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MAIN ARTICLE

Relationship between bacteriology of the adenoid core and middle meatus in children with sinusitis

S ELWANY[1], A N EL-DINE[2], A EL-MEDANY[1], A OMRAN[1], Z MANDOUR[1], A ABD EL-SALAM[1]

Departments of [1]Otolaryngology, and [2]Microbiology, Alexandria Medical School, Egypt

Abstract

Objective: To assess the correlation between bacterial pathogens in the adenoid core and the middle meatus, in children with hypertrophied adenoids and chronic or recurrent sinusitis.

Design: The study was conducted at Alexandria University Hospitals. We included 103 children aged four to 12 years who were scheduled for adenoidectomy and who had clinical and/or radiological evidence of chronic or recurrent sinusitis. Adenoid core specimens and middle meatal swabs were obtained from every patient and were sent for bacteriological evaluation using standard qualitative and quantitative microbiological techniques. The results were statistically analysed.

Results: The bacterial species isolated most frequently from the adenoid core were coagulase-negative staphylococci (40.8 per cent), *Staphylococcus aureus* (22.3 per cent), *Streptococcus pneumoniae* (18.4 per cent), *Haemophilus influenzae* (16.5 per cent) and group A streptococci (15.5 per cent). The bacterial species isolated most frequently from the middle meatus were coagulase-negative staphylococci (41.7 per cent), *S aureus* (32 per cent), *S pneumoniae* (28.1 per cent), *H influenzae* (21.6 per cent) and group A streptococci (19.4 per cent). The adenoid core and middle meatal cultures were both positive for at least one bacterial species in 63 cases, and were both negative in 25 cases. In six cases, a positive adenoid core culture was associated with a negative middle meatal culture. In five cases, a negative adenoid core culture was associated with a positive middle meatal culture (for one or more pathogenic species). Thus, adenoid core culture had a positive predictive value of 91.5 in forecasting the middle meatal culture result, and a negative predictive value of 84.3.

Conclusion: Apart from its effect on nasal airway patency, adenoidal tissue may function as a bacterial reservoir initiating and maintaining sinus infection in children. These study findings support a potential role for adenoidectomy in the treatment of chronic or recurrent paediatric sinusitis.

Key words: Adenoids; Nasal Cavity; Sinusitis; Child; Bacteriology

Introduction

Paediatric sinusitis is a very common problem in clinical practice. Several studies have demonstrated improvement of sinusitis symptoms following adenoidectomy.[1,2] However, the exact role of the adenoids in the pathogenesis of rhinosinusitis is unknown.[3–5] The adenoids may predispose to rhinosinusitis by causing mechanical obstruction and resultant stasis of secretions, or by acting as a reservoir for pathogenic bacteria.[6,7] A recent study provided evidence to support the latter pathogenetic mechanism in paediatric rhinosinusitis.[8] Another recent study showed that the adenoids could harbour mucosal bacterial biofilms, and demonstrated the existence of living bacteria within them.[9]

Most published studies of adenoid bacteriology have investigated the bacteriology of the adenoid surface rather than its core.[10,11] The present study sought to address this issue, and to assess the correlation between the bacteriology of paediatric sinusitis and the prevalence of bacterial pathogens in the adenoid core.

Patients and methods

The study was conducted at Alexandria University Hospitals between June 2007 and November 2009. We included 103 children aged four to 12 years who were scheduled for adenoidectomy and who had clinical and/or radiological evidence of chronic or recurrent sinusitis. Children were excluded if they had had antibiotic therapy during the past seven days, or prior sinus or adenoid surgery.

The study protocol was approved by the appropriate ethical review committee, and informed consent was obtained from all the patients' parents or guardians.

At the time of surgery, the nasal vestibule and anterior nasal cavity were disinfected, and Calgi swabs were used to obtain specimens of the middle meatal discharge,

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under sterile endoscopic vision. The swabs were immersed immediately and aseptically into sodium thioglycolate transport medium, and were transported to the laboratory and processed within one hour.

Adenoidectomy was performed with adenoid curettes, under endoscopic visualisation of the nasopharynx. Strict adherence to sterile technique was maintained in order to decrease the risk of contamination of the specimen. The resected adenoid specimen was placed in a sterile container and was immediately transported to the bacteriology laboratory.

Specimen cultures were prepared within one hour. Specimens were divided aseptically into two halves and core biopsies were taken, using cupped forceps, in order to analyse deep tissue infection rather than surface colonisation. Core samples were weighed and then minced and mixed in a known amount of sterile saline solution.

Swabs, together with aliquots of the core specimen saline suspension, were plated onto 5 per cent sheep blood, chocolate, MacConkey's and phenyl ethyl alcohol blood agars. The plates were incubated at 37°C either aerobically or under 5 per cent carbon dioxide, and were examined at 24, 48 and 72 hours. Micro-organisms were counted and reported as colony-forming units per gram of adenoid tissue. Aerobic and anaerobic bacteria were identified using standard bacteriological techniques. All organism counts greater than 105 colony-forming units per gram of adenoid tissue were considered significant.[12] In each adenoid specimen, the bacterial species with the greatest concentration was reported as the dominant bacteria. All specimens were processed by the same investigator, who was blinded to the identity of the specimens.

The bacteriological data were analysed using the Statistical Package for the Social Sciences version 10.0 software. Data were described using the standard definitions of true positive, true negative, false positive and false negative. Correlative statistics were performed to calculate positive predictive value, negative predictive value, specificity and sensitivity.[13,14]

Results

Adenoid core cultures

The mean adenoid core specimen weight ± standard deviation was 3.03 ± 0.97 g, with a range of 1.53–6.29 g. Bacterial concentrations of greater than 105 colony-forming units were found for one bacterial species in 72 cultures (69.6 per cent), for two species in 17 cultures (8.2 per cent), for three species in eight cultures (7.7 per cent) and for four or more species in six cultures (5.8 per cent). The bacterial species isolated most frequently were coagulase-negative staphylococci (40.8 per cent), *Staphylococcus aureus* (22.3 per cent), *Streptococcus pneumoniae* (18.4 per cent), *Haemophilus influenzae* (16.5 per cent) and group A streptococci (15.5 per cent) (Table I).

TABLE I
POSTIVE SAMPLE CULTURES*

Bacteria	Adenoid core (*n* (%))	Middle meatus (*n* (%))
Coag −ve staph	42 (40.8)	43 (41.7)
S aureus	23 (22.3)	34 (32)
S pneumoniae	19 (18.4)	29 (28.1)
H influenzae	17 (16.5)	21 (21.6)
Grp A strep	16 (15.5)	20 (19.4)
Diphtheroids	19 (18.4)	18 (18.5)
Other	24 (23.3)	35 (33.9)

*For a total of 103 cases. Coag −ve staph = coagulase-negative staphylococci; grp A strep = group A streptococci

Middle meatal cultures

One hundred and three middle meatal swabs were taken. The bacterial species isolated most frequently from these swabs were coagulase-negative staphylococci (41.7 per cent), *S aureus* (32 per cent), *S pneumoniae* (28.1 per cent), *H influenzae* (21.6 per cent) and group A streptococci (19.4 per cent) (Table I). Bacterial concentrations of greater than 105 colony-forming units were found for one bacterial species in 70 cultures (76.9 per cent), for two species in 13 cultures (12.6 per cent), for three species in 10 cultures (9.7 per cent) and for four or more species in nine cultures (8.7 per cent).

Relation between adenoid core and middle meatal cultures

The adenoid core and middle meatal cultures were both positive for at least one bacterial species (i.e. true positive) in 63 cases, and were both negative (i.e. true negative) in 25 cases (Table II). Six positive adenoid core cultures were associated with negative middle meatal cultures. Conversely, five negative adenoid core cultures were associated with positive middle meatal cultures for one or more pathogenic organisms. Thus, adenoid core culture had a positive predictive value of 91.5 in forecasting the middle meatal culture result, and a negative predictive value of 84.3.

Discussion

Adenoid bacteriology has been investigated by several authors. DeDio *et al.* found a greater number of bacterial isolates in patients with chronic or recurrent adenoid

TABLE II
PREDICTIVE VALUE OF BACTERIOLOGICAL RESULTS

Middle meatal cultures (*n*)	Adenoid core cultures (*n*)		Pred value
	Positive	Negative	
Positive	TP = 65	FP = 6	PPV = 91.5
Negative	FN = 5	TN = 27	NPV = 84.3
	Sens = 92.8	Spec = 81.8	Acc = 89.3

Pred = predictive; TP = true positive; FP = false positive; FN = false negative; TN = true negative; PPV = positive predictive value; NPV = negative predictive value; sens = sensitivity; spec = specificity; acc = accuracy

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infection, compared with patients with symptoms of adenoid hyperplasia.[15] Similar to the present study, the most common pathogenic organisms identified included *S aureus*, *S pneumoniae*, *H influenzae* and group A streptococci. These bacteria are similar to those commonly found during acute and chronic sinusitis in children.[16–19]

Brodsky and Koch found that adenoids removed from patients with chronic adenoid infection or nasal obstruction had a significantly higher concentration of pathogenic bacteria, compared with adenoids removed for hyperplasia alone.[20] However, these authors' primary focus was otitis media, and patients with sinusitis were specifically excluded. The most common pathogenic bacteria identified in these authors' series included *S aureus*, *H influenzae* and group A streptococci.

- **This study assessed adenoid core and middle meatal bacteriology in children with hypertrophied adenoids and chronic or recurrent sinusitis**
- **Organisms isolated most frequently from both adenoid core and middle meatal samples included coagulase-negative staphylococci, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Haemophilus influenzae* and group A streptococci**
- **The adenoids may form a reservoir of pathogenic bacteria which can re-infect the paranasal sinuses**
- **Adenoidectomy may help control sinus infections in children with hypertrophied adenoids or recurrent adenoiditis**

Pillsbury *et al.* quantitatively examined adenoid cultures and found a significant correlation between suppurative otitis media prevalence and adenoid culture density.[21] They thus theorised that adenoid tissue may function as a bacterial reservoir, and that any local or systemic change may result in bacterial overgrowth and clinical symptoms.

Conclusion

The present study demonstrated a significant positive correlation between quantitative bacteriology results for the adenoid core and the middle meatus. Our results suggest that adenoidal tissue may function as a reservoir of bacteria. When children with chronically infected adenoids and sinusitis are treated with systemic antibiotics, their acute symptoms generally resolve. However, when the antibiotics are discontinued relapse is frequent because the pathogens persist in the adenoid core. This cycle may be interrupted by adenoidectomy. In other words, our results suggest that an adenoidal reservoir of bacteria may produce paediatric sinusitis in a manner similar to that observed for otitis media. Therefore, our results support a potential role for adenoidectomy in the management of children with hypertrophied adenoids and chronic or recurrent sinusitis.

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Address for correspondence:
Dr Samy Elwany,
4 Kfr Abdou Street,
Roushdey,
Alexandria, Egypt

Fax: +2034872665
E-mail: samyelwany@msn.com

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