Radiofrequency Ablation of a Solitary Liver Metastasis Complicated by Colonic Perforation

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ABSTRACT

Radiofrequency ablation is used for the treatment of primary liver malignancies and liver metastases. In this case, the authors performed percutaneous radiofrequency ablation of a solitary esophageal carcinoma metastasis within the left hepatic lobe. Following the procedure, the patient developed a colonic perforation with a large right upper quadrant abscess. Although the abscess nearly resolved after intravenous antibiotics and percutaneous drainage, the patient ultimately developed a colocutaneous fistula that required surgical excision and right hemicolectomy. The risks for developing this complication as well as measures to minimize this risk are discussed.

KEYWORDS: Radiofrequency ablation, liver, thermal injury

CASE REPORT

A male patient was seen in our clinic for radiofrequency (RF) ablation of a 2.5-cm left hepatic lobe esophageal adenocarcinoma metastasis. He was initially diagnosed with esophageal adenocarcinoma 18 months prior, after biopsy of a distal esophageal mass revealed a T3 infiltrating adenocarcinoma. Prior to diagnosis, the patient's past medical history was only significant for prior cholecystectomy. The patient subsequently underwent neoadjuvant chemotherapy with paclitaxel and carboplatin as well as external beam radiation therapy. Four months after diagnosis, the patient had a transhiatal esophagectomy and proximal gastrectomy with a cervical gastroesophageal anastomosis. Final pathology revealed a poorly differentiated grade 3/3 infiltrating adenocarcinoma with 7/16 positive lymph nodes. After a relatively uneventful postoperative course, the patient had 4 cycles

of postoperative chemotherapy with capecitabine, docetaxel, and oxaliplatin.

Routine restaging positron emission tomography (PET) and computed tomography (CT) scans taken 18 months after the initial diagnosis revealed a solitary 2.5-cm lesion within the medial left hepatic lobe (Fig. 1). Because this lesion was the only metastasis discovered and it was located relatively superficially within the liver, the patient was felt to be a good candidate for local regional therapy using RF ablation, rather than a more-invasive surgical procedure.

Under CT guidance, RF ablation was performed using a cluster of 3 separate 15 cm, 17-gauge internally cooled electrodes (Cool-tip, Covidien, Mansfield, MA) with a 3-cm active tip, each of which was placed within the liver lesion (Fig. 2). Following placement of the electrodes, a single 12-minute ablation was performed.

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Figure 1 The white arrow marks a 2.5-cm esophageal carcinoma metastasis within the left hepatic lobe.

After completion of the procedure, tract ablation was performed as the electrodes were removed. The patient tolerated the procedure well and was discharged home with no immediate postprocedure complications.

Twelve days after the RF ablation, the patient presented to the oncology clinic with complaints of right upper quadrant pain and a temperature of 38.3°C. A CT scan performed at that time revealed perforation of the colon at the hepatic flexure with a 10 × 8 × 9 cm abscess centered within the left hepatic lobe, which extended through the musculature and into the subcutaneous fat of the anterior abdominal wall (Fig. 3). Because the perforation was contained within the abscess cavity and the patient was otherwise stable medically, conservative treatment with intravenous antibiotics and ultrasound-guided drainage was pursued (Fig. 4). Follow-up CT examinations showed gradual decrease in size of the abscess; however, a colocutaneous fistula eventually developed that ultimately required surgical excision. Five months after the RF ablation procedure, the patient underwent a right hemicolectomy with excision of the fistula tract for definitive treatment of this post-RFA complication.

DISCUSSION

Colonic perforation is a well-documented major complication associated with RF ablation whose incidence has been estimated between 0.1% and 0.3%.¹⁻³ In a multicenter review of RF ablation complications, Livraghi et al found an overall complication rate across multiple hospital centers of 7.1%, with the breakdown between major and minor complications being 2.4% and 4.7%, respectively. Additional major complications documented in this study were bleeding (0.5%), intrahepatic abscess (0.3%), hemothorax (0.1%), and neoplastic seeding of the electrode catheter tract (0.5%).¹

Figure 2 (A) Axial computed tomography (CT) image demonstrating a cluster of 3 radiofrequency ablation (RFA) electrodes 1.5 cm away from the adjacent hepatic flexure. (B) Axial CT image through the tips of the RFA probes, which terminate within the region of the patient's metastatic lesion, ~4 cm distal to the portions of the probes in image A. (C) Axial CT image demonstrating the metastatic lesion after treatment. Note the foci of air surrounding the lesion, which is an expected finding after treatment.

The primary mechanism of injury in RF ablation is coagulation necrosis.⁴ In the case of a liquid cooled electrode (the type used in this procedure), the coagulation radius has been estimated in an ex vivo study to be less than 1.5 cm.⁵ An in vivo study in animals found that no bowel injuries occurred when the edge of the ablation was greater than 1 cm from the liver surface.⁶ In addition to absolute distance from the RF ablation probe, Livraghi et al found that a majority of cases of colonic perforation

Figure 3 (A) Axial computed tomography (CT) image with a white arrow marking a large abscess adjacent to the left hepatic lobe that extends through the musculature and into the subcutaneous fat of the anterior abdominal wall. (B) Coronal CT image with a white arrow marking the connection between the hepatic flexure of the colon and a large right upper quadrant abscess.

occurred in patients with a history of prior colonic resection, most of whom were noted at surgery to have fibrotic adhesions affixing the colon to the liver.¹ In our case, the patient had no significant prior upper abdominal surgery, and the hepatic flexure was no closer than 1.5 cm from the nearest electrode (Fig. 2). Also, the distance between the colon and the electrode tip was measured at 4 cm, presumably outside of the electrode's exposure region. One potential factor that may have contributed to this complication was the use of multiple probes. By using 3 probes simultaneously, the total ablation zone is larger than when performing 3 separate ablations with a single electrode. The mechanism for creating a larger, more confluent region of coagulation necrosis with a cluster of electrodes is based on the principle of thermal synergy and allows for the treatment of larger liver lesions.⁷ In this case, the use of multiple probes may have enlarged the ablation zone enough to bring the colon into the exposure region.

Figure 4 Axial computed tomography image demonstrating a drainage catheter within a large right upper quadrant abscess.

Multiple techniques have been proposed for protection against thermal damage during RF ablation procedures. One method involves the displacement of bowel loops from the liver surface by infusion of sterile water or 5% dextrose into the peritoneal cavity.⁸ A second method involves the interposition of a balloon catheter between the liver surface and the adjacent gastrointestinal tract.⁹ Both of these methods serve to increase the distance between the edge of the ablation region and the adjacent gastrointestinal organs through minimally invasive methods. Noninvasive methods have been proposed by Chen et al and include (1) positioning of the patient in the right anterior oblique position, so as to allow gravity to draw the hepatic flexure away from the liver surface; (2) instructing the patient to take repeated abdominal breaths to allow movement of the bowel and avoid prolonged contact with the ablation site; and (3) instructing the patient to fast for 24 hours after the procedure and then transition the patient to a semifluid diet for the 2 days thereafter.¹⁰ The third technique serves to limit the amount of feculent material that could spill into the peritoneal cavity.

Imaging with nonenhanced CT immediately after ablation can have ablated tissue appearing hypodense, isodense, or hyperdense relative to the adjacent hepatic parenchyma. By 1 month, many of these hyperdense lesions will decrease in attenuation and become hypo to isodense relative to the adjacent parenchyma.¹¹ Contrast-enhanced imaging up to 1 month after RF ablation of a hepatic lesion will almost always demonstrate a well-demarcated region of hypoenhancement, assuming the entire tumor has been ablated. Although many ablated lesions will initially demonstrate peripheral enhancement related to hyperemia, these findings are usually absent by 1 month.^{11,12} Foci of air can be normally seen within an ablated region immediately after RF ablation. Intraabdominal free air, intraabdominal free fluid or abscess, colonic wall thickening or pericolonic fat

stranding should raise the concern of bowel injury or perforation.^{11,12} Although patients can report pain or a low-grade fever (up to 39°C) up to 3 days after the procedure, early severe pain or pain/fever more than 3 days after the procedure should raise concern for a postprocedural complication and should be further evaluated with cross-sectional imaging.¹

Treatment of colonic perforation depends on the size of the perforation and the severity of the associated complications. Treatment options range from conservative methods including intravenous antibiotics, percutaneous abscess drainage and endoscopic perforation closure to more aggressive methods including laparotomy with or without hemicolectomy.^{1-3,13,14} The prognosis in these patients can be poor. Among the colonic perforations identified in 3 large research studies, a majority of patients ultimately required laparotomy and greater than 40% of all of the patients with colonic perforation died.¹⁻³

In conclusion, RFA of malignant liver tumors is a very safe and effective procedure; however, care should be taken to minimize the risk of complications, such as gastrointestinal injury.

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