SERIAL PULMONARY PERFUSION
SCANNING IN RADIATION THERAPY
FOR BRONCHOGENIC CARCINOMA

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Alterations in the perfusion lung scan pattern in bronchogenic carcinoma have been described by several authors (1–8). The potential usefulness of the perfusion lung scan technique by numerous authors has included early diagnosis, demonstration of perfusion deficits in excess of those predicted on chest x-ray as a possible guide to resectability and evaluation of response to therapy techniques. A group of patients referred for radiation therapy for inoperable bronchogenic carcinoma were studied by serial scanning techniques to ascertain whether the change in the perfusion scan pattern might be a useful guide in predicting the effectiveness of radiation therapy in this disease.

CASE MATERIAL

Thirty-four patients referred to the Claire Zellerbach Saroni Tumor Institute, Mount Zion Hospital and Medical Center, San Francisco, for radiation of inoperable bronchogenic carcinoma were included in this study. Perfusion lung scans using 131I-macro-aggregated albumin were carried out prior to radiation therapy, half way through therapy, after completion of therapy, and at followup periods of 3–12 months following therapy. Most of the patients were treated using a split-course technique, each course consisting of 6–8 treatments, with a 1-month rest period between courses. The total calculated mid-chest dose, using opposed anterior and posterior ports with supravoltage equipment, was usually 4,800 rads in 7–8 weeks.

At completion of the study, the serial scintiscan results were compared with serial x-ray studies of the chest taken at similar time intervals, with the

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**TABLE 1. CORRELATION OF LUNG SCAN CHANGES WITH X-RAY AND CLINICAL CHANGES AND SURVIVAL DATA**

<table>
<thead>
<tr>
<th>Changes in mass size by x-ray</th>
<th>Improved perfusion pattern</th>
<th>No change in perfusion pattern</th>
<th>Progressive perfusion deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decreasing 7</td>
<td>Decreasing 3</td>
<td>Decreasing 6</td>
</tr>
<tr>
<td></td>
<td>No change 4</td>
<td>No change 3</td>
<td>No change 2</td>
</tr>
<tr>
<td></td>
<td>Increasing 1</td>
<td>Increasing 0</td>
<td>Increasing 1</td>
</tr>
<tr>
<td>Clinical changes</td>
<td>Improved 7</td>
<td>Improved 3</td>
<td>Improved 5</td>
</tr>
<tr>
<td></td>
<td>No change 4</td>
<td>No change 2</td>
<td>No change 4</td>
</tr>
<tr>
<td></td>
<td>Deteriorated 1</td>
<td>Deteriorated 1</td>
<td>Deteriorated 0</td>
</tr>
<tr>
<td>Average survival after radiation therapy</td>
<td>6 months</td>
<td>7 months</td>
<td>8 months</td>
</tr>
<tr>
<td>Totals</td>
<td>12</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

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RESULTS

Of the 27 patients in the series who had two or more scans, there were 12 who showed an improvement in perfusion pattern following radiation therapy, six who showed no change, and nine who showed a decreased perfusion in the involved area (Table 1). These three groups of patients, separated on the basis of the serial lung scan patterns, were evaluated in regard to changes in serial chest x-ray examinations, alteration in clinical status, and average survival following radiation therapy. There was no apparent difference in these parameters of response among the three perfusion pattern groups.

The longest survivor expired 17 months after completion of radiation therapy. The perfusion pattern and chest x-rays showed slight improvement following therapy, but there was gradual progressive symp-

clinical response to radiation therapy, and with survival after radiation therapy. Recognizing the difficulty in making scans done at varying intervals exactly comparable in technical factors, only distinct differences in the volume of perfused lung seen in more than one view were considered significant evidence of improvement or deterioration in perfusion patterns.

Of the 34 patients originally entered in the study, seven completed only the first course of therapy and did not receive the second course because of the intervening development of distant metastases or death. Complete studies up to a 3-month post-therapy period were not attained on a further six patients because one patient left the area immediately after completing radiation therapy and the five others died of brain metastases or carcinomatosis.

FIG. 1. 69-year-old female with moderately undifferentiated squamous cell carcinoma of left lung. Posterior view perfusion scans were obtained at start of first half of split-course radiation therapy (A) and at start of second half of split course (B). Marked improvement in perfusion pattern and marked regression in left hilar mass was noted on serial study. Patient expired from widespread metastatic disease 6 weeks after completion of radiation therapy.

FIG. 2. 60-year-old male with oat cell carcinoma of left lung, diagnosed on sputum cytology. Scans shown were obtained at beginning of radiation therapy (A) and 3 months after completion of split-course radiation therapy (B). There was improvement in perfusion volume and decrease in hilar mass on x-ray examinations. Metastases to right acetabulum were noted on 2-11-69, and patient expired from generalized carcinomatosis 6 weeks later.
tomatology after therapy to the time of death. Other patients in this group showed marked improvement in perfusion (Figs. 1 and 2) and x-ray findings but expired within a few months from widespread metastatic involvement.

At the time the results of this study were tabulated, there was one survivor in each of the three perfusion scanning groups. The survivor showing an improved perfusion pattern had no change in x-ray findings but nearly complete resolution of chest symptomatology (Fig. 3). Only mild persistent cough was noted on the last follow-up evaluation 15 months after completion of radiation therapy.

The remaining survivor who showed no change in perfusion deficit related to tumor was alive 8 months after completion of radiation therapy. The only suggested change on perfusion pattern following radiation therapy was one of minimally decreased perfusion in the field of radiation therapy (Fig. 4). Metastatic spread of disease was noted 4 months after completion of therapy, and further radiation was given to supraclavicular metastatic spread. The sole survivor in the group showing a progressive deterioration in perfusion pattern was alive 10 months following radiation therapy. The remainder of this group expired with progression of pulmonary disease or development of distant metastatic spread.

DISCUSSION

The possible use of serial lung scan procedures to evaluate therapeutic response in treating inoperable bronchogenic carcinoma was suggested by Maynard et al in 1969 (4) and Goldman et al (1). It was felt that perfusion deficits caused by compression or infiltration of the major pulmonary arterial systems by primary tumor growth or nodal involvement might show demonstrable improvement as a sign of beneficial response to the therapy regime being used. Such serial perfusion scintiscan studies would only be helpful in evaluating therapeutic response of the primary lesion. This technique would not be expected to be helpful in evaluating potential metastatic spread.

The initial intent of this study was to evaluate the usefulness of the serial perfusion lung scans with respect to the changes in serial x-ray studies, change in clinical status, and survival patterns in this group of patients. The data derived from the serial studies show that the serial perfusion lung scans were not particularly helpful in predicting changes in any of these three parameters. The proportion of these patients showing a demonstrable decrease, increase, or no change in size of the mass demonstrated on chest x-ray studies did not correlate with the improvement or deterioration of perfusion patterns. A similar lack of correlation was noted in regard to the changes in clinical status in relation to changes in perfusion patterns. Another possible use of serial evaluation might be its value in predicting those patients who might have progressive pulmonary complications leading to death. The listed cause of death in 29 patients known to have expired in this series included only three whose deaths were directly attributable to respiratory complications. Two of these expired without completing the course of radiation therapy, and the third died 10 months after com-

FIG. 3. 52-year-old male with oat cell bronchogenic carcinoma involving upper right hilar structures, diagnosed at thoracotomy. Scans shown were obtained after first half of split-course therapy (A), and intervals of 3 months (B), 9 months (C), and 15 months (D) after completion of radiation therapy. There was return of perfusion to right middle lobe, but no return to right upper lobe. Patient is sole survivor among those showing some improvement in perfusion pattern after radiation therapy.
pleting radiation therapy. The latter patient showed increasing perfusion deficit 3 months after completion of therapy, a decrease in the size of the mass noted on chest x-ray, and an initial moderate improvement in clinical status. The results in this series of patients would suggest that radiation therapy is effective in controlling potentially fatal local complications, but that the serial perfusion lung scans were not particularly helpful in predicting a fatal pulmonary course of disease.

The average survival time of the three groups of patients in this study was not significantly different. The two patients who survived the greatest period of time following radiation therapy were both in the group showing some improvement in perfusion patterns, but the average survival in this group is slightly less than in the other two groups. At the time the study was completed, there was one remaining survivor in each of the three assigned perfusion groups. The data collected on this group of patients with inoperable bronchogenic carcinoma treated with radiation therapy indicated that the serial perfusion lung scans have not been helpful in predicting future clinical course or survival potential.

REFERENCES