Percutaneous Radiofrequency Ablation for Pulmonary Metastases from Colorectal Cancer: Midterm Results in 27 Patients

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PURPOSE: To retrospectively evaluate the midterm outcomes (eg, safety, local efficacy, and survival) after radiofrequency (RF) ablation for pulmonary metastases from colorectal cancer.

MATERIALS AND METHODS: Twenty-seven patients (19 men and eight women; mean age, 61.6 years) with 49 pulmonary metastases (mean long axis diameter, 1.5 cm) from colorectal cancer underwent 41 percutaneous computed tomography (CT)–guided RF ablation sessions. Follow-up examinations were performed with CT by using contrast medium administration in all patients; positron emission tomography was performed in five patients. The safety of the procedure, local tumor control, and patient survival were evaluated. Multiple variables were analyzed to determine prognostic factors.

RESULTS: Pneumothorax occurred after 20 of the 41 sessions (49%), three of which necessitated chest tube placement. A small pleural effusion was found after six of the 41 sessions (15%). No major hemorrhagic event was observed. None of the patients died due to the procedure. The median follow-up period was 20.1 months (range, 11.2−47.7 months). The primary and secondary technique effectiveness rates were 72% and 85%, respectively, at 1 year, 56% and 62% at 2 years, and 56% and 62% at 3 years. The overall survival rates after RF ablation were 96% at 1 year, 54% at 2 years, and 48% at 3 years. The presence of extrapulmonary metastasis was determined to be a prognostic factor ($P = .001$).

CONCLUSIONS: The midterm outcomes of percutaneous RF ablation for colorectal pulmonary metastases appear promising. The presence of extrapulmonary metastasis had an adverse effect on survival after RF ablation.

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Abbreviations: CI = confidence interval, RF ablation = radiofrequency ablation

MOST cases of recurrence after surgical resection of colorectal cancer are locoregional. The most common site of distant metastases is the liver, followed by the lung. Approximately 10% of patients who undergo curative resection for colorectal cancer develop pulmonary metastases (1). Standard treatment options for pulmonary metastases include surgery and chemotherapy. Many surgeons believe that surgical resection is the best treatment that offers the potential for long-term survival in patients with a relatively small number of metastases. Several large studies (>100 patients) have demonstrated a survival rate of approximately 40% 5 years after pulmonary metastasectomy (2–5). Most patients with pulmonary metastases, however, are not candidates for surgery because they have other coexistent metastases, have poor cardiopulmonary function, and refuse to undergo surgery. A recent chemotherapy regimen using fluorouracil and leucovorin with irinotecan or oxaliplatin has been shown to prolong survival, but the long-term results are still less than satisfactory: The median survival was 14.8−21.5 months for patients with metastatic colorectal cancer (6). Therefore, various other treatment modalities may be attractive and have been the focus of research, including stereotactic radiation therapy, cryoablation, laser ablation, and radiofrequency (RF) ablation.

RF ablation is a thermal therapy that results in coagulation necrosis. The procedure involves the placement of an electrode into the target followed by the application of radiofrequency energy. Initially, RF ablation was

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mainly used for treating hepatocellular carcinoma. The favorable outcomes in the treatment of hepatocellular carcinoma have encouraged the application of this technique to neoplasms in other organs, including the lungs. Preliminary studies about the use of RF ablation in treating lung tumors have shown promising initial local control (7–9). The purpose of the present study was to retrospectively evaluate the midterm outcomes of RF ablation for pulmonary metastases from colorectal cancer.

MATERIALS AND METHODS

Approval from the institutional review board and informed consent from the patients were obtained to perform RF ablation of lung tumors.

Study Population

From June 2001 to February 2006, 209 patients with primary or metastatic lung neoplasms underwent 329 percutaneous RF ablation sessions at our institution. Of these 209 patients, 27 with 49 tumors were diagnosed with pulmonary metastases from previously resected colorectal cancer and underwent RF ablation for all of the pulmonary metastases that were demonstrated on preprocedural computed tomographic (CT) scans (ie, RF ablation was performed with curative intent for pulmonary metastases). Thus, these patients formed the basis of our study. We excluded the patients who had pulmonary metastases and underwent RF ablation, but in whom the treatment was aimed at palliation of the patient's symptoms or tumor cytoreduction. The diagnosis was made on the basis of the results of serial CT scans. In five patients, the diagnosis was confirmed with histologic examination. Positron emission tomography (PET) was performed in 11 patients. None of the patients were considered to be candidates for surgery because of their advanced ages, poor cardiopulmonary function, poor performance status, and/or refusal to undergo surgery. All patients met our inclusion criteria with regard to bleeding parameters, as follows: platelet count of more than 50×10^9/L and prothrombin time–international normalized ratio of less than 1.5.

Our study population included 19 men and eight women (mean age, 61.6 years; age range, 43−80 years). The site of the primary cancer was the colon in 14 patients and the rectum in 13. At the time of the first RF ablation session, 11 patients had one tumor, 12 had two tumors, and two each had three and four tumors, respectively. The pulmonary metastases were unilateral in 22 patients and bilateral in five. The mean long axis diameter of the 49 tumors was 1.5 cm (range, 0.3–3.5 cm). The long axis diameter of the largest metastasis in each patient was less than 2 cm in 16 patients (mean, 1.5 cm) and at least 2 cm in 11 patients (mean, 2.5 cm); specifically, the long axis diameter was less than 1 cm in one patient, 1−1.9 cm in 15 patients, 2−2.9 cm in nine patients, and at least 3 cm in two patients. Eleven patients had extrapulmonary metastasis, including metastasis to the liver ($n = 8$), the pulmonary hilar lymph node ($n = 1$), the pelvic lymph node ($n = 1$), and the ovary ($n = 1$). All eight patients with hepatic metastasis had undergone surgical resection for the metastasis before RF ablation; however, hepatic metastasis recurred at the time of RF ablation in three patients. Three patients with lymph node metastasis or ovarian metastasis had undergone systemic chemotherapy for the metastasis, but it was not completely treated. The pulmonary metastases were identified 0−60.8 months (median, 24.0 months) after surgery for the primary cancer. The first therapy for the pulmonary metastases was surgical resection in 12 patients, systemic chemotherapy in six, and RF ablation in nine. In the 18 patients who underwent surgical resection or chemotherapy as the first therapy, RF ablation was performed for residual or recurrent intrapulmonary tumor 1.2−38.5 months (median, 23.6 months) after the first therapy. The 27 patients underwent a total of 41 RF ablation sessions, including six repeat sessions to treat local progression after a previous session and/or intrapulmonary de novo recurrence. None of the patients underwent concomitant systemic chemotherapy.

RF Ablation Techniques

The electrodes used in the 41 sessions included a multitined expandable electrode with a 2-cm ($n = 21$) or 3-cm ($n = 1$) diameter array (LeVeen; Boston Scientific, Natick, Mass) and a single internally cooled electrode with a 1-cm ($n = 1$), 2-cm ($n = 17$), or 3-cm ($n = 1$) noninsulated tip (Cool-tip; Valleylab, Boulder, Colo). Each procedure was performed percutaneously by using CT fluoroscopy. Intraprocedural pain was treated by using local anesthesia alone ($n = 29$) or a combination of local and epidural anesthesia ($n = 12$). Conscious sedation was obtained with intramuscular administration of hydroxyzine and intravenous drip infusion of fentanyl in all patients. Prophylactic antibiotics were not used in any patient.

The patients were placed in the supine ($n = 13$) or prone ($n = 28$) position depending on the tumor location, and grounding pads were placed on their thighs. After the administration of anesthesia, the electrode was introduced into the tumor and connected to a generator (CC-1, Valleylab; RF 2000 or RF 3000, Boston Scientific). In the case of the Valleylab device, radiofrequency energy was applied with an impedance control algorithm for 12 minutes during internal cooling of the electrode. Thereafter, the temperature was measured at the electrode tip; if it had not reached 60°C, another energy application was performed at the same site. When using the Boston Scientific device, the energy was applied until the impedance showed a rapid increase or an automatic shut-off at 15 minutes; this was repeated once at each site. Multiple overlapping ablation zones were created when an ablation zone per application was expected to be smaller than the tumor along with an ablative margin. Immediately after the procedure, CT scans of the entire lung were obtained to assess the procedure. A posteroanterior upright chest radiograph was obtained 4 hours later and again the following morning.

Follow-up

The patients were followed up, whenever possible, 1, 3, 6, 9, and 12 months after the procedure and thereafter at 6-month intervals. At every follow-up, chest CT was performed to assess the RF ablation outcomes. The images were obtained before and 30 and 90 seconds after the initiation of