Radiofrequency ablation of lung tumours

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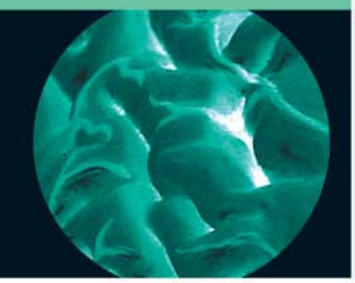


Introduction

Image-guided percutaneous radiofrequency (RF) ablation is a minimally invasive technique for the treatment of solid tumours that has been introduced into clinical practice relatively recently. It is now considered a feasible treatment option for patients with primary hepatocellular cancer or limited liver metastases.
As the technology evolves, RF ablation is now being evaluated in other types of tumours. A general review of RF ablation was included in a previous issue of C²I² [2]. This paper focuses on the use of the technique for lung tumours and updates an earlier review [1] with new clinical trial results presented at the Annual Scientific Meeting of the Cardiovascular and Interventional Radiology Society of Europe (CIRSE) in September 2005.

The lung is the most common site for primary cancer worldwide (accounting for 13% of all new cancer cases in the US), and is also a common site for metastatic disease. Many of these patients are not suitable for surgical treatment, often because of their age, poor cardiovascular or respiratory function, or other serious coexisting health conditions or because of the size and location of the tumour. Hence, it is logical to extend the use of RF ablation to patients with limited lung tumours not eligible for surgical resection.

RF ablation

The principle of RF ablation is that the high-frequency current from the RF generator passes between the needle electrode placed in the tumour and a large electrode on the patient's skin. The alternating electric field that is created between the electrodes induces marked agitation of the ions resulting in frictional heating of the surrounding tissue, which causes irreversible damage. In animal studies, a well-defined area of coagulation necrosis is observed 72 hours after RF ablation, surrounded by a zone of hyperaemia that gradually resolves. The technique may be particularly suitable for lung tumours because the air in the surrounding alveoli acts as insulation, helping to concentrate the energy in the lesion. However, since each tumour or metastasis must be treated individually, the technique is only suitable for patients with a small number of lung lesions.

A careful pretreatment assessment is essential, including chest CT to determine the exact size and position of target tumours. During the procedure, the needle electrode is positioned in the tumour, using the same guidelines as for CT-guided lung biopsy, with the skin entry site selected to allow the shortest and most vertical path for the needle, avoiding blood vessels, interlobar fissures and bullae. It is particularly important to ensure the correct placement of the electrode needle within the tumour, using image reconstructions in multiple planes. At our centre, we use an expandable electrode needle with 9 flexible hooks deployed from the trocar tip (Figure 1); others use cooled tip electrodes. The power output of the RF generator and duration of ablation are programmed according to the tumour volume and monitored by computer. A track ablation

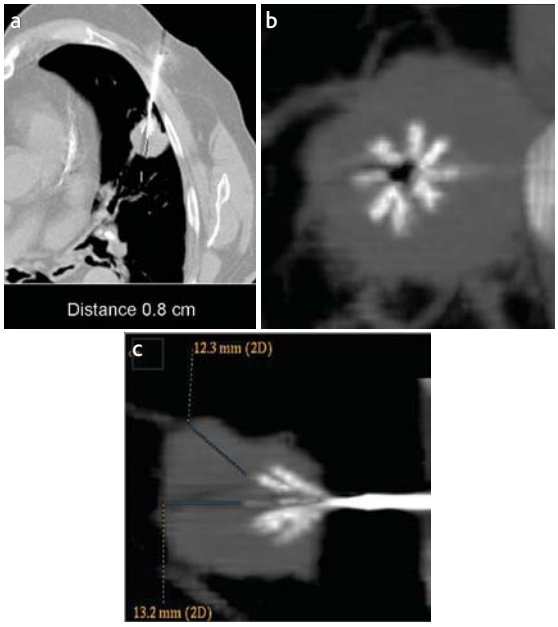
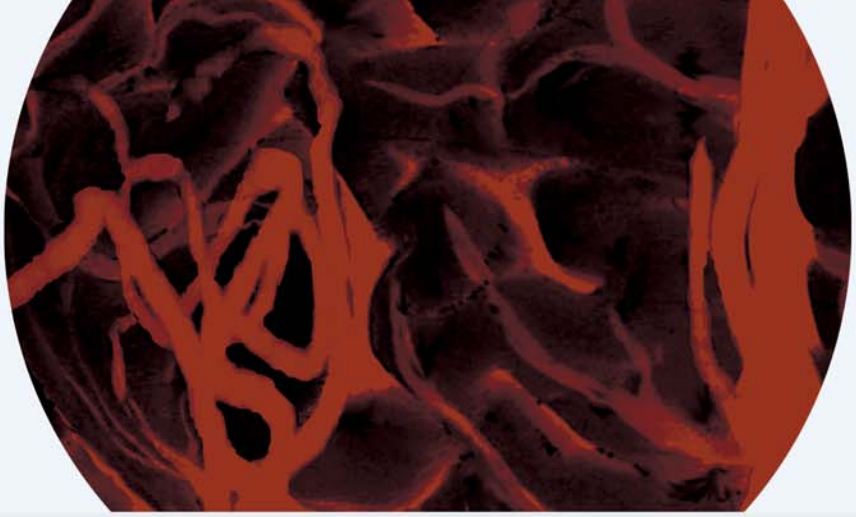


Figure 1. CT-guided ablation of lung tumour. Axial CT scan shows the multi-tined electrode for radiofrequency ablation precisely placed into the tumour (a). Multiplanar CT reformations confirm proper placement (b) and indicate the degree of deployment needed to completely cover the tumour (c).



procedure is carried out at the end of the procedure to reduce the risk of seeding of tumour cells. Lung RF ablation is a painful procedure which requires adequate pain relief. In our centre, we use conscious sedation with a hypnotic and a short-acting analgesic. Other centres carry out the procedure under a general anaesthetic, although there may be a greater risk of pneumothorax in the ventilated patient.

Clinical experience

Initial studies have indicated that RF ablation is well tolerated by most patients and that it can achieve complete necrosis of the targeted lesion (Figure 2). Pneumothorax is the most common treatment-related complication, typically occurring in up to 40% of cases, with up to half of these requiring drainage.

We recently completed one of the largest trials of RF ablation for lung tumours, with patients followed for up to 27 months. The results of this prospective, multicentre trial in patients with primary lung cancer or lung metastases 3.5 cm or less in diameter who were not candidates for surgery were presented at CIRSE in Nice in September 2005. One hundred and six patients (36 women and 70 men) with 186 malignant tumours were enrolled in this trial. Thirty-three patients had non-small cell lung cancer, 53 had colorectal cancer metastases and 20 had metastases from other primary malignancies; none were suitable for surgery. Patients underwent RF ablation treatment with CT guidance and under conscious sedation as described above. No procedure-related deaths occurred. There were 27 cases of pneumothorax requiring treatment, 4 pleural effusions, 2 cases of pneumonia and one case of atelectasis.

At a CT evaluation 3 months after the procedure, complete ablation of the tumour was observed in 173 of 186 tumours, a primary effectiveness rate of 93%. Overall survival of the primary lung cancer patients was 69% at 1 year and 49% at 2 years. However, many of the deaths were not cancer related and when these were excluded, the cancer-specific survival rates were 91% at 1 and 2 years. In patients with lung metastases from colorectal cancer, the survival rates were 88% at 1 year and 72% at 2 years, after exclusion of non-cancer-related deaths.

These results are encouraging and suggest that RF ablation can improve survival, reduce pain, and improve quality of life in patients with unresectable lung tumours. However additional clinical trials are required to further evaluate the place of RF ablation in the management of primary tumours and metastases in the lung, either alone or in conjunction with chemotherapy or radiotherapy.

Further reading

1. Lencioni R, Crocetti L, Cioni R *et al*. Radiofrequency ablation of lung malignancies: Where do we stand? *Cardiovasc Intervent Radiol*; **27**: 581–90.

Figure 2. Lung tumour treated with radiofrequency ablation. Pre-treatment CT shows the focal mass (a). CT obtained after electrode placement confirms proper deployment (b). CT after the ablation shows ground-glass density area encompassing the native tumour as well as a safety margin of surrounding lung parenchyma (c). T1-weighted gadolinium-enhanced MR imaging confirms complete ablation by showing a non-enhancing hypointense area of coagulation necrosis surrounded by a thin enhancing rim representing inflammatory reaction (d).