Gamma/delta cells in tissue from patients with sarcoidosis

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Abstract
Background — Because gamma/delta T lymphocytes (γδ cells) respond to mycobacterial antigens in vitro and accumulate in the skin lesions of patients with certain granulomatous infections (leprosy, leishmaniasis), it was hypothesised that these cells might have a role in the pathogenesis of sarcoidosis, a disease also characterised by granuloma formation. Having failed to demonstrate an increase in γδ cells in the blood of patients with sarcoidosis, the aim of this study was to examine samples of bronchoalveolar lavage (BAL) fluid and biopsy tissue.

Methods — Samples from 23 patients (13 women) with newly diagnosed sarcoidosis, of mean age 31 years and median percentage of lymphocytes in the BAL fluid of 31%, were studied. Controls included normal subjects and patients with other interstitial lung diseases (ILD). Cyto-preparations of BAL fluid (n = 13) and cryostat sections (five mediastinal nodes, 14 transbronchial biopsies) were stained with alkaline phosphatase-antialkaline phosphatase and monoclonal antibodies to CD3, CD4, CD8, CD25, and γδ T cell receptor (TCR).

Results — All patients had typical chest radiographs (16 stage I, four stage II, three stage III). All were Mantoux negative with negative tuberculosis cultures. Compared with normal controls and patients with other interstitial lung diseases there was no increase in γδ cells in the BAL fluid (sarcoidosis, 1% (range 0–4%) total cells; ILD, 1% (0–2%); controls, 0.5% (0–2%); p>0.05, Kruskal-Wallis). Likewise, there was no increase in γδ cells in the transbronchial biopsy specimens (sarcoidosis, 1/high power field (hpf) (range 0–2); ILD, <1/hpf (0–4); controls <1/hpf (0–2); p>0.05). γδ cells were rarely seen in the lymph nodes in spite of the presence of numerous granulomas.

Conclusion — These results provide further evidence that γδ cells are not increased in most patients with sarcoidosis.

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Keywords: sarcoidosis, T lymphocyte, gamma/delta cells.

T cells expressing gamma/delta (γδ) T cell receptor (TCR) have been postulated as having a role in the pathogenesis of several infectious disorders characterised by the formation of granuloma at sites of infection.1,3 In humans these cells recognise a variety of mycobacterial antigens in vitro and accumulate in the granulomatous skin lesions of leprosy and cutaneous leishmaniasis.4 In murine models γδ cells tend to accumulate at epithelial surfaces such as the skin, gut and lung, suggesting that they represent the first line of immune defence as they are found at sites of initial antigen contact.5,7

Although the aetiology of sarcoidosis remains unknown, evidence points to an antigen driven T cell response with cytokine production and subsequent granuloma formation.8,9 Because γδ cells are associated with infectious granulomatous responses, we asked whether these cells might also have a role in the pathogenesis of sarcoid granuloma. We have previously found no increase in the mean percentage or absolute numbers of γδ cells in the peripheral blood of 21 patients with newly diagnosed sarcoidosis, although two patients had increased proportions of γδ cells.10 These findings have been supported by other publications.11–14

Although a number of studies have reported a variable proportion of patients with increased γδ cells in bronchoalveolar lavage (BAL) fluid,15 only two groups have examined biopsy material from patients with sarcoidosis. Nakata et al examined lung biopsy specimens from five patients and found few γδ cells.16 Tazi et al examined node and Kveim biopsy tissues and failed to find any increase in γδ cells.17

In this study we sought to extend our initial findings by looking for γδ cells in tissue samples from patients with newly diagnosed untreated sarcoidosis.

Methods

SUBJECTS AND CONTROLS

Samples were obtained from 23 patients (13 women) of mean age 31 years with newly diagnosed sarcoidosis who were on no treatment at the time of diagnosis or within the previous year (table 1). The diagnosis was established using previously described criteria and all but two patients had non-caseating granulomas in the biopsy samples.18 These two patients presented with erythema nodosum and hilar lymphadenopathy which resolved spontaneously and both had a BAL lymphocytosis with negative screen for tuberculosis. Eight patients were smokers and all were Mantoux negative, 22 of the 23 having previously received BCG vaccination. The median BAL lymphocyte percentage was 31% (range 4–60) and 14 patients had an absolute blood lymphopenia (<1.5 cells/μl). The chest radiograph was abnormal in all cases: 16 stage I; four stage...
Abnormal chest

Table 1 Patient characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sarcoidosis (n=23)</th>
<th>Controls† (n=12)</th>
<th>Other ILD* (n=13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>31</td>
<td>45</td>
<td>49</td>
</tr>
<tr>
<td>M:F</td>
<td>10:13</td>
<td>8:4</td>
<td>5:8</td>
</tr>
<tr>
<td>Previous BCG</td>
<td>22</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Positive Mantoux</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Abnormal chest radiograph</td>
<td>23</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Median (range) % lymphocytes in BAL fluid</td>
<td>31 (4-60)</td>
<td>4 (1-8)</td>
<td>18 (2-34)</td>
</tr>
<tr>
<td>Samples stained BAL fluid</td>
<td>13</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Transbronchial tissue</td>
<td>14</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Mediastinal node</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thoracotomy lung</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* Other interstitial lung diseases included EAA (2), pulmonary fibrosis (8), lymphangitis (1), pneumonitis (1), lymphangioleiomyomatosis (1).
† Controls included patients with cough undergoing bronchoscopy or patients undergoing lung resection for benign or malignant tumour.

II; three stage III. BAL samples were available for study from 13 patients, transbronchial biopsy specimens from 14, and mediastinal lymph nodes from five.

Normal controls included patients undergoing bronchoscopy for cough or minor haemoptysis in whom the chest radiograph was normal and no bronchoscopic abnormality was present (n=6), and patients undergoing thoracotomy for lung cancer in whom tissue for study was taken away from the affected area (n=6). Patients with other interstitial lung diseases (ILD) were used as further controls (n=13) (table 1).

Tissue samples

Bronchoalveolar lavage was performed using standard techniques. Briefly, 180 ml was instilled into the lateral basal segment of the right lower lobe and aspirated using gentle suction. The specimen was transported on ice and cytological preparations were made for DiffQuik staining (for cell differential counting) and monoclonal antibody labelling. Cytopreparations were frozen at −20°C prior to immunohistochemical analysis.

Transbronchial biopsy specimens and thoracotomy lung tissue samples were mounted in OCT and snap frozen in isopentane prior to storage at −70°C. Mediastinal lymph node biopsy specimens were snap frozen and stored in liquid nitrogen. Cryostat sections (5 μm) from all samples were taken for immunohistochemical analysis.

Immunohistochemical analysis

Monoclonal antibodies to the following antigens were used as the primary antibody: CD3, CD4, CD8, CD25, and γδ (TCR δ1 recognising the δ protein expressed in association with the γ chain and hence all γδ positive cells). Controls included cells incubated without the primary antibody or isotype matched antibody added instead. Sections of human tonsil were used as positive controls for CD3 positive α/β cells, and blood and sections of skin from a patient with intestinal lymphangiectasia were used as positive controls for CD3 positive γδ cells.

Table 2 Immunocytochemical analysis of cytopeniae of BAL fluid

<table>
<thead>
<tr>
<th>Antigen</th>
<th>Sarcoidosis</th>
<th>Interstitial lung disease</th>
<th>Normal control</th>
</tr>
</thead>
<tbody>
<tr>
<td>γδ</td>
<td>0 (0-0.3)</td>
<td>0 (0-1)</td>
<td>0 (0-0.1)</td>
</tr>
<tr>
<td>CD3</td>
<td>31** (6-60)</td>
<td>26** (7-63)</td>
<td>6 (2-10)</td>
</tr>
<tr>
<td>CD4</td>
<td>0 (0-4.1)</td>
<td>0 (0-4.2)</td>
<td>0 (0-1)</td>
</tr>
<tr>
<td>CD8</td>
<td>19* (2-32)</td>
<td>17* (9-35)</td>
<td>3 (0.5-6)</td>
</tr>
<tr>
<td>A</td>
<td>5* (1-17)</td>
<td>13* (2-24)</td>
<td>1 (0.6-4)</td>
</tr>
<tr>
<td>B</td>
<td>0.6 (0-4)</td>
<td>0.3 (0-3)</td>
<td>0 (0-0.1)</td>
</tr>
</tbody>
</table>

Data are presented as percentage positively staining cells of total BAL fluid cells with γδ cells also expressed as a percentage of CD3 positive cells. Values are median (range).

For light microscopy BAL cytopeniae were stained with DiffQuik and histological specimens were fixed in formalin and stained with haematoxylin and eosin. For immunohistochemistry all slides were fixed with methanol/alcohol and thoroughly dried prior to incubation with monoclonal antibodies. Briefly, the alkaline phosphatase-anti-alkaline phosphatase (APAAP) technique (Dako) was used; the slides were incubated with 20% AB serum for 20 minutes before adding the primary antibody for 30 minutes, washed and then incubated with the secondary antibody (alkaline phosphatase rabbit anti-mouse) for 30 minutes. After washing again the slides were incubated with APAAP for 30 minutes, washed, and steps 2 and 3 repeated to amplify the reaction prior to staining with the substrate (levamisole/fast red). The slides were then counterstained with Mayer's haematoxylin (blue) and mounted in glycerol/gelatin.

Data analysis

A minimum of 300 cells was counted for each BAL cytopeniae and the mean number of positively staining cells expressed as a percentage of the total cells in the BAL fluid. A minimum of three high power fields (magnification ×400) was examined for each cryostat section. All slides were examined by two observers blinded to the clinical diagnosis. The coefficient of variation for inter-observer and intra-observer observations was less than 15%. Because of the small size of the biopsy specimens and the low number of positively staining cells, a grid was not routinely applied. For the same reason γδ cells are expressed as absolute numbers per high power field (hpf) as well as a derived percentage of CD3 positive cells.

Results were analysed using the Kruskal-Wallis one way analysis of variance. Differences were considered to be significant at the 5% level. Data are expressed as median plus range.

Results

Bronchoalveolar Lavage Fluid

Compared with samples from normal controls and those with other interstitial lung diseases, there was no increase in γδ cells in the samples of BAL fluid (table 2). Both patient groups had more CD3 positive cells than normal controls (p<0.01, Kruskal Wallis) and corresponding significant increases in CD4 and CD8 positive...
cells (p<0.05). Although the percentage of CD25 positive cells was higher in the subjects with sarcoidosis and other interstitial lung diseases, because of the small numbers of positively staining cells this did not reach statistical significance.

**TRANSCORONARY BIOPSY SPECIMENS**

The patients with sarcoidosis had scant numbers of γδ cells in the biopsy specimens regardless of whether or not granulomas were present. There was no significant difference in the percentage of γδ/CD3 positive cells between the three groups (table 3).

**MEDIASTINAL LYMPH NODES**

In all five lymph nodes numerous granulomas were seen with more than 100 CD3 positive cells/hpf. γδ cells were rarely seen and constituted less than 1/hpf and, even as a derived percentage of CD3 positive cells, less than 1%.

**Discussion**

We have shown in this study that patients with newly diagnosed sarcoidosis do not have increased numbers of γδ cells in their BAL fluid, transcronary biopsy or lymph node biopsy specimens. These results are in accord with our earlier published results. We have endeavoured in this study to recruit patients with active disease as evidenced by symptoms such as fatigue or erythema nodosum and clinical findings such as peripheral blood lymphopenia and BAL lymphocytosis. None of our patients had any evidence of tuberculous infection or disease which might have confounded our results, as it has been reported that γδ cells are increased in tuberculosis.

We examined the specimens of BAL fluid using cytopreparations and APAAP staining in order to minimise the confounding effects of autolysolysis of the alveolar macrophages during Fluorescence activated cell sorter (FACS) analysis. Our initial studies used FACS exclusively to assess staining of BAL fluid and, although the results were similar to those obtained with the APAAP method, there was considerable variability. Adhering the macrophages out has been suggested as a way to reduce the problem of autolysolysis in BAL samples, but γδ cells themselves can be adherent and this technique could have led to bias (unpublished observation).

Our results in this study are similar to previously published reports. Forrester et al found only a small percentage of γδ cells in the BAL fluid. Balbi et al showed that the percentage of γδ cells in the BAL fluid of nine patients was similar to that in their blood and to the blood of normal control subjects. However, in an earlier paper Balbi and other authors found increased numbers of CD3 positive αβ negative cells (hence presumptive γδ positive) in patients with sarcoidosis. More recently, Rauf et al found higher numbers of γδ cells in BAL fluid from patients with sarcoidosis compared with idiopathic pulmonary fibrosis. Nakata et al did not find increased numbers of γδ cells in the BAL fluid and specifically noted that three patients with high proportions of γδ cells in the blood had low numbers of these cells in their BAL fluid. These same authors studied lung biopsy tissue from five patients and reported small numbers of γδ cells present (0.2-3.6% CD3 positive cells). Tazi et al examined lymph nodes from four patients and Kveim biopsy specimens from four and observed only rare γδ cells inside or at the periphery of granulomas. Our findings are identical.

Although these studies viewed collectively suggest that few patients with sarcoidosis have an increased number of γδ cells in the BAL fluid, it has been shown that a higher proportion of these cells express V61 gene segments. This finding is not universal, however, as two other studies have shown that some patients with sarcoidosis have increased V62 transcripts or cells staining positively with anti-TCR V62. In spite of our findings, it is still possible that γδ cells may be important for some patients with this disease, particularly those of Asian or Middle Eastern origin. However, the failure to find increased numbers of γδ cells in association with granulomas suggests that, for most patients, γδ cells are not important in the pathogenesis of sarcoidosis.

We gratefully acknowledge the support of Phillip Townsend, Senior Technical Officer, and Dr Par Haslam, National Heart and Lung Institute, London, and Mes Jan Nelson, Scientific Officer, Department of Haematology, Auckland Hospital. Financial support was provided by the Asner Trust and the New Zealand Lottery Grants Board. We thank Mrs Rochelle Mason for typing the manuscript.

8 Tamura N, Mallor DR, Balbi B, Crystal RG. Preferential use of the T cell antigen receptor beta-chain constant

**Table 3 Immunohistochemical analysis of lung biopsy samples**

<table>
<thead>
<tr>
<th>Antigen</th>
<th>Sarcoidosis</th>
<th>Intestinal lung disease</th>
<th>Normal control</th>
</tr>
</thead>
<tbody>
<tr>
<td>γδ</td>
<td>0.2 (0-4)</td>
<td>0.2 (0-1)</td>
<td>0.55 (0-3)</td>
</tr>
<tr>
<td>CD3</td>
<td>21 (3-20)</td>
<td>23 (8-37)</td>
<td>23 (6-25)</td>
</tr>
<tr>
<td>γδ/CD3</td>
<td>1.8 (0-18)</td>
<td>2.0 (0-11)</td>
<td>2.9 (0-4.6)</td>
</tr>
<tr>
<td>CD4</td>
<td>13 (2-31)</td>
<td>14 (10-23)</td>
<td>15 (3-21)</td>
</tr>
<tr>
<td>CD8</td>
<td>8 (2-22)</td>
<td>11 (6-21)</td>
<td>9 (3-25)</td>
</tr>
<tr>
<td>CD25</td>
<td>0.8 (0-2)</td>
<td>1.1 (0.5-2)</td>
<td>0.2 (0-2)</td>
</tr>
</tbody>
</table>

Data are presented as positively staining cells per high power field with γδ cells also expressed as a percentage of CD3 positive cells. Values are median (range).

There were no significant differences between the groups (Kruskal Wallis one way analysis of variance).