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ULCERO-CASEOUS TUBERCULOUS BRONCHITIS

A METHOD OF "SPREAD" IN PULMONARY TUBERCULOSIS

BY

J. W. CLEGG

From the Brompton Hospital, London

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One of the striking features of the surgical pathology of pulmonary tuberculosis is the frequent finding of epithelioid tubercles in the bronchial mucosa of otherwise normal bronchi. Fig. 1 is a typical example, and it is important to note that the epithelium over the tubercle is normal. The segment of bronchus from which this section is taken was examined bronchoscopically immediately before the operation and reported as normal. Meissner (1945) drew attention to these tubercles and pointed out the frequency with which they could be found in areas where the bronchi and surrounding lung tissue appeared normal to the naked eye. The epithelium is usually intact and caseation rare, two findings which led Meissner to conclude that these tubercles were more likely to result from a spread of the infection through the bronchial lymphatics than from the surface implantation of tubercle bacilli aspirated from an "open" focus. I have never failed to find these mucosal tubercles in apparently normal areas remote from any macro-

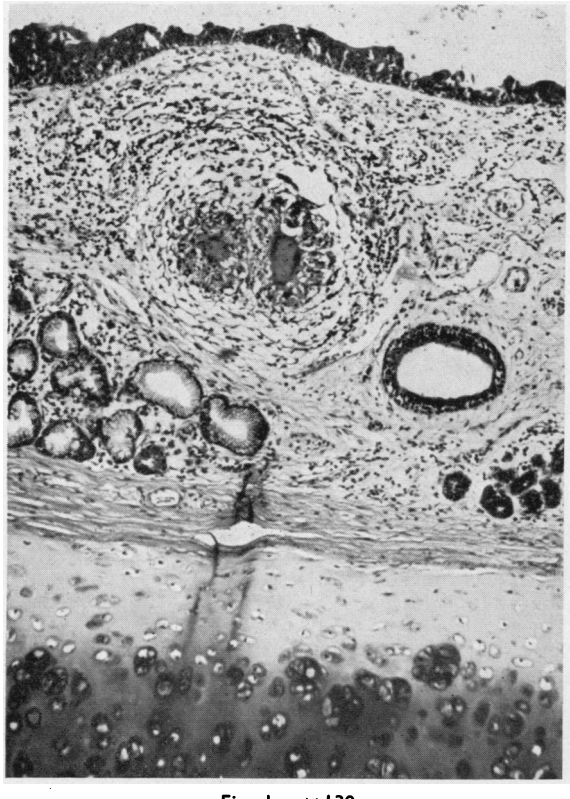


Fig. 1.—× 130

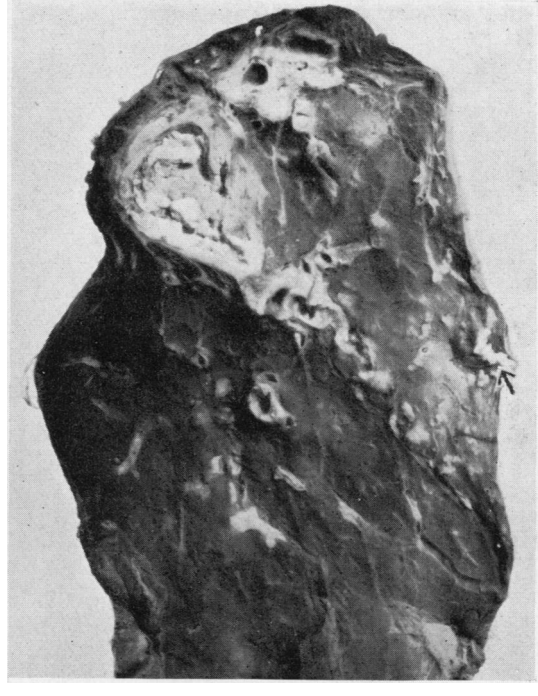


Fig. 2.—× $\frac{2}{3}$

scopic tuberculous lesion when a search has been made. It follows that such tubercles must be very common and the majority must heal without giving rise to any significant lesion. On the other hand, detailed examination of many surgical specimens resected from patients suffering from pulmonary tuberculosis has shown that foci of caseous tuberculous bronchitis frequently develop at some distance from the main disease. Such caseous bronchi may not serve areas of tuberculous pneumonia and the alveoli they serve may be either normal or collapsed. It appears therefore that new areas of disease are arising directly in the bronchi.

The first specimen is the left upper lobe from a woman aged 28 years with a seven-year history of pulmonary tuberculosis (Fig. 2). The surgical resection was performed for the removal of the "cavitating" pear-shaped lesion in the posterior segment which communicated directly with the segmental bronchus. The adjacent apical segment is entirely free of any foci of tuberculous pneumonia, but did contain a number of twig-like bodies, one of which is indicated by the arrow in

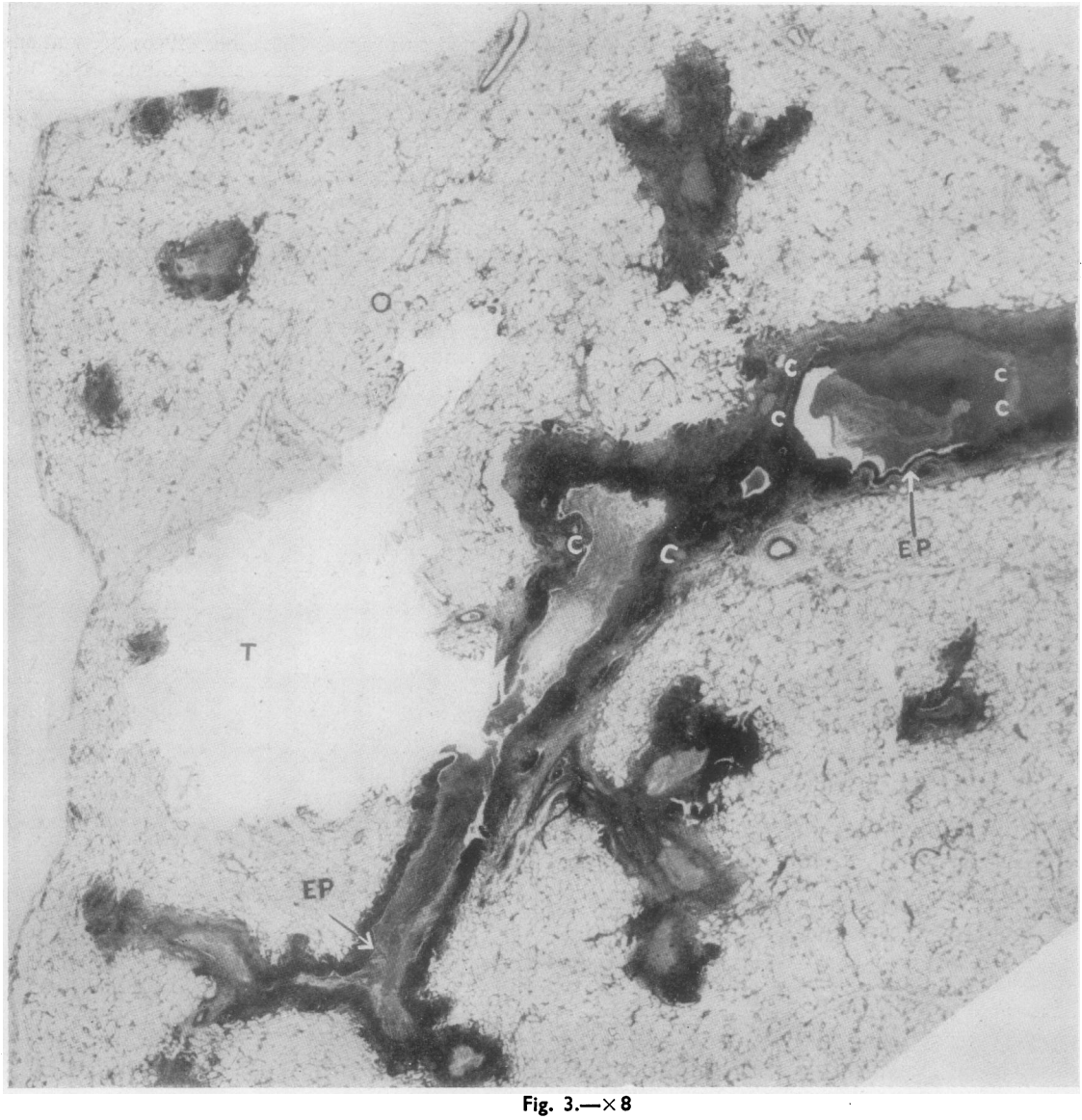


Fig. 3.—×8

Fig. 2. These bodies are 5–8 mm. long and 2–4 mm. in diameter and are frequently branched. In the fixed specimen these bodies are easily palpated and several more can be felt below the cut surface of the specimen. A block of tissue from the apical segment containing one of these "twigs" was submitted to serial sectioning. One of the sections is seen in Fig. 3. A small bronchus, cut longitudinally, stretches across the section to terminate just below the pleura. This bronchus is the site of a severe ulcero-caseous bronchitis, but remnants of bronchial epithelium (EP) and many bronchial cartilages (C) are still easily made out. The muscle, however, has disappeared, being replaced by caseous material which is slightly distending the lumen. In addition to the bronchus seen longitudinally there are a number of round lesions each with a caseous centre. The serial sections showed conclusively that these are all bronchioles or small bronchi derived from the larger bronchus. In each case there is an ulcero-caseous tuberculous bronchitis which has destroyed the mucosa filling up the lumen with caseous material. The considerable hypertrophy of the adventitia gives the appearance of a round, caseous, encapsulated nodule which may easily be mistaken for a healed pneumonic lesion. No tuberculous pneumonia was found in any of the serial sections cut from this block, and it is clear that a destructive ulcero-caseous tuberculous bronchitis is developing in this segment of bronchus before there is any pneumonia in the lung tissue to which it is functionally related. It will be noted that there is a tear (T) in the section (Fig. 3). This is due to the fact that the normal alveolar tissue is very easily torn from the rigid diseased bronchus during the process of trimming a block for histological examination.

Fig. 4.—× 1½

The second specimen is the apical segment of the left lower lobe resected from a male patient aged 20 years with a one-year history of pulmonary tuberculosis. The cut surface of the specimen is shown in Fig. 4. There are multiple small round caseous foci, each surrounded by dark zones of collapsed lung tissue. In the centre of the pathological area the caseous foci are becoming confluent. A block of tissue from just below the pleura, containing one of these rounded caseous lesions, was taken, and a section is shown

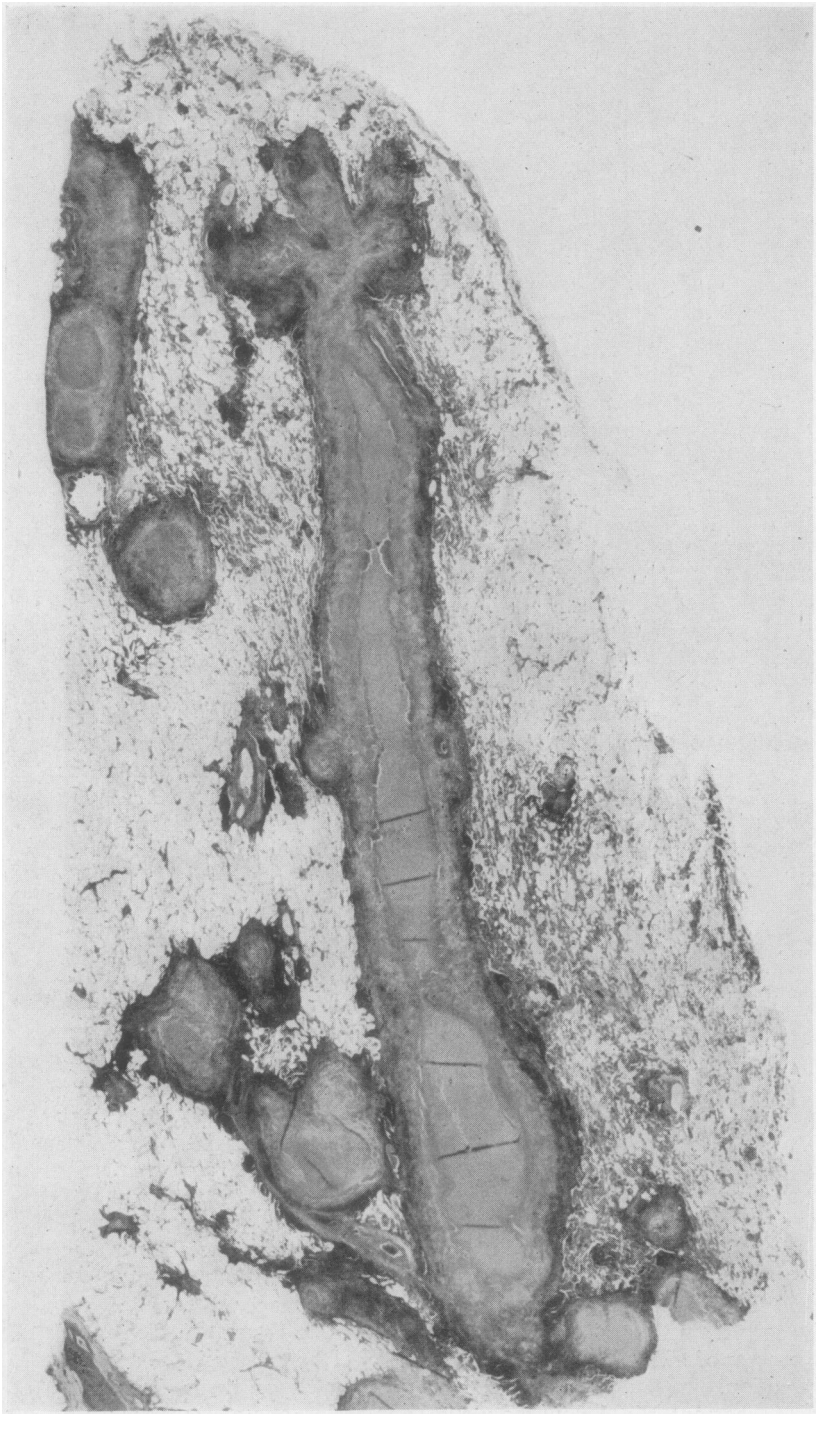


Fig. 5.—×10

in Fig. 5. Once again there is a small bronchus seen longitudinally and several smaller bronchi cut at right angles. In this section, however, the destructive process is more severe, and recognizable bronchial elements are much harder to find. Serial sections were again cut and showed that all the bronchioles cut at right angles were branches of the bronchus seen longitudinally, and no tuberculous pneumonia was found in any section. This lesion differs from the first only because it is slightly more extensive and destructive, with the result that the bronchial occlusion is now sufficiently severe for collapse to be detectable. Towards the bottom of the section there is a moderate degree of alveolar collapse with the result that the ulcerated bronchi are becoming approximated.

The earlier stages of caseous tuberculous bronchitis are easily overlooked in histological sections when only the smaller bronchi and bronchioles are involved, especially if these are seen only in cross-section. Fig. 6 is from another specimen and the block of tissue is over two inches from any recognizable tuberculous lesion. Indeed the area appeared normal to the naked eye but felt "shotty." There are a number of small round, oval, or irregular lesions present, each consisting of a caseous central zone surrounded by a capsule of fibrous tissue. At first sight these might be mistaken for small pneumonic foci, but in fact they are all bronchioles or small bronchi. To prove this it may be necessary to cut a number of sections to find surviving islands of bronchial epithelium or cartilage, and

often the most helpful method is to stain for elastic tissue, as this will frequently outline the position of the bronchial wall and artery long after the specialized tissues have disappeared.

The lesions so far described are small, with only a short segment of the bronchial tree involved. Such ulcerated bronchi are far too small to be recognized in the chest radiograph. When the entire bronchial tree of a segment or subsegment is involved the degree of collapse is much more severe. Clearly the caseous bronchi will then be separated from each other only by very narrow bands of collapsed lung tissue and the histological picture becomes more complicated. At this stage it will require only a very slight extension of the ulcero-caseous process through the collapsed lung tissue for the caseous and expanded bronchi to fuse and become confluent. Such a caseous mass may be termed a bronchial cold abscess and be large enough to cast a shadow in the chest radiograph.

Solitary Bronchial Cold Abscess

The next group of specimens illustrate the histological features of the pathogenesis of a bronchial cold abscess. Fig. 7 shows the cut surface of the right upper lobe from a woman aged 17 years with a two-year history of pulmonary tuberculosis. The apical segment is collapsed, but the anterior and posterior segments are fully expanded. In the collapsed area there are many round caseous foci each measuring 2–3 mm. in diameter surrounded by rims of collapsed lung tissue. In the centre these caseous areas are becoming confluent and a block of tissue from the edge of this area (A) was taken for histological examination. Fig. 8 is a section from this block, and five small bronchi (Br.) filled with caseous material are included in the section. In all these bronchi there is extensive destruction of the bronchial mucosa, but all contain sufficient bronchial remnants to establish their identity as bronchi. The intervening

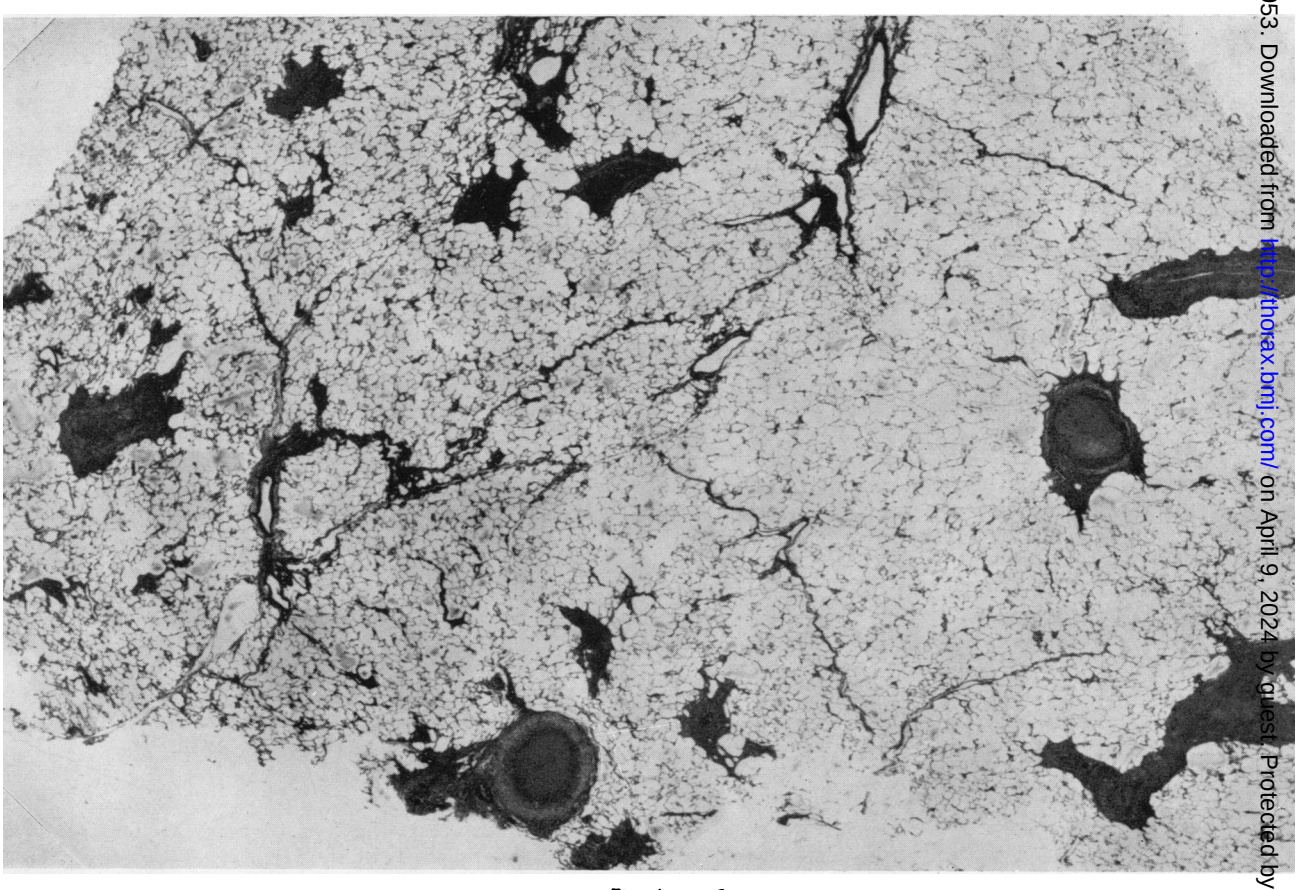


Fig. 6.—×8

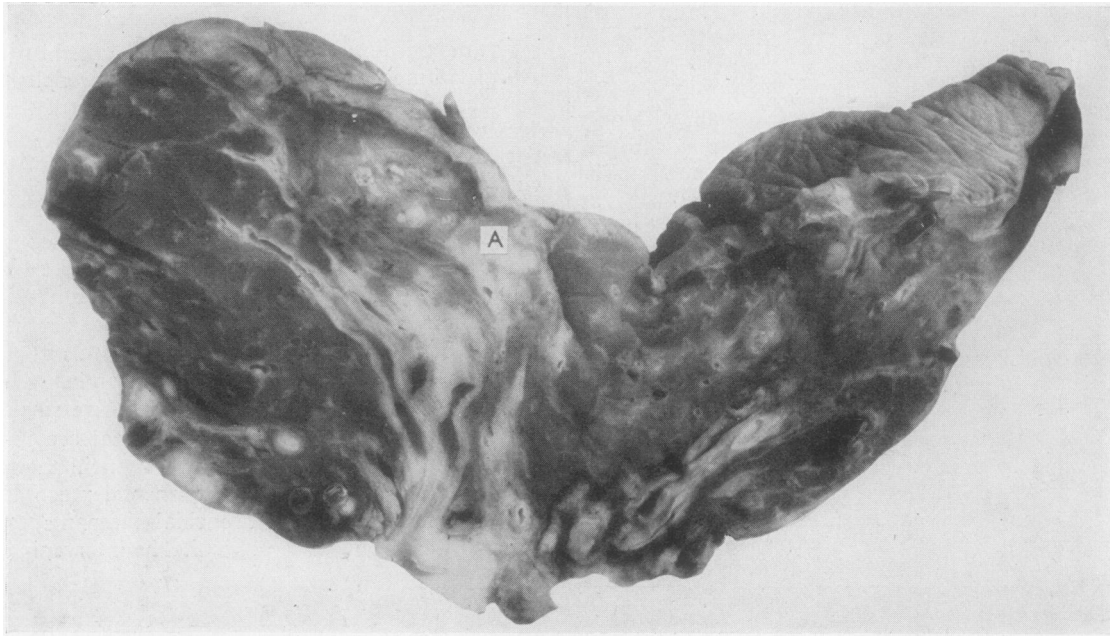


Fig. 7.—×1⅓

lung tissue is collapsed and in some fields shows slight alveolar thickening. There is well-marked lymphoid hyperplasia in the collapsed lung tissue, but there is a complete absence of tuberculous pneumonia. The condition of the alveoli is entirely the mechanical result of the bronchial occlusion. The three larger bronchi, towards the bottom of the section, are enlarged as a result of the caseous bronchitis and approximated as a result of the collapse. Clearly only a very slight extension of the ulceration will result in the fusion of these three caseous bronchi into a single bronchial cold abscess. At the left of the section the normal alveoli belonging to a neighbouring and unaffected bronchopulmonary segment make a striking contrast with the collapsed alveoli of the affected segment.

Fig. 9 shows both the medial and lateral views of the left lower lobe from a woman aged 45 years with a one-year history of pulmonary tuberculosis. Resection was performed on account of the large cavity in the apical segment. The cut surface of the hilar aspect of the lobe is studded with small round caseous foci which at a casual glance might be mistaken for foci of aspiration bronchopneumonic tuberculosis. Examination with a hand lens, however, reveals that each caseous nodule is actually a small bronchus distended with caseous material. A block of tissue extending right across the sub-apical segment (marked in the figure) was taken for section, and a portion is shown in Fig. 10. The figure shows a tapering band of caseous material which branches at B. The many remaining bronchial cartilages (C) are the only surviving remnants of the former bronchial wall, but the position of these cartilages leaves no doubt that this branching tube of caseous material occupies both the lumen and mucosa of a bronchus which has been destroyed in an ulcero-caseous process. All the other rounded foci in this section, each of which has a caseous centre, can be recognized as a bronchus if serial sections are cut. The lung tissue between the caseous bronchi is severely collapsed, the alveolar walls are thickened and frequently lined with cuboidal cells, and there is marked lymphoid hyperplasia. There are no tuberculous lesions in this collapsed tissue. Indeed the changes in the lung tissue are indistinguishable from the changes seen in any other form of collapse due to bronchial occlusion, as, for example, in bronchial adenoma or carcinoma. It is very clear that had not operation terminated the process these caseous bronchi would soon have fused into a complex bronchogenic cold abscess.

A further stage in the formation of a bronchogenic cold abscess is seen in the next specimen. This is the apical segment of the left upper lobe

of a patient aged 27 years with a 10-year history of pulmonary tuberculosis (Fig. 11). The segment is cut across to demonstrate that the three main branches of the segmental bronchus are expanded by a severe ulcero-caseous process. In the fresh specimen the expanded bronchi were completely filled with caseous material, but the central areas were semi-fluid and washed away in the course of preparing the specimen; thus the appearance of cavitation is an artefact. The bronchus on the left is the most severely ulcerated and the bronchus on the right the least affected. A block of tissue from the tip of the bronchus on the right (marked in Fig. 11) was taken for section and is seen in Fig. 12. Over about two-thirds of the surface of the bronchus is still covered with epithelium, but elsewhere there is caseous ulceration. In some places this epithelium is normal, but at some points it is of the simple cuboidal type. The caseous ulcers have undermined the epithelium. The adjacent lung tissue is collapsed around the caseous bronchus and it is evidently merely a matter of time before the ulcerating process extends through the collapsed lung tissue to fuse with a similar process extending from the neighbouring bronchus.

Fig. 13 is a low-power magnification ($\times 2\frac{1}{2}$) of a section through the pear-shaped "cavitating" lesion seen in the posterior segment of the upper lobe seen in Fig. 2. Clearly this is comparable to the previous case except for the fact that the ulcerating bronchi have now fused with caseous destruction of the intervening collapsed lung tissue. The ulcerating bronchi have retained communication with the segmental bronchus. The resulting bronchial abscess has undergone partial liquefaction with the formation of a "cavity."

Once the process of ulcero-caseous bronchitis is established in a lung it is clear that it may produce a variety of differing types of picture. For example, it might produce multiple nodular lesions widely separated from each other in a lobe or even the whole lung. Alternatively it might give rise to a progressive ulcero-caseous bronchitis involving a whole lobe or lung with the production of an extensive caseous bronchiectasis. Furthermore, as in all forms of tuberculosis, the process may become quiescent or even heal. It is a matter of observation that all these possibilities frequently occur. It is proposed to consider both the multiple disseminated form of ulcero-caseous bronchitis and also the process of healing in this paper. Ulcero-caseous tuberculous bronchiectasis, however, is a complicated subject and will be the subject of another communication.

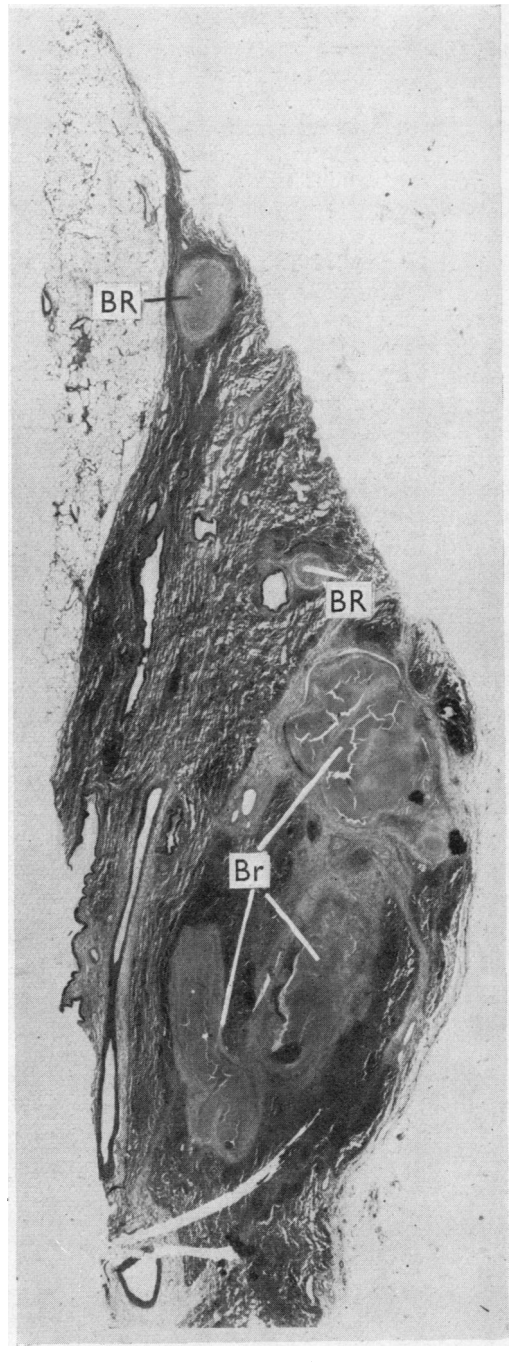
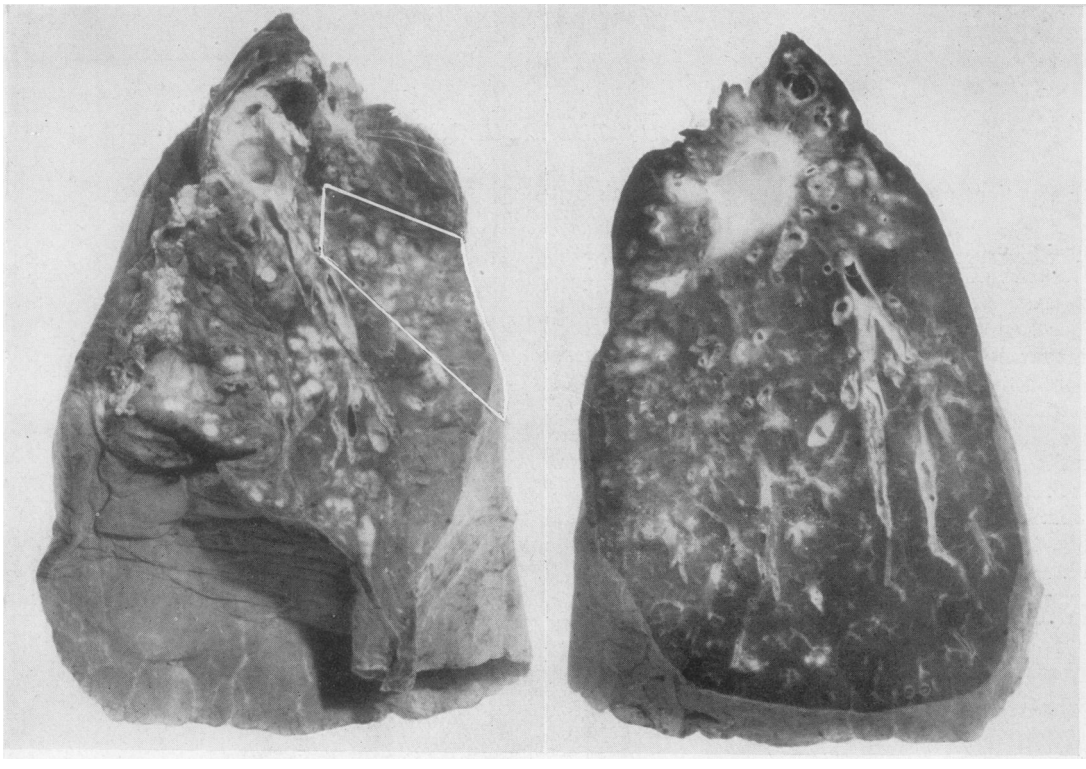


Fig. 8.—$\times 6$



Medial

Fig. 9.—× ⅔

Lateral

Fig. 10.—× 16

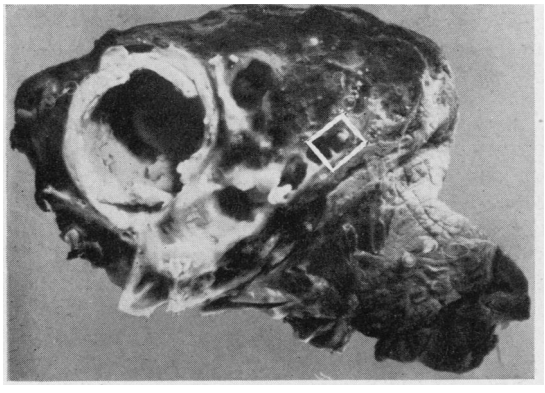


Fig. 11.—× ⅔

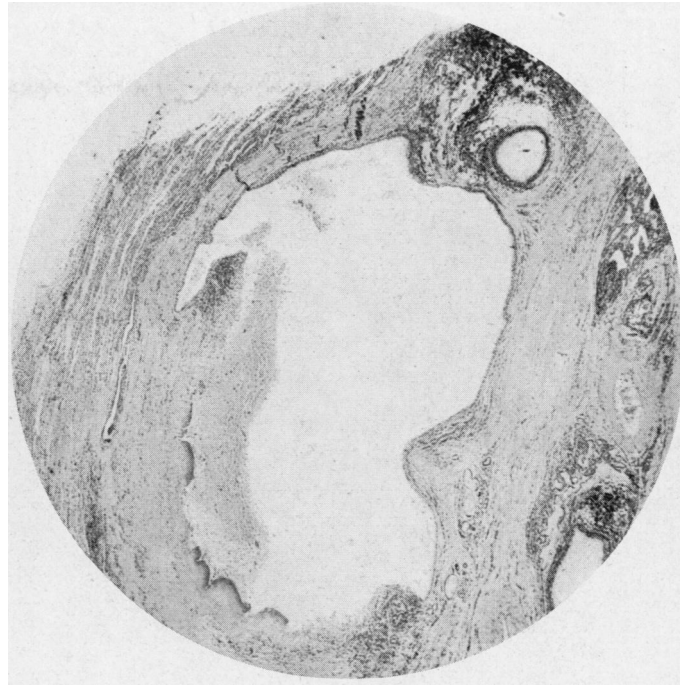
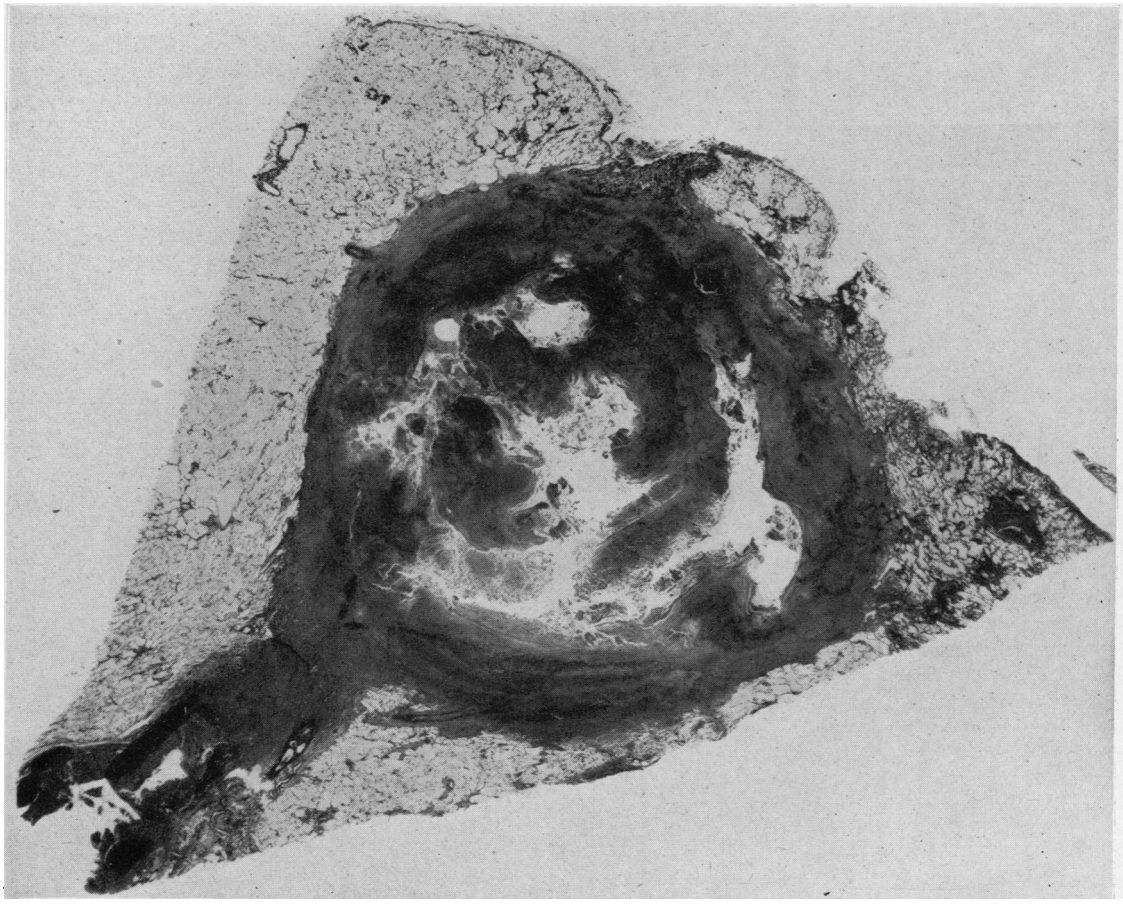


Fig. 12.—× 15

Fig. 13.—×4



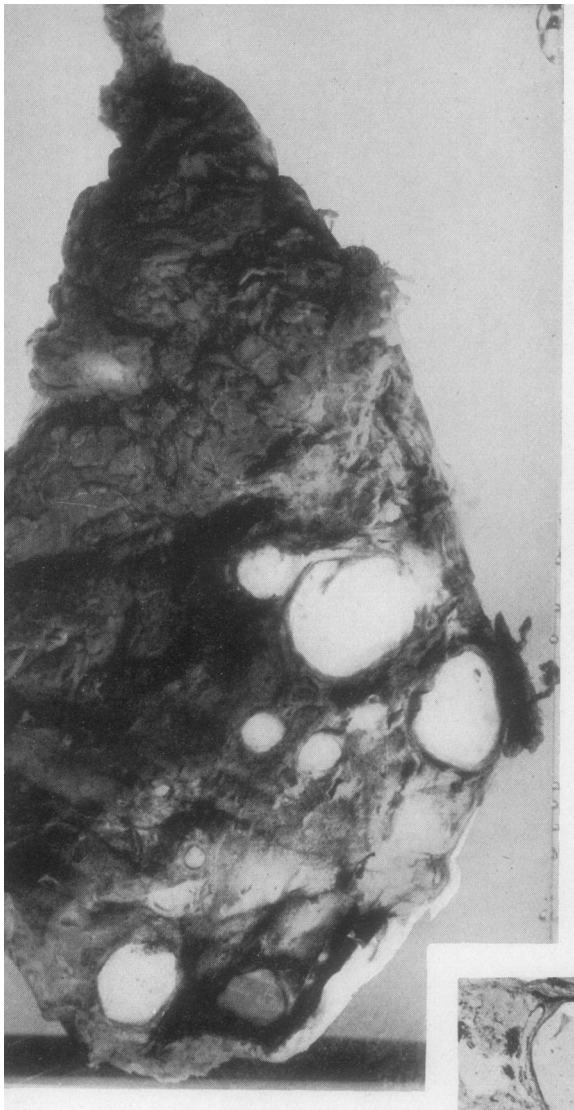


Fig. 14.—× 1½

Multiple Disseminated Bronchial Cold Abscess

An example of the disseminated type of bronchial cold abscess is seen in Fig. 14. This shows the cut surface of the right upper lobe resected from a woman aged 42 years with a six-year history of pulmonary tuberculosis. The surface shows many round caseous foci which appear well-encapsulated, and dissection shows them to be in direct communication with the bronchial tree though in many cases there is a bronchial stenosis immediately proximal to the caseous area. A typical section from one of the smaller of these lesions is seen in Fig. 15 with the characteristic picture of ulcero-caseous tuberculous bronchitis.

Healing

As in all other types of tuberculosis healing may occur at any stage in the development of the disease. The first example is the resected lower lobe from a woman aged 47 years with a one-year history of pulmonary tuberculosis. Fig. 16 shows the cut surface of the lower lobe with part of the anterior basic bronchus exposed. When a blunt probe was passed down this bronchus it was found to terminate in a complete stenosis at the point A. Distal to this stenosis the bronchus could be palpated dilating into a solid oval mass 2.5 × 1.0 cm. This was opened and found to be filled with caseous material which could easily be lifted from the dilated bronchus. The caseous material was replaced, and the whole area marked A in Fig. 16 was taken for histological examination. Fig. 17 shows a section from this block. The bronchial cold abscess (Ca) has been shut off from the anterior basic bronchus by the development of a zone of fibrous stenosis (F.S.). In this stenotic zone bronchial cartilage and mucous glands were present, but serial sections showed the stenosis was complete. In the area of the abscess there is des-

Fig. 15.—× 14

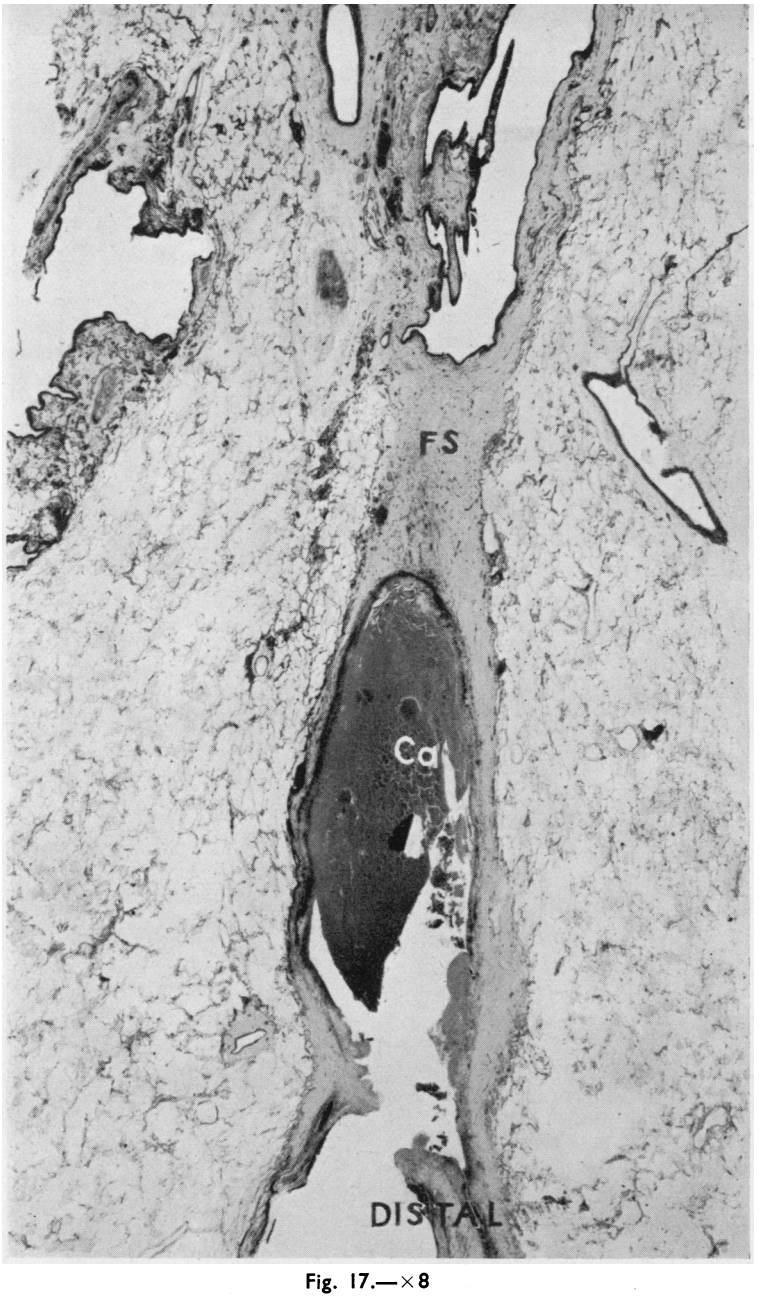


Fig. 17.—×8

truction of the bronchial mucosa, but at the distal end of the abscess the bronchial epithelium can again be seen. At this point there is a small bronchus branching off the main stem and here again the bronchial mucosa is destroyed and a fibrous stenosis is developing. Clearly there is a marked tendency to localize this destructive tuberculous bronchitis and seal it off by means of fibrous strictures both above and below the length which has been transformed into an abscess. Further dissection of the specimen revealed multiple bronchial cold abscesses but no areas of tuberculous pneumonia. Fig. 18 shows the middle basic bronchus of the same lower lobe. The middle basic bronchus terminates abruptly in a small calcified cold abscess about an inch proximal to its normal end. This is a small caseous bronchial abscess which has become almost completely calcified (A). The central portion of this abscess is still caseous, but there is a complete eggshell of calcification around the caseous centre. A small branch bronchus (B) branching from the mid-basic bronchus also contains a small caseous bronchial abscess (C). In dissecting this bronchus, tight but still incomplete strictures both above and below the caseous abscess were cut. Here again the lesion was becoming sealed off the main bronchial tree by the development of stenosis at the margins of the caseous bronchial segment. Further dissection of this specimen revealed the extensive bronchial cold abscess

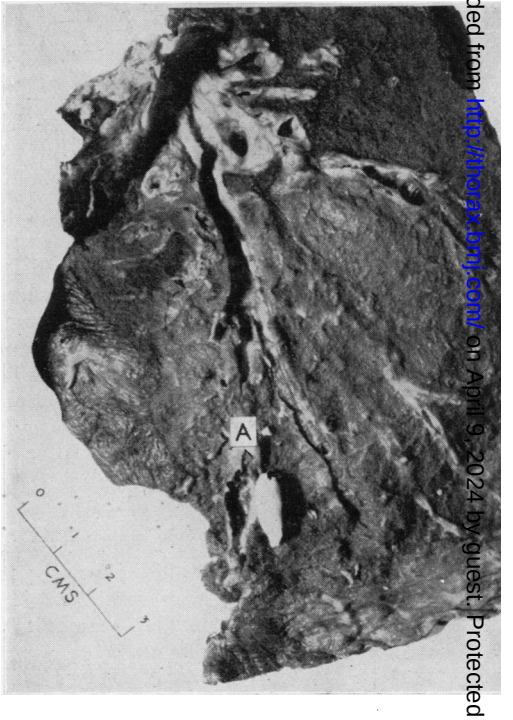


Fig. 16.—×$\frac{2}{3}$

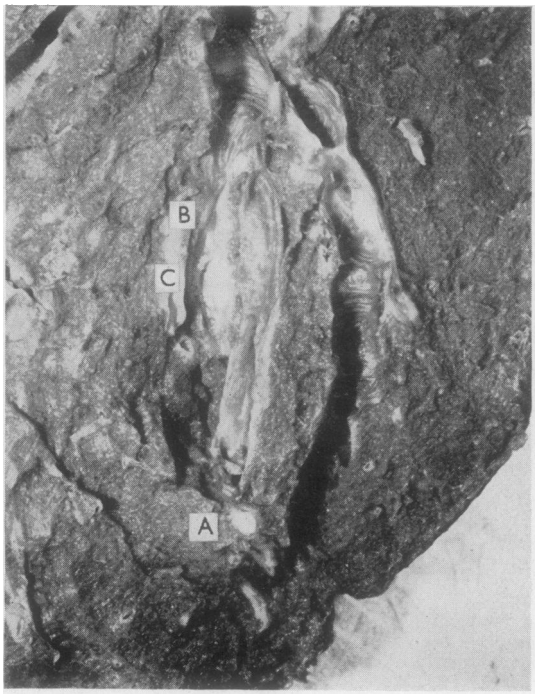


Fig. 18.—× 1½

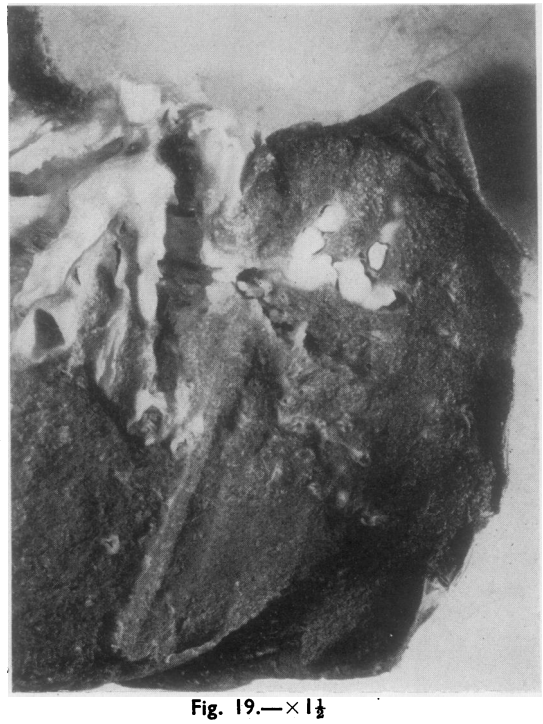


Fig. 19.—× 1½

in the bronchus to the apical segment (Fig. 19). There were no foci of tuberculous pneumonia in this lower lobe. Clearly this is an example of disseminated tuberculous bronchitis with multiple bronchial abscess formation in which some of the lesions are "healing."

Another example is seen in Fig. 20, which shows the cut surface of the apical segment of the upper lobe resected from a woman aged 26 with a five-year history of pulmonary tuberculosis. The segmental bronchus is exposed and appears normal until it bifurcates just below the pleura. Immediately beyond this bifurcation each branch expands into a small calcified cold abscess. These lesions are completely calcified and undoubtedly represent the "healed" stage of a caseous bronchial cold abscess.

Discussion

The purpose of this paper is to show how ulcero-caseous tuberculous bronchitis develops in isolated small bronchial segments as the initial tuberculous lesion in areas of lung tissue which were previously normal. It has been shown that these bronchial lesions frequently precede the development of tuberculous pneumonia in the

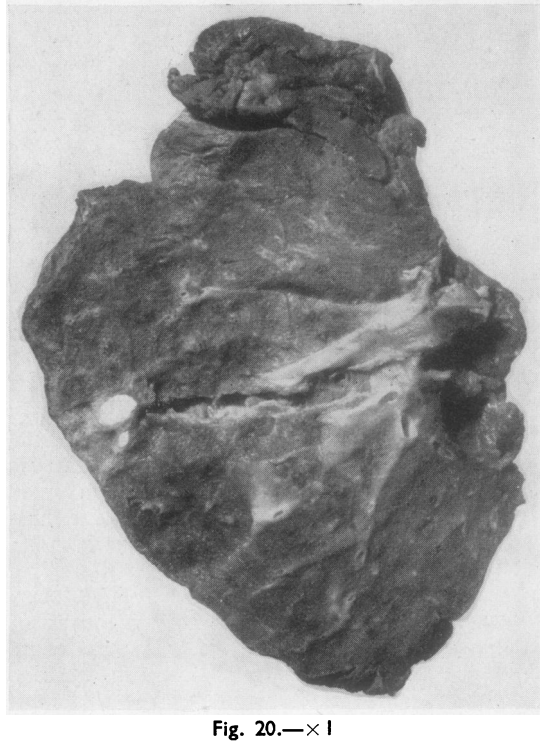


Fig. 20.—× 1

alveolar tissue to which they are functionally related. In cases where ulcero-caseous bronchitis is progressive, and tuberculous pneumonia does not develop, the alveolar tissue becomes collapsed. One important consequence of the pulmonary collapse is the drawing together of the caseous, dilated bronchi like a ripening bunch of grapes. Progressive ulceration of the diseased bronchi will then rapidly lead to fusion of the individual bronchi and the production of a caseous mass which may be termed a bronchial cold abscess. As the ulcero-caseous bronchitis ultimately involves total destruction of the bronchial wall, it is frequently very difficult, or even impossible in a fully developed caseous lesion, to determine if it arose from an area of tuberculous pneumonia or as a result of extensive ulcero-caseous bronchitis. If a number of blocks and many sections are examined patience is usually rewarded by finding such bronchial remnants as cartilage, mucous gland, or epithelium where the lesion is a consequence of ulcero-caseous bronchitis. In the true pneumonic lesions sections stained for elastic tissue will frequently outline the remnants of alveolar walls, destroyed in the expanded state, whereas in the bronchogenic cold abscess similar sections will often clearly show the remnants of the former bronchial wall and bronchial artery and collapsed alveoli. These difficulties are at their greatest in post-mortem material where there is usually a widespread destruction of the lung. In surgical material the destruction is usually far less extensive and pneumonic lesions can usually be differentiated fairly easily from the bronchial types of the disease.

Detailed examination of many surgical specimens has shown that progressive tuberculous bronchitis, often progressing from the periphery of the lung towards the hilum, is a very important mechanism in the development of pulmonary tuberculosis. As has already been pointed out, this type of tuberculosis is inevitably complicated by mechanical consequences. Clearly the severity of the mechanical complications will depend more upon the site of the bronchial lesion than upon its extent. Thus, ulcero-caseous bronchitis with stenosis close to a lobar or main bronchus may lead to total collapse and destruction of a whole lobe or even a lung distal to the point of stenosis. The amount of lung tissue lost and disability suffered by the patient may be entirely disproportionate to the extent of the tuberculous lesion. It is my experience that tuberculous bronchitis occurring in bronchi ranging from the small subpleural type to the lobar and main bronchus are commonplace. In the larger bronchi, however, the picture is usually complicated by the development of extensive tuberculous bronchiectasis, and this will be examined in a subsequent communication.

Summary

Ulcero-caseous tuberculous bronchitis of all the segments of the bronchial tree may arise as the initial lesion in the "spread" of pulmonary tuberculosis to areas of the lung which were previously healthy.

If such a focus of ulcero-caseous bronchitis extends, it will be complicated by collapse of the alveolar tissue to which it is functionally related.

Where collapse has occurred a further extension of the ulcerative process leads to confluence of the caseous bronchi with the formation of a bronchial cold abscess.

Bronchial cold abscesses may be single, giving rise to solitary caseous foci, or multiple, giving rise to disseminated caseous foci.

The process may heal either by fibrosis or calcification. Either process leads to bronchial stenosis.

I would like to thank the physicians and surgeons of the Brompton Hospital for allowing me to use the cases contained in this paper. I would also like to thank Mr. D. F. Kemp, of the Photographic Department of the Institute of Diseases of the Chest, for the photographs and histological preparations.

Reference

Meissner, W. A. (1945). *Dis. Chest*, **11**, 18.