Pulmonary hemorrhage during percutaneous radiofrequency ablation: a more frequent complication than assumed?

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Received 17 January 2003; received in revised form 30 April 2003; accepted 30 May 2003

Abstract

Objective: To alert clinicians of the underreported complication of intraparenchymal lung hemorrhage during percutaneous radiofrequency ablation (RFA) of primary and secondary pulmonary malignancies. Methods: Of 101 RF ablations performed in 46 patients, 81 were retrospectively assessed for periprocedural intrapulmonary bleeding. The data was compared with the literature for this minimally invasive interventional treatment as well as with the reported frequency of lung hemorrhage during diagnostic lung biopsies. Results: Our incidence of hemorrhage during percutaneous lung RFA was 5.9%. The reported frequency in the scarce literature available is less than 1%. Data in the literature for percutaneous biopsy-related intraparenchymal hemorrhage ranges from 1.4% for fine-needle aspirations to 29% for core biopsies. Conclusion: Intraparenchymal lung hemorrhage during percutaneous RFA of primary and secondary pulmonary malignancies is similar to reported lung hemorrhage for diagnostic core biopsies. We believe this complication to be underreported in the literature.

Keywords: Percutaneous; Radiofrequency ablation; Lung; Tumor; Hemorrhage; Complication

1. Introduction

Radiofrequency ablation (RFA), an imaging-guided minimally invasive treatment, is regarded as an alternative treatment to open thoracic surgery for some cancer patients. Patients considered for RFA are not suitable for surgery because of poor cardiorespiratory reserve, extensive disease, number of lung metastases, or refusal to have surgery.

RF thermal ablation works by converting RF waves into heat. An alternating current of 460 kHz passes from the uninsulated tip of the electrode into the surrounding tissue and causes ionic vibration as the ions attempt to follow the change in the direction of the rapidly alternating current. Thus, it is not the probe generating the heat, but the friction caused by the vibrating ions. The higher the current, the more vigorous the motion of the ions and the higher the temperature reached over a certain time.

The heat produced by the oscillating ions occurs only in close proximity to the electrode(s), with the current density dropping precipitously away from the electrode(s). This results in a lower temperature rise in the periphery. It can be approximated that the heat generated in a region at distance \( d \) from the electrode drops as \( 1/d^4 \).

The goal of RFA is to achieve local temperatures such that tissue destruction occurs. In general thermal damage to cells begins at 42°C. At temperatures above 60°C intracellular proteins are denaturated and the lipid bilayer melts with irreversible cell death occurring.

Percutaneous pulmonary RFA is a treatment of low cost, low toxicity, low morbidity and with short hospital stay. RFA allows easy percutaneous access, feasibility of the procedure under conscious sedation and has the capability of creating fairly predictable ablations, which spare surrounding healthy tissue next to the lung tumors. Lung tumors appear to be well suited to RFA because the surrounding air in adjacent normal lung parenchyma provides an insulative effect that may concentrate the RF energy [1].

Apart from patients having uncorrectable coagulopathy and/or an excessive number of lung metastases, there appear
to be no real limitations and contraindications for percutaneous treatment of lung tumors. Most of the centers, which now routinely perform pulmonary RFA, treat the lung lesions irrespective of their size and location [2].

We describe and comment on the management of a patient who had a pulmonary hemorrhage during RFA for lung metastases. This complication seems to occur more frequently than previously assumed.

2. Case report

A 57-year-old white man, 12 months post resection of a Dukes’ C adenocarcinoma of the sigmoid colon and 6 months post liver metastasectomy, was concurrently treated with a regime of regional chemotherapy (Floxuridine). The patient presented for computed tomography (CT)-guided percutaneous RFA of five lung metastases, four in the right lung and one in the left lung, which were 0.8–2 cm in maximum axial diameter. On admission the laboratory results were normal with a platelet count of 172 000/ml (150 000–350 000/ml), ranging rather at the lower limit. Coagulation status was normal with a partial thromboplastin time of 31.6 s (25–35 s), a prothrombin time of 12.9 s (11–13.5 s) and international normalized ratio of 0.9 (0.8–1.2). The patient was not taking any concomitant medication apart from his intra-arterial chemotherapy.

The generator used was the Model 1500 (RITA Medical Systems, Mountain View, CA), with a frequency of 460 kHz and power range from 0 to 150 W. A 10-cm expandable 14-gauge Starburst XL electrode (RITA Medical Systems) was inserted under CT-fluoroscopy (Toshiba Xpress SX) into the lung lesion. An ablation algorithm with staged deployment, a target temperature of 90 °C and maximum power of 150 W was applied.

Maximum possible deployment is 5 cm. According to the protocol used, for a single ablation, the total ablation size should exceed the diameter of the tumor by 2 cm, allowing for a 1-cm surrounding safety margin. Ablation of the lesion always begins at 2 cm and, depending on the tumor size, proceeds to 3, 4 or 5 cm, once the target temperature is reached and maintained for the required time period. The ablation of the first metastasis, located apically in the right upper lobe was uneventful apart from the development of a small pneumothorax. While approaching the second lesion located in the right hilar region adjacent to a major pulmonary vessel (Fig. 1a), a blossoming opacification was noticed along the electrode, consistent with intrapulmonary hemorrhage. The hemorrhage occurred at first needle placement, before deploying the tines or initiation of RF current. The hemorrhage increased in size over the following 2 min to a maximum diameter of roughly 5 × 8 × 8 cm (Fig. 1b), but then remained stable. Apart from some coughing and a temporary increase in diastolic blood pressure (from 130/85 to 135/100 mmHg) the patient, who was under conscious sedation (Pethidine and Midazolam on demand) did not show any signs of distress. We therefore decided to continue the ablation. Although the surrounding blood now masked the metastasis, we knew because of imaging prior to the bleeding that the tip of the electrode was correctly positioned, and we continued with the staged deployment algorithm. The ablation was completed uneventfully, without increase of the hemorrhage. As the patient was stable we ablated the remaining two lesions located in the right lower lobe. For safety reasons we did not ablate the single remaining metastasis in the contralateral lung.

Chest X-ray following the RFA showed that the pneumothorax had increased, occupying approximately half of the hemithorax, and an intercostal chest tube was inserted. The pneumothorax resolved in 2 days, the chest tube was
removed and the patient was discharged with non-opioid analgesics.

3. Discussion

Hemorrhage is a known complication in lung RFA, and results from the positioning of the device rather than from the ablative procedure. While the reported percentage of infection (<1%) and bronchopleural fistula formation (<1%) in the literature [1] accords with our experience, the occurrence of pneumothorax, reported as 20% [1,3] and the incidence of hemorrhage, reported as <1% [3] is in our view an underestimate. In the 46 patients (101 lesions) we have treated by percutaneous RF ablation the incidence of pneumothorax was 33% (15/46) and the incidence of hemorrhage was 5.9%. The five hemorrhages we have seen were all mild, self-limiting and of little clinical significance, but intraprocedural hemorrhage is a complication to be aware of.

Data in the literature for percutaneous biopsy-related pneumothoraces and intraparenchymal hemorrhage ranges from 8.2% and 1.4% for fine-needle aspirations with a 22-gauge needle [4] to 24% and 29% for core biopsies with a 20-gauge needle [4]. The largest study published is a survey of a United Kingdom series of 5444 biopsies, which reports a pneumothorax-rate of 20.5% and a rate of hemoptysis of 5.3% [5]. The hemoptysis rate does not allow a conclusion to be made on the rate of intraparenchymal hemorrhage, as none of the 29% with lung hemorrhage in Richardson’s work [6] has been reported as having had hemoptysis. Taking into account the thicker RF device (14 gauge) and the fact that we perform multiple ablations, can explain our higher pneumothorax-rate. The discrepancy between the reported data and our results may be explained by a bias in patient inclusion and management. We ablate up to six metastases per hemithorax. The size and central lesions’ location close to major vessels and bronchi is not a contraindication to treating multiple ablations, as it was earlier in our experience.

Percutaneous CT-guided pulmonary RFA appears to be considered as a minimally invasive treatment modality for primary and secondary lung malignancies, as reflected by several recent publications [1,3,7–10], but is presently a treatment under review. Practitioners of RFA should be aware of the risk of peri-procedural intrapulmonary hemorrhage, which is usually self-limiting, but according to the literature [1,3] can also be massive and lead to death.

A careful medication history should be taken, including the use of anticoagulants or antiplatelet drugs use, which, if considered necessary, should be discontinued for the appropriate period before ablation. When evaluating patients for RFA treatment pulmonary artery hypertension should be taken into account and echocardiographic evaluation of tricuspid regurgitation should be undertaken prior to treatment, especially when targeting central lesions such as that shown in this case report.

Clinicians should be mindful that the patient group treated by RFA comprises cancer patients who may have received chemotherapy with possible bone marrow suppression and thrombocytopenia. Floxuridine, an antimetabolite (pyrimidine antagonist) with which our patient was treated, is known to cause bone marrow toxicity, chemical hepatitis, sclerosing cholangitis, and biliary toxicity [11].

Prior radiation to the RF-region may lead to an increased risk of intraparenchymal bleeding, with a reported incidence of lethal hemorrhage after external irradiation of 4.3% [12].

For patients with poor respiratory reserve, as often encountered in heavy smokers, parenchymal hemorrhage of the extent and cause described may lead to a sudden deterioration of oxygen saturation, which could be even more difficult to manage than in the setting of open resection.

It can be concluded that percutaneous CT-guided RFA is an effective minimally invasive therapy with acceptable morbidity for primary and secondary lung tumors. Intraparenchymal hemorrhage is a complication underreported in the literature. Although it is usually self-limiting, it is advisable that the procedure be performed in centers with thoracic surgeons available to treat any potential major bleeding.

Acknowledgements

We are grateful to the Swiss Academy of Medical Sciences (SAMS) for Dr. K.S.’s scholarship.

References


