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# Volume Navigation image fusion in ultrasound-guided interventional radiology procedures

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# Volume Navigation image fusion in ultrasound-guided interventional radiology procedures

A growing number of practitioners are now becoming involved in the developing field of interventional radiology. Of the various different imaging techniques used for guidance, ultrasound provides a high level of spatial resolution combined with so-called "real-time" images, providing maximum safety during procedures. The limitations of this imaging technique are well known and relate essentially to deep lesions which are difficult for ultrasound to reach, and poor patient echogenicity. Here, we present a clinical case to demonstrate these limitations and up-to-date solutions used to counteract them using ultrasound contrast agents but also, more importantly, image fusion techniques.

# Investigations

A 49 year-old patient was referred to our department for staging of a rectal tumour discovered after repeated bleeding episodes. In the first instance, an abdominal ultrasound was performed using the new LOGIQ E9 (GE Healthcare, Chalfont St. Giles, UK) ultrasound machine. Although the patient was thin, he proved to be poorly echogenic. An irregular, heterogeneous, hyperechoic lesion measuring approximately 25mm was identified in segment I (fig. 1). A second, well-circumscribed heterogeneous mass was also identified with difficulty in segment VII in the right liver lobe (fig. 2).

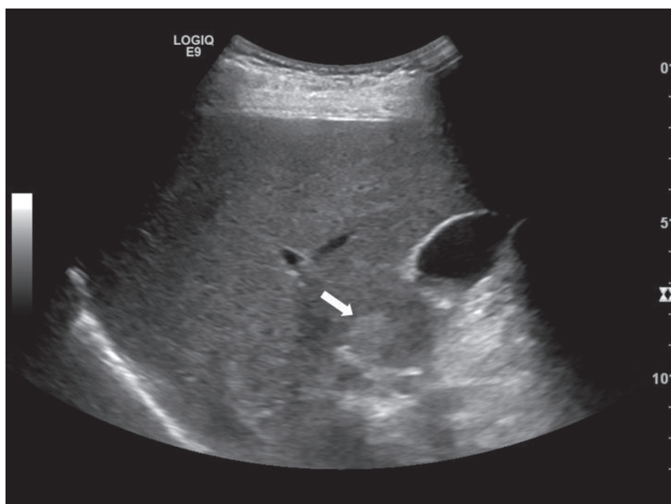


**Fig.1: The mass in segment I (arrow) is clearly visible as it is hyperechoic and heterogeneous.**

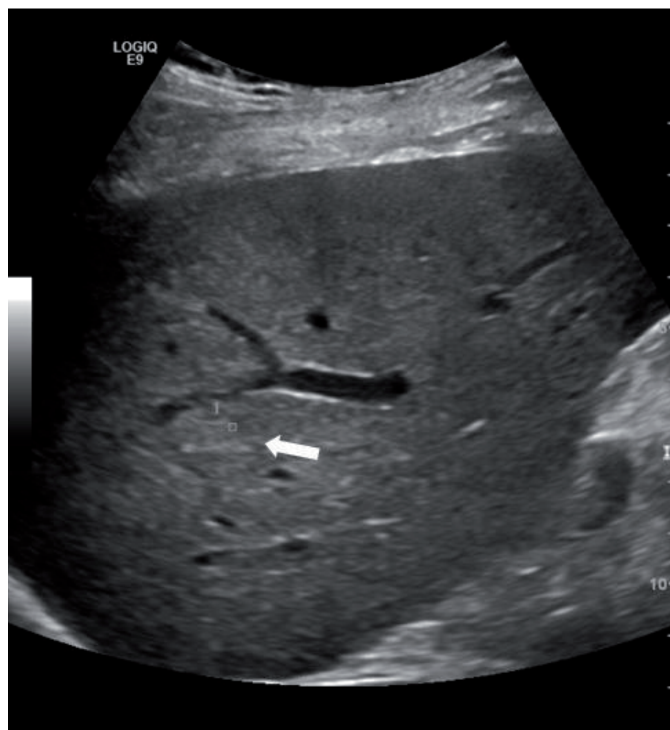


**Fig.2: The mass in segment VII (arrow) is barely discernible as a well-circumscribed, heterogeneous mass using conventional ultrasound.**

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# Diagnosis

An ultrasound contrast agent was injected for the purpose of characterising the tumour and mapping any secondary lesions that might be present. 1.5 ml Sonovue (Bracco) was injected intravenously, followed by a flush of 10ml saline solution. During the late phase of the injection after approximately two minutes, the segment 1 lesion was very clearly hypoechoic. The image of the hepatic parenchyma also showed a hypoechoic poorly-circumscribed, approximately 25mm-wide nodule in segment VII where the well-circumscribed heterogeneous zone had been seen (fig. 3). The conclusion from this ultrasound scan was a strong likelihood of metastasis at two locations in the liver. During the following days, a CT scan of the chest, abdomen and pelvis was performed to complete the staging of the disease. It provided definitive confirmation of these two locations in the liver, with two hypodense lesions during the late phase of the injection, both approximately 25mm wide (fig. 4).

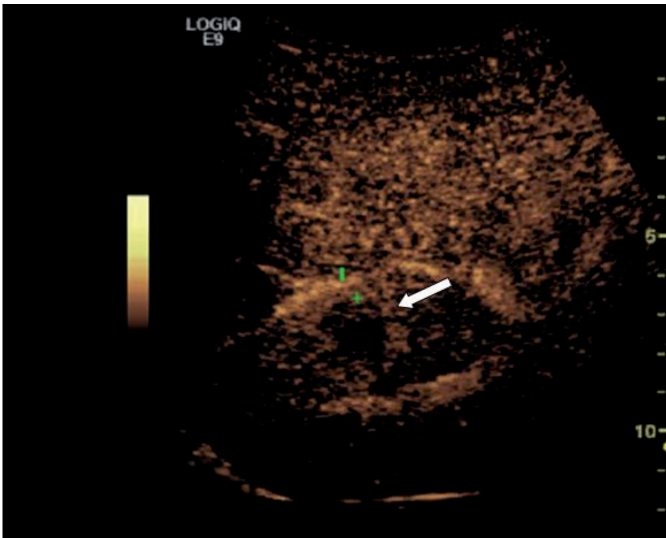


Fig.3: Using an ultrasound contrast agent, the segment VII lesion (arrow) which is hypoechoic during the late phase, provides the best indication of malignancy. It is also very clearly distinguishable from the adjacent hepatic parenchyma.

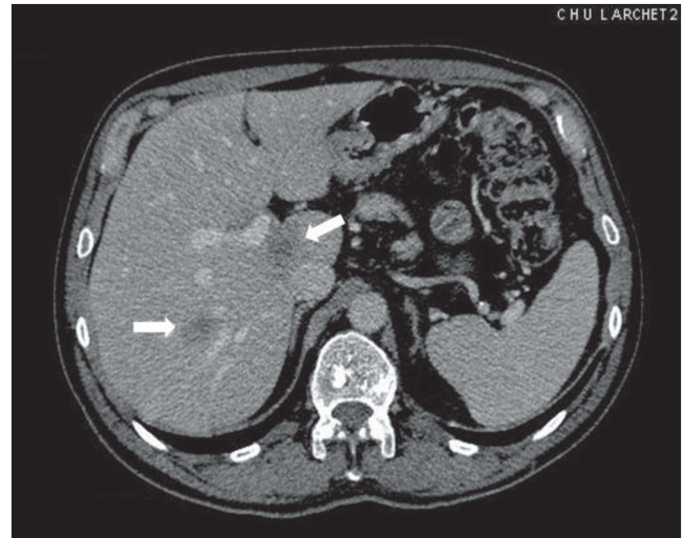


Fig.4: The segment VII and I lesions (arrows) appear hypodense and irregular during the portal venous phase of the injection. No other lesions were detected during this examination.

## Treatment

Following a multidisciplinary meeting, the patient was readmitted to the imaging department to treat the lesion in segment VII using radiofrequency ablation. According to the treatment plan, a surgical intervention was to be performed subsequently to remove the rectal tumour and the segment I tumour. Ultrasound with image fusion was chosen as the preferred guidance technique for the radiofrequency ablation procedure. A DICOM series from the liver CT scan performed a few days before was integrated and processed by the LOGIQ E9 image fusion software, part of the Volume Navigation (V Nav) package. The ultrasound and CT scan cross-sections were perfectly synchronised in a few clicks. This gave the operator the benefit of real-time ultrasound guidance combined with the portal venous phase contrast resolution from the CT scan image (fig. 5). For even greater certainty and safety during the procedure, a contrast ultrasound scan was used to clearly identify the known lesion in segment VII during the late phase (fig. 6). A 4cm diameter radio-frequency ablation probe (LeVeen, Boston Scientific) was then inserted into the lesion and thermal ablation was carried out using the recommended settings (fig. 7a and b).

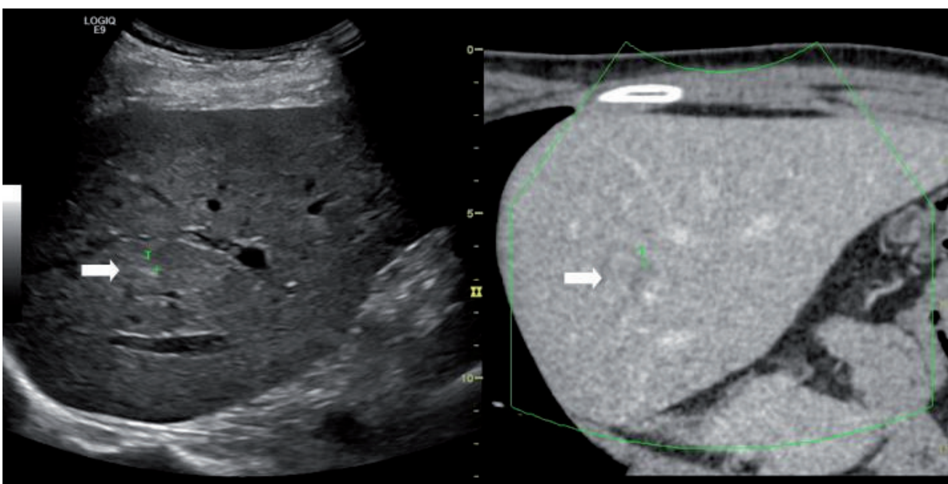


Fig.5: The image fusion mode allows the data from the ultrasound scan currently in progress to be shown on the same screen as the reconstructed CT scan images in the plane chosen by the user performing the exam. The segment VII lesion is seen much more clearly in the CT examination.

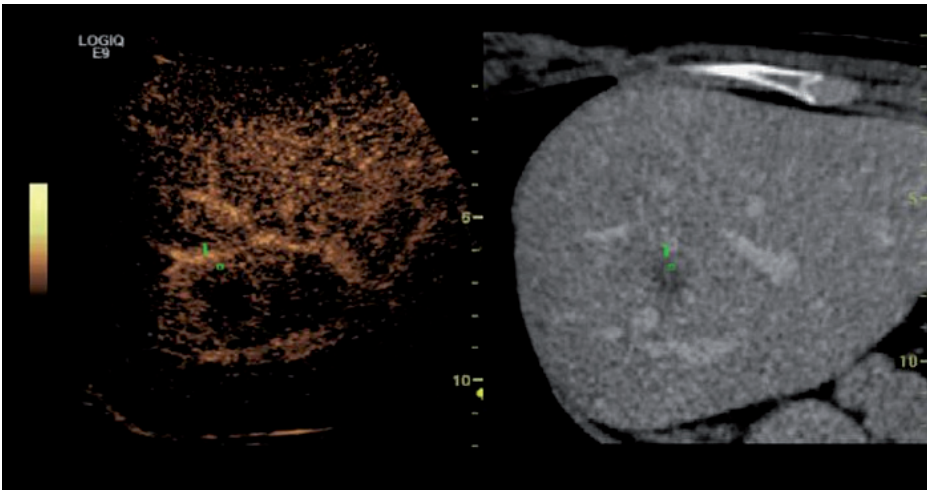


Fig.6: Image fusion can be implemented with complex ultrasound data, including contrast-enhanced ultrasound data. The segment VII lesion can be tagged by a GPS Target and identified using both types of imaging.

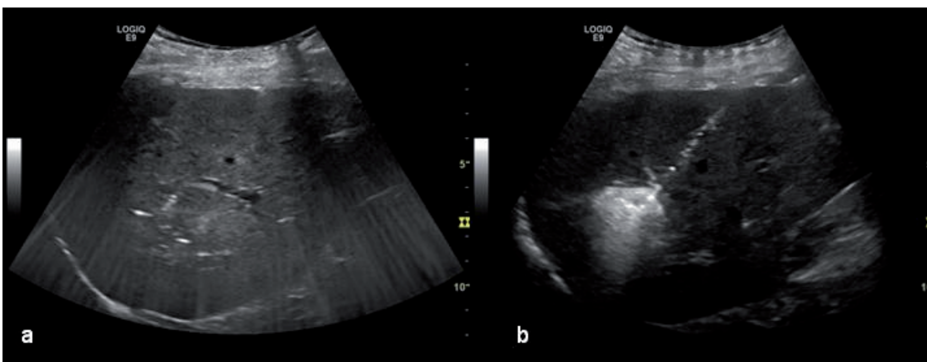


Fig.7: a) The use of image fusion provides more secure guidance as the radiofrequency ablation probe is inserted into the tumour.
b) $CO_2$ bubbles are released around the lesion during the thermal ablation procedure, which creates a diffuse hyperechoic appearance.

## Monitoring

The lesion was treated in 27 minutes and a further contrast-enhanced ultrasound exam confirmed the ablation zone where the tumour had been (fig. 8). Follow-up was straightforward and the CT check-up scan six weeks after the procedure revealed a 35mm-wide thermal ablated area at the previous lesion location.

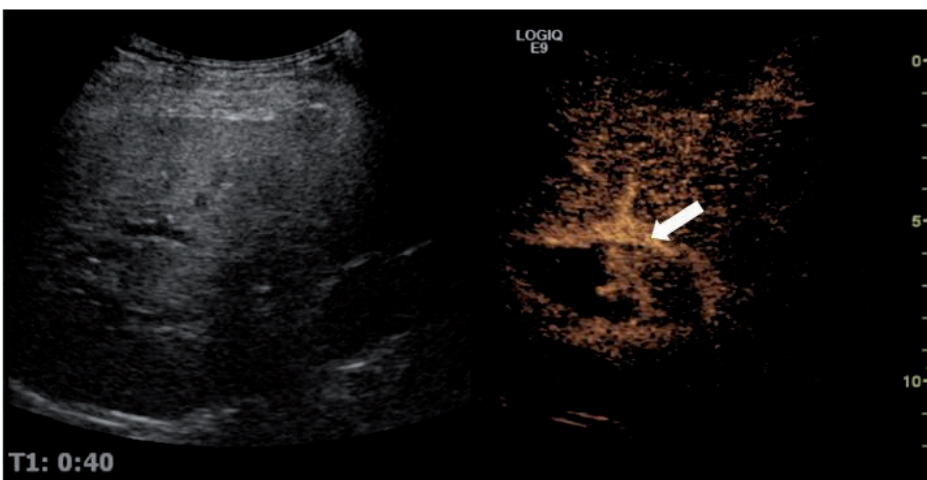


Fig.8: A contrast-enhanced ultrasound is carried out immediately after the thermal ablation. In conventional ultrasound, the necrotic cavity does not show up very clearly. Following injection of contrast medium, there is a non-opacified area which remains from the early phase onwards for the whole duration of the ultrasound examination.

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