Detection of occult cardiac invasion by two dimensional echocardiography in patients with bronchial carcinoma

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ABSTRACT Cardiac invasion by bronchial carcinoma may prevent successful resection but may be undetected before operation. In a retrospective analysis of 100 consecutive thoracotomies nine patients had unsuspected cardiac invasion by tumour. A prospective study of preoperative two dimensional echocardiography was therefore undertaken in patients with bronchial carcinoma who had no clinical evidence of cardiac tumour. Comparison with anatomical findings was possible in 65 patients in whom an echocardiogram of suitable quality had been obtained. There was one false negative among 55 negative echocardiograms and three false positives among 10 positive echocardiograms; non-malignant pericardial disease accounted for the echocardiographic finding in one of the latter. The predictive value of a negative test was 98%, and the predictive value of a positive test was highest (80%) if the echocardiogram suggested atrial invasion.

Secondary carcinoma of the heart has been reported at necropsy in 5-25% of patients dying of malignant disease,^{1,2} yet it rarely produces important clinical symptoms.^{3,4} Although this applies to cardiac invasion by primary carcinoma of the bronchus, the presence of tumour in the heart or pericardium may prevent successful surgical resection.

To assess the magnitude of the problem we first reviewed retrospectively 100 consecutive thoracotomies performed for carcinoma of the bronchus. The overall resection rate in these patients was 81%, which is similar to that in previously published series.^{5,6} Of the 100 patients, nine were found to have cardiac invasion by tumour, four with tumour in the left atrium and five with pericardial invasion alone. The tumour was unresectable in six of these nine patients.

Two dimensional echocardiography allows visualisation of much of the cardiac anatomy, and has proved valuable in the detection of intracardiac masses, such as primary tumours of the heart.⁷ The purpose of this study was to evaluate prospectively the use of two dimensional echocardiography in the preoperative detection of occult cardiac invasion in patients with bronchial carcinoma.

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Patients and methods

Two dimensional echocardiography was performed in 87 patients with proved carcinoma of the bronchus who were being assessed for surgery. There were 70 men and 17 women with a mean age of 61 years. No patient had clinical, radiographic, or cardiographic evidence of cardiac tumour and all were in sinus rhythm.

The two dimensional echocardiography was performed and interpreted by two of the authors using either an ATL MK-300C or a Toshiba SSH-10A sector scanner. Parasternal (long and short axis), subcostal (short axis and four chamber), and apical (long axis and four chamber) views were used in all cases (fig 1). The echocardiogram was considered suitable for interpretation only if the heart could be visualised to the apex, the left atrium could be clearly seen in two or more views, and at least two of the pulmonary veins could be seen at the point of entry into the left atrium.

All echocardiograms were interpreted before thoracotomy and the results were compared with subsequent operative postmortem findings. Cardiac invasion was suspected if a pericardial effusion was detected or if there was evidence of a mass within a cardiac chamber, including the point of entry of the pulmonary veins into the the left atrium.

On the basis of these criteria the sensitivity,

Fig 1 Diagram of the two dimensional echocardiographic imaging planes.

specificity, and predictive value of two dimensional echocardiography in the detection of occult cardiac invasion were calculated in the following manner:

$$\text{Sensitivity} = \frac{\text{true positives}}{\text{true positives} + \text{false negatives}}$$

$$\text{Specificity} = \frac{\text{true negatives}}{\text{true negatives} + \text{false positives}}$$

$$\text{Predictive value of a positive test} = \frac{\text{true positives}}{\text{true positives} + \text{false positives}}$$

$$\text{Predictive value of a negative test} = \frac{\text{true negatives}}{\text{true negatives} + \text{false negatives}}$$

Any unrelated echocardiographic abnormalities were also noted.

Results

Of the 87 patients in the study, 15 did not proceed to thoracotomy because of the discovery of distant metastases, and they received either radiotherapy or chemotherapy. These patients have been excluded from the analysis as anatomical confirmation of the findings from two dimensional echocardiography was not available although in one patient the echocardiogram was interpreted as showing atrial

invasion. Of the remaining 72 patients, the echocardiogram was judged to be of insufficient quality for interpretation in seven (9.7%). The study population therefore comprised 65 patients; in 64 the echocardiographic findings could be compared with the findings at thoracotomy, while information obtained at necropsy was used in one patient who died suddenly before operation.

Of the 65 echocardiograms 55 were interpreted as showing no evidence of cardiac invasion. The negative findings were confirmed in 54 cases (98.2%) but in one patient (1.8%) pericardial invasion was found at thoracotomy. An extended pneumonectomy was performed in this patient.

Ten echocardiograms were interpreted as showing cardiac invasion. The positive findings were confirmed anatomically in seven cases (70%), with pericardial invasion in three and atrial tumour in four (fig 2). The three false positive echocardiograms (30%) included one interpreted as showing atrial tumour and two as having pericardial invasion. In one of the latter patients extensive chronic pericardial adhesions were found at thoracotomy to account for the echocardiographic findings.

The overall sensitivity of two dimensional echocardiography in this study was 87.5%, with a specificity of 94.7%. The predictive value of a negative echocardiogram was 98.2% and of a positive one 70%. The latter comprises a predictive value of 80% for a positive echocardiogram showing atrial invasion and 60% for a positive echocardiogram showing pericardial invasion.

In the eight patients with proved cardiac invasion histological examination of the tumour showed squamous carcinoma in six, adenocarcinoma in one, and undifferentiated large cell carcinoma in one. All eight patients had centrally placed tumours arising in a lobar or main bronchus with no predominant side or site of origin. In two patients resection of tumour was possible despite cardiac invasion. Both had pericardial invasion and died of metastatic disease four and five months respectively after extended pneumonectomy.

Twenty-one other cardiac abnormalities that were unrelated to the carcinoma were found in 17 of the 80 technically acceptable echocardiograms (this includes data from the 15 patients who did not proceed to thoracotomy), and in many cases the findings were unexpected (table).

Discussion

There has been considerable interest in the pre-operative diagnosis of mediastinal disease in patients with bronchial carcinoma, but in a recent review⁸ of

Fig 2 Still frame photograph of a two dimensional echocardiogram showing an apical four chamber view of the heart, with a schematic diagram of the main features on the right. There is an echogenic lesion encroaching into the left atrium, which was due to invading tumour (T). RV—right ventricle; LV—left ventricle; RA—right atrium, LA—left atrium, MV—mitral valve; TV—tricuspid valve.

Additional cardiac abnormalities detected by two dimensional echocardiography in 80 patients

Abnormality	Number
Left ventricular wall motion abnormality	9
Thickened aortic valve	3
Right ventricular enlargement	2
Mitral valve thickening	1
Mitral stenosis	1
Mitral annular calcification	1
Mitral valve prolapse	1
Asymmetrical septal hypertrophy	1
Concentric left ventricular hypertrophy	2
Total	21

the use of computed tomography in the diagnosis and management of malignant disease of the thorax no mention was made of occult cardiac invasion. If, however, the results of our prospective and retrospective series are combined, unexpected cardiac or pericardial invasion was confirmed in 16 of 172 patients (9.8%) who were candidates for thoracotomy and in 11 of these successful resection was not possible. Three patients in the retrospective series and two in the prospective series had an extended pneumonectomy performed despite cardiac invasion but the median survival in these patients was only four months, all five dying of metastatic disease. The poor prognosis associated with cardiac invasion is supported by a recent review⁹ of 65 patients with lung cancer and pericardial metastases, who had a median survival of only 21 weeks from diagnosis; although

the patients were treated surgically (including by pericardiectomy), in no case did survival exceed four weeks.

In the present study two dimensional echocardiography has proved to be a sensitive means of detecting occult cardiac invasion by bronchial carcinoma. We did not perform routine computed tomography in these patients so no direct comparative data are available on the sensitivity and specificity of the two techniques in the recognition of cardiac invasion. But cardiac invasion was associated with mediastinal adenopathy at surgery in 10 of the 16 patients discussed here (eight malignant, two reactive hyperplasia) and computed tomography is likely to have at least detected these and prompted further investigation, perhaps avoiding unnecessary thoracotomy in some of these patients.

The frequency of uninterpretable echocardiograms (9.7%) in our series is acceptable for a population of patients with a high prevalence of chronic obstructive airways disease as satisfactory images are notoriously difficult to obtain in such patients.

The predictive value of a positive result was less than that of a negative result. Two of the three false positive echocardiograms were interpreted as showing pericardial invasion but in one this was attributable to chronic inflammatory pericardial disease. In the other a subsequent review of the echocardiogram still resulted in the report of a small pericardial effusion. This highlights the non-specific nature of pericardial abnormalities on an echo-

cardiogram, which may also be due to sympathetic effusions, coincidental viral infections, or even adipose tissue in obese patients. The predictive value of a positive echocardiogram showing chamber invasion is therefore likely to be greater, as was the case in this study.

Review of the one false positive echocardiogram suggesting atrial invasion showed that it was of relatively poor quality yet had been judged suitable for interpretation before surgery. This emphasises the pitfalls in the interpretation of two dimensional echocardiography of inadequate quality. In addition, two of the three false positive echocardiograms occurred early in the course of the study and, since the interpreters were aware as the study progressed of whether their findings were being confirmed, there may have been a learning effect that improved the accuracy of interpretation in the latter part of the study.

In conclusion, occult cardiac invasion by bronchial carcinoma has been found in an important proportion of patients with centrally placed tumours undergoing thoracotomy. Whether a tumour is deemed resectable depends on the individual surgeon's criteria for the technical feasibility of curative surgery, but even with a radical approach a strong preoperative suspicion of cardiac invasion might aid surgical planning.

Although echocardiography was accurate in most cases, there was an appreciable false positive rate, especially for pericardial abnormalities. For this reason it would be unwise to regard an echocardiographic abnormality, in the absence of other abnormal findings, as the sole criterion for deciding

against thoracotomy. On the other hand, a normal echocardiogram gives strong reassurance that cardiac invasion is not present.

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