

# Computed tomographic staging of anterior mediastinal neoplasms

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**ABSTRACT** Sixty patients with anterior mediastinal neoplasms undergoing computed tomography before surgical exploration were entered in a prospective study to assess the value of computed tomography in the preoperative staging of anterior mediastinal tumours. Correct prediction of location, size, and tissue density was obtained in all 60 cases. Correct identification of the nature of the tumours was achieved by computed tomography in 37 of the 54 previously undiagnosed cases. Particular attention was given to the evaluation of the relation of the tumour to adjacent mediastinal structures, to predict the feasibility of radical surgical procedures. Overall sensitivity, specificity, and accuracy in identifying resectability were 46%, 85%, and 64%, with positive and negative predictive indices of 78% and 58%. Capsulated or highly invasive lesions were clearly distinguished, and the presence or absence of infiltration of mediastinal vessels, pericardium, and chest wall was correctly recognised in most cases. It is suggested that the evaluation of anterior mediastinal neoplasms should include computed tomography because of its accuracy in predicting size, location, and tissue density of the neoplasm. Computed tomography may suggest, often with good reliability, the histological type of the tumour and its relation to contiguous mediastinal structures, thus contributing to the choice of the appropriate surgical approach or route for biopsy.

Computed tomography has proved to be an excellent tool for investigation of the mediastinum; it allows precise location of mediastinal masses and may predict with good accuracy their solid or cystic nature. In addition, computed tomography causes little discomfort for the patient and may drastically reduce the need for other diagnostic procedures.<sup>1</sup>

The encouraging results obtained by computed tomography with other intrathoracic neoplasms<sup>2</sup> stimulated us to ascertain the value of the technique in the assessment of anterior mediastinal tumours, with regard to their accurate localisation and, in particular, to invasion of adjacent structures for determining the feasibility of radical resection. We have therefore conducted a prospective study on consecutive patients who were referred to our department for the evaluation of an anterior mediastinal mass and who subsequently underwent surgery that established the nature and extent of the tumour.

## Methods

The study was a prospective survey based on 60 consecutive patients—33 men and 27 women, age 14–84 (mean 41) years—investigated or treated surgically for tumours in the anterior mediastinum in the department of thoracic surgery of the University of Rome from January 1983 to April 1987.

Computed tomography of the chest and abdomen was performed by a third generation computed tomography scanner (Siemens DR1); scans 8 mm thick were obtained at 1.5 cm intervals from the thoracic inlet to the diaphragm; abdominal scans were negative in all patients. Repeated bolus injections of contrast material (Selectografin 70%, 20–30 ml up to a total of 120–140 ml) were performed in 59 patients; all scans were interpreted by the same team of radiologists. All 60 patients underwent surgery within two weeks of computed tomography. The operative procedures undertaken were partial or total median sternotomy in 50 patients, thoracotomy in five, and mediastinotomy or mediastinoscopy in five patients. Resection was complete in 30 patients and subtotal in 16; in 14 patients only a biopsy was performed.

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Accepted 21 January 1988

Table 1 *Histology of the tumours*

|                 |                  |    |
|-----------------|------------------|----|
| Thymoma:        |                  | 25 |
| Stage I         | 10 (2 cystic)    |    |
| Stage II        | 3 (1 cystic)     |    |
| Stage III       | 12 (3 recurrent) |    |
| Lymphoma:       |                  | 23 |
| Hodgkin's       | 12               |    |
| Non-Hodgkin's   | 11               |    |
| Dysgerminoma    |                  | 2  |
| Morgagni hernia |                  | 2  |
| Goitre          |                  | 3  |
| Haemangioma     |                  | 1  |
| Thymolipoma     |                  | 1  |
| Hamartoma       |                  | 1  |
| Mesodermal cyst |                  | 2  |
| Total           |                  | 60 |

Histological findings are reported in table 1. Thymomas were classified as stage I (capsulated lesion), stage II (infiltration of the capsule), or stage III (infiltration of surrounding organs).<sup>3</sup> Nine patients with thymoma (three stage I or II and six stage III) had myasthenia gravis.

We evaluated the ability of computed tomography to determine (1) the location, (2) the nature, and (3) the local extent of disease.

Local extension and invasion by tumour was suggested by one or more of the following criteria: obliteration of fat planes; indentation or irregularity of vascular, pleural, or pericardial margins in contact with the tumour; apparent infiltration into intercostal muscles or periostium. On the basis of the presence or absence of these features the neoplasms was classified as likely to be totally resectable (cleavage plane present, no features suggesting infiltration), partially

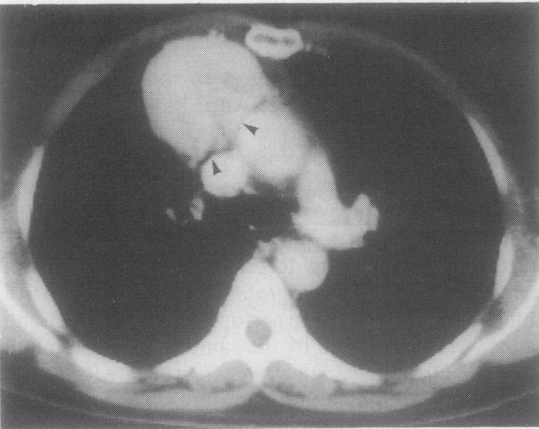


Fig 1 *Retrosternal goitre. Computed tomography correctly detected the benign attitude of the neoplasm (arrows show the cleavage plane), but failed to characterise the mass histologically (computed tomography diagnosis: non-invasive thymoma).*

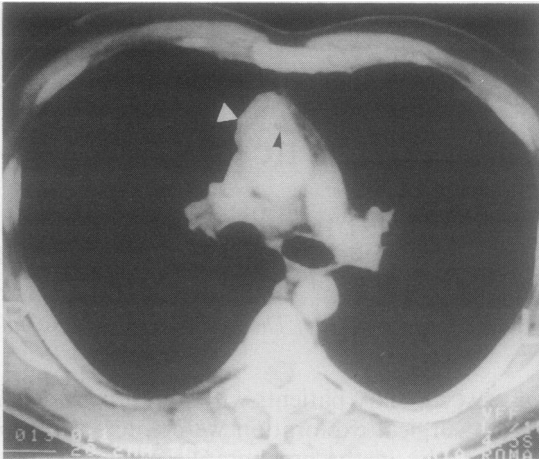


Fig 2 *Stage II thymoma (microscopic evidence of capsular invasion) diagnosed correctly by computed tomography. Absence of infiltration of the aortic wall was correctly reported (black arrow), but irregular mediastinal pleural margins suggested infiltration (white arrow), which was not confirmed at surgery, when a good cleavage plane was identified.*

resectable, or non-resectable (cleavage plane incomplete or absent, infiltration apparently present). In addition, we separately assessed the relation of the tumour to lung parenchyma, mediastinal vessels, mediastinal wall, and chest wall. Uncertain results concerning location, characterisation of the tumour, or relation to adjacent structures were classified as either false negative (feature present at surgery) or false positive (feature absent at surgery).

Fifty four patients had radical surgery and six biopsy only. All pathological material was carefully examined to identify adhesion to or infiltration of the structures that were resected along with the tumour.



Fig 3 *Hodgkin's disease showing presence of a cleavage plane with the aortic wall (black arrows) and inner chest wall (white arrows). The histological diagnosis and absence of infiltration were correctly predicted.*

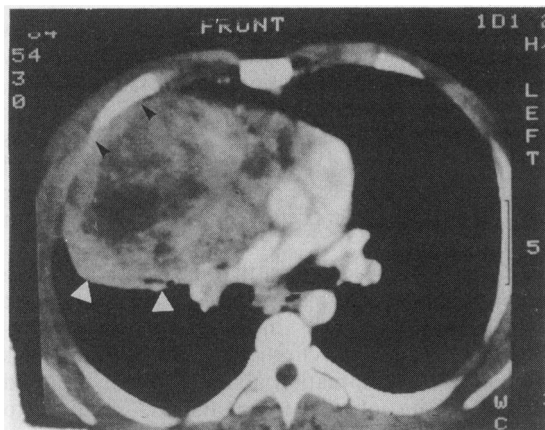


Fig 4 Yolk sac tumour. Computed tomography diagnosis (thymoma) and prediction of lack of invasion by tumour were incorrect. Tumour infiltration of the lung parenchyma (white arrows) and chest wall (black arrows) was found at operation.

After surgical exploration sensitivity, specificity, accuracy, and positive and negative predictive value<sup>4</sup> were calculated for the overall resectability of the tumour, and separately for the infiltration of lung parenchyma, mediastinal vessels, mediastinal wall (pleura, pericardium), and inner chest wall.

## Results

In all 60 cases computed tomography allowed accurate localisation of the tumour (see fig 1) and also correctly distinguished whether it was solid or cystic.

The ability of computed tomography to predict the histological nature of the neoplasm was evaluated in 54 patients. This was already known in the remaining six, of whom three had recurrent thymoma and three underwent surgery for restaging of previously diag-

nosed lymphoma. Correct diagnosis was achieved in 37 patients (68.5%). Prediction was more accurate with stage I and II thymomas, especially when evidence of myasthenia gravis was present (three patients); 12 of 12 such cases were correctly interpreted. Stage II (fig 2) and stage III moderately invasive thymomas and non-infiltrative lymphomas presenting as multiple, conglomerate, and enlarged anterior mediastinal nodes (fig 3) were characterised with good accuracy. Fat containing lesions such as Morgagni hernias (two cases) were correctly interpreted, but in one patient with a thymolipoma the computed tomography result was equivocal. Widely infiltrative, aggressive neoplasms (fig 4) were variously classified as stage III thymoma, lymphoma, or dysgerminoma, and there was no relation between the computed tomography prediction and the histology.

The relation of the tumour to adjacent structures was evaluated by computed tomography to assess the value of the technique in the preoperative assessment of disease. The results are summarised in table 2.

## Discussion

The management of patients with anterior mediastinal neoplasms is often difficult.<sup>5</sup> The surgical approach varies with the histology of the tumour and its local invasiveness; none of the conventional radiographic imaging techniques is accurate in providing these data,<sup>6</sup> so that on occasion the decision to perform simple biopsy, debulking procedures, or radical resection is made only in the operating theatre.

The increasing sophistication of computed tomography scanners and greater experience in reading the scans<sup>7,8</sup> have improved the preoperative assessment and characterisation of mediastinal masses.<sup>9</sup> Computed tomography has been reported to be helpful in identifying thymic lesions,<sup>10,11</sup> reaching an accuracy of 91% in patients with myasthenia gravis. Lymphoma may also be recognised by computed tomography,<sup>12</sup> especially when it presents as in figure 3; uninodular capsulated lymphoma was, however, misinterpreted as stage I thymoma twice in our series, and very aggressive disease could not be distinguished from stage III thymoma or germ cell tumour (fig 4).<sup>13,14</sup> Computed tomography may allow mediastinal thyroid tissue to be identified by its continuity with the thyroid in the neck.<sup>15,16</sup> Goitres that are completely intrathoracic, however, arising from ectopic thyroid tissue, represent 0.2–1% of all goitres.<sup>9,17,18</sup> Two of our cases showed these features and the first of these was incorrectly interpreted (fig 1). In our experience stage I, II, and III moderately invasive thymomas (fig 2); enlarged conglomerate lymph nodes due to lymphoma (fig 3); and Morgagni hernias were interpreted with highest accuracy.

Table 2 Sensitivity, specificity, and accuracy of computed tomography in assessing resectability and local invasion

| Criterion                              |             | %   |     | %   |
|--|-------------|-----|-----|-----|
| Overall resectability<br>(60 cases)    | Sensitivity | 46  | PPI | 78  |
|  | Specificity | 85  | NPI | 58  |
|  | Accuracy    | 64  |     |     |
| Invasion of vessels<br>(60 cases)      | Sensitivity | 54  | PPI | 90  |
|  | Specificity | 94  | NPI | 77  |
|  | Accuracy    | 80  |     |     |
| Invasion of lung<br>(58 cases)         | Sensitivity | 41  | PPI | 100 |
|  | Specificity | 100 | NPI | 72  |
|  | Accuracy    | 76  |     |     |
| Invasion of mediastinum*<br>(58 cases) | Sensitivity | 60  | PPI | 72  |
|  | Specificity | 85  | NPI | 77  |
|  | Accuracy    | 76  |     |     |

\*Includes pericardium, mediastinal pleura, endothoracic fascia, intercostal muscles.

PPI, positive predictive index; NPI, negative predictive index.

The main purpose of our study was to assess the ability of computed tomography to determine the relation of anterior mediastinal tumours to surrounding structures. Such neoplasms not infrequently show unpredicted invasiveness at operation, so that more accurate preoperative imaging might modify treatment plans. In addition, tumours such as thymoma or lymphoma may impinge on or invade mediastinal pleura, pericardium, phrenic nerves, great vessels, or lung parenchyma. Appropriate treatment is strongly influenced by such factors, especially where age, cardiorespiratory condition, and general health are adverse factors.<sup>8,18</sup> According to the data of Brown and colleagues,<sup>6</sup> none of the conventional radiographic imaging techniques is accurate in predicting whether a thymoma is locally invasive. Although in many cases computed tomography may determine whether the lesion is invasive,<sup>7</sup> Nakata and associates<sup>9</sup> concluded that differentiating a benign from a malignant thymoma is impossible in some cases. Graeber and colleagues<sup>1</sup> reported that invasiveness was correctly identified from the computed tomography scan in nine of 11 patients with solid mediastinal tumours. We have reported<sup>2</sup> a computed tomography accuracy of 70% in discriminating direct mediastinal infiltration by lung cancer. The complexity of the relationship within the anterior compartment of the mediastinum, however, requires a more specific approach.

Overall, when the lesions were relatively benign—for example, stage I thymoma, lymphoma, intrathoracic goitre, Morgagni hernia, mesodermal cyst, or teratoma—computed tomography staging was accurate; with appearances suggesting possible invasion—for example, stage II (three false negatives were due to microscopic invasion) and stage III thymoma (fig 2) and dubiously infiltrative lymphoma, dysgerminoma (fig 4) or haemangioma—computed tomography was less reliable diagnostically. On the other hand, when the tumour displays definite characteristics of invasiveness on the computed tomography scan (stage III thymoma, aggressive lymphoma) prediction is again fairly reliable (positive predictive index 78%). For each of the three areas of possible invasion taken separately (lung, vessels, and mediastinal wall) the accuracy of identifying invasion was better than the overall estimate of resectability; for example, an error in interpreting infiltrations of the brachiocephalic vein would not influence the figures regarding the lung or mediastinal pleura, but would lower the overall accuracy. Specificity was consistently good in each of these areas, reflecting the presence of some capsulated tumours in our series. The 100% specificity for recognition of lung parenchymal infiltration is, however, atypical; this is relatively easy with capsulated masses, but the prediction of disease affecting the lung is more difficult and often impossible

when the tumour abuts on the mediastinal pleura (figs 2 and 4). The value of computed tomography is likely to be greater when infiltration of mediastinal vessels, pericardium, and endothoracic fascia is investigated; intravenous injection of contrast material allows detection of any irregularity of the vascular wall, and the presence of fat tissue planes between the tumour and these organs offers better contrast than does air in the lung.

In conclusion, we suggest that the evaluation of an anterior mediastinal mass detected on a plain chest radiograph should always include computed tomography. This is rapid, cost effective, and safe, and provides very accurate information about location, size, and tissue density of the mass and its relation to anatomical structures. In addition, computed tomography may suggest, often with good reliability, the histological type of the tumour, and it may also suggest whether invasion of adjacent mediastinal organs has occurred, thus contributing to the decision about surgical strategy.

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