

ORIGINAL RESEARCH—PEDIATRIC OTOLARYNGOLOGY

Increased risk of otitis media with effusion in allergic children presenting with adenoiditis

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OBJECTIVE: Otitis media with effusion (OME) is a common disorder in childhood. The aim of the study was to assess the association of atopy and endoscopic features with the presence of OME.

SUBJECTS AND METHODS: This cross-sectional study evaluated 287 children presenting with acute upper-airway infections persistent for at least ten days and tested through nasal endoscopy and skin-prick test.

RESULTS: Fifty-three patients had a diagnosis of OME; out of them, 23 showed acute rhinosinusitis, ten adenoiditis, and 20 both features. OME was diagnosed in 26 atopic children and in 27 nonatopic ones. On a multivariable analysis, allergic rhinitis, endoscopic pattern of adenoiditis, and younger age were all shown to be independently associated with a diagnosis of OME.

CONCLUSIONS: This study suggests that allergic rhinitis and adenoiditis are significant risk factors to OME development and that the risk becomes higher when these two conditions are concomitantly present.

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Otitis media is an inflammation of the middle ear. Two forms are recognized: acute otitis media (AOM) and otitis media with effusion (OME). OME usually follows one or more episodes of AOM, and it is characterized by the persistence of fluid in the middle ear, even after resolution of the acute phase of the disease; however, OME can even occur independently, being associated with other causes that may decrease the eustachian tube function. OME is a common disease in children, having an incidence of 15 percent to 20 percent; it can also be accompanied, as it may often occur, by persistent hearing loss, leading thus to surgical intervention.^{1,2}

OME affects mainly children aged six months to four years, and most of the episodes resolve spontaneously within three months; nevertheless, in 5 percent to 10 percent of cases they can last even more than one year, and, in 30 percent to 40 percent of the cases, they are recurrent.^{3,4}

Several factors, including infectious agents and allergy,

support the development of OME.⁵ Moreover, in recent years, there has been increasing interest in the role played by biofilms in perpetuating the chronicity of certain bacterial infections, such as OME. Indeed, direct detection of biofilms on biopsy specimens, taken from the middle ear mucosa in children with OME, supports even more this hypothesis that chronic middle ear disorders may be biofilm related.^{6,7}

Therefore, the aim of the present cross-sectional study was to assess the association of atopy and endoscopic features with the presence of OME in a cohort of children affected by upper respiratory tract infections.

METHODS

Population

This cross-sectional study evaluated, throughout the whole year, 287 consecutive children (152 males and 135 females aged between two and 15 years) presenting with acute upper-airway infection persistent for at least ten days.

Middle ear effusion (MEE) associated with OME can be detected by screening or as an incidental finding because, in most of the cases, there are no acute infectious symptoms. Nevertheless, MEE is a prerequisite for OME. Even though myringotomy keeps being the gold standard, pneumatic otoscopy and tympanometry offer the optimum balance of sensitivity and specificity in the diagnosis of MEE.^{1,2} Nevertheless, OME was primarily diagnosed on the basis of the patient's history and symptoms, such as hearing loss, otalgia, language or behavioral disorders, vertigo, and tinnitus aurium. In order to confirm the diagnosis, physical examination findings were required; all patients underwent pneumatic otoscopy and tympanometry. The presence of hearing loss, the presence of middle ear effusion on pneumatic otoscopy (at least two tympanic membrane abnormalities and/or otoscopy typically showing a retracted/concave tympanic membrane with a color change) with no signs of acute

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inflammation, and the results of the conducted tympanometric examination allowed us to make a diagnosis of OME.

A nasal endoscopy with optical fibers was performed on each patient, according to validated criteria.⁸ A diagnosis of acute rhinosinusitis (ARS) was made in the presence of purulent discharge from the ostiomeatal and/or sphenoethmoidal complex and a diagnosis of adenoiditis in the presence of pus on the adenoids.⁹

Allergic rhinitis (AR) was diagnosed, according to validated criteria, on the basis of history, typical signs and symptoms, and positive skin prick test.¹⁰ Children were arbitrarily subdivided into three age groups: two to five years, six to ten years, 11 to 15 years.

A university-based ethical committee approved the present study, and both parents of each child signed an informed consent.

Statistical Analysis

Data were described as mean and SD or as counts and percent. Logistic regression was used to measure the association of AR and the endoscopic diagnosis of rhinosinusitis, adenoiditis, or both, with the presence of OME, while adjusting for age groups (2-5, 6-10, and 11-15 years). Odds ratios (ORs) and their 95 percent confidence intervals (CIs) were computed. Moreover, subgroup analysis was performed to assess the strength of the found associations within each age group. The Fisher exact test was also used for univariable analysis whenever the logistic model could not be estimated. Finally, to identify the independent role of AR, endoscopic pattern, and age, a multivariable logistic model was fitted. We calculated the c statistic and the shrinkage coefficient to measure model discrimination and model calibration, respectively. Stata 9.2 (Stata Corporation, College Station, TX) was used for computation. A two-sided *P* value <0.05 was considered statistically significant.

RESULTS

Two hundred eighty-seven consecutive patients, 152 males and 135 females, with a mean age of 7.5 years (SD, 3.9) were enrolled in our study. The patients were stratified into three age groups: two to five years old, 6 to 11 years old, and 12 to 15 years old.

All children were evaluated by an ENT specialist who performed a nasal endoscopy with optical fibers and an otoscopic and tympanometric evaluation. After nasal endoscopy, 207 (75%) showed an endoscopic pattern of ARS, 20 of adenoiditis (7.3%), and 49 (17.7%) of both. Fifty-three patients had a diagnosis of otitis media with effusion; out of these, 23 showed ARS, ten isolated adenoiditis, and 20 both features; thus, only 11 percent of children affected by ARS without adenoiditis had OME, but the percentage increased to 50 percent when considering patients with adenoiditis

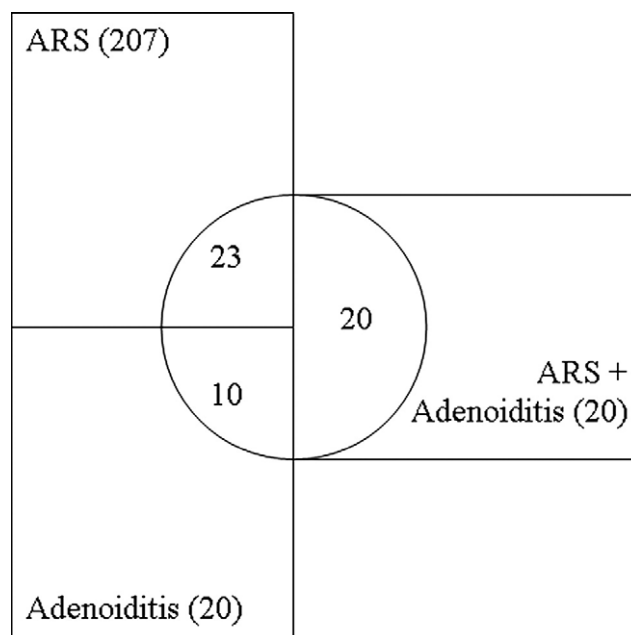


Figure 1 The scheme of the evaluated population.

and 40 percent when considering those with ARS associated to adenoiditis (Fig 1).

The association of OME and specific endoscopic diagnosis was confirmed in the two to five years group, with a prevalence of OME in children with adenoiditis, ARS, or both of 50 percent, 17 percent, and 42 percent, respectively ($P = 0.008$), and in the 6 to 11 years group (prevalences of 62%, 8%, and 58%, respectively; $P < .001$) but not in the older patients (prevalences of 25%, 6%, and 0%, respectively; $P = 0.290$).

OME was diagnosed in 26 allergic children (24%) and in 27 nonallergic ones (15%), corresponding to a significant increase in risk in the former group, with an age-adjusted OR of 2.33 (95% CI, 1.22-4.47, $P = 0.011$).

Similarly, OME was significantly more frequent in children with atopy (20% vs 10%; age-adjusted OR, 2.69 [95% CI, 1.31-5.50]; $P = 0.007$). Moreover, when comparing atopic children with nonatopic ones, OME was more frequent in the first group in the youngest patients aged 2 to 5 years (43% vs 20%, $P = 0.016$) and in the oldest patients aged 11 to 15 years (13% vs 0%, $P = 0.022$); it was equally common in the intermediate age class of 6 to 10 years (20% vs 19%, $P = 1.000$).

On a multivariable analysis, allergic rhinitis ($P = 0.01$), endoscopic pattern of adenoiditis ($P < 0.001$), and age group ($P = 0.013$) were all shown to be independently associated with a diagnosis of OME.

The model could be considered as sufficiently reliable for future predictions because both calibration (c statistic = 0.77) and shrinkage coefficient (=0.89) were high (Table 1 and Fig 2). At last, we have also detected a progressive increase in the risk of OME in patients with atopy only, with adenoiditis only, and with both of them, with age-adjusted ORs of 2.83 (95% CI, 1.39-7.75; $P = 0.004$), 8.12 (95% CI,

Table 1
Multivariable logistic model for otitis

Variable	Coefficient	Standard error	Z test	P value	OR (95% CI)
Atopy (yes vs no)	0.93	0.36	2.59	0.010	2.53 (1.25-5.11)
Aden only vs both	0.65	0.56	1.16	0.247	1.92 (0.64-5.81)
Rhino only vs both	−1.51	0.38	−3.95	<0.001	0.22 (0.10-0.47)
Age 2-5 vs 11-15	1.64	0.56	2.94	0.003	5.17 (1.73-15.42)
Age 6-10 vs 11-15	1.19	0.57	2.08	0.037	3.28 (1.07-10.00)
Intercept	−2.11	0.62	−3.38	0.001	—

Wald test for endoscopic pattern of adenoiditis: $\chi^2 = 15.63$, $P < 0.001$; Wald test for age group: $\chi^2 = 8.72$, $P = 0.013$.

2.37-27.83; $P = 0.001$), and 10.30 (95% CI, 1.85-57.27; $P = 0.008$), with respect to patients with neither adenoiditis nor atopy.

DISCUSSION

Even though some studies have shown that allergic rhinitis predisposes to the development of OME,¹¹⁻¹⁴ there is no complete agreement in the literature. Nevertheless, it has been shown that nasal inflammation can cause a longstanding obstruction of the eustachian tube and that inflammation in allergic children affected by OME has a similar allergic profile in the nasopharynx and in the middle ear.^{15,16} More investigations are needed to enhance the knowledge of the pathophysiologic interactions between the nose and middle ear.

Our epidemiologic data support the existence of a relationship between OME and allergic rhinitis, but we have underlined that even adenoid infection, associated or not with ARS, is a risk factor for OME; on the whole, our results tend to explain that adenoiditis and atopy are independent risk factors influencing the persistence of middle ear effusion.

In fact, 50 percent of the children with isolated adenoiditis and 40 percent of those with adenoiditis and ARS presented with a concomitant OME; on the other hand, only 11 percent of the children with isolated ARS presented with a concomitant OME. As for allergy, OME was diagnosed in 26 children with (24%) and in 27 patients without AR (15%), with a statistically significant difference. Moreover, the prevalence of OME resulted inversely correlated to age.

Even when these data were analyzed by multivariate analysis, allergic rhinitis ($P = 0.010$), endoscopic pattern of adenoiditis ($P < 0.001$), and age group ($P = 0.013$) have been shown to be independently associated with a diagnosis of OME. Therefore, allergic rhinitis and adenoiditis would be independent factors in determining the risk of OME in the present cohort.

Nasal obstruction associated with allergic rhinitis could increase the risk of OME independently from a concomitant tubaric dysfunction, without having to be associated with adenoiditis. Also, the presence of OME may cause obstruction at the eustachian tube ostia and may thus promote the development of persistent MEE. In other words, there could be some degree of allergic inflammation in the middle ear mucosa that is actually able to promote MEE.

The “shock organ” hypothesis, considering airways as a whole, underlines that an allergic process takes place in situ and that the same process is responsible for an inflammatory swelling of the eustachian tube and middle ear mucosa, which is true particularly during childhood.¹⁷ On the other hand, another hypothesis considers the persistency of MEE only as a result of an eustachian tube dysfunction; in this case, the dysfunction would be secondary to an inflammatory obstruction of the nose, causing a poor ear cavities ventilation and an increasing absorption of nitrogen.¹⁸

However, it must be noted that none of our allergic children without adenoiditis developed OME, accounting for a major role of the latter condition in its pathogenesis. Thus, allergy does not seem to be able to cause by itself a clinically evident OME, although it could promote local exudation in the middle ear according to the “shock organ” hypothesis.

At last, it could also be interesting to consider the role probably played by biofilms in perpetuating the chronicity and severity of OME. In fact, biofilms have been identified

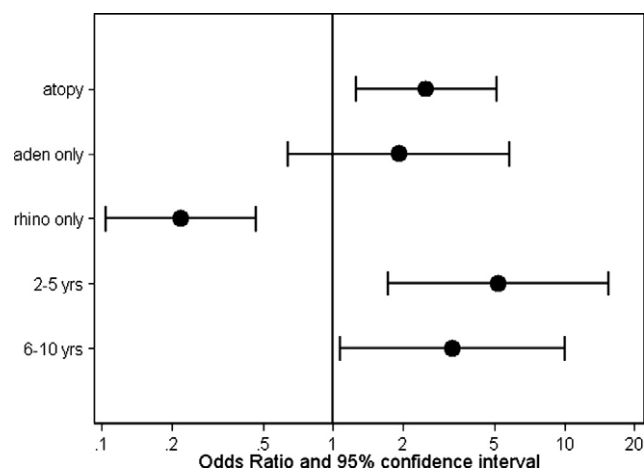


Figure 2 The multivariable logistic model for otitis.

in samples of tissue obtained during sinus surgery in patients presenting with chronic rhinosinusitis; also, in these types of patients, it has recently been evidenced, after removal, that their adenoids had almost their entire mucosal surface covered with biofilms.¹⁹ Biofilms in the nasopharynx of children with chronic rhinosinusitis may act as a chronic reservoir for bacterial pathogens resistant to standard antibiotics.²⁰ Also, it has been very recently reported that there is a direct detection of biofilms on middle ear mucosa biopsy specimens from children with OME and recurrent otitis media, which could actually support the hypothesis that these chronic and recurrent middle ear disorders are biofilm related.⁷ On the whole, even though there are several issues that still need to be clarified regarding this topic, the presence of bacterial biofilms in many disease states of otolaryngologic interest is now becoming well documented.²¹

CONCLUSION

This study suggests that allergic children and children with adenoiditis may be at risk to develop OME. Nevertheless, this risk might become much higher when these two conditions are concomitantly present and the patients are younger. These claims are relevant and significant, and, although not novel, they represent an important message for clinicians because these pathologies affect a significant percentage of the population and the presented considerations may affect their management.

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FINANCIAL DISCLOSURE

None.

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