

Nasal endoscopy in asthmatic children: assessment of rhinosinusitis and adenoiditis incidence, correlations with cytology and microbiology

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Summary

Background Upper respiratory airway diseases may induce a worsening of asthma. Sinusitis represents one of the most common chronic diseases. The association of asthma and sinusitis varies greatly in different studies, depending on diagnostic procedures.

Objective The aims were: (i) to demonstrate that nasal endoscopy may be easily feasible in asthma at paediatric age; (ii) to evaluate the incidence of rhinosinusitis and adenoiditis in children with asthma by nasal endoscopy; (iii) to correlate inflammatory parameters such as cytology and microbiological cultures with nasal endoscopy findings.

Subjects and methods One hundred and forty-five asthmatic children were evaluated, 48 males and 97 females, with an average age of 7.27 years. Evaluated parameters were the incidence of rhinosinusal infections in asthmatic children, and the role of: (i) nasal endoscopy, (ii) nasal cytology, and (iii) nasal microbiology in their diagnoses.

Results Nasal endoscopy was successfully performed on 128 patients. Twenty-six children had endoscopic rhinosinusitis alone, 10 had adenoiditis alone, and 35 showed endoscopic rhinosinusitis associated with adenoiditis. There were significant correlations between endoscopic rhinosinusitis and adenoiditis ($P < 0.001$), between clinical and endoscopic rhinosinusitis ($P < 0.001$), between endoscopic rhinosinusitis and adenoiditis and microbiology ($P < 0.05$ and $P < 0.0001$, respectively), and between microbiology and cytology ($P < 0.05$).

Conclusion This study shows that rhinosinusal infections are common in asthmatic children. Moreover, nasal endoscopy might represent a fruitful tool in the management of asthmatic children.

Keywords: asthmatic children, rhinosinusitis, adenoiditis, nasal endoscopy, microbiology, cytology

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Introduction

There is general agreement that upper respiratory airways diseases may induce a worsening of asthma, mainly concerning allergic rhinitis, viral infections and rhinosinusitis

[1]. Unrecognized sinusitis has been considered by several authors as a significant pathogenic factor in asthmatic patients [1–3].

Sinusitis represents one of the most common chronic diseases, affecting > 14% of general population in the USA but, at paediatric age, it is probably underestimated [4].

From a pathophysiological point of view, the definition of rhinosinusitis seems to be more appropriate, since

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>90% of adult patients suffering from uncomplicated rhinitis, probably due to a viral infection, shows some abnormalities of the mucosa of the paranasal sinuses studied with computed tomography (CT) scans [5].

The obstruction of the ostiomeatal complex (OMC), which is a crucial area for the ventilation and drainage of the paranasal sinuses, is the first pathogenic event leading to a process of acute or chronic rhinosinusitis [6]. Nasal infections and allergic inflammation can induce: mucosal oedema of the mucosa of this important region, alteration of mucociliary clearance, production of numerous cytokines and chemokines and adhesion molecule up-regulation [7]. All these factors are involved in the genesis and maintenance of inflammatory process of paranasal mucous membranes.

Recently, the introduction of a new standardized technique, rhinosinusal endoscopy with rigid and flexible instruments, for diagnostic and surgical aims, has offered the possibility of an *in situ* examination and of collecting samples for microbiological cultures and cytological evaluation [8].

Nasal cytology is another important technique to evaluate the presence of rhinosinusal inflammation. The importance of examining smears of nasal secretions to differentiate allergic and infectious nasal diseases was emphasized many years ago by Hansel: in a study performed on 1000 allergic patients, he reported that nasal eosinophilia was strongly associated with allergy, whereas neutrophils were more indicative of an infectious disease [9]. Another study, performed in 1994, demonstrated that occult chronic sinusitis in children may be suspected when there are more than five neutrophils per field, using nasal cytology, performed with scraping of the inferior turbinate, even though the authors suggested a confirmation of sinusitis through X-ray films [10].

Traditional sinus radiography has been the most commonly employed tool to diagnose chronic sinusitis.

This method suffers from several limitations, since it is characterized by high false-negative and false-positive rates and can not correctly evaluate ethmoid sinuses and OMC. Moreover, Rx radiographic film can be difficult to interpret in young children.

In 1989, McAlister *et al.* demonstrated that traditional radiography did not correlate with CT scanning in a group of children with recurrent rhinosinusitis: CT scanning was more accurate and able to identify abnormalities in >80% of patients [11].

However, according to the report of the American Academy of Otorhinolaryngology (AAO) of 1996, all the patients with a history of recurrent acute or chronic rhinosinusitis should be examined with a rigid or flexible endoscope, as a standard procedure [12]. This report states that nasal endoscopy provides reliable visualization of all the accessible areas of the sinus drainages and adenoids, and should be performed before the evaluation by CT scanning.

Our principal aims were: to demonstrate that nasal endoscopy may be easily feasible at paediatric age, and to evaluate consequently the incidence of rhinosinusitis and adenoiditis in children with asthma, since there are some studies showing a relevant association between asthma and rhinosinusal infections. The secondary aim was to correlate inflammatory parameters, such as cytology and microbiological cultures, to nasal endoscopic findings.

Materials and methods

Subjects

Asthmatic children ($n = 145$) were evaluated consecutively, 48 males and 97 females, with an average age of 7.27 years (range 2–15 years), 10 of them aged <4 years. All of them attended for asthma assessment. A detailed clinical history and a complete physical examination, including allergy evaluation, were carried out by a paediatrician and an ENT specialist for each patient (Table 1). Asthma diagnosis and severity were established according to GINA criteria [13]. Moreover, spirometry was performed in 68 co-operating children. A reduced forced expiratory volume in 1 s (FEV₁) was detectable in 17 children, all of them showing a reversible bronchoconstriction.

Study design

To evaluate the incidence of rhinosinusal infections in a group of asthmatic children, the role of nasal endoscopy, of nasal cytology and microbiology in the diagnosis of rhinosinusitis or adenoiditis and the correlation between these parameters, we excluded all the children who met the

Table 1. Demographic data

Demographic characteristics

Patients studied 145
Age (mean of years) 7.3

Clinical findings

Asthma grade
Grade 1 = 88/145
Grade 2 = 40/145
Grade 3 = 13/145
Grade 4 = 4/145

Allergy
80/145 allergic patients
65/145 non-allergic patients

following exclusion criteria: use of antibiotics, nasal corticosteroids or oral corticosteroids within the previous 2 weeks. The study was approved by the Institutional Review Board and informed oral consent was obtained from their parents.

The complete and differential blood cell count, erythrocyte sedimentation and total and specific IgE were analysed.

ENT examination consists of nasal and laryngeal endoscopy with optical fibres, and otoscopy. Signs and symptoms of rhinosinus infection were also investigated, according to validated criteria [12], to show a possible correlation with the endoscopic findings.

Nasal endoscopy

This approach is crucial to visualize the inferior and middle turbinate, the septum, the OMC, the fontanella area, the sphenoethmoidal recess (SER) and the rhinopharynx.

The endoscopic technique can detect mucosal infections, mechanical obstructions and lymphoid tissue disease of the rhinopharynx, such as adenoids.

The endoscopy is performed with a paediatric rigid endoscope diameter 2.7 mm with 30° angle of vision (Smith & Nephew code no. 23-0854) with a 250-W light source (Smith & Nephew code no. 23-0556) and a light cable of 1.8 m length. Some of these endoscopies were video recorded with a micro camera (Panasonic WV-K156) connected to a VHS video recorder-monitor set.

The child lies supine with his head bent by about 45°. Some cotton wool soaked with anaesthetic and decongestion solution (ossibuprocaine chlorhydrate 1% and xylo-metazoline chlorhydrate 0.1% in equal parts) is placed into the nose.

Endoscopic evaluation for children can be reduced to two phases. As a first step, after removing the cotton wool soaked with anaesthetic and decongestant solution, the endoscope is introduced along the nasal fossa floor to evaluate the inferior turbinate volume, the inferior meatus, the septum morphology. The endoscope proceeds toward the rhinopharynx to evaluate the presence of lymphatic tissue, oedema, pathologic drainages and the conditions of the Eustachian tube: in this way the nasal obstruction and the presence of adenoiditis are assessed. In the second step the sphenoethmoidal recess and, turning the instrument towards the lateral nasal wall, the fontanel area and the OMC are investigated. In this region it is important to study the presence of pathological drainages. Purulent discharges at the level of the OMC and the posterior fontanel area are a sign of anterior sinusitis (maxillary sinus, anterior ethmoid sinus and frontal sinus), whereas secretions in the sphenoethmoidal recess show sinusitis of the posterior area (posterior ethmoid and sphenoid sinus). After complete

diagnostic rhinosinus endoscopy, a small flexible tampon is introduced to take nasal culture directly from the pathological drainage under endoscopic view, as near as possible to the natural ostium of the pathological sinus. The endoscopy procedure takes $\pm 3-5$ min for both nasal cavities. After each ENT examination and rhinosinus endoscopy, all clinical data are registered on a proper form.

Nasal specimens for cytology and microbiological culture are collected during nasal endoscopy.

The endoscopic diagnosis of rhinosinusitis and the criteria for evaluating its severity were performed according to validated criteria [8,12].

Microbiology

Nasal specimens for culture were collected with a sterile cotton swab directly from the infected area under fiberoptic endoscopic guidance, to investigate the presence of *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Moraxella catarrhalis*, *Str. pyogenes*, *Staphylococcus aureus* and other pathogens. When there was no infected area, nasal specimen was obtained from the middle meatus. Nasal specimens were collected from each nostril. The specimens were cultured using standard techniques in a central laboratory.

Nasal cytology

Nasal scrapings were obtained by scraping the head of the inferior turbinate with a cotton swab, as described in previous reports [14,15]. Briefly, after the nasal scraping, the cotton tip of the swab was immersed in a plastic tray with PBS and transferred to a 10-mL polypropylene tube. The recovered fluids were centrifuged at 220 g for 10 min, and each pellet was re-suspended in PBS (2 mL). Cell suspensions were filtered to reduce the quantity of mucus, and cytospin slides were prepared using standard techniques.

Smears were stained with Diff Quik stain to differentiate between eosinophils, neutrophils and epithelial cells and were analysed by optic microscope (Olympus U-SPT). The number of inflammatory cells was expressed as a percentage of cells. Samples were examined in a blinded fashion.

Statistical analysis

The data collected were subjected to statistical analysis by χ^2 test. Regression analysis was included. All tests with *P*-values < 0.05 obtained were considered statistically significant.

Table 2. Endoscopic findings—128/145 patients performed nasal endoscopy*Endoscopic diagnosis*

26/128 patients with endoscopic rhinosinusitis alone

10/128 patients with adenoiditis

35/128 patients with endoscopic rhinosinusitis and adenoiditis

Clinical diagnosis

79/128 patients with positive clinical rhinosinusitis

49/128 patients without clinical rhinosinusitis

Results

Patients with asthma ($n = 145$) occurring in the previous year were examined: 88 with mild intermittent asthma, 40 with mild persistent asthma, 13 with moderate and four with severe asthma (according to the GINA criteria) (Table 1). There was no significant association between the presence of endoscopic sinusitis and a particular grade of asthma ($P = \text{NS}$).

Eighty-four patients were allergic to the more common aeroallergens, 39 were sensitized to *Dermatophagoides farinae* and *D. pteronyssinus*, seven to pollens, 38 were polysensitized to mites and pollens. There was no association between atopy and endoscopic sinusitis and adenoiditis ($P = \text{NS}$). Fifty-seven patients (43.5%) had also allergic rhinitis.

Nasal endoscopy was successfully performed on 128 patients (Table 2). Nevertheless, 17 children did not undergo endoscopy because of poor co-operation (without correlation with their age).

Twenty-six patients showed endoscopic findings of rhinosinusitis alone, 10 showed endoscopic features of adenoiditis alone, and an association of rhinosinusitis and adenoiditis was endoscopically detected in 35 children (Table 2). Endoscopy revealed that rhinosinusitis was bilateral in 36 children and monolateral in 25 (15 in the right nostril and 10 in the left nostril).

Clinical sinusitis was diagnosed in 79 children on the basis of history and according to the AAO criteria [12] (Table 2).

Microbiological culture results, concerning children with endoscopic and clinical rhinosinusitis, and adenoiditis, are analytically reported in Table 3 and in Fig. 1.

Cytological findings, concerning the neutrophil infiltrate, arbitrarily defined as $>5\%$ of neutrophils [16], are represented in detail in Table 4.

There was a significant association between clinical rhinosinusitis and endoscopically demonstrated rhinosinusitis ($P < 0.001$) with an odds ratio (OR) of 3.0. Moreover, there was a significant association between endoscopic OR of 8.1.

Table 3. Microbiological findings*61 patients with positive endoscopic sinusitis*18/61 patients were positive for *Streptococcus pneumoniae*12/61 patients were positive for *Haemophilus influenzae*4/61 patients were positive for *Moraxella catarrhalis*7/61 patients were positive for *Staphylococcus aureus*2/61 patients were positive for *Str. pyogenes*

1/61 patients were positive for other pathogens

*67 patients with negative endoscopic sinusitis*7/67 patients were positive for *Str. pneumoniae*9/67 patients were positive for *H. influenzae*4/67 patients were positive for *M. catarrhalis*6/67 patients were positive for *Sta. aureus*0/67 patients were positive for *Str. pyogenes*

3/67 patients were positive for other pathogens

*79 patients with positive clinical sinusitis*20/79 patients were positive for *Str. pneumoniae*13/79 patients were positive for *H. influenzae*6/79 patients were positive for *M. catarrhalis*13/79 patients were positive for *Sta. aureus*2/79 patients were positive for *Str. pyogenes*

2/79 patients were positive for other pathogens

*49 patients with negative clinical sinusitis*4/49 patients were positive for *Str. pneumoniae*6/49 patients were positive for *H. influenzae*1/49 patients were positive for *M. catarrhalis*11/49 patients were positive for *Sta. aureus*0/49 patients were positive for *Str. pyogenes*

2/49 patients were positive for other pathogens

*45 patients with adenoiditis*13/45 patients were positive for *Str. pneumoniae*13/45 patients were positive for *H. influenzae*3/45 patients were positive for *M. catarrhalis*6/45 patients were positive for *Sta. aureus*0/45 patients were positive for *Str. pyogenes*

0/45 patients were positive for other pathogens

*83 patients without adenoiditis*9/83 patients were positive for *Str. pneumoniae*10/83 patients were positive for *H. influenzae*3/83 patients were positive for *M. catarrhalis*16/83 patients were positive for *Sta. aureus*0/83 patients were positive for *Str. pyogenes*

0/83 patients were positive for other pathogens

Endoscopic rhinosinusitis and adenoiditis were significantly associated with positive microbiology ($P < 0.05$ and $P < 0.0001$, respectively), whereas clinical rhinosinusitis was not associated with a positive microbiological result ($P = \text{NS}$). Particularly, *Str. pneumoniae* and its association with *H. influenzae* were significantly associated with endoscopic rhinosinusitis ($P = 0.009$, OR = 3.2 and $P = 0.025$, OR = 7.1, respectively); the presence of *Str. pneumoniae* and *H. influenzae* was associated with adenoiditis ($P = 0.024$, OR = 7.3).

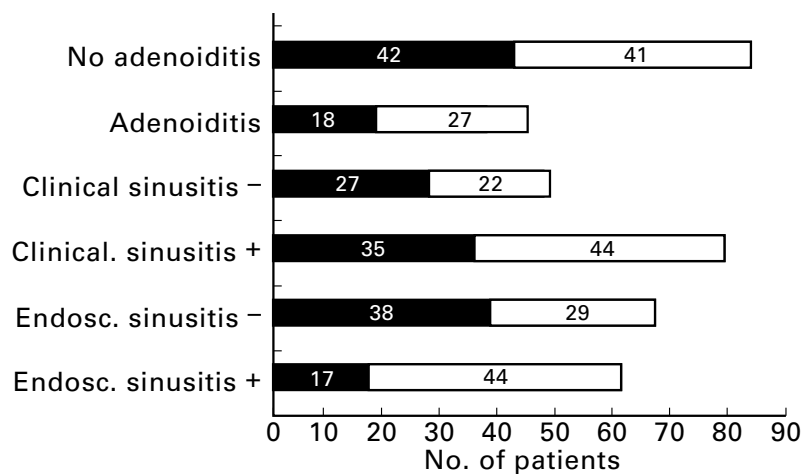


Fig. 1 Distribution of patients with positive and negative cultures according to the diagnostic issues. ■, Patients with negative culture test; □, patients with positive culture test.

Clinical and endoscopic rhinosinusitis were not associated with cytological findings ($P = \text{NS}$). On the other hand, an association between cytological and microbiological results was present ($P < 0.05$). Particularly, neutrophils were significantly associated with *Str. pneumoniae* ($P = 0.005$) or *H. influenzae* ($P = 0.008$).

Discussion

Nasal endoscopy is a useful and practicable technique, also in very young children, after an appropriate local topical anaesthesia, since it entails visualization of numerous sinusal structures.

This new approach allows a better diagnosis in paediatric asthma, to identify some worsening factors, such as rhinosinusitis and adenoiditis, and to treat them adequately. Thus, asthma management may improve, as some authors have already demonstrated that, treating sinusitis, asthmatic symptoms, lung function, and non-specific hyperreactivity improve [17–19].

Table 4. Cytological findings—112/128 patients performed nasal scraping and nasal endoscopy

50/112 patients with positive endoscopic sinusitis	
30/50 patients have neutrophil infiltrate	
20/50 patients have no neutrophil infiltrate	
62/112 patients with negative endoscopic sinusitis	
35/62 patients have neutrophil infiltrate	
27/62 have no neutrophil infiltrate	
67/112 patients with positive clinical sinusitis	
41/67 patients have neutrophil infiltrate	
22/67 patients have no neutrophil infiltrate	
46/112 patients with negative clinical sinusitis	
26/46 patients have neutrophil infiltrate	
15/46 patients have no neutrophil infiltrate	

Frequent upper respiratory infections, a partial immaturity of the immune system, and narrow respiratory airways predispose children to having more sinusal complications. Allergy is a controversial pathogenic factor. In fact, sinus disease prevalence was found to be 63% in atopic children with chronic respiratory disease symptoms [20]. Nevertheless, in a more recent study, Rachelefsky *et al.* demonstrated that only 37% of children with chronic rhinosinusitis have a positive skin prick test [21]. Actually, controlled studies showing the incidence of sinusitis in the allergic group compared with non-allergic group are very few. In our study, we demonstrate that there is no association between atopy and endoscopic rhinosinusal infections.

The association of chronic rhinosinusitis with asthma has been reported by some authors. One study demonstrated that 34.7% of patients with chronic asthma had chronic rhinosinusitis and that 25% of children with chronic rhinosinusitis has asthma [22]. Other studies did not demonstrate this association [23,24].

We have demonstrated that nasal endoscopy may be considered a feasible and correct approach in asthmatic children to investigate rhinosinusal or adenoid infections. Endoscopic findings correlate with clinical diagnosis, moreover endoscopy allows to identify infections even without rhinosinusal symptoms (Fig. 1). Thus, we have more chance to treat asthmatic children correctly by identifying a subclinical rhinosinusal infection [25]. On the other hand, the clinical diagnosis is sometimes not supported by endoscopic finding of infection, probably since there are no pathognomonic symptoms (Fig. 2). Moreover, clinical diagnosis does not correlate with microbiology, whereas the endoscopic diagnosis is significantly associated with positive cultures.

In addition, since traditional radiography is not useful for evaluating the anterior ethmoid cells and the ostiomeatal complex from which most sinus disease originates,

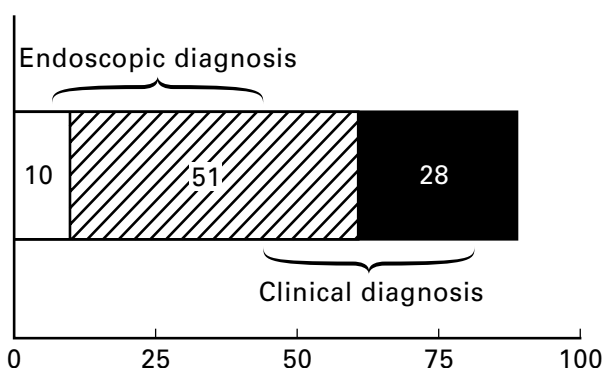


Fig. 2 Distribution of asthmatic children according to endoscopic and/or clinical diagnosis. □, Patients with endoscopic diagnosis alone; hatched, patients with endoscopic and clinical diagnosis; ■, patients with clinical diagnosis alone.

endoscopy might be considered as a 'first level' diagnostic tool in asthmatic children. In fact, CT and magnetic resonance have to be envisaged as more complex and expensive diagnostic steps to be performed in selected cases on the basis of endoscopic findings.

Even though nasal cytology is not associated with clinical and endoscopic diagnosis, it should, however, be considered in the diagnostic pathway, since neutrophils are significantly associated with some pathogens. Only by considering all procedures can a correct management be achieved, as for example high levels of positive culture have been reported in normal subjects as well as negative microbiology in patients with rhinosinusitis [26]. Nasal endoscopy allows guidance of micro swab sampling of purulent drainage from specific sinus drainage regions, minimizing contamination by the general nasal flora, to identify the involved pathogen(s).

Moreover, a close follow up of those children with negative endoscopic findings and positive cytology and microbiology should be considered. In fact, further longitudinal studies are required to define better this category, also concerning the decision of treating them, since they may be at risk of developing a rhinosinusal infection.

In conclusion, this study points out that nasal endoscopy might play a fruitful role in the management of asthmatic children, because it can really 'see' what the situation of the nose is.

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