CARBON PNEUMOCONIOSIS IN A SYNTHETIC GRAPHITE WORKER

BY

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A case of carbon pneumoconiosis is described and discussed. A man, aged 60, who had been turning and grinding synthetic graphite bars for 17 years, developed pneumoconiosis, Category 3. In conjunction with others previously published, this case confirms that pneumoconiosis can be caused by “nearly pure” carbon of low ash content and a wide range of particle size after long exposure to synthetic graphite or carbon black dust.

Miller and Ramsden (1961) described a case of carbon pneumoconiosis mainly from the pathologist’s point of view and included a description of the chemistry of carbon black, and reference to these two aspects is therefore omitted.

A considerable literature on carbon pneumoconiosis has accumulated in the past 30 years but closer scrutiny reveals only very few cases in which the dust was pure carbon or “nearly pure” carbon (Hollmann, 1928; Töppner, 1952; Rüttner, Bovet, and Aufdermaur, 1952; Meiklejohn, 1957). The conclusions drawn from these cases are oddly contradictory. Koelsch (1958) finds the evidence that lung fibrosis can develop without silica unconvincing. He thinks that pneumoconiosis, caused by pure graphite without any admixture of silica or silicates, may possibly be produced experimentally but hardly occurs in practice. Meiklejohn (1957) on the other hand says “it emerges that pneumoconiosis of the coalworkers’ type, simple and complicated, can be caused in workmen by dust in which silica constitutes only a trace”. Similarly, Gough and Heppleston (1960) find “it may be concluded that free silica is not necessary for the development of the pure dust lesion in coalworkers . . .”.

In view of this divergency of views and the paucity of such cases the report of another example may be useful.

Case Report

In September 1959 the Manchester Pneumoconiosis Panel of the Ministry of Pensions and National Insurance saw a man aged 60. He had been a hod carrier in the building trade for 25 years, spent three years in the Forces, and since 1942 worked as a centre lathe operator in a small factory, turning and grinding bars of synthetic graphite. The bars are used in the manufacture of moulds for the forming of hard metals in electric furnaces.

There was nothing of note in the family history and he had had no serious previous illnesses. His first radiograph, taken by a mass radiography unit in 1953, showed diminished transluency on the left side and a hard nodule in the left apex. He continued at his job and chest symptoms started about two years later. He developed a cough with greenish sputum, pain in the midsternal region, dyspnoea on hills, tiredness and giddiness on exertion. He was referred to the Chest Clinic in November 1958 and the report mentions kypho-scoliosis, a fixed chest, and poor respiratory excursions. The radiograph showed coarse nodulation in both lungs. Another film in June 1959 showed no change. Sputum was negative for tuberculosis in the smear and culture. He made a claim for disablement benefit and was seen by the Pneumoconiosis Board three months later.

He was found to be of moderate physique, weight 10 stone, height 5 ft. 7 in., chest measurement 35 in./36½ in. There were no abnormal physical signs in his chest, his blood pressure was 170/90 mm. Hg, and indirect M.B.C. 73 litres/min. The chest radiograph showed pneumoconiosis, Category 3m (Fig. 1). Fig. 2, an enlargement of the left upper zone, shows the well-marked nodulation. A pulmonary function test (Table 1) was carried out later by Dr. C. Ogilvie at the Liverpool Thoracic Surgery Centre.

There was a moderate impairment of maximum breathing capacity and flow rates, a slight reduction in vital capacity, and a diffusing capacity at the lower limit of the normal range. Dr. Ogilvie considered the findings compatible with chronic bronchitis, probably with only a mild degree of either emphysema or fibrosis.

The dust exposure was 17 years and the material used was synthetic graphite made from carbonization
CARBON PNEUMOCONIOSIS

Fig. 1. — Chest radiograph showing pneumoconiosis, Category 3m.

Fig. 2. — Enlarged radiograph of left upper zone showing nodulation.

of oil or, as stated by the manufacturers, from petroleum coke which is wholly calcined and free from volatile materials. A dust sample obtained from the deposit on the work bench was examined by the Government Chemist and contained, by chemical extraction, less than 0·02% by weight of free silica. None was detected by x-ray method. Carbon accounted for over 90% by weight, with 0·45% ash and volatile matter and a trace of moisture. Spectrographic examination showed only traces of iron, silicon, magnesium, nickel, and calcium. Table 2 shows that the particle size ranged from below 0·6 μ to over 100 μ, the median size being 8·5 μ. The particle shape was irregular.

As the man had been grinding synthetic graphite bars on carborundum wheels there may have been some risk from the bonding material of the wheel as discussed by Posner (1960). However, as the dust sample contained only a trace of free silica, this can hardly be held

### Table 1

**PULMONARY FUNCTION TEST**

<table>
<thead>
<tr>
<th>Lung Volumes (litres)</th>
<th>Mechanical Function</th>
<th>Before Adrenalin (litres/min.)</th>
<th>After Adrenalin (litres/min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vital capacity</strong></td>
<td>Maximum breathing capacity</td>
<td>46</td>
<td>1·20 litres</td>
</tr>
<tr>
<td><strong>Inspiratory capacity</strong></td>
<td>F.E.V. 1 second</td>
<td>48</td>
<td>1·32 litres</td>
</tr>
<tr>
<td><strong>Expiratory reserve volume</strong></td>
<td>Timed vital capacity</td>
<td>32%</td>
<td>150</td>
</tr>
<tr>
<td><strong>Functional residual capacity</strong></td>
<td>Maximum inspiratory flow rate</td>
<td>133</td>
<td>75</td>
</tr>
<tr>
<td><strong>Residual volume</strong></td>
<td>Maximum expiratory flow rate</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td><strong>R.V./T.L.C. ratio</strong></td>
<td>33%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diffusing capacity for carbon monoxide 18·6 ml/mm.Hg/min. (71% normal).

### Table 2

**RANGE OF PARTICLE SIZE**

<table>
<thead>
<tr>
<th>Maximum Size (μ)</th>
<th>Per cent in Size Range</th>
<th>Per cent up to Given Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0·6</td>
<td>5·25</td>
<td>5·25</td>
</tr>
<tr>
<td>0·6–1·2</td>
<td>4·20</td>
<td>9·45</td>
</tr>
<tr>
<td>1·2–2·4</td>
<td>7·35</td>
<td>16·80</td>
</tr>
<tr>
<td>2·4–3·6</td>
<td>6·30</td>
<td>23·10</td>
</tr>
<tr>
<td>3·6–4·8</td>
<td>3·15</td>
<td>32·55</td>
</tr>
<tr>
<td>4·8–6·0</td>
<td>4·20</td>
<td>36·75</td>
</tr>
<tr>
<td>6·0–7·5</td>
<td>6·30</td>
<td>43·05</td>
</tr>
<tr>
<td>7·5–9·0</td>
<td>9·45</td>
<td>52·50</td>
</tr>
<tr>
<td>9·0–12·0</td>
<td>10·50</td>
<td>63·00</td>
</tr>
<tr>
<td>12·0–15·0</td>
<td>10·50</td>
<td>73·50</td>
</tr>
<tr>
<td>15·0–24·0</td>
<td>10·50</td>
<td>84·00</td>
</tr>
<tr>
<td>24·0–32·0</td>
<td>6·30</td>
<td>90·30</td>
</tr>
<tr>
<td>32·0–40·0</td>
<td>4·20</td>
<td>94·50</td>
</tr>
<tr>
<td>40·0–50·0</td>
<td>—</td>
<td>94·50</td>
</tr>
<tr>
<td>50·0–60·0</td>
<td>1·05</td>
<td>95·55</td>
</tr>
<tr>
<td>60·0–80·0</td>
<td>2·10</td>
<td>97·65</td>
</tr>
<tr>
<td>80·0–100·0</td>
<td>1·05</td>
<td>98·70</td>
</tr>
<tr>
<td>&gt; 100·0</td>
<td>1·30</td>
<td>100·00</td>
</tr>
</tbody>
</table>

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responsible for the radiological changes. There were four other men employed in the same room for more than five years but none at the same job. Two of them had chest radiographs taken in which we found nothing abnormal.

Discussion

It is interesting to compare some features of this case with those described in the literature. Unfortunately, the data in the few cases known are incomplete; for example, it is generally not stated whether the dust samples were collected from airborne or deposited dust. As regards particle size therefore, the figures are not very helpful but Rüttner’s was 3 \( \mu \) to over 30 \( \mu \), Meiklejohn’s mainly less than 2 \( \mu \), and Miller and Ramsden (1961) found it generally less than 0-5 \( \mu \), compared with our median figure of 8-5 \( \mu \). As for ash content, the synthetic graphite in Rüttner’s case contained 0-085\%, and Meiklejohn mentions three different types of carbon, i.e. “nearly pure carbon” containing 0-01\%, “retort carbon” 1-9\%, and oven coke 0-5\%. Miller’s carbon black contained 0-038\% and 0-047\%, ours 0-45\%. Length of exposure was 10 years in Töppner’s case, 21 years in Rüttner’s, 12 and 22 years in Meiklejohn’s, 21 years in Miller’s and 17 years in ours. The occupations concerned have been carbon stick workers (Hollmann), synthetic graphite mill worker (Rüttner), carbon black factory worker (Töppner), mixing and grinding lamp black with other grades of carbon produced from gas and oil cokes (Meiklejohn), mixing carbon black in rubber (Miller), and turning and grinding synthetic graphite bars in the case now reported. Progressive massive fibrosis is described only in one case by Hollmann, one by Rüttner, one by Meiklejohn, and in Miller’s case. The symptoms are generally slight. There is occasional dyspnœa, cough, and sputum; also, in our case, midsternal pain, lassitude, and giddiness on exertion.

It is perhaps premature to draw any definite conclusions from the small number of published cases but it is to be expected that more will be detected with increasing awareness of the risk. The facts appear to be that pneumoconiosis, simple and complicated, can be caused by “nearly pure” carbon of any particle size from less than 0-5 \( \mu \) upwards, with only traces of silica or silicates, an ash content of 0-01\% to 1-9\%, and an exposure of 10 to 22 years to synthetic graphite or carbon black dust.

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REFERENCES


