Radiology in Lung Cancer: Problems and Prospects

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As bronchogenic carcinoma continues to be the most insidious of all neoplasms and the most common cancer in males, it is time to reappraise the role of radiology in diagnosis, staging and follow-up. When lung cancer reaches the threshold of visibility on a chest radiograph, 60 to 80 percent of its life span is completed; it will kill the host in over 90 percent of cases. Quite obviously, the conventional chest radiograph has failed as an acceptable screening method in detecting curable lung cancer. Although not often appreciated, radiographic signs of bronchogenic tumors are many, varied and nonspecific. This article summarizes the presenting radiographic features of the various histologic types of primary bronchogenic carcinoma and demonstrates how radiographic methods can be applied to pretreatment evaluation and follow-up.

Most bronchogenic tumors are beyond the scope of surgical cure on presentation. In a series of 1,000 cases, the disease had extended to the hilar nodes in 54 percent and the mediastinal lymphatics in an additional 35 percent.

Parietal pleural involvement was found in 15 percent and direct chest wall invasion occurred in six percent. In seven percent of the cases, major vessel involvement was noted. In probably 50 percent of “curative” resections, unrecognized distal metastases in the liver, bone, brain or elsewhere are present at the time of initial treatment.1

At present, approximately 50 percent of all patients with bronchogenic tumors undergo thoracotomy. Of this group, 15 will have a diagnostic thoracotomy only, five a palliative procedure, and the remaining 30 will be resected with some hope of long-term survival. Of the latter, only seven or eight will achieve long-term control. Surgical mortality will claim approximately three of the original group of 50.1

To change this dismal outlook for patients with lung cancer, an improved technique of screening and detection is an obvious priority for the future.2 Within our present capabilities, however, existing methods, both clinical as well as radiologic and pathologic, can be applied in a systematic manner to better determine the extent of lung tumor prior to treatment.

In general, bronchial carcinomas occur more frequently in the right than the left lung with a six:four ratio. The most common sites of involvement of a primary bronchogenic carcinoma are the
Table 1.
Lung Cancer
Histologic and Radiographic Features

| Histology       | Approximate Frequency (Percent) | Parenchymal Abnormality                  | Hilar Involvement | Intrapulmonary Involvement | Comments                                                                 |
|-----------------|---------------------------------|------------------------------------------|------------------|---------------------------|--------------------------------------------------------------------------|
| Epidermoid      | 35-60                           | Central large or small ill-defined mass  | Common           | Pleural effusion          | • Grows by direct invasion                                                |
|                 |                                 |                                          |                  |                           | • Cavitation                                                             |
|                 |                                 |                                          |                  |                           | • Obstructive pneumonia and collapse                                     |
|                 |                                 |                                          |                  |                           | • Late metastases                                                        |
| Small cell anaplastic | 35                           | Hilar mass                               | Typical          | Mediastinal widening      | • Grows by submucosal lymphatic extension                                 |
|                 |                                 |                                          |                  |                           | • Early metastases                                                       |
|                 |                                 |                                          |                  |                           | • Obstructive pneumonia and collapse                                     |
| Adenocarcinoma  | 15-20                           | Peripheral small or large ill-defined mass | Uncommon         | Uncommon                  | • Early hematogenous metastases                                          |
|                 |                                 |                                          |                  |                           | • Rare cavitation                                                        |
|                 |                                 |                                          |                  |                           | • Scar carcinoma                                                         |
| Large cell anaplastic | 5-15                           | Peripheral large ill-defined mass        | Common           | Occasional mediastinal mass | • Very rapid growth                                                      |
|                 |                                 |                                          |                  |                           | • Early lymphatic and hematogenous metastases                            |
|                 |                                 |                                          |                  |                           | • Infrequent cavitation                                                  |
| Bronchial adenoma | 5-10                           | Central, sharply margined mass           | Rare             | Uncommon                  | • Low-grade malignancy                                                   |
|                 |                                 |                                          |                  |                           | • Infrequent metastases                                                  |
|                 |                                 |                                          |                  |                           | • Bronchial obstruction                                                  |
|                 |                                 |                                          |                  |                           | • Hemoptysis                                                             |

upper lobes; the middle lobe is involved least often. Interestingly, tumors of the upper lobes have a curious predilection for the anterior segment. Bronchogenic carcinoma originates in the major, rather than peripheral, bronchi in 75 percent of cases. These lesions tend to extend along the submucosal surface of bronchi, destroying cartilage and, probably in this way, reaching the peripheral pleural, diaphragmatic and mediastinal surfaces.

Histologic Classification —Radiographic Patterns
Rigler described and classically demonstrated the common radiographic features of bronchogenic tumors. Unfortunately, none is pathognomonic, and virtually any X-ray finding may be associated with a primary lung tumor. For this reason as well as the reality that lung cancers visible on X-ray are usually far advanced, the chest radiograph has lost its role as a screening procedure in all but the high-risk patient.

In practice, the radiologist and clinician are often faced with an abnormal chest radiograph consistent with a primary lung cancer in a patient with nonspecific complaints. It is, therefore, essential to understand the common hist-
Epidermoid Carcinoma

The largest group, epidermoid carcinoma, comprises some 35 to 60 percent of all lung cancers. They vary histologically from highly differentiated tumors with epithelial pearls and abundant keratin to less well-differentiated lesions with few pearls, little keratin or only questionable intracellular bridges.

The hallmarks of this lesion are its central origin, late metastases and intraluminal submucosal growth, gradually occluding the bronchus of origin. Central cavitation may occur within either the primary or metastatic pulmonary deposit of epidermoid composition, usually subsequent to central necrosis. Of all cell types, epidermoid cancers are the most common to undergo cavitation.

The radiographic features of primary epidermoid cancer can easily be predicted by understanding its pathologic expression. Some 60 to 75 percent are central in origin. Loss of lung volume (37 percent of 263 patients) or obstructive pneumonitis (20 percent of 263 patients) is the most frequent presenting abnormality. Only 24 percent of the 263 epidermoid cancers reported by Byrd had a peripheral mass as the only radiographic abnormality. In a smaller series by Bateson, the indistinct margins of these central epidermoid lesions further camouflaged their pres-
Squamous Carcinoma. This 52-year-old male heavy smoker, with productive cough and fever, had a normal chest radiograph one year previously. A. PA and lateral views reveal a right hilar mass with basilar segment, right lower lobe pneumonia. B. PA and lateral views four days later show confluent pneumonia. C. By July 7, 1971, PA and lateral views demonstrate collapse-consolidation as indicated by posterior displacement of the major fissure and uniform density of the lower lobe. Squamous carcinoma arising in the lower lobe bronchus was diagnosed by bronchoscopic biopsy.

Small Cell Undifferentiated Carcinoma (Oat Cell)

These anaplastic tumors, constituting approximately 35 percent of all bronchial carcinomas, are composed of small, round or oat-shaped cells which often resemble lymphocytes. Probably related to bronchial carcinoids (derived from Kulchitsky-type cells), they contain cytoplasmic neurosecretory granules and can cause endocrine disorders.

Small cell undifferentiated carcinoma arising in any region involves the hilar and mediastinal lymph nodes early in the disease; hematogenous dissemination is frequently widespread at the time of diagnosis. The most common radiographic abnormality is a hilar or perihilar mass. This finding was noted in 87 of 114 patients (76 percent); in 34 of these 87 patients (39 percent), evidence of associated bronchial obstruction with loss of volume, consolidation or obstructive pneumonitis was found. (Fig. 3.)
Adenocarcinoma

Adenocarcinomas, accounting for approximately 15-20 percent of lung cancers, are well differentiated and composed of cuboidal or columnar epithelial cells with fairly uniform, round nuclei arranged in distinct acinar or glandular patterns. Less well-differentiated tumors lack these features but show distinct evidence of acinar formation. Typically, these lesions arise in the periphery of the lung, show early hematogenous dissemination with late lymphatic spread. They can attain a large size without undergoing central necrosis, as cavitation is rarely reported.  

Lehar substantiated the clinical impression that most bronchogenic adenocarcinomas radiographically present as peripheral lung masses. 10 (Fig. 4.) Of 126 patients with adenocarcinoma who underwent surgical exploration for possible curative resection, 75 percent had a peripheral mass alone or in combination with other lesions; 43 were located in the upper lobes, 29 in the middle and lower lobes. Interestingly, 49 of the single mass lesions were four cm. or less in diameter and only 19 had well-defined margins. Thirty of the 49 single lesions had ill-defined, spreading or infiltrative margins, 7 which Heitzman has termed "corona radiata." He demonstrated in pathologic sections that desmoplastic contractions around a tumor nodule produce a radiolucent halo of paracicatricial emphysema. Linear striations crossing the radiolucent zone are composed of reoriented connective tissue septa gathered to the nodule as it contracts. 11

Bronchiolar carcinoma, a variant of adenocarcinoma, 12 is relatively infrequent, comprising approximately two to five percent of all bronchial carcinomas. 13 While problems may arise in the histologic identification of bronchiolar carcinoma, these tumors are usually composed of tall columnar epithelial cells which line the alveolar walls. The cells produce mucus, which is sometimes associated with the production of copious, watery mucoid sputum. Pathologically and radiographically the tumor
Fig. 4. Adenocarcinoma. Middle-aged, asymptomatic man.
A. PA chest radiograph shows poorly defined left upper lobe solitary nodule.
B. Linear tomograph reveals "corona radiata" around the nodule margins and eccentric calcification, typical of carcinoma which has engulfed a granuloma.

occurs in two different forms—local and diffuse. The localized form consists of either the more common solitary nodule or a small poorly defined parenchymal infiltrate. The diffuse form occurs as lobar or segmental air space disease.
Fig. 5 Bronchioloalveolar Carcinoma. A. Healthy middle-aged woman with focal air-space right lower lobe infiltrate on routine PA chest radiograph. B. PA film five months later shows RLL confluent infiltrate. C. Whole lung tomography reveals air bronchogram of all basilar segments. The patient underwent uneventful right lower lobectomy confirming the diagnosis of bronchioloalveolar carcinoma. D. Follow-up radiograph in 1973 taken because of progressive respiratory failure shows bilateral air space infiltrate, confirmed at autopsy as tumor.
I Fig. 6. Large Cell Undifferentiated Carcinoma. This middle-aged male smoker presented with weight loss, fatigue and cough.
A. PA chest radiograph shows large poorly defined right upper lobe mass with hilar enlargement. Biopsy proved large cell undifferentiated carcinoma.

Multiple nodules or multiple poorly defined patchy densities.\(^1\)\(^-\)\(^3\) (Fig. 5.) Bronchiolar carcinoma has an increased incidence in patients with interstitial fibrotic processes,\(^4\) including scleroderma.\(^5\) The tumor may also produce cicatrization appearing as a sunburst or "corona radiata."\(^6\) A patient with diffuse disease has an extremely dismal outlook, while a patient with localized nodular disease has a remarkably favorable prognosis.\(^7\)

Large Cell Undifferentiated Carcinoma
Lacking uniformity in criteria for histologic diagnosis, the incidence of large cell undifferentiated tumors is unknown but estimated at between 4.5 and 15 percent.\(^8\)\(^-\)\(^10\) The representative cells are anaplastic with abundant cytoplasm and no evidence of maturation or differentiation, and are arranged in clusters, nests, strands or isolated patterns. These tumors often develop in the peripheral lung and frequently give rise to early widespread metastases, resulting in a poor prognosis.\(^9\)

The most common radiographic finding is a rapidly growing, large peripheral mass. (Fig. 6.) Over 60 percent of 97 patients had a peripheral mass alone or in combination with other abnormalities, and in 65 percent of 59 patients, it was the sole lesion described. Approximately 70 percent of 39 single peripheral masses were larger than four cm. in diameter and most had ill-defined borders. Cavitation is infrequent, but when seen is usually thick-walled and eccentric without air fluid levels.\(^7\)

Bronchial Adenoma
These uncommon, low-grade neoplasms are of two distinct pathologic types. Carcinoids, which histologically resemble carcinoid intestinal tumors, are highly vascular and account for 85 to 95 percent of bronchial adenomas. Salivary gland types comprise the remainder and primarily include cylindromas and mucoepidermoid adenomas which are more invasive than carcinoids and metastasize more frequently.\(^10\)

Approximately 80 percent of adenomas arise from the submucosa of major bronchi and are well circumscribed. Hilar mass, alone or in combination with a peripheral infiltrate or atelectasis, is the most common radiographic presen-
A. PA chest radiograph shows a right apical mass lesion with pleural thickening.
a. Upright linear tomography confirms destruction of first and second ribs. Needle biopsy revealed squamous cell carcinoma.

tation. However, in most instances, the radiographic features are nonspecific and indistinguishable from other types of carcinoma.26

Pancoast Tumor
Pancoast described an apical pulmonary tumor which invaded the pleura, chest wall and soft tissues including the brachial plexus and sympathetic nerves causing severe shoulder pain, Horner's syndrome and upper extremity muscular atrophy.21,22 Any histologic type may arise in the upper lobe apex to produce this syndrome,23 but squamous cell carcinoma predominates.16,24 The radiographic appearance of a superior sulcus tumor depends on its size and the presence of bone destruction. These lesions are often missed until late in the disease, as they tend to produce subtle radiographic abnormalities. (Fig. 7.)

Staging
After establishing the histologic diagnosis of bronchial carcinoma, the extent of disease must be assessed in order to assign a therapeutic regimen, evaluate response and establish prognosis.
Bronchial carcinoma may be classified by cell type, anatomic location, regional and distant spread and the patient’s clinical status. The most recent and complete classification is the TNM System (American Joint Committee for Cancer Staging and End Results Reporting) which is expected to receive multidisciplinary acceptance in the management of bronchial carcinoma.

In this system, T designates the primary tumor, N the regional lymph nodes and M distant metastases. Each case must be assigned to the highest category of T, N and M which describes the full extent of disease. Conceptually, three phases of assessment are necessary to properly stage lung cancer: (1) prethoracotomy or clinical; (2) surgical, as derived from thoracotomy and biopsy data; and (3) postsurgical (pathologic), following thoracotomy and including the entire resected specimen. (Table 2.) Once a tumor has been assigned TNM designations, it can then be staged as occult or invasive: Stage I, II or III. (Table 3.) The exception is undifferentiated small cell carcinoma which carries a dismal prognosis and is not meaningfully classified by the TNM System. The oat cell tumor is frequently systemic at the time of discovery, and has a 40-50 percent incidence of bone marrow invasion on initial detection by routine marrow aspiration.

Radiologic Role in Staging

Tumor Assessment

Recently Watson predicted the end of wasteful, expensive and unproductive radiographic screening programs for people over 40 years of age. The National Cancer Institute is currently sponsoring the “Early Lung Cancer Cooperative Group” to determine whether the death rate from bronchogenic carcinoma can be significantly reduced by vigorous application of modern techniques for detecting and localizing the disease in high-risk individuals. Their belief is that radiographic screening techniques deserve further trial. Of 33 lung cancer cases detected to date, 24 had abnormal chest radiographs. The remaining nine had positive sputum cytology tests and were radiographically occult; all nine were of the squamous cell type.

The fiberoptic bronchoscope has spurred progress in early diagnosis of lung cancer, permitting instrumentation and visualization of subsegmental and central bronchi, especially in the upper lobes. Unfortunately, even with the fiberscope, current techniques for localizing radiographically occult bronchogenic carcinoma are arduous, complex and cumbersome, requiring carefully planned sequential endobronchial inspection, biopsy and brushing.

Radiographically occult lesions are usually in situ or minimally invasive squamous cell carcinomas. Thus, stereoscopic chest radiographs, whole lung tomography and meticulous bronchography repeated at short intervals cannot be expected to accurately pinpoint small, potentially curable cancers without adjunctive fiberoscopy. Occult tumor localization remains a singularly challenging problem.

It must be emphasized that not all diagnostic examinations or procedures are indicated or necessary in evaluating patients with bronchogenic carcinoma. Ideally, the radiologic work-up should proceed in a logical fashion in step with other clinical and laboratory data. Tissue retrieval for definitive diagnosis and staging are given priority, from sputum cytology examination to bronchoscopy and/or brush-forceps-needle biopsy, mediastinoscopy and thoracotomy. The most important information is that which points to carcinoma with sufficient credence to justify further study; selection of procedures should be based on the likelihood that forthcoming data will influence patient management.

High quality standard chest radiography usually includes erect PA and left lateral or PA stereo views using 72 inch...
Table 2.  
TNM Classification of Lung Cancer

|   | Description                                                                                       |
|---|--------------------------------------------------------------------------------------------------|
| T | Primary Tumor                                                                                     |
| T0 | No evidence of primary tumor.                                                                     |
| TX | Tumor proven by the presence of malignant cells in bronchopulmonary secretions, but not visualized roentgenographically or bronchoscopically. |
| T1 | A tumor that is 3.0 cm. or less in greatest diameter, surrounded by lung or visceral pleura and without evidence of invasion proximal to a lobar bronchus at bronchoscopy. |
| T2 | A tumor more than 3.0 cm. in greatest diameter or a tumor of any size which, with its associated atelectasis or obstructive pneumonitis, extends to the hilar region. At bronchoscopy, the proximal extent of demonstrable tumor must be at least 2.0 cm. distal to the carina. Any associated atelectasis or obstructive pneumonitis must involve less than an entire lung, and there must be no pleural effusion. |
| T3 | A tumor of any size with direct extension into an adjacent structure such as chest wall, diaphragm or mediastinum and its contents; a tumor shown at bronchoscopy to be less than 2.0 cm. distal to the carina; any tumor associated with atelectasis or obstructive pneumonitis of an entire lung or pleural effusion. |
| N | Regional Lymph Nodes                                                                             |
| N0 | No demonstrable metastasis to regional lymph nodes.                                               |
| N1 | Metastasis to lymph nodes in the ipsilateral hilar region (including direct extension).           |
| N2 | Metastasis to lymph nodes in the mediastinum.                                                     |
| M | Distant Metastasis                                                                                |
| M0 | No distant metastasis.                                                                           |
| M1 | Distant metastasis, such as scalene, cervical or contralateral hilar lymph nodes, brain, bones, lung, liver, etc. |

It is very important to obtain previous chest radiographic studies, a responsibility shared by the radiologist and the attending physician. A frequently neglected and underestimated contribution to evaluation of bronchial carcinoma, previous chest radiographs should be evaluated. It is very important to obtain previous chest radiographic studies, a responsibility shared by the radiologist and the attending physician. A frequently neglected and underestimated contribution to evaluation of bronchial carcinoma, previous chest radiographs should be evaluated.
Table 3.
Stage-Grouping in Carcinoma of the Lung

| Occult Carcinoma |
|------------------|
| TX, NO, MO       |
| An occult carcinoma with bronchopulmonary secretions containing malignant cells but without other evidence of primary disease or regional or distant lymph node metastasis. |

| Invasive Carcinoma |
|-------------------|
| Stage I           |
| T1, N0, M0        |
| A tumor without distant metastasis or with spread to the lymph nodes in the ipsilateral hilar region only is classified T1. A tumor without any spread to nodes or distant metastasis is classified T2. |
| Note: TX, N1, M0 and T0, N1, M0 are also theoretically possible, but such a clinical diagnosis would be difficult if not impossible to make. If such a diagnosis is made, it should be included in Stage I. |
| T1, N1, M0        |
| T2, N0, M0        |
| Stage II          |
| T2, N1, M0        |
| A tumor with spread to the lymph nodes in the ipsilateral hilar region only is classified as T2. |
| Stage III         |
| T3 with any N or M |
| N2 with any T or M |
| M1 with any T or N |
| These stage groupings include a tumor more extensive than T2 or any tumor with spread to the lymph nodes in the mediastinum or with distant metastasis. |

zealously sought from all available sources, so that the natural history of a lesion can be placed in perspective. Stability of a solitary pulmonary nodule for two years almost always indicates benignancy.

30 Other investigators have emphasized that tumor growth rate is an important prognostic factor in patients with bronchial cancer.31,32 Previous chest films are usually the least expensive component in a diagnostic evaluation, are uniquely noninvasive and may bring further work-up to an abrupt halt.

Chest fluoroscopy aids the radiologist in localizing pulmonary lesions, obtaining a problem-related history and planning further radiographic work-up. Well-collimated spot films may obviate tomography and also allow optimum positioning for subsequent overhead oblique views.

Despite presently available multidirectional tomographic capabilities, linear tomography appears best suited for pulmonary lesions and may help assess size, calcification, margination and cavitation in parenchymal tumors. Calcification in a central nidus, laminar or conglomerate configuration in a pulmonary nodule indicates a benign tumor (tuberculosis, histoplasmosis and hamartoma, respectively).30 Eccentric calcification suggests the carcinomatous engulfment of an inflammatory lesion, usually an adenocarcinoma. Tomography with the patient in an upright
position, rather than supine, permits recognition of air fluid levels, reduces magnification, and also obviates anatomic rearrangements and venous distention found with recumbency.

Bronchography is performed less frequently today than in the past, primarily because bronchographic abnormalities constitute indirect evidence of pulmonary diseases. Powdered tantalum and barium sulfate suspensions have been proposed for bronchography, but Dionosil Oily is most frequently used in clinical practice. Bronchial obstruction, by far the most common and reliable indication of carcinoma, is nonspecific. Other signs include indentation, displacement and localized narrowing of bronchi. Widening of the bronchial lumen by a slowly growing tumor which then stretches the bronchial wall has been found to be pathognomonic for bronchial adenoma. Radiologists have now pioneered fluoroscopically assisted studies to obtain a tissue or cytologic diagnosis from radiographically suspicious lesions, when carefully performed sputum cytology and bronchoscopic studies are unrewarding or in clinically inoperable patients. Transcatheter brush and forceps biopsies of central and peripheral lesions under fluoroscopic control, introduced via the nose, mouth and percutaneous transtracheal approaches, are relatively simple and safe procedures which have gained widespread acceptance.

(Fig. 8.) Bronchial brushing, aspiration and forceps biopsies can now be performed through the fiberoptic bronchoscope with fluoroscopic assistance. The diagnostic accuracy of these procedures can be as high as 85 percent. A "negative" result requires further evaluation and study.

Fig. 8. Aspiration and Biopsy Needles
A. (a) Nine cm. 20 gauge disposable aspiration needle (Abbott Laboratories)
   (b) Nine cm. 18 gauge disposable aspiration needle (Abbott Laboratories)
   (c) Franklin-Silverman biopsy needle
   (d) Disposable biopsy needle (Travenol Laboratories)
B. Magnified view, showing detail

Percutaneous transthoracic needle
aspiration biopsy of small, peripherally situated lung lesions has the highest diagnostic yield, short of thoracotomy, and is frequently the procedure of choice.\textsuperscript{40,44-47} Using the techniques and instrumentation described by Dahlgren and Nordenstrom,\textsuperscript{46} a small gauge (18-21) needle is introduced into the lesion using fluoroscopic guidance, and cells are aspirated for cytologic and microbiologic examination. A small pneumothorax is not infrequently encountered, but it usually resolves spontaneously. A variety of larger gauge cutting needles has been devised to yield larger tissue specimens, but they are associated with a higher incidence of complication.\textsuperscript{46} Biopsy techniques generally have gained wide acceptance in detecting malignant and benign lung lesions, frequently sparing the patient costly, uncomfortable and more serious diagnostic procedures.

**Lymph Node Assessment**

A careful and painstaking search for subtle radiographic alterations in the hila and mediastinum is vital in detecting abnormalities, which could indicate involvement by bronchogenic carcinoma. Although subject to individual variations, the major mediastinal structures have highly constant relations to one another, and precise delineation by plain radiography is frequently possible.\textsuperscript{48-51} Quality high kV PA and lateral chest radiographs can be easily supplemented with the following studies.

- **Comparison of previous films.** While the diagnosis of hilar and mediastinal adenopathy can be based on small departures from normal (e.g., azygous or ductus lymph node enlargement\textsuperscript{49,50}), changes occurring between initial and follow-up radiographs are particularly significant.\textsuperscript{50}
- **A well-penetrated erect PA film with mediastinal technique.** This is mandatory to evaluate mediastinal contours, particularly the distal trachea, carinal and subcarinal areas (azygoesophageal recess\textsuperscript{49}) where lymph node involvement may otherwise escape detection.
- **Shallow right and left anterior obliques (10 to 20 degrees rotation maximum).** These studies also allow inspection of hila, which are seen end face and separated from adjacent cardiomedial structural. The mainstem bronchi and carina are well visualized in shallow oblique views.
- **Fluoroscopy.** Not routinely helpful, but it may: (1) establish the response of structures to changes in intrathoracic pressure, e.g., the azygous vein enlarges with recumbency and the Mueller maneuver, but is smaller with Valsalva maneuver and can be differentiated from azygous node enlargement; (2) show that mediastinal lesions move independently of lung or diaphragm; and (3) establish pliability, excursion and direction of diaphragmatic motion with suspected phrenic nerve involvement.
- **Contrast esophagram.** Along with barium in PA, lateral and both oblique views, contrast esophagram should always be performed in the evaluation of possible mediastinal involvement by tumor.\textsuperscript{51} Distortion and fixation of the esophagus by posterior-inferior tracheobronchial (posterior carinal) nodes is often accepted as a sign of nonresectability.\textsuperscript{3}
- **Tomography.** Ideally performed in the upright position with linear tube motion, this procedure permits detailed inspection of mediastinal contours and the carina in the AP position. The hila should be evaluated in lateral or, preferably, in the oblique projection\textsuperscript{52} to detect lymph node enlargement and central pulmonary arterial anatomy.
- **Iodinated contrast studies of the mediastinal vascular structures.** Azygography,\textsuperscript{53-55} venacavography,\textsuperscript{51,56} angiography,\textsuperscript{57} aortography,\textsuperscript{51}
and pulmonary arteriography may be useful in assessing the resectability of a bronchial cancer. However, absolute angiographic criteria for inoperability have not been defined. In addition, false negatives may occur, for example, when an unresectable tumor in the mediastinum escapes detection.

■ Mediastinoscopy. This technique has become widely used as a diagnostic and staging procedure for retrieving tissue from the anterior mediastinum. Careful attention to detail coupled with a high index of suspicion in evaluating chest radiographs can help to correctly predict resectability in a high percentage of lung cancer patients.

Evaluation for Metastatic Disease
At autopsy, lung tumors of all histologic types have been found to involve virtually all body systems, but particularly the brain, bones, liver, adrenals and opposite lung. As mentioned, small cell undifferentiated (oat cell) tumors have the highest incidence of dissemination at diagnosis, suggesting more intensive extrathoracic radiographic surveys prior to treatment. In other histologic types of primary lung cancer, the search for extrathoracic manifestations of disease should be directed by clinical symptoms and signs. Routine pretherapy metastatic bone surveys, radionuclide scans, and other radiographic studies have not proven efficacious in the detection of occult metastatic disease.

Conclusion
The role of radiology in lung cancer is focused primarily on tumor definition and follow-up, as well as detection in individuals at high risk. A greater understanding of the classification, staging, biology and treatment of lung cancer should result in the appropriate application of radiologic expertise in the management of these patients.

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