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A Changing Pattern of Bacterial Flora in Empyema of the Maxillary Sinus[1,2]

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= Abstract = The bacterial flora of empyema of the maxillary sinuses in 100 patients were studied. Patients' age ranged from 15 to 58 : 65 were males and 35 were females. Aseptic collection of the pus material from only one of the maxillary sinuses was made when the patients were under local anesthesia for Caldwell-Luc operation. All samples were cultured for both aerobes and anaerobes. At least one type of organism was isolated in 96 patients and in the remaining 4, no bacterial growth was obtained after 2 weeks of cultivation.

Aerobes were isolated in 76 patients, either alone (52), or mixed with other aerobe(s) (15) or anaerobe(s) (9). Anaerobes were isolated in 29 patients, either alone (13), or mixed with other anaerobe (7). There were 95 aerobic isolates and the predominant ones were: 31 coagulase-negative Staphylococci (24.6%), 28 Streptococcus viridans (22.2%), and 5 Corynebacterium species (4.0%). There were 31 anaerobic isolates and the predominant ones were: 6 Propionibacterium acnes (4.8%), and 4 each of Bacteroides species, Peptococcus species, Bacillus corrodens, Streptococcus intermedius (3.2% each).

The presence of aerobic and anaerobic organisms in empyema of the maxillary sinus suggested that anaerobic organisms could play a significant role in its pathogenesis. There appears to be a changing trend in the bacterial flora of chronically inflamed paranasal sinuses. It is plausible that this change may have been brought by the increased awareness of significance of anaerobic bacteria, better methods of cultivation, and the emergence of resistant strains to conventional antimicrobial agents.

Key words: ***Bacteriology, Empyema, Maxillary sinus, Maxillary sinusitis***

INTRODUCTION

The bacteriological characteristics of chronic maxillary sinusitis have been widely studied with varying results. The reason for this variability has been attributed by some to different sampling method, transportation and culture techniques than in real differences of bacterial flora (Palva *et al.* 1962). Furthermore, newer and more sensitive bacteriological methods, especially those dealing with anaerobic organisms, have brought more confusion in attempts to define the correct pathogens.

To avoid undesirable nasal contamination from various antral puncture techniques, the bacterial specimen should be taken directly from the diseased maxillary sinus (Su *et al.* 1983). Some investigators have done this by directly obtaining the samples during Caldwell-Luc operation. Poor drainage of the chronically inflamed maxillary sinus reduces the antral pO_2 (Carenfelt 1979). It has been suggested that anaerobic bacteria may play a signi-

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ficant role in the pathogenesis of chronic maxillary sinusitis (Brook *et al.* 1981; Carenfelt 1978; Frederick *et al.* 1974; Su *et al.* 1983), especially in empyema.

The purpose of this study is to establish bacterial findings in patients with empyema of the maxillary sinus in view of the duration of symptoms and intraoperative findings. Special care has been taken for possible anaerobic infection which has been suggested as one of the significant pathogens by recent investigations.

MATERIALS AND METHODS

One hundred patients (65 males and 35 females) with empyema of at least one of the maxillary sinuses were studied. Their ages ranged from 15 to 58, and all of them underwent Caldwell-Luc's procedure at Seoul National University Hospital from March to December 1986. No preoperative antibiotics had been used and none of the patients yielded any history of previous treatment with antibiotic regimen, at least within 8 weeks of sampling.

Samples were obtained intraoperatively from one of the maxillary sinuses when the patients were under local anesthesia for Caldwell-Luc operation. Gram's stain was taken and undiluted antral discharge was aspirated with air-expelled syringe immediately after creating antral window in the canine fossa. Any gas was expelled from the collecting syringe and the syringe was sealed air-tight with rubber stopper. All specime were inoculated in culture media within 15 minutes of collection.

Sheep blood agar plate, McConkey agar plate, and chocolate agar plates were used for the cultivation of aerobic bacteria. Brucella blood agar plate and phenyl-ethyl alcohol media were used for anaerobic bacteria. All media were incubated at 37°C for 48-72 hrs and in case of anaerobes, they were kept under gaseous environment consisting of 85% N_2, 5% CO_2, 10% H_2 (V/V %). In case they did not yield any growth after 72 hours of initial cultivation, the specimens were incubated for 2 weeks more. Thus, samples were regarded as being sterile after 1 week of cultivation in aerobes and after 2 weeks of cultivation in anaerobes. Gram's stain preparations were made of all specimens. The specimens were handled, analyzed and identified as described earlier (Lennette *et al.* 1985).

Table 1. Bacteriological categories in the specimens obtained by Caldwell-Luc's procedures in empyema of the maxillary sinus

Bacteriological Category	No. of Specimen
No growth	(4)
Single	(65)
aerobe	52
anaerobe	13
Mixed	(31)
aerobes	15
anaerobes	7
both aerobe(s) and anaerobe(s)	9

RESULTS

A total of 126 strains were isolated either alone or in combination with other strains and it is presented in Table 1. Aerobic bacteria were isolated from 76 sinuses, either alone (52), or mixed with other aerobe(s) (15) or anaerobe(s) (9). Anaerobes were isolated in 29 sinuses, either alone (13), or mixed with other anaerobe(s) (7). In 4 sinus aspirates, no bacterial growth was obtained after 2 weeks of cultivation.

Becterial findings demonstrated predominance of Gram-positive aerobes (73%), consisting of 31 strains of coagulase-negative Staphylococcus, 28 strains of Streptococcus viridans, and 5 strains of Corynebacterium species (Table 2). The predominant Gram-negative strains included Klebsiella, Neisseria, and Enterobacter (Table 3). In the category of anaerobes (31%), however, there was no significantly predominant single species (Table 4). They marked a rather even distribution among Propionibacterium acnes, Bacteroides species, Peptococcus species, Bacillus corrodens, and Streptococcus intermedius.

Table 2. Gram positive aerobic strains isolated in empyema of the maxillary sinus

Coagulase-negative Staphylococcus	31
Streptococcus viridans	28
Corynebacterium spp.	5
Staphylococcus aureus	4
Streptococcus pneumoniae	3
Enterococcus	2
Total	73

Table 3. Gram negative aerobic strains isolated in empyema of the maxillary sinus

Klebsiella	6
Neisseria	4
Enterobacter	4
Pseudomonas	3
E. coli	2
Acinetobacter	2
Salmonella arizonae	1
Total	22

Table 4. Anaerobic strains isolated in empyema of the maxillary sinus

Propionibacterium acnes	6
Streptococcus intermedius	4
Bacillus corrodens	4
Peptococcus	4
Bacteroides	4
Lactobacillus acidophilus	3
Fusobacterium	3
Unidentifiable G(+) strains	3
Total	31

Table 5. Bacterial analyses by different investigators

	C.W.Lee(1967)	I.M.Lee(1977)	K.S.Lee(1981)	Present study
Coagulase(−) Staph.	6.7	7.0	13.2	31.0
Strep. viridans	5.3	6.0	13.8	28.0
Staph. aureus	9.3	10.0	6.6	4.0
Strep. pneumoniae	29.3	2.0	13.2	3.0
Klebsiella	4.0	2.0	--	6.0
Neisseria	5.3	—	—	4.0
Psedomonas	—	4.0	2.0	3.0
E. coli	—	3.0	1.0	2.0
H. influenzae	48.7	25.0	4.0	—

Note: Above percentages are derived from dividing the numbers of common aerobic strains by total numbers of sinuses studied.

When we tried to correlate the bacterial findings with clinical characteristics, such as duration of symptoms, color of the pus material, and mucosal changes (observed intraoperatively), no statistically significant difference was found in all groups.

DISCUSSION

The bacteriology of chronic sinus infection has varied widely in most published series. Obtaining the appropriate causative agent was difficult because of the question of whether or not the bacterial findings are influenced by the type and method of specimen collection (Frederick and Braude 1974; Palva *et al.* 1962; Su *et al.* 1983). In 1962, Palva *et al* reviewed reports up to that time and difference in bacterial flora. Antral washings or nasal punctures with irrigation were prone to contamination with residental nasal flora. In this study, specimens were obtained from Caldwell-Luc procedures to eliminate this problem. And interest was focused on isolation of anaerobic bacteria, which could play a significant role in the pathogenesis of empyema of the maxillary sinus. The most important bacteriological findings in recent studies conducted in this country were summarized in Table 5. Although earlier reports (Lee 1967; Lee *et al.* 1977; Lee *et al.* 1981) did not consist of anaerobic cultures and their methods of sampling differed from our present study, they may be regarded as being pertinent for the purpose of comparing the trend in bacterial isolates over time. Coagulase-negative Staphylococcus and Streptococcus viridans are increasingly detected as the periods of studies approach the present one. In the analysis conducted by Lee, C.W. in 1967, only 6.7% and 5.3% of respective species were isolated. As these figures are compared to our present study (31.1% and 28.0% respectively), and taking into consideration of the fact that Lee, I.M. (1977) and Lee,

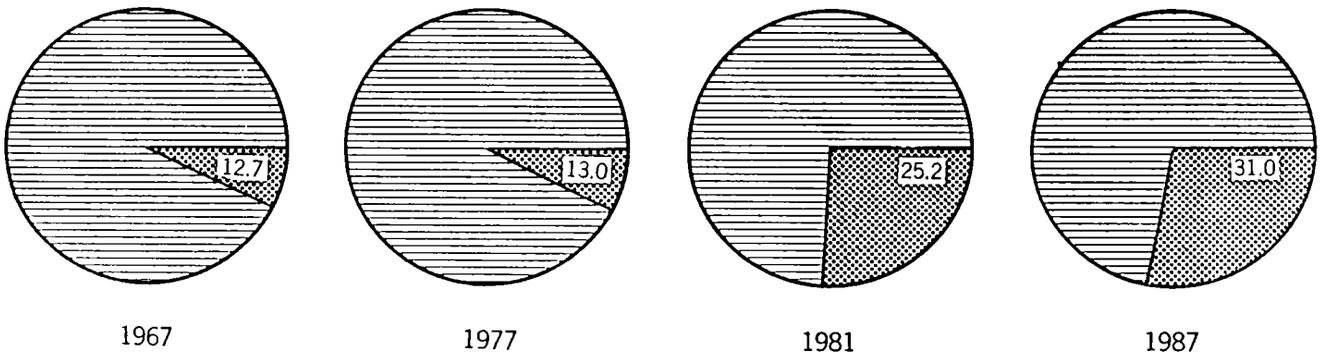

Fig. 1. Changing patterns of anaerobic isolates in maxillary sinusitis in Korea.
Note: Above percentages are derived from dividing the numbers of anaerobic strains by total numbers of sinuses studied.

K.S. (1981) are reporting these organisms in increasing frequency, it is apparent that there has been a change in the significance of these species in the pathogenesis and/or maintenance of the chronic disease process in the maxillary sinus. Similarly, Streptococcus pneumoniae and H. influenzae are the two bacteria that are being less frequently isolated.

Aerobes were identified in studies where appropriate techniques were employed (Lee 1967; Lee *et al.* 1977; Lee *et al.* 1981), however, fastidious methods of collection and transportation were not always observed. In more recent studies in which improved techniques of cultivation were employed, anaerobes were recovered in large numbers (Brook 1981; Su *et al.* 1983). In one study involving healthy sinuses (Brook 1981), anaeorbic organisms were isolated from all of the sample sinuses. Although the issue of presence of normal anaerobic flora in the paranasal sinus still remains controversial (Su *et al.* 1983), it is plausible that anaerobes could contribute significantly to the pathogenesis and/or maintenance of chronic inflammations of the paranasal sinuses (Carenfelt 1977; Su *et al.* 1983).

Poor drainage of the chronically inflamed maxillary sinus reduces the antral pO_2 (Carenfelt 1979); thus, this facilitates the growth of anaerobic bacteria. It is conceivable that the reduced oxygen tension in the sinus during the serous phase better meets the requirements for the growth of those bacteria isolated in acute sinusitis, while the complete lack of oxygen in the purulent stage supports the growth of the anaerobic organisms recovered in chronic sinusitis (Brook 1981; Carenfelt 1979). However, our analysis showed that bacteriological finding was essentially the same, irrespective of duration of symptoms, pus color, and appearance of mucosal changes. Therefore, the symptoms and intraoperative findings gave no clue to suggest the causative microorganism. This does not diminish the importance of anaerobic organisms as one of the pathogens in chronic inflammation of the paranasal sinus. In previous studies concerning the bacteriology of chronic maxillary sinusitis (Palva *et al.* 1962; Lee 1967; Lee *et al.* 1977; Lee *et al.* 1981), little attention has been paid on cultivation of anaerobic bacteria. If we can safely assume that sinuses that did not yield any organism in previous other studies could have been due to anaerobic infection, an increasing trend in the rate of anaerobic isolation can be observed (Fig. 1). The question whether this reflects the increased awareness in the part of the investigator or a true increase in the significance of anaerobes in the pathogenetic mechanism still remains to be elucidated.

There appears to be a changing trend in the bacterial flora of chronically inflamed paranasal sinuses. With increasing awareness of significance of anaerobic bacteria, better methods of cultivation, and possibly with the emergence of new generations of antimicrobial agents, anaerobic organisms are recovered in greater quantity in recent studies. Preliminary studies fail to disclose the relationship between anaerobic infection and clinical characteristics and the precise pathogenetic mechanism in relation to clinical findings remains to be studied.

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= 국문초록 =

상악동 축농에서의 세균학적 연구

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민양기 · 신진성

상악동 축농으로 확진된 100명의 환자를 대상으로 세균배양을 시행하였다. 환자의 연령은 15세에서 58세의 범위에 있었으며 65명은 남자환자, 35명은 여자환자이었다. Caldwell-Luc 수술중에 무균적으로 상악동에서 농을 채취하여 호기성 및 혐기성 세균 배양을 실시하였다. 96명의 환자에서 최소 1균주가 배양되었으며, 나머지 4명의 환자에서는 2주일간의 배양후에도 균주가 발견되지 않았다.

76명의 환자에서 호기성 세균이 배양되었다. 이중 52명에서는 1균주만이 배양되었고, 15명에서는 다른 호기성 세균이 혼합 배양되었으며, 9명에서는 혐기성 세균이 혼합 배양되었다. 혐기성 세균이 배양된 환자는 모두 29명이었으며, 이중 13명에서는 1균주만이 동정되었으나 7명에서는 다른 혐기성 세균이 혼합배양 되었다. 호기성 세균은 coagulase(−) Staphylococcus가 가장 많이 동정되었으며, 그 다음은 Streptococcus viridans, Corynebacterium의 순서로 배양되었다. 혐기성 세균에 있어서는 Propionibacterium acnes가 가장 많이 동정되었고, 그 다음은 Bacteroides, Peptococcus, Bacillus corrodens, Streptococcus intermedius의 순서로 배양되었다.

상악동 축농에서 호기성 세균과 혐기성 세균의 검출은 혐기성 세균이 이 질환의 병인에 있어서 중요한 역할을 하고 있다는 사실을 시사하고 있다. 연대별로 비교 고찰하여 볼때 상악동 축농을 일으키는 세균이 달라지고 있는 양상을 보이고 있으며, 여기에는 세균 배양 기술의 발달, 혐기성 세균에 대한 관심의 증가, 그리고 항생물질의 남용에 의한 내성 균주의 출현 등 여러가지 요인을 생각할 수 있다.

(본 논문의 게재는 신광신약의 도움으로 이루어졌음)