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# Clinical study on bacteria detected in the upper and lower respiratory tracts in patients with sinobronchial syndrome

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SUMMARY

*The authors examined bacteria to confirm the pathogenesis of sinobronchial syndrome (SBS). There were several theories such as the pus-descending, the pus-ascending, the coinciding theory and so on. Detection of bacteria was performed in SBS patients, empyema patients with no lower respiratory disease, and healthy adults. Considering SBS bacteriologically from the obtained results, the authors consider that internal infections of aerobic gram-negative bacteria of the normal flora mainly including Haemophilus influenzae possibly develop in two directions, downward and upward (into nasal cavities) from the pharynx, and so the pathogenesis of SBS might not be explained satisfactorily by either the ascending or the descending theory alone.*

## INTRODUCTIONS

Sinobronchial syndrome (SBS) is defined as a syndrome of chronic paranasal sinusitis (empyema) and non-specific chronic bronchial diseases such as chronic bronchitis, bronchiectasia, and diffuse panbronchiolitis (DPB). Concerning the pathogenesis of this syndrome, there are several theories such as the pus-descending theory, the pus-ascending theory, the coinciding theory and so on. But they are not confirmed.

This is the report of a bacteriological study of the pathogenesis of SBS in which bacteria detected in the upper and lower respiratory tracts of SBS patients were compared with those in the upper respiratory tracts of empyema patients with no lower respiratory disease and healthy adults.

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## SUBJECTS AND METHODS

The subjects include 35 SBS patients (20 males, 15 females), whose average age is 61 years, and whose bronchial diseases include bronchiectasia (15), chronic bronchitis (5), DPB (8), and unknown diseases (7). The control group include 25 empyema patients without lower respiratory diseases (20 males, five females) whose average age is 40.1 years and eight healthy adults (seven males, one female) whose average age is 33.9 years.

Bacteria were detected in the maxillary sinus, the middle nasal meatus, the inferior nasal meatus, the epipharynx, the mesopharynx and the trachea. Transtracheal aspiration (TTA) was performed only in SBS patients. Bacteria from the maxillary sinus were obtained by puncture of the lateral wall of the inferior nasal meatus with a Schmidt needle in SBS patients, and by aspiration during operation in empyema patients. Bacteria were detected from the other upper respiratory tracts by using sterile cotton swab. Anaerobic porters made by the Clinical Supply Company in Japan were used in order to preserve bacteria, and bacteria were classified into aerobic bacteria, anaerobic bacteria, and fungi. TTA was performed by the Sawaki's method (1983), i.e. puncture and aspiration through the space between the thyroid and the cricoid cartilage with a 16 G venula indwelling needle.

## RESULTS

### 1. *Bacteria in the maxillary sinus*

In the 10 sides of SBS patients and 33 sides of empyema patients, no bacterium was detected in 70% of the SBS patients and 48% of the empyema patients. In the SBS patients no anaerobic bacterium was detected. 33% of aerobic bacteria were gram-positive and the other (67%) were gram-negative, including Pseudomonas. In empyema patients gram-positive aerobic bacteria accounted for 61% of isolates (Table 1).

### 2. *Bacteria in the middle nasal meatus*

The examined sites include 48 sides of SBS patients, 21 sides of empyema patients, and eight sides of the normal. In the normal cases only aerobic gram-positive bacteria were detected. There was no difference between SBS patients and empyema patients concerning the gram-negative and positive ratio of the aerobic bacteria, but in SBS patients seven strains of Haemophilus, a high rate of 10%, were detected. In empyema patients, on the other hand, anaerobic bacteria were detected at a high rate of 20% (Table 2).

### 3. *Bacteria in the inferior nasal meatus*

The examined sites include 19 sides of empyema patients and seven sides of the normal. In the normal cases only aerobic gram-positive bacteria were detected in

Table 1. Bacterial plexus of maxillary sinus.

| | SBS (10 sides) | Empyema (33) | normal |
|---|---|---|---|
| ORGANISMS(+) | | | |
| AEROBIC | 3 sides (30%) | 17 (52%) | |
| G(+) Staphylococcus | 1 strain | 6 | |
| aureus | (1) | (2) | |
| epidermidis | (0) | (4) | |
| Streptococcus | 1 | 8 | |
| pneumoniae | (0) | (4) | |
| viridans | (1) | (4) | |
| | 2 strains (33%) | 14 (61%) | |
| G(−) Haemophilus | 1 | 1 | |
| influenzae | (0) | (0) | |
| parainfluenzae | (1) | (1) | |
| Neisseria | - | 1 | |
| Pseudomonas | 2 | - | |
| Enterobacter | 1 | - | |
| | 4 strains (67%) | 2 ( 9%) | |
| ANAEROBIC | | | |
| Peptostreptococcus | | 5 | |
| Bacteroides | | 1 | |
| Veillonella | | 1 | |
| | | 7 (30%) | |
| ORGANISMS(−) | 7 sides (70%) | 16 (48%) | |

the middle nasal meatus. In empyema patients aerobic gram-positive bacteria occupied 67%, but aerobic gram-negative ones, mainly Klebsiella occupied 21%, and anaerobics ones 12%. In SBS patients detection of bacteria was performed only in the middle nasal meatus, because the previous study showed that the flora of the middle nasal meatus is the same as that of the inferior nasal meatus (Table 3).

4. *Bacteria in the epipharynx*

Samples were taken from 16 SBS patients, three empyema patients and seven normal subjects. In SBS patients the detection rate of aerobic gram-positive bacteria was 64%, a high rate, and that of Haemophilus was about 10% in each group. There was no difference among the groups (Table 4).

5. *Bacteria in the mesopharynx*

Samples were taken from nine SBS patients, three empyema patients and eight normal subjects. Only aerobic bacteria and Candida were detected in each group. Non-pathogenic bacteria of the normal flora such as Staphylococcus epidermidis,

Table 2. Bacterial plexus of middle meatus.

| | SBS (48 sides) | Empyema (21) | normal (8) |
|---|---|---|---|
| ORGANISMS(+) | | | |
| AEROBIC | 44 sides (92%) | 20 (95%) | |
| G(+) Staphylococcus | 29 strains | 12 | 7 |
| aureus | ( 7) | (3) | (2) |
| epidermidis | (21) | (5) | (5) |
| Streptococcus | 7 | 9 | 1 |
| pneumoniae | ( 4) | (0) | (0) |
| viridans | ( 2) | (0) | (0) |
| Corynebacterium | 7 | – | – |
| Bacillus | 1 | – | – |
| | 44 strains (64%) | 21 (58%) | 8 (100%) |
| G(–) Haemophilus | 7 | 1 | |
| influenzae | (5) | (1) | |
| parainfluenzae | (2) | (0) | |
| Neisseria | 2 | 1 | |
| Pseudomonas | 1 | – | |
| Klebsiella | 2 | 2 | |
| Enterobacter | 1 | 1 | |
| Branhamella | 2 | 2 | |
| Eschelichia | – | 1 | |
| Proteus | 1 | – | |
| Citrobacter | 1 | – | |
| Acinetobacter | 1 | – | |
| | 18 strains (26%) | 8 (22%) | |
| ANAEROBIC | | | |
| Peptococcus | 2 | 4 | |
| Peptostreptococcus | 1 | – | |
| Bacteroides | – | 2 | |
| Veillonella | – | 1 | |
| | 3 strains ( 4%) | 7 (20%) | |
| CANDIDA | 3 | | |
| FUNGUS | 1 | | |
| | 4 strains ( 6%) | | |
| ORGANISMS(–) | 4 sides (8%) | 1 ( 5%) | |

Streptococcus viridans, and others were detected as gram-positive bacteria and Neisseria as gram-negative ones. There was no difference among the groups (Table 5).

6. *Bacteria in the trachea*

The samples include 33 specimens of sputum and 35 specimens obtained by TTA. In TTA specimens no Staphylococcus was detected, Streptococcus pneu-

Table 3. Bacterial plexus of inferior meatus.

| | Empyema (19 sides) | normal (7) |
|---|---|---|
| ORGANISMS(+) | | |
| AEROBIC | 18 sides (95%) | 6 (86%) |
| G(+) Staphylococcus | 15 strains | 6 |
| aureus | (5) | (1) |
| epidermidis | (8) | (5) |
| Streptococcus | 13 | 1 |
| pneumoniae | (6) | |
| viridans | (6) | |
| | 28 strains (67%) | 7 (100%) |
| G(−) Klebsiella | 4 | |
| Enterobacter | 1 | |
| Branhamella | 2 | |
| Eschelichia | 1 | |
| Citrobacter | 1 | |
| | 9 strains (21%) | |
| ANAEROBIC | | |
| Peptococcus | 2 | |
| Peptostreptococcus | 1 | |
| Bacteroides | 1 | |
| Veillonella | 1 | |
| | 5 strains (12%) | |
| ORGANISMS(−) | 1 side (5%) | 1 (14%) |

moniae occupied 17% (47 strains) of aerobic gram-positive bacteria and α-Streptococcus was 10%. On the other hand in aerobic gram-negative bacteria Haemophilus influenzae (28 strains) occupied 28%, Neisseria 11% and Pseudomonas 8%. Gram-negative bacteria occupied 69% of all bacteria and Haemophilus was prominent in the gram-negative bacteria (Table 6).

7. *The detective ratios of bacteria in each part of the airway in each group*

The detective ratios of bacteria are illustrated in Figure 1. In SBS patients the lower the examined airway was, the higher the ratio of aerobic gram-negative bacteria became. The gram-negative and positive ratio in the maxillary sinus was 20 versus 10, very similar to that of TTA (69 versus 27). In the maxillary sinus of empyema patients, aerobic gram-negative bacteria were significantly fewer and fungi were significantly more comparing with SBS patients. Bacteria detected in the epipharynx and in the mesopharynx revealed no difference among the SBS patients, the empyema patients and the normal subjects.

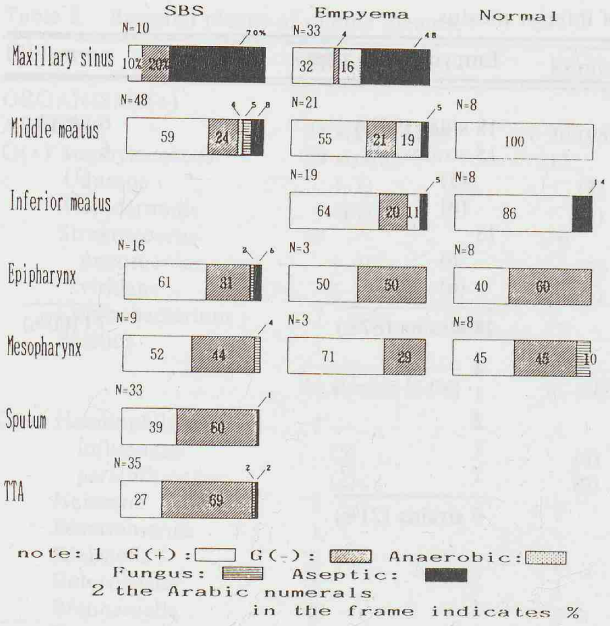


Figure 1. Comparison of bacterial strains in each respiratory tract among SBS, empyema, and normal subjects.

Table 4. Bacterial plexus of epipharynx.

| | SBS (16 cases) | Empyema (3) | normal (7) |
|---|---|---|---|
| ORGANISMS(+) | | | |
| AEROBIC | 15 cases (94%) | | |
| G(+) Staphylococcus | 5 strains | 1 | – |
| aureus | ( 2) | (0) | |
| epidermidis | ( 3) | (1) | – |
| Streptococcus | 20 | 3 | 4 |
| pneumoniae | ( 0) | (0) | (0) |
| viridans | (13) | (2) | (3) |
| Corynebacterium | 1 | – | – |
| Micrococcus | 1 | – | – |
| | 27 strains (64%) | 4 (50%) | 4 (40%) |
| G(–) Haemophilus | 4 | 1 | 2 |
| influenzae | ( 3) | (1) | (0) |
| parainfluenzae | ( 1) | (0) | (1) |
| Neisseria | 7 | 3 | 4 |
| Pseudomonas | 1 | – | – |
| Klebsiella | 1 | – | – |
| Branhamella | 1 | – | – |
| | 14 strains (33%) | 4 (50%) | 6 (60%) |
| CANDIDA | 1 strain ( 3%) | | |
| ORGANISMS(–) | 1 case ( 6%) | | |

Table 5. Bacterial plexus of mesopharynx.

| | SBS (9 cases) | Empyema (3) | normal (8) |
|---|---|---|---|
| AEROBIC | | | |
| G(+) Staphylococcus | 2 strains | 1 | – |
| aureus | (0) | (0) | |
| epidermidis | (2) | (1) | |
| Streptococcus | 11 | 4 | 5 |
| pneumoniae | (0) | (0) | (0) |
| viridans | (8) | (1) | (3) |
| | 13 strains (52%) | 5 (71%) | 5 (45%) |
| G(–) Haemophilus | 3 | – | 2 |
| influenzae | (1) | | (1) |
| parainfluenzae | (2) | | (1) |
| Neisseria | 6 | 2 (29%) | 3 |
| Pseudomonas | 1 | – | – |
| Klebsiella | 1 | – | – |
| | 11 strains (44%) | | 5 (45%) |
| CANDIDA | 1 strain ( 4%) | | 1 (10%) |

Table 6. Bacterial plexus of trachea and sputum in SBS patients.

| | SPUTUM (33 cases) | TTA (35) |
|---|---|---|
| AEROBIC | | |
| G(+) Staphylococcus | 6 strains | – |
| aureus | ( 4) | |
| epidermidis | ( 1) | |
| Streptococcus | 34 | 27 |
| pneumoniae | ( 4) | (17) |
| viridans | (25) | ( 0) |
| α-Streptococcus | ( 5) | (10) |
| | 40 strains (39%) | 27 (27%) |
| G(–) Haemophilus | 23 | 35 |
| influenzae | (14) | (28) |
| parainfluenzae | ( 5) | ( 6) |
| Neisseria | 29 | 11 |
| Pseudomonas | 1 | 8 |
| Klebsiella | 2 | – |
| Enterobacter | 5 | – |
| Branhamella | 1 | 13 |
| Eschelichia | 1 | – |
| Serratia | – | 2 |
| | 62 strains (60%) | 69 (69%) |
| ANAEROBIC | | |
| Propionibacterium | | 1 |
| Bacteroides | | 1 |
| | | 2 ( 2%) |
| CANDIDA | 1 strain ( 1%) | 2 ( 2%) |

## DISCUSSION

Sinobronchial syndrome is defined as a syndrome of chronic paranasal sinusitis, with non-specific chronic inflammation of the lower respiratory tract including chronic bronchitis, bronchiectasia, and additionally diffuse panbronchiolitis in Japan. Diffuse panbronchiolitis is a bilateral chronic inflammation of the respiratory bronchiolar regions including the terminal bronchioli, and it causes severe respiratory disturbance. The histopathological feature of this condition shows bronchiolitis and peribronchiolitis of the respiratory bronchioli. Productive cough with wheezing or dyspnea is a common complaint and severe respiratory obstruction with an increased rate of residual lung volume are shown by pulmonary function tests. Chest X-ray shows diffuse finely-granular shadows in the lower pulmonary fields. This disease is considered to have a racially specific nature related to HLA antigens, so it is often found in the Japanese, Chinese and Korean, but rarely in the white people (Homma, 1986). At present, the authors cannot explain satisfactorily whether the clinical features of sinobronchial syndrome depend on the kind of the lower respiratory disease or not. According to the study of the normal bacterial flora of the upper respiratory tract by Funada (1975), the normal flora in the pharynx in healthy adults consists of five kinds of the fixed flora such as $\alpha$-Streptococcus, Neisseria, $\gamma$-Streptococcus, Micrococcus and Corynebacterium and 2–4 other kinds of the floating ones.

Lee and co-workers (1958) think that H. influenzae, S. pneumoniae and B. catarrhalis are also included in the important normal flora of the pharynx. The five kinds of bacteria presented above such as H. influenzae, S. pneumoniae, Branhamella, Neisseria and $\alpha$-Streptococcus which were detected by TTA in SBS patients this time were all included in the normal flora of the pharynx irrespective of virulence. Although 70% of the maxillary sinuses of SBS patients were aseptic, the detective rate of bacteria would possibly be increased even more if discharge was gained from the superficial layer of the maxillary sinus mucosa in both SBS and empyema patients according to the report by Ishida (1983). The gram-negative and positive ratio of detected bacteria is about 2 in both the maxillary sinus and TTA of SBS patients and there is a great similarity between them. On the other hand, the gram-negative and positive ratio of detected bacteria in the maxillary sinus of empyema patients is 0.1, and causative bacteria in the maxillary sinus can be considered different between SBS and empyema patients. Considering that only aerobic gram-positive bacteria were detected in the nasal cavity of the healhty (in the middle and inferior nasal meatus) and that the bacterial floras in the mesopharynx and the epipharynx show few differences among SBS, empyema and healthy subjects, the authors can build up the hypothesis that in SBS internal infections of aerobic gram-negative bacteria of the normal flora including Haemophilus influenzae mainly develop in two directions, downward and upward (into nasal cavities) from the pharynx, and that in empyema patients

internal infections of aerobic gram-positive bacteria of the of nasal normal flora develop mainly in one direction, toward the maxillary sinus. Although it is a matter of course that internal infections should be caused by the lowered defending factors such as abnormality of the ciliary movement system, secretory IgA, lysozyme-lactoferin and so on, the development of SBS seems not to be satisfactorily explained by either the pus-ascending or pus-descending theory alone.

## CONCLUSIONS

The authors summarize as follows, based upon the bacteriological study about the pathogenesis of SBS by comparing bacteria detected in the upper and lower respiratory tracts of SBS patients with those in the upper respiratory tracts of empyema patients having no lower respiratory disease and healthy adults.

1. In TTA of SBS patients 86% of the bacterial flora in the pharynx was occupied by normal bacterial flora such as Haemophilus influenzae, S. pneumoniae, Branhamella, Neisseira and $\alpha$-Streptococcus.
2. In the maxillary sinus of SBS patients, asepsis was 70% but the gram-negative and positive ratio of detected bacteria was 2 and similar to the ratio by TTA.
3. The aerobic gram-negative and positive ratio of bacteria detected in the maxillary sinus of empyema patients without lower respiratory diseases was 0.1 and very different from that of SBS patients.
4. In the middle nasal meatus and the inferior nasal meatus of normal subjects no aerobic gram-negative bacteria was detected.
5. Bacteria detected in the mesopharynx and the epipharynx revealed no remarkable difference among SBS patients, empyema patients without lower respiratory diseases and the healthy subjects.

From the above results, the authors consider that internal infections of aerobic gram-negative bacteria of the normal flora mainly including Haemophilus influenzae possibly develop in two directions, downward and upward (into nasal cavities) from the pharynx, and so the pathogenesis of SBS might not be explained satisfactorily by either the ascending or the descending theory alone. The authors also consider that internal infections of the nasal normal bacterial flora possibly take place in empyema patients without lower respiratory diseases.

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