Bronchography in Diagnosis of Bronchogenic Carcinoma

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Bronchography is an underestimated and neglected tool in the diagnosis of diseases of the chest. Opaque medium in outlining the bronchial tree can be as useful as the use of barium in the gastrointestinal x-ray series. As of this writing the bronchogram has not nearly reached its full diagnostic potential. Possibly this is so because the examination is considered too cumbersome for routine work. With development of methods each investigator can modify to suit his own needs, and with attention to detail, the examination need not be more complicated or difficult than the routine gastrointestinal series.

Many observers have commented on the valuable loss of time between the onset of cancer of the lung and the final decision to institute definitive therapy. According to Davis et al.,¹ physicians must accept responsibility for the seven month delay in establishing the diagnosis. They state further, “Our immediate concern is with the need for a more prompt and more thorough investigation of symptoms, not after months of observation, but in their incipiency.” Rigler² pinpoints the problem in his observation, “While detection of an abnormal process in the lungs can be accomplished with relative ease and accuracy, identification of the nature of the disease presents many more difficulties.” If a procedure were available which could materially shorten the period of uncertainty and establish a diagnosis with relative ease and accuracy, it would be worthy of widespread adoption. It is the purpose of this paper to advance the bronchogram as useful in this respect. In the group comprising the basis of this report, 50 per cent of the bronchograms were performed within two weeks of hospitalization and a diagnosis accurately established in 89 per cent of bronchogenic carcinoma. It is my firm belief that this time can be shortened materially.

**Material and Results**

This report is based on 147 bronchograms, all but nine of which were performed since 1959. Of these, 61 revealed malignant neoplasms of the chest. In evaluating the sensitivity of the bronchogram in establishing a diagnosis of bronchogenic carcinoma, eight cases were excluded for the following reasons:

1. Two in which the lesions were extrinsic to the respiratory tract. These will be discussed.
2. Two in which the bronchogram failed to demonstrate bronchial obstruction. One of these proved to be a mesothelioma at necropsy and so considered both clinically and radiologically. The second, also considered a mesothelioma, was unfit for exploration; necropsy was not allowed and anaplastic carcinoma was found on a scalene node biopsy.
3. Four cases in which there was definite bronchial obstruction on bronchography. Two of these left the hospital of their own accord and were lost to followup. The remaining two were not candidates for exploration by virtue of distant metastases and necropsy was not permitted.

Of the remaining 53 cases, the diagnosis of bronchogenic carcinoma was established in 47 (89 per cent) and six were considered failures of the procedures, all of them before 1959 when the procedure was relatively new to me.

**Diagnosis of Bronchogenic Carcinoma**

Aside from the history and physical examination, the diagnosis of bronchogenic carcinoma depends on a suspicious lesion on radiologic examination of the chest and the “diagnostic triad.” The first is ably

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*From the Veterans Administration Hospital.*
discussed by Rigler and associates in their excellent article, “The Duration of Carcinoma,” and by Bobrowitz, and the latter by Umiker and Farber.

*The Roentgen Signs of Lung Cancer*

These are listed as: (1) the nodule; (2) unilateral hilar abnormality; (3) the abscess; (4) recurrent vascular infiltrate; (5) blurred apex simulating thickened apical pleura; (6) pleural effusion; (7) obstructive emphysema and atelectasis; (8) lobar and lobular consolidation; (9) an infiltrate simulating acid-fast infection or atypical pneumonitis; (10) and finally, a suspicion of abnormality, but no definite demonstrable lesion.

These are not the signs of bronchogenic carcinoma alone. They are also manifestations of bacterial, viral, fungal and tuberculous infections, dust diseases, lymphoma, metastatic carcinoma, sarcoidosis and other diseases. In fact, lung cancer imitates and is imitated by practically every disease the lung is heir to. Finding a lesion such as is listed above, by chance or otherwise, poses the problem of identification and this is not easy. The main object of this paper is:

1. To point out that the lesions appearing on the conventional chest roentgenogram, and suspicious but not diagnostic of bronchogenic carcinoma, have one common denominator if in fact they are bronchogenic carcinoma—malignant bronchial obstruction. This was demonstrated in bronchi as small as the fifth order of division and found absent in mesotheliomas and bronchiolar carcinoma. There are two corollaries:

   a. Lesions suspicious of bronchogenic carcinoma, but showing no malignant bronchial obstruction, are not bronchogenic carcinoma, bronchiolar carcinoma excluded.

   b. Lesions not suspicious of bronchogenic carcinoma, but which show malignant bronchial obstruction on the bronchogram, are bronchogenic carcinoma.

2. To describe the roentgen features of malignant bronchial obstruction as appearing on the bronchogram, and to differentiate it from bronchial obstruction due to benign causes.

3. And, to evaluate the diagnostic sensitivity of the bronchogram and compare it with that of the “diagnostic triad” individually and collectively.

*Bronchial Obstruction as a Diagnostic Sign*—That bronchial obstruction is a reliable sign of bronchogenic carcinoma is amply recognized. Rigler and colleagues quote Westmark as stating that he found 96 bronchial obstructions in 100 cases of bronchogenic carcinoma, and Bobrowitz states, “The presence of bronchial obstruction in any degree warrants presumptive diagnosis of lung cancer.” The main signs of such obstruction are obstructive emphysema and atelectasis. Both of these signs are indirect. Direct demonstration by bronchography is mentioned only rarely in the literature reviewed and then only incidentally. The advocacy of this procedure for the specific purpose of demonstrating malignant bronchial obstruction as a primary attack, is not encountered. In fact, Golden writes, “One should not rely on bronchography . . . for it is quite possible to overlook the presence of an obstructive lesion by this method,” and Ackerman and del Ragato discourage the procedure, stating that it is being used less and less.

*The Common Denominator*—The group of lesions appearing on the conventional chest roentgenogram, and listed above, are considered suspicious, but not diagnostic of bronchogenic carcinoma. Those exhibiting features characteristic of malignant bronchial obstruction were eventually proved to be bronchogenic carcinoma. This was true whether the lesions were atelectasis or a unilateral abnormal hilum, lobar or lobular consolidation, a solitary abscess or an infiltrate. In one instance, there was suspicion of an abnormality, but no definite demonstrable lesion. The aortic knob was less sharp than expected, and the history was confused by an onset attributed to a fall from a 20-foot ladder and absence of symptoms relative to the respiratory tract. The
bronchogram, however, demonstrated malignant bronchial obstruction and this was eventually verified at necropsy.

The Corollaries

There are two corollaries to this finding:

1. Lesions suspicious of bronchogenic carcinoma on the conventional chest roentgenogram, but showing no malignant bronchial obstruction on the bronchogram, were not bronchogenic carcinoma. Thus, a unilateral abnormal hilum was found in tuberculous adenitis and pneumonia secondary to tuberculosis of the spine, in bronchiectasis, and benign abscess. A mass lesion extending from the right hilum to the apex and resembling a lobar consolidation and suspected as being bronchogenic carcinoma, proved to be carcinoma of the thyroid. It will be discussed further. A mass lesion suspected to be bronchogenic carcinoma proved to be an unresolved infarction, and bronchiectasis was found in a lesion simulating perivascular infiltration associated with incomplete obstruction of bronchogenic carcinoma. In all of these, there was no malignant bronchial obstruction (Fig. 1).

2. Lesions not suspicious of bronchogenic carcinoma, but which are associated with bronchographic evidence of malignant bronchial obstruction proved to be bronchogenic carcinoma. In this group were blurred apices, commonly interpreted as thickened apical pleura, subclavicular infiltrates, as tuberculous infiltrations, and lobulated hilar masses, as lymphomas. Golden reports a case in the latter category, stating, "A sharply demarcated shadow was seen in the right lung root . . . Because of its shape and location it was thought to

[Figure 1: Unilateral hilar abnormality suggestive of bronchogenic carcinoma. Surprisingly, there was no malignant bronchial obstruction. Tubercle bacilli were recovered from the sputum and there was a destructive process in the ninth dorsal vertebral body.]

[Figure 2: The lobulated masses in the left hilum were thought to represent lymphoma, but the bronchogram revealed malignant bronchial obstruction and the pathologic report was "oat cell carcinoma."
represent a lymphomatous tumor and a course of radiation therapy was therefore given. It did not respond. The shadow proved to be a lipoma.” A bronchogram in our case almost identical with the above, and also considered to be a lymphoma, demonstrated malignant bronchial obstruction and proved to be an oat cell carcinoma (Fig. 2).

Features of Bronchial Obstruction, Malignant and Benign—Characteristic features of malignant bronchial obstruction are as follows:

1. The obstructed end is abrupt and irregular.

2. The bronchus leading to the point of obstruction is normal in caliber and conforms in size and shape to those in its vicinity, and has lost caliber in its progress peripherally.

3. The obstructed end is in relation to an atelectatic process, an abscess or mass.

Features of Benign Obstructions:

1. The bronchus involved is usually small and associated with a nodule usually containing calcium.

2. The bronchial end appears to be eroded rather than cut off, and what is more significant.

3. The bronchus leading to the site of obstruction is abnormal. It appears to be tubular, larger than the bronchi in its vicinity, and has failed to lose caliber in its progress peripherally. The contained contrast medium is either pooled or appears granular.

Exceptions do occur. In one instance, a malignant lesion developing in an area of inflammatory disease exhibited characteristics of the latter. A wedge resection of
the dime-size lesion was interpreted as bronchiectasis, but subsequent re-evaluation revealed adenocarcinoma. It would seem then that a malignant bronchial lesion developing in an area of inflammatory disease may assume the characteristics of the latter (Fig. 4).

The characteristics of malignant bronchial obstruction may also be absent where a primary lesion originating in a small bronchus extends by contiguity to a larger bronchus feeding it. In that event, the bronchus primarily involved will not be shown on the bronchogram since the “feeding bronchus” is obstructed. The latter, though obstructed, will not exhibit features of malignant bronchial obstruction due to an intrinsic lesion, since the obstructing force applied from without will be spread over a long segment. This was true in one of our cases. Other exceptions are undoubtedly present.

Sensitivity of Diagnostic Methods

Confronted with a suspicious respiratory history, or with a conventional chest roentgenogram possibly suggesting bronchogenic carcinoma, most clinicians advise an intensive workup. By this is generally meant:

1. A thorough roentgenologic study including various positions and techniques, such as oblique, lateral, lordotic and stereoscopic views, roentgenoscopy and laminography. These maneuvers are well known to the clinician and radiologist and need not be discussed further. Ochsner and coworkers, however, consider careful radiography only presumptive, and Overholt and Schmidt state that the time interval usually employed for serial roentgenograms and different diagnostic maneuvers has produced a low yield of localized pulmonary cancer.

2. The diagnostic triad—this includes the Papanicolaou staining of the sputum, bronchoscopy with its attendant bronchial biopsy, Papanicolaou staining of its secretions, and finally, biopsy of scalene nodes, pleura and peripheral lesions. Individually and collectively, members of this triad are valuable in the diagnosis of bronchogenic carcinoma. Of the three, Papanicolaou staining of the sputum is the most sensitive, but is limited in its scope by unavailability of experienced teams necessary to carry it out, except at medical centers where the diagnostic rate is high. Umiker reports 63 per cent positive findings in a series of 100, but Theodoulou (Table 1) reports only 28 per cent, and our rate is only 11 per cent.

Bronchoscopy with its associated biopsy and Papanicolaou staining of the bronchial secretions is considered as a single examination. It is limited in its sensitivity by the inability of the bronchoscope to explore beyond the larger bronchi. Its field of exploration, however, is enlarged by its ability to obtain bronchial secretions for examination by the Papanicolaou method. As will be

Table 1—Comparative Sensitivity of the Diagnostic Triad and Bronchoscopy

<table>
<thead>
<tr>
<th>Author</th>
<th>Cases Reported</th>
<th>Sputum Papanicolaou Staining</th>
<th>Bronchoscopy</th>
<th>Diagnostic Triad Combined</th>
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<td>Per Cent Positive Unselected Cases</td>
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<td>1. Umiker</td>
<td>100</td>
<td>63</td>
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<td>2. Umiker</td>
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<td>3. Meyer and Umiker</td>
<td>205</td>
<td>50</td>
<td>35</td>
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<td>4. Theodoulou</td>
<td>65</td>
<td>28</td>
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<td>5. Campagna and Greenberg</td>
<td>32</td>
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<td>6. Ochsner et al.</td>
<td>875</td>
<td>11</td>
<td>26</td>
<td>38</td>
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<td>7. Nissenbaum</td>
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seen from Table 1, its sensitivity rate is less than the Papanicolaou staining of the sputum.

The scalene node biopsy is least sensitive of the triad as reported by authors listed in Table 1 and varies from 10 to 22 per cent. It is also the least useful in that a positive biopsy is considered by most a sign of inoperability and of hopeless prognosis. As Ravdin and Garrot put it, "Rings down the curtain on any curative attempt." Comparison of the bronchogram with members of the triad individually and collectively is made in Table 1.

**DISCUSSION**

The patient with bronchogenic carcinoma can ill afford to lose time in establishing an unassailable diagnosis. Klassen, in an editorial, exhorts for prompt and accurate diagnosis, and then bemoans the fact that the resectability rate has not changed in 26 years. If by "accurate" is meant "pathologic," it bespeaks of a rigidity which contributes to that lack of change. Rosahn, in another editorial, maintains that the pathologist resolves the problem of diagnosis according to his individual philosophy. The pathologic approach has its limitations and the pathologist is not infallible, nor does he claim to be. The fact is, the welfare of the patient demands establishment of a reasonable diagnosis, one that leads to prompt intervention in eradicating the disease, not necessarily an accurate or academic one, much though it be desired. Bronchographic demonstration of malignant bronchial obstruction is adequate diagnosis of bronchogenic carcinoma and sufficient reason for undertaking definitive therapy where feasible.

Nor is it desirable to pursue a course of watchful waiting. Conservative therapy is counselled far too often for atypical pneumonitis, and lung cancer only is considered if the latter fails to resolve after a few weeks of treatment. Nothing is proved if an atypical pneumonitis does clear up. Pneumonitis secondary to a partially obstructing lesion often does clear up, and if so, this only lengthens the period of uncertainty. Following the course of a suspicious lesion and adopting a policy of watchful waiting may only end in having our worst fears confirmed when a bronchogram could have proved or excluded our suspicions from the very beginning. Bronchial obstruction can be shown even when the lung appears to be fully aerated.

**SUMMARY AND CONCLUSIONS**

Bronchography is an underestimated and neglected tool in the diagnosis of diseases of the chest. In reviewing five leading American journals for the years 1960 and 1961, and well accepted textbooks on radiology and cancer, it is mentioned only incidentally and never as an accepted major approach in establishing a diagnosis. In the presence of clinical evidence and chest roentgenograms suggestive of bronchogenic carcinoma, reliance is almost wholly placed on Papanicolaou staining of the sputum, bronchoscopy, and biopsy of peripheral lesions, together referred to as the "diagnostic triad." Bronchography remains relatively non-utilized. My experience with 147 bronchograms in which the modality was used designedly in an attempt to explain underlying chest pathology, indicates that:

1. The bronchogram is a valuable tool in diagnosis of diseases of the chest, other than bronchogenic carcinoma.

2. It is more informative than any other single diagnostic approach and more sensitive as a diagnostic agent than all the methods constituting the "diagnostic triad" combined.

3. The bronchographic findings in bronchogenic carcinoma consist of malignant bronchial obstruction.

4. Such obstruction has definite roentgen characteristics which identify it as malignant and these have been described.

5. The bronchogram is reliable in excluding bronchogenic carcinoma when the conventional chest roentgenogram simulates it and conversely, establishing its diagnosis when it simulates another disease.
6. And lastly, the bronchogram saves time in establishing or excluding the diagnosis.

**RESUMEN**

La broncografía es un procedimiento subestimado y muy descuidado como un medio de diagnóstico en las enfermedades del tórax. Haciendo una inspección de las revistas de los años de 1960 y 1961, así como de los libros de texto de radiología y cáncer, sólo se encuentran menciónes incidentales y nunca como un procedimiento de importancia mayor al establecer el diagnóstico. En presencia de roentgenogramas sospechosos de carcinoma broncogénico y con evidencia clínica, se confía más a menudo en el Papanicolaou de esputos, broncoscopia y biopsia de lesiones periféricas, todo esto llamado la "tríada del diagnóstico." La broncografía permanece relativamente inutilizada. Mi experiencia con 147 broncogramas en los que la modalidad fue usada con el plan de explicar la patología subyacente del tórax me indica que:

1. El broncograma es un valioso procedimiento para el diagnóstico de las enfermedades del tórax, además del carcinoma broncogénico.

2. Es más valioso como información que cualquiera otro procedimiento solo y más fino como medio de diagnóstico que todos los métodos llamados la "tríada diagnóstica" combinados.

3. Los hallazgos broncográficos en el carcinoma broncogénico consisten en la obstrucción maligna bronquial.

4. Tal obstrucción tiene definidas características roentgenológicas que hacen que se identifique la malignidad y esas características se describen.

5. El broncograma es de fiar para excluir el carcinoma broncogénico cuando las radiografías habituales lo simulen y, por el contrario, para establecer el diagnóstico del carcinoma cuando éste simula otra enfermedad.

6. Por último, el broncograma ahora tiempo para establecer o excluir el diagnóstico.

**RESUMÉ**

La bronchographie est un moyen sous-estimé et négligé du diagnostic des affections thoraciques. En passant en revue cinq journaux américains importants, pour les années 1960 et 1961, et des traités classiques sur la radiologie et le cancer, l'auteur ne l'a trouvée mentionnée qu'accessoirement et jamais comme un important moyen permettant d'établir le diagnostic. En présence de preuve clinique et de radiographies thoraciques suspects de cancer bronchique, on se fie presque entièrement sur l'examen d'expectoration par la méthode de Papanicolaou, la bronchoscopie et la biopsie des lesions périphériques que l'on réunit comme étant "le trépied diagnostique." La bronchographie reste relativement peu utilisée. L'expérience des 147 bronchographies de l'auteur, qui furent mises en œuvre systématiquement comme une tentative d'expliquer la pathologie thoracique sous-jacente, montre que:

1. la bronchographie est un instrument de valeur dans le diagnostic des affections thoraciques, autres que le cancer bronchique;

2. elle donne plus d'informations que toute autre tentative simple de diagnostic, et est plus sensible comme instrument diagnostique que toutes les méthodes constituant le "trépied diagnostique."

3. les constatations bronchographiques du cancer bronchique consistent en une obstruction bronchique de nature maligne;

4. une telle obstruction a des caractéristiques radiologiques précises, qui l'identifient comme maligne et qui ont été décrites.

5. on peut se fier à la bronchographie pour exclure le cancer bronchique lorsque la radiographie thoracique standard le simule et vice-versa, elle permet d'établir le diagnostic lorsqu'un autre est simulé;

6. enfin, la bronchographie gagne du temps en établissant ou en excluant le diagnostic.

**ZUSAMMENFASSUNG**

Die Bronchographie ist ein unterschätztes und vernachlässigtes Instrument bei der Diagnostik von Thoraxerkrankungen. Bei einer Durchsicht 5 führender medizinischer Zeitschriften der Vereinigten Staaten der Jahre 1960 und 1961 sowie allgemein anerkannter Lehrbücher über Radiologie und über Krebs fand sie sich nur gelegentlich erwähnt und niemals als ein allgemein anerkannter und wesentlicher Weg zur Ermittlung einer Diagnose. Beim Vorliegen klinischer Anhaltspunkte und verdächtige Thoraxröntgenbilder im Zusammenhang mit einem bronchogenen Carcinom vertraut man meist ganz auf die Sputumuntersuchung nach Papanicolaou, die Bronchoskopie und die Biopsie peripher gelungener Läsionen, was man alles zusammengenommen als eine "diagnostische Trias" benennt. Die Bronchographie bleibt wenig genutzt. Meine Erfahrungen an 147 Bronchogrammen, bei denen dieses Verfahren bewußt zur Anwendung gelangte, um die zugrundeliegen pathologischen Thoraxveränderungen möglichst aufzuklären, ergaben Folgendes:

1. Das Bronchogramm ist ein wertvolles Instrument in der Diagnostik von Thoraxerkrankungen, auch wenn es sich nicht um bronchogene Carcinome handelt.

2. Das Bronchogramm gibt mehr Aufschlüsse als irgend eine andere diagnostische Methode für sich allein genommen und ist empfindlicher.
as diagnostisches Verfahren als alle die Methoden, die die "diagnostische tria" bilden, zusammengenommen.  
3. Die bronchographischen Befunde beim bronchogenen Carcinom bestehen in malignen bronchialen Obstruktionen.  
4. Eine solche Obstruktion hat ganz bestimmte röntgenologische Merkmale, die sie als bösartig identifizieren lassen. Eine Beschreibung darüber wird gegeben.  
5. Das Bronchogramm ist zuverlässig zum Ausschluß eines bronchogenen Carcinoms, wenn die üblichen Thoraxröntgenaufnahmen es vermuten lassen, und umgekehrt vermag es die Diagnose sicherzustellen, wenn eine andere Erkrankung vermutet wird.  
6. Schliesslich kann man bei Anwendung der Bronchographie Zeit gewinnen, um eine Diagnose zu stellen oder auszuschließen.

References

STUDY OF 22 CASES WITH TISSUE DIAGNOSIS OF TUBERCULOSIS OF THE LIVER

The authors found that tuberculous involvement of the liver is not too infrequent in patients with miliary tuberculosis and tuberculous enteritis and peritonitis. Diagnosis was made by needle puncture biopsy, the method the authors prefer to laparoscopy. A detailed report on the clinical, etiological

DECORTICATION, LATE FUNCTIONAL RESULTS

The authors review the records of 645 patients who had decortications performed between 1952 and 1962. Ninety per cent of the cases had pulmonary tuberculosis. In more than 200 cases, functional studies were performed before and after surgery. Good results were obtained in approximately 70 per cent of the patients. The authors conclude that the condition of the underlying pulmonary parenchyma is of major importance both as an indication for the operation and as a determining factor in the results.