REVIEW ARTICLE

Pre-operative mediastinal evaluation in primary bronchial carcinoma—a review of staging investigations

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Introduction

The rational management of primary bronchial carcinoma presupposes accurate knowledge of the extent of spread of disease in individual patients. Thus, for example, the demonstration of distant organ metastases clearly precludes the curative potential of local treatment modalities, while the extent of loco-regional disease will determine surgical resectability. Careful clinical evaluation together with scrutiny of chest radiographs and bronchoscopic assessment of operability will exclude a majority of patients for whom surgery is inappropriate, but among the remaining 'presumably operable' patients will be a proportion in whom unsuspected occult metastases or locally advanced disease renders surgery unrewarding.

A variety of staging procedures are employed in order to assist in the process of identifying those patients most likely to benefit from surgery. However, opinions differ regarding the clinical utility of certain of these investigations and there is thus no standard approach to the preoperative staging of lung cancer.

This article concerns those staging investigations that have been suggested as being of greatest value in the assessment of mediastinal disease. It attempts by means of a critical review of the literature to evaluate the utility of these procedures in any preoperative screening programme for patients with non-small cell lung cancer.

Mediastinal staging: the controversial significance of mediastinal lymph node involvement

Controversy concerning the prognostic significance of mediastinal lymph node involvement underpins much of the disagreement regarding the routine application of screening investigations. Many author-

ities have considered mediastinal involvement at any level as a contra-indication to surgery, even when resection is technically possible. This view is based on evidence from many series of a 5-year post-operative survival of less than 10% in patients with metastasis to mediastinal nodes (Ashraf, Milsom and Walesby, 1980; Bergh and Scherstén, 1965; Delarue and Starr, 1967; Fosburg *et al.*, 1974; Gunn and Ross, 1960; Inberg *et al.*, 1972; Kirklin *et al.*, 1955; Sarin and Nohl-Oser, 1969; Shields *et al.*, 1975; Vincent *et al.*, 1976). Others report worthwhile long-term survival after resection, with or without adjuvant therapy, in the presence of mediastinal node involvement (Abbey Smith, 1978; Jackman *et al.*, 1969; Kirsh *et al.*, 1971; Martini *et al.*, 1980; Naruke *et al.*, 1978; Ramsey *et al.*, 1969). In many cases detailed information regarding the exact anatomical location of affected mediastinal nodes has not been provided. Thus, while it is accepted that involvement of bilateral or contralateral mediastinal nodes contra-indicates surgery, opinion remains divided concerning the correct management of stage III tumours [tumours involving the mediastinum either by direct invasion (T₃) or by spread to mediastinal lymph nodes (N₂)], associated with ipsilateral mediastinal disease.

There is a great need for prospective studies relating prognosis to the extent of mediastinal involvement based on accurate mapping of mediastinal nodes. Until the results of such studies become available it would appear that mediastinal staging procedures will continue to have greatest relevance for those who regard any mediastinal involvement as contra-indicating surgery, or where the value of surgery is accepted in only certain subgroups of patients that can be identified pre-operatively. Pearson (1980) and Pearson *et al.* (1982) have recently attempted to clarify this important issue in relation to the use of mediastinoscopy (*vide infra*).

Mediastinoscopy and mediastinotomy

After its introduction into clinical practice (Carlens, 1959), mediastinoscopy rapidly replaced other available methods of tissue biopsy (Daniels, 1949; Harken *et al.*, 1954; Radner, 1955) as a diagnostic and evaluative procedure in patients with intrathoracic disease. Its widespread application throughout the 'sixties established the low morbidity of the technique as well as its high diagnostic yield (Carlens and Hambreus, 1967; Jepson, 1966). Initial emphasis on this diagnostic potential led to the pioneering work of Nohl-Oser (1965) who, among others (Paulson and Urschel, 1971; Pearson, 1968), advocated the routine pre-operative use of mediastinoscopy and the adoption of this policy undoubtedly contributed to the high resectability rate reported in subsequent surgical series (Gunstensen and Wade, 1972; Inberg *et al.*, 1972; Paulson and Urschel, 1971; Pearson, 1968).

The reported frequency of positive findings in bronchial carcinoma varies depending upon the criteria used for selecting patients for mediastinoscopy. In a combined series of 4,953 patients with primary bronchial carcinoma, positive mediastinal biopsies were obtained in 39% of cases (Jepson and Rahbek, 1970). In more recent series, 28–48% of presumably operable patients have yielded positive mediastinal biopsies (Ashraf *et al.*, 1980; Fishman and Bronstein, 1975; Gibbons, 1972; Kirschner, 1971; Larsson, 1976; Otto, Zaslonska and Lukianski, 1972), this proportion representing 80–90% (sensitivity) of all patients found to have mediastinal disease at thoracotomy (Jepson and Rahbek, 1970; Larsson, 1976; Pearson, 1968; Pearson *et al.*, 1972). Positive findings, as denoted by the presence of pathologically identifiable tumour in mediastinal biopsies, provide a highly specific diagnosis and for practical purposes the specificity of mediastinoscopy can be assumed to be 100%. False negative examinations have usually resulted from lymph node involvement at sites which are inaccessible by conventional cervical mediastinoscopy such as subaortic and anterior mediastinal nodes (Jolly *et al.*, 1973; Pearson *et al.*, 1972). This accounts for the lower yield of positive biopsies in patients with left-sided tumours which tend to spread preferentially to these groups of nodes. For this reason Pearson *et al.* (1972) added modified anterior mediastinotomy in the assessment of left upper lobe and left hilar tumours when cervical mediastinoscopy yielded negative findings. Others have advocated the routine use of anterior mediastinotomy in preference to mediastinoscopy as providing better surgical exposure and therefore more accurate evaluation, especially of left-sided lesions (Bowen *et al.*, 1978; Steiger, Chaudhry and Wilson, 1981). However, its superiority has not been conclusively demonstrated. Recently, Jolly, Li and Anderson (1980) have empha-

sized the essentially complementary nature of the two methods of exploration.

While the use of mediastinoscopy for evaluative purposes will increase the resectability rate, its routine application will entail a high proportion of unrewarding examinations, various series reporting 70–75% of negative mediastinoscopies in these circumstances. Various criteria have therefore been suggested for the selection of patients for mediastinoscopy. Based on an analysis of their findings in 112 patients, Hutchinson and Mills (1976) demonstrated a high yield from mediastinoscopy with central tumours irrespective of cell type and with histologically poorly differentiated peripheral tumours. These authors suggested that preoperative mediastinal exploration was unnecessary in patients with peripheral adeno- or squamous carcinomas associated with a normal radiographic appearance of the mediastinum, when mediastinoscopy was helpful in less than 5% of cases. However, others (Jepson, 1966; Baker, Stitik and Marsh, 1975; Fosburg *et al.*, 1974; Larsson, 1976) have found an appreciable yield (28–35%) from mediastinoscopy even with small, peripheral and well-differentiated tumours of non-small cell histology. Tumour size and site cannot therefore be regarded adequate criteria for selective purposes.

The selected use of mediastinoscopy only in those patients who have enlarged mediastinal nodes demonstrated using imaging techniques requires further study. The value of mediastinal tomography has been claimed by some workers (James and Ellwood, 1974; Peace and Price, 1973). However, Fishman and Bronstein (1975) found that lymph node involvement was detected by mediastinoscopy in 28% of a group of patients in whom mediastinal tomography failed to reveal metastases. More recent studies (Hirleman *et al.*, 1980; Osborne *et al.*, 1982) have demonstrated a sensitivity of 50–75% for conventional mediastinal tomography in identifying positive nodes. The greater sensitivity of computerized tomography (CT) in this respect (vide infra) suggests a role for non-invasive staging in selecting for mediastinoscopy only those patients in whom enlarged mediastinal nodes are demonstrated. The clinical impact of such an approach has yet to be evaluated.

In the light of the controversy regarding the prognostic significance of mediastinal node involvement, Pearson (1980) has upheld the value of mediastinoscopy and has attempted to define its role more clearly. Only a very small proportion of patients with positive mediastinoscopy findings will be found to have completely resectable disease at thoracotomy. Thus in a 17-year period, during which pre-operative mediastinoscopy was used routinely as an evaluative procedure, thoracotomy was undertaken in only 79 of Pearson's patients with non-small cell lung cancer who had a positive mediastinoscopy

but in whom complete resection was nevertheless judged feasible. This highly selected subgroup represented only one-fifth of all patients with presumably operable lung cancer in whom mediastinal involvement was demonstrated by mediastinoscopy. Most reports of favourable survival rates in surgically resected patients with mediastinal disease have established N₂ status only at thoracotomy (Abbey Smith, 1978; Kirsh *et al.*, 1971; Martini *et al.*, 1980; Naruke *et al.*, 1978; Ramsey *et al.*, 1969) and precise details of the location of mediastinal nodes are not usually given. Where these data are available, support is gained for the notion that surgical resection is capable of yielding worthwhile survival in a selected group of patients with mediastinal involvement which is ipsilateral and judged to be completely resectable at mediastinoscopy. This represents only a small subgroup of patients with N₂ disease and while mediastinoscopy is the investigation best suited to identifying this select group, it must be emphasised that any survival benefit from surgery in such patients has yet to be demonstrated in a controlled trial.

Non-invasive staging

An extensive literature attests to the comparative safety of mediastinoscopy. Nevertheless, the procedure is not entirely without risk. Larsson (1976) reported a 3% incidence of major haemorrhage and minor complications in 2.6% of 486 examinations. False negative mediastinoscopy and the large number of fruitless examinations if performed on a routine basis represents definite limitations. A wide variety of non-invasive investigations have been employed in the pre-operative evaluation of lung cancer. Their obvious advantages over more invasive procedures have led, in some centres, to their uncritical application with the result that less reliance is placed upon traditional surgical staging methods. It is important therefore that the indications and limitations of these non-invasive techniques are clearly defined.

Conventional and computed mediastinal tomography

The introduction of computed tomography (CT) into clinical practice in 1972 represented a major development in diagnostic imaging. With respect to pulmonary cancer management, CT has been shown to have a valuable role in the identification of pulmonary metastases (Muhm, Brown and Crowe, 1977) and in radiotherapy treatment planning (Emami *et al.*, 1978). The potential of CT as a staging procedure in the preoperative assessment of bronchial carcinoma has been emphasized by a number of authors (Crowe, Brown and Muhm, 1978; Heitzman, Goldwin and Proto, 1977; Mintzer *et al.*, 1979;

Pugatch and Faling, 1981; Robbins *et al.*, 1978, 1980), but its exact role has not been clearly defined.

Two studies that have correlated radiographic findings with pathologically determined disease stage at thoracotomy have clearly demonstrated the greater sensitivity of CT compared with standard chest radiographs in the detection of malignant mediastinal adenopathy (Faling *et al.*, 1981; Osborne *et al.*, 1982). In the same studies, standard radiographs appeared to be as sensitive as CT in detecting hilar adenopathy. The specificity of the methods were reported to be similar for hilar assessment but standard X-rays were more specific than CT in assessing the mediastinum.

Several reports have compared CT with conventional tomography as preoperative staging procedures (Hirleman *et al.*, 1980; Mintzer *et al.*, 1979; Osborne *et al.*, 1982), with definitive staging achieved by thoracotomy, mediastinoscopy or at autopsy. In the study by Mintzer and colleagues (1979), CT demonstrated mediastinal adenopathy in 12 of 16 (75%) patients subsequently shown to have mediastinal disease at surgery. By contrast, conventional mediastinal tomograms were either falsely negative or equivocal in as many as 62.5% of cases. However, conventional tomography appeared to be as sensitive as CT in disclosing hilar lymphadenopathy. Tables 1 and 2 summarize the comparative data from the investigations by Hirleman *et al.* (1980) and Osborne *et al.* (1982). Both studies demonstrate the greater sensitivity of CT for mediastinal evaluation, but also its poorer specificity. In the detection of hilar lymphadenopathy, conventional 55° oblique hilar tomography (Table 2) was more sensitive than CT, although the techniques were similar in terms of specificity and overall accuracy.

Direct mediastinal invasion by tumour is more readily appreciated by CT than by conventional means, when obliteration of tissue interfaces is demonstrable. Similarly, whereas conventional studies may reveal tumour extending to the pleural surface, chest wall and pleural invasion by tumour are better defined using CT (Kollins, 1977). In these instances, CT findings may permit increased diagnostic confidence and contribute to an assessment of operability. However, the clinical utility of thoracic CT and, in particular, the extent to which it is capable of replacing mediastinal exploration in the preoperative assessment of bronchial carcinoma is controversial (Center, 1981).

A total of seven studies have prospectively evaluated CT as a non-invasive method of mediastinal staging in primary bronchial carcinoma (Table 3). In general, the results confirm a high degree of sensitivity in the detection of enlarged mediastinal nodes. In the small series by Underwood *et al.* (1979), CT failed to detect abnormal nodes in five of nine patients

TABLE 1. Comparative evaluations of CT and conventional tomography for staging of primary bronchial carcinoma: mediastinal involvement

		<i>n</i> *	Sensitivity (%)†	Specificity (%)†	(Accuracy (%)†)
Hirleman <i>et al.</i> , 1980	CT	50	96	73	84
	Conventional tomography	47	73	92	83
Osborne <i>et al.</i> , 1982	CT	42	94	62	76
	Conventional tomography	42	50	95	76

*Total number of radiographic/pathology correlations; †All definitions after Galen (1975).

TABLE 2. Comparative evaluations of CT and conventional tomography for staging of primary bronchial carcinoma: hilar involvement

Reference		<i>n</i> *	Sensitivity (%)†	Specificity (%)†	Accuracy (%)†
Hirleman <i>et al.</i> , 1980	CT	50	83	75	80
	Conventional tomography	47	97	72	87
	CT	42	65	88	78
Osborne <i>et al.</i> , 1982	Conventional tomography	42	70	80	76

*Total number of radiographic/pathology correlations; †All definitions after Galen (1975).

shown to have malignant nodal involvement by mediastinoscopy; the authors attributed this low sensitivity (44%) to microscopic intranodal metastasis in the absence of marked lymph node distortion or enlargement. Both this study and that reported by Mintzer *et al.* (1979) made use of scanners with relatively slow scanning times (18–20 s) and this could have accounted for a proportion of the false negative examinations. Certainly, false negative CT findings have been infrequent in more recent studies (Faling *et al.*, 1981; Osborne *et al.*, 1982, Rea, Shevlund and House, 1981) which have employed rapid CT scanners with scanning times of 2–5 s. As a consequence, the reported predictive accuracy of a negative CT examination has been consistently high in these latter series.

Mediastinal lymph nodes are considered to be

abnormal if their measured diameter exceeds an arbitrary threshold, usually 1.0 or 1.5 cm, but the precise criteria employed are often not stated and vary from study to study. While it is possible that the diagnosis of abnormal mediastinal nodes may be assisted by the establishment of more reliable size criteria, a low incidence of false negative results will remain. In a retrospective study by Ekholm *et al.* (1980), using a 4-s scanner, surgical staging disclosed tumour involvement in five out of 14 cases in which mediastinal nodes measured less than 1.0 cm on the CT scan, clearly confirming that lymph nodes considered to be normal in size may harbour microscopic foci of malignant cells.

The reported specificity of CT in the prediction of mediastinal involvement is in the range 63–100% (Table 3), the combined results indicating a mean

TABLE 3. Mediastinal metastasis in primary bronchial carcinoma: reported evaluations of CT

	<i>n</i> *	Sensitivity (%)†	Specificity (%)†	Accuracy (%)†	Predictive value†	
					Positive scan	Negative scan
Underwood <i>et al.</i> , 1979	18	44	89	67	80	62
Mintzer <i>et al.</i> , 1979	26	75	100	85	100	71
Hirleman <i>et al.</i> , 1980	50	96	73	84	77	95
Rea <i>et al.</i> , 1981	22	80	76	77	50	93
Faling <i>et al.</i> , 1981	51	88	94	92	88	94
Osborne <i>et al.</i> , 1982	42	94	63	76	65	94
Goldstraw <i>et al.</i> , 1983	41	57	86	76	67	79
Total	250	—	—	—	—	—
Mean	—	76	83	80	75	84

*Total number of CT scan/pathology correlations; †All definitions after Galen (1975).

predictive accuracy of only 75% for a positive CT scan, i.e. about one-quarter will be false positive examinations. The source of false positive CT evaluation may be related to the presence of associated radiographic changes of pulmonary collapse (Faling *et al.*, 1981; HIRLEMAN *et al.*, 1980), or to benign causes of mediastinal node enlargement, especially reactive hyperplasia and granulomatous reactions (OSBORNE *et al.*, 1982; REA *et al.*, 1981). Just as nodes that are infiltrated by tumour are not always enlarged, so lymph node enlargement does not guarantee malignant involvement and these considerations clearly pose fundamental limitations to the clinical utility of CT.

How much therefore can thoracic CT contribute to the pre-operative staging of lung cancer? Although most patients with enlarged mediastinal nodes on CT will have mediastinal involvement confirmed at thoracotomy, the relative lack of specificity of CT suggests that mediastinal exploration will be necessary to confirm CT findings in the majority of cases. The possibility that false positive scans may exclude patients from potentially curative surgery is clearly unjustifiable. Positive scans may usefully aid more accurate mediastinal assessment by specifically directing mediastinoscopic biopsy or by suggesting a more appropriate method of mediastinal exploration such as left parasternal mediastinotomy. The high predictive accuracy of a negative scan suggests that further staging will be unrewarding in the vast majority of patients. In this situation, thoracotomy without prior mediastinoscopy will avoid the extra morbidity of the latter procedure without significantly lowering the resectability rate. The clinical impact of such a role for CT has yet to be assessed.

Other radiographic procedures

Barium swallow examination as a means of detecting oesophageal invasion and posterior mediastinal lymph node enlargement is frequently performed as part of the preoperative assessment of the lung cancer patient, its potential value having first been commented upon by Fleischer and Sachsse (1963). Although cheap to perform, there is no evidence to support its routine application as a screening procedure in truly asymptomatic patients. The indirect nature of the method, its lack of specificity and the difficulty experienced in the interpretation of minor abnormalities suggest that its value lies in confirming oesophageal involvement in patients with suggestive symptomatology.

Pulmonary angiography as a means of defining central vascular involvement by the neoplastic process has also been employed in pre-operative staging (Sanders, DeLarue and Lau, 1962; Sanders, DeLarue and Silverberg, 1970). In the latter study, surgical

and angiographic findings were correlated in a large series of patients with 'operable' lung cancer. Out of 241 angiographic examinations, as many as 211 (88%) were either negative or equivocal and out of the 30 patients with positive angiograms seven proved to have resectable disease, a false positive rate of 23%. The low yield of positive angiographic findings in 'operable' cases and the technique's relative lack of specificity, except when mediastinoscopy is also positive, militate against its use as a screening procedure. For similar reasons, the pre-operative evaluative roles of azygography, pneumomediastinography and mediastinal lymphography (Ikins *et al.*, 1962; Sone, Tachiiri and Ishida, 1968; Wolfel, Linberg and Light, 1966) are of historical interest only.

Radionuclide imaging techniques

Two quite different approaches have made use of radionuclide imaging as a non-invasive means of evaluating the mediastinum, the first functional, making use of ventilation and perfusion scans and the second anatomical, employing tumour-seeking isotopes.

Ventilation and perfusion lung scans

Radioisotope lung scans will reveal tumour-related abnormalities of regional ventilation and perfusion in a high proportion of patients with primary bronchial carcinoma. Arborelius *et al.* (1971) showed a close correlation between regional loss of lung function and extent of tumour growth, whilst Secker-Walker *et al.* (1971) demonstrated a relationship between the size of the perfusion defect and the proximity of tumour to the pulmonary hilum. In a study of 26 patients with bronchial carcinoma, a large perfusion defect in the tumour-bearing lung (relative perfusion less than 33%) was found to be a strong indication of non-resectability (Secker-Walker *et al.*, 1974). In a similar study reported by Lipscomb and Pride (1977), including 21 patients, extensive loss of lung perfusion was, in each of three cases, associated with extensive mediastinal involvement at surgery. However, 11 patients (55%) had mediastinal involvement which was not predicted by the perfusion scan. Other workers have also found perfusion lung scans to be a relatively insensitive method of detecting mediastinal tumour involvement (Maynard *et al.*, 1969). Another more recent study has emphasized the fact that large perfusion defects are not necessarily incompatible with complete resection at a subsequent thoracotomy (Ellis *et al.*, 1981).

It is doubtful therefore whether resectability can be predicted with any accuracy by preoperative lung scanning. A gross perfusion defect indicates a strong probability of non-resectability but this finding alone

cannot be regarded as contra-indicating attempted resection. Pre-operative ventilation and perfusion lung scanning has been usefully applied for predicting postoperative lung function after pulmonary resection, but on the available evidence it does not appear to be a valuable method for assessing operability.

Tumour-seeking isotopes

Clinical experience with tumour-seeking radiopharmaceuticals in the staging of bronchial carcinoma has essentially been limited to the use of ^{67}Ga and ^{57}Co -labelled bleomycin. Of these two techniques, gallium scintigraphy has been the more extensively studied.

Since its introduction by Edwards and Hayes (1969), imaging with gallium-67 has found wide application in the evaluation of a variety of inflammatory and neoplastic pulmonary disorders (Bekerman *et al.*, 1980). A majority of reports indicate abnormal accumulation of ^{67}Ga in between 80–90% of all primary bronchial carcinomas (Hayes and Edwards, 1973; Larson, Milder and Johnston, 1975; Pinsky and Henkin, 1976; Siemsen *et al.*, 1976; Teates, Bray and Williamson, 1978). Uptake of ^{67}Ga by inflammatory lesions and neoplasms other than primary lung tumours clearly limits the diagnostic applications of ^{67}Ga imaging, but this inherent lack of specificity is less problematical when evaluating the extent of an abnormality in patients whose primary diagnosis has been established. A number of studies have evaluated ^{67}Ga scanning as a method of assessing mediastinal involvement in bronchial carcinoma (Table 4). Studies that have directly compared plain chest radiography with ^{67}Ga scanning have confirmed the comparative lack of sensitivity and low overall accuracy of the former in the detection of mediastinal lymph node involvement (Alazraki *et al.*, 1978; Lunia *et al.*, 1981). No direct prospective comparisons of ^{67}Ga imaging with conventional mediastinal tomography have been made. In Fos-

burg's retrospective series (Fosburg, Hopkins and Kan, 1979), the sensitivity and overall accuracy of mediastinal tomography appeared comparable to the results obtained with ^{67}Ga scanning. However, the majority of patients who underwent tomography were pre-selected on the basis of equivocal or probable mediastinal abnormalities on the plain chest X-ray. On these grounds it would seem reasonably clear that ^{67}Ga scanning offers an advantage over conventional radiographic techniques.

There is remarkably close agreement between all of the studies (Table 4) as to the accuracy of the technique in demonstrating mediastinal lymph node metastasis, but two main factors limit the sensitivity of the technique. Microscopic intranodal metastases may fail to increase the size of a node into the range (> 1.5–2.0 cm) which can be successfully resolved by ^{67}Ga imaging. Secondly, in patients with primary paramediastinal tumours, gallium uptake by adjacent mediastinal nodes may not be separately identifiable owing to their close proximity to the primary tumour. Thus, DeMeester *et al.* (1979) found an overall accuracy of 84% for ^{67}Ga scanning in predicting mediastinal involvement associated with peripheral tumours compared with an accuracy of only 61% for paramediastinal tumours.

The combined results show that the predictive values of positive and negative scans are roughly equal. It may be significant however that the three largest studies (Table 4) suggest that a positive scan indicates mediastinal metastases with a somewhat greater degree of certainty than a negative gallium study demonstrates their absence. Nevertheless, only DeMeester *et al.* (1976, 1979) place greater emphasis on positive scan findings, suggesting on the basis of a 90% probability that a positive mediastinal scan indicates stage III disease and precludes the necessity for further staging. By contrast, Lunia *et al.* (1981) and Fosburg *et al.*, (1979) regard the positive scan as an indication for mediastinoscopy.

The clinical significance of a negative mediastinal gallium scan is also arguable. If the primary tumour

TABLE 4. Mediastinal metastasis in primary bronchial carcinoma: evaluations of ^{67}Ga imaging

	n*	Sensitivity (%)†	Specificity (%)†	Accuracy (%)†	Predictive value†	
					Positive scan	Negative scan
DeMeester <i>et al.</i> , 1976	47	75	83	79	82	76
Lesk <i>et al.</i> , 1978	34	89	67	79	77	83
Alazraki <i>et al.</i> , 1978	25	100	71	84	73	100
Fosburg <i>et al.</i> , 1979	70	88	86	87	93	76
DeMeester <i>et al.</i> , 1979	66	56	94	74	90	67
Hirleman <i>et al.</i> , 1980	52	50	94	75	85	72
Lunia <i>et al.</i> , 1981	75	92	70	85	82	76
Total	369	—	—	—	—	—
Mean	—	79	81	80	83	79

*Total number of scan-pathology correlations; †All definitions after Galen (1975).

is gallium-positive and the mediastinum shows no abnormal uptake, DeMeester *et al.* (1979) recommend mediastinoscopy. Others point to the expected low yield of mediastinoscopy in these patients based on a predictive value of 76–100% for a negative scan (Alazraki *et al.*, 1978; Lesk *et al.*, 1978; Lunia *et al.*, 1981). By proceeding directly to thoracotomy in patients with negative scans the additional morbidity of mediastinoscopy may be averted without affecting the resectability rate. Schemes of management which incorporate the use of ^{67}Ga scans in this way have been outlined by a number of authors, but the clinical impact of these approaches especially with regard to effect on resectability rate, operative morbidity and survival have yet to be assessed in prospective studies.

^{67}Ga is not an ideal imaging agent, poor image quality being a common problem and ^{57}Co -labelled bleomycin may be superior to ^{67}Ga for tumour localisation (Poulouse *et al.*, 1975). In one prospective study in which scan findings were correlated with surgically determined tumour stage, imaging with ^{57}Co -bleomycin was found to be both sensitive (80%) and specific (97%) (Rasker *et al.*, 1976) and a recent comparative study indicated significantly greater sensitivity (89%) with ^{57}Co -bleomycin as scanning agent than with ^{67}Ga -citrate (45%) for the detection of mediastinal metastases (Nieweg *et al.*, 1983). However, the long physical half-life of ^{57}Co (270 days) is a major practical disadvantage.

While technological improvements can be expected which will allow more accurate interpretation of isotope scans, it must be concluded that current radioisotope imaging technology is capable of making only a limited contribution to lung cancer staging. Positive scans may be of some value in specifically directing the surgeon's attention to site or sites of abnormal uptake that are especially worthy of exploration and biopsy. The localization of tracer uptake may also help in dictating the most appropriate method of mediastinal exploration. However, the clinical impact of these applications requires further evaluation.

Summary

A review of staging investigations in the pre-operative evaluation of mediastinal involvement in primary bronchial carcinoma is presented.

The following conclusions are offered as guidelines for the use of mediastinal staging procedures in clinical practice:

Surgical staging methods have the over-riding advantage of superior specificity over indirect imaging techniques. Where ^{67}Ga -imaging or CT scanning are not available, routine pre-operative mediastinoscopy or, when appropriate, mediastinotomy will

identify most patients with non-resectable disease but this approach entails a high proportion of true negative examinations.

Radioisotope ventilation and perfusion lung imaging has no place in the pre-operative staging of lung cancer.

Where the techniques are available, ^{67}Ga -imaging and CT scanning have a use in selecting patients for mediastinal exploration.

A negative mediastinal ^{67}Ga scan or a negative CT examination suggest that mediastinal exploration will be unrewarding in the vast majority of cases and may be omitted prior to thoracotomy.

A positive mediastinal ^{67}Ga scan or the demonstration of abnormal mediastinal nodes by CT is an indication for mediastinal exploration which, if negative should be followed by thoracotomy.

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