Pulmonary Ray Fungus Disease
Clinical Aspects and Pathogenesis

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Pulmonary ray fungus is a relatively rare condition. In 1938 Cope\(^1\) was able to collect 200 cases of pleuro-pulmonary actinomycosis from the literature and Reiter\(^7\) in 1954, noted 47 cases of this disease described during the preceding ten years; of pulmonary nocardiosis only 47 cases have been described.\(^20\)\(^21\) It is reported that in large hospitals clinicians encounter three to five cases of pulmonary ray fungus disease over a period of ten years.\(^4\)\(^10\)

In the Rothschild Hadassah University Hospital five cases of thoracic ray fungus diseases were detected during the sixteen year period 1940-1955 and these are described in the present report. Two were cases of actinomycosis and two of nocardiosis; in one case the genus of the ray fungus was not determined.

**Case Reports**

**Case 1. Actinomycotic pneumonitis of the right upper lobe.**
A 17 year old schoolgirl was admitted to hospital in March, 1954, for an obscure pulmonary condition. The illness began in December, 1953, with pain in both sides of the neck lasting sometimes for a quarter of an hour, sometimes an entire day. These pains, which were aggravated by swallowing and deep inspiration, extended later to the right shoulder and to the right scapular region. In February, 1954, she coughed up a cupful of bright red blood. At the same time her temperature rose to 102.2\(^\circ\) F. A radiograph showed a triangular consolidation of the right lung with a small area of translucency at the inferior angle of the opacity (Figure 1).

On admission to hospital she looked well and her temperature was sustained at 37\(^\circ\) C. The erythrocyte sedimentation rate (Westergren) was 80 mm. in the first hour and the leukocyte count 8,000 per cm. Sputum culture gave a growth of non-hemolytic staphylococci. Bronchoscopy was without pathological findings and no tubercle bacilli, malignant cells and fungi were detected in bronchial washings. The patient was given penicillin and streptomycin without any observable effect on the clinical or radiological condition. In April, 1954, right thoracotomy was performed (Dr. Milwidsky). The apex of the right lung was found to be infiltrated with hard masses and its separation from the thoracic wall was rendered very difficult by dense adhesions, especially posteriorly and medially. The adhesions involved the brachial plexus, the subclavian artery and the superior vena cava and profuse bleeding occurred during the operation. Biopsy and immediate microscopic examination did not reveal signs of malignancy and resection of the apical segment only was therefore performed. Microscopic examination after fixation revealed chronic inflammation with fibrosis and small abscesses. Within the abscesses colonies of *Actinomyces* were found but it was impossible to identify the species. The patient, after operation, received 76 million of penicillin, 65 gm. of chloramphenicol and 36 gm. of streptomycin over a period of three months and she made a complete recovery.

**Case 2. Bilateral actinomycotic bronchopneumonia.**
A 55 year old gardener was admitted to hospital in April, 1955, with the diagnosis of unresolved pneumonia. A week before admission he had developed a severe cough and a temperature of 40.0\(^\circ\) C. for which he was treated with penicillin and streptomycin. When admitted to hospital he looked fairly well and was apyrexial. Medium-sized rales were heard over the lower parts of both sides of the thorax, especially the left. X-ray film showed a massive homogeneous consolidation in the middle of the left lung field and a smaller net-like opacity of the cardio-diaphragmatic region of the right lung (Figure 2). Erythrocyte sedimentation rate was 75/100 (Westergren)

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and leukocyte count 11,000 per cm. Cold agglutinin and ornithosis tests were negative. Sputum examinations were negative for tubercle bacilli and neoplastic cells, but abundant *Candida albicans* were found. In the left submental area a firm, non-painful swelling 4 cm. in diameter was observed. He had noted this swelling one year earlier; it had increased slowly in size, causing slight disturbance of swallowing. His teeth were in poor condition with severe pyorrhrea alveolaris. Sputum culture twice gave a growth of anaerobic *Actinomyces israelii*, but more often pure cultures of *Candida albicans* were obtained.

He was treated for four months with penicillin, streptomycin, chloramphenicol, chlortetracycline, oxytetracycline, sulphadiazine and iodides in various combinations. A marked diminution in the size of the submental swelling was observed and radiographs showed a marked improvement in the pulmonary condition. The massive opacity cleared up partially but multiple foci remained in the affected region. The patient, therefore, received two courses of deep x-ray therapy followed again by antimicrobial drugs. However, the infiltrations showed no further improvement. In this case it is possible that a mixed monilial-actinomycotic infection was present.

*Figure 1* (Case 1): Actinomycotic pneumonitis of the apical segment of the right upper lobe.—*Figure 2* (Case 2): Bilateral actinomycotic bronchopneumonia.
Case 3. Lung abscess in descending actinomycosis.

A 29 year old housewife was admitted to hospital on June, 1941, because of severe pains along the spine accompanied by dyspnoea. Previous history: In May 1939, after the birth of her second child, she developed pain in right haemithorax, temperature 38.5° C, and cough with purulent inoffensive sputum. X-ray film had shown right sided pleural effusion and an opacity with central translucency on right lower lobe (Figure 3). Sputum was constantly negative for tubercle bacilli but in one specimen anaerobic Actinomyces israeli was detected. Following three months of sulphonilamide therapy disappearance of the opacity and of the effusion was noted. However, in October 1939, an abscess in upper sternal region appeared. This was punctured and pus with abundant sulphur granules was withdrawn. The organism present was diagnosed as anaerobic Actinomyces israeli. At this time an exacerbation of a periodontal infection from which the patient had suffered for many years was also noted.

A sinus was present in the gum of the left side of the lower jaw and for this she had been treated by the dentist by the application of silver nitrate, three teeth were extracted and the sinus had closed. In 1940 she developed an abscess in left submammary area; this abscess was opened and pus containing Actinomyces israeli was again found. A sinus lined with granulation tissue persisted and an oesophagogram performed because of dysphagia showed a free passage of barium from oesophagus to the sinus in the submammary region.

During her hospitalisation in 1941 the sternal and sub-mammary sinuses were treated by radium and deep roentgen-therapy. Moreover, sulphanilamides were given orally and intravenously. Her condition improved, the pains disappeared and the sinuses closed; however, during menstruation reopening of the sinuses and secretion of a small quantity of pus was sometimes observed. During the period 1942-1944 new sinuses appeared at varying intervals, necessitating hospitalisation. The sinuses appeared in the left lumbar region and over the left greater trochanter (November, 1942) left upper gluteal region (March, 1943) and left lower gluteal region (May, 1944). All these sinuses were treated by deep roentgen-therapy and the patient also received sulphanilamides and iodides with good results. A check-up in December, 1945, showed that all the sinuses had closed. Radiographs of chest and spine were without pathological findings.

Case 4. Haematogenous nocardiosis of the chest and extremities.

A 46 year old bookseller, in August, 1950, developed superficial painful swellings in the right lumbar region, the right thigh and leg and the left forearm. Later, abscesses

appeared in these regions accompanied by pyrexia. Biopsy and pathological examination showed non-specific inflammation. In September, 1950, x-ray film of the chest showed a large left parahilar opacity. Lateral tomogram showed the opacity to be extrapulmonary and retrosternal, with some pleural thickening and collapse of the lingula. This radiographic finding was not accompanied by any symptoms directly referable to the thorax. When admitted to hospital some days later his general condition was poor and his temperature was 39° C.; erythrocyte sedimentation rate was 104/131 (Westergren) and leukocyte count 22,500 per cm. Blood culture was sterile and no tubercle bacilli were found in the sputum. Biopsy from the abscess of the forearm showed acute purulent inflammation of adipose tissue and a few areas of granulation tissue. In one of these areas a mass of fungus was found which was identified as Nocardia.

Treatment, consisting of penicillin, one million units per day and sulpha thiazole, 6 gm. per day, was instituted. The temperature subsided and his condition improved. After discharge from hospital the antimicrobial treatment was continued for five months with the addition of chlor tetracycline. The abscesses of the extremities healed.

A radiograph in 1951 showed almost complete regression of the retrosternal opacity with only pleural thickening still present. He was last seen in 1956 and his condition was excellent.

Case 5. Nocardial middle lobe pneumonia.

A 54 year old lawyer was admitted to hospital in December, 1954, with the diagnosis of pneumonia. Two weeks prior to this date he had started feeling tired and had developed a cough with a small amount of yellow, inoffensive sputum tinged with blood. He also gave a history of subtotal gastrectomy for gastric ulcer in 1940 and dental pyorrhoea with abscess formation for some years.

While in hospital his temperature was at first normal but later rose to 39° C.; the erythrocyte sedimentation rate was 92/116 (Westergren) and the leukocyte count 11,600 per cm. X-ray film revealed consolidation of the right middle lobe (Figure 4). Penicillin treatment for two weeks was unsuccessful. Bronchial carcinoma was suspected and bronchoscopy was performed. This revealed redness of the mucosa of the opening of the middle lobe bronchus; mucopurulent secretion was present and this was aspirated. Cytological examination revealed neither neoplastic cells nor tubercle bacilli but some colonies of ray fungus were detected. This organism, seen in smears, grown in cultures, and injected into mice, was identified as Nocardia.

He received intensive antibiotic treatment for four months. 103 million units of penicillin, 50 gm. of chloramphenicol, 38 gm. of streptomycin and 120 gm. of sulphadiazine being administered. His chronic gum infection was also treated locally; 12 teeth were extracted and in scrapings from the tooth sockets Nocardia was again found. The root of one of the curious teeth was found penetrating the wall of a cyst which was thereafter enucleated. No pathogenic organisms were found in the cyst but it may be
mentioned that the enucleation was performed after the completion of antimicrobial treatment. He was discharged from Hospital in May 1955, clinically and radiologically recovered.

Discussion

In discussing pulmonary ray-fungus disease, it is to be stressed that 85 per cent of cases are due to the anaerobic Actinomyces israeli and 15 per cent to the acid-fast aerobic Nocardia asteroides. Actinomycosis usually spreads by continuity, while in nocardiosis, haematogenous spread is prevalent. In a review of 1,330 cases of actinomycosis, Cope found thoracic localization in only 15 per cent, while in 62 cases of nocardiosis, the lung was affected in 65 per cent.

The long controversy between Bostroem's "grass chewing" theory which maintained that actinomycosis is due to aerobic organisms which abound in vegetables and gain entrance to the body from the outside, and Israel's "endogenous" theory that the disease is caused by anaerobic organisms which are unable to exist outside the body, has been definitely resolved in favor of the latter theory. The oral cavity is considered the normal habitat of Actinomyces israeli; when trauma or infection occurs in the mouth, the organism alters its habits and from being saprophytic becomes parasitic and invades the tissues.

Actinomycotic infection of the mouth is certainly a much more frequent condition than is diagnosed or suspected. Probably many cases diagnosed as simple pyogenic periodontitis are mild infections with the Actinomyces israeli. Axhausen was surprised to find sulphur granules in 28 per cent of patients with these mild conditions when tissues excised from the affected area were examined microscopically. There are three routes by which Actinomyces israeli can reach the lung from the mouth: 1) via the bronchial tree by aspiration; 2) via the blood stream (septic phlebitis of a small vessel associated with a dental infection); 3) along the fascial planes of the neck and mediastinal structures. In the latter eventuality (Case 3), the spread from the periodontal tissues may have been first to the oesophagus and then by direct spread to the mediastinum structures. The lung involvement could have occurred by way of the bronchi or by direct spread from the mediastinum, which also accounted for the sternal and sub-mammary sinuses. The mediastinal infection may then have descended through one or more of the normal apertures in the diaphragm to the retroperitoneal tissues of the abdomen, thereafter tracking through the posterior abdominal wall in the region of the lumbar triangle of Petit and then to the trochanteric and glutal areas.

The diagnostic problem of Actinomycosis is complicated by the fact that Actinomyces israeli may be found as a saprophyte in the mouths of healthy persons as well as in pulmonary suppurations. Some authors consider these saprophytic ray-fungi to be non-pathogenic Actinomyces naeslundii. However, in patients with obscure pulmonary disease compatible with actinomycosis, the demonstration of ray-fungus in the sputum may be considered sufficient proof that the organism is pathogenic.

Antimicrobial drugs have completely altered the clinical course and
progress of ray-fungus disease. In only one of our patients (Case 3) were there multiple sinuses so characteristic of actinomycosis and this case was treated before antibiotic drugs had come into use. In the remaining four cases, the use of antimicrobial drugs from the onset of the disease, even before the diagnosis was made, completely changed the usual course of the disease. Pulmonary actinomycosis, which previously was fatal in more than 50 per cent of cases and nocardiosis with a mortality of 90 per cent are now controllable and curable.

SUMMARY

Five cases of pleuro-pulmonary ray-fungus disease are presented—two of actinomycosis, two of nocardiosis and one with genus undetermined. In two of the clinicoradiological aspects were those of chronic suppurative pneumonitis. The others had acute and unresolved bronchopneumonia, unresolved middle lobe pneumonia and retrosternal fluid collection with pleural involvement. Three had severe periodontal infection, and in two of them the ray-fungus was detected in the sockets of extracted teeth.

In three cases the lung involvement probably occurred by way of bronchial aspiration and in the remaining cases by direct spread from the mediastinum and by hematogenous spread.

Antimicrobial drugs completely altered the clinical course and prognosis of the ray-fungus disease. In four patients treated with antibiotics from onset of the disease, no sinus was observed and all were cured.

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RESUMEN

Se relatan cinco casos de enfermedad por los hongos radiantes: dos por actinomicosis, dos de nocardiosis y uno de género indeterminado. En dos, el aspecto clínico radiológico era el de neumonitis crónica supurativa. Los otros tenían bronconeumonía aguda no resuelta, neumonía no resuelta del lóbulo medio, y colección retroesternal con compromiso pleural. Tres tenían seria infección periodontal y en dos dellos se encontró el hongo en los alveolos de los dientes extraídos.

En tres casos el compromiso pulmonar ocurrió probablemente por aspiración y en el resto de casos por diseminación directa del mediastino y/o diseminación hematogena.

Las drogas antimicrobianas alteraron completamente la evolución y el pronóstico de estas enfermedades de hongos radiantes. En cuatro tratados con antibióticos desde el principio de la enfermedad nose observaron fistulas y todos curaron.

RESUME

L’auteur présente cinq cas de mycosé avec localisation pleuro-pulmonaire: deux cas d’actinomycone, deux de nocardiose et un dû à un germe indéterminé. Dans deux cas, les aspects cliniques étaient ceux d’une pneumonie chronique suppurative. Les autres se présentaient comme une bron-
chopneumonie aiguë, une pneumonie du lobe moyen n'ayant aucune tendance résolutive, et une collection liquidienne rétro-sternale avec atteinte pleurale. Trois malades eurent une sévère infection dentaire, et chez deux d'entre eux le champignon fut découvert dans les alvéoles des dents extraites.

Dans trois cas, l'atteinte pulmonaire survint probablement par aspiration bronchique, et dans les autres cas, par extension directe à partir du médiastin et/ou dissémination hématogène.

Les médicaments antimicrobiennes ont complètement modifié l'évolution clinique et le pronostic de l'affection mycosique. Les quatre cas traités par les antibiotiques dès le début de l'affection guérirent tous parfaitement.

**ZUSAMMENFASSUNG**


In 3 Fällen erfolgte die Lungenbeteiligung wahrscheinlich durch bronchiale Aspiration und in den übrigen Fällen durch direkte Aussaat vom Mediastinum oder durch haematogene Aussaat.

Antimikrobielle Medikamente veränderten den klinischen Verlauf und die Prognose der Strahlenpilzerkrankung vollständig. In 4 Fällen, die von Beginn der Behandlung mit Antibiotikas behandelt wurden, kam keine Pistel zur Beobachtung und alle wurden geheilt.

**REFERENCES**

8 Hoeden, J.: Quoted by Porter, I. A. 1916