified the technique of Jiang et al. in this study. Jiang et al. (1997) put a sterile cannula into the ethmoid sinus and passed a cotton tipped swab through it. This technique still carries the risk of nasal contamination during the introduction of the swab into the cannula; therefore the culture must be obtained under sterile conditions. In order to minimize contamination, we sterilized the swab and the cannula together. This technique can be used easily even in the office for obtaining middle meatal cultures.

The microbiological results of our study suggest that we have prevented contamination from the vestibule to a high degree. *Staphylococcus epidermidis* was isolated in only 14 of the 386 specimens (3.6%). This rate is quite small in comparison to the other studies in which transnasal sampling was used for ethmoid sinus or middle meatal cultures (Gold and Tami, 1997; Orobello et al., 1991). Jiang et al. (1997) also reported that they had reduced the isolation rate of *Staphylococcus epidermidis* when they used a sterile cannula while obtaining cultures from the ethmoid sinus.

Staphylococus aureus was the most commonly encountered microorganism in our study (Table 2). It was one of the most frequent isolates in many studies performed by different authors (Doyle and Woodham, 1991; Gold and Tami, 1997;

Muntz and Lusk, 1991; Şfiener et al., 1996; van Cauwenberge et al., 1993). We isolated anaerobes in 31.2% of ethmoid sinus cultures. This rate was 6% in the study of Muntz and Lusk (1991). Doyle and Woodham (1991) did not isolate any anaerobes from the ethmoid sinuses of 59 patients with chronic sinusitis whereas Brook and Yocum (1995) recovered them from all of the 40 children with chronic sinusitis. Our results indicate that aerobes constitute the major pathogens of chronic sinusitis, but anaerobes may contribute the disease process; and if they do so, appropriate antibiotics must be administered. We found a correlation rate of middle meatus and ethmoid sinus bacteriology of 91.2% in our study. Administration of preoperative antibiotics probably does not have an influence on the correlation rate of middle meatus and ethmoid sinus cultures because they probably affect both sites equally. This rate is similar to the results of Orobello et al. (1991) and Gold and Tami (1997). Obtaining middle meatal cultures from patients with chronic sinusitis and administering appropriate antibiotics may be possible in this manner.

Our method of sampling is easy, minimizes contamination and is non-invasive, so middle meatal sampling can easily be performed in the office on the first admission of the patient. Furthermore, bacterial eradication may be investigated by middle meatal cultures at the end of the therapy. Culture-directed therapy of chronic sinusitis is cost-effective, may minimize antibiotic failure and the development of bacterial resistance, and may increase the effectiveness of antibiotic therapy.
There is still a need for a study whether or not specific antibiotic therapy increases the success rate of the medical treatment of chronic sinusitis. Administering appropriate antibiotics for an appropriate period of time may eliminate the bacterial infection and may help the chronic changes of the sinus mucosa to return to normal. In this way, a smaller number of patients may require surgical therapy for the disease.

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