# A Novel Strategy for Treatment of Metastatic Pulmonary Tumors: Radiofrequency Ablation in Conjunction with Surgery

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**Introduction:** Local treatment that includes surgical resection of metastatic pulmonary tumors is controversial because of the biologic features and invasiveness of these tumors. We report our experience with a premeditated treatment involving combined computed tomography-guided radiofrequency ablation and surgical resection in three patients with metastatic pulmonary tumors.

**Methods:** Three patients underwent radiofrequency ablation in conjunction with surgical resection. The first was a 67-year-old man with pulmonary metastases of bronchial adenoid cystic carcinoma. We performed partial resection of five tumors in the right lung and ablated a tumor in the left lung. The second was a 66-year-old man with pulmonary metastases of renal cell carcinoma. He underwent radiofrequency ablation for three tumors in the right upper and middle lobes, and right lower lobectomy for tumors in that lobe. The third was a 55-year-old man with pulmonary metastases of high-grade sarcoma of the right thigh. We performed partial resection of five tumors in the left lung and ablated a tumor in the right lung.

**Results:** Two patients had metastatic lesions on both sides of the lung; we performed surgical resection on one side and radiofrequency ablation contralaterally to avoid bilateral thoracotomy. The third patient underwent surgical resection and radiofrequency ablation to avoid highly invasive right pneumonectomy. All patients survived for more than 1½ years after combination therapy.

**Conclusions:** Premeditated treatment involving a combination of radiofrequency ablation and surgical resection can be a useful option in patients with metastatic pulmonary tumors, improving curability and avoiding highly invasive procedures.

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Despite recent medical advances, the prognosis of metastatic pulmonary tumors is still poor, perhaps because of their biologic features. Most pulmonary metastases arise from the hematogenous spread of malignant cells, and the lung is considered to be the first filter for malignant cells in most primary cancers. In selected patients, local treatment that includes surgical resection of these tumors is considered a controversial but acceptable option. Especially in nonsurgical candidates, treatment options are limited to chemotherapy with or without radiation therapy. Nevertheless, no effective chemotherapy regimen has been proposed for most metastatic pulmonary tumors, and therefore we must find alternative modalities.

Since the early 1990s, percutaneous radiofrequency ablation (RFA) has been one of the more successful options for the treatment of solid malignant tumors in various organs, especially the liver, because of its minimal invasiveness.[1–6] RFA of pulmonary tumors was first reported in 2000[7] and has become a promising treatment option for patients who are not surgical candidates.

We have treated patients with metastatic pulmonary tumors using a premeditated treatment involving RFA in conjunction with surgical resection, as there is potential for local control with these two modalities. In this article, we propose a new treatment option for metastatic pulmonary tumors.

## PATIENTS AND METHODS

Percutaneous RFA was performed in patients with intrathoracic malignancies between June 2001 and April 2006 in Okayama University Hospital. The RFA technique has been described previously.[8–10] The study was conducted with the approval of our institutional Human Studies Committee on June 12, 2001, and written informed consent was obtained from all patients.

In brief, RFA is usually performed under local anesthesia and sedation with intravenous fentanyl or epidural anesthesia, if necessary. Patients are monitored by continuous

pulse oximetry, electrocardiography, and blood pressure measurement. The placement of the radiofrequency electrode is confirmed by computed tomographic fluoroscopy. We usually use two types of electrodes coupled to a radiofrequency generator and a perfusion pump (Cool-tip RF system, 17-gauge internally cooled electrodes; Radionics/ValleyLab, Boulder, CO) or a LeVeen Needle Electrode (17-gauge multitined expandable electrodes with an RF 3000 generator; RadioTherapeutics Corp., Sunnyvale, CA, distributed by Boston Scientific, Natick, MA). The electric current was grounded by applying four grounding pads to the opposite chest wall.

A total of 229 patients underwent 389 RFA sessions applied for 637 lesions. Of these 229 patients, 188 (82.1%) who received RFA had metastatic pulmonary lesions, whereas 41 (17.9%) had primary lung carcinomas. All patients were nonsurgical candidates because they were at high risk for surgery, or had refused surgery, or because of the extent of their disease. The hospital observation period after RFA was 24 hours for most patients without any complications. Three patients underwent RFA in conjunction with surgical resection in this series.

The first patient, 67-year-old man, was diagnosed with bronchial adenoid cystic carcinoma and underwent sleeve resection of the bronchus in 1994. A metastatic tumor in the right lung was revealed on follow-up chest computed tomography (CT) in 1999, for which partial resection of the lung with adjuvant chemotherapy was performed. Approximately 1 year later, there was a new lesion in the left lung, and he underwent partial resection by video-assisted thoracic surgery. In 2003, six metastatic lung tumors on both sides were revealed on follow-up CT (five tumors on the right side and one on the left) (Figure 1*A–E*1). Bone scintigraphy and magnetic resonance imaging of the brain revealed no other metastatic lesions. The patient was not considered a candidate for surgical resection in both lungs because of the extent of the disease and poor respiratory function because of his history of multiple pulmonary resections. Surgical resection of the five tumors in the right lung followed by percutaneous RFA for the tumor in the left lung was considered the best option for local tumor eradication. We performed partial resection of the five tumors in the right lung on August 15, 2003 and ablated the tumor in the left lung (left S8, 27 × 23 mm) on September 9, 2003 (Figure 1*E*–2). Ablation was done three times using a Cool-tip electrode (total time 34 minutes, maximum power 117 W) under local anesthesia.

The second patient, a 66-year-old man, was diagnosed with renal cell carcinoma after presenting with hematuria in August 1995; he underwent left nephrectomy in September 1995. His medical history included diabetes mellitus, hypertension, and arrhythmia. A chest radiograph taken during a check-up in September 2002 revealed a nodule in the right lung, which was biopsied and found to be a metastatic lesion from the renal cell carcinoma. He then received immunotherapy with interferon. In September 2004, a follow-up CT revealed metastatic tumors in the right lung (Figure 2*A–D*). We considered it imperative for him to avoid right pneumonectomy, because of his comorbid conditions. Percutaneous RFA for three tumors in the right upper and middle lobes

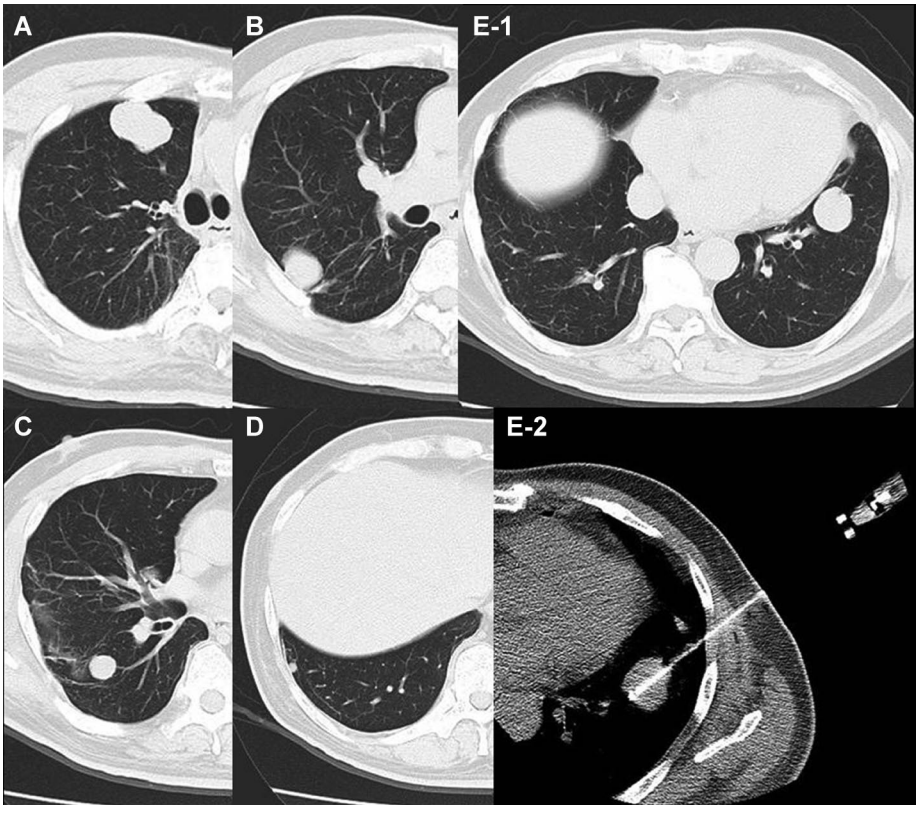


**FIGURE 1.** A 67-year-old man with pulmonary metastases from bronchial adenoid cystic carcinoma. *A, B, C, D, E-1*, CT scans of the chest show metastatic tumors in both lungs. *E-2*, CT scan obtained during radiofrequency ablation shows the position of the electrode in the tumor.