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COMPARISON OF CELLULAR AND BIOCHEMICAL MARKERS OF AIRWAY INFLAMMATION IN PATIENTS WITH MILD-TO-MODERATE ASTHMA AND CHRONIC OBSTRUCTIVE PULMONARY DISEASE: AN INDUCED SPUTUM AND BRONCHOALVEOLAR LAVAGE FLUID STUDY

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Although the clinical pictures of asthma and chronic obstructive pulmonary disease (COPD) may be similar, the pathogenesis differs in many aspects. The aim of the present study was to compare the cellular and biochemical features of airway inflammation in patients with asthma and COPD. The study was conducted in 22 patients with asthma (M/F 12/10, mean age 36 ±14 years) and 17 patients with COPD (M/F 10/7, mean age 57 ±11 years). Each patient underwent sputum induction followed by bronchoscopy, and bronchoalveolar lavage. Total and differential cell counts and the concentration of interleukin-8 (IL-8) and myeloperoxidase (MPO) were measured in induced sputum (IS) and BALF. We found no significant differences in the total and differential cell counts in IS between asthma and COPD patients. However, COPD patients showed an increased total macrophage count in BALF compared with asthma patients. The relative eosinophil count in BALF was significantly higher in patients with asthma *vs*. COPD. The concentration of IL-8 in IS and BALF was significantly higher in patients with COPD *vs*. asthma patients. The BALF concentration of MPO was significantly higher in patients with COPD compared with asthma patients. We conclude that the comparison of cellular composition and the concentration of inflammatory mediators in IS does not differentiate between asthma and COPD. The evaluation of BALF reveals more differences in the cellular and biochemical features of airways inflammation in patients with asthma and COPD than that of IS.

Key words: *asthma, BALF, IL-8, COPD, induced sputum, MPO*

INTRODUCTION

Despite a number of important differences in the pathogenesis, course, and prognosis, asthma and chronic obstructive pulmonary disease (COPD) have many features in common, such as, *e.g.*, airways inflammation. Recent studies have shown that the nature of the inflammatory changes in the airways of asthma patients differs considerably from the inflammatory changes observed in COPD patients (1). Therefore, determining the type of airways inflammation could play an important role in the clinical management of these conditions, being of potential use in the differential diagnosis and the prediction of response to treatment. Although numerous studies characterised numerous cellular and biochemical aspects of airways inflammation in asthma and COPD, several issues still need to be elucidated.

Various types of samples are used to assess the nature and severity of inflammation in the airways of patients with asthma and COPD. The most reliable data are obtained from samples taken directly from the bronchial wall, such as biopsies. Obtaining such materials *in vivo* is, however, fraught with difficulties, which is why numerous studies have investigated techniques for indirect evaluation of airway inflammation, based on samples obtained from bronchial lumen and/or pulmonary alveoli. Such samples include induced sputum (IS) and bronchoalveolar lavage fluid (BALF). Experience so far suggests clear correlations between the cellular composition of IS and BALF (2). On the other hand, many authors think that these two materials originate from two anatomically and functionally different areas of the respiratory tract and hence reflect inflammatory phenomena in two different compartments of the airways (3). In light of the above data, examination of both IS and BALF is a good tool for the evaluation and monitoring of chronic airways inflammation. Because bronchoalveolar lavage (BAL) requires an invasive procedure of bronchoscopy, it is used in research studies rather than in routine clinical practice. IS and BALF evaluate both the number and cellular composition as well as the concentration of inflammatory mediators, including interleukin-8 (IL-8) and myeloperoxidase (MPO). IL-8 is a potent activator and recruitment factor for of neutrophils (4) and eosinophils, and shows chemotactic properties for T cells (5). MPO is considered one of the markers of neutrophil activity.

Given the scarcity of publications on airways inflammation in subjects with mild COPD, we decided to compare selected cellular and biochemical markers of airways inflammation in subjects with mild to moderate COPD and mild to moderate asthma.

The detailed aims of our investigation were: (1) to evaluate the cellular composition and concentration of selected inflammatory mediators in IS and BALF in patients with asthma and COPD, (2) to compare cellular composition and concentrations of the selected inflammatory mediators (IL-8 and MPO) in IS

and BALF, and (3) to evaluate the use of the above evaluations for the differential diagnosis of asthma and COPD.

MATERIAL AND METHODS

The study is part of a research project approved by the Bioethics Committee of the Medical University of Warsaw (No. 172/2003) and each subjects gave written informed consent.

The study included 22 subjects with asthma (12 men and 10 women) and 17 subjects with COPD (10 men and 7 women) with stable disease. The diagnosis (asthma or COPD) was based on the typical medical history and physical examination, chest X-ray, spirometry, flow-volume curve (Lung Test 1000, MES, Poland), the bronchial obstruction reversibility test, according to the guidelines of the European Respiratory Society (ERS) (6), methacholine bronchial challenge, allergy skin prick tests, and total serum IgE. The severity of asthma and COPD was assessed in accordance with the Global Initiative for Asthma (GINA) 2002 guidelines (7) and the 2001 guidelines of the Global Initiative for Chronic Obstructive Lung Disease (GOLD) (8), respectively. Additional enrolment criteria included: (1) stable disease, and (2) at least 3 months of symptomatic treatment without the use of anti-inflammatory medication (glucocorticosteroids) prior to the study. A detailed description of the study groups is presented in *Table 1*.

The sputum was induced by hypertonic NaCl solutions, in accordance with the ERS standards (9). The detailed induction protocol has been described in a previous publication (10). Induction was discontinued after a subject produced a sufficient volume of sputum (at least 2 ml), or FEV_1 decreased by at least 20% from baseline (FEV_1 following salbutamol administration was taken as the baseline FEV_1). The sputum was processed as described previously (11). The total cell count was assessed per 1 ml of sputum. The differential cell count was determined in May-Grunwald-Giemsa-stained smears based on the morphology of 300 cells from various fields. The sputum sample was considered adequate if epithelial cells accounted for no more then 50% of total cellularity, and the

Table 1. Demographic data of the asthma and COPD patient groups.

Variable	Asthma n = 22	COPD n = 17	P
Gender (n)			
• females	10	7	NS
• males	12	10	NS
Age (years)	36.1 ±14.5	56.8 ±11.2	<0.05
BMI (kg/m^2)	24.7 ±3.3	26.4 ±4.2	NS
Smoking history, n (%)	10 (45)	17 (100)	<0.05
Pack-years (in current and ex-smokers)	6.4 ±12.1	38.6 ±12.1	<0.05
Age at onset of symptoms (years)	18.2 ±19.7	51.1 ±12.4	<0.05
Duration of symptomatic illness (years)	16.0 ±11.2	5.1 ±4.2	<0.05
Atopy, n (%)	16 (73)	3 (18)	<0.05
Chronic rhinitis, n (%)	12 (55)	3 (18)	<0.05
Chronic sinusitis, n (%)	8 (36)	5 (29)	NS
Pc_{20} (mg/ml)	2.3 ±3.0	9.3 ±8.3	<0.05
FEV_1 % predicted	84 ±17	73 ±19	NS
FVC % predicted	102 ±14	102 ±23	NS
FEV_1% FVC	69 ±8	59 ±6	<0.05

Mean values are ± SD.

non-epithelial cell count was in excess of 200 cells per slide. Results obtained by Beld *et al* (12) were used as reference values for healthy adults, where the mean percentage counts were: 0.4% for eosinophils, 37.5% for neutrophils, 58.8% for macrophages, and 1.0% for lymphocytes.

Flexible bronchoscopy was performed under local anaesthesia (2% lidocaine) following premedication (inhalated salbutamol 400 µg, atropine 0.5 mg i.m., and diazepam 10 mg i.m.). Flexible bronchoscopy (11004 BC, Storz, Germany) was performed through an intubation tube, as described previously (13). Following macroscopic evaluation of the bronchial tree, BAL was performed by wedging the bronchoscope in the bronchi of the middle lobe or the lingula and by administering 4 × 50 ml sterile NaCl warmed to 37°C. BALF was collected into sterile containers and placed in an ice bath. During the procedure, the patient received oxygen intratracheally and the blood oxygen saturation was monitored with a pulse oximeter (400 HS, TridentMed, Poland). The subsequent steps of BALF processing were completed as described previously (14).

The total count and cellular composition were assessed in the sediment after IS and BALF centrifugation and the concentrations of IL-8 and MPO were determined in the supernatant. The IL-8 concentration was determined with the QuantiGlo chemiluminescent ELISA immunoassay (R&D Systems, Inc.; Minneapolis, MN, USA). The concentration of human MPO was determined with the MPO-EIA kit (OxisResearch; Portland, OR, USA).

The results were presented as means ±SD. Statistical analysis referred to three types of relationships: (a) between the qualitative variables and quantitative variables, (b) between qualitative variables, and (c) between quantitative variables. All relationships were tested non-parametrically with the Mann-Whitney and Chi-square tests and Spearman's rank correlation. $P<0.05$ was considered significant for all study analyses.

RESULTS

Mild persistent asthma was diagnosed in 13 (59%) subjects and moderate asthma in the remaining nine (41%). Mild COPD was present in nine (53%) and moderate COPD in eight (47%) subjects. No clinical or spirometric signs of bronchoconstriction were observed during sputum induction that would necessitate discontinuation of the test. Sputum samples were obtained from 15 (88%) subjects with asthma and from 17 (100%) subjects with COPD. Less than 50% of epithelial cells were seen in 77% of all sputum samples; 14 (64%) samples from asthma patients and 16 (94%) from COPD patients, and these samples were further analyzed.

Flexible bronchoscopy was performed in 21 asthma patients and 12 COPD patients. BAL could not be performed in two patients. In one (asthma group), the procedure was stopped due to dyspnea and cough and, in another one (COPD group), a portion of administered fluid could not be recovered. In the 31 BALF samples, the mean volume was 103.0 ±22.0 ml in asthma patients and 104.5 ±14.0 ml in COPD patients; the difference being insignificant.

The analysis of the total count and cellular sputum composition showed no significant differences between asthma patients and COPD patients (*Table 2*). An increased eosinophil rates were demonstrated in both groups; as referenced to the normal values for healthy individuals (12). The total cell count in BALF was significantly higher in COPD than in asthma patients (*Table 2*). In both groups,

macrophages were the largest fraction of BALF cells. The absolute macrophage count was significantly higher in COPD *vs*. asthma patients (*Table 2*). On the other hand, a significantly higher mean eosinophil count was observed in asthma *vs*. COPD patients (5% *vs*. 1%, P<0.05).

No correlation was demonstrated between the cellular composition of the sputum and BALF in either group (*Table 3*).

The concentration of IL-8 in COPD patients was markedly higher in IS (1015.6 ±1664.0 pg/ml) and BALF (15.0 ±21.0 pg/ml) compared with asthma patients (123.6 ±91.1 pg/ml and 4.0 ±3.0 pg/ml, respectively; P<0.05). MPO concentration was significantly higher in COPD BALF than in asthma BALF (7 ±3 pg/ml *vs*. 4±3 pg/ml, P<0.05), while no significant difference was observed between the two groups with respect to the concentration of MPO in IS (60.7 ±70.1 pg/ml in COPD *vs*. 92.1 ±81.3 pg/ml in asthma; NS). IL-8 and MPO concentrations in both study groups were significantly higher in IS *vs*. BALF (P<0.05).

In the asthma group, a correlation was demonstrated between the duration of symptoms and the relative sputum neutrophil count (r=0.6, P<0.05) and between

Table 2. Comparison of total and differential cell count of induced sputum (IS) and BALF in asthma and COPD patients.

Variable	Asthma IS (n=14)	COPD IS (n=16)	P	Asthma BALF (n=20)	COPD BALF (n=11)	P
Total cell count (x10^6 cells/ml)	3.5 ±2.6	5.1 ±5.8	NS	10.1 ±9.7	17.9 ±11.8	<0.05
Neutrophils (%)	20 ±16	24 ±17	NS	6 ±4	5 ±2	NS
Neutrophils (x10^6 cells/ml)	0.8 ±1.0	0.9 ±0.8	NS	0.6 ±0.6	0.8 ±0.5	NS
Lymphocytes (%)	4 ±2	5 ±7	NS	13 ±11	15 ±13	NS
Lymphocytes (x10^6 cells/ml)	0.1 ±0.1	0.2 ±0.2	NS	1.8 ±5.0	2.7 ±3.6	NS
Eosinophils (%)	22 ±16	30 ±17	NS	5 ±9	1 ±2	<0.05
Eosinophils (x10^6 cells/ml)	1.0 ±1.4	2.1 ±3.1	NS	0.5 ±0.8	0.3 ±0.7	NS
Macrophages (%)	54 ±22	42 ±21	NS	76 ±16	79 ±15	NS
Macrophages (x10^6 cells/ml)	1.6 ±0.9	1.9 ±2.3	NS	7.1 ±5.5	14.0 ±9.1	<0.05

Valueas are means ±SD.

Table 3. Total and differential cell count of induced sputum and BALF in the study group.

Variable	Induced sputum (n=11)	BALF (n=18)	Correlation factor (r)
Total cell count (x10^6 cells/ml)	3.4 ±2.7	9.7 ±10.2	r=0.2, NS
Neutrophils (%)	21 ±17	6 ±4	r=-0.4, NS
Neutrophils (x10^6 cells/ml)	0.7 ±1.0	0.6 ±0.6	r=-0.1, NS
Lymphocytes (%)	4 ±3	13 ±12	r= 0.4, NS
Lymphocytes (x10^6 cells/ml)	0.1 ±0.1	1.9 ±5.3	r=-0.1, NS
Eosinophils (%)	23 ±18	5 ±10	r=0.2, NS
Eosinophils (x10^6 cells/ml)	1.0 ±1.5	0.5 ±0.9	r=0.5, NS
Macrophages (%)	52 ±22	76 ±17	r=-0.4, NS
Macrophages (x10^6 cells/ml)	1.5 ±0.9	6.7 ±5.5	r=0.2, NS

Values are means ±SD.

PC_{20} and the absolute and relative neutrophil counts in BALF (r=0.7 and r=0.7, respectively; P<0.05). In this group, a correlation also was demonstrated between the absolute and relative eosinophil count in BALF and the peripheral blood absolute and relative eosinophil count (r=0.7 and r=0.6, respectively; P<0.05) and total serum IgE (r=0.5; P<0.05). A correlation was also demonstrated between the IL-8 concentration in asthma BALF and the total cell count (r=0.5; P<0.05), absolute neutrophil count (r=0.7; P<0.05), and MPO concentration in BALF (r=0.5; P<0.05).

In the COPD group, a correlation was demonstrated between the absolute and relative eosinophil sputum counts and PC_{20} (r=0.6 and r=0.5, respectively; P<0.05) and between the absolute and relative neutrophil sputum counts and smoking history in pack-years (r=0.7 and r=0.6, respectively; P<0.05). The neutrophil and macrophage BALF counts were significantly higher in subjects with COPD who were current smokers, compared with ex-smokers. In this group, a correlation was found between the BALF, IL-8 and MPO concentrations (r=0.6, P<0.05). No correlation was, however, seen between the BALF concentrations of IL-8 or MPO and the cellular composition.

DISCUSSION

According to a current understanding, inflammation in the airways differs considerably in patients with asthma and with COPD. These differences relate to the contribution and role of the individual inflammatory and structural cells and to the composition of proinflammatory and destructive substances released by these cells. Eosinophils and $CD4^+$ T cells are considered to be the most typical cellular components of the inflammatory infiltrate in subjects with asthma. On the other hand, in COPD patients, macrophages appear to play a leading role in triggering inflammation. Macrophages, when exposed to cigarette smoke, release IL-8 and leukotriene B_4 (LTB_4)-chemotactic factors for neutrophils. Increased macrophage counts in COPD patients are found in both central and peripheral airways and in pulmonary parenchyma (15). At a later stage of the disease, neutrophils and $CD8^+$ lymphocytes play an important role in protraction of inflammation. A correlation between the cellular counts and the severity of bronchial obstruction has been demonstrated (15).

With the above information in mind, we expected to demonstrate, in a strictly selected groups of subjects with asthma and COPD, significant differences in the nature of airways inflammatory reaction. We used two types of samples from the lower respiratory tract to evaluate the markers of inflammation, namely IS and BALF. For practical reasons, IS examination seems to be of far greater importance (ease of collection and of repeating the test without the risks associated with repeat bronchoscopy). However, being aware of the differences in the cellular and biochemical composition of the sputum and BALF and wishing

to characterise airways inflammation in the greatest possible detail, we performed both types of tests.

The results were not entirely as we had expected. Although we did demonstrate certain differences in the cellular composition of BALF between asthma and COPD patients, the cellular composition of the sputum was very similar in both groups. The results of the determination of the inflammatory markers that are considered typical of COPD were consistent with previous findings (16). The concentrations of IL-8 and MPO were higher in COPD than in asthma patients.

While attempting to explain the similarity of cellular composition of the sputum and BALF in asthma and COPD patients we rejected the simplest hypothesis, which assumed incorrect assignment of the clinical diagnosis to individual patients. Rejection of this hypothesis was justified, in our opinion, because special care was taken during the recruitment in order to counter any objections as to the correctness of the diagnosis. One reason for the exceptionally long recruitment period (30 months) was that the most important of the inclusion criteria required a clinical picture that would allow unequivocal diagnosis of asthma *vs*. COPD. Many patients who underwent preliminary screening were finally excluded due to an ambiguous clinical picture.

By adopting a sufficiently long period (of at least 3 months) preceding inclusion in the study as an eligibility criterion, during which period no anti-inflammatory medication was used, we eliminated the potential effect of medication on the course of inflammation. This criterion was essential, given the fact that our aim was to evaluate markers of airways inflammation in the natural course of the disease, as the effect of corticosteroid treatment (even brief) on inflammatory markers and on the structural changes in the airways is commonly recognised (17). Long-term use of theophylline formulations affects not only the neutrophil count, but also the concentration of proinflammatory cytokines (18).

Below is a discussion of the results of IS and BALF evaluation in both study groups.

Cellular composition of induced sputum

The few studies conducted in healthy non-smoking volunteers have demonstrated that macrophages and neutrophils are also the most important cellular components of IS with eosinophils account for an average of 0.4-0.6% of all cells and are in higher numbers in females and atopic patients (12). Studies of asthma have revealed that eosinophilia in IS is very common in patients who have received no "controller" (anti-inflammatory) drugs. Increased eosinophil counts have also been demonstrated in more than 50% of asthma patients managed with glucocorticosteroids (19). An increased neutrophil count in IS is considered typical of COPD patients. The negative correlation between the neutrophil count in IS and FEV_1 and the annual FEV_1 decrease (20) suggested a relationship between airways neutrophilia, respiratory function, and the severity of the disease.

We found no significant differences in the cellular composition of IS between asthma and COPD patients. Patients with COPD demonstrated a tendency towards a higher total cell count and a higher absolute and relative eosinophil counts in the sputum compared with asthma patients. Eosinophils and neutrophils predominated in the IS of both groups of patients. The above findings might suggest a similar nature of airways inflammation in patients with mild to moderate COPD and asthma.

Taking into account the predominance of subjects with mild COPD in the study group, with low severity and short duration of symptoms, it seems that the predominance of eosinophils in IS may be specific for this type of COPD. Previous findings indicated that the neutrophil count in the airways in COPD increased with the severity of obstruction (16). Eosinophils may well play a role in the initial phases of inflammation in COPD. The results of the available studies generally apply to subjects with moderate to severe COPD. The reasons for the small number of studies in subjects with mild COPD include the limited and uncharacteristic symptomatology (16) and the resulting delayed diagnosis. We did not manage to find a study that described the nature of inflammation in the airways of subjects with mild COPD. Therefore, one of the reasons for the different cellular composition of IS compared with the results of other authors may be a different patient population studied.

The cellular composition of IS in asthma patients was consistent with the results published by other authors (16). Asthma patients have a known and considerable variability in the clinical and pathological phenotype of the disease. The study results prompt differentiation between at least two profiles of airways inflammation in asthma patients referred to by working terms as "eosinophilic asthma" and "neutrophilic asthma" (21). The underlying mechanism and significance of neutrophilic asthma is still a controversial issue, since, among other reasons, some studies have confirmed the contribution of neutrophils to asthmatic inflammation, while others have not. For example, the relative neutrophil count increase has been shown following allergen challenge (22), in periods of exacerbation and in patients currently experiencing clinical symptoms (23). A high neutrophil count is also known to be a common characteristic of severe asthma refractory to glucocorticosteroids (24).

We demonstrated a relationship between the duration of the disease and the neutrophil count in IS. This finding may suggest that neutrophils may replace eosinophils from the original infiltrate at later stages of untreated disease. The findings by other authors demonstrate that "eosinophilic asthma" and "neutrophilic asthma" may be two distinct phenotypes of the disease (21).

Cellular composition of BALF

BALF from COPD patients contained a significantly higher number of cells than BALF from subjects with asthma. In both groups, macrophages

predominated in BALF, and accounted for 79% and 76% of all cells in asthma and COPD patients, respectively. Despite the similar percentage of these cells, the absolute count was significantly higher in COPD patients. This was especially marked in smokers *vs*. non-smokers (in both asthma and COPD groups). This is consistent with the commonly recognized effect of smoking on increasing the pulmonary macrophage count (25).

In contrast to the total macrophage count, the relative eosinophil count in BALF was significantly higher in asthma compared with COPD patients. However, no significant differences were found in the absolute cell counts between the two groups of patients.

In the asthma group, the eosinophil count in BALF correlated with the peripheral eosinophil count and with total serum IgE. A correlation between the eosinophil count in BALF and in peripheral blood has also been reported in other studies (26). Importantly, we observed no difference in the cellular composition of BALF between atopic and non-atopic subjects with asthma. We could not find any other studies that compared the cellular composition of BALF between atopic and non-atopic asthma. Amin *et al* (27) evaluated bronchial biopsies and demonstrated a higher eosinophil count and a lower neutrophil count in patients with atopic *vs*. non-atopic asthma.

The neutrophil count in BALF was comparable in both study groups and was elevated compared with the neutrophil count in healthy individuals. Our results are consistent with the few reports on BALF composition in groups of patients comparable with our patients (26).

The absolute neutrophil count was significantly higher in actively smoking COPD patients *vs*. ex-smokers. Neutrophils play a much more important role in the pathophysiology of airways inflammation in subjects with COPD than in patients with asthma. Previous studies have shown an increased neutrophil count and MPO concentration in BALF among COPD patients and healthy smokers *vs*. healthy individuals and patients with asthma (28). To a great extent, the picture of inflammation in the airways of patients with COPD results from exposure to tobacco smoke. However, most asthma studies have demonstrated increased neutrophils and eosinophils in BALF (29).

The increased BALF eosinophil count in patients with a shorter duration of asthma demonstrated in our study suggests that neutrophils may play an important role in remodelling processes leading to the persistence of bronchial obstruction in the later stages of the disease.

Concentrations of IL-8 and MPO in IS and BALF

Tests of IL-8 and MPO concentrations in the sputum and BALF were a key part of our study. IL-8 is secreted by pulmonary macrophages, neutrophils, and epithelial cells of the airways. Numerous studies have shown elevated concentrations of IL-8 in the sputum (16, 30) and BALF (26, 31) mainly in

COPD patients, but also in patients with asthma, especially non-eosinophilic asthma. Smoking is known to be one of the factors increasing IL-8 production. However, smoking cessation does not suppress the already ongoing airways inflammation (30).

As we had expected, the concentration of IL-8 was significantly higher in subjects with COPD compared with subjects with asthma. This was true for IS and BALF alike. In both study groups, the concentration of IL-8 was higher in the sputum than in BALF. This is consistent with the results of measurements performed by other authors (26, 31). The concentration of IL-8 in IS in both groups did not correlate with BALF concentrations, and only a few studies have managed to demonstrate such a relationship (26).

Most authors have reported correlations between the concentration of IL-8 and the neutrophil count in BALF and IS from subjects with COPD (31), but also in asthma patients (21, 31). We found a correlation between the concentration of IL-8 and the neutrophil count in BALF in asthma patients only. Taking into account the relatively high percentage of neutrophils in BALF in asthma group (similar to the relative eosinophil count), it may be assumed that the elevated IL-8 concentration has a causal relationship with the absolute (and relative) neutrophil count.

Furthermore, we could not demonstrate a significant increase in the IL-8 concentration in smokers *vs*. non-smokers, in asthma patients and in COPD patients, although such an increase has been observed by other authors (16, 30).

As regards another inflammatory marker, MPO, we showed a significantly higher concentration in BALF from COPD patients *vs*. asthma patients. As with IL-8, the MPO concentrations were also higher in IS *vs*. BALF. Previous studies have demonstrated that an increased MPO levels in respiratory samples (compared with controls) may be found both in patients with asthma and in patients with COPD (21, 30). Nevertheless, MPO appears to be more specific to COPD. In COPD patients, Linden *et al* (32) has demonstrated a relationship between the concentration of MPO in BALF and the degree of bronchial obstruction. We, on the other hand, showed a correlation between the levels of IL-8 and MPO in BALF from both study groups, but no such correlation in IS. We found no correlation between the MPO concentration and the cellular composition of the sputum or BALF. We were also unable to show any correlation between the concentration of MPO in BALF and the sputum.

Conclusions

The analysis of the cellular composition of IS from subjects with asthma and COPD does not allow differentiating between the two conditions. Patients with mild-to-moderate COPD have a higher total cell count in BALF and a higher total macrophage count, compared with patients with mild-to-moderate asthma. In

asthma patients, the relative eosinophil count in BALF is considerably higher than in COPD patients.

IL-8 appears to be more specific for COPD than for asthma, and its levels in IS and BALF are significantly higher in COPD than in asthma patients. Similar relationships have been demonstrated for MPO, although only BALF was statistically significant. While the concentration of MPO in IS from COPD patients was higher than that in asthma patients, the difference was not significant. Cellular composition and the concentration of inflammatory mediators in BALF reveal more differences between asthma and COPD than respective measurements in IS.

Conflicts of interest: No conflicts of interest were declared with relation to this work.

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