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Radiofrequency ablation for the treatment of stage I non–small cell lung cancer in high-risk patients

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Objective: Surgical resection is the standard of care for stage I non–small cell lung cancer. The objective of this study was to evaluate computed tomography–guided radiofrequency ablation as an alternative treatment option for high-risk patients with stage I non–small lung cancer.

Methods: Patients with medically inoperable stage I non–small lung cancer were offered radiofrequency ablation. Thoracic surgeons evaluated and performed radiofrequency ablation under computed tomographic scanning guidance. Response was assessed by means of computed tomographic and positron emission tomographic scanning. Time to progression and survival were monitored every 3 months.

Results: Nineteen patients underwent radiofrequency ablation over a 3-year period. There were 8 men and 11 women with a median age of 78 years (range, 68-88 years). Radiofrequency ablation resulted in pneumothorax requiring a pigtail catheter in 12 (63%) patients. An initial complete response was observed in 2 (10.5%) patients, a partial response in 10 (53%) patients, and stable disease in 5 (26%) patients. Early progression occurred in 2 (10.5%) patients. During follow-up, local progression occurred in 8 (42%) nodules, and the median time to progression was 27 months. There were no procedure-related mortalities, and 6 deaths occurred during follow-up. The mean follow-up in the remaining patients was 29 months (range, 9-52 months). The probability of survival at 1 year was estimated to be 95% (95% confidence interval, 0.85-1.0). The median survival was not reached.

Conclusion: Our experience indicates that radiofrequency ablation is safe in high-risk patients with stage I non–small lung cancer, with reasonable results in patients who are not fit for surgical intervention.

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Lung cancer is the most common cause of cancer-related mortality in the United States. Surgical resection is the standard treatment in resectable disease and offers the best chance of cure, particularly in the earlier stages.[1-3] In an aging population, many patients with otherwise resectable lung cancer have other comorbidities, including pulmonary dysfunction, which might preclude them from surgical resection.[4] In these patients conventional external beam radiotherapy is typically offered as treatment, with reported 5-year survival rates of 10% to 30%.[5-8] Sibley and colleagues[6] reviewed the results of radiotherapy for stage I non–small lung cancer (NSCLC) from Duke University in 156 patients and reported a 2- and 5-year survival of 39% and 13%, respectively. Recently, Qiao and associates[8] reviewed 18 studies investigating the treatment of stage I NSCLC with radiotherapy and reported a mean 3-year and 5-year overall survival of 34% and 21%, respectively. Thus the results of conventional radiotherapy have not been satisfactory, prompting investigators to study other modalities of treatment, such as radiofrequency ablation (RFA), in this high-risk group of patients with lung cancer.

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Abbreviations and Acronyms

CCI = Charlson Comorbidity Index
CT = computed tomography
FEV_1 = forced expiratory volume in 1 second
NSCLC = non–small cell lung cancer
PET = positron emission tomography
RECIST = Response Evaluation Criteria in Solid Tumors
RFA = radiofrequency ablation
SRS = stereotactic radiosurgery

The use of interstitial hyperthermia to treat lung neoplasm was initially reported by Lilly and colleagues[9] in 1983. RFA is a thermal ablative technique and is a relatively new modality of treatment, which might be applicable in high-risk patients with lung cancer. There have been several reports in the literature on the use of RFA for lung neoplasm, but many of these are case reports or series with a focus on immediate response, without rigorous longer-term follow-up for recurrence or survival.[10-14] Furthermore, there are few reports with an emphasis on stage I NSCLC. We have previously described our experience with RFA in the treatment of both primary and metastatic lung neoplasms.[15,16] The principal findings of our earlier report were that RFA was more effective for smaller (≤5 cm) tumors, with better early survival and response to treatment. Additionally, in our previous report, we described a modification of the Response Evaluation Criteria in Solid Tumors (RECIST) criteria (Table 1) that were used to assess treatment response and progression at the ablated sites. In this article we report our experience with the use of RFA in the treatment of stage I NSCLC in medically inoperable patients. This is part of an ongoing institutional review board-approved study that continues to accrue at the University of Pittsburgh.

Materials and Methods

We reviewed our experience with RFA for the treatment of stage I non–small lung neoplasm in medically inoperable patients at the University of Pittsburgh over a 3-year period from 2002-2005. Some of these patients have been reported previously.[16] Informed consent was obtained from all patients, and the study was approved by the Institutional Review Board at the University of Pittsburgh.

Selection of Patients

Patients with NSCLC were routinely staged with chest computed tomographic (CT) scanning, and most patients also underwent a positron emission tomographic (PET) scan. Patients with mediastinal lymph nodes greater than 1 cm in the short axis, a positive PET scan result, or both underwent mediastinoscopy. Mediastinoscopy was performed in 2 patients, and left-sided video-assisted thoracoscopic surgery was performed in 1 patient for biopsy of hilar and aortopulmonary window nodes. The inclusion criteria for RFA in the treatment of patients with stage I NSCLC for this study were as follows: (1) patients who were considered medically inoperable because of poor pulmonary function, high cardiac risk, and/or other comorbidities and (2) presence of a target tumor of 4 cm or smaller. In addition, patients who refused an operation were offered RFA if the tumor was peripheral and less than 4 cm. Exclusion criteria included central tumors. All patients were evaluated by a thoracic surgeon to determine inoperability and suitability for RFA.

Treatment Protocol

Technique. A percutaneous CT-guided approach was used in all patients, and as described previously, all procedures were performed by thoracic surgeons.[15,16] The RFA equipment consists of a generator, active electrode, and dispersive pads. Electrosurgical dispersive pads (Dispersive Electrodes, RITA Medical Systems, Inc, Moutainview, Calif, or Valleylab Polyhesive, Valleylab, Boulder, Colo) were applied to the patient's thighs and plugged into the return electrode socket on the front panel of the radiofrequency generator.

RFA was performed by using 2 different radiofrequency generators and needle electrodes. The radiofrequency generator was set up in accordance with the generator's instructions for use. One

TABLE 1. Modified RECIST criteria

Response	CT scan mass size	CT scan mass quality	PET scan*
Complete (2 of the following)	Lesion disappearance (scar) or <25% original size	Cyst cavity formation; low density	SUV < 2.5
Partial (1 of the following)	>30% Decrease in the sum LD of target lesions	Mass central necrosis or central cavity with liquid density	Decreased SUV or area of FDG uptake
Stable lesion (1 of the following)	<30% Decrease in the sum LD of target lesions	Mass solid appearance, no central necrosis or cavity	Unchanged SUV or area of FDG uptake
Progression (2 of the following)	Increase of >20% in sum LD of target lesions	Solid mass, invasion adjacent structures	Higher SUV or larger area of FDG uptake

CT, Computed tomography; *PET*, positron emission tomography; *SUV*, standardized uptake value of fluorodeoxyglucose F18; *FDG*, fluorodeoxyglucose F18; *LD*, lesion diameter. *Positron emission tomographic scan done selectively.

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