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Microbiology of the middle meatus in children requiring adenotonsillectomy

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Abstract

Middle meatus samples were cultured in 120 children undergoing adenotonsillectomy with, or without, insertion of ventilation tubes. Every child (except one) had positive cultures. *Haemophilus influenzae* (62 per cent of the children), *Moraxella catarrhalis* (53 per cent) and *Streptococcus pneumoniae* (48 per cent) were the most commonly isolated bacteria. The presence of *Moraxella catarrhalis* and (to a lesser extent) *Streptococcus pneumoniae* was higher in younger children, while *Haemophilus influenzae* was cultured independently of age.

Culture results of these middle meatal samples, carefully taken in order to avoid any contamination, probably reflect some ongoing sinus infection in these children requiring adenotonsillectomy. The problems inherent in the interpretation of surface cultures are addressed.

Key words: Microbiology; Nasal cavity; Child

Introduction

Problems with antibiotic susceptibility are no longer limited to hospitals. Even the general population is threatened by the emergence of resistant strains of *Streptococcus pneumoniae*. Therefore, a stringent antimicrobial policy remains mandatory. Samples collected in symptomatic children can be useful to monitor evolution of resistance. Relatively little is known about the middle meatal flora in children. This paper intends therefore to get a better insight into the middle meatal flora and its resistance.

Materials and methods

In this prospective study middle meatal samples were obtained from children who had undergone adenoidectomy or adenotonsillectomy with, or without, insertion of ventilation tubes. Exclusion criteria were: age above eight years, administration of antibiotics within two weeks prior to surgery, or known congenital or systemic diseases. The children included had no clinical infection severe enough to interfere with general anaesthesia. Pre-operative symptoms of rhinosinusitis were not recorded, while a systemic search for the nature of secretions (purulent versus non-purulent) was done per-operatively. Details of the study group are given in Table I.

TABLE I
STUDY GROUP

n	120
Male	56
Female	64
Average age	4.6 years
Range	15 months–8 years

Surgery was carried out under general anaesthesia. At the beginning of the procedure, the nasal mucosa was decongested with xylometazolin 0.05 per cent nose drops. After decongestion, secretions were aspirated from both nasal cavities. The skin of the vestibulum nasi was disinfected with chlorhexidine. Additional contamination was avoided by using a sterile ear speculum to by-pass the vestibulum nasi. Samples were collected from the middle meatus on both sides and immediately transferred into Stuart transport medium. Care was taken not to touch the nasal mucosa at sites other than within the middle meatus.

Swabs were cultured on horse blood agar supplemented with haemin and NAD, sheep blood agar supplemented with nalidixic acid, manitol-soft agar and MacConkey agar incubated aerobically, as well as Fastidious anaerobe agar® (LabM, Bury, >UK) supplemented with horse blood, nalidixic acid and Tween 80 incubated anaerobically. All organisms grown were identified by standard bacteriological methods. Susceptibility tests were performed by disc diffusion using NeoSensitabs® tablets (Rosco, Taastrup, Denmark) following the

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NCCLS method[1] and the manufacturer's interpretative criteria. β-lactamase was detected by using a nitrocephin-based test.[2] For pneumococci, if the diameter for penicillin and/or oxacillin indicated a diminished susceptibility to penicillin, minimal inhibitory concentrations were determined by the agar dilution procedure described by the NCCLS[2] in order to distinguish accurately between resistant (MIC $\geqslant 2$ mg/l) and intermediate (MIC 0.12 to 1 mg/l) isolates.

For the analysis of statistical data, the Statistical Package for the Social Sciences (SPSS) was used. The association between dichotomous variables such as the presence or absence of the bacteria of interest was analysed using the Pearson chi-square test. To account for the association between age and the presence or absence of the bacteria, the 120 children were first categorized into four age groups: one and two years, three and four years, five and six years, seven and eight years. Afterwards, the association was tested using the Mantel-Haenszel chi-square test for linear association and the Pearson chi-square test for general association.

Results

In the 120 children eligible for inclusion, both the left and right middle meatus were cultured. Only in one child was culture of material collected from the middle meatus on both sides negative. In order to avoid duplication of culture results, only one isolate for each patient was taken into account.

The different organisms as well as the corresponding number of children in whom these species were cultured are listed in Table II. Sixty-seven per cent of the children had mixed cultures, in which at least two of the following bacteria were present: *Haemophilus influenzae*, *Moraxella catarrhalis*, *Streptococcus pneumoniae*, *Streptococcus pyogenes*, α-haemolytic or non-haemolytic streptococci.

The three most common bacteria were *Haemophilus influenzae* (present in 62 per cent of the children), *Moraxella catarrhalis* (53 per cent) and *Streptococcus pneumoniae* (48 per cent) (Table III). These bacteriae were present as a trio in 22 per cent of the children. Coagulase-negative staphylococci (and to a lesser extent *Staphylococcus aureus*) as possible contaminants are also listed in Table III.

In 40 children middle meatal secretions had a purulent character, whereas in the remaining 80 the middle meatus appeared to contain non-purulent secretions. Nevertheless, cultures collected in this second group of children yielded almost exactly the same proportion of the three most common organisms (Table IV).

A linear association between age and the presence of *Moraxella catarrhalis* was found (children grouped in four age groups; Mantel-Haenszel chi-square test for linear association; $p = 0.01548$): *Moraxella catarrhalis* being less frequently cultured in the older children. For *Streptococcus pneumoniae*, the same trend was obvious (children grouped in four age groups; Pearson chi-square test; $p = 0.01122$) while the Mantel-Haenszel chi-square test was nearly significant at the five per cent level ($p = 0.05326$). For *Haemophilus influenzae* no association between age and the presence of this bacterium could be found (children grouped in four age groups; Pearson chi-square test; $p = 0.86603$ and Mantel-Haenszel chi-square test for linear association; $p = 0.88479$). Cultures for *Moraxella catarrhalis* and *Streptococcus pneumoniae* were strongly associated with each other (Pearson chi-square test; $p = 0.00967$). There was also an association between *Moraxella catarrhalis* and *Haemophilus influenzae* (Pearson chi-square test; $p = 0.08789$). However, no association was found between the presence of *Haemophilus influenzae* and *Streptococcus pneumoniae* (Pearson chi-square test; $p = 0.40141$).

TABLE II
CULTURED ORGANISMS

Organisms	Number of children	(%)
Haemophilus influenzae	74	62
Moraxella catarrhalis	64	53
Streptococcus pneumoniae	58	48
Staphylococcus aureus	13	11
Coagulase-negative staphylococci	24	20
Non-haemolytic streptococci	30	25
α haemolytic streptococci	9	7
Streptococcus pyogenes	7	6
Haemophilus haemolyticus	2	1
Haemophilus parahaemolyticus	1	<1
Moraxella nonliquefaciens	3	2
Moraxella lacunata	1	<1
Corynebacterium species	26	22
Bacillus species	1	<1
Neisseria species	7	6
Peptostreptococcus species	1	<1
Fusobacterium nucleatum	1	<1

Table III provides figures concerning β-lactamase production or resistance to penicillin and/or erythromycin: β-lactamase was produced by 16 per cent of the *Haemophilus influenzae* and by 86 per cent of *Moraxella catarrhalis* strains. Thirty-six per cent of the *Streptococcus pneumoniae* were resistant to penicillin, erythromycin or both: eight per cent presented a diminished susceptibility to penicillin – being intermediate (five per cent) or resistant (three per cent), 21 per cent to erythromycin and seven per cent to both penicillin and erythromycin. Of the 13 *Staphylococcus aureus* cultured, 11 (84 per cent) were resistant to penicillin and one (eight per cent) to erythromycin.

No association (children grouped in four age groups; Mantel-Haenszel chi-square test for linear association) could be found between age and the presence of the β-lactamase producing strains of *Haemophilus influenzae* ($p = 0.92573$) and *Moraxella catarrhalis* ($p = 0.54954$) or the resistant strains of *Streptococcus pneumoniae* ($p = 0.15724$).

[1]National Committee for Clinical Laboratory Standards (1997) Performance standards for antimicrobial disk susceptibility tests, M2–A6. Villanova, Pennsylvania, USA.
[2]National Committee for Clinical Laboratory Standards (1997) Methods for dilution antimicrobial susceptibility tests for bacteria that grow aerobically. M7-A4. Villanova, Pennsylvania, USA.

TABLE III
PREVALENCE AND RESISTANCE DATA FOR THE THREE MOST COMMON ORGANISMS AND FOR STAPHYLOCOCCI

Organisms	Number of children	Resistance
Haemophilus influenzae	74	12/74 beta-lactamase positive
Moraxella catarrhalis	64	55/64 beta-lactamase positive
Streptococcus pneumoniae	58	12/58 resistant to erythromycin 5/58 resistant to penicillin 4/58 resistant to erythromycin and penicillin
Staphylococcus aureus	13	11/13 resistant to penicillin 1/13 resistant to erythromycin
Coagulase-negative staphylococci	24	

Discussion

The children included in this study are by no means representative of a normal population. Nevertheless, we were impressed by the fact that bacteria were cultured from the middle meatus in virtually all children: adenoidectomy and/or tonsillectomy are more frequently intended to deal with adenoid or tonsillar hyperplasia and recurrent tonsillitis, than with pediatric rhinosinusitis where there is only an indirect indication for adenoidectomy (Takahashi *et al.*, 1989; Rosenfeld, 1995). This omnipresence of bacteria, even in the absence of obvious purulent secretions, gives rise to several questions: does this meatal flora mirror the 'normal' nasal flora or does it reflect some ongoing rhinosinusitis in these children?

In animals, a study (Lambrecht *et al.*, 1986) suggests that normal sinuses are sterile. In humans, results about 'normal' sinus flora are contradictory: Brook (1981) recovered anaerobes in all and aerobes (including *Streptococcus pneumoniae* and *Haemophilus influenzae*) in 58 per cent of samples of 'normal' maxillary sinuses. These authors investigated the maxillary sinuses of adults during nasal septal correction. However, septal deviation is a known risk factor for sinusitis and imaging studies were not used to exclude sinusitis prior to sinus puncture. On the other hand, Almadori *et al.* (1986) failed to isolate a single anaerobe in patients operated for a non-exposed fracture of the maxillary sinus while the few aerobes found were more likely to be non-pathogenic. Data about 'normal' sinusal flora will perhaps always remain debatable: it is indeed difficult to justify puncture of normal sinuses, especially in children.

If data about 'normal' sinus flora are conflicting, figures for 'normal' nasal flora are not uniform either. Moreover, the flora seems to vary with the site of the culture sampling. *Staphylococcus epidermidis* and diphtheroids are considered commensals. In healthy adults, these organisms are frequently cultured, not only at the level of the nasal vestibule (*Staphylococcus epidermis* and diphtheroids, both up to 100 per cent (Maran and Lund, 1990)) but also in the nasal cavity (*Staphylococcus epidermidis*: 79 per cent, diphtheroids: 41 per cent (Savolainen *et al.*, 1986)). The role of *Staphylococcus aureus* is less clear: these bacteria can be cultured in normal adults from both the nasal vestibule (40 per cent (Maran and Lund, 1990)) and the nasal cavity (34 per cent (Savolainen *et al.*, 1986)).

TABLE IV
ORGANISMS CULTURED FROM PURULENT VERSUS NON-PURULENT SECRETIONS

Organisms	Purulent nature of secretions	Non-purulent
Haemophilus influenzae	63%	62%
Moraxella catarrhalis	55%	52%
Streptococcus pneumoniae	53%	43%

Potentially pathogenic bacteria are not infrequently isolated from the posterior nasopharynx: *Haemophilus influenzae* (six to 40 per cent in normal adults (Maran and Lund, 1990), 30 per cent in children above four years (Wald, 1993)), *Streptococcus pneumoniae* (15–25 per cent (Maran and Lund, 1990)), *Streptococcus pyogenes* (six per cent (Maran and Lund, 1990)). However, at the level of the nasal cavity, potentially pathogenic bacteria are only rarely found in healthy young adults: α-haemolytic streptococci (four per cent), *Haemophilus influenzae* (five per cent), *Moraxella catarrhalis* (three per cent) and *Streptococcus pneumoniae* (0.5 per cent) (Savolainen *et al.*, 1986). In 139 samples of the adult middle meatus, Klossek *et al.* (1996) had only two cultures with *Haemophilus influenzae* and two cultures with *Streptococcus pneumoniae*. Therefore, the much higher prevalence in the present study of *Haemophilus influenzae* (62 per cent), *Moraxella catarrhalis* (53 per cent) and *Streptococcus pneumoniae* (48 per cent) could indeed suggest some degree of ongoing sinus infection in these children. Whether this abundant meatal flora accurately represents the actual sinus flora still has to be proven: since convincing evidence is lacking that antral lavage is effective for chronic rhinosinusitis (Maes and Clement, 1987; Otten and Grote, 1988; Lusk *et al.*, 1989), the authors gave up the idea of performing antral endoscopy and lavage to obtain samples from within the sinus in this particular population of children.

Nevertheless, one study (Orobello *et al.*, 1991) shows a good correlation between cultures from the middle meatus and the maxillary sinus (83 per cent) and between the middle meatus and the ethmoid sinuses (80 per cent). This study was performed in children in whom antral irrigations and/or functional endoscopic surgery were performed for chronic sinusitis. Unfortunately, this study is flawed by a high number of coagulase-negative staphylocci, *Streptococcus viridans* and 'normal respiratory flora', which is suggestive of contamination.

Therefore, other authors (Wald, 1996) advocate – in the presence of certain clinical indications – puncture of the maxillary sinus (the most accessible sinus) with a bacterial colony count or Gram stain in order to differentiate between actual sinus infection and contamination.

In a recent paper, Brook *et al.* (1997) also suggest quantitative cultures and Gram staining to exclude that isolates originate from the nasal mucosa rather than the sinus cavity. These authors compared specimens obtained by maxillary sinus endoscopy and by a Caldwell-Luc operation (a surgical procedure contra-indicated in children), while no correlation with the middle meatus was sought for.

The resistance observed among the children of the present study is in accordance with recent regional figures from another Belgian institution: Lontie and Blaton (1997) collected samples from out-patients suffering from infections of ear, throat, eye or lower airways. They observed β-lactamase production by 17 and 95 per cent of *Haemophilus influenzae* and *Moraxella catarrhalis* respectively, while four per cent of *Streptococcus pneumoniae* had an intermediate resistance for penicillin and 24 per cent for erythromycin.

Since the present study group represents neither a true 'normal' population nor a population suffering from severe rhinosinusitis, one has to be cautious when interpreting these findings with respect to antimicrobial therapy. With 28 per cent of *Streptococcus pneumoniae* being resistant to erythromycin and respectively 16 and 86 per cent of *Haemophilus influenzae* and *Moraxella catarrhalis* producing β-lactamases, a straightforward conclusion might be to discard macrolides and agents that are susceptible to the action of β-lactamase enzymes.

However, another suggestion might be not to use antibiotics at all. The omnipresence of bacteria (even in the absence of purulent secretions; cf. Table IV) among children that are otherwise not overtly ill, supports the approach of the members of the Consensus Panel on the Management of Rhinosinusitis in Children (Clement *et al.*, 1998): in children suffering from a non-severe rhinosinusitis, neither microbiological assessment nor antimicrobial therapy are necessary, except in selected cases with concomitant disease.

Conclusion

Nearly every middle meatus of children requiring adenotonsillectomy yields bacteria. Among this abundant and often mixed flora, potentially pathogenic bacteria were cultured in a significant number of children: *Haemophilus influenzae* in 62 per cent, *Moraxella catarrhalis* in 53 per cent and *Streptococcus pneumoniae* in 48 per cent of the children.

With age, a linear decrease in the prevalence of *Moraxella catarrhalis* was observed, and the same trend was suggested for *Streptococcus pneumoniae*. However, for *Haemophilus influenzae* no association with age was found. The resistance observed was in accordance with data available for the region. No association could be found between age and the occurrence of resistance. In the absence of convincing studies that correlate the middle meatal flora with the sinus flora, we do not know whether the high number of potential pathogens found in this study (quite different from data observed in healthy adults) reflects some ongoing sinus infection among the children studied or whether this only represents colonization.

These findings illustrate the need for a similar study with the inclusion of 'normal' children undergoing non-ENT surgery in order to confirm the data obtained thus far and make an adequate comparison between groups.

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