High Dose-rate Endobronchial Irradiation in Malignant Airway Obstruction*

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We evaluated the effectiveness of high dose rate (HDR) endobronchial irradiation for palliation of malignant airway obstruction. Between May 1989 and February 1992, 39 patients were treated in our department. Thirty-two patients (82 percent) had primary lung neoplasms and 7 (18 percent) had metastatic disease. Thirty-three patients (85 percent) had prior external irradiation (either alone or in combination with chemotherapy), and 9 patients (23 percent) received laser excision before treatment. Of the 39 patients, 14 (36 percent) presented with hemoptysis, 20 (51 percent) with cough, 15 (38.5 percent) had dyspnea, and 15 patients (38.5 percent) had pneumonia or atelectasis. There were 57 applications performed in the 39 patients. Patients with hemoptysis had 83 percent complete response (CR), 20 percent with cough had CR; 60 percent improved (partial response [PR]); no response was seen in 20 percent. Atelectasis and pneumonia resolved in 20 percent of patients. Eighteen patients (46 percent) underwent a second procedure and were evaluated for objective response; 34 percent had CR, 44 percent had PR, and 22 percent did not respond. There were two acute (one bronchospasm, one pneumothorax) and three late (two strictures, and one exsanguination) complications. In our experience, HDR was highly effective in the palliation of airway symptoms caused by malignant tumors, with acceptable toxicity.

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| CR = complete response; HDR = high dose rate; PR = partial response |

**METHODS AND MATERIALS**

Between May 1989 and February 1992, 39 patients with endobronchial disease, referred to the Department of Radiation Oncology at Beth Israel Medical Center, New York, were treated by HDR endoluminal therapy. The selection criteria included the presence of endobronchial tumor, proven malignancy, and a performance status of at least 2 according to the Eastern Cooperative Oncology Group. The indications included hemoptysis, cough, dyspnea, atelectasis, or postobstructive pneumonia. The median age in this group of patients was 63 years, with a range of 37 to 88 years. There were 28 (72 percent) male and 11 (28 percent) female patients. Thirty-two patients (82 percent) had primary pulmonary neoplasm, and 7 patients (18 percent) had metastatic disease from other sites (2 breast, 1 hepatoma, 1 colon, 1 esophagus, 2 renal cell). Thirty-three (85 percent) of the 39 patients received external irradiation, 20 patients (51 percent) received chemotherapy, either alone or in combination with external irradiation prior to HDR. Six (15 percent) of the 39 patients had planned external irradiation in combination with HDR. Nine patients (23 percent) had laser therapy on one or two occasions before receiving endobronchial treatment. There was no unplanned laser treatment in any of the patients. They were referred to us after failure to maintain a patent lumen. Of the patients, 19 (49 percent) had >80 percent, 11 (28 percent) had >50 percent, and 9 patients (23 percent) had <50 percent obstruction of the lumen at presentation. At greater than 80 percent obstruction, only a catheter could be passed and, at 50 to 80 percent obstruction, a bronchoscope could be passed. Characteristics of patients by histologic condition and treatment received before HDR are shown in Table 1.

**Procedure**

Patients were admitted to an endoscopy room, then transferred to the endoscopy room. Intravenous sedation was started (midazolam [Versed], 4 mg, and meperidine [Demerol], 50 to 100 mg). Topical anesthesia (lidocaine [Xylocaine] and/or cocaine) was used as local anesthetic. A 4.9-mm diameter bronchoscope (Olympus BF-P20 dual ports) was introduced and passed via the patient's

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Table 1—Characteristics of Patients Treated With High Dose Rate Endobronchial Irradiation Presented by Type of Cancer and Previous Treatment Received

<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>No. of Patients</th>
<th>Radiation Therapy</th>
<th>Chemotherapy</th>
<th>Laser Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squamous cell</td>
<td>16</td>
<td>13</td>
<td>8</td>
<td>4</td>
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<tr>
<td>Adenocarcinoma</td>
<td>9</td>
<td>10</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Large cell cancer</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>...</td>
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<tr>
<td>Small cell cancer</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>...</td>
</tr>
<tr>
<td>Metastatic tumor</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>33</td>
<td>20</td>
<td>9</td>
</tr>
</tbody>
</table>

nostril to the endobronchial lesion. Under direct visualization and video imaging, the degree of obstruction was evaluated. The longitudinal dimension of the tumor was measured by passing the endoscope beyond the visible tumor. When this was not possible, the length of the tumor was estimated from the pretreatment computed tomographic (CT) scan. After measuring the length of the tumor and careful positioning of the bronchoscope, the afterloading catheter (6 French bronchial catheter) with guidewire was passed beyond the tumor. Position was confirmed on the fluoroscope and the bronchoscope was removed. The patient was transferred to the radiation therapy department for orthogon al radiographs with dummy sources for verification of catheter position and computer-assisted treatment planning. Figure 1 shows orthog onal films with dummy sources in place and computer-generated isodose curves superimposed on the lateral radiograph.

A micro selection HDR device (Nucletron, Veenendaal, the Netherlands) with high-activity 192Ir was used for treatment. The 8 to 10 Ci 192Ir radiation source, 3.5-mm active length × 0.6-mm diameter, is programmable in up to 48 dwell positions per catheter (step size of 2.5 or 5.0 mm) with 0 to 999.9 s in each dwell position. This enables the radiation dose to be shaped as required, or to match conventional dosimetry. The tumor and, whenever the anatomic situation permitted, a 2-cm distal and proximal margin, were treated. A uniform dose of 10 Gy was given at 1-cm depth from the center of the source. The patient was discharged from the hospital on the same day. If the procedure was repeated, a period of 2 weeks was kept between the two treatments.

Evaluation of Response

Patients were evaluated for subjective and objective response. Subjective response was assessed in terms of improvement in the symptoms. Assessment was done at 2 and/or 4 weeks posttreatment. This information was available for all but two patients and was

![Image](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/20382/)

**Figure 1.** Orthogonal radiographs with dummy sources in place. Lateral radiograph shows superimposed isodose curves.
scored as "excellent," "good," or "no response." Excellent response meant that the symptom disappeared entirely, good response meant when there was a definite improvement but the symptom was still present, and no response meant no change or worsening of the presenting symptoms.

Objective evaluation included bronchoscopy in those patients who underwent a second application. Patients who had one application only were evaluated and followed up by chest radiograph and CT of the chest or repeated bronchoscopy when feasible. Survival was measured from the time of the first HDR treatment.

RESULTS

There were 57 applications performed in the 39 patients. Thirty-seven of the 39 patients were available for subjective and/or objective response evaluation at 2 and/or 4 weeks following treatment. Two were unavailable to follow-up shortly after treatment and were not available for reexamination. Hemoptysis showed the best subjective response insofar as 93 percent (13 of the 14 patients) achieved complete resolution of bleeding. They remained hemoptysis free until the end of their lives. We were less successful in controlling cough. Only 20 percent of the patients became symptom free, 60 percent were able to reduce the amount of cough medication taken, and 20 percent did not have any improvement. Atelectasis and pneumonia cleared completely in 20 percent of patients.

Only 18 patients had a second bronchoscopy. Complete resolution of the endobronchial tumor was seen in six patients (34 percent), eight (44 percent) showed partial response, and four (22 percent) did not respond to the first treatment. Response to treatment did not correlate with histologic features, stage of disease, or anatomic location of tumor. Survival was also independent from response. For the 18 patients who were evaluable on second bronchoscopy, the median survival was 6.3 months with a range of 1 to 20 months. Figure 2 shows the radiographs of a patient with CR on second bronchoscopy. Chest radiograph was performed 35 days after treatment.

Toxicity

The incidence of acute complications was 3.5 percent; late complication was 8 percent with a 2 percent fatality rate. Acute complications included one bronchospasm in a patient with a known left vocal cord paralysis. The bronchospasm was relieved promptly by removing the catheter and the administration of low-dose (10 mg intravenously) dexamethasone. Another patient developed a loculated pneumothorax with the catheter in the right lower lobe. On reviewing the orthogonal radiographs, it appeared that the catheter slipped far out to the periphery and punctured the pleura. We removed the catheter, and the pneumothorax subsequently resolved spontaneously. Both of these patients subsequently underwent a second procedure and completed the prescribed treatment with no further complication.

Late toxic reactions included two bronchial strictures in two patients who had had two applications performed. There was no tumor in the strictured segment. One of the patients had dilatation of stricture 6 months after treatment and the bronchus stayed open until the patient died. The second patient did not respond to dilatation, but progressed to complete obstruction and collapse of the corresponding lobe. One of our patients exsanguinated 6 months after treatment; in him, the right upper lobe bronchus was treated with complete resolution of atelectasis 1 month.
after treatment. He also received 66 Gy in 33 fractions of external irradiation after that one application.

DISCUSSION

Different therapeutic modalities are currently available for palliation of malignant airway obstruction. These include external beam radiation, laser therapy, endobronchial radiation, and various combinations of these techniques.1-7

Endobronchial brachytherapy has an established role as one of these effective modalities. Roach et al8 have reviewed the current literature and reported response rates for low dose rate and HDR endobronchial irradiation. The results of eight series demonstrated a 67 to 100 percent symptomatic improvement with low dose rate and a 70 to 94 percent with HDR irradiation. They concluded that these two treatment modalities are highly comparable in terms of symptomatic relief and radiographic reaeration. Stout9 reports their experience with 77 patients at Christie Hospital in Manchester. Posttreatment hemoptysis stopped in 86 percent of cases, dyspnea was relieved in 61 percent, and cough was relieved in 51 percent. Reexpansion of lobes was achieved in 46 percent.

Our results are comparable to that of Stout insofar as 13 of the 14 patients (93 percent) who presented with hemoptysis achieved complete palliation without recurrence of hemoptysis. Relief of cough and dyspnea are also the same, while complete reexpansion of lobes occurred in only 20 percent of our patients compared to 46 percent in Stout's. Several criteria have been used to evaluate response to endobronchial HDR brachytherapy. These include symptom resolution, radiographic improvement, repeated bronchoscopic examination, and/or survival.10-12 However, one has to question the wisdom of repeated bronchoscopy in a group of patients with a median survival of a few months,4,6,7,10 only to document objective response. In the 15 patients who received rebronchoscopy, we were not able to document any correlation between response to therapy and survival. One may argue that, for patients treated with curative intent in combination with external irradiation, quantitative response evaluation to compare results is essential. Currently, high-resolution CT scan is under evaluation in our department as a potential instrument for an accurate objective reproducible system for response assessment.

Presently, there are no recommendations for dose specifications in endobronchial HDR brachytherapy. However, because there is a significant variation in the diameter of the bronchus lumen from a maximum of 13 mm in the trachea to a minimum of 4 mm in the lobar bronchus, a single 1-cm prescription point, as pointed out by Mehta et al.,10,11 may prove excessive for distal lesions. Similarly, for central lesions, a 1-cm prescription point may be inadequate to cover the tumor. Based on these observations, we chose to be more flexible in prescribing treatment depths in the future.

Acute complications are rare and, in most cases, not significant.7,11,13-15 Speiser and Spratling16 reported 4 acute complications occurring in 128 brachytherapy treatments. We had one bronchospasm in a patient with left vocal cord paralysis and one loculated pneumothorax. Both patients underwent a second procedure and received the prescribed treatment without further complication. Among the subacute and chronic complications, pseudomembrane formation, stricture, esophagobronchial, esophagotracheal, or bronchovascular fistulas are well documented.7,10,11,14,15 Khanavar et al16 reported seven serious complications, including cavitation of tumor, bronchoesophageal fistulas, and massive, fatal hemorrhage. These complications occurred mostly in patients who were treated with high-dose external irradiation or received laser therapy combined with high-dose endoluminal irradiation.11-14

With careful treatment planning and dosimetry, radiation-induced fatal bleeding and fistulas may be completely avoided or at least reduced to a minimum. In the Mayo Clinic series, 11 percent of the fistulas were treatment induced.15 High dose of radiation, tumor progression, or a fistula that manifested after irradiation are among the possible causes. In conclusion, HDR is highly effective in the palliation of debilitating symptoms caused by recurrent tumors with endobronchial components. As such, it improves the quality of life for a significant duration of the remaining life of patients. It also offers the advantage of an outpatient setting and reduced exposure to personnel. Since this procedure is almost always palliative, repeated bronchoscopy seems less than optimal.

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REFERENCES


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