

THE TUMOUR-LIKE FORMS OF ASPERGILLOSIS OF THE LUNG (PULMONARY ASPERGILLOMA)

A REPORT OF FIVE NEW CASES AND A REVIEW OF THE PORTUGUESE LITERATURE

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The increasing number of cases of pulmonary aspergilloma makes this more frequently encountered in daily practice, and it should be considered in the differential diagnosis of patients with haemoptysis, pulmonary suppuration, and unexplained radiological shadowing. Although about 180 cases have already been reported in the world's medical literature, some points remain to be settled, and opinions vary with different schools of thought.

In Portugal the first case of "aspergilloma" diagnosed at necropsy was reported by May Figueira in 1862, only six years after Virchow gave the first necropsy report of this condition. Since Fernando Rodrigues's paper was read to the Sociedade das Ciências Médicas in July, 1957, there has been great interest in this disease in Portugal, and up to the present 25 examples have been reported, approximately one-sixth of all known cases. The clinical, radiological, and especially the pathological study of these cases has enabled Portuguese authors to have some definite opinions on some of the problems posed by this disease entity but, due to language difficulties, these ideas are little known. The object of this paper, besides presenting five new cases with some interesting features, is to make known the studies of Portuguese authors on the subject of the tumour-like forms of aspergillosis.

CASE REPORTS

CASE 1.—L.P., a 46-year-old white man, was admitted to the Lisbon University Hospital in September, 1959, complaining of weakness, cough, and haemoptysis. He gave a history of chronic bronchitis since childhood with abundant purulent sputum. From 1949 to 1952 the patient had worked as a driller in wolfram mines, but latterly he worked as a labourer loading bales of rubber and hides.

Three years after leaving the mines, blood-streaked sputum was noted, and in June, 1957, the patient had a large haemoptysis. There was no dyspnoea or any other respiratory symptom. Latterly there were profuse night sweats, loss of appetite, weakness, and a weight loss of over 20 lb. in the last two months.

The patient was a well-nourished, well-developed man. Examination of the chest was completely negative, and a blood count essentially normal. The sedimentation rate was 18 mm./hr (Westergren) and direct smears and cultures of the sputum and secretions collected at bronchoscopy were repeatedly negative for tubercle bacilli, bacteria, and fungi.

The chest radiograph on admission showed many radio-opaque, silicotic nodules in both lungs, more numerous and larger in the upper thirds, with bilateral silicotic tracheobronchial lymph nodes, some of which had "egg-shell" calcification. In the right infra-clavicular zone the lesions seemed to coalesce and form an infiltrate in the midst of which there was a more definite nodule surrounded by a transparent halo (Fig. 1). The tomogram shows this more clearly (Fig. 2).

As tuberculosis could not be demonstrated, the fact that a patient with a relatively mild form of silicosis had persistent blood-streaked sputum and haemoptysis seemed difficult to explain. The radiograph suggested the idea of "aspergilloma," and, even though fungus could not be demonstrated in the sputum, our pre-operative diagnosis was silicosis with secondary "aspergilloma."

On this basis right upper lobectomy was performed on October 14, 1959 (Professor C. Costa). The right upper lobe was grossly adherent posteriorly and difficult to dissect off the chest wall. The mediastinum was full of hard, stone-like lymph nodes, one of which was removed. A fibrous-walled cavity the size of an almond was found in the apex of the upper lobe. Inside it there was a dull, dark-brown or yellowish-grey, granular mass containing a calcified focus the size of a grain of maize. Some of the bronchi around the cavity had pieces of this mass within their lumina. The remaining lobe showed a

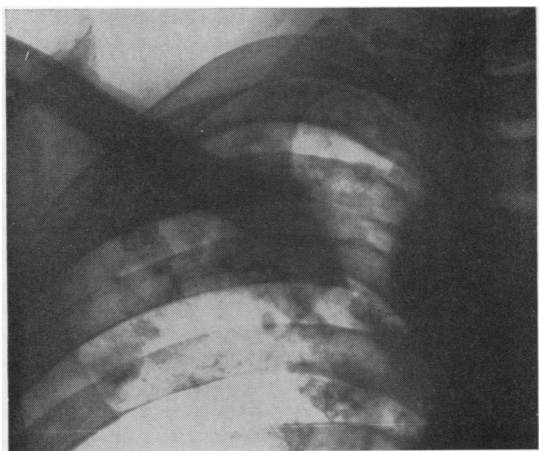


FIG. 1

FIG. 1.—Radiograph of Case 1 showing silicotic lesions in the right upper lobe and a nodule surrounded by a transparent halo.

FIG. 2.—Same aspect as in Fig. 1 brought out more clearly on a tomogram.

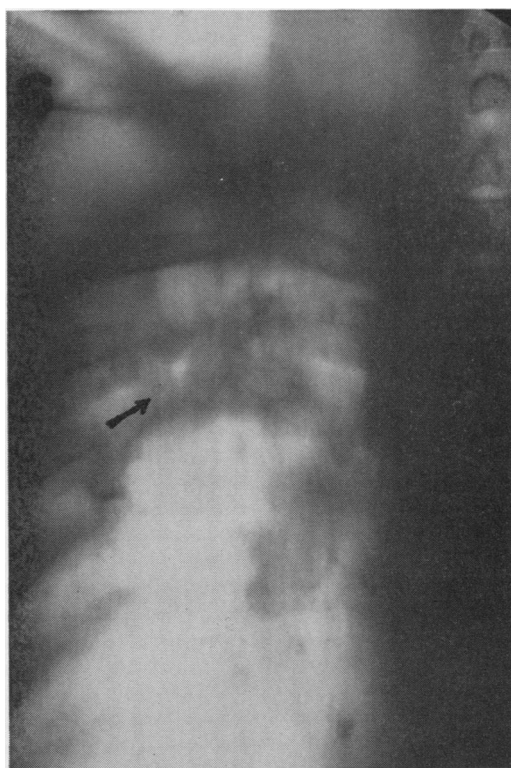


FIG. 2

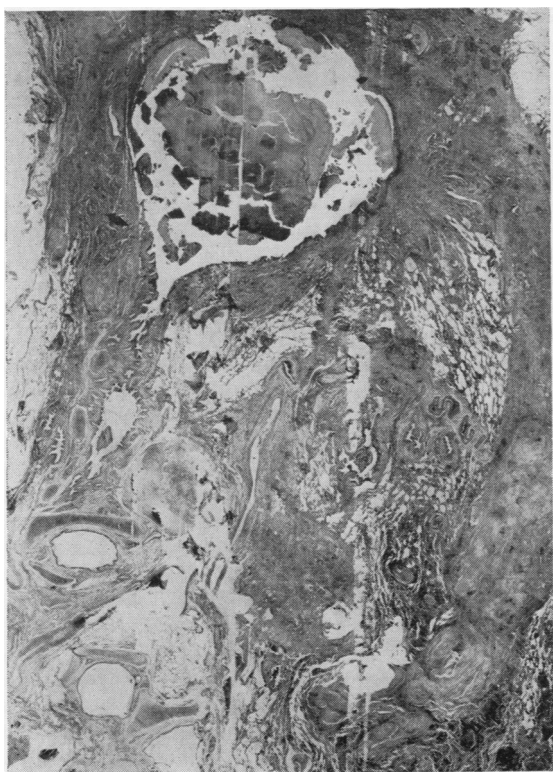


FIG. 3

FIG. 3.—Section of the cavity wall in Case 1 showing the characteristics of a bronchus with abundant fibrous tissue and lymphoplasmocytic infiltrations.

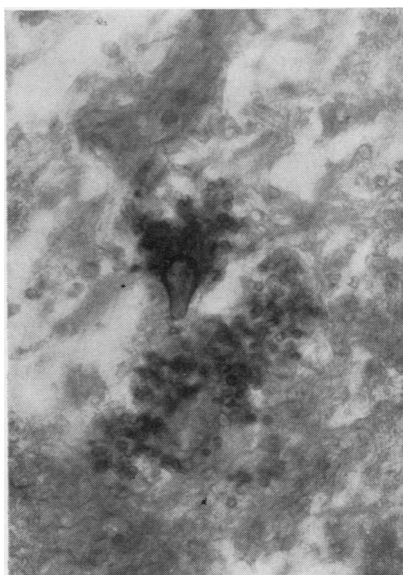


FIG. 4

FIG. 4.—Fungus mass in Case 1 with some regressive changes and a columnar spore-bearing head characteristic of *Aspergillus fumigatus*.

marked thickening of the pulmonary reticulum. Microscopically the wall of the cavity showed the characteristics of a bronchial wall with abundant fibrous tissue and lymphoplasmocytarian infiltrations (Fig. 3). Part of the cavity was lined by cylindrical or metaplastic epithelium, atrophic in some zones. In other parts the epithelium was substituted by erosions, ulcerations, or buds of granulation tissue in which some foreign-body giant cells could be seen. The mass found within the cavity was made up of a mycelium with septate hyphae. This showed regressive changes in some areas. A columnar spore-bearing head characteristic of *Aspergillus fumigatus* was seen (Fig. 4). The remaining lobe showed extensive silicotic lesions, and the examined lymph node had, in addition, lamellar calcifications and ossifications.

In this patient the aspergillus apparently infected a previously silicotic portion of the lung. This association is very rare and we could only find nine other cases in the literature (Balgairies, Aupetit, and Lenoir, 1960; Heppleston and Gloyne, 1949; Hinson, Moon, and Plummer, 1953; Pecora and Toll, 1960). However, since the cavity in our case was of bronchial origin and there was a history compatible with the existence of bronchiectasis since childhood, it is difficult to tell if the silicosis in itself had any important role in the genesis of the aspergilloma.

CASE 2.—A. S. D., a 53-year-old white woman, was admitted to the Surgical Department of the University Hospital in November, 1959, for repeated haemoptyses. Approximately 14 years before the patient had had repeated severe haemoptyses. A year later an echinococcus cyst was removed from the left lung. From then on the patient remained well, but, two years ago, cough and blood-streaked sputum recurred. These symptoms got progressively worse, and in the last three months became very severe. The patient was an apparently healthy woman with a completely negative physical examination and laboratory data.

The chest radiograph on admission showed a round, relatively homogeneous mass in the left mid-zone, partially surrounded by a transparent halo, and clearly seen in the tomogram (Fig. 5). The mass seemed to be located anteriorly, and the fact that it tapered off to a point at the outer edge suggested that it might be localized in the interlobar fissure. The contrast medium did not penetrate the pathological region in the bronchogram.

A tentative diagnosis of aspergilloma was made pre-operatively by the surgeon (Professor C. Costa), and an exploratory thoracotomy was performed in January, 1960. A large cavity with smooth, brilliant walls was found with two bronchi opening into it. This cavity contained a suet-like mass the size of a chestnut, and seemed to be part of the interlobar fissure. The cavity was opened, its contents removed, the bronchi sutured, and the cavity closed with mattress sutures.

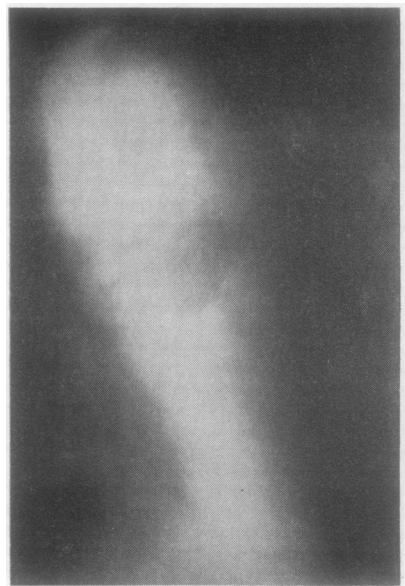


FIG. 5.—Tomogram of Case 2 showing a dense nodule surrounded by a transparent halo in the left lung.

The endocavitary body consisted of pieces of a friable granular greyish-brown mass, made up of a mycelium with septate hyphae, some of which show regressive changes ranging from loss of structure of the hyphae with intense eosinophilia to a complete transformation of the mycelium into a granular amorphous mass.

Since operation the patient has been well.

In this case aspergillus seems to have invaded the residual space left by the removal of an echinococcus cyst 13 years previously. The two bronchi opening into this space gave access to the parasite. The surgical technique employed in this patient has not, to our knowledge, been reported in cases of aspergilloma and seems to have been completely effective.

CASE 3.—F. M. C., a 50-year-old white man, was admitted to Lisbon University Hospital for repeated haemoptyses. Fifteen years before he had been in another hospital with right upper-lobe "pneumonia." A radiograph taken a year later after a haemoptysis showed a large cavity in the right upper lobe, and tubercle bacilli were found in the sputum. There were no other respiratory symptoms, and although artificial pneumothorax was instituted, he stopped treatment after six months since he felt well. He then remained well up to one and a half years ago when he had a large haemoptysis, and a chest radiograph showed a round infiltrate at the site of the previous tuberculous lesions. The sedimentation rate was within normal limits and the sputum was repeatedly negative for tubercle bacilli. Six months later he had another large haemoptysis. Treatment with streptomycin and



FIG. 6.—Radiograph of Case 3 showing a thin-walled cavity with a rounded mass hanging from its upper pole.

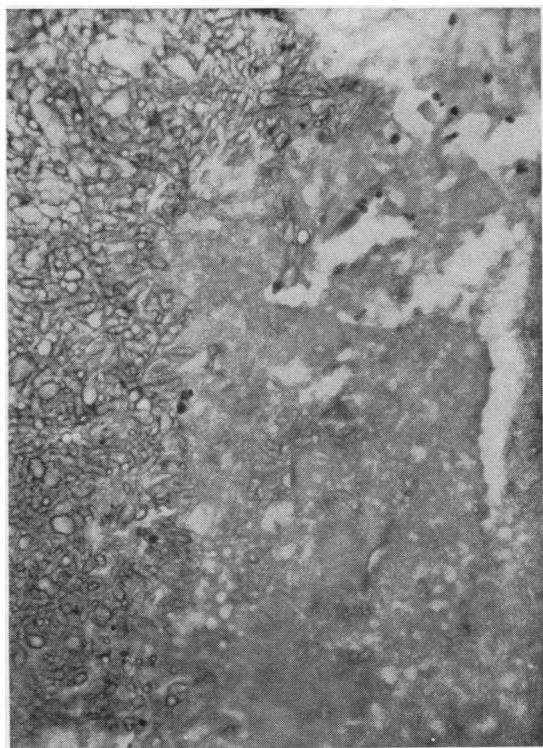


FIG. 8.—Section of the intracavitary mass in Case 3 showing a mycelium made up of septate hyphae, part of which show intense regressive changes.



A



B

FIG. 7.—Bronchogram of Case 3 with the contrast penetrating the cavity and displacing the intracavitary mass. A, Postero-anterior view; B, lateral view.

I.N.H. was started, and the patient was admitted to the University Hospital for further investigation.

The patient was a well-developed, well-nourished, apparently healthy man. The only positive findings were reduced breath sounds and low-pitched bronchial breathing at the right apex.

Blood count: R.B.C. 3,980,000 per c.mm.; haemoglobin 80%; W.B.C. 10,000 per c.mm. (neutrophils 76%, eosinophils 2%, lymphocytes 15%, monocytes 7%). The sedimentation rate was 35 mm./hr. (Westergren). Repeated sputum cultures were negative for tubercle bacilli and fungi. An E.C.G. was normal.

His chest radiograph showed a rounded low-density shadow in the right infraclavicular region behind the anterior arch of the first rib. On the tomogram this shadow was seen to consist of a thin-walled cavity in which a dense rounded mass hung from the upper pole, looking like a bud jutting into the cavity space (Fig. 6). In the bronchogram the contrast medium penetrated the cavity, seeming to displace the intracavitary mass which now appeared on the floor of the cavity. The bronchi all around appeared normal (Fig. 7).

With the pre-operative diagnosis of aspergilloma within a bullous residual tuberculous cavity, a right thoracotomy was done in March, 1960 (Dr. Grauate). The right upper lobe was grossly adherent at the apex and posteriorly, and it was very difficult to separate from the chest wall: the right upper lobe was removed.

A cavity the size of a walnut was found in the apical segment, full of a friable granular greenish-brown mass. The cavity wall was whitish-grey and irregular. At one point there was a fibrous septum which divided the cavity practically into two equal parts. Some of the bronchi round the cavity also had some of the mass within their lumen. Microscopically the wall was made up of a bronchial wall where smooth muscle, mucous glands, and cartilage could still be seen. The lining was made up partly of respiratory epithelium and partly of metaplastic epithelium. In some places there were erosions and in others buds of granulation tissue where there was no epithelium. There were intense fibrous changes in the bronchial wall. The endocavitary mass was made up of a mycelium with septate hyphae, part of which show intense regressive changes—loss of structure, eosinophilia, homogenization, and softening (Fig. 8). Round the cavity, besides bronchiectasis and an intense fibrous thickening of the interalveolar and interlobar septa, a large fibrous scar was visible, next to the cavity wall.

In this case the fungus developed at the site where the patient had had a tuberculous cavity 15 years before. We had thought that the cavity in which the aspergillus lodged was a residual tuberculous bullous cavity. However, it turned out to be a bronchial cavity, and a large scar which was probably the remains of the original tuberculous cavity was found alongside.

CASE 4.—M. A. R. was a 39-year-old woman who had been a diabetic for the last 20 years and had developed a Kimmelstiel-Wilson syndrome. Three months previously she developed cough and weakness. Soon after, the cough became productive of abundant purulent sputum which, however, never showed any traces of blood. Physical examination was entirely negative. The sedimentation rate was 63 mm./hr. (Westergren). Sputum cultures were repeatedly negative for tubercle bacilli, but a culture on Sabouraud medium gave a pure growth of *Aspergillus niger*.

A chest radiograph showed a circular low-grade density in the right mid-zone, with a transparent halo over the upper half. On a tomogram the density was well focused at 9.5 cm. from the posterior chest wall, and the transparency was seen in the centre of the mass (Fig. 9).

The patient's renal condition precluded surgery.

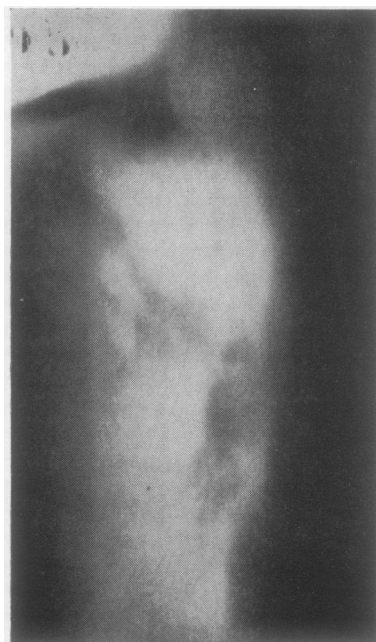


FIG. 9.—Tomogram of Case 4 showing rounded density with transparency in the centre.

Although we have no pathological confirmation of this case, the typical radiograph and the pure culture of *Aspergillus niger* isolated from the sputum are sufficient to warrant the diagnosis of pulmonary aspergilloma. *Aspergillus fumigatus* is more frequently recovered from these patients, but in some cases *Aspergillus niger* has been the cause (Guénon, Rousselot, and Bézard, 1959; Utz, German, Louri, Emmons, and Bartter, 1959). Even though the mass seemed to move within the cavity, perhaps because the postero-

anterior film was taken standing, and the patient was lying down for the tomogram, there were no haemoptyses.

CASE 5.—G. F. M., a 52-year-old white man, was admitted to the University Hospital because of pulmonary suppuration. The patient was a heavy smoker and had had a chronic cough for many years. Six months ago there was a definite increase in the frequency and intensity of the coughing spells, but the sputum showed little change. There was a sharp pain in the right anterior chest wall on coughing, which irradiated to the back. During this period the patient noted that, for two or three days at a time, he had temperatures up to 102° F. and purulent, foul-smelling sputum. There was also great loss of appetite and of weight (20 lb. in a month).

On admission to the Medical Department, haemoptysis set in and never quite cleared up until the patient was transferred to the Surgical Department for operation. During this time his temperature ran an irregular course. The patient looked acutely ill and a few scattered rales were heard in the right infra-clavicular region. His blood count showed a severe anaemia: R.B.C. 2,500,000 per c.mm., 48% haemoglobin, and a leucocytosis of 12,200 per c.mm. (81% neutrophils, 2% eosinophils, 16% lymphocytes, and 1% monocytes). The sedimentation rate was 144 mm./hr. (Westergren), and repeated sputum cultures for tubercle bacilli and fungi were negative.

The chest radiograph on admission only showed a para-mediastinal shadow in the standard postero-anterior film. However, the lateral film showed an oblong cavity with a small fluid level, anteriorly placed, right behind the sternum (Fig. 10). A lateral tomogram (Fig. 11) showed that the cavity was partly filled by a dense mass adherent to its posterior wall. This mass contained various air bubbles. The bronchi seen on the bronchogram were normal, but the contrast did not penetrate the cavity. Bronchoscopy showed an oedematous right upper lobe spur, which moved normally. A foul smell was noted as soon as the tip of the bronchoscope reached the upper lobe branch. After correcting the patient's anaemia with blood transfusions he was referred to the Surgical Department with the diagnosis of aspergilloma or cavitated carcinoma (?).

Right thoracotomy was performed in April, 1961 (Dr. Granate). The right upper lobe was strongly adherent to the anterior chest wall. While dissecting off the lung the cavity was opened and found to be filled by masses of necrotic tissue, some with a stringy aspect, others with a wavy contour and sometimes with a semblance of stratification (Fig. 12). Part of this mass was cultured, but no fungi or bacteria developed. Microscopically it was possible to find the "ghosts" of hyphae, some of which could be impregnated by the metanamine-silver nitrate method of Gomori (Fig. 13).

The cavity wall was made up of richly vascularized granulation tissue, rich in plasmocytes, and with marked sclerosis in the deeper layers. In some places

there was a metaplastic epithelium, quite often thin and sometimes with semicircular depressions. In areas where there was no epithelium, buds of granulation tissue bulged into the cavity lumen and some foreign-body giant cells could be seen.

The diagnosis of cancer was considered in this patient because of severe anaemia and the poor general condition, not usually found in these cases. We believe that this may be due to a very virulent infection within the cavity of a chronic abscess secondarily invaded by aspergillus, which also killed the fungus.

DISCUSSION

From 1958 to date 30 cases of pulmonary aspergilloma, including the five presented in this paper, have been reported in Portugal and, to our knowledge at least, 15 more have been recognized. Some data on the published cases are presented in Table I in the order that they were reported. In all these it was possible to trace a previous bronchopulmonary disease on which the fungus developed.

These lung changes were of a non-specific inflammatory nature in 10 cases: post-pneumonic pneumatocele in one (Case 20), chronic lung abscess in two (Cases 4 and 30), bronchiectasis in six (Cases 6, 7, 11, 14, 15, and 24), and a bronchogenic cyst in one (Case 13).

Tuberculous lesions were the predecessors of aspergilloma in 17 cases. Of these, 11 had tuberculous lesions around the cavity, and one even had an active lesion in the cavity wall (Case 5). In the remaining cases, there was at one time a clinical diagnosis of tuberculosis, not bacteriologically proved, and the pathological picture was compatible with healed, completely burned-out, tuberculosis with residual cavitation. Besides these, there were two with pulmonary lesions rarely invaded by the aspergillus: silicosis (Case 26) and the residual space of an echinococcus cyst (Case 27).

There had been clinical evidence of the previous disease from six months to 25 years before the aspergilloma was diagnosed. However, only in six cases had the symptoms lasted for less than one year; some think that the longer a chronic pulmonary disease lasts the greater the chances of its infection by aspergillus.

This brings us to the very controversial problem of whether, in cases of aspergilloma, the fungus "disease" is of a primary or secondary nature. According to Rodrigues (1958b), the absence of bronchopulmonary lesions before aspergilloma set in has not been proved in the cases reported as primary, as no tomograms or bronchograms had

TABLE I

Case No.	Author	Sex	Age	Presenting Symptoms	Radiology			Bronchoscopy	Previous Disease in Lung
					Standard	Tomogram	Bronchogram		
1	Rodrigues (1958a) Case 1	F	15	Haemoptysis, expectoration of mycotic grains	Bullous cavity with intracavitary nodules	Kidney-like cavity with two masses separated from wall by transparent crescent	Cavity penetrated and mass partially impregnated by contrast	Oedema of the orifice of L.U.L.B.	Tuberculosis (- T.B.)
2	Ibid. Case 2	F	24	Repeated haemoptysis	Bilateral tuberculous cavity R.U.L.	Cavity with intracavitary masses	—	—	..
3	Marques (1958)	F	32	Repeated haemoptysis for 12 years	Thin-walled cavity with intracavitary mass left apex	Dense rounded mass with halo	—	Normal	Tuberculosis (?)
4	Rodrigues and Rodrigues (1958)	M	21	Pulmonary suppuration, repeated haemoptysis	Cavity with fluid level; clean cavity; cavity with masses	Typical "bell-like" image	—	..	Pulmonary suppuration (abscess)
5	Pimentel and Marques (1958)	M	35	Weakness, dry cough, malaise, tiredness	Cavity with calcified nodules in upper part of L.U.L.	Thick-walled cavity with round calcified masses in upper part	—	Reddened mucosa in L.U.L.B.	Active tuberculosis (- T.B.)
6	Pinto <i>et al.</i> (1958) Case 1	F	34	Repeated haemoptysis for 12 years	Dense irregular shadow R.U.L.	Cavity with mass separated by crescent	Anterior segment R.U.L. not penetrated	Normal	Bronchiectasis (?)
7	Ibid. Case 2	F	38	Pulmonary suppuration, blood-streaked sputum	Thin-walled cavity with round intracavitary mass R.U.L.	"Bell-like" image	—	..	Tuberculosis Pulmonary suppuration
8	Pedro (1958) Case 1	M	23	Repeated haemoptysis	Round low density mass left mid lung	Round dense mass with semicircular halo	—	—	Healed tuberculosis
9	Ibid. Case 2	F	22	Haemoptysis treated as tuberculosis for 1½ years	Round, badly defined density R.U.L.	Round mass with peripheral halo	—	Normal	Tuberculosis (?)
10	Ibid. Case 3	M	30	Repeated haemoptysis treated as tuberculosis	Cavity (?) R.U.L.; laier round nodule with halo in same place	Thick-walled cavity with intracavitary buds	—	Congested and oedematous R.U.L.B.	Tuberculosis
11	Ibid. Case 4	M	48	Repeated haemoptysis, bad general condition	R.U. lobar density with large hyper-transparent area	Multicavitated density in all of the R.U.L.	R.U.L.B. not penetrated, M.L.B. and R.L.L.B. normal	Oedematous stenosis R.U.L.B.	Pulmonary suppuration
12	Villar (1959) Case 1	M	10	Haemoptysis leading to acute anaemia	Multiloculated cavity with intracavitary mass	—	Cavity penetrated by contrast that dislocates the mass	Oedematous stenosis of R.U.L.B. with suppuration	Tuberculosis primary infection
13	Ibid. Case 2	F	34	Pulmonary suppuration	Large, round, well-limited mass in right mid-lung with halo	Same image with halo at opposite end	—	Oedematous stenosis and suppuration in apical branch R.L.L.B.	Bronchogenic cyst? Lung abscess?
14	Ibid. (addenda)	M	38	Pulmonary suppuration, persistent blood streaking, especially on back tapping for postural drainage	Large round hilar mass with central hyper-transparency	Lateral view shows mass with semicircular halo at lower end	Apical-branch R.L.L.B. amputated	Oedematous stenosis and suppuration in apical branch R.L.L.B.	Bronchiectasis
15	Pimentel and Marques (1959) Case 4	F	56	Pulmonary suppuration, repeated haemoptysis	Round dense mass with lateral halo	Same picture	—	Normal	Bronchiectasis?
16	Ibid. Case 5	M	30	Repeated haemoptysis	Irregular density in R.U.L.	Large round nodule with halo	—	Oedematous stenosis R.U.L.B.	Tuberculosis (negative T.B.)
17	Ibid. Case 10	M	20	Bilateral apical calcification; cavity with fluid level L.U.L.	Multicavitation L.U.L.	—	L.U.L.B. infiltrated and bleeding	Tuberculosis (negative T.B.)
18	Ibid. Case 15	M	49	Lung abscess?; blood-streaked sputum	Irregular density R.U.L. with cavities	Large nodule with lateral halo	—	Oedematous stenosis and suppuration R.U.L.B.

DETAILS OF PUBLISHED CASES

Localiza- tion	Preliminary Diagnosis	Mycology	Therapy	Course	Duration of Pul- monary Disease	Pathology	
						Cavity	Contents
L.U.L.	Aspergilloma	Sputum culture <i>Aspergillus fumigatus</i> in the grains	Surgery refused	1, Tuberculosis; 2, bullous cavity; 3, septate cavity; 4, endocavitary masses; 5, suppuration; 6, blood-streaked sputum; 7, growth of masses; 8, grains in sputum	4 years	?	?
R.U.L.	„	Sputum culture <i>Aspergillus fumigatus</i> ; negative in cavity	Speleostomy	1, Tuberculosis; 2, bullous cavity; 3, suppuration; 4, intracavitary buds; 5, haemoptysis; 6, growth of masses; 7, sputum culture positive for <i>Aspergillus fumigatus</i> ; 8, speleostomy	7 „	?	Live (++) and dead (+) fungus
L.U.L. (apical post. segment)	„	Sputum and cavity culture negative for aspergillus	L.U.L. lobectomy	1, Tuberculosis?; 2, repeated haemoptysis; 3, cavity on radiograph; 4, endocavitary mass; 5, lobectomy	19 „	Bronchial	Dead (++) and live (+) fungus
R.L.L. (apical segment)	„	Sputum culture <i>Aspergillus niger</i> ; cavity culture <i>Aspergillus fumigatus</i>	R.L.L. lobectomy	1, Pulmonary suppuration; 2, cavity with fluid level; 3, clean cavity; 4, haemoptysis; 5, endocavitary mass; 6, sputum culture <i>Aspergillus niger</i> ; 7, lobectomy	4 „	Chronic abscess cavity?	Live (++) and dead (+) fungus
L.U.L. (apical post. segment)	Tuberculosis	—	L.U.L. lobectomy	1, Tuberculosis; 2, active cavity; 3, calcified intracavitary masses; 4, lobectomy	1½ „	Tuberculous cavity (active)	Dead and calcified fungus
R.U.L. (anterior segment)	Uncertain diagnosis	Septate hyphae in pathological specimen	R.U.L. + M.L. lobectomy	1, Pneumonia (?); 2, haemoptysis; 3, cavity with endocavitary masses; 4, lobectomy	12 „	Bronchial	Live (++) Dead (+) fungus
R.U.L. (posterior segment)	Aspergilloma	Sputum and cavity cultures negative	R.U.L. lobectomy	1, Pulmonary suppuration; 2, blood-streaked sputum; 3, round mass in R.U.L.; 4, cavity with endocavitary mass; 5, lobectomy	14 „	„	Live fungus
Between anterior segment L.U.L. and lingula	Echinococcus cyst	—	Wedge resection	1, Haemoptysis; 2, round dense mass with halo; 3, wedge resection	1 year	Old tuberculous cavity	Live (++) Dead (+) fungus
R.U.L. (anterior segment ?)	Aspergilloma	Bronchial washing "Sacaromyces S.P." and "geotricum." Cavity culture <i>Aspergillus fumigatus</i>	R.U.L. lobectomy	1, Haemoptysis; 2, antituberculosis treatment; 3, rounded mass; 4, halo round mass; 5, lobectomy	2 years	Old tuberculous cavity?	Live (++) Dead (+) fungus
R.U.L. (anterior segment)	Cavitated tuberculosis	—	R.U.L. lobectomy	1, Blood-streaked sputum; 2, cavitary tuberculosis; 3, "bell-like" image; 4, buds in cavity; 5, lobectomy	1 year	Bronchial (multiple)?	Live (++) Dead (+) fungus
R.U.L.	Pulmonary abscess	—	Right pneumonectomy	1, Bronchiectasis?; 2, haemoptysis; 3, infection; 4, lobar condensation with cavity; 5, pneumonectomy; 6, death	1 „	Bronchial (multiple)	Dead fungus
R.U.L. (apical segment)	Tuberculous lymph node cavity containing blood clot	—	R.U.L. + M.L. lobectomy	1, Tuberculous primary infection; 2, upper lobar condensation; 3, infection; 4, haemoptysis; 5, cavitation; 6, mass in cavity; 7, lobectomy; 8, death by suffocation with mass	3 years	Old tuberculous cavity (?)	„ „
R.L.L. (apical segment)	Pulmonary abscess	—	R.L.L. apical segmentectomy	1, Electro shock therapy; 2, pulmonary suppuration; 3, filled cavity; 4, segmentectomy	8 mth	Bronchogenic cyst	„ „
R.L.L. (apical segment)	Aspergilloma	—	R.L.L. lobectomy	1, Pulmonary suppuration; 2, retention periods; 3, blood streaking; 4, persistent suppuration; 5, halo round mass; 6, lobectomy	2½ years?	Bronchial	„ „
R.U.L. (anterior segment)	Carcinoma of lung	—	Right pneumonectomy	1, Suppuration; 2, haemoptysis; 3, right parahilar mass; 4, pneumonectomy	1 year	Bronchial (multiple)	Live (++) Dead (+) fungus
R.U.L.	Tuberculosis	—	R.U.L. lobectomy	1, Blood streaking; 2, antituberculous treatment for 6 years; 3, haemoptysis; 4, "bell-like" density; 5, lobectomy	8 years	Old tuberculous cavity (?)	Live (++) Dead (+) fungus
L.U.L.	„	—	L.U.L. lobectomy	1, Haemoptysis; 2, antituberculous treatment for 2 years; 3, haemoptysis; 4, cavity with fluid level; 5, lobectomy	2 „	Old tuberculous cavity	Live fungus
R.U.L.	Aspergilloma	Sputum culture <i>Aspergillus fumigatus</i> ; cavity culture <i>Aspergillus fumigatus</i>	R.U.L. + M.L. lobectomy	1, Pulmonary suppuration (?); 2, blood streaking; 3, "bell-like" density; 4, positive culture; 5, lobectomy	25 „	Tuberculous cavity?	Dead (++) and live (+) fungus

TABLE

Case No.	Author	Sex	Age	Presenting Symptoms	Radiology			Bronchoscopy	Previous Disease in Lung
					Standard	Tomogram	Bronchogram		
19	Pimentel and Marques (1959) Case 23	M	16	Weakness, anorexia, weight loss, productive cough	L.U.L. cavity with intracavitary calcifications	Thin-walled cavity with intracavitary calcified masses apparently loose	—	Normal	Tuberculosis (positive culture T.B.)
20	Pinto <i>et al.</i> (1960) Case 3	F	14	Repeated pneumonias from 5 to 10 years	Cyst-like image, low density image in cavity	Cavity with intracavitary mass	Cavity not penetrated. No bronchiectasis	—	Post-pneumonic pneumatocele
21	Ibid. Case 4	M	20	Pulmonary suppuration, repeated haemoptyses	Cavitary tuberculosis, bullous cavities endocavitary mass	Intracavitary mass	Cavity not penetrated	—	Tuberculosis (negative T.B.)
22	Ibid. Case 5	F	34	Repeated haemoptyses	Small cavity right lung	Cavity with intracavitary mass and halo	Saccular bronchiectasis apical segment R.L.L. cavity penetrated	R.L.L.B. diseased	" "
23	Ibid. Case 6	M	24	Pulmonary tuberculosis T.B. + blood-streaked sputum	Bilateral cavitary tuberculosis; later left localized mass with halo	Dense mass within cavity with halo	—	—	Tuberculosis (positive, then negative T.B.)
24	Pimentel (1961) Case 1	M	27	Haemoptysis for 6 years; brain abscess	—	—	—	—	Bronchiectasis
25	Ibid. Case 2	M	29	Haemoptysis for 4 years	Homogeneous density L.L.L. coral-like calcification with halo	Same aspect	Inconclusive	Normal	Tuberculosis
26	Present series Case 1	M	46	Weakness, weight loss, haemoptysis	Bilateral silicosis; round infiltrate right upper lobe	Thin-walled cavity with intracavitary mass	—	"	Silicosis
27	Case 2	F	53	Repeated haemoptyses	Low density round infiltrate in left mid lung with pleural reaction	Lateral view shows round density with halo over upper half	Pathological region not penetrated	—	Residual space of removed echinococcus cyst
28	Case 3	M	50	" "	Bullous cavity R.U.L.	Cavity with bud-like formation on upper pole	Cavity in apical segment penetrated by contrast with the mass displaced to lower end	—	Tuberculosis
29	Case 4	F	39	Diabetes. Weakness, cough, and purulent sputum	Round, low-grade density with halo in R.U.L. (upper half)	Round density with central transparency	—	—	?
30	Case 5	M	52	Pulmonary suppuration, anaemia and weight loss, haemoptysis	Cavity in anterior segment R.U.L. on lateral film	Lateral film intracavitary mass with air bubbles	Pathological region not penetrated	R.U.L.B. suppuration	Chronic abscess?

been done before this diagnosis was made. The increasing use of antibiotics has created in the lungs of an increasingly large number of patients the ideal conditions for the development of the fungus (Villar, 1959). This is especially true for tuberculosis (Rodrigues, 1958a)—bullous and residual inactive tuberculous cavities—and bronchiectasis. Cases in which the filling of previously "clean" cavities has been followed up radiologically (Rodrigues, 1959) are also proof of the secondary nature of the condition. This showed the invasion of a previously existing cavity by a

fungus mass in nine of the Portuguese cases (Cases 1, 2, 3, 4, 10, 12, 20, 21, and 28).

One of the arguments put forward in favour of a bronchodilating action of the fungus mass is the absence of bronchiectasis around the bronchus containing the fungus. One of us (J.C.P.) undertook the pathological study of 61 cases of bronchiectasis and found solitary bronchial dilatations in seven. A pre-existing cavity may reduce in size due to the fibrosis of its wall (Pimentel, 1958a) or enlarge because the fungus ball acts as a ball valve (Villar, 1959),

DETAILS OF PUBLISHED CASES (continued)

Localiza- tion	Preliminary Diagnosis	Mycology	Therapy	Course	Duration of Pul- monary Disease	Pathology	
						Cavity	Contents
L.U.L.	Remains of aspergilloma in tuberculous cavity	—	L.U.L. lobectomy	1, Tuberculosis; 2, antituberculous treatment for 2 years; 3, cavity with intracavitary calcification; 4, lobectomy	2 years	Tuberculous cavity	Dead and calcified fungus
L.L.L. (anterior basal segment)	Aspergilloma	Cavity culture <i>Aspergillus S.P.</i>	L.L.L. lobectomy	1, Repeated "pneumonias"; 2, pneumatocele; 3, intracavitary mass; 4, lobectomy	9 "	Pneumatocele	Live fungus
L.L.L. (apical segment)]	"	Sputum culture negative; skin test positive	Left pneumonectomy	1, Pneumonias with haemoptysis; 2, tuberculous cavitation; 3, antituberculous treatment for 6 years with haemoptysis; 4, bullous cavities; 5, endocavitary mass; 6, pneumonectomy	7 "	Bullous tuberculous cavity	?
R.L.L. (apical segment)	?	—	R.L.L. apical segmentectomy	1, Haemoptysis; 2, tuberculosis; 3, haemoptysis; 4, antituberculous treatment; 5, cavity with endocavitary mass; 6, segmentectomy	3 "	Bronchial	?
L.U.L. (apical post. segment)	Inspissated cavity or aspergilloma	—	L.U.L. apical posterior segmentectomy	1, Tuberculosis; 2, blood streaking; 3, bilateral cavitation; 4, large nodule; 5, halo; 6, segmentectomy	2 "	"	?
R.U.L. (autopsy)	—	—	—	1, Haemoptysis for 6 years; 2, brain abscess; 3, death; 4, necropsy	6 " ?	Bronchial multiple	Dead and calcified fungus
L.U.L. (base)	Tuberculosis	—	L.U.L. lobectomy	1, Tuberculosis; 2, haemoptysis; 3, coral-like calcification with halo; 4, lobectomy	13 "	Bronchial	Dead and calcified
R.U.L. (apical segment)	Aspergilloma + silicosis	Sputum and secretion cultures negative. Spore-bearing head in pathological sections characteristic of <i>Aspergillus fumigatus</i>	R.U.L. lobectomy	1, Chronic bronchitis; 2, silicosis; 3, haemoptysis; 4, "bell-like" image; 5, lobectomy	10 "	"	Dead (+ +) Live (+) fungus
Fissure between left upper and lower lobe	Aspergilloma	—	Removal of fungus mass and obliteration of cavity	1, Haemoptysis; 2, echinococcus cyst; 3, removal; 4, haemoptysis; 5, "bell-like" image; 6, removal of mass and obliteration of cavity	15 "	Pleural	Dead (+ +) and live (+) fungus
R.U.L. (apical segment)	"	Sputum cultures negative for fungus	R.U.L. lobectomy	1, Cavitary tuberculosis; 2, cure?; 3, haemoptysis; 4, bullous cavity; 5, "bell-like" image; 6, lobectomy	15 "	Bronchial	Dead (+ +) and live (+) fungus
R.U.L. (post. segment?)	"	Sputum <i>Aspergillus niger</i>	Surgery precluded by kidney condition	?	?	—	—
R.U.L. (anterior segment)	Aspergilloma? Carcinoma?	Culture of cavity wall and contents negative	R.U.L. lobectomy	1, Chronic bronchitis; 2, pulmonary suppuration; 3, haemoptysis; 4, intracavitary mass on lateral tomograms; 5, lobectomy	6 mths	Chronic abscess cavity	Dead fungus

but it is certainly not the pressure of the soft mass on the rigid bronchial wall that dilates it.

The predominance of aspergilloma in the upper lobes of the lungs has also been considered proof of the primary nature of the condition on the basis that bronchiectasis is much more frequent in the lower lobes. Rodrigues (1958c) points out it is not the actual bronchial dilatation which is rarer in the upper lobes where, tuberculosis being its most frequent cause, it is even more frequent. It is rather the clinically significant bronchiectasis, i.e., the infected type, that predominates in the

lower lobes. In 107 specimens of pulmonary resection examined (Pimentel and Marques, 1959), bronchiectasis was found in the upper lobes in 57%. The higher incidence of infection and the speed with which it develops in lower-lobe bronchiectasis (Pimentel, 1959), together with the antagonism that exists between the fungal and bacterial growths, can transform the aspergilloma into a residual form which may not be easily recognized. The fact that we have seen three residual aspergillomas of this type in lower-lobe bronchiectasis makes us believe that the idea that

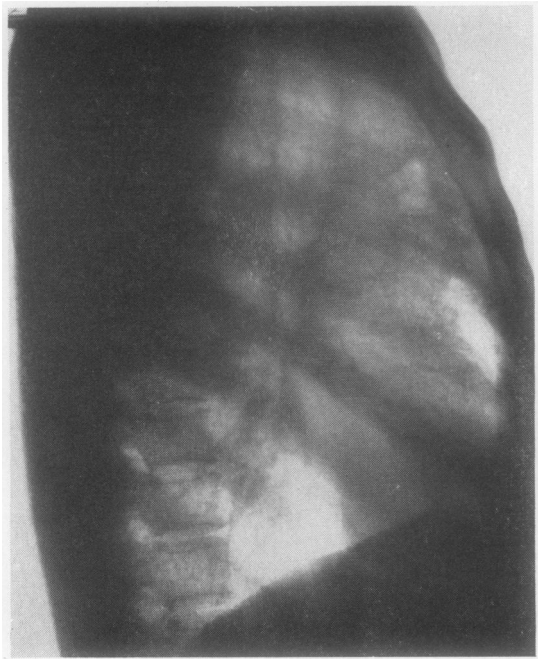


FIG. 10.—Lateral radiograph of Case 5 shows an oblong cavity with a small fluid level right behind the sternum.

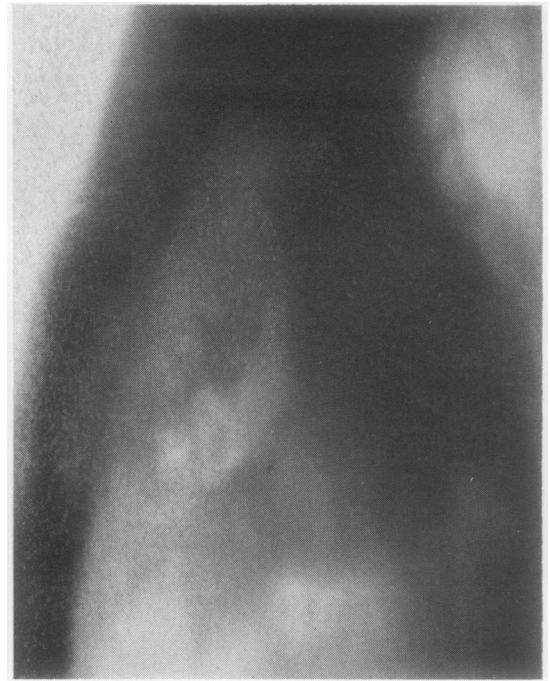


FIG. 11.—Lateral tomogram of Case 5 shows that the cavity is partially filled by a dense mass adherent to its posterior wall.



FIG. 12.—Necrotic intracavitary tissue in Case 5 with a semblance of stratification.

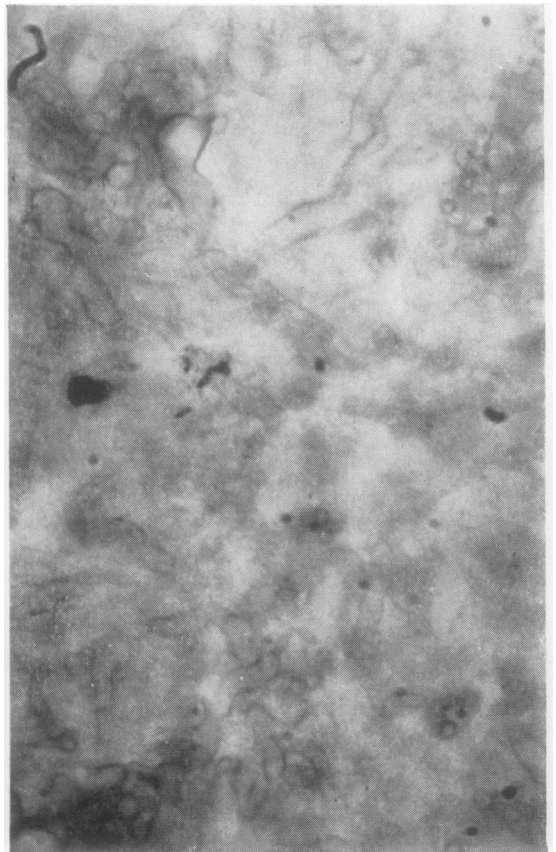


FIG. 13.—Ghosts of hyphae in Case 5 brought out by Gomeri's method.

the fungus does not invade the lower lobe bronchi should be revised (Pimentel, 1959).

PATHOGENICITY.—The problem of whether or not the fungus is pathogenic in cases of aspergilloma has also been a subject of discussion. According to some authors, the fungus has invasive properties and, as a proof of this, they mention the fact that mycelium can be found in the midst of the granuloma which grows out from the cavity walls. However, for the great majority, the fungus acts as a saprophyte. In our opinion (Pimentel, 1958a and b) it does not behave as a really pathogenic fungus, but its presence within a cavity can give rise to a pathological condition fundamentally identical to that produced by a foreign body, generally badly tolerated by the host. In this particular case the foreign body is living matter and grows.

The progressive growth of the fungus within the cavity and the friction caused by the displacement of the mass brought on by respiration, cough, and even by the changes in position of the patient, produce an atrophy of the lining epithelium and later erosions and even ulcers. In the denuded areas of the cavity wall granulation tissue grows, forming small buds and later large sheets that envelop the more peripheral portions of the fungus mass. As in foreign body granuloma, a variable number of foreign body giant cells can be found in this granulation tissue, particularly in the areas that come into direct contact with the mycelium.

The great vascularity of this granulation tissue and the traumatic factors already mentioned explain the marked haemorrhagic character of this condition. In the 30 Portuguese cases we have analysed, only five did not have blood-streaked sputum or haemoptysis at some time during the course of the illness.

Once the fungus lodges in a cavity, bronchial or not, it grows and dies continuously so that generally there is some dead and some living fungus. As it dies the mycelium tends to calcify. The foci of calcification which are so frequently formed in the devitalized portions of the fungus and attain their maximum intensity in calcified aspergilloma increase the trauma produced by the displacement of the endocavitary mass and the seriousness of its consequences (Villar, 1959; Pimentel, 1961).

Only in four of the cases discussed in this paper did the fungus found in the cavity seem to be mostly alive; in eight cases live fungus predominated, and in five dead; in nine cases the fungus was completely dead, and in four of these

it was completely calcified. Active tuberculosis or suppuration was nearly always associated with dead fungus, as either the fungus overpowers the associated infection or is overwhelmed by it (Pimentel, 1959; Villar, 1959). However, the existence of suppuration does not completely exclude the possibility of culturing the aspergillus (Rodrigues, 1958c). This only depends on the phase in which the specimen is taken, i.e., if there is still some live fungus present. On the other hand, sometimes the fungus dies without any sign of suppuration (Pimentel and Marques, 1959).

CAVITY CONTENTS.—The intracavitary mass of the aspergilloma may vary. In some cases it is greyish-yellow or greyish-green, with a dry, granular aspect: in others it has a pasty or definitely stringy look (Case 30), is dark-brown or black, and lets out a foul odour. In four cases the appearance of the intracavitary mass was different: in one there was an extensive calcification (Case 19); in another it looked like wet sand (Case 12); and in two other cases it took the form of a coral-like calcification (Cases 24 and 25) (Fig. 14A and B).

Microscopically, in the intracavitary mass there may be abnormal hyphae showing eosinophilic affinity, loss of structure, hyalinization, partial or total fragmentation, softening, and, quite frequently, focal calcification (Pimentel, 1959). We think these changes in the mycelium are characteristic of "dead" fungus. These regressive changes can be very intense, and the correct diagnosis of the condition may be difficult. The knowledge of the aspects just described and others, such as the wavy contours and stratification of the necrotic masses, and also the finding of the shadows of hyphae, which can be better brought out by Gomori's metanamine-silver nitrate technique, make it possible to determine the correct nature of the condition. It is also possible to prove the aspergillar origin of the calcified aspergillomata using Gomori's technique after first decalcifying the intracavitary mass (Fig. 15A and B).

Macroscopically, two varieties of aspergillomata can be found (Pimentel, 1958b), the solitary and the multiple forms, according to the number of cavities that are parasitized by the fungus. In this series of 30 patients only four examples of the multiple type were seen.

CAVITY WALLS.—The wall of the cavities in which the aspergillus develops is generally thick and fibrous, and the larger diameter of these cavities varies from 3 to 7.5 cm. Sometimes around the solitary type of aspergilloma smaller cavities are filled with mycelium.

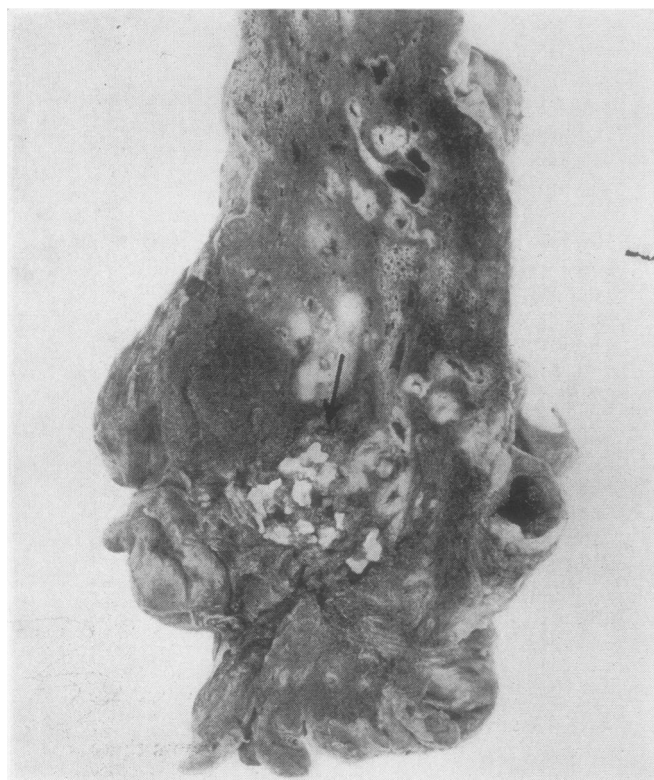


FIG. 14A

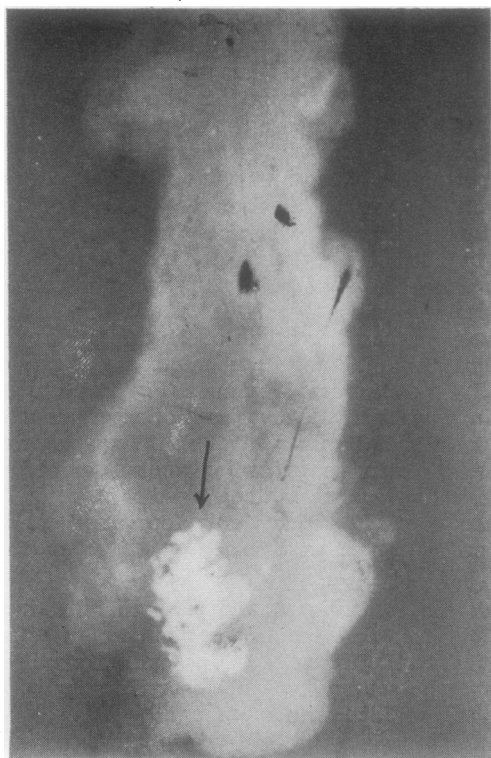


FIG. 14B

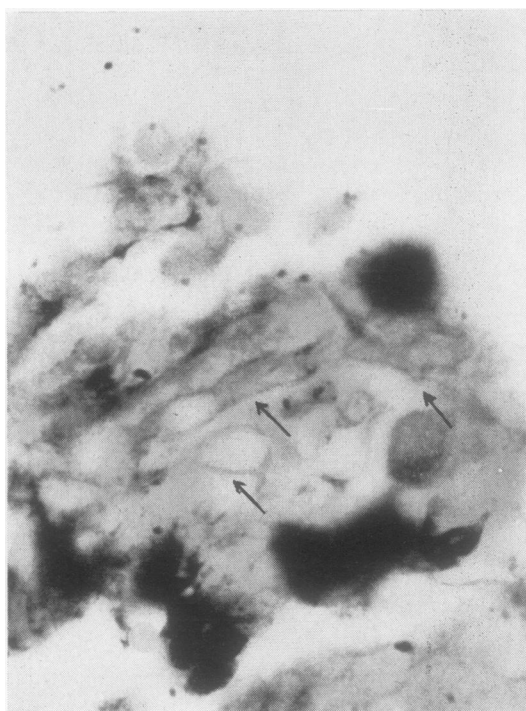


FIG. 15A

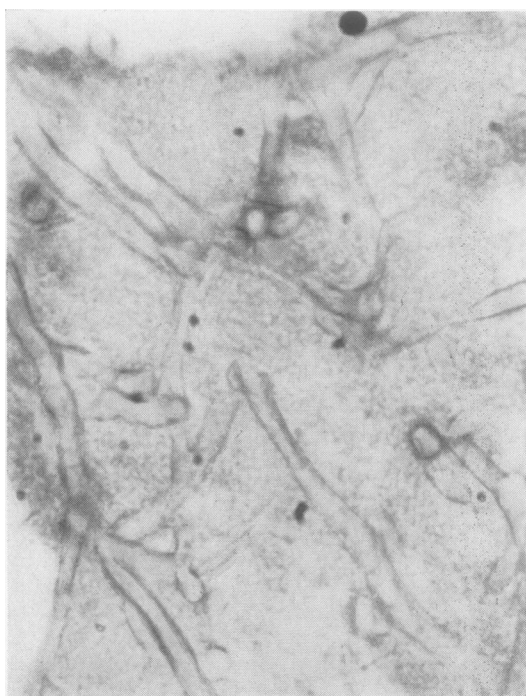


FIG. 15B

FIG. 14.—A and B, coral-like calcifications.

FIG. 15.—A and B, the aspergillar origin of calcified aspergillomata demonstrated by Gomori's technique.

The histological study of the cavity wall shows that, although it is generally a bronchiectatic cavity (presence of smooth muscle, mucous glands, and, sometimes, cartilage), it can also be a "cured" or active tuberculous cavity, a probable tuberculous cavity, the residual cavity of a lung abscess, or a bronchogenic cyst.

The cavities that were examined in this series were bronchiectatic in 13 cases, bronchogenic cyst in one, definite tuberculous cavities in four cases, probable tuberculous cavities in five, and residual abscess cavities in three cases.

The relations between the cavity and its contents were studied on serial sections (Pimentel, 1958a). In many places there were no changes in the cylindrical or metaplastic epithelium that lines the cavity. However, in some places, where it comes in contact with the fungus mass, the epithelium is greatly thinned and can even be completely missing, forming depressions in the cavity wall in which the fungus settles. Where the epithelium is missing granulation tissue develops and grows into the lumen of the cavity in the form of buds. Finally this granuloma involves the more peripheral portions of the mycelium more or less completely. In this way the fungus is included in the depth of the granulation tissue and may suggest invasive properties of the fungus which serial sections prove to be false. In a large number of cases foreign-body giant cells are found in places where the fungus ball is in contact with the granulation tissue.

Marked pathological changes were seen in the lung tissue around the aspergillomata in 15 cases. These consisted of bronchiectasis, tuberculous lesions in various stages of healing, healing chronic interstitial pneumonia, silicotic lesions and, in most cases, intense localized pleural symphysis (Pimentel and Marques, 1959; Pinto, Gonzaga, Alexandrino, and Neves, 1958).

EARLY OR RESIDUAL ASPERGILLOMATA.—Having agreed that the aspergilloma develops in a pre-existing cavity, and having become familiar with the various aspects of the necrobiosis of the fungus ("dead" fungus) we wondered if it would be possible to identify the initial stages of aspergilloma. Because of the frequency with which we found calcifications of the fungus mass we also wondered what role this condition plays in the pathogenesis of bronchololiths and cavernololiths. Would histopathology make it possible to recognize residual aspergillomata in some cases of bronchopulmonary suppuration?

HISTOPATHOLOGICAL STUDIES.—Studies undertaken by one of us (Pimentel, 1959) resulted in the

following conclusions: (1) In bronchopulmonary cavities similar to those in which aspergilloma developed, it was possible to find clumps of aspergillar hyphae much smaller than the cavities in which they lodge. Culture of these clumps yielded *Aspergillus fumigatus*. This aspect probably corresponds to the initial stages of the development of aspergilloma interrupted by pulmonary resection before it could be seen on the chest film. This aspect was found in four of 370 pulmonary resection specimens.

(2) The regressive changes seen in the fungus when simultaneously there is a serious infection might be accompanied by a process of softening and liquefaction so that the greater part of the fungus was eliminated with the sputum. For this reason only small masses of necrotic tissue remained within the cavity and the aspergilloma lost its typical aspect. The condition might then be interpreted as a chronic lung abscess or as infected bronchiectasis, and the correct diagnosis could only be made by careful microscopical study of the cavity contents. These remains of an aspergilloma could be called "residual aspergilloma." To prove that the necrotic mass was part of a mycelium, we looked for the "ghosts" of hyphae. These were brought out in appreciable numbers in necrotic tissue using Gomori's technique with some modifications.

(3) In some cavernololiths and bronchololiths these shadows of hyphal structure could also be found using the same technique. The presence of one or more of this type of small concretion within bronchopulmonary cavities constituted, in our opinion, another form of "residual aspergilloma" (Fig. 16).

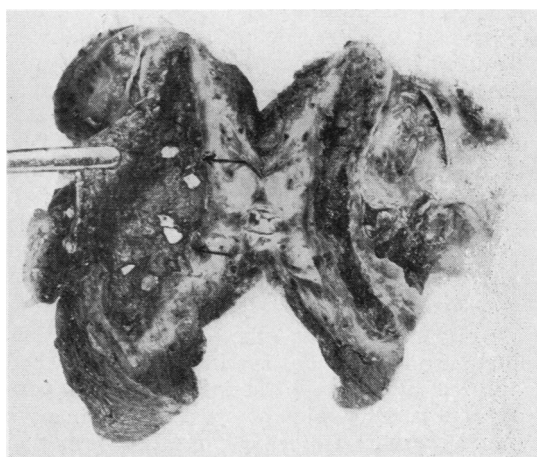
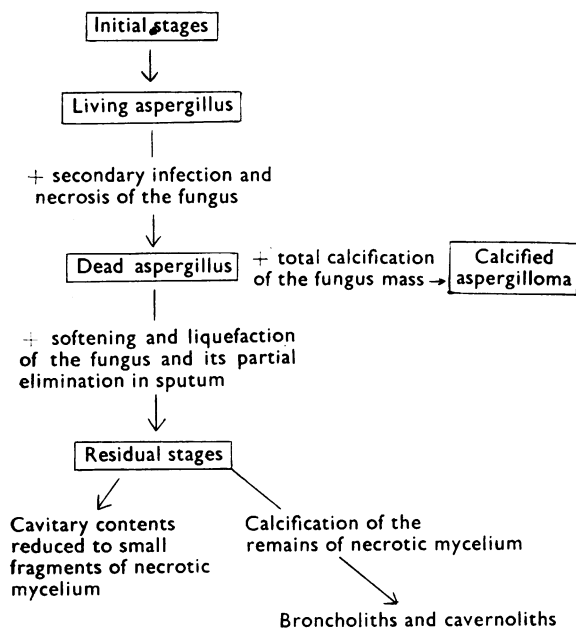


FIG. 16.—Multiple calcified aspergillomas in a resected lobe.

From our review of the literature and from what we have seen, it seems possible to summarize the natural history of aspergilloma as follows (Pimentel, 1961):



THE CLINICAL PICTURE.—Pulmonary aspergilloma is dominated by two groups of symptoms: haemoptysis and signs of pulmonary suppuration. Some authors think that there is quite a long asymptomatic period, but in the Portuguese cases which were apparently followed through the earlier stages blood streaking appeared as soon as the first signs of the condition were seen on the chest film (Rodrigues, 1958c).

Haemoptysis dominated the clinical picture in 23 out of 30 patients in this series, and in some cases was so severe that it led to acute anaemia. In five patients the symptoms were those of pulmonary suppuration, and in two only those of the underlying disease. The general condition of the patient is usually not affected in cases of pulmonary aspergilloma. Only in two patients, in whom there was serious suppuration of the cavity, did the condition have any systemic repercussion.

DIAGNOSIS.—Despite the ease with which sputum and secretion specimens can be contaminated by aspergilli, and the fact that when we isolate a fungus in the sputum we can never be sure it comes from the lungs, it is important to try to cultivate the aspergillus from the sputum

in cases of "aspergilloma" because, as Riddell has stated, in cases of positive culture the chances are that it comes from the lungs. One should also look for mycotic grains in the sputum, as they can be of great help in diagnosis. These grains were only seen in one of the cases in this series.

We compared the histological aspects of the fungus mass with the results of sputum cultures and of cultures taken from the cavity contents, so that we could check whether our morphological classifications as "live" and "dead" fungus were correct.

The sputum was cultured in 11 of the cases presented in Table I. In three *Aspergillus fumigatus* developed and in two *Aspergillus niger*. In the remaining six cases the sputum cultures were negative for fungi. Of these six the histological study of the endocavitary mass showed "predominantly dead" fungus in three and "completely dead" fungus in two. In the remaining case with negative sputum cultures we did not see the slides and the published description (Pinto *et al.*, 1960) is not clear on this point.

The cavity contents were cultured in eight cases. *Aspergillus fumigatus* grew in a case where *Aspergillus niger* had been isolated from the sputum, and in three other cases, in one of which the fungus had also been cultivated from the sputum. In the remaining four cases no fungus developed from the cultures of the intracavitary material. Of these, the histological aspect was of live fungus in one case in which *Aspergillus fumigatus* had been cultured from the sputum; in two cases the pathological picture was of predominantly dead and dead fungus; in the remaining case, although the fungus did not grow on culture, sporulating aspergillar heads were found in the pathological sections (Orie, de Vries, and Kikstra, 1960).

Of the cases with positive cultures from the sputum or from the cavity contents, one presented the histological picture of live fungus, three of predominantly live fungus, and one of predominantly dead fungus.

The morphological aspects of dead and live fungus may explain the negative cultures.

Skin tests were only done in one of the Portuguese cases (Case 21) as, on the whole, we agree with Pepys, Riddell, Citron, Clayton, and Short (1959) that these are completely unreliable in aspergilloma.

Radiology is probably the most important pre-operative diagnostic method in the study of pulmonary aspergillomas. The classical "bell-like" image—*grelot* of the French authors—in which

the cavity represents a round bell and the intracavitary mass the clapper, is the most frequent radiological picture of this condition. It appeared in 23 cases of the series under discussion. However, if changes such as pneumonitis in the surrounding lung obliterate this image, tomography will usually bring it out.

The transparent halo that separates the fungus mass from the cavity wall may appear in many positions, generally depending on the position of the patient when the film is taken. The changing position of the halo represents the mobility of the intracavitary mass, and was seen in some of our patients.

This classical picture is not the only radiological aspect of pulmonary aspergilloma. Rodrigues (1958c) reports what he considers to be the early phase of the invasion of a pre-existing cavity by the fungus. He describes long, sausage-like, homogeneous masses, with a rounded free end and a narrow base fixed to the cavity wall, and considers these images typical of a growing fungus. However, knowing the trauma to which the intracavitary masses are subjected during respiration, and especially during cough, it is difficult to understand how these erectile growths can stand out from the cavity wall. One of us has examined a cavity in a resection specimen that presented this radiological aspect and found it practically full of fungus masses. We believe that the sausage-like formations described by Rodrigues are packed in other fungus masses that have a lesser radio-opacity and so cannot be seen. For these reasons this radiological aspect may not correspond to such an early stage as it would seem. Probably the earlier stages of aspergilloma are not detectable radiologically.

When the fungus "dies" it may still give the classical "bell-like" image or it may simulate an abscess cavity. However, it differs from the ordinary pyogenic abscess in that it does not have a horizontal fluid level but rather a crescent-shaped intracavitary shadow. In this phase the fungus mass may also show many small air bubbles in its midst (Case 30) (Fig. 11). This aspect may be the predecessor of coral-like calcifications (Fig. 14A).

Once calcification of the dead fungus sets in, stratification of the intracavitary mass may be discernible on the chest film. In a more advanced phase, multiple, small, irregular calcified densities may appear free inside the cavity. In other cases these stick together and form "coral-like" densities within the cavities. These latter are the "residual forms of aspergilloma."

The changes in the cavity itself can also be followed radiographically. Quite often the cavity reduces in size with thickening of its walls when the intracavitary mass appears. The speed with which this reduction takes place precludes the mechanism most frequently invoked, fibrosis of the cavity wall, and is probably due to a ball-valve mechanism produced by the mobile intracavitary mass (Villar, 1959).

Although in most of the reported cases bronchography was not of much help in pulmonary aspergilloma, we have found it useful in some of our own patients. In the cases published in Portugal, bronchography was done in 12 patients. In five the contrast did not penetrate the pathological region. In two the bronchogram seemed normal, and in one there was a block in the apical branch of the right lower lobe bronchus, corresponding to the location of the aspergilloma. In four cases the cavity was penetrated by the contrast and in all of them the intracavitary mass was displaced by the contrast. In only one of these cases did the bronchogram show bronchiectasis round the aspergilloma cavity. Bronchoscopy was not of much help as it only showed the signs of the associated suppuration or tuberculosis. We feel that its greatest use is in collecting material for mycological studies.

TREATMENT.—Although medical treatment has been tried in some cases of pulmonary aspergilloma, on theoretical grounds the results cannot be expected to be uniformly good, especially when "dead" fungus is the cause of the disease. The Portuguese cases were all treated surgically except two, one because the patient refused surgery, the other because the surgeon did not dare to operate. The operation of choice is a lobar resection, but in some cases pneumonectomy or segmentectomies have to be done. In special cases, as in Case 2 of Rodrigues (1958a), speleostomy may be indicated. In our second patient (Case 27) the treatment consisted of the removal of the endocavitary mass and obliteration of the cavity space.

SUMMARY

Five new cases of pulmonary aspergilloma are presented and the 30 cases reported up to now in Portugal are reviewed.

All these patients had disease in their lungs before the aspergillus invaded them (bronchiectasis, lung abscess, bronchogenic cyst, echinococcus cyst, and tuberculosis). In some cases the invasion of cavities by the parasite could be followed radiographically.

Aspergilloma is found more frequently in the lower lobes than is generally thought: since lesions in this location are more likely to be infected, it appears in one of its "residual forms."

The fungus once in the lung grows and dies continuously, and as it dies the mycelium calcifies. Only in four of the cases discussed was the fungus mostly "alive." In nine it was completely "dead," and in four of these calcified (two wholly calcified). A morphological criterion for "dead" and "live" fungus, which correlates closely with the results of cultures, is presented and a pathogenic theory is developed in which the fungus is followed from "initial stages" to "residual stages" ending in necrosis and elimination or calcification.

Haemoptysis and blood streaking dominated the clinical picture of the great majority of patients, the syndrome of pulmonary suppuration coming next.

Besides the classical "bell-like" image other radiological aspects are described, such as sausage-like intracavitary masses, masses containing air bubbles, stratification of the intracavitary masses, partial calcification, and coral-like calcification.

In four cases in which the cavity was penetrated by the contrast during bronchography the fungus mass was displaced by the contrast, which was

another proof of the mobility of the fungus ball within the cavity.

Lobar resection is considered the treatment of choice.

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