Pseudotumour of the lung caused by infection with
Bacillus sphaericus

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SYNOPSIS  A patient is described who suffered from severe chronic asthma complicated by repeated
chest infections. She developed a large gelatinous pseudotumour of the lung which was found to
be caused by Bacillus sphaericus.

Human infections with organisms of the Bacillus
genus other than anthrax are uncommon although,
especially under conditions of decreased resistance,
the pathogenicity of these organisms is well recog-
nized (Farrar, 1963; Pearson, 1970; Ihde and
Armstrong, 1973). The most commonly reported
pathogen of this genus has been Bacillus subtilis but
other members of the genus have been incriminated
from time to time.

The following case report is the fourth in which
Bacillus sphaericus has been documented as a
pathogen, and it is unique in that the organism
produced a massive pseudotumour of the lung.

Case report
The patient, who was born in 1939, developed severe
bronchial asthma at the age of 2 years after an attack
of whooping cough. During childhood she also
suffered from eczema, hay fever, and angioneurotic
oedema. She was first seen in Southampton in 1963
when, at 24 years of age, she demonstrated a per-
sistent grade II dyspnoea with central cyanosis and
evidence of pulmonary hypertension with right
ventricular hypertrophy. Chest x-rays showed wide-
spread fine mottling throughout the lungs, and
pulmonary function tests showed severe fixed air-
ways obstruction. Skin tests were positive to a wide
variety of antigens including Aspergillus fumigatus,
but aspergillus precipitins were negative. The
Mantoux test was negative. Treatment was started
with prednisone, 5 mg three times per day, and
prophylactic isoniazid. Steroid therapy in one form
or another was continued throughout the course of
the illness. Over the next few years there was no
significant change in the chest x-ray but there was
some improvement of clinical status and pulmonary
function. In 1965 she was able to visit a relative in
California, but she continued to suffer from attacks
of severe wheezing dyspnoea associated with purulent
sputum. These episodes of infection became more
frequent and severe. Klebsiella pneumoniae was
isolated from the sputum and the patient was given
frequent courses of ampicillin, gentamicin, and
cotrimoxazole. In 1971 the chest x-ray showed an
increase in the diffuse lung shadowing, and there was
a persistent leucocytosis of over 20 × 10⁹/l.

In November 1973, after her return from a second
visit to California, she deteriorated considerably, and
the chest x-ray showed a large area of consolidation
in the anterior segment of the left upper lobe, which
gradually increased in size over the next year (fig 1).
Bronchoscopy on two occasions showed the left
upper lobe segmental bronchi to be occluded by thick
mucus which could not be aspirated easily. Culture
from bronchoscopy grew coliforms and Pseudomonas
pseudomallei. Serum immunoglobulins were measured
at this time and were normal. Skin tests and serology
for coccidioidomycoses and histoplasmosis were
negative.

In October 1974 she was admitted in terminal
respiratory failure, and a soft fluctuant swelling was
noted in the second left intercostal space anteriorly
with a similar swelling over the sternum. She died
shortly after admission, aged 35 years.

Necropsy
The body was that of an emaciated young woman. A
6 cm soft subcutaneous mass was present in the left
second intercostal space anteriorly, and a similar
3 cm mass bulged parasternally in the third inter-
costal space on the left. On reflecting the sternum it
was apparent that these subcutaneous masses were
extensions of a large, soft, mucoid tumour that
replaced the medial half of the upper lobe of the left lung (fig 2). The tumour infiltrated the intercostal muscles and the mediastinum, where it closely surrounded the large vessels. The remainder of the left lung, and the right lung, showed marked fibrosis and basal bronchiectasis with scattered locules of pus and clear fluid. Fragments of the tumour were taken for bacteriological examination, as were swabs from the purulent foci.

Other significant macroscopic findings were obliterative fibrous pericarditis, right ventricular hypertrophy (the right ventricle weighing 76 g with a total heart weight of 290 g), and atrophy of the adrenal glands, which together weighed 5 g.

Microscopic examination of multiple sections of the mass in the left chest showed it to consist of masses of eosinophilic organisms. These were elongated, frequently curled, and coiled, and ranged in length from 3.75 μ to 12.5 μ and in width from 1.25 μ to 2.5 μ. They were separated by fine fibrous bands and mixed with an infiltrate of neutrophil polymorphs (figs 3 and 4). A broad, fibrous band separated this process from the lung parenchyma but clumps of similar organisms were seen in bronchi of the left upper lobe. Gram stain showed that the organisms consisted of a Gram-negative sheath enclosing long bacilliform rods which were both Gram-positive and Gram-negative (fig 5). This Gram-negative material around the organisms stained faintly positive with periodic acid-Schiff but mucicarmine, Ziehl Nielsen, and Grocott stains were all negative.

**Bacteriology**

A direct smear of the ‘tumour’ revealed a Gram variable bacillus similar to that seen in histological sections. No capsule was demonstrable but the organisms were surrounded by a viscous matrix.

Fungal and mycobacterial cultures were negative. No growth was obtained on horse blood agar after overnight incubation, but after four days’ aerobic incubation at 37°C slight growth was obtained in glucose heart infusion broth. Gram stain revealed a pleomorphic Gram variable bacillus, 0.5 μ to over 50 μ in length (fig 6). Morphology was essentially similar to that seen in the tissue sections. Some unusual features included swelling and bulging of the cell wall with pseudobranching and serpiginous forms. ‘Horseshoe’ and ‘boomerang’ shapes were frequently seen in cultures incubated at 37°C but infrequently at 30°C. Colonies were best established on horse blood agar and on heated chocolate agar and were an opaque, smooth, greyish-yellow with an
Fig 3  Section of left upper lobe. The tumour on the left is separated from the lung by a broad band of fibrous tissue. The tumour consists of small bodies intermingled with neutrophils and delicate fibrous tissue septa. (Haematoxylin and eosin × 83)

Fig 4  High-power detail of tumour showing masses of eosinophilic organisms, inflammatory cells, and some fibrous tissue. (Haematoxylin and eosin × 300)
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Fig 5  Gram stain of histological section of tumour. Gram variable pleomorphic bacilli are enclosed in a Gram-negative sheath.  
(× 750)

Fig 6  Gram stain of organism grown at 37°C showing Gram variability with marked pleomorphism.  
(× 975)

entire edge and a papillate centre having an average diameter of 1 mm.

At 30°C growth was more easily established in both broth and plate cultures. Soft, emulsifiable colonies were up to 2 mm in diameter, flat and irregular, and exhibited a chrome yellow pigment with faint haemolysis. In contrast to organisms grown at 37°C (fig 6), incubation at the lower temperature produced a straight, more uniform rod (fig 7).

Motility, which lessened with increasing incubation temperature, was of a rapid gyrating type. After
one week spores were produced, most of which were spherical, subterminal or terminal with bulging of the sporangia. No anaerobic growth was obtained at 37°C or at 30°C.

Biochemical characteristics are summarized in the table. The organism was accordingly identified as *Bacillus sphaericus*, and this identity was confirmed by Dr. L. R. Hill, Curator of the National Collection of Type Cultures, and Professor J. R. Norris, of the Meat Research Institute, Bristol.

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Table Biochemical characteristics

Discussion

Before the appearance of the pseudotumour the patient had developed persistent infection with a variety of pathogenic organisms. There is a well recognized group of patients with chronic asthma in whom persistent infection is a feature, and this is known to affect the prognosis unfavourably (Ogilvie, 1962). Although there was no evidence of immunoglobulin deficiency or fibrocystic disease in this patient it is possible that a defect of cellular immunity could have been responsible for repeated infections. No studies of lymphocyte function were, however, performed.

Although the initial response to steroids was good, there can be little doubt that the long period of treatment predisposed to the development of an opportunistic infection. Previous reports of infections with members of the bacillus genus have emphasized predisposing factors leading to diminished host resistance which have included diabetes mellitus, chronic alcoholism, and malignancy (Farrar, 1963; Ihde and Armstrong, 1973). A significant number of infections have, however, occurred in previously healthy individuals (Pearson, 1970; Ihde and Armstrong, 1973). Of the three previously reported infections with *B. sphaericus* (Lacorte, 1932; Farrar, 1963; Allen and Wilkinson, 1969), two had an associated debilitating condition (chronic alcoholism and nephrotic syndrome) (Lacorte, 1932; Farrar, 1963).

This case serves once again to illustrate that, while it is traditional to regard aerobic spore-forming bacilli, when isolated, as contaminants, they may cause serious infections. With regard to *B. sphaericus*, in particular, the ease of growth at 30°C as compared to 37°C has not been commented on previously. It is of interest, too, that *in vitro* morphology at 37°C so closely resembled that seen in tissue sections.

The formation of a large pseudotumour in a patient has not to our knowledge previously been described in association with bacillus infections or, indeed, with any bacterial infection. The production
of a viscous matrix by the organism, which accounted for much of the tumour bulk, has been noted in laboratory cultures of the bacillus group (Gibson, 1944) but not in human infections, although Ihde and Armstrong (1973) describe a gelatinous exudate from a necrotic axillary tumour infected with *B. subtilis*; the tumour, however, is not further characterized. Pulmonary cryptococcosis may result in the formation of well circumscribed fibrous tumours containing gelatinous foci (toruloma) (Spencer, 1968), and with the history of this patient’s visit to California, it was this diagnosis that was suspected and led to bacteriological examination of what, at first sight, appeared to be an unusual mucus-producing adenocarcinoma of the lung.

We are grateful to Dr. L. R. Hill, of the National Collection of Type Cultures, to Professor J. R. Norris, Meat Research Institute, Langford, Bristol, for confirming the identity of the organism as *B. sphaericus*, and to Dr. W. Macleod, of the Western Hospital, Southampton, whose patient this was.

References
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P Isaacson, P H Jacobs, A M Mackenzie and A W Mathews

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