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Predictive value of nasal bacterial culture for etiological agents in acute maxillary sinusitis

S. Savolainen, J. Ylikoski and H. Jousimes-Somer, Helsinki, Finland

SUMMARY

Nasal secretion, aspiration yield and lavage content from the sinus were studied for bacteria in 175 patients (247 sinuses) with acute maxillary sinusitis. The same pathogen was cultured from the nose and aspiration fluid in 91% of cases of acute purulent sinusitis. This indicated a significant predictive value of the nasal bacteriological culture for presence of pathogenic bacteria in the sinus in purulent cases. In cases with no growth of pathogens in the aspirate, the nasal culture showed pathogenic bacteria in about 50%. Examination of the aspiration fluid may occasionally give false negative result in purulent maxillary sinusitis (at least 3% in the present series). In these cases, culture of the irrigation yield may prove helpful.

INTRODUCTION

Viral infection, popularly referred to as common cold is the most frequent cause of inflammation of the upper respiratory tract in wintertime in cold climate. In its uncomplicated form common cold is a usually self-limited and harmless illness. In some individuals, however, the inflammatory reaction associated with common cold is more severe and spreads from the nasal cavity to the mucous membranes of the paranasal sinuses. Due to superinfection by pathogenic bacteria, acute sinus inflammation may develop into a serious infectious disease. Acute purulent sinusitis may be difficult to recognize clinically, because symptoms are often diffuse, e.g. general malaise, tiredness, fever. Not infrequently, the most prominent symptoms come from the lower respiratory tract, e.g. cough, and the disease may initially be erroneously diagnosed as bronchitis or pneumonia. From a clinical point of view it is important to reach the differential diagnosis between inflammatory sinusitis, which often gives typical sinus symptoms (facial pain, frontal headache, pressure), and the more serious disease of purulent sinusitis at an early stage.

The diagnosis of sinusitis is based on history, clinical rhinoscopic findings, radiological and ultrasonographic examination and findings on irrigation of the sinus. Aspiration of the maxillary sinus is advocated as a diagnostic aid, particularly in the differentiation between purulent and non-purulent sinusitis (Carenfelt,

1982). Aspiration is also a reliable method for obtaining sinus secretion for bacteriological examination, which ideally should be the basis on which antimicrobial medication is chosen. In many instances, however, sinus puncture cannot be performed for various reasons. The question arises, whether bacteriological examination of the secretion in the nasal cavity could be useful in these cases. This question has earlier been studied in chronic maxillary sinusitis by Palva et al. (1962) and Kessler (1968) and in acute maxillary sinusitis by Lystad et al. (1964) and Axelsson and Brorson (1973). Most of these studies reported fairly low correlations between pathogenic bacteria in the nose and maxillary sinus. The purpose of the present study was to make further analyses of the bacterial flora in the nose and sinuses of patients with acute maxillary sinusitis (AMS) to assess whether nasal findings had a predictive value for etiological agents in maxillary sinusitis.

SUBJECTS AND METHODS

The study was carried out in 175 patients with acute maxillary sinusitis. The patients were mainly young men, aged 18–26 years (army conscripts). None of the patients had had symptoms for more than three weeks and acute maxillary sinusitis was verified by radiological examination. No patient had received antimicrobial treatment during the two weeks preceding enrollment in the study. At anterior rhinoscopy a sample of visible nasal secretion was taken with a sterile cotton swab, soaked in activated charcoal carefully avoiding contamination from the nasal vestibule. The sample was placed in modified Stuart's transport medium (Transpocult, Orion Diagnostica, Helsinki, Finland). The aspiration sample was sucked into a 20 ccm syringe through a 2.0 mm diameter puncture needle. If aspiration was negative, the needle was kept in place and 1–2 ccm of sterile saline was injected through it into the antrum and then aspirated again. The syringes were carefully plugged and all collected samples were taken within ten minutes to the bacteriological laboratory where they were processed immediately. A sample of the lavage content was also obtained on sinus irrigation with physiological saline. The macroscopic appearance of the aspiration and irrigation yields was recorded. In the laboratory the samples were inoculated on to blood and chocolate agar plates for aerobic bacteria and on to vitamin K1- and hemin-supplemented nonselective and selective Brucella agar for anaerobes and into thioglycollate broth for enrichment. Aerobic plates were incubated at 36° C in 5% CO_2 for 48 hours and anaerobic plates up to 7 days in anaerobic jars filled with mixed gas containing 10% H_2, 10% CO_2 and 80% N_2. Thioglycollate broth was subcultured aerobically and anaerobically, when growth appeared. Gram stained smears were prepared from aspirates and irrigates.

RESULTS

Bacterial findings

The disease was bilateral in 72 of the 175 patients and bacteriological analyses were thus performed in a total of 247 sets of secretion sample, aspirate and irrigate. Pathogenic bacteria were isolated from 181 aspirates (73%) while 66 aspirates (27%) showed normal flora or no growth of pathogens (Table 1). In nine of the pathogen-negative cultures there was a weak growth of non pathogenic bacteria, which was considered to represent contamination from the nasal cavity during the puncture. The results of bacterial cultures are reported in detail in another study (Jousimies-Somer et al., 1987). Haemophilus influenzae (Hi) was by far the commonest of the pathogens, followed by Streptococcus pneumoniae (Pn), a combination of these two bacteria, and Streptoccus pyogenes (Sp). Branhamella catarrhalis (Bc) was the next most common species (Table 2). The same pathogenic bacteria were found in about the same relative frequency in the cultures from nasal secretion and irrigate (Table 1) and pathogenic bacteria were clearly more frequent in these samples than in aspirates. Thus only 47 irrigates (19%) and 32 nasal secretion samples (13%) were pathogen-negative on culture (Table 1). All samples from nasal secretion and more than 90% of the irrigates grew bacteria belonging to normal nasal flora (NF).

Table 1. Acute maxillary sinusitis; results of bacterial cultures ($N = 247$).

culture	aspirate	irrigate	nasal secretion
pathogenic bacteria (Hi, Pn, Sp or Bc)	181	205	220
Normal flora (NF)	10	47	32
negative	56	0	0

Correlations between bacterial findings

Aspirate, irrigate and nasal secretion cultures from the same side were positive for the same pathogens in 137 instances (76% of all purulent cases) (Table 2). The same pathogen as in the aspirate plus one more pathogen were cultured from the irrigate and/or nasal secretion in 15 cases. In 4 cases the aspirate showed two pathogens but irrigate and nose only one of these. In 8 cases a pathogen was isolated from the aspirate and the nose while the irrigate showed NF only. Thus, the same pathogen was present both in the aspirate and in the nose in 164 instances of all 181 cases of purulent infection (91%). In 2 cases the pathogen found in the nose was not the same as the one cultured from aspirate or irrigation (false positive). In 15 cases, finally, a pathogen grew in the aspirate and irrigate while the culture from the nose was negative for pathogenic bacteria (false negative).

Table 2. Acute purulent maxillary sinusitis; comparison of bacterial findings in aspirate, lavage content and nasal secretion of the same patient, $N = 181$ (73%).

	aspirate	irrigate	nasal secretion	*N*	%
same pathogen at all 3 sites $N = 137$ (57%)	Hi	Hi	Hi	86	35
	Pn	Pn	Pn	24	10
	Sp	Sp	Sp	12	5
	Hi + Pn	Hi + Pn	Hi + Pn	11	4.5
	Sp + Hi	Sp + Hi	Sp + Hi	1	0.5
	Bc	Bc	Bc	3	1.0
same pathogen + 1 more pathogen in irrigate and/or nose, $N = 15$ (6%)	Hi	Hi or Hi + Pn	Hi or Hi + Pn	10	4
	Pn	Pn or Pn + Hi	Pn or Pn + Hi	5	2
Two pathogens in aspirate, only 1 of them in irrigate or nose, $N = 4$ (1.5%)	Hi + Pn	Hi + Pn or Hi	Pn or Hi or Hi + Pn	4	1.5
pathogen in aspirate and nose, but NF in irrigate, $N = 8$ (3.5%)	Hi	NF	Hi	6	2.5
	Pn	NF	Pn	1	0.5
	Sp	NF	Sp	1	0.5
different pathogen in aspirate and nose $N = 2$ (1%)	Hi	Hi + Pn	Pn	1	0.5
	Bc	Bc	Hi	1	0.5
pathogen in aspirate and irrigate, NF in nose, $N = 15$ (6.5%)	HI	Hi	NF	12	5
	Pn	Pn	NF	1	0.5
	Hi	Pn	NF	1	0.5
	Hi	Bc	Bc	1	0.5

Table 3. Acute maxillary sinusitis; bacterial findings in the irrigate and nasal secretion in cases with pathogen-negative aspirates, $N = 66$(27%).

aspirate	irrigate	nasal secretion	*N*	%
negative	NF	NF	23	9.5
negative	NF	Hi or Pn	7	3
negative	pathogen	pathogen	23	9.5
negative	Hi	NF	3	1
NF	NF	NF	6	2.5
NF	NF	NF + pathogen	3	1
NF	NF + pathogen	NF + pathogen	1	0.5

Table 3 summarizes the findings of bacterial cultures from the irrigate and nose in the 66 cases which showed no growth of pathogenic bacteria in the aspirate. In 23 cases both the irrigate and nasal secretion also showed NF only. In another 23 cases pathogens were cultured both from the irrigate and the nose and in 3 cases showing Hi in the irrigate, only NF was isolated from the nose. In the 10

cases in which the aspirate showed growth of NF 9 of the irrigates also had NF only but one showed Hi + NF. Of the corresponding secretion cultures 4 were positive for NF + Hi while the remaining 6 showed NF.
A separate analysis was made of the ten cases in which the aspirate showed no growth of pathogenic bacteria but irrigation yielded yellowish, purulent-looking secretion which was positive for a pathogen. In 8 of the patients aspiration of the opposite side gave purulent secretion and profuse growth of a pathogen (usually Hi) was observed in the cultures from all three locations. These 8 sinuses were considered to have purulent sinusitis although sinusitis was not revealed by culturing the aspirate alone. Thus, bacteriological examination of the aspirate alone may occasionally – in this series in 3% – give a false negative result. Examination of the irrigation yield may then be helpful in deciding whether the infection is purulent or not.

DISCUSSION

Earlier bacteriological studies have provided conclusive evidence that staphylococci, both S. aureus and S. epidermidis are nonpathogenic organisms in the nasal cavity and, when found in sinus cultures, most probably contaminants from the nose (Björkwall, 1950; Palva et al., 1962; Kessler, 1968; Axelsson and Brorson, 1973; Hay and Mullard, 1972; Jousimies-Somer et al., 1987). Therefore, the pathogens that can cause purulent sinusitis are in effect brought down to three, Pn, Hi and Sp (Björkwall, 1950; Lystad et al., 1964; Axelsson and Brorson, 1972; Savolainen et al., 1986). Recent studies have suggested a pathogenic role for Branhamella catarrhalis in a number of clinical infections, particularly those of the respiratory tract (Hamory et al., 1979), including sinusitis (Brorson et al., 1976; Chapman et al., 1985).
There are only few studies on the predictive value of the bacteriological examination of the nasal secretion in evaluating the pathogenic organism responsible for acute sinusitis. Lystad et al. (1964) concluded that nasal samples for bacteriological examination gave valuable information about the bacteria causing sinusitis.Axelsson and Brorson (1973) found the same organisms in nasal and sinus secretions of patients with sinusitis in only 64%, and concluded that nasal samples were of low predictive value in reflecting sinus flora. Nasal swab cultures correlated poorly with cultures from the sinus aspirate in a study by Gwaltney et al. (1981).
These studies demonstrated a predominance of Pn in sinus aspirates. Hi was the second most common microbe and next in frequency were anaerobic bacteria, which were not found in any of our cases. We have recently analysed aspirates in another somewhat larger group and anaerobic bacteria were isolated from five cases (2%) (Jousimies-Somer et al., 1987). The proportion of aspirates with no growth was similar in the studies mentioned above and in our series (about 25%),

but findings in the nasal secretion differed markedly. Axelsson and Brorson (1973) reported no growth in 25%, whereas all nasal cultures in our study were positive for at least one microorganism. This difference between results of nasal cultures probably reflects methodological differences (e.g. enrichment culture), because Axelsson and Brorson also reported negative nasal cultures for 10% of healthy controls and we have found that at least one microorganism could be recovered from nasal secretion in normals (Savolainen et al., 1986).

In the present material the cultures from nasal secretion and sinus aspirate demonstrated the same pathogenic bacteria in all but 17 cases of purulent sinusitis. Thus the microbe responsible for purulent infection of the sinus could be predicted from the nasal sample for 164 out of 181 sinuses (91%). False negative results (no or irrelevant bacteria cultured from the nose but pathogen from the aspirate) were seen in only 9%.

In cases with no growth of pathogenic bacteria in the aspirate, the nasal secretion sample from the same side demonstrated pathogenic bacteria in 34 out of 66 cases (51%). Thus, about half of the nasal cultures showed false positive results in cases with non-purulent or inflammatory sinusitis and nasal culture alone was not of great predictive value in evaluating whether a sinusitis was purulent or non-purulent. On the other hand, growth of pathogenic bacteria in the nasal secretion almost invariably indicates a purulent infection in the nasal cavity, because pathogens are found in the healthy nose only in about 5% (Axelsson and Brorson, 1973; Savolainen et al., 1986).

In many cases in which the aspirate was negative for pathogens, initial aspiration dit not yield any secretion, and an aspirate was obtained only after injection of physiological saline into the sinus through the puncture needle. This method has been shown not to be 100% accurate (Axelsson and Brorson, 1973). In the present material eight sinuses with negative aspiration were considered to have aspirate from the opposite sinus of the patients. This would mean that cultures from the aspirate gave false negative results in 3% of the cases.

ZUSAMMENFASSUNG

Nasale Sekretion, Aspirationsergebnisse und Spulungsinhalt von dem Sinus maxillaris wurden in Bezug auf Bakterien bei 175 Patienten (247 Sinus) mit akuter Sinusitis maxillaris untersucht. Dieselbe pathogene Bakterie wurde aus der Nase und der Aspirationsflüssigkeit bei 91% von den Fällen von akuter purulenter Sinusitis gezuchtet. Dieses deutete auf einen signifikanten prädiktiven Wert von der nasalen bakteriologischen Zuchtung bei der Feststellung des Vorhandeseins pathogener Bakterien in dem Sinus maxillaris bei purulenten Fällen. In Fällen, wo kein Wachstum von pathogenen Bakterien in der Aspirate festzustellen war, wies die nasale Zuchtung pathogene Bakterien in ungefähr 50% nach.

Die Untersuchung der Aspirationsflüssigkeit kann zufälligerweise in Fällen von purulenter Sinusitis maxillaris ein falches negatives Resultat geben (wenigstens 3% in der vorhandenen Serien). In diesen Fälllen könnte eine Zuchtung der irrigationsergebnisse von Hilfe sein.

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Jukka Ylikoski, M.D.
Asematie 27 B
SF-02700 Kauniainen
Finland