Exhaled leukotrienes and prostaglandins in COPD

P Montuschi, S A Kharitonov, G Ciabattoni, P J Barnes

Background: The role of eicosanoids, including leukotrienes (LTs) and prostaglandins (PGs), in chronic obstructive pulmonary disease (COPD) is uncertain. The aim of this study was to investigate whether eicosanoids are measurable in exhaled breath condensate (EBC), a non-invasive method of collecting airway secretions, in patients with stable mild to moderate COPD, and to show possible differences in their concentrations compared with control subjects.

Methods: LTB₄, LTE₄, PGE₂, PGD₂-methoxime, PGF₂α, and thromboxane B₂ (TxB₂) were measured in EBC in 15 healthy ex-smokers, 20 steroid naïve patients with COPD who were ex-smokers, and in 25 patients with COPD who were ex-smokers and who were treated with inhaled corticosteroids. The study was of cross sectional design and all subjects were matched for age and smoking habit.

Results: LTB₄ and PGE₂ concentrations were increased in steroid naïve (LTB₄: median 100.6 (range 57.9–170.5) pg/ml, p<0.001; PGE₂: 93.6 (range 52.8–157.0) pg/ml, p<0.001) compared with control subjects (LTB₄: 38.1 (range 31.2–53.6) pg/ml; PGE₂: 44.3 (range 30.2–52.1) pg/ml). Both groups of patients had similar concentrations of exhaled LTB₄ [p=0.43] and PGE₂ [p=0.59]. When measurable, LTE₄ and PGD₂-methoxime concentrations were similar in COPD patients and controls, whereas PGE₂α concentrations were increased in the former. TxB₂-LI was undetectable in any of the subjects.

Conclusions: There is a selective increase in exhaled LTB₄ and PGE₂ in patients with COPD which may be relatively resistant to inhaled corticosteroid therapy.

Table 1

<table>
<thead>
<tr>
<th>Characteristics of study subjects</th>
<th>Healthy subjects (n=15)</th>
<th>Steroid naïve COPD patients (n=20)</th>
<th>Steroid treated COPD patients (n=25)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>60 (5)</td>
<td>65 (2)</td>
<td>67 (2)</td>
</tr>
<tr>
<td>F/M</td>
<td>8/7</td>
<td>11/9</td>
<td>13/12</td>
</tr>
<tr>
<td>Smoking</td>
<td>Ex</td>
<td>Ex</td>
<td>Ex</td>
</tr>
<tr>
<td>Pack years</td>
<td>&gt;10</td>
<td>&gt;10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>FEV₁ (l)</td>
<td>4.55 (0.29)</td>
<td>1.29 (0.27)*</td>
<td>1.41 (0.19)*</td>
</tr>
<tr>
<td>FVC (l)</td>
<td>4.72 (0.31)</td>
<td>2.41 (0.25)*</td>
<td>2.56 (0.15)*</td>
</tr>
<tr>
<td>FEV₁ (% pred)</td>
<td>95.1 (4.5)</td>
<td>52.4 (3.8)*</td>
<td>50.6 (4.3)*</td>
</tr>
<tr>
<td>FVC (% pred)</td>
<td>99.2 (3.7)</td>
<td>79.4 (3.3)*</td>
<td>74.9 (4.0)*</td>
</tr>
<tr>
<td>FEV₁/FVC (%)</td>
<td>96.4 (2.3)</td>
<td>53.2 (2.8)*</td>
<td>55.1 (3.3)*</td>
</tr>
<tr>
<td>Atopy</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Treatment</td>
<td>Theophylline</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>β₂ agonists</td>
<td>4/20</td>
<td>5/25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14/20</td>
<td>15/25</td>
</tr>
</tbody>
</table>

Groups were frequency matched by age and smoking habit. Data are expressed as means (SE).

COPD=chronic obstructive pulmonary disease; FEV₁=forced expiratory volume in 1 second; FVC=forced vital capacity.

†p<0.01 compared with healthy subjects.

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Subjects attended on one occasion for clinical examination, spirometry, and EBC collection. The diagnosis of COPD was based on the Global Initiative for Obstructive Lung Disease (GOLD) guidelines. All patients had moderate COPD and were clinically stable with forced expiratory volume in 1 second (FEV₁) <80% predicted and FEV₁/forced vital capacity (FEV₁/FVC) ratio <70% which did not change markedly over 8 weeks. Patients with other respiratory or systemic diseases were excluded from the study. All study subjects were ex-smokers and had stopped smoking for at least 1 year. Smoking status was checked by measuring urinary cotinine levels which were <10 ng/ml in all study subjects. None of the steroid naïve COPD patients had received corticosteroids in the previous 4 weeks. Inhaled β2 adrenergic agonists and theophylline were also used in some patients (table 1).

Repeatability for eicosanoid measurements was assessed in 25 patients with COPD. A second EBC sample was collected within 7 days of the first sample.

The study was approved by the ethics committee of the Royal Brompton Hospital and Harefield Trust and informed consent was obtained from all subjects.

Pulmonary function
Spirometric tests were performed using a dry spirometer (Vitalograph Ltd, Buckingham, UK) and the best value of the three manoeuvres was expressed as an absolute value (litres) and as a percentage of the predicted value.

Measurement of exhaled eicosanoids
EBC samples were collected using a commercially available condensing chamber, as previously described (Ecoscreen; Jaeger, Hoechberg, Germany). Subjects breathed tidally through a mouthpiece connected to the condenser for 15 minutes.

LTB₄, LTE₄, PGF₂α, TXB₂, and PGD₂methoxime (MOX), a stable derivative of PGD₂, were measured by enzyme immunoassays (Cayman Chemical, Ann Arbor, MI, USA). PGE₂ concentrations were measured by a radioimmunoassay (RIA).

The intra-assay and inter-assay coefficients of variability of the eicosanoid assays were within 10% and 15%, respectively. LTB₄, LTE₄, PGF₂α, TXB₂, and PGD₂methoxime were referred to as eicosanoid like immunoreactivity (LI).

The possible influence of the ventilation rate on exhaled LTB₄, LTE₄-LI, and PGE₂ concentrations was excluded as previously described. Saliva contamination of EBC was excluded by measuring amylase concentrations which were undetectable in all samples tested.

Statistical analysis
Eicosanoid concentrations in EBC were expressed as median values with the minimum to maximum range. A Kruskal-Wallis test followed by pairwise Mann-Whitney U tests was used to compare groups. Correlation was expressed as Spearman’s correlation coefficient. Significance was defined as a p value of <0.05. Within-subject repeatability of exhaled eicosanoid measurements was expressed as intraclass correlation coefficient.

RESULTS
Exhaled LTB₄ was increased in both steroid naïve COPD patients (100.6 (73.5–145.0) pg/ml; p<0.001) and those treated with steroids (99.0 (57.9–128.4) pg/ml; p=0.001) compared with age matched controls (38.1 (31.2–53.6) pg/ml; fig 1A). PGE₂ in EBC was also increased in both steroid naïve (98.0 (57.0–128.4) pg/ml; p=0.001) and steroid treated patients with COPD (93.6 (52.8–157.0) pg/ml; p<0.001) compared with healthy subjects (44.3 (30.2–52.1) pg/ml; fig 1B).

There was no difference in exhaled LTB₄ (p=0.43) and PGE₂ (p=0.59) concentrations between steroid naïve and steroid treated patients with COPD. LTB₄ (p=0.86) and PGE₂ concentrations (p=0.57) were similar in patients with COPD treated or not treated with theophylline. There was no difference in LTB₄ (p=0.89) and PGE₂ concentrations (p=0.23) between COPD patients treated or not treated with β₂ agonists.

There was no difference (p=0.31) in LTE₄-LI between healthy subjects (15.5 (11.0–27.0) pg/ml), steroid naïve patients with COPD (23.3 (9.1–31.3) pg/ml), and steroid treated patients with COPD (19.5 (9.0–42.0) pg/ml). PGF₂α-LI was measurable in five steroid naïve COPD patients, in six steroid treated patients, and in five healthy subjects. In those subjects in whom PGF₂α-LI was measurable, its concentrations were higher in steroid naïve (15.0 (10.9–19) pg/ml; p<0.05) and in steroid treated patients with COPD (14.7 (10.0–21.7) pg/ml; p<0.05) than in healthy subjects (8.9 (5.9–10.9) pg/ml). PGD₂-MOX was measurable in six steroid naïve COPD patients (11.2 (8.7–15) pg/ml), in seven steroid treated COPD patients (11.4 (8.0–14.9) pg/ml), and in six healthy subjects (10.0 (8.0–15) pg/ml). In those subjects in whom PGD₂-MOX was measurable, there was no difference in the levels of this PG between the three study groups (p=0.80). TXB₂-LI was undetectable in any study subjects.

There was a correlation between LTB₄ and PGE₂ in both steroid naïve (r=0.75, p<0.001) (fig 2A) and steroid treated
patients with COPD ($r=0.67, p<0.001$; fig 2B). The intraclass correlation coefficient was 0.72 for LTB$_4$, 0.82 for PGE$_2$, 0.68 for LTE$_4$, and 0.73 for PGF$_2$, indicating a high degree of reliability.

**DISCUSSION**

We have identified the profile of exhaled LTs and PGs in COPD. Patients with COPD had about 2.5-fold higher LTB$_4$ concentrations in EBC than age-matched control subjects, consistent with a primary pathophysiological role for LTB$_4$ in COPD.$^{11,15}$ LTB$_4$ concentrations in EBC were about 30-fold lower than those reported in sputum.$^{16}$ Exhaled PGE$_2$ was 2.2-fold higher in COPD patients than in healthy subjects. Since PGE$_2$ may have anti-inflammatory effects in the airways,$^{21,22}$ its increase, concomitant with enhanced levels of LTB$_4$, a potent pro-inflammatory mediator, may represent a mechanism to counteract lung inflammation in COPD. This hypothesis is further supported by the correlation found between LTB$_4$ and PGE$_2$ in COPD.$^{23}$ However, the cross-sectional design cannot exclude steroid reduction of LTB$_4$ or PGE$_2$, and controlled studies with these drugs are required. Moreover, the effects of potential variables which may influence the effects of exhaled eicosanoids such as the use of previous medication, effects of feeding, effects of exercise, and diurnal variation need to be investigated.

In conclusion, we have shown that LTB$_4$ and PGE$_2$ are increased in EBC in patients with stable COPD. The profile of exhaled LTs and PGs in patients with COPD is different from that previously reported in patients with asthma. Identification of selective profiles of eicosanoids in COPD, a completely non-invasive method, may be relevant for the diagnosis and management of COPD.

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**REFERENCES**

LUNG ALERT

CT-guided pleural biopsy preferable to traditional Abram’s needle in diagnosing malignant pleural disease


Malignant disease is a leading cause of pleural effusion, with about 40 000 cases occurring annually in the UK and 175 000 in the USA. Pleural fluid cytology establishes a diagnosis in only 60% of these effusions. Pleural biopsy using an Abram’s needle, first introduced in 1958, is routinely performed for establishing a diagnosis in the remaining cases. This procedure has a low sensitivity and is associated with numerous complications. Undiagnosed patients may either have to undergo the procedure again or be referred for a thorascopic biopsy.

In this single centre, prospective, parallel, randomised study the authors compared CT-guided needle biopsy with standard pleural biopsy using Abram’s needle. Fifty patients with cytologically negative unilateral and exudative pleural effusions were randomised to undergo either CT-guided pleural biopsy or Abram’s pleural biopsy performed by a single competent operator. Three patients did not undergo the procedure at all and, of the remaining 47, 24 underwent Abram’s biopsy while 23 underwent CT-guided biopsy. The results showed that sensitivity for pleural malignancy with the CT-guided procedure was 87% compared with 47% with Abram’s needle. Although the specificity and positive predictive value for both CT-guided biopsy and Abram’s biopsy were the same at 100% each, the negative predictive value of CT-guided biopsy was superior at 80% compared with 44% with Abram’s needle.

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