Radiofrequency Ablation of Pulmonary Neoplasm Complicated by Pulmonary Hemorrhage

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ABSTRACT

Pulmonary hemorrhage is a potentially serious complication of radiofrequency ablation of pulmonary neoplasms that may occur with or without hemoptysis. Several factors influence the development of parenchymal hemorrhage, including tumor size, tumor location, and procedural technique. As radiofrequency ablation has become more common, the prompt diagnosis and appropriate treatment of hemorrhage is vital. The authors report a case of radiofrequency ablation of a solitary pulmonary metastasis complicated by pulmonary hemorrhage and hemoptysis.

KEYWORDS: Radiofrequency ablation, lung, hemorrhage

CASE REPORT

A 53-year-old man with a history of cirrhosis secondary to hepatitis B presented with multiple hepatic lesions and was diagnosed with multifocal hepatocellular carcinoma (HCC). He subsequently underwent multiple courses of radioembolization with ⁹⁰Yttrium microspheres and a systemic chemotherapy regimen (sorafenib). Follow-up imaging showed a new 1.5 × 1.3 cm pulmonary nodule in the right lower lobe (Fig. 1A). Computed tomography- (CT-) guided biopsy revealed metastatic HCC. A multidisciplinary consensus-based decision was made to pursue percutaneous radiofrequency (RF) ablation of the patient's metastatic lung lesion.

The patient was in his usual state of health prior to the procedure with a negative pulmonary review of symptoms. Preprocedure medications included entecavir 0.5 mg/d, lisinopril 20 mg/d and hydrochlorothiazide 25 mg/d. Baseline laboratory findings included hemo-

globin of 13.8 g/dL, a platelet count of 89,000 per μ L, and an international normalized ratio (INR) of 1.6, corrected from a baseline of 2.0 with administration of fresh frozen plasma (FFP). Additional FFP was withheld to prevent volume overload.

At the time of RF ablation, the patient was placed in a prone position and the right posterior chest was prepped and draped in the usual sterile manner. The anesthesia service provided monitored anesthesia care (MAC) for the patient during the procedure. Under CT guidance, a 17-gauge Cool-Tip (Valleylab, Covidien, Mansfield, MA) RF ablation electrode was directed toward the lesion. After initial attempts at redirecting the needle, an increasing amount of blossoming parenchymal infiltrate was observed surrounding the needle tract, consistent with pulmonary hemorrhage (Fig. 1B). Several attempts were made at repositioning the RFA electrode into the lesion itself. With each pass the needle was retracted almost entirely out of the lung parenchyma

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Figure 1 Computed tomography (CT) imaging shows the metastatic lesion in the right lower lobe (A). Developing pulmonary hemorrhage during radiofrequency electrode placement (B) and hemorrhage with associated hemothorax immediately postprocedure (C) are observed. Follow-up CT imaging at 3 months shows complete resolution of the parenchymal hemorrhage and hemothorax (D).

before being redirected. After the fifth pass of the electrode, the patient began to experience severe hemoptysis and the procedure was immediately terminated.

The patient was emergently intubated by the anesthesia service because of the worsening hemoptysis. Postprocedure imaging showed worsening right lower lobe parenchymal hemorrhage and interval development of a moderately sized right pleural collection consistent with a hemothorax (Fig. 1C). After transfer to the medical intensive care unit, 2 units of fresh frozen plasma were transfused in the setting of active hemorrhage with a stable posttransfusion INR. Two units of packed red blood cells were transfused for postprocedure hemoglobin of 9.8 g/dL with an appropriate response. Serial chest X-rays showed improving parenchymal hemorrhage and effusion. The patient remained hemodynamically stable under invasive hemodynamic monitoring without requiring vasoactive support throughout the postprocedure course.

Initial attempts at extubation were delayed secondary to altered mental status attributed to mild hepatic encephalopathy. Serum ammonia level on postprocedure day 3 was elevated at 88 $\mu\text{mol/L}$, for which lactulose was given. The patient was successfully extubated on postprocedure day 4 and safely weaned to room air with adequate hemoglobin oxygen saturation. Follow-up chest CT 3 months after discharge showed complete resolution of parenchymal hemorrhage and hemothorax (Fig. 1D).

DISCUSSION

RF ablation of non-small cell lung cancer (NSCLC) and pulmonary metastases has been used with increasing frequency over the past decade in patients who are not

surgical candidates for lobectomy, the current gold standard for treatment of early NSCLC or locally controlled primary tumors with low pulmonary metastatic burden.¹⁻³ The procedure involves image-guided percutaneous placement of one or more RF ablation probes into the lesion of interest. Alternating RF current is initiated, heating the targeted tissue with the goal of uniform local tissue necrosis.

Studies have shown promising results in both initial and long-term response to RF ablation of pulmonary tumors. A prospective study of 54 lung neoplasms in 31 patients found complete necrosis in 32 of 54 tumors (59%) after the initial RF session, independent of histology.⁴ Lencioni et al showed sustained complete response to treatment, as defined by the modified RECIST criteria, lasting at least one year in 75 of 85 (88%) of treated patients.⁵ Chua et al described significantly increased 5-year survival in patients with complete or partial response compared with patients with stable or progressive disease status post-RF ablation.⁶

Factors influencing treatment success among nonsurgical candidates must be considered in parallel with those associated with increased complication rates. Improved rates of complete necrosis and lower rates of recurrence, for example, have been seen in smaller tumors ($\leq 3\text{--}3.5$ cm in diameter) and in tumors separated from local blood vessels, which act as “heat sinks” during thermal ablation.^{4,7,8} Higher rates of pulmonary hemorrhage, however, have been described with smaller target lesions (≤ 1.5 cm) due to their relatively high degree of difficulty in targeting, requiring multiple iterative probe passes.⁹ Pulmonary hemorrhage and the need for chest tube placement are more frequent in hilar versus peripheral lesions.^{6,9}

Despite the need to puncture lung tissue, pulmonary hemorrhage is an infrequent complication of RF ablation of pulmonary neoplasm. The reported postprocedure rates of pneumothorax and pleural effusion are between 30–45% and 10–16%, respectively. The rates of hemoptysis and/or pulmonary hemorrhage have been reported to be 1–6%.^{6,10–13} The incidence of pulmonary hemorrhage can be attributed to several predisposing factors. Nour-Eldin et al found a significant risk of hemorrhage associated with tumors ≤ 1.5 cm, tumors located in the basal and middle lung zones, and needle track distance traversing the lung parenchyma greater than 2.5 cm (i.e., tumors more central in location).⁹ Targeting smaller tumors may require more passes with the probe and therefore will increase the likelihood of transecting a pulmonary vessel. Lesions that are hilar in location are not only near the branch points of larger pulmonary arteries and the confluence of pulmonary veins, but are targeted only after traversing more lung tissue and vessels. It would seem, then, that pulmonary tumors amenable to RF ablation with more optimal risk/benefit profiles include lesions, both NSCLC and metastatic, that are peripheral in location and less than or equal to 3 cm in diameter.

The mortality rate related to RF ablation has been reported to be between 0–2.6%.^{9,10,14} In a trial of 137 patients undergoing RF ablation of 211 lesions, Sano et al reported 2 deaths.¹⁰ One of these deaths was secondary to massive hemorrhage. In their trial of 164 patients with 248 pulmonary lesions, Nour-Eldin et al reported one death, also secondary to massive pulmonary hemorrhage.⁹ In a case report, Vaughn et al discussed the death of a patient whose hospital course began with pulmonary neoplasm RF ablation complicated by severe hemorrhage.¹⁵ The locations of the target lesions in these patients were not described. While overall mortality is low, and although hemorrhage occurs less frequently than other complications, these examples suggest that pulmonary hemorrhage may represent a significant risk factor for death or a prolonged postprocedure course when it does occur.

The small size of the pulmonary metastasis in our patient and its separation from adjacent blood vessels made the lesion amenable to percutaneous RF ablation. Several risk factors, however, predisposed our patient to parenchymal hemorrhage and hemothorax. The lesion was small, required several attempts at correct probe placement, and was central in location. With a history of cirrhosis, the patient's INR was mildly elevated and platelet levels were decreased.

Once worsening hemorrhage and hemoptysis was observed, appropriate initial response with airway protection, oxygenation, and correction of coagulopathy was pursued. Patients should be placed with the affected lung in a dependent position to prevent the contralateral

airway from filling with blood and/or clot. Hemorrhage is often self-limited,¹⁶ but if worsening hemorrhage is observed on serial chest X-rays or there is continued hemoptysis, bronchial artery embolization, pulmonary vessel vasooclusion, or bronchoscopy with possible balloon catheter occlusion of the affected airway should be considered.

CONCLUSION

Pulmonary hemorrhage is an infrequent, but serious complication of RF ablation of pulmonary neoplasms. Given the promising findings in patients treated with RF ablation, the risk to benefit profile is advantageous in properly chosen candidates. Although pulmonary hemorrhage may be relatively uncommon, the severity of this complication should limit pulmonary RF ablation to settings in which a multidisciplinary treatment approach is available to the patient.

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