Radiofrequency Thermal Ablation in the Treatment of Lung Malignancies

COSMO GADALETA 1, ANNAMARIA CATINO 1 and VITTORIO MATTIOLI 2

1 Interventional Radiology Operative Unit and
2 Critical Area Department, Oncology Institute, Bari, Italy

Abstract. Background: Radiofrequency ablation (RFA) is an advanced, minimally invasive technique used to treat several types of neoplasm. Its application in the treatment of lung tumors has received great interest. Patients and Methods: Fifty-four patients with 10 unresectable primary lung tumors and 83 lung metastases from various solid tumors were treated with percutaneous RFA. Results: The procedure was performed under CT scan guidance and general anaesthesia. The rate of complete necrosis of the treated neoplasms was 95%, while the most frequent complication was pneumothorax, requiring pleural drainage in 12% of sessions. CT scan and MRI with gadolinium have shown to be accurate and useful in assessing the therapeutic efficacy of lung RFA. Conclusion: Lung RFA is a very promising technique, minimally invasive and well-tolerated in the majority of patients; further investigation is required in order to define the optimal role of lung RFA in the multidisciplinary therapy of lung malignancies.

Among the new image-guided percutaneous techniques which are based on hyperthermic energy, radiofrequency thermal ablation (RFA) has recently received much attention as minimally invasive approach for the local treatment of solid neoplasms (1). Medium-frequency electromagnetic waves of 480 kHz produce ionic agitation and frictional heat within the tissue surrounding the tip of the needle, leading to irreparable cellular damage and coagulative necrosis (1).

Lung tumors seem to be good targets for RFA because the surrounding air in the adjacent normal lung parenchyma provides an insulating effect, concentrating the RF energy within the tumor tissue (2).

Patients and Methods

From February 2002 to June 2006, 54 patients with 93 lung neoplasms (9 with primary NSCLC and 45 with metastases from other solid tumors) underwent lung RFA.

Lung lesions were subclassified as follows: paramediastinal, those in contact with mediastinal structures (without infiltration) or less than 1 cm from them, including fibrous pericardium, major vessels, cardiac pedicle, trachea and bronchi; central-parenchymal, those fully surrounded by pulmonary aerated parenchyma, more than 1 cm from the mediastinal structures and visceral pleura; subpleural, those in direct contact (without infiltration), or distant less than 1 cm from the pleura.

Patients were considered unresectable due to technical or anatomic/functional contraindications, or in case of refusal of surgery.

Main inclusion/exclusion criteria are summarized in Table I.

The technique was performed under general anaesthesia with intubation by a double-lumen tube used for all patients. After CT scan centering, percutaneous lung RFA was performed using a 17-gauge monopolar, cooled electrode needle, with lengths ranging between 10 and 15 cm, depending on the depth of the lesion to be treated. The exposed part of the needle (i.e., the non-insulated portion) was between 1 and 3 cm. Selection of the exposed tip length of the needle was based on the diameter of the lesion (36), choosing a needle size always greater than the area to be treated. The wattage/current setting is selected automatically by the system and is based on the amount of water within any specific tissue (i.e., the amount of free-ions present). The system adjusts itself according to the level of resistance and impedance. A maximum treatment time of 12 min has been found to ensure complete necrotic coagulation of the tumor volume according to the corresponding diameter of the exposed part of the needle. The system alternates between "on" (active) and "off" (inactive) modes. Long periods (30-40 sec) of inactivity by the machine and short

Correspondence to: Dr. Cosmo Gadaleta, Interventional Radiology Operative Unit, Oncology Institute Bari-Italy, Via Hahnemann,10 – 70126, Bari, Italy. Tel: +39 0 805555674, Fax: +39 0 805555677, e-mail: c.gadaleta@infinito.it

Key Words: Radiofrequency thermal ablation (RFA), lung malignancies.
Results

Ninety-three lung neoplasms in 54 patients underwent RFA, while 67 sessions of treatment were carried out.

With a median follow-up of 18 months, complete ablation of the entire lesion was achieved in 88 out of 93 cases (95%). Local recurrence only in the treated area was observed in 2 cases (2%), whereas 5 cases showed relapse both in treated area and/or other distant sites. Among the 5 patients who relapsed in the treated area, 3 had nodules larger than 3.5 cm.

The major complication was pneumothorax, requiring chest-tube placement in 8 out of 67 (12%) sessions.

Discussion

Lung RFA was demonstrated to be safe and feasible; the percutaneous approach and imaging guidance made this procedure suitable for patients considered unfit for standard surgical resection. The usually short hospital stay and the good tolerability contributed to RFA being well accepted by patients, resulting in a favourable impact on quality of life. Pneumothorax was the most serious complication; in our experience it occurred in 12% of sessions.

The technique was extremely promising also with respect to the efficacy; in our experience it was possible to obtain a high rate of complete ablation in the treated nodules (95%).

In agreement with other authors (8), we think that in case of lesions larger than 3.5 cm it is difficult to achieve complete necrosis; nevertheless, when the subdivision of the lesion in overlapped sectors is required, the use of repeated CT scan during the procedure could improve the technical results, due to the capability of monitoring even the slightest repositioning of the electrode-needle.

Lung RFA produces a typical radiological appearance which resembles a "cockade", so-called due to the formation of concentric layers surrounding the ablated lesion, most...
likely corresponding to histopathological changes and related to thermal gradients between the tumoral nodule and the surrounding parenchyma (5).

CT scan is the most widely used imaging technique to evaluate lung tumors treated with RFA, able to detect changes in contrast-enhancement, as well as the presence of cavitation (5-7, 9-12). In addition, NMR with gadolinium could be potentially useful to evaluate the therapeutic efficacy of lung RFA, by providing information about tumoral density and composition, as well as to accurately determine the extent of tissue necrosis (5-7, 13). Notwithstanding the need for more standardized methods, we consider CT scan and NMR with gadolinium reliable techniques for radiologic assessment of treatment efficacy and follow-up of lung neoplasms submitted to RFA.

Further well-designed and long-term clinical trials are warranted to: 1) identify which subgroups of patients are ideal candidates for this procedure, 2) determine the optimal combination of lung RFA with other antineoplastic therapies, and finally 3) establish the impact of lung RFA on patient survival with respect to standard therapy.

In conclusion, the current experience on lung RFA suggests that this procedure could represent an important tool in the multidisciplinary approach to unresectable lung tumors.

References