Radiofrequency Ablation

of Lung Malignancies

by Ryan Neff, MD, and Thomas L. Bauer, MD

The American Cancer Society (ACS) estimated 173,770 new lung cancers, 160,400 deaths from lung cancer, and 440,000 deaths from tobacco-related illness for the United States in 2004.[1] According to ACS, deaths from lung cancer in this country outnumber the cumulative deaths from colon, breast, and prostate cancers. Since lung cancer rarely causes symptoms until later stages, most patients present with advanced disease, thus explaining the poor, 14 percent, five-year survival rate.[2] Although survival of early-stage lung cancer has been reported up to 85 percent,[3] survival rates are much lower for advanced stages of the disease.

Many patients with primary and secondary lung malignancies are not surgical candidates, and treatment options are limited and controversial. Among the treatment options are external beam radiation and stereotactic radiosurgery.

External beam radiation therapy (EBRT) has been used for local control of tumors, but its damage to adjacent lung tissue and local failure rates make it inferior to resection. EBRT also requires daily visits to a treatment center over several weeks.

Stereotactic radiosurgery attempts to maximize radiation delivery to the tumor through multiple radiation emitting pathways intersecting on the tumor thereby minimizing radiation exposure to the surrounding lung and adjacent tissues.[4]

Radiofrequency ablation (RFA) of primary or secondary lung malignancies is gaining acceptance in improving the quality of life for patients with lung cancer. RFA is used in tumors of the liver, bone, spleen, pancreas, breast, and adrenal glands[5] and provides a reasonable alternative for patients who are not candidates for definitive surgical resection.

RFA Delivery

Radiofrequency ablation is a thermal energy delivery system that uses an alternating electrical current. After a needle electrode is introduced into the tumor, multiple tines are deployed that create ionic agitation increasing temperatures up to 100°C. As a result, coagulative necrosis and tissue destruction occur in the vicinity of the probe. RFA has been used extensively on hepatic tumors as reported by Curley and associates who demonstrated a 1.8 percent local recurrence at a median follow-up of 15 months as well as a low 2.4 percent complication rate.[6]

Despite its role in hepatic malignancies, concern remained regarding RFA in the lung. Heat diffusion from the lesion can be erratic, because of air-filled lung and large nearby vessels acting as heat sinks. Moreover, tines within the aerated lung have little surrounding tissue which would minimize the contact with the device at the time of energy application. This process can induce edema and hemorrhagic necrosis of the normal lung.[7] Nevertheless, animal studies illustrated that RFA could be utilized safely and effectively in pulmonary parenchyma.[8]

The technique of radiofrequency ablation uses imaging such as computed tomography (CT), ultrasound, or MRI to target the lesion and deploy the needle with tines. Direct vision has also been used such as bronchoscopy,[9] laparotomy, or mini-thoracotomy.[10] The LeVeen needle is introduced into the center of lesions less than 3 cm and a compound thermal lesion can be made as described by Buscarini and Curley with multiple needle passes.[11,12] A significant percentage of the procedures in pulmonary tumors are done on an outpatient basis under conscious sedation as demonstrated by Steinke and Morris.[13] Antibiotics are given the day of the procedure and up to seven days thereafter. Patients generally experience mild pain overnight in the treated areas and an increased temperature up to three days post-procedure due to tumor lysis.

After the ablation, tumor response and surveillance are performed by CT imaging with or without PET scans. The timing of imaging is anywhere from immediately following the procedure if done in a radiology suite up to one week thereafter. Scheduled CT scans are obtained at three month intervals at most centers. As most studies indicate, the size of the tumor on imaging will increase following radiofrequency ablation due to the surrounding parenchymal hemorrhage, atelectasis, and pneumonitis. Akeboshi and colleagues utililized both CT and PET to monitor response to radiofrequency ablation.[14] They defined a complete response following RFA as a complete resolution of FDG-uptake in the treated lesion on PET image and the eradication of tumor enhancement on contrast-enhanced CT images. According to their findings, PET showed a higher sensitivity and specificity to detect residual tumors at one week but at three months the two tests were almost equivalent. Residual tumors were always observed in the periphery of the zone of ablation with a punctuated or crescentic shape on both PET and contrast-enhanced CT images. The study also showed size was a factor affecting complete tumor necrosis as tumors less than 3 cm faired better than those greater than 3 cm (69 percent vs. 39 percent). They further demonstrated no significant difference between primary and secondary tumor response to ablation.[14]

RFA Considerations

While the local control of lung tumors with radiofrequency ablation is encouraging, it still is second to surgical resection. However, in patients with medically unresectable lung tumors, radiofrequency ablation does provide a reasonable alternative. Radiofrequency ablation can achieve up to 46 percent complete response in the treatment of primary lung tumors.[14] Radiofrequency ablation can destroy the central, poorly oxygenated portion of tumors. These areas are traditionally less responsive to chemotherapy and radiation therapy. Another advantage includes the ability to eradicate tumors without necessitating their removal. The patient is spared from the systemic effects of chemotherapy and the patient's pulmonary function is preserved as radiofrequency ablation decreases the toxicity to surrounding tissues. Also, the single experience outpatient nature of the procedure improves quality of life by eliminating subsequent procedures such as with chemotherapy and conventional radiation.

During radiofrequency ablation complications have been encountered that range from pneumothoraces and pleural effusions not requiring intervention to massive hemorrhage and cerebral microembolization. Drainage for pneumothoraces ranged from 10 to 30 percent consisting of either a chest tube or pigtail catheter. Pleural effusions also were drained after 10 to 30 percent of procedures at the discretion of the treating physician.[13] Inability to retract the hooks has also been described, a potential for damage to adjacent tissue along the needle axis.[15] Massive intraparenchymal and extrapleural hemorrhage was noted in a patient taking clopidigrel.[16] Rose and colleagues demonstrated microemboli during ablation of lung tumors within the carotid circulation. Fortunately, these emboli had no clinical effect on the patients and their significance is unknown.[17] Despite being a less invasive means of controlling medically unresectable tumors, the potential side effects of radiofrequency ablation should not be overlooked. Still, an international study demonstrated a mortality of 0.4 percent in 463 patients pooled from three institutions and a low rate of complications.[13]

Radiofrequency ablation of primary or secondary lung malignancies provides a reasonable alternative for patients who are not candidates for definitive surgical resection. By providing a relatively safe, minimally invasive tool for controlling local tumor growth that may be provided on an outpatient basis, radiofrequency ablation has gained acceptance in improving the quality of life for those patients with lung malignancies. A prospective randomized trial is required to adequately compare RFA to radiation therapies. Until then, this procedure should be performed at centers that have a large experience with RFA and are able to closely follow these patients.

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