CHEST WALL INVASION IN NON–SMALL CELL LUNG CARCINOMA: A RATIONALE FOR EN BLOC RESECTION

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Objective: The choice of surgical approach to non–small cell lung cancer invading the chest wall, extrapleural resection versus en bloc chest wall resection, is much more related to the experience of the surgeon than to objective criteria. The aim of the present study is to help to establish a rationale for en bloc chest wall resection in lung cancer invading the chest wall.

Methods: From January 1990 to June 1999, of 1855 patients having major pulmonary resections for non–small cell lung carcinoma, 104 (5.6%) patients with neoplasms involving the chest wall underwent en bloc chest wall and lung resection plus radical mediastinal lymphadenectomy.

Results: All patients underwent complete resection with microscopically disease-free tissue margins. Depth of invasion was into the parietal pleura only in 28 (26.92%), into the pleura and soft tissue in 36 (34.62%), and into the pleura, soft tissue, and bone in 40 (38.46%). No operative mortality was reported. Follow-up was completed in 96 patients. One patient had a local recurrence. The overall 5-year estimated survival was 61.4%. Survival in the subsets T3 N0 and T3 N2 were, respectively, 67.3% and 17.9% ($P = .007$). The 5-year survival was 79.1% in involvement of parietal pleura only and 54.0% in involvement of soft tissue with or without bone invasion ($P = .014$). Five-year survival was 53.0% in adenocarcinoma versus 71.8% in squamous cell carcinoma ($P = .329$) and 74.1% in patients who did undergo radiation therapy versus 46.7% in patients who did not undergo radiation therapy ($P = .023$).

Conclusions: En bloc resection of the chest wall and lung is the procedure of choice to obtain complete resection in lung carcinoma invading the chest wall. Survival is highly dependent on the completeness of resection, nodal involvement, and depth of chest wall invasion. (J Thorac Cardiovasc Surg 2001;121:649-56)

Approximately 5% to 8%¹⁻³ of patients undergoing a resection for non–small cell lung carcinoma (NSCLC) have involvement of parietal pleura, soft tissue, intercostal muscles, or ribs. Coleman⁴ in 1947 first reported long-term survival after en bloc excision of the chest wall with pulmonary resection. Since that

report other groups from the Massachusetts General Hospital,¹ the Mayo Clinic,² and the Memorial Sloan-Kettering Cancer Center³ have confirmed the acceptable morbidity and mortality of this approach and have stressed the survival benefit in a significant percentage of these patients. It is generally believed that survival after resection of an NSCLC invading the chest wall is significantly related to the completeness of resection and to the lymph node involvement.^{2,3,5,6} In our opinion en bloc resection, without opening the extrapleural space and avoiding exposure of tumor, is the procedure of choice to achieve a complete resection (R0). This article reports our homogeneous experience with 104 R0 en bloc resections mostly performed by the same surgeon with the same technique in a 9-year period.

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Methods

From January 1, 1990, to June 30, 1999, 12,059 patients were admitted to the Division of Thoracic Surgery, Carlo Forlanini Hospital, in Rome. Of these, 1855 patients underwent major pulmonary resections (Current Procedural Terminology codes 32440-32445 and 32480-32488) for NSCLC. In 104 patients (5.60%) with NSCLC invading the parietal pleura or chest wall, en bloc resection of the chest wall and lung parenchyma plus routine systematic dissection of all hilar and mediastinal nodes was performed. Indications for chest wall resection were chest pain and computed tomographic (CT) or magnetic resonance imaging (MRI) evidence of chest wall invasion intraoperatively confirmed by parietal pleural attachment of a peripheral NSCLC tumor.

En bloc resection of the chest wall and lung was defined as removal of lung parenchyma in continuity with parietal pleura and chest wall soft tissue with bony structures without removal of the overlying integument. Extrapleural resection was defined as extrapleural dissection of the tumor from the chest wall with removal of lung parenchyma and of a portion of the overlying parietal pleura. A complete resection (R0) was defined as pathologic evidence of disease-free (negative) tissue margins and an assessment by the operating surgeon that all grossly detectable disease had been removed. Patients with Pancoast tumor and patients whose tumor invaded the thoracic spine were excluded.

All patients were routinely evaluated with a thorough medical history, physical examination, complete blood cell count, blood chemistry, liver function test, respiratory function test, and electrocardiogram and underwent chest radiography, total body CT scan, MRI, and fiberoptic bronchoscopy.

Operative mortality was defined as mortality within 30 days or within the same hospitalization. Histologic typing was conducted according to the International Classification of Disease for Oncology.⁷

Statistics. Crude survival proportions were calculated by the method of Kaplan and Meier.⁸ Differences in survival distribution were tested with the log-rank test. Multivariate analysis was done by the Cox model.

Operative technique. The great majority of the operations (94/104) was performed by the same surgeon (F.F.), who used the following surgical approach: The chest cavity is entered posterolaterally. Depending on the level of involvement, it is possible to tailor the incision for more effect. Within the pleural cavity, the limits of chest wall invasion and the state of the hilar and mediastinal nodes are explored to ascertain operability and to define the margins of resection. The margins of resection should include an uninvolved rib and intercostal space above and below.⁹ The ribs are divided at a safe distance from the tumor, at least 4 cm.¹⁰ The transection starts with the lowest rib, each preceded by ligation and transection of the intercostal vessels. Special attention is paid to the region of tumor attachment to the vertebral bodies. Transection of ribs must at times be flush with the vertebral bodies, through the costotransverse joints. The resected portion of the chest wall attached to the lung is then allowed to

drop into the pleural cavity, where pulmonary resection is performed in the usual manner and associated with a radical standard lymphadenectomy. Closure is accomplished with either scapular or chest wall musculature.

Results

The demographic features and treatment data are shown in Table I. In 37 patients with suspected radiologic N2 disease (mediastinal lymph nodes 12 mm or more in largest diameter), mediastinoscopy or anterior mediastinotomy was performed. Of these patients, 6 had histologically proven N2 disease and underwent preoperative induction therapy (chemotherapy only). Transparietal fine needle aspiration biopsy was performed in 49 patients and yielded a positive result in 38 (77.55%).

No attempt at extrapleural dissection was made in the present series of 104 patients. Only the presence of filmy adhesions with a clear plane between the visceral and parietal pleura precluded chest wall resection. In such cases (49 patients), not reported in the present series, extrapleural dissection in the area of filmy adhesions was done and no microscopic parietal pleural involvement was detected.

All patients underwent R0 radical en bloc resection with microscopically negative tissue margins and intraoperative assessment of removal of all detectable disease. Histologic features were reviewed at the time of the study, with emphasis on the depth of tumor invasion and degree of lymph node involvement. In all patients the pathologic stage was T3. The pathologic depth of invasion was into the parietal pleura alone in 28 (26.92%) patients, into the parietal pleura and soft tissue in 36 (34.62%) patients, and into the parietal pleura, soft tissue, and bone in 40 (38.46%) patients. Resection margins were less than 3 mm in 1 patient, between 3 mm and 1 cm in 3 patients, between 1 cm and 2 cm in 11 patients, and more than 2 cm in the remaining 89 patients. The mean number of resected lymph nodes per patient was 15.8 ± 9.6 . All lymph nodes were negative (N0) in 83 (79.81%) patients, 5 (4.81%) patients had diseased (positive) N1 nodes, and 16 (15.38%) patients had positive N2 nodes. Prosthetic reconstruction of the costal wall was not performed.

No operative mortality was reported. Mean hospital stay was 12.3 ± 4.5 days. Major complications occurred in 20 (19.23%) patients and included atrial fibrillation in 5 patients, bleeding that necessitated reoperation in 2 patients, transient spinal fluid leak in 1 patient, prolonged (>6 days) air leak in 8 patients, pleural empyema in 2 patients, bronchopleural fistula in 1 patient, and entrapment of the scapula during

movement of the arm in 1 patient. Spinal fluid leak and prolonged air leak resolved spontaneously. Broncho-pleural fistula was successfully treated endoscopically. The patient with entrapment of the scapula underwent resection of the tip of the scapula.

Forty-two patients received postoperative radiotherapy (average dose, 35 Gy). Patients with positive N2 lymph nodes were given postoperative chemotherapy.

All patients were entered in the follow-up program, which included clinical examination and chest radiography 1 and 3 months after the operation. Six months after the operation and every 6 months thereafter, a total body CT scan was performed. Follow-up ended April 25, 2000. The median length of follow-up was 25.5 months (range 10-120 months). Eight patients were lost to follow-up and were not considered in this study: Four of these patients were alive and free of disease 14, 16, 29, and 38 months after their operations, when they disappeared from our database; 3 patients refused further follow-up 6 months after the operation; and 1 patient moved to another country and did not forward information regarding his health status. Ninety-six patients completed the follow-up program with at least 1 total body CT scan performed within the past 6 months.

One patient had a local recurrence 17 months after the operation. Pathologic review of the surgical specimen showed close margins (<3 mm). This patient underwent radiotherapy and chemotherapy and is still alive with disease 22 months after the operation.

The overall 5-year Kaplan-Meier estimated survival in 96 patients who completed the follow-up was 61.4% with a median survival of 74 months. The 5-year estimated survival of patients with T3 N0 M0 disease was 67.3% (77 patients), with a median of 74 months; in those with T3 N1 M0 disease, 100% (only 5 patients); and in those with T3 N2 M0 disease (14 patients), 17.9%, with a median survival of 23 months. The difference in survival between N0 and N2 is highly significant by log-rank test ($P = .007$) (Fig 1 and Table II).

Five-year estimated survival was 71.8% in squamous cell carcinoma and 53.0% in adenocarcinoma. There was no statistically significant difference by log-rank test ($P = .329$ (Table II). Five-year estimated survival was 60.8% in men and 70.7% in women ($P = .573$).

Regarding the pathologic depth of invasion, the 5-year estimated survival was 79.1% with a median survival of 74 months in 26 patients with involvement of the parietal pleura only (2 patients were lost to follow-up); the overall 5-year survival was 52.1% in 33 patients with involvement of the parietal pleura and soft tissue (3 patients lost to follow-up); the overall 5-

Table I. Demographic features and treatment data in 104 patients

No. of patients	104
Men	90 (85.5%)
Women	14 (14.5%)
Ratio	6.42
Age (y)	
Mean	62.9 ± 9.73
Range	35-80
>65 y	42
>75 y	7
Location	
Right	64 (61.5%)
Left	40 (38.5%)
Symptoms	
Chest pain	41 (39.4%)
Dyspnea	11 (10.6%)
Weight loss	10 (9.6%)
No. of smokers	69 (66.3)
Packs/year	170
Preoperative treatment	
Chemotherapy only	6 (5.7%)
Radiation only	—
Radiation + chemotherapy	—
Histologic type	
Squamous cell carcinoma	56 (53.9%)
Adenocarcinoma	42 (40.3%)
Adenosquamous carcinoma	3 (2.9%)
Large cell carcinoma	3 (2.9%)
Tumor diameter (cm)	
Range	2-16.5
Type of operation	
Pulmonary resection	
Lobectomy	72 (69.3%)
Right upper	35
Left upper	29
Right inferior	4
Left inferior	4
Bilobectomy	15 (14.4%)
Superior/middle	15
Pneumonectomy	10 (9.6%)
Right	2
Left	8
Wedge/segmentectomy	7 (6.7%)
Chest wall resection	
5 ribs*	1 (0.96%)
4 ribs	30 (28.85%)
3 ribs	44 (42.31%)
2 ribs	26 (25%)
1 rib	3 (2.88%)

*Plus scapular tip.

year survival was 56.4% in 37 patients (3 patients lost to follow-up) with involvement of parietal pleura, soft tissue, and bone. Depth of cell wall invasion showed a statistically significant difference by log-rank test ($P = .037$). The cumulative 5-year survival in 70 patients with involvement of soft tissue, with or without bone invasion, was 54.0% ($P = .014$) (Table II).

Table II. Five-year survival rates and hazard ratios with 95% confidence intervals by clinical and histopathologic features

	<i>n</i>	%	Five-year survival (%)	<i>P</i> value*	Median survival time (mo)	Hazard ratio†	95% CI	<i>P</i> value‡
Study patients	96							
Sex								
Male	85	88.5	60.8		74			
Female	11	11.5	70.7	.573	96			
Histologic type								
Squamous cell carcinoma	52	57.8	71.8		74	1.00		
Adenocarcinoma	38	42.2	53.0	.329	—	1.72	0.79-3.76	.174
Staging								
N0	77	84.6	67.3		74	1.00		
N2	14	15.6	17.9	.007	23	3.09	1.27-7.55	.013
Level of invasion 1								
Parietal pleura	26	27.1	79.1		74			
Soft tissue	33	34.4	52.1		—			
Bone	37	38.5	56.4	.037	—			
Level of invasion 2								
Parietal pleura	26	27.1	79.1		74	1.00		
Soft tissue + bone	70	72.9	54.0	.014	—	3.16	1.18-8.46	.022
Radiation therapy								
No	47	49.0	46.7		50	1.00		
Yes	49	51.0	74.1	.023	74	0.47	0.21-1.04	.064

CI, Confidence interval.

*Log-rank test.

†Final Cox regression model includes histologic type, staging, level of invasion, and radiation therapy.

‡Wald test.

The subset pN0 with parietal pleural involvement only (22 patients) showed a 90.3% 5-year estimated survival with a median survival of 96 months; the subset pN0 with soft tissue involvement with or without bone invasion (55 patients) showed 55.9% 5-year survival ($P = .010$). The overall 5-year estimated survival for right lung neoplasms was 63.6% and the overall estimated survival for left lung neoplasms was 58.0%. There was no statistically significant difference between right and left lung neoplasms ($P = .808$).

The overall 5-year estimated survival for patients who underwent radiation therapy was 74.1%, whereas in patients who did not undergo radiation therapy it was 46.7%. A statistically significant difference was measured by log-rank test ($P = .023$) (Table II).

The effect of each factor on the 5-year survival was estimated by multivariate analysis by using the Cox analysis. The final model included 4 variables: N status, pathologic depth of chest wall invasion, histology, and postoperative radiation therapy. Only N0 status and involvement of parietal pleura were significantly linked to a better prognosis. Squamous cell carcinoma compared with adenocarcinoma and postoperative radiation therapy compared with no radiotherapy did not show any significant difference.

At the end of follow-up, 51 (49.04%) patients were alive without evidence of disease, 12 (11.53%) patients were alive with disease (local recurrence in 1 patient, regional recurrence in 2 patients, and distant recurrence in 9 patients), 10 (9.62%) patients died without evidence of disease, and 23 (22.12%) died of metastatic disease. Eight patients (7.69%) lost to follow-up have been excluded from this analysis.

Discussion

The assessment of chest wall invasion by an NSCLC is still a matter of debate. Preoperative evaluations (chest x-ray films, ultrasound examinations, CT scan, and MRI) lack specificity and sensitivity except in the presence of extensive bone destruction.^{11,12} Although persistent localized chest pain in a patient with a peripheral lung neoplasm is a strong indication of chest wall involvement, the absence of pain does not exclude such a possibility, in that 3 (7.5%) of 40 patients with tumor extending to the periosteum and bone did not have pain.

The lack of adherence of the tumor to the parietal pleura at operation effectively excludes invasion of the chest wall. Only filmy adhesions with a clear plane between parietal and visceral pleura can be safely divided.⁶

Fig 1. Survival in patients with N0 vs N2 disease.

If a tumor is found at operation to be adherent to the parietal pleura, intraoperative assessment of chest wall invasion represents a challenge both for the thoracic surgeon and for the pathologist, and controversy exists over the management of such tumors. In the past, some surgeons believed that parietal pleura is a barrier to tumor invasion and claimed that en bloc resection was an unnecessary operation.¹³ Provided that en bloc resection can be safely performed without significant increase of morbidity or mortality,^{2,5,6} nowadays this view has changed.

Most surgeons perform extrapleural dissection until they find clear-cut (macroscopic or microscopic) evidence of chest wall invasion.⁵ The assessment of a tumor-free plane represents a subjective evaluation and is related more to the experience of the surgeon than to objective criteria. Frozen section histologic studies can rarely help the surgeon in making the decision to resect or not to resect the chest wall. According to such criteria, the number of incomplete resections and the likelihood of local recurrence are high.^{6,14} Even if the long-term survival in NSCLC is highly related to the nodal status, the completeness of resection still affects survival.^{2,5,6,15}

In the series reported by Albertucci and coauthors,⁶ the rate of local recurrence was significantly lower in patients undergoing en bloc chest wall resection than in patients undergoing extrapleural resection (9.5% vs 37.5%, respectively), with a significant improvement in survival in patients treated by en bloc chest wall resection. Trastek and associates¹⁶ reported an improved

survival when a chest wall resection was performed: the 5-year actuarial survivals were 75% in chest wall resection versus 28% in extrapleural resection.

In the series reported by Downey and coworkers,⁵ the overall 5-year survival in 175 patients with chest wall invasion who underwent R0 resection was 32%, whereas it was only 4% in 94 patients with chest wall involvement who underwent incomplete (R1/R2) resections. Our policy was to perform an en bloc resection in all of our 104 patients with parietal pleural attachment of an NSCLC. Such an approach may look too radical. Nevertheless, the complication rate observed in our series (19.23%) was very similar to that observed in the overall series of 1855 major pulmonary resections performed at our institution. The 0% operative mortality was remarkable if compared with other reports in which the operative mortality ranged from 2%³ to 15%.^{1,2,17} Moreover, we would like to stress that our series, if compared with other reports published in the literature, appears to be homogeneous: around 90% of the operations (94/104) were performed by the same surgeon in a relative short period (9½ years) with a consistent and accurate follow-up. The impressive 0% of positive margins with only 1 close margin is the goal of such a radical approach. There were no patients with microscopic tumor invasion limited to the visceral pleura, and in only 28 (26.92%) patients was the invasion limited to the parietal pleura. Only this very small group of patients could have safely undergone extrapleural resection. It is generally believed that bony invasion can be easily ascertained

with CT/MRI examination,¹⁸ but evaluation of soft tissue invasion represents a serious challenge: intraoperative examination with frozen section underestimates the degree of invasion and seems responsible for the high rate of positive margins reported in some series favoring extrapleural dissection as a first choice and reserving en bloc resection only to macroscopic evidence of chest wall invasion.^{6,14} It is generally believed that an incomplete resection (R1 or R2) offers the patient no curative benefit independently from the nodal status.^{5,6,14} Long-term survival is very similar in patients having incomplete resection and those not undergoing resection: 4% 3-year survival in patients having R1/R2 resection versus 0% in patients not having resection.⁵ The effort to obtain a microscopically negative margin in every patient is the rationale for our radical approach in tumor invading the chest wall. In our opinion, it is better to offer an overtreatment to patients with tumor limited to parietal pleura than to leave residual disease in patients with tumor invading soft tissue and bone.

As the extent of the resection is concerned, lobectomy represented the procedure of choice in our series; only 7 (6.73%) patients underwent wedge resection because of respiratory insufficiency. The percentage of wedge resection is in agreement with other reports: 3% in the series by Piehler and colleagues,² 8.1% in the series by Shah and Goldstraw,¹⁵ and 10% in the series by Downey and associates.⁵ The percentage of pneumonectomies has been very low (11.53%) in our experience if compared with other series: 24% in the experience of Piehler and coworkers,² 20% in the experience of Downey and colleagues,⁵ and 54.05% in the experience of Albertucci and associates.⁶

Regarding sex as a prognostic factor, the small number of women in our series (14/104) does not allow us to draw any conclusion in light of recent reports^{19,20} that support the hypothesis that hormonal status may influence the prognosis in lung carcinoma.

The presence of mediastinal lymph node metastasis significantly reduced the 5-year actuarial survival both in our experience and in the previously reported series: 67.3% versus 17.9%, respectively, in N0 and N2 ($P = .007$) in our cases; 49% versus 15% in the experience of Downey and colleagues⁵; 41% versus 0% in the experience of Albertucci and coworkers⁶; and 53.7% versus 7.4% in the experience of Piehler and associates.² The small number of N1 patients (5 cases) does not allow us to comment regarding the 100% 5-year actuarial survival. We could not find any statistically significant effect on survival of age (<57, 58-65, 66-70, or >71 years), histology, sex, tumor size, or location of the tumor.

The depth of tumor invasion did significantly affect prognosis independently from the nodal status. Similar results have not been demonstrated in the recent experience of Downey's group.⁵

If we match lymph node involvement and depth of chest wall invasion, the subset pN0 with parietal pleural involvement shows a 5-year estimated survival significantly better than the subsets pN0 with soft tissue involvement (with or without bone invasion): respectively, 90.3% versus 55.9% ($P = .010$). In the subsets of patients with soft tissue involvement, bone invasion has not lowered prognosis ($P = .489$).

The indications for radiation therapy for chest wall invasion are not well defined. Most of the series reported in the literature^{2,5,14,21} did not find any improvement in survival with radiotherapy. Patterson and associates²² reported an insignificant improvement in survival with radiation therapy. Our results showed a positive effect of radiation therapy on long-term survival, even if the improvement was not statistically significant with the Cox analysis ($P = .064$).

The choice to reconstruct the chest wall defect with no prosthesis was mainly related to our large experience with muscular flaps. This approach was cost-effective and avoided the use of synthetic material. No respiratory complication or impairment of pulmonary function was seen in our patients.

Concerning follow-up, only periodic total body CT scan (with a range from 6 months to 1 year) may detect early locoregional or distant recurrences. Most of the previously reported series do not address the problem of follow-up examinations. The policy of the Italian Health System, which offers CT scans and clinical consultations free of charge to patients with lung cancer, probably enhances the patient's acceptance.

In conclusion, in NSCLC invading chest wall, there is no way to ascertain before or during surgery the exact extent of tumor invasion through the chest wall; the high percentage of invasion of soft tissue and bone found in the pathologic review of the specimens reported in the present series (76/104) justifies the routine use of en bloc resection; the trial of extrapleural dissection may expose the tumor and delay the timing of conversion to chest wall resection; routine en bloc resection is associated with the finding of microscopically negative margins in almost all patients and with an acceptable morbidity and mortality.

Furthermore, the present series emphasizes the need of special technical skills in performing a somewhat delicate surgical procedure: the great majority of the procedures (90.38%) was performed by only one surgeon with special interest and training, and in a rela-

tively short period of time, using the same technique in all patients.

Prognosis is highly related to the completeness of resection, the lymph node involvement, and the depth of tumor invasion. The subset of patients with pT3 (parietal pleura only) N0 disease with microscopically negative margins who underwent en bloc resection of lung and chest wall showed in our experience an impressive 90.3% 5-year estimated survival.

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Discussion

Dr Valerie W. Rusch (New York, NY). I congratulate you on an excellent and interesting presentation. Although this study does not present entirely new data, it nicely extends and corroborates previous reports describing the surgical management of NSCLC invading the chest wall. You are to be commended on your excellent results, relatively low morbidity, and zero mortality. These results emphasize the importance of complete resection, the negative prognostic impact of N2 disease, and the influence of depth of tumor penetration into the chest wall on survival. They also underscore that the safest course of action is to perform a chest wall resection in cases in which the extent of pleural involvement is in doubt at the time of the operation, particularly if the operating surgeon does not have extensive experience in this type of procedure.

You have suggested that postoperative low-dose radiation may be beneficial, or at least that its impact on survival approaches statistical significance. However, I would caution that this conclusion is based on a small subset of patients treated in an individualized manner and, on that basis, probably should be discounted. I would also remark that this find-

ing is somewhat at odds with all other published information regarding the use of adjuvant radiation.

I have 4 questions. First, given the results of this study and of previous reports, have you changed your policy regarding mediastinoscopy? I noted that you did this selectively and you now choose to perform this routinely in patients who have T3 chest wall tumors.

Second, have you modified your attitude about the use of chest wall reconstruction given the low risk and excellent results reported by other authors, including ourselves? Posterior chest wall reconstruction, usually performed with a 2-mm thick polytetrafluoroethylene patch to provide support to the scapula, particularly the tip of the scapula, is certainly technically easy. It avoids the morbidity caused by the lack of support of the tip of the scapula and certainly would avoid a second operation to resect the tip of the scapula, as you had to do in 1 case.

I noticed that you performed MRI preoperatively in a small number of patients. Most of us do not do this routinely. Do you continue to do preoperative MRI and, if so, why?

Finally, because you have been able to identify what you think is a group of patients with a somewhat poorer prognosis due to soft tissue or bony involvement, have you considered using induction chemotherapy or testing induction chemotherapy as a routine approach in that group of patients?

Dr Thomas W. Rice (*Cleveland, Ohio*). Your surgical philosophy is to assume that the chest wall is involved. Would you do an extrapleural dissection so long as there were no filmy adhesions? In how many chest wall resections was there no parietal pleural invasion?

Dr Mark S. Allen (*Rochester, Minn*). In your presentation you mentioned some patients with N2 disease, and you stated in your abstract that you treated them preoperatively with induction therapy. Could you describe what that was? I was also impressed that you had a 30% or a 27% 5-year survival in those patients. In the other reports emanating from other institutions, or at least from the Massachusetts General Hospital in our series, the survivals were nowhere near that high. Could you comment on that? Is there something special about the group of patients with early chest wall invasion? Why did they have such a good survival? What are you doing differently that the rest of us can do to get that kind of cure rate?

Dr Cardillo. The first question concerned mediastinoscopy. At our institution we do not perform many mediastinoscopies because we use this approach only in patients with clinical evidence of N2 disease. It is not a routine procedure but is performed only in the presence of N2 disease.

Regarding chest wall reconstruction, in these patients it

was possible to reconstruct the chest wall with muscle, so we did not use any prosthetic material. Of course, we had a problem with the scapular tip in 1 patient, and we reoperated merely to cut the scapular tip. However, I do not believe that implanting a prosthesis would improve the postoperative results in these patients.

We have used MRI only in the last patients we have treated this year and other years. Because of the organization at our institution, it was possible to use MRI in all patients only in the last 2 years.

I cannot answer the question regarding induction therapy in patients with soft tissue involvement. Our results are good, so perhaps we should not change our approach. This is a point that must be addressed in the future.

Regarding Dr Rice's question, our approach may look too radical. However, only 28 patients had involvement of only the parietal pleura, and these patients perhaps should have been treated with extrapleural dissection. Because it is very difficult for a surgeon to understand the depth of invasion of the tumor in advance, we used radical excision in every patient. Some series say that the surgeon has to try extrapleural resection initially and decide at what point he or she should convert. However, tissue for frozen section examination is very difficult to obtain intraoperatively. Therefore, the surgeon must sometimes base the decision on his or her experience, and it is difficult for a young surgeon or a less experienced, less skilled surgeon to make the right choice. We have decided to use this approach in every patient.

Dr Rice. Have you ever done a chest wall resection for a T1 or T2 lesion?

Dr Cardillo. No. Peripheral lung tumor with attachment of the tumor to the parietal pleura does not mean filmy adhesions. If we find filmy adhesions between the tumor and the pleura with a clear plane, of course we dissect. In another series of around 49 cases that I reported, we used extrapleural dissection because the adhesions were just filmy adhesions, not a fixed mass to the tumor. The tumor with a fixed mass has been addressed in the present series and we have treated with chest wall resection.

Regarding the question of Dr Allen, our results really are impressive. Our statistician commented that these results are "three times better than the others." I do not know the reason for that. Maybe peripheral lung tumors have less drainage to the mediastinal node. We are sure that only 17 patients had N2 disease—a very small number compared with the extensive lymphadenectomy we have performed in every patient. There may be other biologic reasons. However, these results have impressed us and other colleagues besides you.