Surgical Treatment of Primary Lung Cancer
and Solitary Intracranial Metastasis*

Frank P. Catinella, M.D., F.C.C.P.;‡
C. Frederick Kittle, M.D., F.C.C.P.;†
L. Penfield Faber, M.D., F.C.C.P.;†
Frank J. Milloy, M.D., F.C.C.P.;†
William H. Warren, M.D., F.C.C.P.;†
and Keloin A. Von Roenn, M.D.‡

From 1976 through 1986, 12 patients underwent 14 thora
cotomies (two patients had a second thoracotomy for recur-
rence) and 16 craniotomies (two patients had three craniot-
omies for recurrence) for carcinoma of the lung and solitary
intracranial metastasis. Age ranged from 40 to 65 years.
Adjuvant therapy (chemotherapy and thoracic irradiation)
was employed in three patients prior to thoracotomy and in
four patients following thoracotomy. Whole-brain irradia-
tion was used in four patients after craniotomy. Improve-
ment in neurologic symptoms following craniotomy was
noted in 15 of 16 instances. There were no operative
mortalities. Overall survival from the time of initial diag-
nosis ranged from 13 to 63 months. Survival following initial
 craniotomy ranged from 12 to 56 months. Eight patients
are currently alive and well with no disabling neurological
symptoms. These results support an aggressive approach to
the resection of solitary brain metastasis from bronchogenic
carcinoma, both for palliation and prolongation of survival.
(Chest 1989; 95:972-75)

The incidence of intracranial metastases in all
patients dying of lung cancer has been reported
to range from 50 to 79 percent in large autopsy
series. 1,3 Clinically apparent intracranial metastases
will develop in approximately 30 percent of lung
 cancer patients, with the average time between diag-
nosis and appearance of metastases being four
months. 1,3 If left untreated, prognosis for these patients
is poor with survival ranging only three to six months. 6,7
Therapeutically, radiation and chemotherapy alone
have done little to improve this outlook, increasing
survival by only a few months. 8

Since the presence of extrathoracic metastatic dis-
ease is considered by many physicians an absolute
contraindication to surgery, the role of combined
resection in stage 3 lung carcinoma with solitary
intracranial metastasis has remained controversial.
Nevertheless, increasing reports document prolonged
survival and improved quality of life offered by such
an aggressive therapeutic approach. 1,4,8,9 The present
report comprises our experience over the past ten
years with combined resection for carcinoma of the
lung and solitary intracranial metastasis.

CLINICAL MATERIALS
From May of 1976 through December 1986, 12 patients
underwent both craniotomy and thoracotomy for carcinoma of the lung
with solitary intracranial metastases. Fourteen thoracotomies and
16 craniotomies were done in these 12 patients, for resection of
either a primary or a metastatic tumor. There were eight women
and four men ranging in age from 40 to 65 years, with a mean age
of 53.8 ± 6.8 years. Follow-up was completed utilizing hospital
charts and physician office records.

RESULTS
The initial symptoms for which patients sought
medical attention were pulmonary in eight and neu-
rologic in four. Two of these four patients had intra-
cranial recurrence each. Metastatic lesions were meta-
chronous in 13 instances (nine patients), and
synchronous in three instances (three patients).
Presenting neurologic symptoms included confusion in
eight patients, seizures in eight patients, hemiparesis
in seven patients, headaches in six patients, aphasia in
eight patients, nausea and vomiting in three patients,
and ataxia in one patient. The diagnosis of intracranial
tumor was confirmed in each case by computed
tomographic scan. Location of the intracranial meta-
tasis was in the frontoparietal region in eight patients,
temporal lobe in one patient, occipital lobe in two
patients, and the cerebellum in one patient. Four
recurrent metastatic lesions were all located in the
frontoparietal region.

The initial surgical procedure was thoracotomy in
nine patients and craniotomy in three patients. Time
period elapsing from thoracotomy to initial craniotomy
ranged from 1 to 29 months (14.7 ± 10.1, mean ± SD).
Conversely, when craniotomy was the initial procedure
(three patients) the time interval to thoracotomy
ranged from one to three months (one month, one
month and three months, respectively). The duration
of neurologic symptoms prior to craniotomy ranged

*From Rush-Presbyterian-St. Luke's Medical Center, Chicago.
†The Department of Cardiovascular-Thoracic Surgery.
‡The Department of Neurosurgery.
Reprint requests: Dr. Kittle, 1725 West Harrison, Room 202, Chicago
60612

972 Surgery for Primary Lung Cancer (Catinella et al)
Table 1—Summary of Pulmonary Resections and Pathologic Findings*

<table>
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<tr>
<th>Procedure</th>
<th>No.</th>
</tr>
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<tbody>
<tr>
<td>Pneumonecctomy</td>
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<tr>
<td>Lobectomy</td>
<td>8</td>
</tr>
<tr>
<td>Segmentectomy</td>
<td>3</td>
</tr>
<tr>
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</tr>
<tr>
<td>T2 N1</td>
<td>4</td>
</tr>
<tr>
<td>T2 N2</td>
<td>3</td>
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<tr>
<td>Cell Type (two were mixed)†</td>
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</tr>
<tr>
<td>Adenocarcinoma</td>
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<td>Squamous cell carcinoma</td>
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<td>Small cell carcinoma</td>
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</table>

*Twelve patients with 14 thoracotomies—two patients had one recurrence each.
†The two recurrences were the same cell type as identified in the initial histologic study.

from one to seven months (2.4 ± 1.8, mean ± SD).

A summary of the types of pulmonary resection, staging of intrathoracic disease, and histopathologic diagnosis is presented in Table 1. Lobectomy was the most common procedure performed, with lesions identified most frequently as adenocarcinoma. When studied microscopically, all metastatic lesions proved to be identical with the primary lung lesion. In all cases complete dissection of mediastinal lymph nodes was accomplished to assure adequate staging of the intrathoracic disease. Of the 14 thoracotomies, five patients had stage 1 thoracic disease, four had stage 2, and five, stage 3.

The combined operative mortality was zero. Combination adjuvant therapy (thoracic irradiation and systemic chemotherapy) was utilized in eight patients (three prior to thoracotomy and five following thoracotomy). Total irradiation dosage was 4,000 rads delivered in divided doses, and the systemic chemotherapeutic agents consisted mainly of cis platinum and 5FU. Whole-brain irradiation was administered following craniotomy in four patients. In all instances, the neurosurgeon reported that the metastatic lesion was removed in its entirety. Complete neurologic improvement was obtained in 11 of 12 patients (92 percent) following initial craniotomy. One patient had a slight residual leg weakness. Complete neurologic improvement following all craniotomies was achieved in 15 out of 16 cases (94 percent).

The duration of neurologic improvement following initial craniotomy ranged from 1 to 56 months (18.2 ± 17.6, mean ± SD) and is depicted graphically in Figure 1. Eighty-one percent of patients were symptom-free one year after craniotomy, with 63 percent remaining so greater than four years afterward. The average time to recurrence of neurologic symptoms following repeat craniotomy was three months. Survival (actuarial) following initial craniotomy is depicted in Figure 2. It ranged from 1 to 56 months (26.3 ± 15.4, mean ± SD). Ninety percent of patients were alive one year following craniotomy, with 56 percent surviving longer than four years.

Overall survival following initial diagnosis is depicted in Figure 3, and ranged from 13 to 63 months.

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![Graph of survival function](image-url)

**Figure 1.** Symptom-free survival after initial craniotomy. Time in months; percentage symptom-free on ordinate.
(37.8 ± 17.9, mean ± SD). Seventy-eight percent of patients were alive 24 months after initial diagnosis while 65 percent of these patients have survived longer than four years. Eight of 12 patients are currently alive and free of disabling neurologic symptoms, with four patients dying, 1, 9, 24, and 36 months, respectively, after resection of their intracranial metastasis.

**DISCUSSION**

It is now well established that the brain is the most common site of early metastasis following apparently curative resection for lung cancer. Knights, in a study of 6,900 autopsies, found brain metastases in 55 percent, with single metastases in surgically accessible areas in 14 percent. He suggested that such lesions could be removed, increasing survival time. Nevertheless the idea of surgery for isolated intracranial metastasis has remained a controversial issue since its appearance in the literature in 1930. Cushing expressed pessimism regarding the results of such procedures, and Dandy also stated that operating on
patients with brain metastases would be unrewarding. Most probably this initial lack of enthusiasm resulted from a prohibitively high operative mortality.12 Refinements in diagnostic methods and neurosurgical skills have accounted for a dramatic fall in operative mortality, with most recent large series showing rates of 0 to 5 percent.13-15 The combined operative mortality in our series is in accordance with this, further supporting the fact that this group of patients may be operated on safely.

Survival in our 12 patients both from the time of diagnosis and initial craniotomy again compares favorably with other reported series, with our longest survivor being free of disease and neurologic symptoms five years after surgery. The longest reported survival time is at least 29 years. This patient had a thoracotomy in 1954 and a craniotomy for metastasis in 1955. In 1984, she presented with a new adenocarcinoma of the opposite lung.16 The number of patients in our series receiving adjuvant therapy for the primary or metastatic lesion is too small to draw any meaningful statistical conclusions from the data. However, reports by Martini,7 Kantarjian et al15 and Yardeni et al17 suggest that combination chemotherapy and whole-brain irradiation will play important roles in increasing survival. Presently, neurosurgeons at our institution are exploring the technique of interstitial irradiation by implanting after-loading catheters at the margins of resection. These catheters exit through the bone flap and are removed following completion of therapy. Perhaps this will provide a better means of local control, eliminating the need for multiple craniotomies, seen in this and other series.3,18

Briefly then, our treatment regimen for primary carcinoma of the lung with solitary brain metastasis has evolved as follows:

1. If the primary lung lesion has been previously resected and no additional metastatic disease is present, resection of the intracranial metastasis is considered if it is solitary, supratentorial, or otherwise suitable for total surgical removal.

2. If simultaneous brain and lung lesions are detected, the intracranial component of the disease is removed first, unless radiographic findings suggest that the intrathoracic component may not be completely resectable. In such cases, thoracotomy with pulmonary resection is completed first, followed shortly thereafter by craniotomy if appropriate.

3. If the metastatic lesion is detected first, and the search for a primary lung tumor is negative, the intracranial metastasis is resected.

4. Postoperative radiotherapy is recommended for all patients either in the form of whole-brain irradiation or local therapy to the area of metastasis.

In conclusion, the prospect of prolonged survival and improved quality of life for patients with cerebral metastasis from carcinoma of the lung has prompted us to adopt an aggressive approach in the treatment of these lesions.

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