Case Report

Early Diagnosis of Intrahepatic Pseudoaneurysm during Radiofrequency Ablation using Contrast-Enhanced Ultrasound

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Abstract

Radiofrequency ablation is one of the more established forms of local treatment in patients with unresectable tumours, including colorectal hepatic metastases. Complications associated with this method of intervention include thermal and mechanical injuries, including vascular insults resulting in haemorrhage or pseudoaneurysm formation. This is the first case demonstrating the detection of post-ablation acute pseudoaneurysm formation identified on the table using contrast-enhanced ultrasound (CEUS) and the subsequent successful management.

Keywords: *hepatic, metastasis, radiofrequency, ablation, pseudoaneurysm*

Introduction

Surgical resection has long been considered the only treatment that offers a potential cure in patients with colorectal liver metastases, but only a small proportion of patients are suitable for this option (1). Local control techniques, such as percutaneous ethanol injection, chemoembolisation, laser ablation, microwave ablation, high intensity focussed ultrasound, and radiofrequency ablation have been considered to be viable alternatives for patients whose liver metastases are not resectable. Radiofrequency ablation (RFA) has emerged as the most popular and effective minimally invasive technique with promising long term control rates and lower morbidity and mortality (2). Post RFA, the major complications such as vascular injury and haemorrhage, iatrogenic visceral injuries, infections including abscess formation, are reported in up to 2% of cases (3,4). Minor complications including pain, fever, ascites, and pleural effusion have been reported in up to 5% of patients (3,4). Multidisciplinary teams of surgeons, oncologists, and interventional radiologists have been adopting a more aggressive approach to the regional treatment of liver metastases with an increasing number and size of metastases being treated with RFA; therefore, the associated complication rates are expected to increase. However, as our understanding of the risk factors improves, many complications may be prevented. We report a case of an acute pseudoaneurysm that occurred during radiofrequency ablation of colorectal liver metastases and evaluate the utility of post-treatment ultrasound assessment.

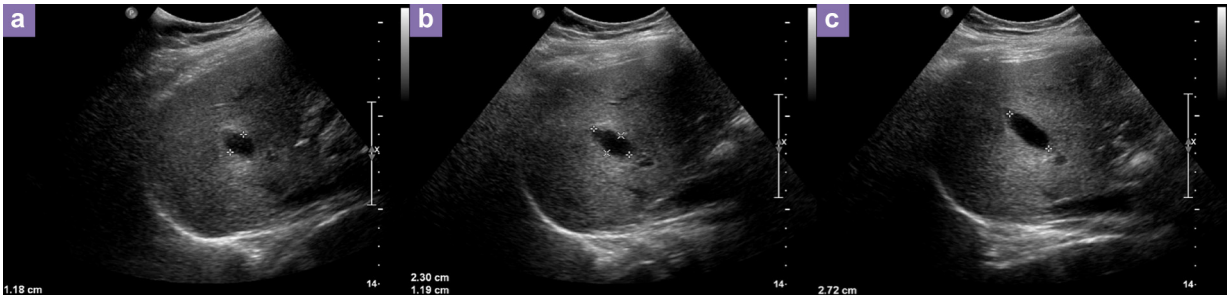
Case Report

A 74-year-old woman developed liver metastases 18 months post-left hemicolectomy for sigmoid carcinoma. She was admitted to our institution for RFA of the lesions due to the location of these tumours, which were not adjacent to major vessels and were favourable for this treatment option. There were four lesions measuring between 2 cm and 5 cm. Her liver function on admission was categorised as Class A according to Child-Pugh classification. Written informed consent was obtained. Using

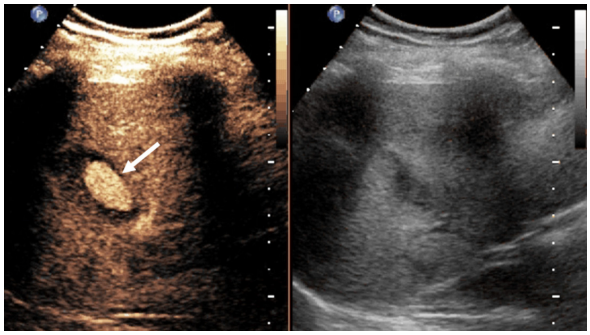
unenhanced and contrast-enhanced ultrasound (US and CEUS, respectively) guidance, RFA was performed using a combination of a cluster Cool-tip needle electrode and a single Cool-tip needle electrode (Radionics, Inc.; Burlington, MA) to deliver radiofrequency energy. All of the metastases were ablated for a total of 60 minutes, achieving temperatures of 65–78 °C. At the end of the last ablation, an on-table ultrasound demonstrated a 1.18 cm x 2.20 cm well circumscribed anechoic focus with flow signal adjacent to one of the heterogeneous, isoechoic to hyperechoic ablation zones in segment VI/VII. Sequential ultrasound showed that the lesion was expanding to approximately 1.20 cm x 2.72 cm (Figures 1a, 1b, and 1c). The acute formation of this lesion was consistent with a vascular injury. This may have been secondary to the direct puncture and mechanical injury of the adjacent vasculature or may have been due to immediate thermal injury to a vessel wall, with consequent haematoma formation. The features of the lesion, an expanding well-circumscribed anechoic focus with flow signal, were compatible with a pseudoaneurysm, rather than a simple haematoma. Contrast-enhanced ultrasonography (with 2.4 ml SonoVue; Bracco SpA, Milan, Italy) in nonlinear imaging mode was then performed and revealed microbubble contrast agent circulating within the lesion, confirming pseudoaneurysm formation (Figure 2a).

The patient was immediately transferred onto an angiographic table and selective coeliac axis and superior mesenteric artery (SMA) angiography was performed. This demonstrated an anatomical variant; the left hepatic artery originated from the common hepatic artery, and the right hepatic artery originated from the SMA. The pseudoaneurysm in the right lobe of the liver with the feeding artery from the inferior posterior branches of the right hepatic artery was identified. There was no active extravasation of contrast to suggest on-going haemorrhage, and the abnormal pooling of contrast was confined to the site of pseudoaneurysm formation in segment VI/VII. The pseudoaneurysm was successfully embolised using four 5 cm embolisation coils. A post-embolisation angiography showed complete devascularisation of the distal segment with no contrast filling of the pseudoaneurysm. This was confirmed on contrast enhanced ultrasound which did not demonstrate any microbubble contrast enhancement within the pseudoaneurysm (Figure 2b). The patient was closely monitored in the high dependency unit, and prophylactic ceftriaxone and metronidazole were administered. The patient remained stable throughout the treatment and surveillance.

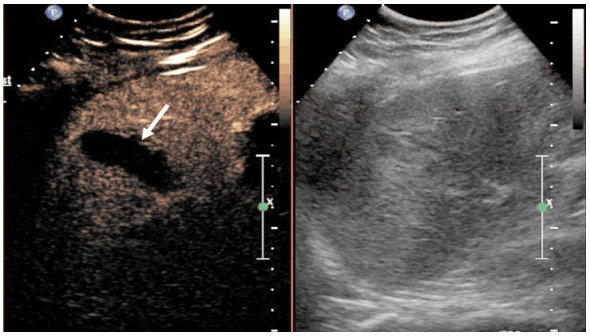
The next day, computed tomography (CT) demonstrated a 1 cm focal enhancement in segment VI/VII of the liver (Figure 3a). However, CEUS showed no evidence of active bleeding; angiography was performed and also showed no evidence of any acute intrahepatic haemorrhage. Therefore, the focal enhancement depicted on CT was deemed to be due to the residual contrast pooled from the previous angiography during embolisation. The patient was haemodynamically stable but developed a pyrexia of 38 °C and was therefore maintained on antibiotics for an additional few days. CT performed four days post-ablation demonstrated tiny bubbles of gas in segment VI, another ablation zone, which was possibly procedure related or was secondary to early abscess formation. No haemorrhage or enhancement of pseudoaneurysm in segment VI/VII was detected (Figure 3b). Two days later, repeat conventional US demonstrated more gas in segment VI, and US guided aspiration was performed for microbiology evaluation, but no growth was detected. Follow up US, ten days post-ablation showed no interval change with regard to the focal areas of ablation, and no evidence of any underlying sepsis; hence the patient was discharged.



Figures 1a,b,c: *Sequential unenhanced* ultrasound images show expanding pseudoaneurysm.



Figures 2a: Contrast-enhanced ultrasound image shows microbubble contrast agent in the haematoma (arrow) confirming the pseudoaneurysm.



Figures 2b: Post embolisation contrast-enhanced ultrasound image shows no contrast agent in the haematoma (arrow) confirming complete devascularization.

Figures 3a: Computed tomography image shows focal enhancement in the pseudoaneurysm (black arrow) adjacent to the ablation zone (white arrow).

Figures 3b: Computed tomography image shows no enhancement in the pseudoaneurysm (black arrow) adjacent to the ablation zone (white arrow).

Discussion

Colorectal carcinoma is the third most common malignancy in the world; hepatic metastases develop in up to 50% of patients and have a dismal outcome of zero survival at five years if left untreated (1). The first choice treatment for colorectal liver metastases is surgical resection, but up to 90% of patients have disease that is unsuitable for resection. RFA has emerged as a viable option for those patients with limited intrahepatic disease but who are not surgical candidates, with reported survival rates of 22 to 57% at three years and 20 to 48.5% at five years (5). Although RFA is a minimally invasive technique, it is still associated with some degree of morbidity and mortality. Several studies have reported mortality rates of less than 0.5% and major complication rates of 2%, which compare favourably with surgical liver resection with mortality and major complication rates of 6% and 15–30%, respectively (6). The most common complications of RFA that may lead to death are bleeding and gastrointestinal perforation.

Complications of RFA may be broadly categorised as follows: 1) direct mechanical injury; 2) secondary to thermal injuries; 3) associated pain, pyrexia and sepsis, including the well documented post-ablation syndrome; and 4) procedure related causes, such as potential

adverse effects from requirements for sedation, analgesia and anaesthesia. With regards to RFA of the liver, direct mechanical trauma has resulted in complications such as haemorrhage and pseudoaneurysm formation from vascular injury, perforation, and peritonitis from adjacent bowel injury, cholecystitis and biloma formation from biliary tree injury.

Systemic complications, such as malaise, vomiting, chills, and pyrexia are more common and fever with temperatures up to 39 °C, as in our case, may be part of the post-ablation syndrome(7). Post-ablation symptoms are often mild, self-limiting and tend to resolve spontaneously. They occur in approximately one third of patients following RFA of liver tumours, and pyrexia is the most common. Recognition of the post-ablation syndrome is important to distinguish it from other complications that have more serious sequelae, such as hepatic abscess formation, to enable appropriate management. In our case, we opted for microbiological confirmation with ultrasound guided sampling of the gas formation within one the ablation zones and prophylactic treatment with antibiotics.

Documented vascular injuries sustained during RFA include haemorrhage, pseudoaneurysm, arteriovenous fistula formation, thrombosis, and infarction. Iatrogenic intrahepatic pseudoaneurysm is a rarer but still known complication of radiofrequency ablation of liver tumours (8) with a potential to cause catastrophic bleeding if left unchecked. Intrahepatic pseudoaneurysm may haemorrhage into the biliary tree or more dramatically rupture into the peritoneal cavity with resultant exsanguination and death. Intrahepatic pseudoaneurysms following RFA have a delayed onset, usually occurring days after the procedure. Direct thermal injury to larger vessels during RFA is rare due to the protective heat-sink effect of blood flow (9). This cooling effect enables treatment of tumours located near vessels, but risks leaving viable residual tumour due to the limited extent of tumour necrosis. During RFA, traumatic injury to small hepatic arteries may not be avoidable even when performed under direct US guidance with the risks increasing with the number of punctures. The exact cause for the acute pseudoaneurysm formation in our case cannot be ascertained, but the chronology favours the latter.

To date, this is the first case of an acute pseudoaneurysm formation that was identified on the table during RFA. The routine use of ultrasound augmented with CEUS allowed the early identification of the complication and appropriate treatment in the same setting. Our protocol involves CEUS as the initial step of the radiofrequency treatment session, similar to other centres (10), to confirm the presence and location of metastatic lesions shown on the referring CT or magnetic resonance imaging (MRI) modalities. This enables real-time targeting of the metastatic lesions and improves the identification in difficult cases. In addition to detecting residual viable tumour and allowing the necessary re-treatment, immediate post-ablation evaluation using CEUS is also very useful for monitoring post-treatment complications. CEUS allowed the inadvertent identification of the acute pseudoaneurysm and demonstrates the value of ultrasound surveillance post-ablation. It also shows the importance of having interventional radiologist or surgical expertise on site to immediately treat any vascular complications that might arise as the result of the RFA.

Conclusion

In conclusion, RFA is an effective minimally invasive technique for the treatment of unresectable colorectal liver metastases. It is important to understand the potential complications that may arise from this form of treatment. On-table surveillance during RFA with US, augmented with CEUS, may help identify complications early and aid clinicians in the subsequent management of these patients.

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Conflict of Interest

None.

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Authors' Contributions

Drafting of the article:SKK
Critical revision of the article for the important intellectual content: OKO
Provision of study materials or patient: PH, EL

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