Adenoid Bacteriology in Otitis Media Children With Effusion

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Objectives. The relationship between the adenoids and otitis media has been well documented. The purpose of this study was to document the current trends in the bacteriology of the adenoids in children with otitis media with effusion (OME). Comparisons of bacteriology of the adenoids with that of the middle ear fluid are made, and the role of adenoidectomy in treating otitis media with effusion is discussed.

Methods. A prospective investigation of 44 patients with adenoid hyperplasia and OME was performed. All patients received transoral endoscopic adenoidectomy and insertion of tympanostomy tubes. The core adenoid tissue and middle ear fluid were cultured. Presumptive pathogens were identified using standard methods.

Results. The age range of the patients was 3 to 14 years with a mean age of 6.95 years; 31 patients were male and 13 were female. Microorganisms were isolated in the core adenoid tissue in 84% (37/44) of the patients and more than two microorganisms were isolated in 41% (20/44) of the patients. Possible pathogenic microorganisms were present in 41% (29/70) of the samples. The most common pathogenic microorganisms were *Staphylococcus aureus, Streptococcus pneumoniae, Haemophilus influenzae* and *Pseudomonas aeruginosa*. Possible nonpathogenic microorganisms were present in 59% (41/70) of the samples. *Streptococcus viridans, Neisseria* species and coagulase(−) *Staphylococcus* were the most common. Only one isolate of *Neisseria* species (2.9%) was cultured from the middle ear effusion.

Conclusions. Our results suggest that the adenoidal reservoir of bacteria may be associated with otitis media with effusion. Although we did not find a significant association between bacteriology of the adenoids and that of middle ear effusion, a significant portion of the reservoir bacteria were pathogenic microorganisms and some of them were oxacillin-resistant or β-lactamase positive. The clinical benefits of adenoidectomy in the health management of children with otitis media with effusion should not be overlooked. **(Mid Taiwan J Med 2002;7:199-205)**

Key words

adenoid, bacteriology, otitis media with effusion

INTRODUCTION

Otitis media is one of the most common infectious diseases occurring during childhood. The etiology and pathogenesis of otitis media are multifactoral, including infection (viral or bacterial), Eustachian tube dysfunction, immunologic status, allergies and even social and environmental factors. Eustachian tube dysfunction plays a central role in otitis media. Mechanical obstruction as well as functional obstruction of the Eustachian tubes may result

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in otitis media [1].

The adenoids lie just adjacent to the Eustachian tube orifice and the posterior choanae of the nasal cavity, in close proximity to the ethmoid, sphenoid and maxillary sinuses. The adenoids (nasoparyngeal tonsils), along with the palatine tonsils and the pharyngeal lymphoid follicles, constitute the important oropharyngeal and nasopharyngeal lymphoid rings, so-called the Waldeyer's ring, and are part of the mucosa-associated lymphoid tissue. This circular ring of lymphoid tissue functions in local immune response to exogenous microorganisms and other inhaled or ingested antigenic substances [2]. The size of the adenoids will increase starting at 3 years of age, reach maximum size at 7 years old and then start to atrophy [3].

Recurrent adenoiditis or hyperplasia of the adenoids is also known to be associated with common diseases of its neighboring structures, such as obstructive sleep apnea, recurrent otitis media, otitis media with effusion (OME) and sinusitis [4]. Removal of the adenoids, as it is a reservoir of pathogenic bacteria, has been hypothesized as a treatment for childhood otitis media [5]. Adenoidectomy with tympanostomy tube insertion is effective in the treatment of recurrent or persistent otitis media [6,7]. Instead of the traditional concept of the obstructive effect of hyperplastic adenoids on the Eustachian tube, more interest has been focused on the chronic inflammatory changes of the adenoids (adenoiditis) and the surrounding Eustachian tubitis [8]. The purpose of this study was to document the current trends in the bacteriology of the adenoids in children with OME in Taiwan. Comparisons of bacteriology of the adenoids with those of the middle ear fluid are made and the role of adenoidectomy in treating otitis media with effusion is discussed.

MATERIALS AND METHODS

The age range of the patients was 3 to 14 years with a mean age of 6.95 years; 31 patients were male and 13 were female (Fig. 1).

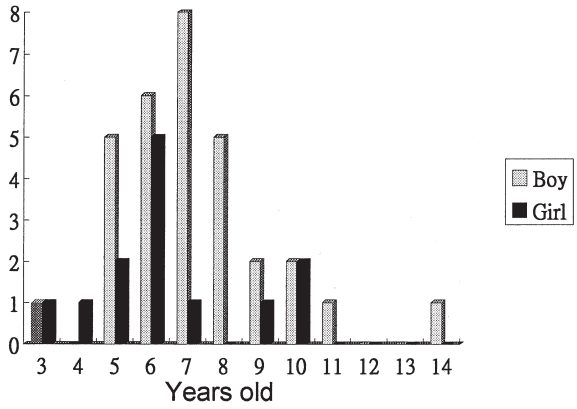

Fig. 1. Age and gender distribution of children with serous otitis media with adenoid hyperplasia (n = 44).

We carried out a prospective investigation of 44 patients who had received adenoidectomy and insertion of tympanostomy tubes in the Department of Otolaryngology at the China Medical College Hospital from January 2001 through April 2002. All patients had adenoid hyperplasia with OME. The condition was diagnosed by physical examination, and confirmed by tympanometry and unresponsiveness to medical therapy for at least 3 months. The diagnosis of hyperplastic adenoids was made from medical history reports (nasal obstruction, mouth breathing, snoring, or sleep apnea), physical examinations (indirect or direct nasopharyngoscopy) and/or skull lateral X-ray imaging of the adenoids. All patients were free of upper respiratory tract infections for at least 3 weeks prior to the operation.

After the induction of general anesthesia, the soft palate was retracted with Negaton tubes. The nasal and oral cavities were irrigated with sterile isotonic sodium chloride solution and disinfected with aqueous beta-iodine solution in order to reduce bacterial contamination on the mucosa surface of the adenoid. Adenoidectomy was then performed under transoral endoscopic guidance [9]. Strict adherence to sterile technique and universal precautions were followed to decrease the risk of contamination of the specimen during processing. The core of the adenoid tissue was dissected and

Table 1. Number of microorganisms cultured from adenoid core tissue in children with otitis media with effusion (n = 44)

Number of microorganisms isolated	0	1	2	3	4
Number of patients	7	17	8	11	1

sampled using a scalpel and forceps. The sample was placed on a sterile swab which was then cultured on BAP/EMB (blood agar plate/eosin methylene blue) agar, chocolate agar, CNA (Comumbia nalidixic acid) agar and Brucella agar. The BAP/EMB agar plate, chocolate agar plate and CNA agar plate were for aerobes and were incubated in a 5% carbon dioxide incubator for 18 to 24 hours. The Brucella agar plate was for anaerobes and was incubated in an anaerobic workstation (Concept Plus) for 1 week. After presumptive pathogens were isolated, they were identified using standard methods. (Kits included: bioMerieux; api ID32GN, rapid 32A and api20A).

The sampling of the middle ear fluid was performed either via needle aspiration (# 22 long needle) or forceps (for sticky and gel-like contents) under microscopy, after disinfecting the external ear canal by irrigating with aqueous beta-iodine solution. The tympanostomy tube was inserted after the middle ear fluid was cleaned. The middle ear fluid was swabbed and sent for culture using methods similar to that for the core adenoid tissue.

The bacteria considered to be potential pathogens were: *Haemophilus influenzae,* group A β-hemolytic *Streptococcus*, *Staphylococcus aureus, Moraxella catarrhalis* and *Streptococcus pneumoniae* as well as other possible pathogens such as *Pseudomonas aeruginosa.* Additional anaerobic pathogens included *Fusobacterium nucleatum, Clostridium, Bacteroides capillosus, Bacteroides oralis*, *Bacteroides fragilis, Bacteroides melaninogenicus, Peptococcus, Peptostreptococcus* and *Actinomyces.* Nonpathogens included *Streptococcus viridans, Neisseria* species as well as other nonpathogens such as micrococcus and diphtheroids [10,11].

RESULTS

During the microscopic examination of the middle ear condition, nine patients were noted to have little or no fluid in the middle ear. Culture of the middle ear fluid was not performed in these patients.

Bacterial growth was found in 84% (37/44) of core adenoid tissue samples. More than two kinds of microorganisms were isolated from 41% (20/44) of the samples (Table 1). A total of 70 bacterial isolates were recovered, accounting for an average of 1.6 isolates per core adenoid tissue sample. Possible pathogenic microorganisms were found in 43% (30/70) of the samples. The most common pathogenic microorganisms isolated from core adenoid tissue were *Staphylococcus aureus* and *Streptococcus pneumoniae,* followed by *Haemophilus influenzae, Pseudomonas aeruginosa, Moraxella catarrhalis, Moraxella lacunata, Peptostreptococcus magnus, Actinomyces* species, *Prevotella disiens, Veillonella* species and *E. coli.* Two (25%) of the eight isolates of *Staphylococcus aureus* were oxacillin resistant *Staphylococcus aureus* (ORSA). β-lactamase was positive in three (75%) of the four isolates of *Haemophilus influenzae* and in the single isolate of *Moraxella catarrhalis* (Table 2).

Possible nonpathogenic microorganisms were found in 57% (40/70) of the samples. *Streptococcus viridans,* coagulase(–) *Staphylococcus* and *Neisseria* species were the most common. Only 8.6% (3/35) of middle ear fluid samples showed evidence of microorganisms and only one *Neisseria* species (2.9%) was isolated (Table 2).

Table 2. Adenoid core tissue culture findings versus middle ear fluid culture findings

	Adenoid core tissue (n = 44)	Middle ear fluid (n = 35)
Possible pathogenic microorganisms	30 isolates	0 isolates
Staphylococcus aureus	8†	
Streptococcus pneumoniae	7	
Haemophilus influenzae	4‡	
Pseudomonas aeruginosa	4	
Moraxella catarrhalis	1*	
Moraxella lacunata	1	
Peptostreptococcus magnus	1	
Actinomyces sp.	1	
Prevotella disiens	1	
Veillonella sp.	1	
E. coli	1	
Possible nonpathogenic microorganisms	40 isolates	1 isolate
Streptococcus viridans	20	
Neisseriae sp.	10	1
Coagulase(–) *Staphylococcus*	7	
Streptococcus intermedius	1	
Streptococcus Group D	1	
Gemella morbillorum	1	
No growth	7	34**

† 2 samples were oxacillin resistant *Staphylococcus aureus* (ORSA); ‡ 3 were β-lactamase(+); * β-lactamase(+); ** 2 samples were noted to contain Gram positive bacilli but no microorganisms could be cultured.

DISCUSSION

Otitis media is one of the most common diagnoses made in infants and children by clinicians, and its prevalence has a significant impact on managed health care. A massive hearing screening program for preschool children in Taiwan showed that 6.3% of preschool children had otitis media [12]. Children exhibited not only the signs and symptoms of acute episodes but also the sequelae of infection of the middle ear, the most important of which was persistent effusion. In the study by Teele et al [13], 10% of patients still had persistent middle ear effusion 3 months after the onset of acute otitis media. OME may result in mild to moderate conductive hearing loss, averaging 27dB, which may cause speech problems and language development delays in children [14].

Common pathogens of acute otitis media are *Streptococcus pneumoniae*, and *Haemophilus influenzae*, followed by *Moraxella catarrhalis*, the so called "saint's triad"; all were present in nearly 75% of effusion samples obtained from patients with acute otitis media [15]. As OME is the sequela of acute otitis media [13], the microorganisms found in OME may not be exactly the same as those found in acute otitis media. The bacterial culture rates of effusion samples obtained from OME vary. Up to 41% of samples showed bacterial growth with *Haemophilus influenzae, Streptococcus pneumoniae* and *Staphylococcus* species being the predominant pathogens, depending on age and the length of effusion [16]. However, Saffer et al [17] found only a 1% bacterial culture rate from the effusion samples of OME and disagreed with the possible role of bacteria in the genesis and maintenance of OME. They postulated that the timing of the tympanic paracentesis might result in the low culture rate of middle ear effusion samples. In the initial state of otitis media, viable bacteria were identified in the acute active stage of infection. At the second resolution stage, the bacteria could only be identified using Gram's stain because of inhibiting substances. Finally, in chronically established effusions, the bacteria may be non-

visible, either in cultures or by Gram's stain [17]. In our study, we conformed to the strictest surgical indications for OME of at least a 3-month medical treatment. This may explain why only one *Neisseria* species was isolated from the effusion sample of the middle ear in our study.

A core specimen rather than the surface colonization was used to analyze the deep-tissue infection. This may be more likely to reflect the true microflora of the adenoids and was not subject to the contamination of other pathogens from postnasal drip or oropharyngeal secretions. Brodsky and Koch [10] found substantive differences in the type and number of bacteria in non-diseased and diseased adenoids. Most non-diseased adenoids either had no bacterial growth in cultures or contained nonpathogenic bacteria (commensal). *Haemophilus influenza* was the most common potential pathogen found in diseased adenoids. In our study, at least 42% of core adenoid tissue samples showed pathogenic microorganisms in the cultures. The most common isolated from the core adenoid tissue, in decreasing order of frequency, were *Staphylococcus aureus* and *Streptococcus pneumoniae,* followed by *Haemophilus influenzae, Pseudomonas aeruginosa, Moraxella catarrhalis, Moraxella lacunata, Peptostreptococcus magnus, Actinomyces* species, *Prevotella disiens, Veillonella* species and *E. coli.*

The relationship between the adenoids and otitis media has been well documented. Pillsbury et al [18] found a significant correlation between suppurative otitis media and adenoid cultures. They theorized that adenoid tissue may function as an asymptomatic reservoir of bacteria and that any local or systemic changes may result in bacterial overgrowth and clinical symptoms. Bernstein [8] reviewed the relationship between the adenoids and otitis media and suggested that: 1) adenoid inflammation led to inflammatory obstruction of the Eustachian tube; 2) early colonization of the adenoid by the three major bacterial pathogens of otitis media was the most important factor in the early pathogenesis of otitis media; and 3) the local immune system in the adenoids, particularly specific secretory IgA directed against both viruses and bacterial pathogens, is probably genetically controlled and represented the immunological factor in protecting the host against the invasion of these agents in the Eustachian tube and the middle ear. Some of the pathogens in our study were either oxacillin-resistant or could produce β-lactamase to enzymatically inactivate penicillin and allow infection to persist. Adenoidectomy has also been shown to produce a physiological effect on the nasopharyngeal flora by conversion of abnormal microflora to a nearly normal one [19]. Therefore, adenoidectomy for children with OME may be beneficial.

In conclusion, our results suggest that the adenoidal reservoir of bacteria may be associated with the persistence of OME. Although we did not find any association between the bacteriology of the adenoids with that of middle ear effusion, a significant portion of the microorganisms in the adenoid reservoir were potential pathogenic microorganisms, were positive for β-lactamase, or were ORSA. This supports our conclusion that adenoidectomy in the health management of children with OME plays a beneficial role. Otitis media is one of the most common infectious childhood diseases. The etiology and pathogenesis of otitis media are multifactoral, and include infection (viral or bacterial), Eustachian tube dysfunction, immunologic status, allergies and even social and environmental factors. Eustachian tube dysfunction plays a central role in otitis media. Mechanical obstruction, as well as functional obstruction of the Eustachian tube may result in otitis media [1].

REFERENCES

1. Bluestone CD, Klein JO. Otitis, ateletasis and Eustachian tube dysfunction. In: Bluestone CD, Stool SE, Kenna MA, eds. Pediatric Otolaryngology. Philadelphia: W.B. Saunders, 1996:411-56.

2. Richtsmeier WJ, Shikhani AH. The physiology and immunology of the pharyngeal lymphoid tissue. [Review] *Otolaryngol Clin North Am* 1987;20:219-28.
3. Hibbert J. Tonsils and adenoids. In: Kerr AG, ed. Scott-Brown's Otolaryngology. London: Butterworths, 1987:371-4.
4. Bicknell PG. Role of adenotonsillectomy in the management of pediatric ear, nose and throat infections. [Review] *Pediatr Infect Dis J* 1994;13(1 Suppl 1):75-9.
5. DeDio RM, Tom LW, McGowan KL, et al. Microbiology of the tonsils and adenoids in a pediatric population. *Arch Otolaryngol Head Neck Surg* 1988;114:763-5.
6. Paradise JL, Bluestone CD, Rogers KD, et al. Efficacy of adenoidectomy for recurrent otitis media in children previously treated with tympanostomy-tube placement. Results of parallel randomized and nonrandomized trials. *JAMA* 1990;263:2066-73.
7. Gates GA, Avery CA, Prihoda TJ, et al. Effectiveness of adenoidectomy and tympanostomy tubes in the treatment of chronic otitis media with effusion. *N Engl J Med* 1987;317:1444-51.
8. Bernstein JM. Waldeyer's ring and otitis media: the nasopharyngeal tonsil and otitis media. [Review] *Int J Pediatr Otorhinolaryngol* 1999;49(Suppl 1):127-32.
9. Lin CD, Hsu CJ, Tsai MH, et al. Transoral endoscopic adenoidectomy. *J Tw Otolaryngol Head Neck Surg* 1999:34;105-8.
10. Brodsky L, Koch RJ. Bacteriology and immunology of normal and diseased adenoids in children. *Arch Otolaryngol Head Neck Surg* 1993;119:821-9.
11. Lee D, Rosenfeld RM. Adenoid bacteriology and sinonasal symptoms in children. *Otolaryngol Head Neck Surg* 1997;116:301-7.
12. Liu TC, Lu YC, Lin HC, et al. Preschool hearing screening. *Formosan J Med* 1998;2:616-22.
13. Teele DW, Klein JO, Rosner BA. Epidemiology of otitis media in children. *Ann Otol Rhinol Laryngol Suppl* 1980:89:5-6.
14. Hsu LP, Chen JC, Lin KN, et al. Otitis media with effusion in children-Analysis of 146 cases. *J Tw Otolaryngol Head Neck Surg* 1996;31:407-12.
15. Bluestone CD, Stephenson JS, Martin LM. Ten-year review of otitis media pathogens. *Pediatr Infect Dis J* 1992;11(8 Suppl):7-11.
16. Brook I, Yocum P, Shah K, et al. Microbiology of serous otitis media in children: correlation with age and length of effusion. *Ann Otol Rhinol Laryngol* 2001;110:87-90.
17. Saffer M, Lubianca Neto JF, Piltcher OB, et al. Chronic secretory otitis media: negative bacteriology. *Acta Otolaryngol* 1996;116:836-9.
18. Pillsbury HC 3rd, Kveton JF, Sasaki CT, et al. Quantitative bacteriology in adenoid tissue. *Otolaryngol Head Neck Surg* 1981;89:355-63.
19. Talaat AM, Bahgat YS, el-Ghazzawy E, et al. Nasopharyngeal bacterial flora before and after adenoidectomy. *J Laryngol Otol* 1989;103:372-4.

中耳積液患童腺樣體的細菌學表現

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背景 目前已有多項研究顯示，腺樣體與中耳炎的關係密切。本研究的目的在探討中耳積液患童腺樣體細菌學之最近表現，並比較中耳積液與腺樣體的細菌培養的差異；進而討論腺樣體在中耳炎病程進展中的角色，與中耳積液患童腺樣體切除的意義。

方法 前瞻性蒐集接受經口內視鏡指引腺樣體切除與中耳通氣管放置手術的中耳積液併腺樣體增殖患童44名，將摘除的腺樣體取出的核心組織與中耳積液分別進行細菌培養，比較兩者的差異。

結果 四十四名患童年齡分佈3到14歲，平均年齡6.95歲，男性31名，女性13名。有84% (37/44)腺樣體核心組織可以培養出細菌，而且41% (20/44)可培養出兩種以上的細菌；41% (29/70)可能屬致病菌，依常見順序爲*Staphylococcus aureus, Streptococcus pneumoniae, Haemophilus influenzae*及*Pseudomonas aeruginosa*，而且其中部份具有對一般penicillin抗藥性的β-lactamase或對oxacillin抗藥性；59% (41/70) 則可能屬一般鼻咽正常菌類，其中以*Streptococcus viridans*及*Neisseria*屬最爲常見。中耳積液細菌培養僅2.9% (1/35)可以培養出*Neisseriae*屬。

結論 本研究顯示腺樣體積存著至少40%以上的致病細菌，這可能與患者持續中耳積液有關。雖然中耳積液與腺樣體核心組織的細菌培養結果並無相關，但是其中腺樣體核心組織的積存致病細菌中，相當比例具有對一般penicillin抗藥性的β-lactamase或對oxacillin具抗藥性，因此我們認爲腺樣體切除手術對於中耳積液患童具臨床意義。（中台灣醫誌 **2002;7:199-205**）

關鍵詞

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