

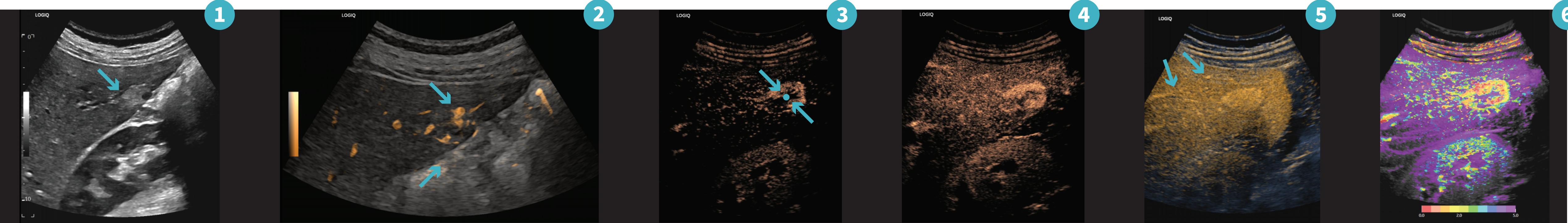
See and characterize a liver lesion in a single exam

Explore the value of using Contrast-Enhanced Ultrasound (CEUS) on focal liver lesions.



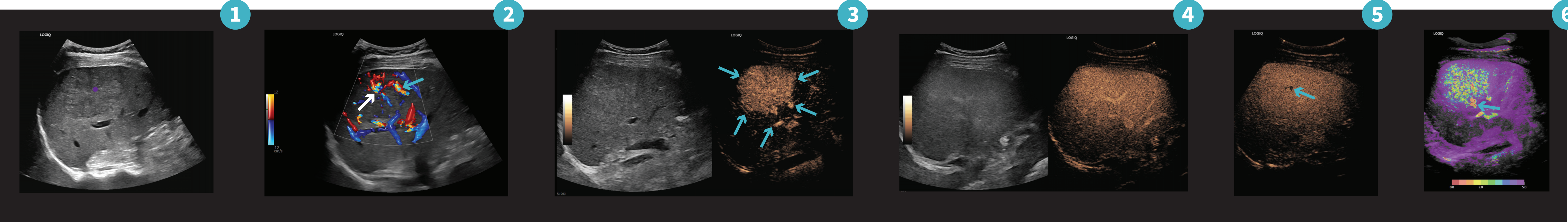
BENIGN

Haemangioma



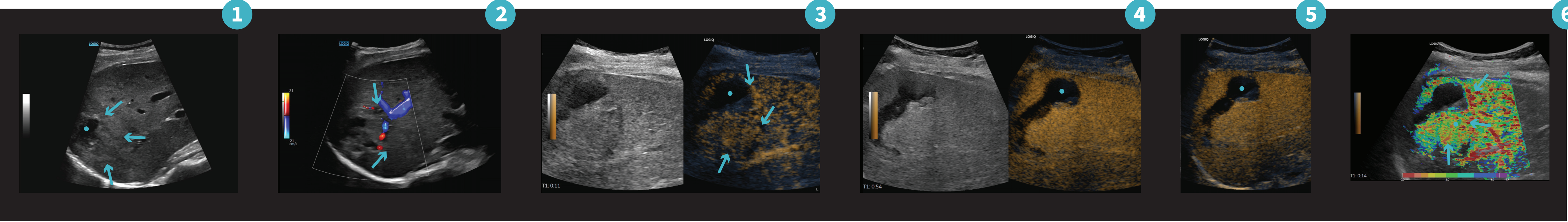
AD.1 B-mode image showing a subcapsular predominantly hyperechoic lesion (arrow) in hepatic segment VI. The lesion is well-demarcated and smooth-bordered. **AD.2** B-flow image showing blood flow signals positioned in a peripheral nodular pattern (arrows). **AD.3** Early arterial phase (9 seconds) CEUS image showing arterial phase hyper-enhancement in a peripheral, nodular and discontinuous pattern (arrows). Micro-bubbles uptake in the enhancing parts of the lesion equals that of arteries. The central part of the lesion is non-enhancing at this stage (asterisk). **AD.4** Later arterial phase (18 seconds) CEUS image showing a gradual centripetal pattern of enhancement. The micro-bubbles move towards the central part of the lesion, while intense enhancement is sustained at the periphery. **AD.5** Portal venous phase (54 seconds) CEUS image showing homogeneous enhancement of the lesion. Note the enhancement of the lesion is higher compared to the adjacent liver parenchyma and similar to the juxtaposed vessels (arrows). **AD.6** Parametric CEUS image adjusted at 5 seconds of enhancement timing. The centripetal pattern of arterial phase enhancement is confirmed. The micro-bubbles initially appear at the periphery of the lesion, forming globules and then gradually move toward the center of the lesion (purple central area).

Focal Nodular Hyperplasia (FNH)



AD.1 B-mode image showing a large focal liver lesion (asterisk). The lesion is ill-defined and has a similar echogenicity to the adjacent liver parenchyma, making it difficult to be discerned. **AD.2** Colour Doppler hybrid image showing the hypervascularity of the lesion. Note the presence of a feeding artery (arrow) and the abundance of internal blood flow signals throughout the lesion. Arteries can be seen positioned in a "spoke-wheel" appearance radiating from a central stellate vascular structure (arrow). **AD.3** Early arterial phase (11 seconds) CEUS image showing quick and homogeneous enhancement of the lesion (arrows). The lesion quickly uptakes micro-bubbles earlier and at a higher degree than the adjacent parenchyma. The lesion enhances similarly to the juxtaposed vessels (arrows), being a highly vascularized lesion. **AD.4** Portal venous phase (12 seconds) CEUS image showing homogeneous enhancement of the lesion. The lesion is now iso-enhancing to the adjacent parenchyma and cannot be easily discerned. **AD.5** Delayed phase (2.10) CEUS image showing sustained homogeneous enhancement of the lesion. Note the presence of a centrally located non-enhancing linear structure, representing a central scar (arrowhead). **AD.6** CEUS parametric image adjusted at 5 seconds, given the quick arterial enhancement of the lesion. The lesion demonstrates a centripetal pattern of enhancement, meaning that micro-bubbles initially appear at the periphery of the lesion and then quickly move toward the center of the lesion (purple central area).

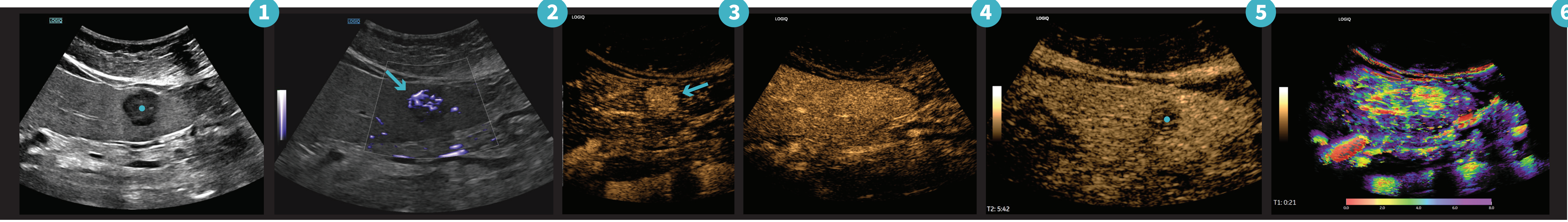
Hepatic adenoma



AD.1 B-mode image showing a mild echogenicity ill-defined lesion (outlined by arrow). Note the presence of anechoic areas in keeping with necrosis or previous episode of hemorrhage (asterisk). **AD.2** Colour Doppler hybrid image showing peripheral blood flow signals (arrows). These signals correspond to peripherally located feeding vessels. **AD.3** Arterial phase (11 seconds) CEUS image showing mild arterial phase hyper-enhancement of the lesion (arrows). Note it made of peripherally located feeding arteries. The haemorrhagic material does not show any enhancement (asterisk). **AD.4** Portal venous phase (12 seconds) CEUS image showing the lesion iso-enhancing to the adjacent liver parenchyma. The lesion's margins cannot be discerned. The haemorrhagic material does not show any enhancement, excluding active haemorrhage (asterisk). **AD.5** Delayed phase (2.10) CEUS image showing the lesion still iso-enhancing to the adjacent liver parenchyma. The absence of wash-out even at this delayed stage is suggestive of a benign lesion. The haemorrhagic material is still non-enhancing (asterisk). **AD.6** CEUS parametric image adjusted at 4.7 seconds, based on the rapid arterial enhancement of the lesion. The lesion demonstrates a centripetal pattern of enhancement, meaning that micro-bubbles initially appear at the periphery of the lesion (arrows), originating from the feeding arteries and then gradually move toward the central part of the lesion (asterisk).

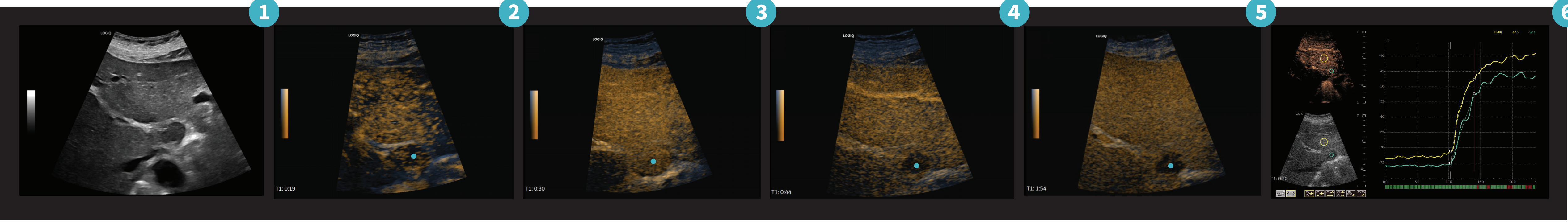
MALIGNANT

Hepatocellular carcinoma (HCC)



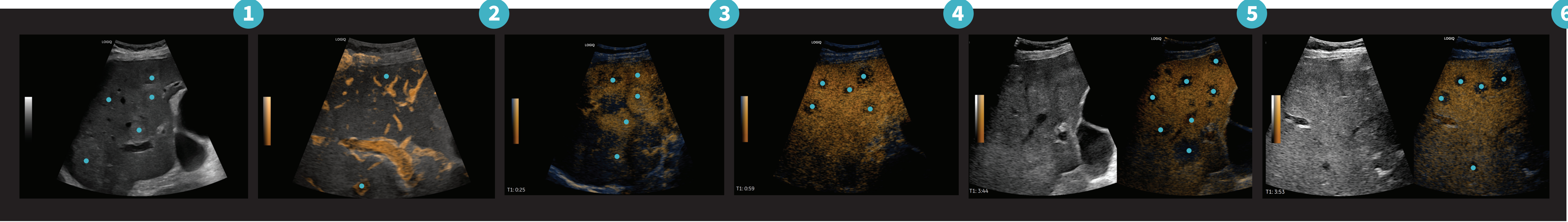
AD.1 B-mode image showing a rounded hypoechoic lesion in the right liver lobe (asterisk). The lesion is subcapsular in location and has lobulated margins. **AD.2** Microvascular imaging (MVI) image illustrating the internal vascular architecture of the lesion. The lesion exhibits a rich network of internal irregular blood vessels. Note the origin of the vascular branches from a single feeding artery (arrow). The term "basket" pattern of vascularity has been used to describe HCC vascularity. **AD.3** Arterial phase (11 seconds) CEUS image showing clear and homogeneous arterial phase hyper-enhancement of the lesion (arrows). The lesion uptakes the micro-bubbles prior to the adjacent parenchyma and at a higher grade. **AD.4** Portal venous phase (12 seconds) CEUS image showing the lesion iso-enhancing to the adjacent liver. The 1.4 minute is an important timepoint as wash-out prior to this point suggests a malignancy of non-hepatocellular origin in the setting of liver cirrhosis. **AD.5** Delayed phase (2.10) CEUS image showing wash-out of the lesion (asterisk), which is now hypo-enhancing to the adjacent liver. Lesions in cirrhotic liver should be followed up for up to 6 minutes, as even late phase wash-out indicates a malignancy of hepatocellular origin. **AD.6** CEUS parametric image adjusted at 4.7 seconds, based on the rapid arterial enhancement of the lesion. The lesion demonstrates a centripetal pattern of enhancement, meaning that micro-bubbles initially appear at the periphery of the lesion (arrows), originating from the feeding arteries and then gradually move toward the central part of the lesion (asterisk).

Hypovascular metastasis



AD.1 B-mode image showing a rounded hypoechoic lesion in hepatic segment I. (asterisk). The lesion is homogeneous in echogenicity and has smooth borders. **AD.2** Early arterial phase (11 seconds) CEUS image showing the lesion (asterisk) as hypo-enhancing compared to the adjacent normal liver parenchyma. The lesion uptakes micro-bubbles at a lower rate than the liver parenchyma. **AD.3** Late arterial phase (12 seconds) CEUS image showing the lesion (asterisk) iso-enhancing to the adjacent parenchyma. The lesion has uptaken micro-bubbles at the same degree with the parenchyma but with a slower rate. **AD.4** Portal venous phase (2.10 seconds) CEUS image showing the lesion (asterisk) with early and marked wash-out. The lesion has retained only a minimal degree of enhancement, starting prior to the time cut-off of 1 minute, a criterion in keeping with malignancy and specifically metastatic disease. **AD.5** Delayed phase (2.10 seconds) CEUS image showing the lesion (asterisk) completely wash-out. There are essentially no micro-bubbles circulating inside the lesion, which appears as a "black hole". **AD.6** Time-intensity curve analysis showing that the lesion (green curve) uptakes the contrast with a slower rate and at a lower degree than the adjacent liver parenchyma (yellow curve). This pattern is in keeping with a hypovascular metastasis, particularly in the setting of a patient with a known primary colon cancer. Objective quantitative parameters can be derived from this type of analysis, useful for prospective monitoring of treatment response to anti-angiogenic treatment.

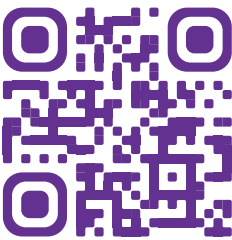
Hypervascular metastases



AD.1 B-mode image showing multiple mildly hyperechoic lesions (asterisks) throughout the right liver lobe in a patient with known primary colon cancer. Some of the lesions have a hypoechoic halo, in keeping with "target" appearance. **AD.2** B-flow image revealing peripheral blood flow signals in some of the lesions (asterisks). The peripheral vascularity pattern follows the hypovascular halo finding on B-mode. **AD.3** Early arterial phase (11 seconds) CEUS image showing arterial phase hyper-enhancement of the lesions (asterisks) in a peripheral "rim" like pattern. The lesions uptake the micro-bubbles quicker than the normal liver parenchyma and at a higher degree, especially in their periphery, and later at their central part. **AD.4** Portal venous phase (12 seconds) CEUS image showing early and intense wash-out of the lesions (asterisks). Following their arterial phase hyper-enhancement, the lesions washed out quickly and intensely, prior to the cut-off of 1 minute. This pattern of wash-out is suggestive of malignancy and specifically hypervascular metastatic disease. **AD.5** Delayed phase (2.10 seconds) CEUS image showing the lesions (asterisks) completely wash-out. There are essentially no micro-bubbles circulating inside the lesions, which appear as a "black hole". **AD.6** During the delayed phase and once the vascularity pattern of liver metastases is established, a "wipe through" examination of the entire liver parenchyma should be performed in every patient assessed for liver metastatic disease, in order to assess the extent (number and size) of liver metastases. The wash-out appearance enables the detection of metastases which could be missed on B-mode due to similar echogenicity with the liver parenchyma.

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