CLINICAL STUDY

Long-Term Survival after Radiofrequency Ablation of Lung Oligometastases from Five Types of Primary Lesions: A Retrospective Evaluation

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ABSTRACT

Purpose: To conduct a retrospective evaluation of long-term survival after radiofrequency (RF) ablation for lung oligometastases from 5 types of primary lesions.

Materials and Methods: The study population consisted of 123 patients with lung oligometastases from colorectal cancer (CRC), non–small-cell lung cancer, hepatocellular carcinoma, esophageal cancer, and renal-cell carcinoma treated with RF ablation. Lung oligometastases were defined as 1–5 metastases confined to the lung while the primary cancer and other metastases were eradicated. Overall survival (OS) and recurrence-free survival (RFS) were estimated for the overall study population and for patients with each type of primary lesion. The OS and RFS rates were compared with those of the patients with any of the other four primary lesion types. Finally, various variables were analyzed to determine what factors influenced OS and RFS.

Results: The median follow-up was 45.7 months, and the 5-year OS and RFS rates for all 123 patients were 62% and 25%, respectively. The OS time for patients with metastases from CRC was significantly longer ($P = .042$); it was significantly shorter ($P = .022$) in patients with metastases from esophageal cancer. Longer disease-free interval was significantly ($P = .015$) associated with better OS. There was no variable significantly associated with OS and RFS on multivariate analyses.

Conclusions: Data from this single-center study appear promising in terms of long-term survival after RF ablation of lung oligometastases from 5 primary lesions.

ABBREVIATIONS

CRC = colorectal cancer, HCC = hepatocellular carcinoma, NSCLC = non–small-cell lung cancer, OS = overall survival, RCC = renal cell carcinoma, RF = radiofrequency, RFS = recurrence-free survival, SBRT = stereotactic body radiation therapy

The lung is the second most frequent site of metastasis from extrathoracic cancers (1), following the liver (2). Lung metastases develop in approximately 5% of patients who undergo curative resection for colorectal cancer (2). Curative local therapy can be applied to oligometastases—defined by Hellman and Weichselbaum (3,4) as metastases that are limited in number and location—with the aim of long-term survival or even cure.

Surgical resection is considered the standard curative local therapy for lung metastases. However, many patients are not candidates for surgical treatment for reasons such as limited organ function, comorbidities, or refusal to undergo surgery.

Radiofrequency (RF) ablation is another local therapy for lung metastasis. RF ablation is less invasive, making it an attractive therapy option for nonsurgical candidates. Although some studies (5–8) have shown long-term

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survival of patients treated with RF ablation of lung metastases from various types of primary cancer, the populations of those studies were not limited to patients with oligometastases. Therefore, long-term survival data following RF ablation of lung oligometastases are still lacking. Therefore, the purpose of the present study was to undertake a retrospective evaluation of long-term survival after RF ablation of lung oligometastases from five types of primary lesions.

MATERIALS AND METHODS

The institutional review board approved this retrospective study (approval no. 2286), and informed consent was obtained from all patients before the procedure was performed.

Study Population

Between June 2001 and December 2013, 556 patients with lung metastases from various primary lesions underwent RF ablation at a single institution. This study focused on lung oligometastases from five types of primary cancer: colorectal cancer (CRC), non–small-cell lung cancer (NSCLC), hepatocellular carcinoma (HCC), esophageal cancer, and renal-cell carcinoma (RCC). Lung oligometastases were defined as one to five metastases confined to the lung while the primary lesion and other metastases, if they existed, were eradicated by any treatment at the time of the initial RF ablation. Patients with lung oligometastases from other primary lesions were excluded because they were limited in number.

The inclusion criteria for the study were as follows: (*i*) lung oligometastases from any of the aforementioned primary lesions, (*ii*) all lung oligometastases treated with RF ablation, and (*iii*) follow-up for surviving patients of longer than 6 months. Therefore, the one patient who survived but was followed up for less than 6 months was excluded, whereas the two patients who died within 6 months after RF ablation were included. The patients who underwent other local therapies (eg, surgery and stereotactic body radiation therapy [SBRT]) in addition to RF ablation to eradicate lung oligometastases were excluded, but patients who underwent concurrent or adjuvant chemotherapy were included.

One hundred twenty-three patients (84 men and 39 women; mean age, 65.6 y; age range, 34–94 y) with a total of 222 lung oligometastases (mean long-axis tumor diameter, 12.5 mm; range, 2–50 mm) met the inclusion criteria. The characteristics of the study population are summarized in **Table 1**. The study cohort included 70 patients (43 with CRC, eight with HCC, 14 with esophageal cancer, and five with RCC) who had been previously described elsewhere (9–12), and their follow-up data were updated for the present study. The present study was newly conducted because it enabled comparison of survival after RF ablation of lung oligometastases among the five primary lesions. In addition, the study was different from the previous studies in that the cohort was confined to patients with lung oligometastases.

Lung oligometastases were primarily from CRC in 52 patients, NSCLC in 33 patients, HCC in 16 patients, esophageal cancer in 14 patients, and RCC in eight patients. One hundred ninety lung metastases were clinically diagnosed based on the results of serial chest computed tomography (CT) scans, whereas 32 were pathologically confirmed by biopsy. There was a single lung metastasis in each of 62 patients and multiple lung metastases in 61. Ninety-two and 31 patients underwent single and multiple RF ablation sessions, respectively. Fifty-six patients had a history of pulmonary metastasis, extrapulmonary metastasis, or both, all of which were eradicated (by any therapy) at the time of RF ablation.

RF Ablation Techniques

RF ablation techniques used at our institution were similar to those that have previously been described in the literature (13). RF ablation was always performed in an inpatient setting. Intraprocedural pain was treated by using a combination of local or epidural anesthesia and conscious sedation with fentanyl. The procedure was percutaneously carried out under CT fluoroscopic guidance (Asteion or Aquilion; Toshiba, Tochigi, Japan).

The electrode used for RF ablation was a multitined expandable electrode (LeVeen; Boston Scientific, Marlborough, Massachusetts) or a single internally cooled electrode (Cool-tip; Covidien, Mansfield, Massachusetts). A multitined expandable electrode was preferred. However, a single internally cooled electrode was used in cases in which there was a concern that expendable tines might result in injury to critical structures, such as large vessels. RF ablation was performed with the aim of ablating the tumors with at least 5 mm of marginal parenchyma. Each session targeted only one lung, so bilateral metastases were treated with multiple sessions.

Follow-up

Follow-up sessions were conducted at 1 month (range, 4–6 wk), 3 months (range, 2–4 months), 6 months (range, 5–7 months), 9 months (range, 8–10 months), and 12 months (range, 11–13 months), and at 6-month intervals (range, 5–7 months) thereafter. At every follow-up session, chest and abdominal CT were performed before and, whenever possible, after intravenous administration of a contrast agent, with 5-mm collimation. The diagnostic criteria for local tumor progression at our institution were similar to those that have previously been described in the literature (13). In short, local tumor progression was indicated by the appearance of an irregular, scattered, nodular, or eccentric focus in the

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