

## THE ROENTGEN SIGNS OF CARCINOMA OF THE LUNG\*

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### INTRODUCTION

THE problems presented by the increasing frequency with which cancer of the lung is encountered have been thoroughly explored on many occasions. The virtues of roentgen examination as a method of detection are generally accepted. Certainly there is no other means so generally applicable whereby tumors of the lung can be found at an earlier stage. Many survey studies have established that simple posteroanterior and lateral roentgenograms of the chest will permit the detection of an abnormality in the lung, which may later be identified as a carcinomatous process, long before the onset of symptoms.

While the detection of an abnormal process in the lungs can be accomplished with relative ease and accuracy, the identification of the nature of the disease presents many more difficulties. This is especially true of carcinoma of the lung for it represents the great simulator of all other types of disease of the lungs. A pathological state which may produce a growing mass in the lung, necrosis and abscess formation, secondary inflammatory reaction, perilymphatic and perivascular infiltrative processes, partial or complete bronchial obstruction, segmental or otherwise, with all the pulmonary sequelae which follow, obviously may simulate almost any of the lesions to which the lung is heir.

With the increasing use of roentgen examination in apparently normal individuals the problem of differential diagnosis has become an extremely pressing one. The finding of an abnormal shadow in the roentgenogram of the lungs of an apparently well individual puts a grave pre-

sponsibility upon the physician in charge. There are many methods whereby a definitive diagnosis of carcinoma of the lung may be established. The most cogent of these, of course, is the microscopic examination of tissue removed either through the bronchoscope, by percutaneous biopsy, or as a result of thoracotomy. Direct visualization of the tumor through the bronchoscope is an extremely effective and often practically definitive method. The demonstration of carcinomatous cells in the sputum or in bronchial aspirates is another effective method for the positive identification of lung cancer. Yet there are still a substantial number of patients with an abnormal process in the lung, in whom none of these methods is effective. In some instances it is because of inability or reluctance to apply such methods. For example, percutaneous lung biopsy is not widely accepted as a reasonably safe procedure. Despite the easy assurance of thoracic surgeons and despite the relatively innocuous character of exploratory thoracotomy, there are many cogent reasons why certain patients cannot be submitted to this procedure. Bronchoscopy, either by direct visualization or by the use of the biopsy, has many limitations. At the present time less than 50 per cent of all the patients operated upon for carcinoma of the lung have had either a positive biopsy or positive bronchoscopic visualization of the tumor. This is, of course, particularly true of the peripheral spheroidal nodules which are now so commonly being found. The demonstration of cancer cells in the sputum is of great value when positive but there are many cases in which the method is ineffective either because of lack of spu-

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tum or failure to shed cells. Furthermore, it is a method which has been successful only in a relatively small number of institutions and is not widely applicable.

It is usually held that while roentgen examination may be of great value as a means of detection its utility as a method of identification is sharply limited. That there are distinct limitations in the roentgen determination of the exact nature of a disease process, no one can gainsay. But there are distinctive roentgenologic signs which seem so characteristic of malignant tumors that they carry with them almost the same weight as the more positive finding of actual cells, whether in the biopsy specimen or in the sputum. In this connection I would emphasize that all diagnoses, including those derived from autopsy findings, are only probabilities. Certainly errors occur in the interpretation of the bronchoscopic biopsy, in the bronchoscopic observations of tumor, even in biopsies obtained from exploratory thoracotomy. The following case is illustrative.

#### CASE REPORT

A male, aged sixty-one, came in with a history of acute pain in the chest, cough and distress beginning about three weeks before. His physician thought he had a virus pneumonia and put him to bed for a time. He was given some medicine which caused him to evacuate a great deal of sputum, following which he felt much better.

The patient had a history of cough with hemoptysis since the age of fifteen occurring at infrequent intervals. During the past few years he had had several attacks of such coughing spells but without hemoptysis.

Roentgen examination of the chest was done and his physician, suspecting a lung tumor, sent him in for examination.

On entrance the temperature was 100.4° F., the leukocyte count 14,500, with 72 per cent neutrophils. Laboratory findings were otherwise negative. Vital capacity was reduced, being 67 per cent of normal. Repeated examinations of the sputum showed no evidence of bacteria. A specific study for tumor cells was made with negative results.

Roentgen examination of the chest (Fig. 1a)

revealed a consolidating process in the right upper lobe involving essentially the anterior axillary segment with some extension, however, into the apical portion. The posterior segment appeared to be clear. The area of density was notable by reason of the bulging character of a mass which extended somewhat inferiorly and anteriorly. The diaphragm was not especially elevated and there were no other evidences of atelectasis. The appearance suggested a carcinoma of the anterior axillary branch of the right upper lobe with tumor extension into the parenchyma of the lung and partial atelectasis. Laminagraphic studies, both antero-posterior and lateral (Fig. 1, *b* and *c*) were made and revealed an obstruction of the axillary branch of the right upper lobe bronchus just as it approached the mass. Some evidence of necrosis within the mass could also be made out. There was also some evidence of enlarged lymph nodes in the hilus. Comparison was made with films made by his local physician three weeks earlier, showing no change.

Because of the finding of stenosis in the laminagraphic study and the bulging mass, a diagnosis of carcinoma of the anterior axillary branch of the right upper lobe was made.

The location of the lesion was such as to indicate that bronchoscopy would not be highly successful since the bronchus was open for several centimeters beyond the origin of the upper lobe bronchus.

Exploratory thoracotomy was undertaken by Dr. Richard Varco. The pleura exhibited plaques of thick, whitish tissue. Biopsies made from such areas, however, indicated that it was purely a fibrous tissue reaction and no tumor could be made out. An extensive nodular lesion could be palpated in the anterior segment of the right upper lobe and enlarged lymph nodes in the mediastinum could also be felt. Sections were made from the parenchyma of the lung and from the lymph nodes by the frozen tissue technique and the pathologist reported that this was entirely a chronic inflammatory disease. Despite this, Dr. Varco felt that pneumonectomy was indicated because of the characteristic roentgen signs and the clinical evidences to suggest carcinoma, and a right pneumonectomy was done.

The specimen revealed a palpable lesion in the upper lobe measuring approximately 4.5 cm. in diameter. This extended well out to the pleura. The tumor mass originates in the an-

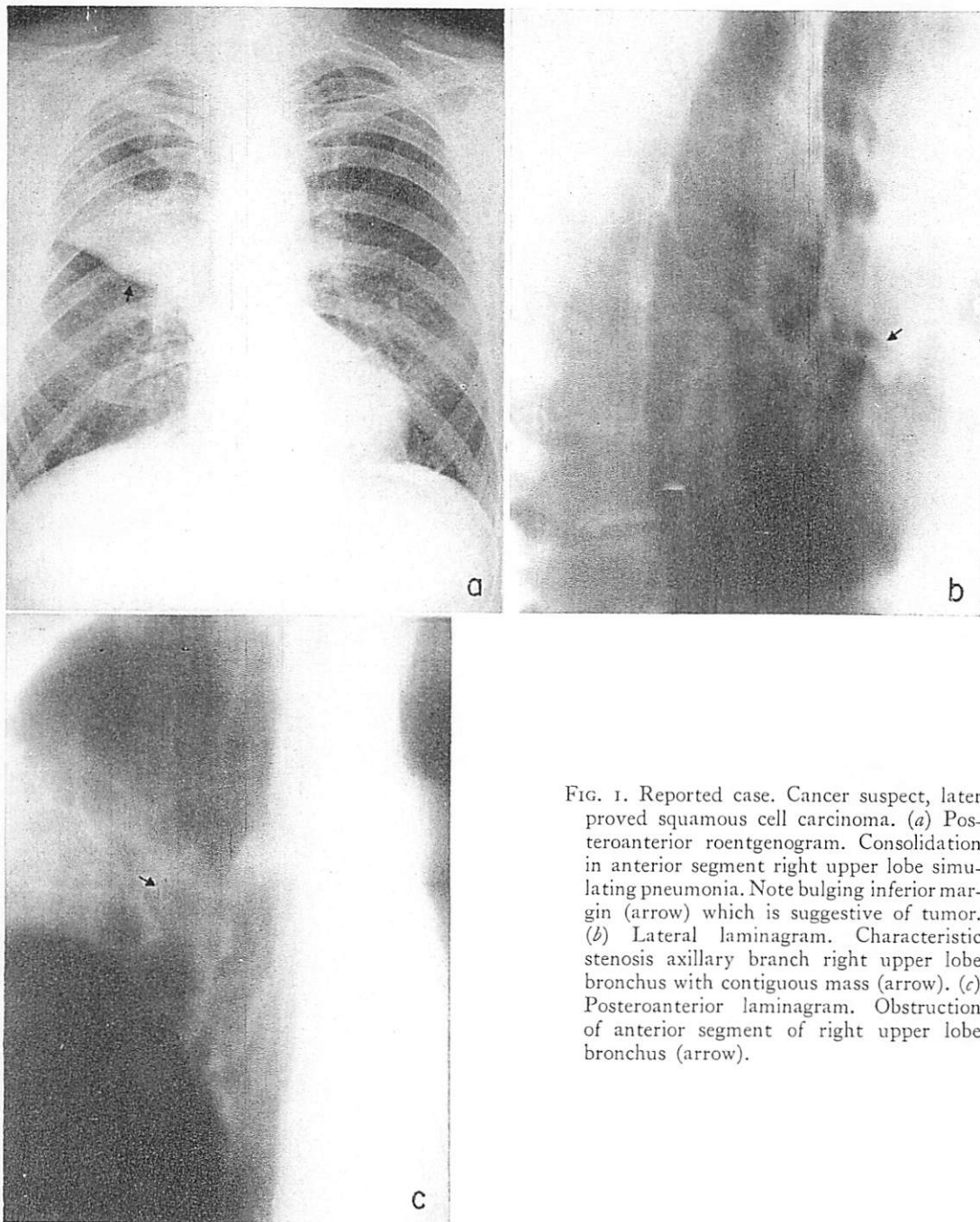


FIG. 1. Reported case. Cancer suspect, later proved squamous cell carcinoma. (a) Posteroanterior roentgenogram. Consolidation in anterior segment right upper lobe simulating pneumonia. Note bulging inferior margin (arrow) which is suggestive of tumor. (b) Lateral laminagram. Characteristic stenosis axillary branch right upper lobe bronchus with contiguous mass (arrow). (c) Posteroanterior laminagram. Obstruction of anterior segment of right upper lobe bronchus (arrow).

terior segment of the upper lobe bronchus. This bronchus is occluded and disappears into a small cavity measuring approximately 1 cm. The bronchus shows a ragged lining as does the cavity. The surrounding mass is composed of compressed and infiltrated lung tissue con-

taining pockets of purulent material. Multiple enlarged lymph nodes are found in the hilus. The main upper lobe bronchus and the posterior and axillary branches appear to be normal.

Microscopic sections through the occluded end of the involved bronchus gave a charac-

teristic picture of squamous cell carcinoma. Sections of fifteen lymph nodes show four of these nodes to contain tumor similar to that found in the lung. No tumor was found in the pleura on restudy.

#### DISCUSSION

In this case both the examination of the sputum and biopsies taken from the parenchyma of the lung and from the lymph node and pleura at operation, as done by the frozen tissue technique, failed to show tumor.

The roentgen findings of a chronic infiltrative process in the lobe with cavitation plus an expanding outer margin, together with a fairly characteristic stenosis of the bronchus were indicative of carcinoma. The added finding of lymph nodes in the hilus gave further confidence in this diagnosis.

Obviously, such a failure of pathology and success of roentgenology is the exception but the case is cited to indicate that in all diagnoses there is the possibility of error and one must weigh all the evidence before coming to a conclusion.

There are many patients with demonstrable lung pathology in whom a definitive diagnosis appears impossible regardless of what method may be used, and exploratory thoracotomy seems to be the only feasible procedure. But surgical invasion of the thorax is not to be undertaken lightly, regardless of the facility with which it may now be accomplished. For one thing it is often difficult to persuade an individual who appears to be perfectly healthy to accept an exploratory thoracotomy only because, during the course of a survey examination, he has been found to have an abnormal shadow in the lung. Everyone has experienced failures in this regard. In many other cases there is a great reluctance on the part of physicians to recommend a procedure of this order when the evidences in favor of a malignant lesion are so minimal.

The problem has become particularly acute at this time, especially because of the solitary spheroidal nodule of the lung.

More and more, as patients have routine examinations of the chest, these solitary pulmonary shadows come to plague us and demand some procedure which will make it possible to determine their exact diagnosis. The same is true of the minor pulmonary infiltrations which we are encountering in apparently normal individuals, infiltrations which we know may be manifestations of carcinoma.

Intensive roentgenologic study should be undertaken in such cases in order to determine the presence or absence of certain roentgen signs which have great diagnostic significance. In order to observe the findings described below it is necessary to make conventional roentgenograms in a variety of positions, to do laminagraphy and, if necessary, bronchography.

Of great importance is the comparison of films made at various times in the history of the patient. A very high percentage of our adult population at the present time will give a history of having had roentgenographic examination of the chest, often fortuitously, at some previous date. Whether done by the photofluorographic method or by the use of full-sized films, such records should be preserved for many years. This is especially true of what were thought to be negative roentgenograms, for often such films actually exhibit the evidences of a very early lesion, not sufficiently apparent to be detectable at the time, but easily seen in retrospect when a larger lesion is found later.

None of the roentgen signs to be described is absolutely diagnostic but the positive findings have a degree of probability which approaches that achieved by microscopic studies. Furthermore, their reliability is sufficient to present a firm indication for exploratory thoracotomy.

#### DEFINITIVE ROENTGEN SIGNS OF CARCINOMA OF THE LUNG

1. The appearance of a solitary pulmonary shadow not present in previous films, especially in an individual past middle age, is of very great significance. It is obvious at

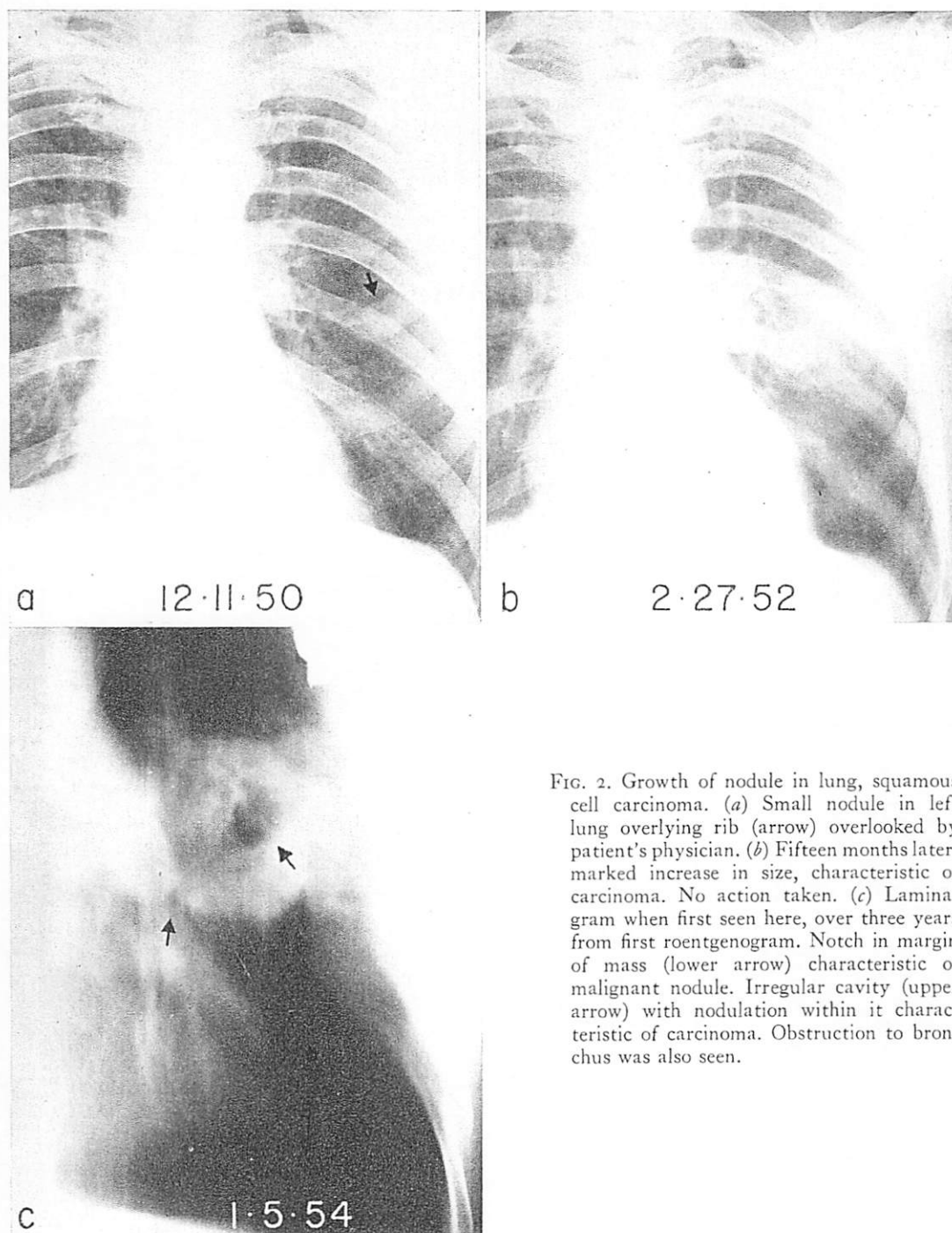


FIG. 2. Growth of nodule in lung, squamous cell carcinoma. (a) Small nodule in left lung overlying rib (arrow) overlooked by patient's physician. (b) Fifteen months later, marked increase in size, characteristic of carcinoma. No action taken. (c) Lamina-gram when first seen here, over three years from first roentgenogram. Notch in margin of mass (lower arrow) characteristic of malignant nodule. Irregular cavity (upper arrow) with nodulation within it characteristic of carcinoma. Obstruction to bronchus was also seen.

once that here there must have been a previous examination at a period of time usually longer than three months before the one under consideration. Almost in-

variably such a situation is encountered in individuals who are completely symptomless. The complete absence of any evidence of a lesion in an area which in later films

shows infiltration or a nodule is a specific indication for resection of the area with more radical procedure if the diagnosis of carcinoma is confirmed microscopically at the time of operation.

The demonstration, in an individual over forty, of a nodular pulmonary shadow which was not present in films made six months, a year, or several years before is not by any means complete assurance that the lesion is a tumor or that it is malignant. We have learned in recent years, from bitter experience, that granulomas will likewise appear suddenly in middle-aged individuals. But I believe this is, by far, the exception and not the rule. A lesion of this kind appearing suddenly is much more likely to be a carcinoma than it is to be a benign process or a granuloma.

2. The demonstration of a peripheral pulmonary mass or nodule in the lung which shows an increase in size when compared to a previous film is likewise of very great importance (Fig. 2, *a* and *b*). This is perhaps an even more cogent indication of the presence of a malignancy than the sudden appearance of a shadow in an area in which none was previously seen. But, again, there are exceptions since granulomas may increase in size under observation, as we have seen, on many occasions. It should be noted, in this connection, that a failure to increase in size does not at all exclude carcinoma. Some malignant tumors grow very slowly. I have observed cases of carcinoma which took as long as seven years to attain a considerable size. Furthermore, I have observed at least one case in which over a period of four years there was no change whatever in size, although it proved to be an adenocarcinoma of the lung. Despite these rather startling exceptions, the probability that a lesion which has increased in size over a period of one year, especially if the increase is reasonably rapid, is a carcinoma is extremely high and should certainly so be regarded until proved otherwise.

3. In any solitary peripheral pulmonary nodule the possibilities of diagnosis are

always very difficult. Some thirty conditions may produce such a shadow in the roentgenogram. Laminagraphic studies, however, may be of very great value in determining whether or not the lesion is malignant or benign. By this means an accurate determination as to the sharpness of outline, the homogeneity, and the contour of the lesion can be obtained. None of these characteristics are highly diagnostic, however, since granulomas may be quite sharply rounded while tumors may or may not be sharply defined. The homogeneity, likewise, is not distinctive since cavitation or necrosis (Fig. 2*c*) may occur both with tumors and with inflammatory processes. The contour may be of some importance because most tumors tend to be reasonably regular in their outline and to assume a spheroidal shape, whereas inflammatory lesions may be much more irregular and much less geometric in form.

Of greater importance is the demonstration of the presence or absence of calcium in the mass. Such a determination is best made by laminagraphy; the procedure is highly effective in demonstrating calcium. While it is true that the absence of calcium is of little significance, since many granulomas and benign lesions do not show calcium, the presence of calcium is of great significance. A few cases, both of bronchial adenoma and of carcinoma, have been reported in which calcium was demonstrated in the lesion. In some of these the calcium may well have been present previous to the development of the tumor which happened to occur in the same area. In others, necrosis of the tumor resulted in calcification. Nevertheless, these are startling and extraordinary exceptions to the general rule. In my own experience I have never seen a true carcinoma of the lung with calcification, and this is the general opinion of many men who have had long experience with these tumors. For practical purposes, therefore, the presence of calcification, barring compelling evidence to the contrary, should indicate that the lesion is not a malignant tumor.

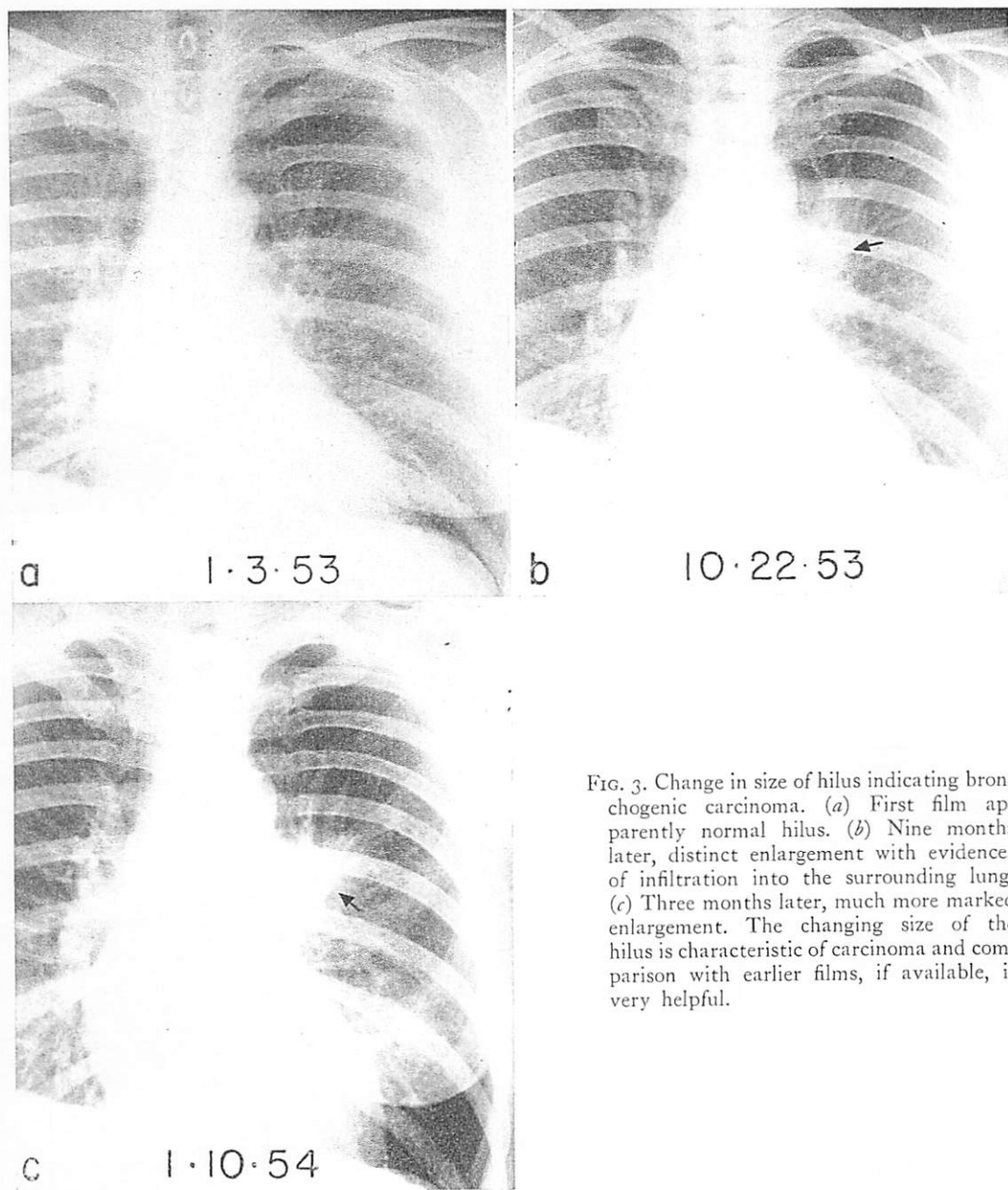


FIG. 3. Change in size of hilus indicating bronchogenic carcinoma. (a) First film apparently normal hilus. (b) Nine months later, distinct enlargement with evidences of infiltration into the surrounding lung. (c) Three months later, much more marked enlargement. The changing size of the hilus is characteristic of carcinoma and comparison with earlier films, if available, is very helpful.

4. In the course of our study of a great many nodules in the lung we have come upon a sign which appears, so far, at least, to be characteristic of malignancy. This consists of a notching or umbilication in the margin of the shadow (Fig. 2c). The deformity is not well seen in the ordinary

roentgenograms, although occasionally we have seen it here as well, but it is quite clearly delineated in body section roentgenograms when the film is made at the proper level. The cause of this notching is not entirely clear although in several sections, which we have seen histologically, it

appears to resemble a hilus in the mass, containing blood vessels and normal lung structures extending into the body of the mass itself, thus producing the irregularity of the contour. The notching is usually single although in some cases it has been multiple. I have observed this in pulmonary metastases, such as from hypernephroma or melanoma, as well as in primary malignancies. Assuming that a solitary metastasis is an indication for extirpation, the presence of this notch seems to be a prime indication for immediate surgery with extirpation of the lesion.

It should be noted that the absence of this notch does not by any means exclude malignancy. While we have found it in small as well as large lesions, it appears more obvious in the smaller lesions. We have, however, seen it in masses as large as 10 cm. in diameter; we have seen it in lesions as small as 1 cm. in diameter. I would emphasize that the presence of such a notch, as seen in laminagraphic studies, is of utmost importance in determining that the patient has an actual malignancy. As yet we have not seen it in any benign condition.

5. A change in the size and appearance of one hilus is a lesion likewise of very great significance and only possible to observe when previous films are available (Fig. 3). Changes in the size of the hilus occur in probably 50 per cent of all the carcinomas of the lung. They are difficult to interpret because of the common occurrence of irregularities in the hilus resulting from inflammatory changes and other disease processes in the lung. Nevertheless, an enlargement of one hilus, even by itself, should be considered a carcinoma until proved otherwise. If the hilus seems to have been enlarging while under observation the probability that it is a carcinoma is extremely high, much higher in fact than if one sees a peripheral lesion enlarging.

It is at once apparent that the demonstration of an enlarged hilus or even the suspicion of enlargement of the hilus should call for intensive roentgen study.

Several positions including oblique and lateral views (Fig. 4c) should be made. Such films will often permit a more definite determination as to whether the shadow seen is truly in the hilus and not in the parenchyma of the lung superimposed upon it, and whether an actual enlargement is present. Under such circumstances, roentgenograms made in inspiration and expiration may be of very great value. For a hilar enlargement of carcinomatous origin is usually the result of a tumor arising in one of the major bronchi which has extended into the peribronchial tissues. Such tumors very often produce sufficient obstruction of the bronchus to exhibit an obstructive emphysema (Fig. 4b) in the area supplied by the involved bronchus. It is best brought out in expiration; this is an extremely important maneuver in determining definitely whether an actual tumor is present (Fig. 4, a and b). Further steps should include laminagraphy, in an effort to visualize the major bronchi, since an enlargement of the hilus is almost always associated with a tumor arising in a bronchus of the first, second, or third order (Fig. 4d). Furthermore, the presence of enlarged lymph nodes can be effectively determined in this fashion. If the laminagraphic study is not entirely satisfactory, that is if the major bronchi are not clearly visualized throughout, it may be necessary to go a step further and do bronchography with an opaque medium. The latter should lead finally to a definitive determination as to whether or not any partial or complete obstruction of a bronchus is present and the nature of that obstruction. The latter will be considered later.

6. An infiltrative lesion in the lung is perhaps the most difficult of all to differentiate, particularly from the various forms of pneumonitis and from tuberculosis. There are two roentgen signs which are of some value in this differentiation. The first is, again, the demonstration over a period of time of the increasing character of the infiltrative process. While it is true

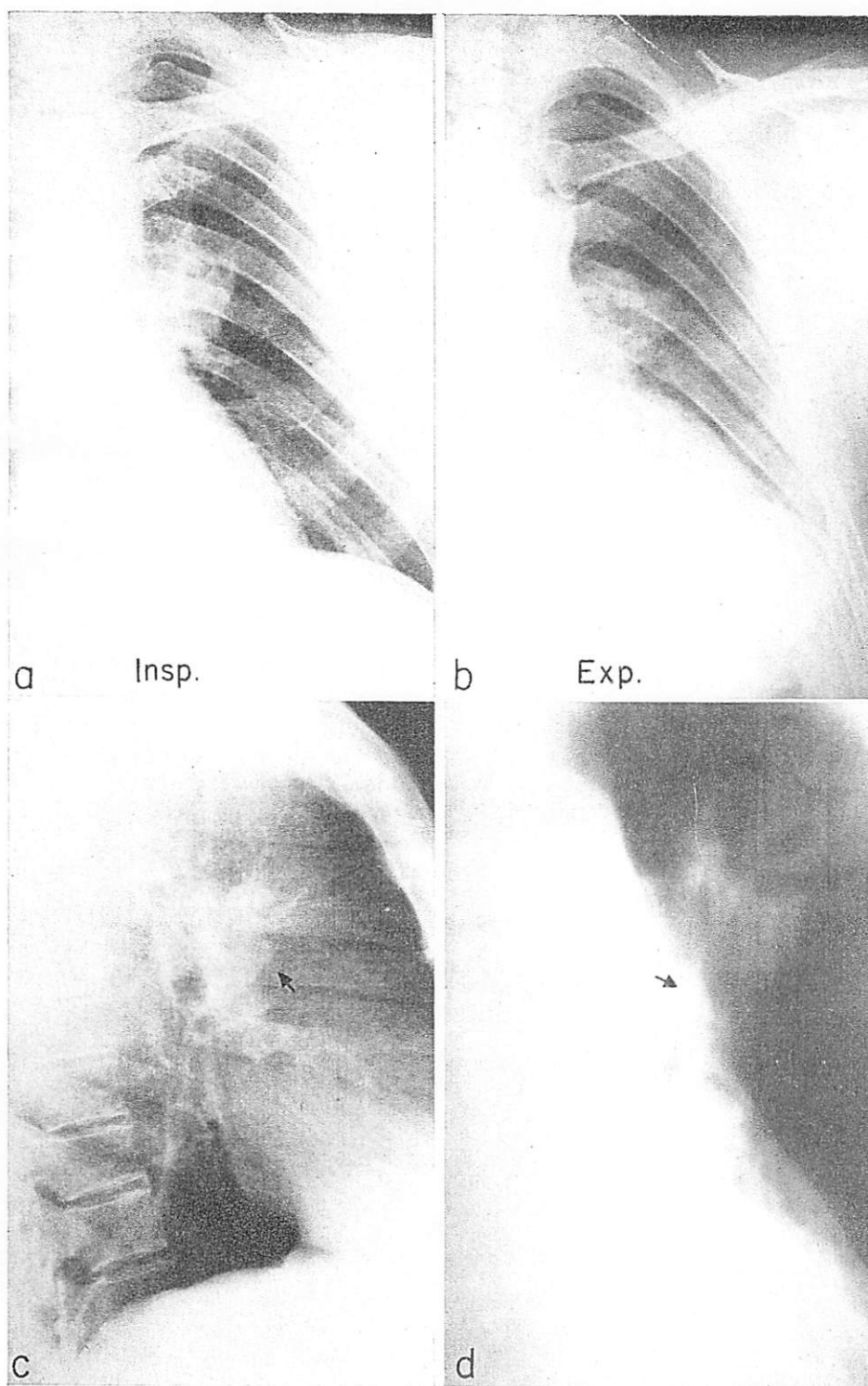


FIG. 4. Carcinoma of lung exhibiting enlarged hilus and obstructive emphysema. (a) Inspiratory roentgenogram. Markedly enlarged left hilus but with apparently normal appearing lung. (b) Expiratory roentgenogram showing marked radiability of upper lobe characteristic of obstructive emphysema. (c) Lateral view indicating that mass is actually in hilus but with some extension into upper lobe. (d) Laminagram showing tumor mass projecting into upper lobe bronchus (arrow) which tends to clinch the diagnosis.

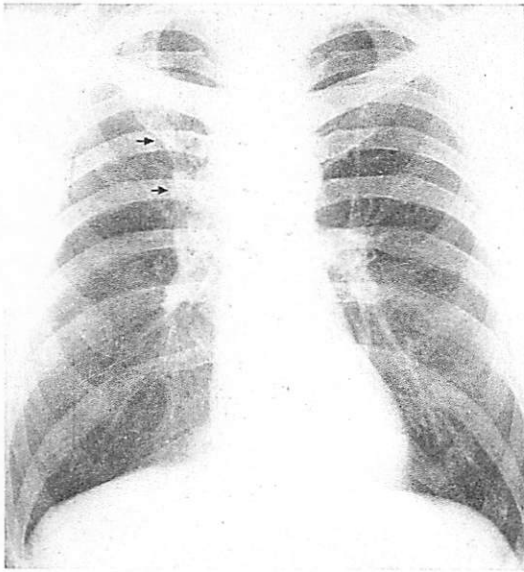


FIG. 5. Posteroanterior roentgenogram in an infiltrating carcinoma of the lung. The nodular character of the infiltration is well shown (arrows). Such rounded, beaded areas along the course of an infiltration usually indicate its carcinomatous origin.

that this may occur in tuberculosis and other chronic lesions, usually it is much slower and less obvious, while in carcinoma the infiltrative process may gradually, but usually much more rapidly, increase in size and in extent of involvement. Secondly in such infiltrative lesions, a nodular beaded character can be demonstrated which is highly significant (Fig. 5). I would say at once that the definitive character of such lesions is far from that which I have discussed under the peripheral lesions or the enlarged hilus. Nevertheless, an infiltrative lesion which exhibits these nodulations along its course should certainly be considered highly suspicious, at least, of malignancy, despite its resemblance to an inflammatory process in other respects.

7. The pneumonic lesions are among those which give us the greatest difficulty in differential diagnosis. There are three roentgenologic findings which should arouse suspicion. (1) The failure of an ordinary pneumonia to resolve should be

regarded as indicative of either carcinoma or a chronic process until proved otherwise. The diagnosis of unresolved pneumonia undoubtedly is correct in some cases but it is a highly risky diagnosis and should never be made without the most careful and repeated observation with roentgen examination. (2) The laminagraphic studies of such areas of infiltration of the lung, which are thought to be pneumonia, may again reveal a nodular type of mass previously indicated. This should suggest its carcinomatous origin. Furthermore, a typical bronchostenosis may be demonstrated in this way (Fig. 6). (3) Bronchography should be undertaken if the bronchi are not clearly delineated in the laminagram for very often in carcinomatous lesions which imitate pneumonia or have associated pneumonitis bronchostenosis can be demonstrated. Bronchostenosis does not accompany pneumonitis; it seldom occurs with chronic tuberculosis of the infiltrating variety. The demonstration, therefore, of a bronchial occlusion, particularly if it is ragged and irregular, should lead to the diagnosis of carcinoma or at least should be sufficiently compelling to indicate the need

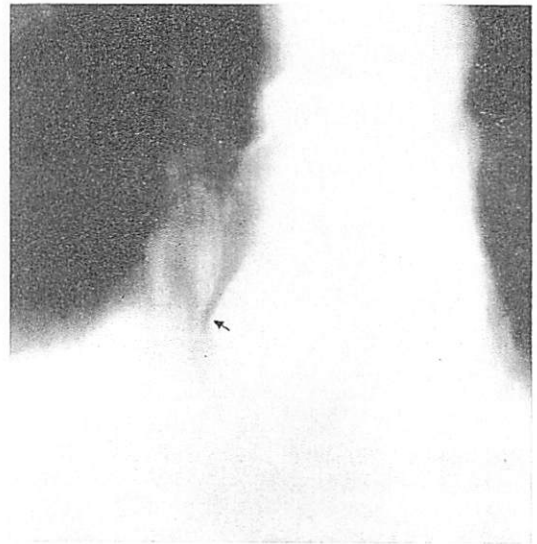


FIG. 6. Posteroanterior laminagram in a case of carcinoma of the lower lobe. Characteristic "rat-tail" obstruction of the lower lobe bronchus is well demonstrated (arrow).

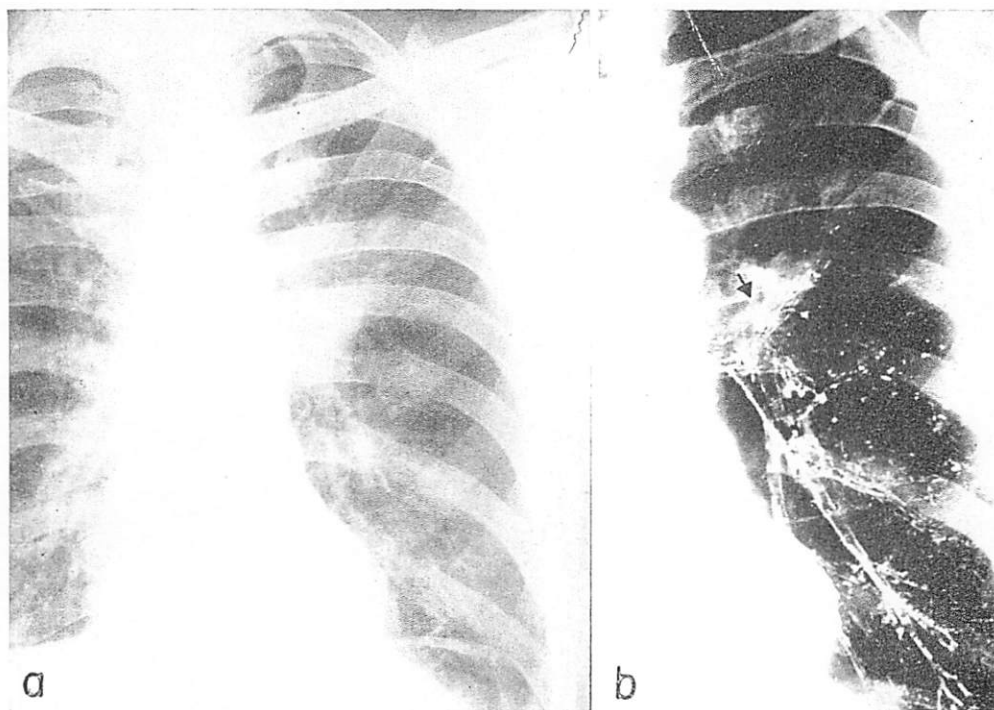


FIG. 7. Case of carcinoma, symptoms and roentgen signs simulating pneumonia. (a) Posteroanterior roentgenogram with enlargement of hilum and infiltration in the lung difficult to distinguish from unresolved pneumonia. (b) Bronchogram showing characteristic obstruction of the apical branch of the left upper lobe bronchus (arrow). This is typical of carcinoma.

for exploration (Fig. 7). A diagnosis of unresolved pneumonia should not be made without undertaking laminagraphic or bronchographic demonstration of the bronchi.

The contrast between an enlarged hilum with pulmonary infiltration of carcinomatous origin and that of inflammatory origin is demonstrated by Figures 7 and 8. In the latter, a case of unresolved pneumonia, the bronchi are seen to be normal.

8. A solitary abscess, even rather small in size, may be the first indication of a carcinoma of the lung. Such abscesses are usually the result of necrosis within a rapidly growing tumor. The distinction from an ordinary pulmonary abscess or from a tuberculous cavity can very commonly be made, especially if laminagraphy is undertaken. Carcinomatous abscesses will usually show a protruding outer margin which extends well beyond the area of the cavity itself (Fig. 9). The appearance of

this protrusion is characteristic of a growing mass. In my own experience it has been present almost invariably in the carcinomatous abscesses, especially if one obtained good laminagraphic studies so that the clear delineation of the outline of the borders of the cavity could be made. In the larger cavities the presence of masses within the air pocket itself can be made out, indicating tumor nodules growing within the cavity (Fig. 2c). It is sometimes difficult to distinguish such shadows from those produced by granulations but, as a matter of fact, it is uncommon for a nontuberculous abscess or a tuberculous abscess cavity to show such masses within the air space.

9. The presence of segmental, lobar or unilateral emphysema, especially in the expiratory phase, is indicative of partial bronchostenosis. This, of course, is far from definitive insofar as carcinoma is

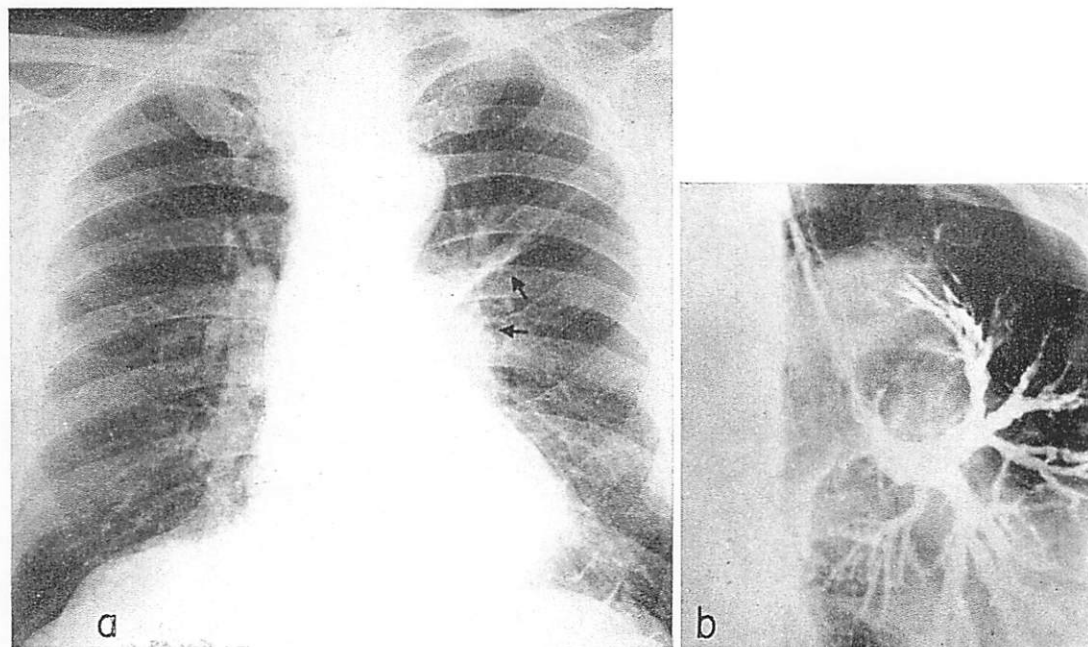


FIG. 8. Case of unresolved pneumonia, symptoms and signs simulating carcinoma. (a) Posteroanterior roentgenogram showing enlarged hilus with infiltration into the lung similar to Figure 7. (b) Bronchogram showing all branches of the left bronchus completely filled out and intact except for slight distortion due to the scar formation in the lung. The value of bronchography in such cases is illustrated.

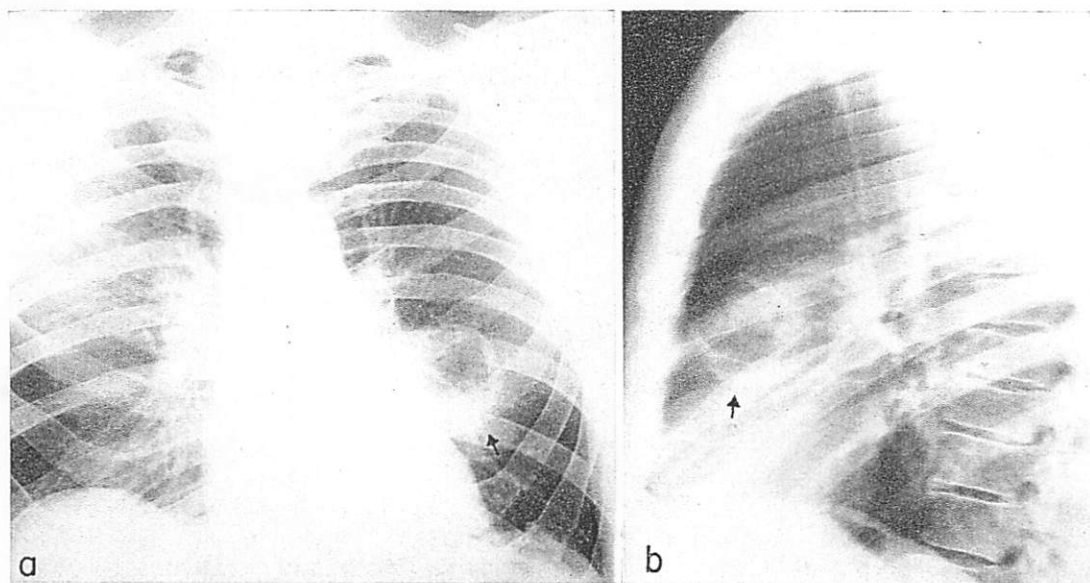


FIG. 9. Pulmonary abscess of carcinomatous origin. (a) Posteroanterior view. Characteristic cavity with fairly thick wall with little fluid within it. Note thick wall at inferior portion (arrow). (b) Lateral view. The bulging portion of the abscess, which is characteristic of carcinoma, is shown in the inferior portion (arrow).

concerned but if found in an individual past middle age it should certainly arouse first of all the thought that this is carcinoma. Further investigation, therefore, with laminagraphy or bronchography to determine the nature of the bronchostenosis is indicated. Very often, as will be observed later, the character of the occlusion thus observed may indicate clearly the fact that this is due to a carcinoma of the bronchus. The combination of emphysema and of an enlarged hilus almost invariably connotes carcinoma (Fig. 4).

10. The same indications are present in atelectasis as in emphysema. Obviously, atelectasis may be the result of a benign type of bronchostenosis but, again, in an individual past middle age in whom it has suddenly appeared the suspicion that this is due to a carcinomatous obstruction of the bronchus is a first consideration. Here, again, laminagraphy or bronchography may exhibit effectively the nature of the bronchostenosis and thus establish the diagnosis.

11. The demonstration of changes in the bronchial lumen can be made effectively in most cases by laminagraphy. Both posteroanterior and lateral laminagrams should be made and the technique is of great importance. When satisfactory, it is possible to delineate the bronchi of the first, second and third orders quite effectively. Smaller bronchi are not well demonstrated by laminagraphy. The demonstration by means of laminagraphy of a tumor as a positive shadow within the bronchus is not rare in carcinoma and may be a crucial deciding point in determining the presence of the tumor. It may be difficult to distinguish between benign adenoma and a malignant tumor on this basis, but at any rate a sufficient indication of the neoplastic nature of the process is afforded to make surgery imperative. A cap shaped indentation of the bronchial lumen either at its end or on one margin is also characteristic. Finally, the demonstration of an elongated, somewhat irregular stenosis of the bronchus is indica-

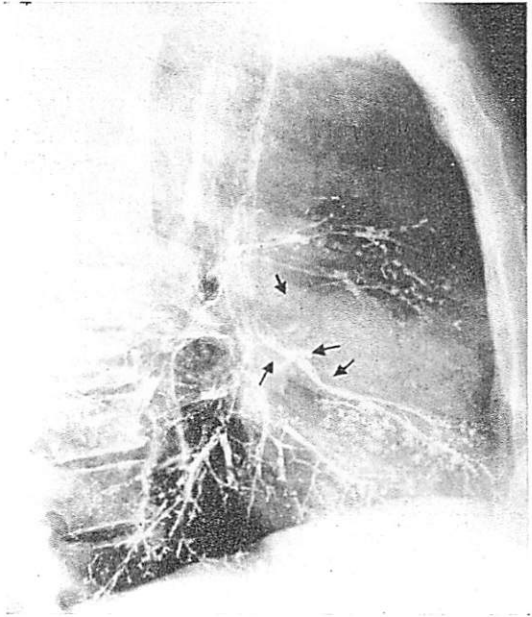


FIG. 10. Carcinoma of segment of right middle lobe difficult to diagnose by most procedures. Bronchogram, lateral view, shows characteristic obstruction of superior branch of right middle lobe bronchus with deformity and compression of inferior branch from the tumor itself (arrows). The other arrows indicate the interlobar fissures outlining the middle lobe, which is completely dense.

tive of malignant obstruction (Fig. 1c, 2c, 4d and 6). In doing laminagraphy it is of great importance to get multiple sections at various levels to be certain that the stenosis is not being simulated by an angulation of the bronchus. With these provisions in mind, however, it may be possible to demonstrate relatively small lesions in this fashion.

In the smaller bronchi and occasionally, because of technical difficulties, in the major bronchi, laminagraphy may be unsuccessful. Under these circumstances the introduction of a contrast medium into the bronchi through a catheter localized to the area under suspicion may be a final method of definitive diagnosis, assuming that bronchoscopy has been unsuccessful in this regard (Fig. 7b and 10). Small branch bronchi may be delineated and the obstruction within them determined. The character of the obstruction, whether exhibited

by means of laminagraphy or bronchography, is reasonably definitive for carcinoma of the bronchus. Such findings are of particular importance in the cases with apparent inflammatory infiltrates, unresolved pneumonias, etc., which are so often actually due to carcinoma and in which so much delay so frequently occurs. The demonstration of a bronchostenosis, particularly by bronchography, and especially if the stenosis is irregular and elongated, should lead to the assumption that the pneumonic infiltration is due to carcinoma rather than to a true pneumonia or any real inflammatory process. Such an assumption will usually prove to be correct as illustrated in the first case reported.

#### DISCUSSION

The findings described above are not by any means completely definitive but must be weighed with the other evidence available. Furthermore, certain cases of carcinoma of the lung will present none of these characteristic findings; many malignancies cannot be identified by roentgen signs. There are, unfortunately, a number of cases which defy all our efforts and must be investigated by exploratory operation. It is obvious that I have pointed out here the positive signs of lung cancer; it is exceedingly difficult to delineate any negative signs. In fact, the absence of carcinoma is almost impossible to establish. But we should not give way to the defeatism which holds that all one sees in the roentgenogram is a shadow from which a definitive diagnosis should not be made. In carcinoma of the lung the roentgen signs are similar in their nature to those observed by the pathologist except that the probab-

ity of their correctness is less. That the histopathologic evidence is far more accurate than the roentgenologic no one would dispute. But in the absence of histopathologic evidence we should utilize the roentgen examination to the fullest extent of its potential to make a definitive diagnosis before operation. This is absolutely necessary, not only to institute surgery at a time when it will be effective, but also to avoid indiscriminate surgery, especially in symptomless individuals.

#### SUMMARY

Roentgen examination may be an effective means of identification, as well as detection, in carcinoma of the lung.

The histopathologic determination of the nature of an abnormal process in the lung may be unavailable or unsuccessful in some cases.

While exploratory thoracotomy is advisable in cases suspected of carcinoma in which positive histopathologic evidence is lacking, it is not always possible to accomplish without more definitive signs than the presence of an abnormal process in the lung.

Intensive roentgen study including comparison with previous films when available, examination in many positions and in different phases of respiration, laminagraphy, and, when necessary, bronchography will produce signs which are highly probable, if not completely definitive for the diagnosis of tumor.

Eleven such findings are described.\*

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\* For discussion see page 436.

