

TUBERCULOMA OF THE LUNG

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The term tuberculoma of the lung is used here to describe a rounded, homogeneous radiographic opacity, with well-defined borders, one centimetre or more in diameter, of a tuberculous nature; no histological pattern is inferred. In the past such shadows have been called Assmann's foci, solitary or round foci, coin lesions, nodular tuberculosis, and localized caseous pneumonias, but none of these terms has come into general use. As a result of the wider application of chest radiography, this form of pulmonary tuberculosis is now being seen more frequently than in the past. Many problems are presented by these lesions, and in the available literature there is no uniformity of opinion concerning them. Only passing reference will be made in this paper to the problem of diagnosis; their natural history and treatment will be discussed in greater detail.

MATERIAL

The material on which this study has been based consists of all cases seen at the Brompton Hospital between 1935 and 1950 in which a minimum follow-up of three years could be obtained. A few treated by pulmonary resection have been followed for a shorter time. Forty-one cases were collected, but this total does not reflect the frequency of this form of tuberculosis, as many more were discarded because of inadequacy of data or short duration of surveillance. The tuberculoma was the sole abnormality on the original radiograph in 29 cases, but in 12 there was minimal disease elsewhere in the lungs.

PATHOLOGY

Three broad patterns were seen: (1) post-primary caseous pneumonia, (2) inspissated cavity, and (3) primary focus.

Assmann (1925, 1930), Stefko (1928), Beitzke (1931), Straub (1932), and others described the histology of the rounded form of early infiltrate as an exudative process, a localized tuberculous bronchopneumonia in which caseation might be found and which might involve a bronchus with discharge of its contents and the assumption of cavitory characteristics. Small contiguous foci were frequently present, and the main lesion was surrounded by a capsule of varying density and morphology dependent on its age and chronicity. They were considered to be reinfection foci.

Following the work of Coryllos (1933, 1936) on the mechanics and biology of tuberculous cavities, blockage of the draining bronchus followed by inspissation of the contents has become recognized as a possible natural mechanism of cavity healing. Amberson (1936), Derscheid and Toussaint (1938), Pagel and Simmonds

(1939, 1942), Auerbach and Green (1940), and others have presented convincing pathological proof of this process. Pagel (1948) in a recent survey stated that this process was the most frequent mode of cavity healing. He wrote :

“ Within four weeks a cavity can be converted into a solid nodule. At first, this focus is soft and cannot be regarded as a stabilized or healed lesion, but later, when the material becomes more and more inspissated and calcifies, it deserves the latter designation.”

Thus, when the bronchus is blocked, caseous material can no longer drain, the contained air is absorbed, and on the radiograph a rounded homogeneous tuberculoma replaces cavitation. A further seldom-appreciated possibility is that a primary tuberculous lung focus may occur in rounded form and come within the radiological definition. Two cases in this series and possibly a third were primary lesions. One was a boy of 18 with a solitary focus in the left lower zone (Fig. 1), without evidence of other disease or hilar enlargement on tomography. Neoplasm was suspected and a left lower lobectomy performed. Examination of the specimen revealed many satellite tubercles around the main lesion with actively caseating glands at the lung root. This was confidently diagnosed as a primary complex. Another case was suspected after pneumonectomy because of comparable findings ; in the third, a hilar gland was observed to resolve and calcify at the same time as the lung focus.

Clinically, when a patient presents with a tuberculoma, there is no means of determining whether it is a post-primary pneumonic focus or an inspissated cavity. Even recognition of a primary lesion may be impossible in the absence of evidence of hilar gland enlargement, lung calcification, or recent Mantoux conversion. Except in the case of the primary lesion, the pathologist has only slightly less difficulty when faced with a resection or post-mortem specimen, especially when a pneumonic focus has liquefied. The only points on which reliance can be placed are: (1) a caseous pneumonic focus before liquefaction has a homogeneous centre firmly adherent to its wall, and this cannot be washed away with water ; (2) microscopic examination of a caseous pneumonic focus stained for elastic fibres may show large portions of intact elastic structure, while in an inspissated cavity only disorganized elastic elements may be seen ; (3) cartilaginous remnants may traverse a pre-cavitary focus.

The proportion of cases falling into each of the three pathological patterns is unknown. The majority are probably in the first two categories and only a few are primary lesions. Of the seven resection cases in this series, three were interpreted as post-primary caseous pneumonias, two as inspissated cavities, and one as a primary infection ; in one, already quoted, no final decision was made, but caseating hilar glands were present.

CLINICAL ASPECTS

Lung tuberculomata are easily confused with other conditions of similar appearance, but they have many distinctive features. In this series the average age was 29 years, the youngest patient being 15 and the oldest 51. Tuberculomata are found most often between the ages of 17 and 35, and are the commonest cause of round lesions in this age group. As in the experience of Sellors and Hickey (1949), they were found more often in females (27 females to 14 males). In 17 cases (41 %) a family or contact history of pulmonary tuberculosis was obtained ; taken in conjunction with other factors this may be of diagnostic value. The past history may

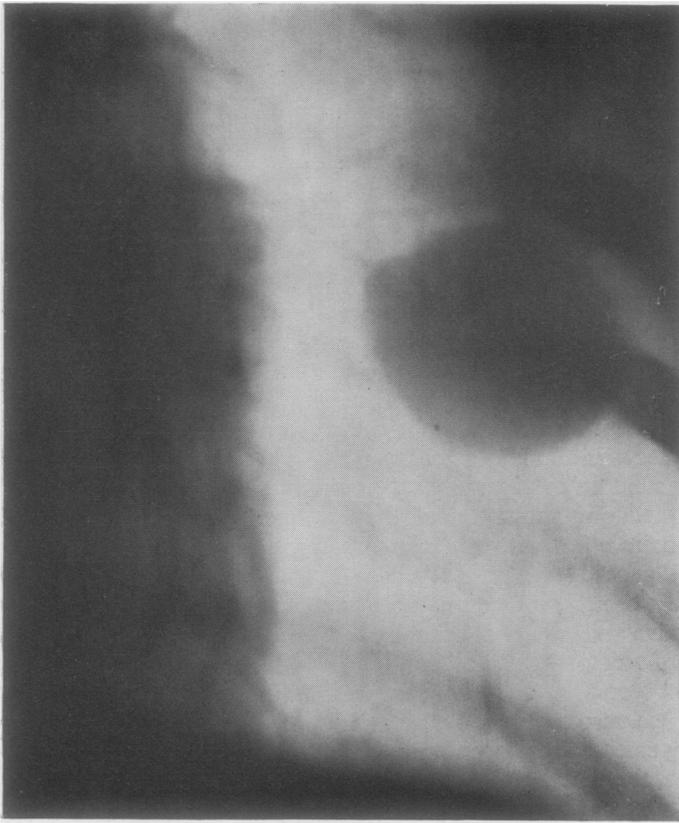


FIG. 1.—Tomograph showing a large tuberculoma in the lower zone of the left lung.

provide assistance ; five patients gave a history of an antecedent pleurisy, and in seven others there had been an acute chest illness during the previous five years.

The silent nature of many of these lesions is well known. Fourteen cases were completely symptom-free, routine radiography being the reason for their reference. Haemoptysis and pleural pain are the most frequent presenting symptoms, and may occur alone or together with other complaints commonly associated with an early tuberculous infection. The duration of symptoms is always of importance and may help in differentiating from malignant and acute inflammatory conditions. The average duration of ill-health in the 27 patients who presented with symptoms was about six months, ranging between one week and two and a half years.

A careful search of the sputum for tubercle bacilli should be made with liberal use of cultures and, where necessary, the examination of laryngeal swabs or gastric contents. Not only is the finding of the organism diagnostic in all but the rare individual in whom tuberculosis and carcinoma or other disease coexist, but it also shows that the disease is active. Seven patients had a positive sputum, six by smear examination and one on culture, during the initial investigation period ; 11 were negative but subsequently became positive ; in the remaining 23 patients no tubercle bacilli were found at any time.

The Mantoux test may be of value in that a negative reaction to a dilution of 1 : 100 O.T. favours an alternative diagnosis, although it does not exclude a tuberculoma. Five cases in this series were tested and all were positive reactors to the higher dilutions. The erythrocyte sedimentation rate (E.S.R.) rarely rises above normal except in a proportion of active cases.

Radiographic Features.—Tuberculomata may be single or multiple, from 1 to 5 cm. or more in diameter, and appear in any part of the lung. Their density is variable; occasionally the presence of an enveloping capsule can be inferred, and concentric laminations have been described by Haight and Farris (1939). The segmental distribution found in this series is shown in Table I, and it will be observed that the sites of election are those frequently involved by the aspiration of infected material in the recumbent position and are similar to those affected in the commoner forms of phthisis.

TABLE I
SEGMENTAL DISTRIBUTION (41 CASES)

	Upper Lobe				Lower Lobe			Right Middle Lobe or Lingula	Lobe not Known	Total
	Anterior Segment	Posterior Segment	Apical Segment	Segment not Known	Apical Segment	Other Segments	Segment not Known			
Right lung	2	7	5	4	7	2	0	0	1	28
Left lung	0	1	1	5	4	0	0	0	2	13
	2	8	6	9	11	2	0	0	3	41

Satellite shadows, calcification, and cavitation are the radiographic features of most importance in diagnosis and prognosis; tomography is necessary to ascertain their presence or absence with any accuracy. Satellite shadows in close relationship to the lesion or infiltration elsewhere in the lungs are highly suggestive of tuberculosis. Such shadowing, not observed in the routine films, was revealed by tomography in three cases in this series. Segmental atelectasis peripheral to the lesion is unusual. Calcification is of even more significance, and as a general rule it means phthisis and suggests an old and healing lesion. Calcium deposition in the lung occurs in other conditions, but they are either rare or uncommon in this country. Confusion between calcification in a tuberculoma and cartilaginous "seeds" in a hamartoma is a possible pitfall. When a tuberculoma cavitates, the typical picture is that of single or multiple translucencies, rarely circular but of smooth outline and often eccentric in situation, within the homogeneous mass of the lesion (Fig. 2). No fluid level is seen, although communication has been established with a bronchus leading to the discharge of some caseous material.

Diagnosis and Differential Diagnosis.—Twenty-eight of the 41 cases in this series were regarded as tuberculous at the first assessment, but 11 of that number presented with other small shadows suggestive of tuberculosis. Of the remaining 13 cases, a new growth was suspected in three and an infected lung cyst in one; in nine no definite opinion was reached. The following are some of the many diseases which produce rounded shadows in chest radiographs and may have to be considered in the differential diagnosis: bronchogenic carcinoma, neoplastic metastases, lung abscess, pneumonia, encapsulated pleural effusion or empyema, congenital and

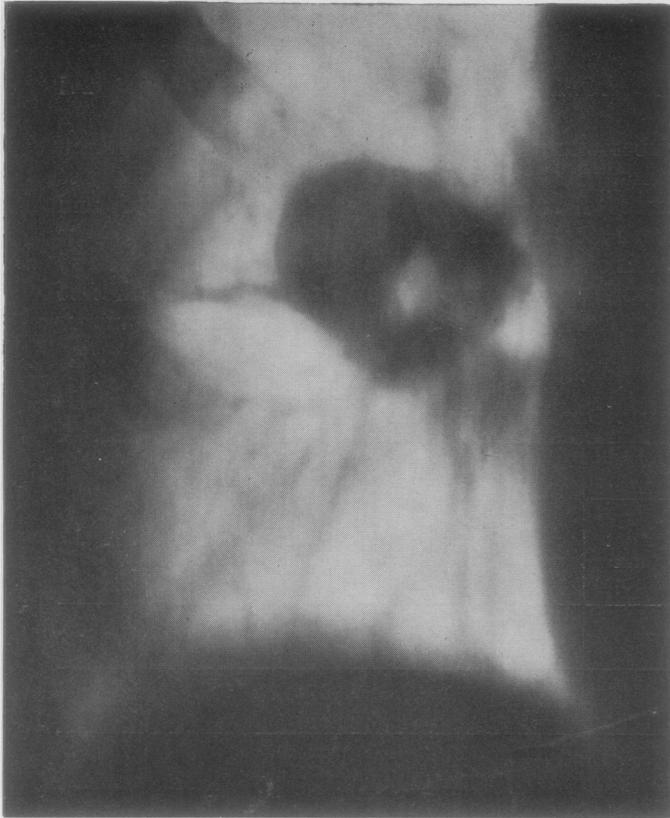


FIG. 2.—Tomograph showing a large tuberculoma with typical eccentric cavitation.

acquired cysts, pulmonary hydatid cysts, coccidioidomycosis, gumma, adenoma, haemangioma, lipoma, hamartoma, pleural fibroma, and neurofibroma.

Carcinoma of the bronchus causes the greatest difficulty. It can be virtually excluded in the presence of a positive sputum, satellite infiltration, and calcification. Further, in contradistinction to tuberculoma, carcinoma of the bronchus shows a predilection for the male sex and an older age group, associated pulmonary atelectasis is more common, and when cavitated the walls are more irregular and a fluid level is frequently seen. It should be noted that neither hilar adenopathy nor increase in size on serial radiographs is a proof of neoplasm. The possibility of primary tuberculosis is raised by the former, and, as will be seen later, enlargement of a tuberculoma is relatively common. Bronchoscopy is rarely of value, as the lesion, whether tuberculous or neoplastic, is usually beyond the range of endoscopic vision. No abnormality was found in any of the six cases bronchoscoped in this series. Exploratory thoracotomy is mentioned as a diagnostic step by Dahl-Iversen and Möller (1946) and McMahon and Forsee (1949), but no case has been reported in which a tuberculoma was found and the chest closed without its removal. There is no certain way of ascertaining the nature of the tumour when the pleura is open, although palpation of the lung may suggest to the surgeon the desirability of a segmental resection, lobectomy or pneumonectomy. To sum up: even after careful investigation and assessment the diagnosis may well remain uncertain.

Course and Prognosis.—Excluding the resection cases in which the natural history was artificially forestalled, there remain for consideration 34 patients who received more conservative treatment or none at all. There were no deaths, and at the end

of between three and 15 years' surveillance 31 (91%) were in good health with radiographically healed or healing disease. Of the remaining three patients, one has active phthisis following directly from the breakdown of the tuberculoma; one, after being well with the lesion healed to a fine fibrous scar for 10 years, has a tension cavity in the same area; and in the third the tuberculoma healed, but the patient after being well for four years developed fresh and not directly related disease in the opposite lung. However, despite this good eventual prognosis 17 showed evidence of activity at some time during the course of this review. The average period of economic loss was about eight months, being four and a half months in the stable cases and, in the active, one year. These figures include time spent on investigation, bed-rest, and convalescence.

The processes by which the lesions heal are similar to those of other forms of tuberculosis; namely, by resolution, fibrosis, and calcification. Radiographically the sequence of events begins with diminution in size and increase in density. Hard streaks then appear, possibly followed by the deposition of calcium salts, and slowly thereafter the homogeneous background of the lesion resolves, leaving scarring and calcification as the only evidence of previous infection. The time taken to pass through these phases varies with the individual and is dependent upon factors which cannot be elucidated by clinical study. It can be said, however, that there is no proof that treatment shortens the process once healing has begun. As in all forms of tuberculosis the proper application of the terms, quiescent, arrested, and healed, is a matter of difficulty. In this series a patient was considered to be progressing towards healing when the changes described above were seen on serial radiographs and the patient remained in good health with a normal E.S.R. and negative sputum.

Radiographically a tuberculoma may demonstrate activity by enlargement, cavitation, or the appearance of tuberculosis elsewhere in the lungs or pleura. Enlargement, which may take place slowly over many months or rapidly, is commonly followed by cavitation, a positive sputum, or the spread of disease. Cavitation may be of the typical form already described or a frank "tension" cavity may occur. Ten of the active cases which subsequently proceeded to heal with or without treatment showed cavitation at some time, two being of the latter type. Cavitation of the former variety may be transient only and disappear as it came; it may disappear and reappear alternately; or it may rarely persist and develop into a tension cavity. While cavitation is present further disease may derive from it. Such fresh infiltration usually develops close to the original lesion, but if remote it is commonly found in the areas most frequently affected by bronchogenic spread. It is unlikely that the lymphatics or blood stream assist in this dissemination.

When spread occurs the radiographic features may be those of early tuberculous infiltration, but there is a tendency for further round foci to appear either initially or as a slow development in a patch of infiltration. This "seeding off" from the original focus offers an explanation for multiple tuberculomata, and in five instances this happened during observation. It is a remarkable fact that in the 12 cases where there was limited attendant disease on the first radiograph, and in the other six cases which were observed to develop fresh infiltration, this disease proceeded favourably in every instance. Even in the patient already mentioned in whom cavitation of a tuberculoma persisted, a daughter tuberculoma appeared and then slowly healed (Fig. 3a, b, c). In another, massive extension to the lower lobe on the same side

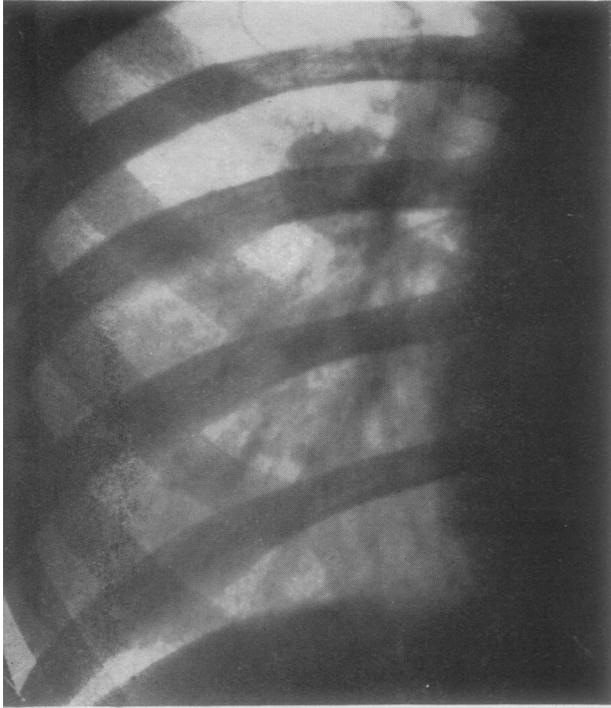


FIG. 3a.

FIG. 3a.—Part of a radiograph of the chest, dated August 13, 1946, showing a tuberculoma lying in the right hilar region.

FIG. 3b.—The same, dated June 2, 1947, showing a “daughter” tuberculoma.

FIG. 3c.—The same, dated September 2, 1949, showing a persistent cavity with a fluid level in the hilar region, and resolution of the “daughter” tuberculoma.

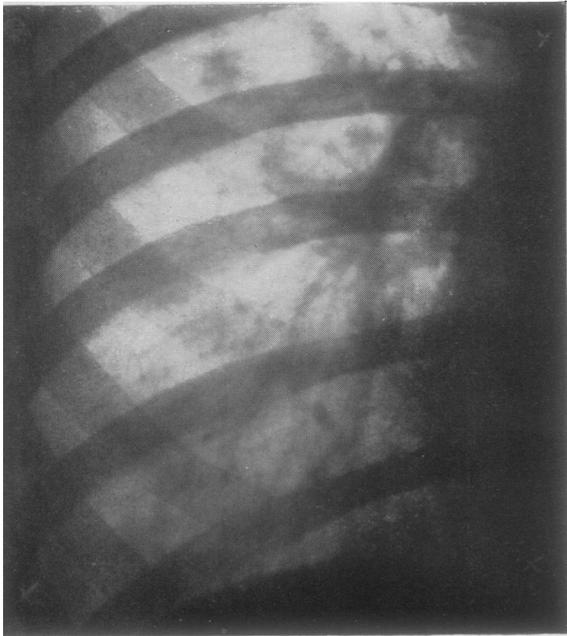


FIG. 3c.

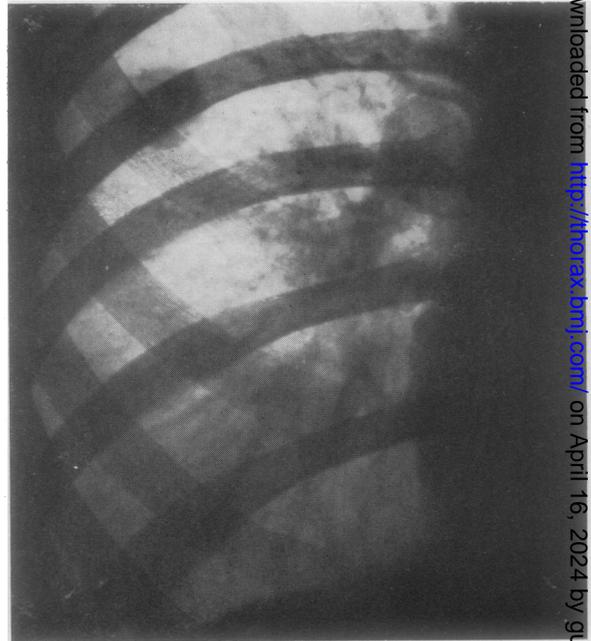


FIG. 3b.

was followed by a mixed infection empyema, but with drainage of the empyema and bed-rest complete resolution resulted. This evidence justifies the conclusion that a spread of disease in these cases is peculiarly benign. It may be that a tuberculoma signifies a high resistance to infection with a tendency to isolate it in rounded form.

Complications such as have been described rarely arise without warning, and in this study they were invariably preceded by symptoms of ill-health, radiographic enlargement, a positive sputum, or a rising E.S.R. No reliable guidance as to the behaviour of a particular lesion can be gained from its size, definition, or density, but as a generalization the small, well-defined, hard focus is less suspect.

TREATMENT

Bed-rest remains unchallenged as the fundamental treatment of active phthisis, and in tuberculomata it is desirable if there are symptoms or signs of activity. It is unnecessary in the asymptomatic patient with a hard lesion, perhaps containing calcium, for whom close out-patient surveillance will suffice. The patient whose symptoms disappear with rest and in whom the lesion is radiologically inactive may be allowed to return to normal life while remaining under observation, but the patient in whom signs of activity persist will require further treatment.

Assmann (1925, 1930) and his contemporary German workers advised therapeutic pneumothorax for all subclavicular infiltrates if "climatic-dietary" treatment failed, but no special regard was given to the large circumscribed foci. Straub (1932) considered that such treatment had little effect. Coryllos (1933, 1936), Eloesser (1937), and Shamaskin (1941) stated that inspissated cavities were refractory to collapse therapy, but, if there was a tendency for the cavity to open and close or remain open, an artificial pneumothorax might effect permanent closure. In practice many physicians still rely on this form of treatment, believing that it may act as an insurance against breakdown, or, if this has already occurred, that the other disease may benefit and the active tuberculoma heal by an alteration of the bronchial mechanics. Phrenic nerve interruption and pneumoperitoneum may be used when a pneumothorax is contraindicated or unobtainable. Major collapse methods such as thoracoplasty and extrapleural pneumothorax are not justified, as they offer no greater therapeutic effect than can be obtained by lesser procedures.

The first resection of a tuberculoma was recorded by Jacobaeus and Key in 1921; the operation was done in the belief that the lesion was a tumour, and the patient died of a tuberculous empyema. Reports of the successful removal of "pseudo-tumoral" tuberculous foci were published by Graham and Singer (1936), Haight and Farris (1939), and others, and at about the same time the possibilities of planned resection were recognized. In 1942 Thornton and Adams collected 75 cases from the literature, adding five of their own, in which tuberculous tissue had been removed from the lung at operation. Among these there were 16 tuberculomata, in all of which neoplasm was the pre-operative diagnosis. There was one immediate death, and three of the remaining 15 cases developed further pulmonary phthisis. Since then, with improvement in surgical technique and after-care and with the advent of antibiotics, resection has become a recognized procedure in certain forms of pulmonary tuberculosis, and many large series have been recorded (Overholt, Langer, Szypulski, and Wilson, 1946, 1947; Bailey, Glover, and O'Neill, 1949; and others) in which tuberculomata feature in small percentage. The present

surgical outlook is reflected by McMahon and Forsee (1949) and Sellors and Hickey (1949), who advised resection in all cases because of the hazards of diagnosis and of considering these lesions as benign or arrested. The immediate results are as good as might be expected in a limited, often closed, and healing lesion: the long-term results are not yet available.

In Table II the 41 cases in this series are analysed in relation to their radiological activity and the results of treatment.

TABLE II
ANALYSIS OF 41 CASES IN RELATION TO RADIOLOGICAL ACTIVITY AND
THERAPEUTIC RESULTS

No. of Cases	Type of Therapy	Activity		Results*			
		Absent	Present	Cure	Apparent Cure	Active P.T.	Death
7	Observation only	6	1	5 1	1 —	— —	— —
16	Bed-rest only	8	8	4 —	4 5	— 3†	— —
7	Pneumothorax	2	5	2 3	— 2	— —	— —
3	Phrenic paralysis	1	2	1 1	— 1	— —	— —
1	Streptomycin	0	1	—	1	—	—
1	Resection : (a) Pneumonectomy	0	1	—	—	—	1
6	(b) Lobectomy	3	3	— —	3‡ 3‡	— —	— —
41		20	21	17	20	3	1

* Cure = A healing process observed for five years or more. Apparent Cure = A healing process observed for less than five years but more than three

† In one of these cases the tuberculoma healed; in another late cavitation occurred after ten years.

‡ Follow-up under one year in all but two of the lobectomy cases.

Nine patients were allowed to remain at work under out-patient supervision, and seven have remained in good health, although in one a further round focus developed and later resolved. In the other two patients subsequent breakdown occurred, necessitating treatment.

Of the 16 patients treated by rest alone, eight never demonstrated radiological activity and were gradually allowed to return to normal life. In seven of the remainder evidence of activity quickly disappeared, but in two of them further disease developed many years after apparent cure. Only one patient treated initially in this fashion failed to respond; she refused further treatment and developed a persistent tension cavity.

Eight pneumothoraces were done on seven patients (one having bilateral tuberculomata). In two, one of whom was pregnant, it was induced as a precautionary measure, but in the others there was evidence of instability. Satisfactory collapse was obtained in all but one in whom restraining adhesions were not divided. No serious complications occurred and the results were uniformly good.

Similar results were obtained in the three patients who had a phrenic operation as the sole collapse measure. In one it was done as a possible safeguard, and in another because of an associated pleural effusion. It was preferred to pneumothorax in the third case, as the lesion, in the apex of the lower lobe, developed into a large cavity during observation; within two months this had closed and further progress was uneventful.

Streptomycin was given to one man in whom a tension cavity and spread had occurred. The effect was most satisfactory, with reduction in size and inspissation of the cavity and clearing of the associated disease. Subsequent follow-up is short, but apparent stability has been obtained.

There were seven resections, the reason for operation being diagnostic error in three, diagnostic doubt in two, and only in the remaining two was the lesion known to be a tuberculoma. There was evidence of enlargement in two of the first five cases, and both the latter cases were clinically and radiologically active. With the exception of one patient who died from a bronchopleural fistula, all are alive and well at the time of this report, between three months and four and a half years later. The post-operative surveillance is too short in all but two cases to allow the designation of apparent cure.

DISCUSSION

A study of the literature reveals divergent opinions on the morbidity of tuberculomata of the lung, the majority of which are based solely on clinical impressions. Houghton (1950) regarded them as "time-bombs" liable to explode at any moment into florid tuberculosis. Potential instability has been advanced as the main reason for their surgical removal (Thornton and Adams, 1942; Sellors and Hickey, 1949). Earlier observers in general recognized the danger of breakdown and spread, but Bruck (1934) was of the opinion that most remained quiescent. It is known that a number of these lesions are inspissated cavities, the others being manifestations of primary or post-primary caseous pneumonia. Shamaskin (1941) found in a study of inspissated cavities that from the clinical and therapeutic standpoint there was little difference between them and caseous pneumonic foci. He stated that the clinical prognosis of inspissated cavities was good, and this opinion was confirmed by Study and Morgenstern (1949) in a series of 24 cases. In 1949 Eriksen investigated 40 cases of tuberculoma of the lung with a follow-up of between two and 11 years. At the end of this time 38 of the 40 were in good health, and treatment had been conservative in all but three. Essentially similar results were obtained in this series, 31 of the 34 patients treated conservatively being alive and well after three to 15 years' observation. Despite this good eventual prognosis, their potential instability cannot be denied, and is shown in this series by the development of cavitation or new disease in 17 patients. However, it has been seen that they are relatively benign if unstable lesions, as complications rarely resulted in progressive phthisis.

There is controversy at the present time regarding treatment. In the past rest and minor collapse therapy were advised, but recently pulmonary resection has been strongly recommended. Few would gainsay the need for resection where bronchogenic carcinoma cannot be reasonably excluded after full investigation. The only possible if flimsy criticism of this course lies in the disappointing results of resection for bronchogenic carcinoma. Might it not be asked if these results justify a major operation with the sacrifice of much valuable lung when reasonable doubt exists as to the presence of such a relatively benign lesion as a tuberculoma?

The place of resection in the treatment of recognized tuberculoma *per se* is more assailable. In its favour its protagonists claim that a potentially unstable lesion is removed with slight risk, thereby avoiding the dangers of breakdown and spread, and allowing the patient to return to normal life with the minimum of delay. My figures and those of Eriksen (1949) do not support the claim that potential instability justifies surgery. Further, as there is no certain way of deciding which lesions are liable to break down, many patients (in this series 50%) would have to be subjected unnecessarily to a major operation. The claim that surgery ensures the minimum economic loss is also questionable. Convalescence after resection is usually limited to six months, sometimes slightly less; this exceeds the total time spent on investigation, bed-rest, and convalescence in the stable lesions in this series, and is only slightly less than the overall average, although about half that of the active case. It is relevant to judge resection from the basis of pathology. It has been seen that an inspissated cavity is regarded both by pathologist and clinician as a healing lesion with a good prognosis. Is it logical to remove such a lesion? Resection of a primary lesion is an undesirable and hazardous procedure, and yet a small proportion of tuberculomata are primaries and unrecognizable as such. Moreover, it is becoming increasingly clear that actual involvement of the lungs is frequently much greater than is expected from a radiograph. Surgical removal of the affected part carries no certain guarantee that unseen disease in the remaining lung will not cause trouble in the future.

In conclusion, tuberculoma as an indication for pulmonary resection is in a different category from other forms of phthisis where greater risks are justified by a poorer prognosis. It is acknowledged, however, that resection has a part to play, but it should not be regarded as a panacea. The asymptomatic patient with the unchanging solid focus does not require treatment. When the lesion is active, bed-rest, possibly assisted by minor collapse methods and antibiotics, will turn the average patient towards cure; pulmonary resection offers an alternative course which must be carefully considered.

SUMMARY

This study is based on a series of 41 cases of tuberculoma of the lung, in which, with the exception of seven cases subjected to pulmonary resection, a follow-up of between three and 15 years has been obtained. Thirty-one (91%) of the 34 cases treated conservatively were alive and well at the end of surveillance, and there were no deaths. Despite this good prognosis, 50% demonstrated instability of the lesion at some time, the remainder healing without event. The pathology of these lesions is discussed with particular reference to the difficulties of separating them into the

three patterns of (1) post-primary caseous pneumonia, (2) inspissated cavity, (3) primary focus. A plea is made for a more optimistic outlook as regards their prognosis and in favour of a more conservative therapeutic policy.

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