

Uncharacterized small hepatic nodules: The value of diffusion-weighted imaging in cancer patients

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Learning objectives

1. To present the basic principles of diffusion-weighted imaging and the technical aspects of performing DW-MR in the body.
2. To present a comprehensive pictorial review focusing the role of DW-MRI imaging in focal hepatic lesions that are too small to characterize or have atypical dynamic behaviour after contrast administration on CT scans.
3. To assess the utility of DW-MRI in differentiating benign and malignant causes of hepatic lesions, in patients with recent history of cancer.

Background

- It is well known by all radiologists the major problem involved in the characterization of small hepatic nodular lesions seen in CT scans. This can be even more challenging when we talk about patients who underwent chemotherapy or liver surgery for metastasis resection.
 - Metastatic liver disease is the most common malignant neoplasm of the liver and is found in about 40% of all cancer patients. They are frequently associated with carcinomas of the gastrointestinal tract such as colorectal, stomach, and pancreas.
 - Accurate detection and characterization of liver nodules are important for treatment planning for patients with liver metastases.
 - CT and MRI, are the two principal imaging techniques for the evaluation of the liver for accurate assessment of hepatic metastases before surgery in patients with cancer.
 - With the advent of multidetector scanners, CT is the most frequently used technique for the depiction of focal liver lesions, with high sensitivity in the detection of metastases. However, even with multidetector scanners, detection of liver lesions is often limited when the lesion is small, especially <1 cm.
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- In 1965, Stejskal and Tanner adapted a standard T2-weighted spin-echo sequence by applying asymmetric pair of diffusion-sensitizing gradients just before and after the 180° refocusing pulse.

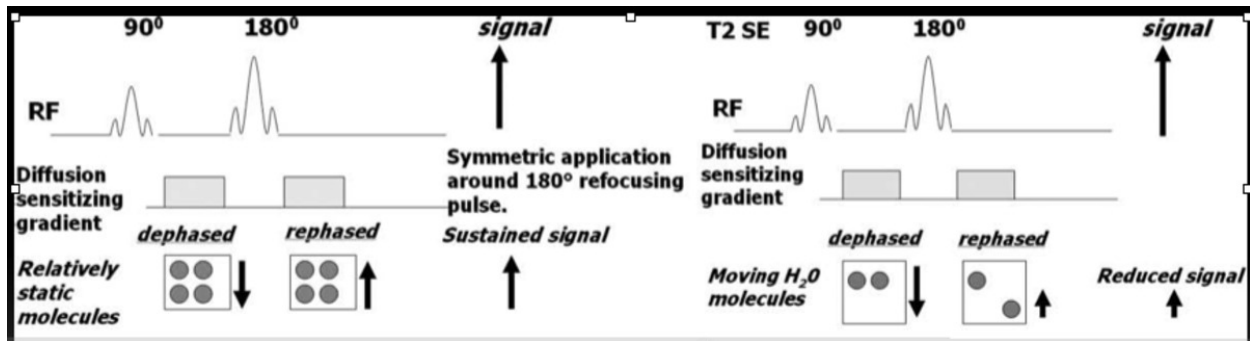


Fig.

References: Aliya Qayyum et al, Diffusion-Weighted Imaging in the abdomen and pelvis: Concepts and applications, RadioGraphics 2009;29:1797-1810

- DWI explores the random motion of water molecules in the body (constant random brownian motion). This movement, in biologic tissues like the liver, is restricted because of the interactions, especially with cell membranes; extracellular space, intracellular space, and intravascular space all contribute to measured MR-DWI signal.

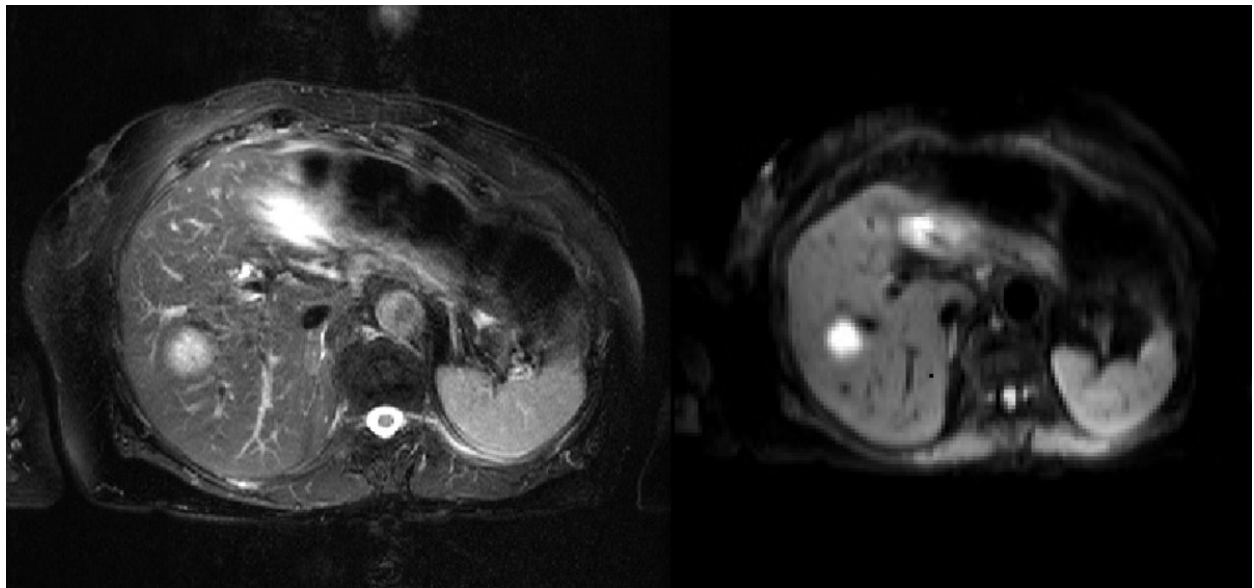


Fig.: T2 TSE FS and Diffusion-weighted image (b=50)

References: F. A. G. V. Cavalheiro; Radiology, Hospital Universidade Coimbra, Coimbra, PORTUGAL

- Several studies have shown that diffusion-weighted imaging can be used for detection and characterization of focal hepatic lesions through quantification of diffusion effects with different "b" values and with apparent diffusion coefficient (ADC) measurements.

- DW-MRI imaging is used to distinguish highly cellular from acellular lesions, cystic regions from solid regions, and treatment response manifested as changes in cellularity in the tumor

Imaging findings OR Procedure details

- The main objective is to present a comprehensive pictorial review in a multimodality approach, comparing Ultrasound, MDCT and MRI studies of small liver nodules, focusing the emerging applications of DWI for tumor detection, tumor characterization, distinguishing tumor tissue from non-tumor tissue.

Images for this section:

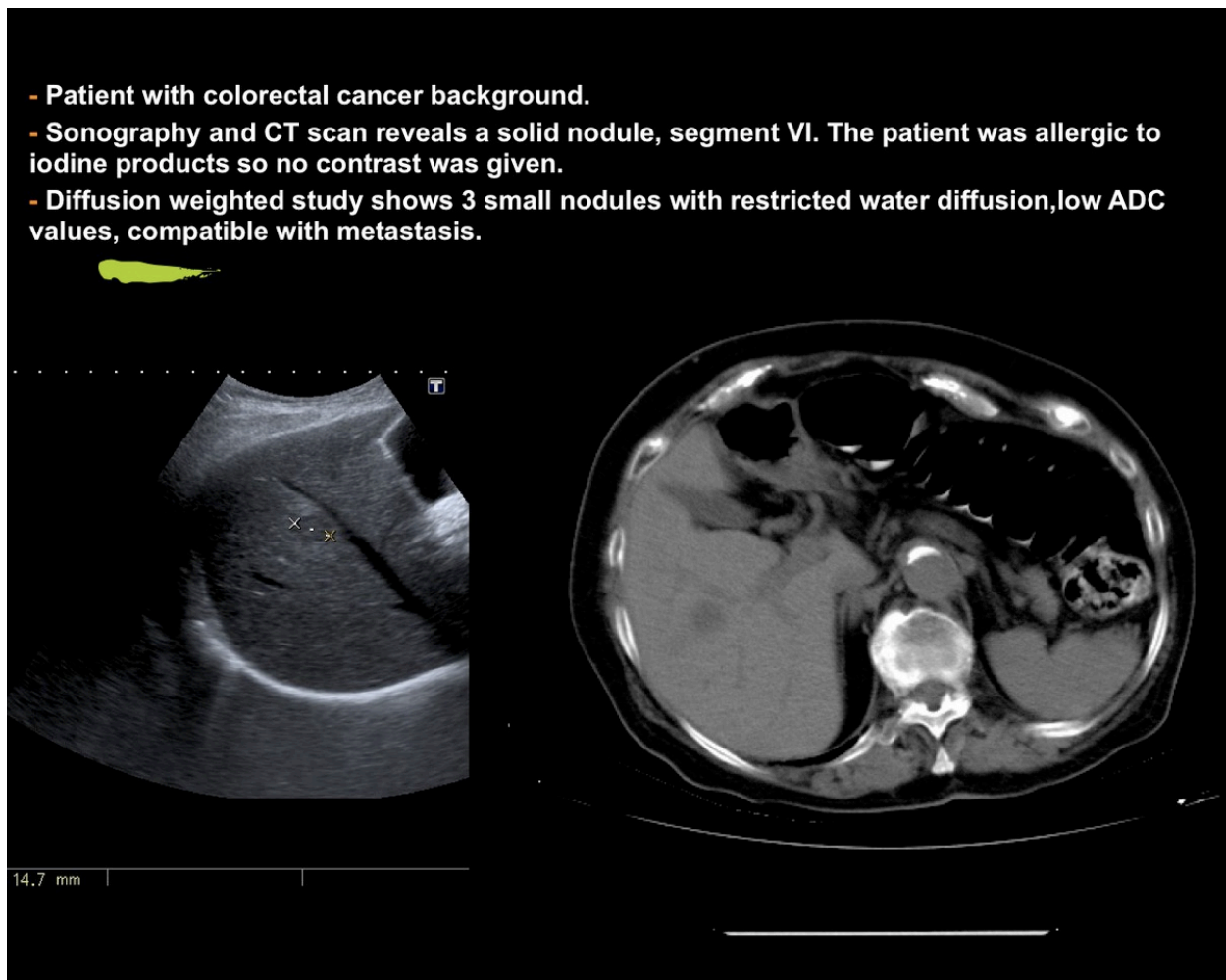


Fig. 1: Please see image nº2

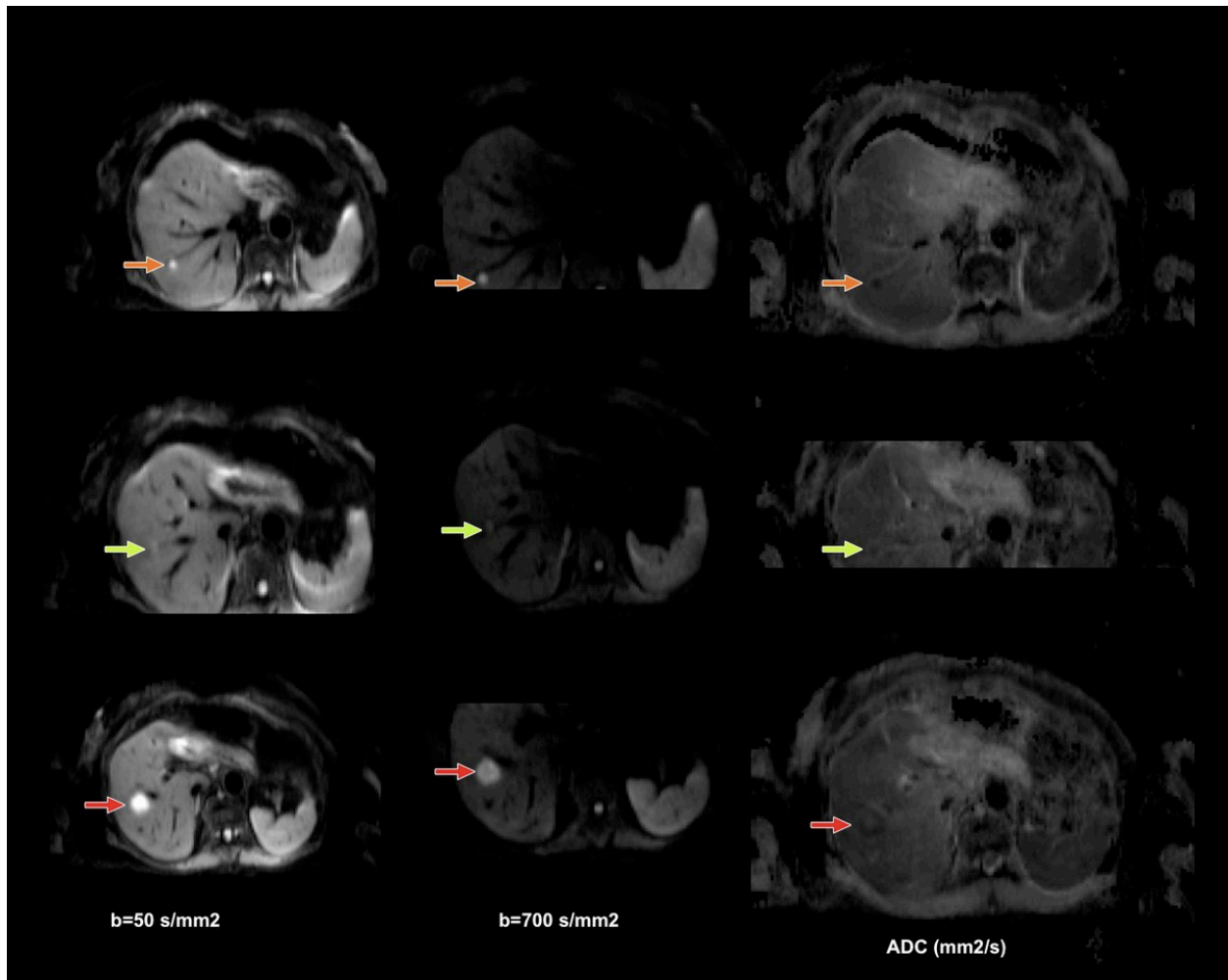


Fig. 2

- Patient with colorectal carcinoma.
- US demonstrates a well-defined hyperechoic nodule.
- Follow-up enhanced CT demonstrates a hypodense nodule in seg. VI, with lobular enhancement (portal phase in figure). The lesion remained hypodense in late venous phase.
- Haemangioma?
- MRI-DWI was performed in this patient.

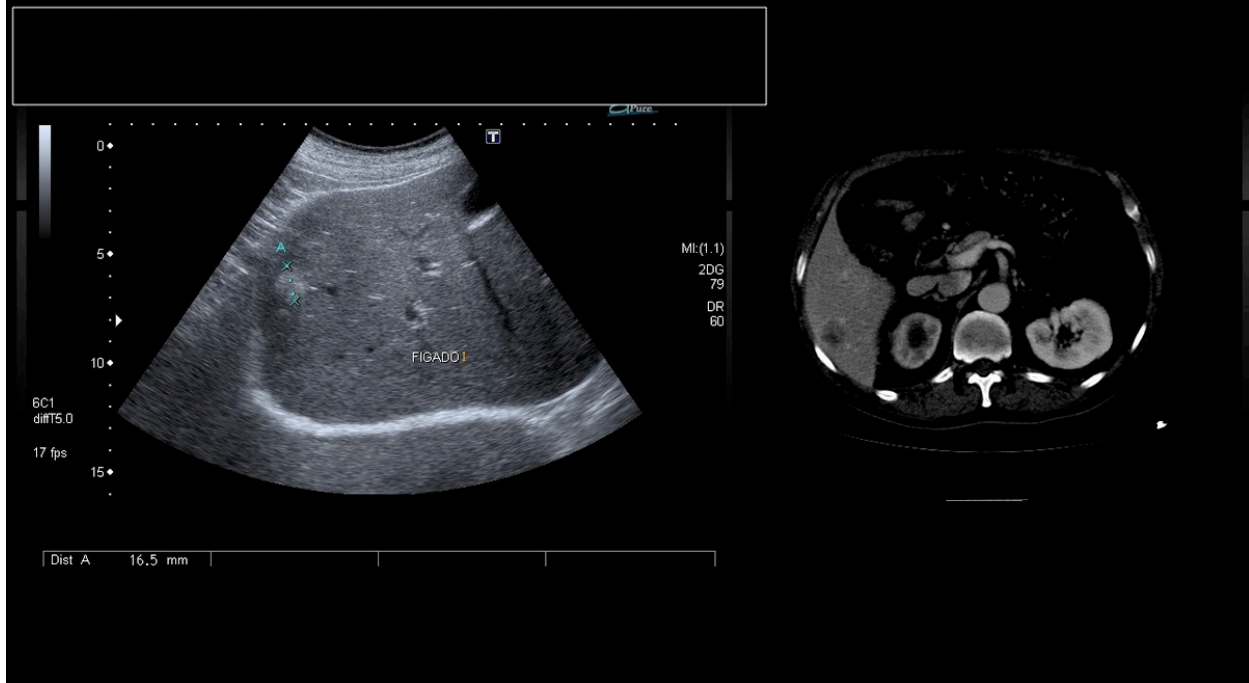


Fig. 3: Case 2. Please see image n°3

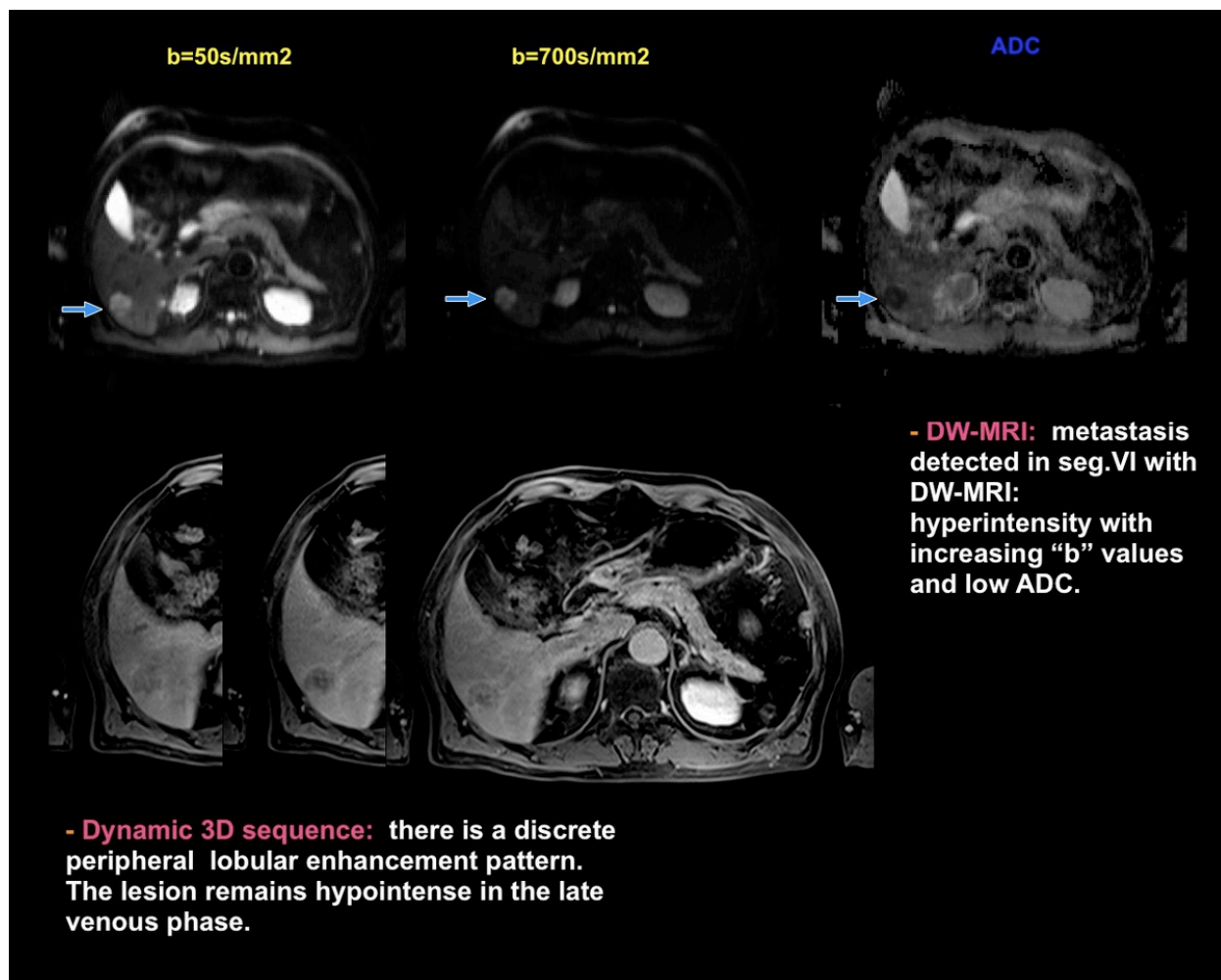


Fig. 4

- Patient with metastatic melanoma with previous liver lobectomy.
- Follow-up arterial enhanced CT was unremarkable.
- MRI-DWI was performed in this patient.

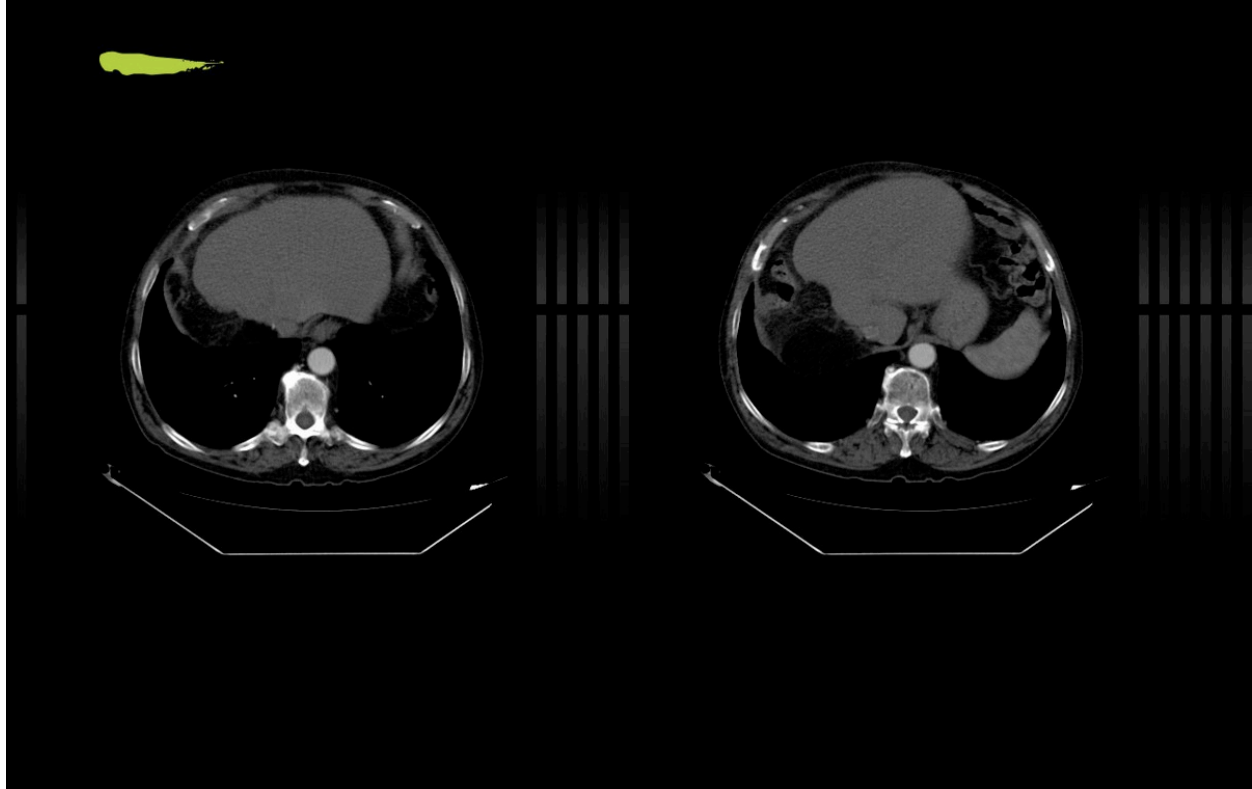


Fig. 5: Case3. Please see image n°5

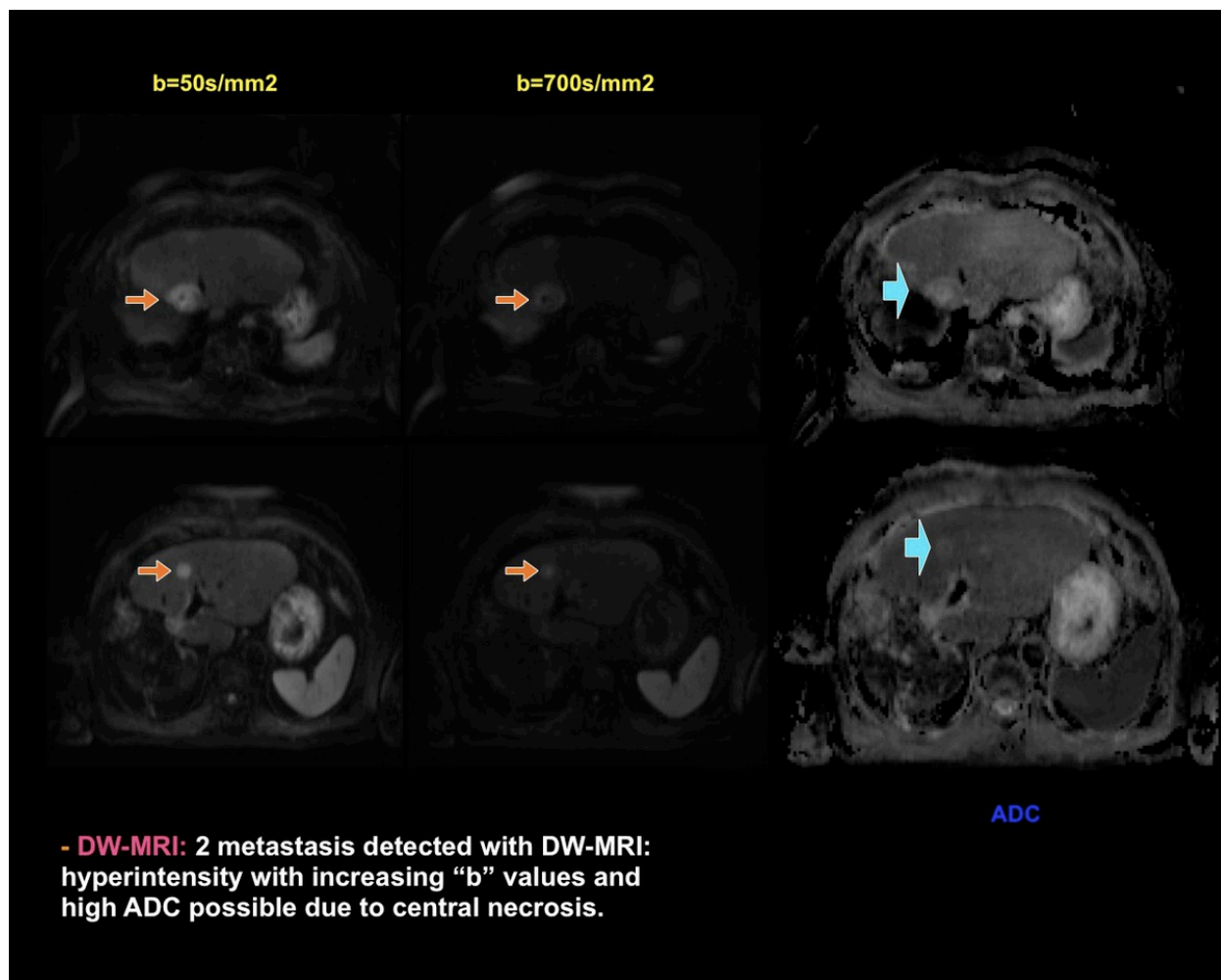


Fig. 6

- Patient with gastric carcinoma background. Follow-up enhanced CT reveals 2 “too small to characterize” hypodense nodules in seg IV and VIII, that were suspicious for metastasis.

- MRI-DWI was performed in this patient.

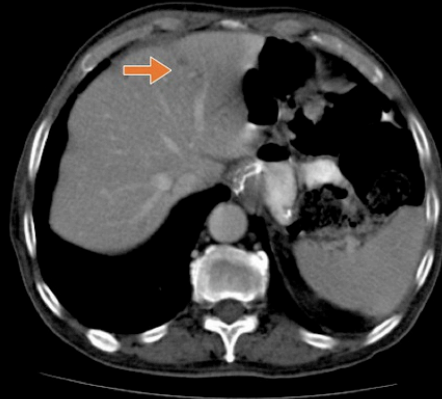
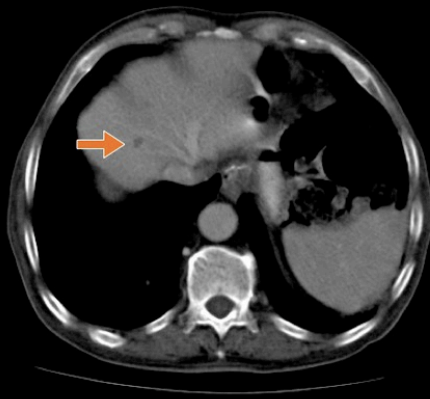


Fig. 7: Case 4. Please see image n°8

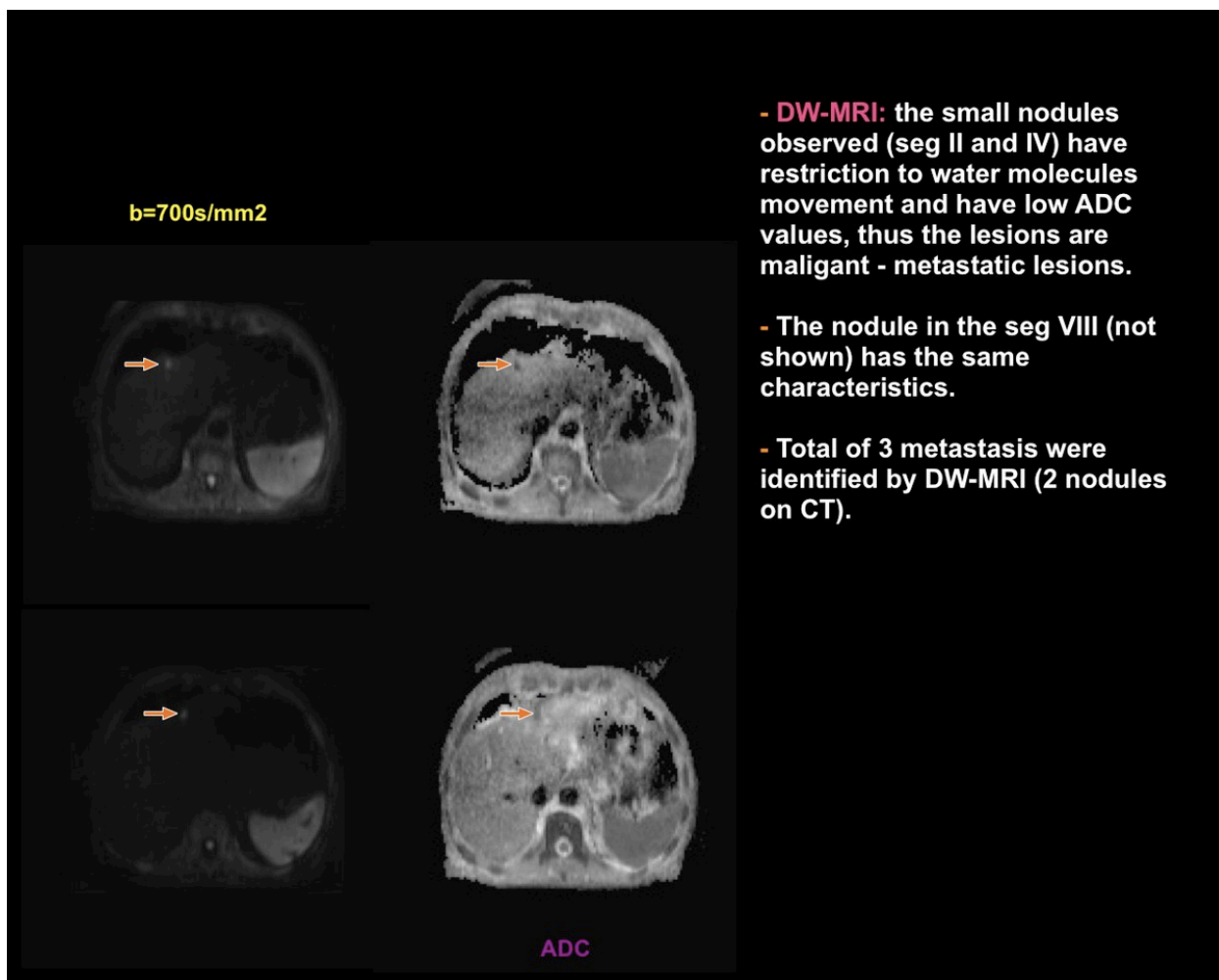


Fig. 8

- Patient with known colorectal cancer.
- CT reveals 2 hypodense, hypovascular nodules, compatible with metastatic nodules.
- MRI-DWI was performed in this patient.

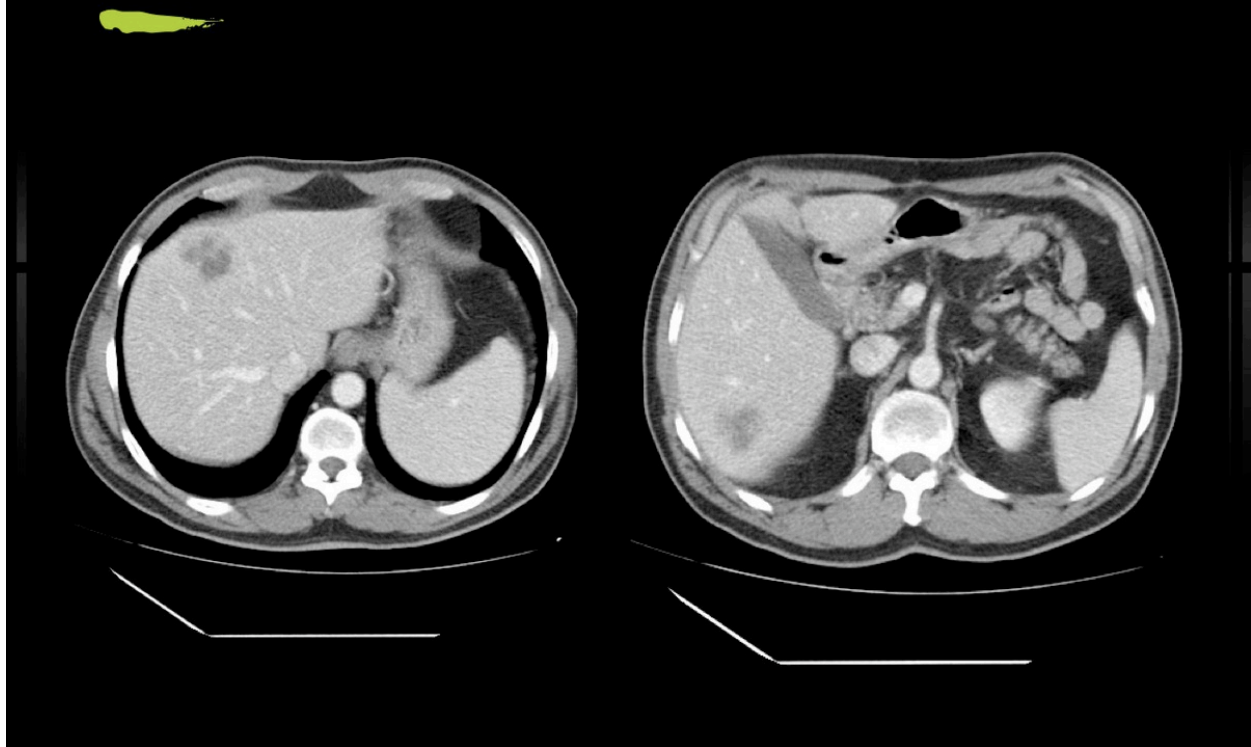


Fig. 9: Case5. Please see image n°10 and 11

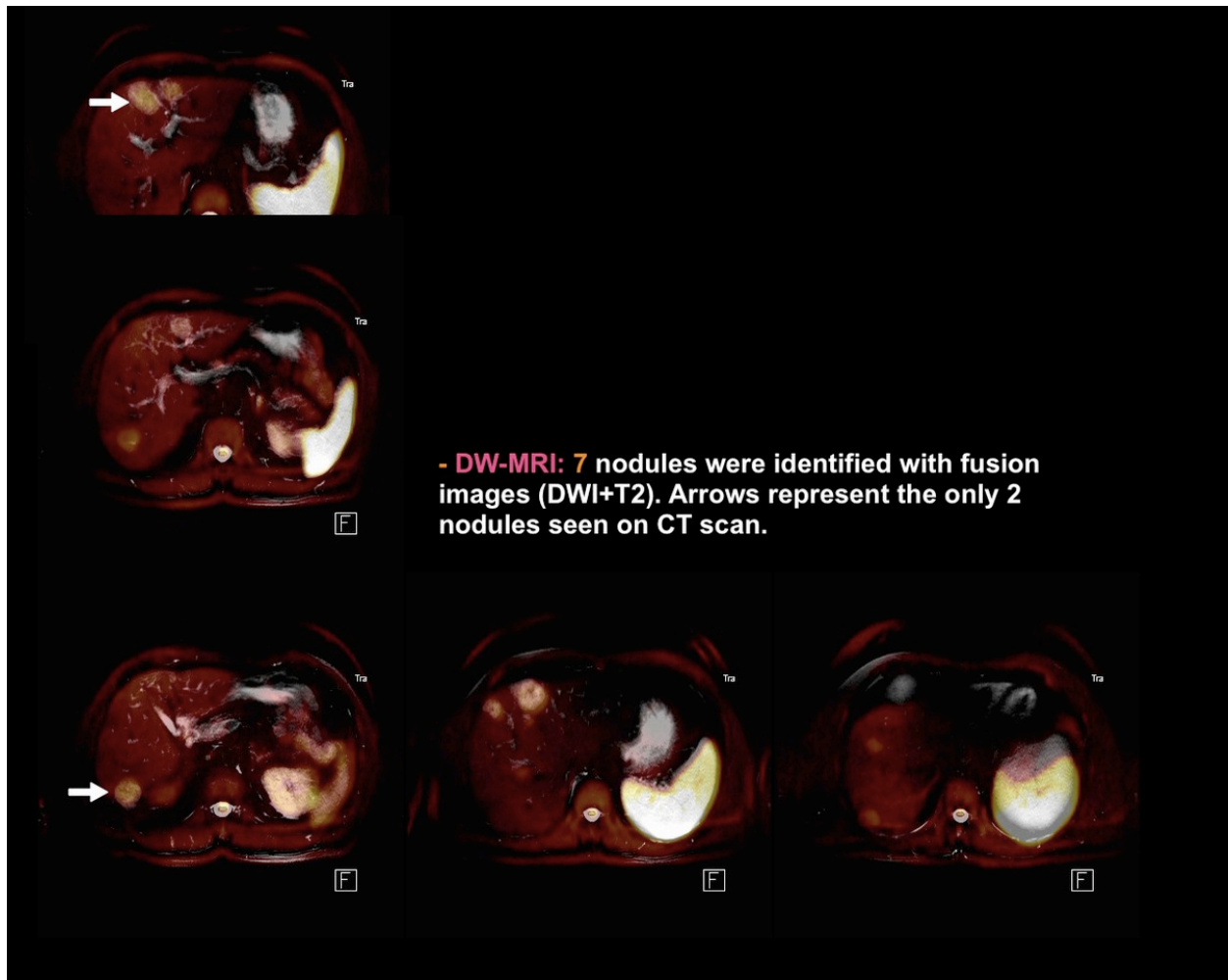


Fig. 10

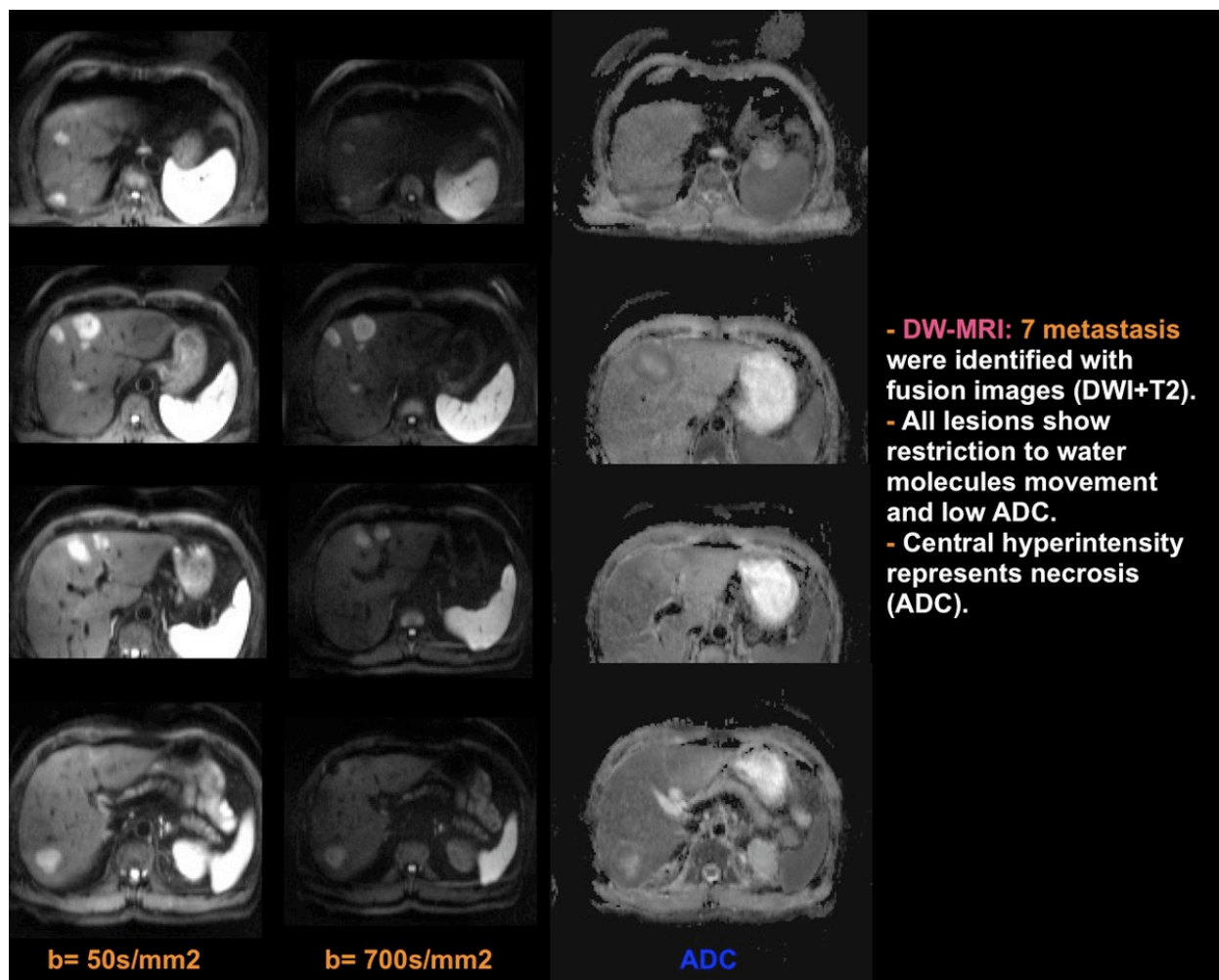


Fig. 11

- Patient with known bladder cancer. Pre-surgical CT reveals several "too small to characterize" hypodense nodules in both lobes. Haemangioma is detected in seg. VI.
- MRI-DWI was performed in this patient.

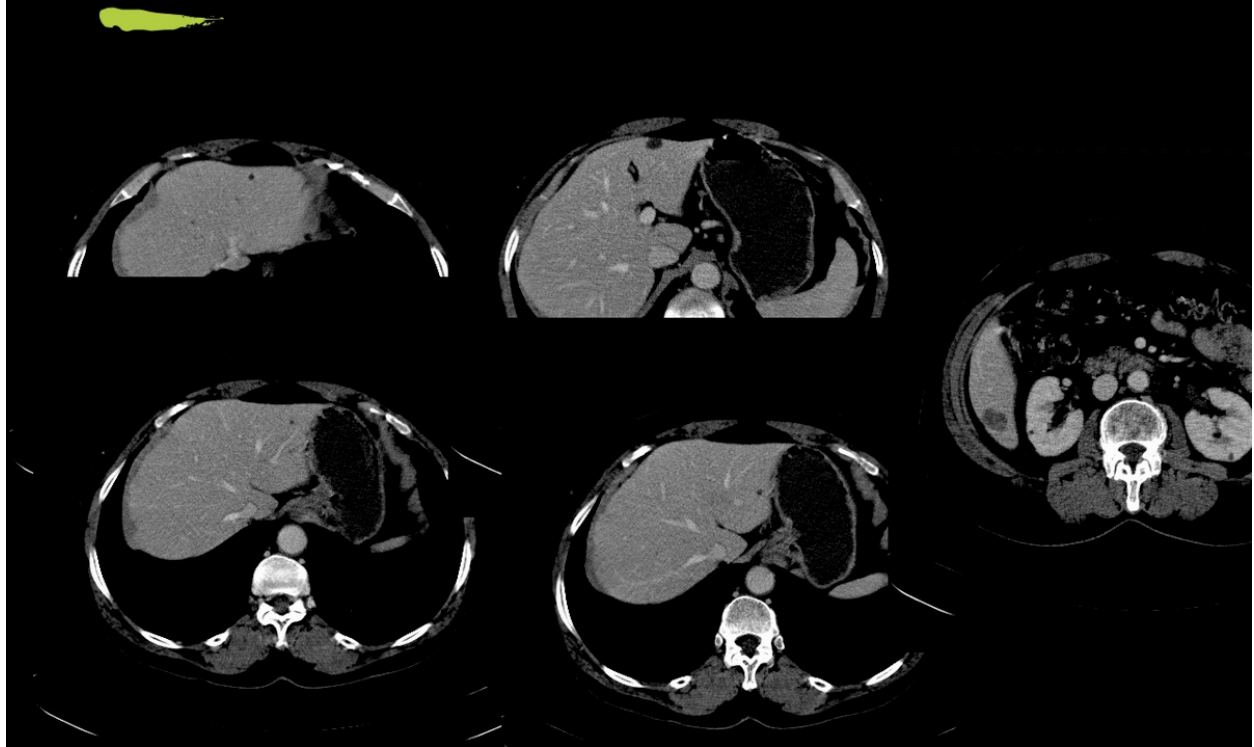


Fig. 12: Case 6. Please see image n°13

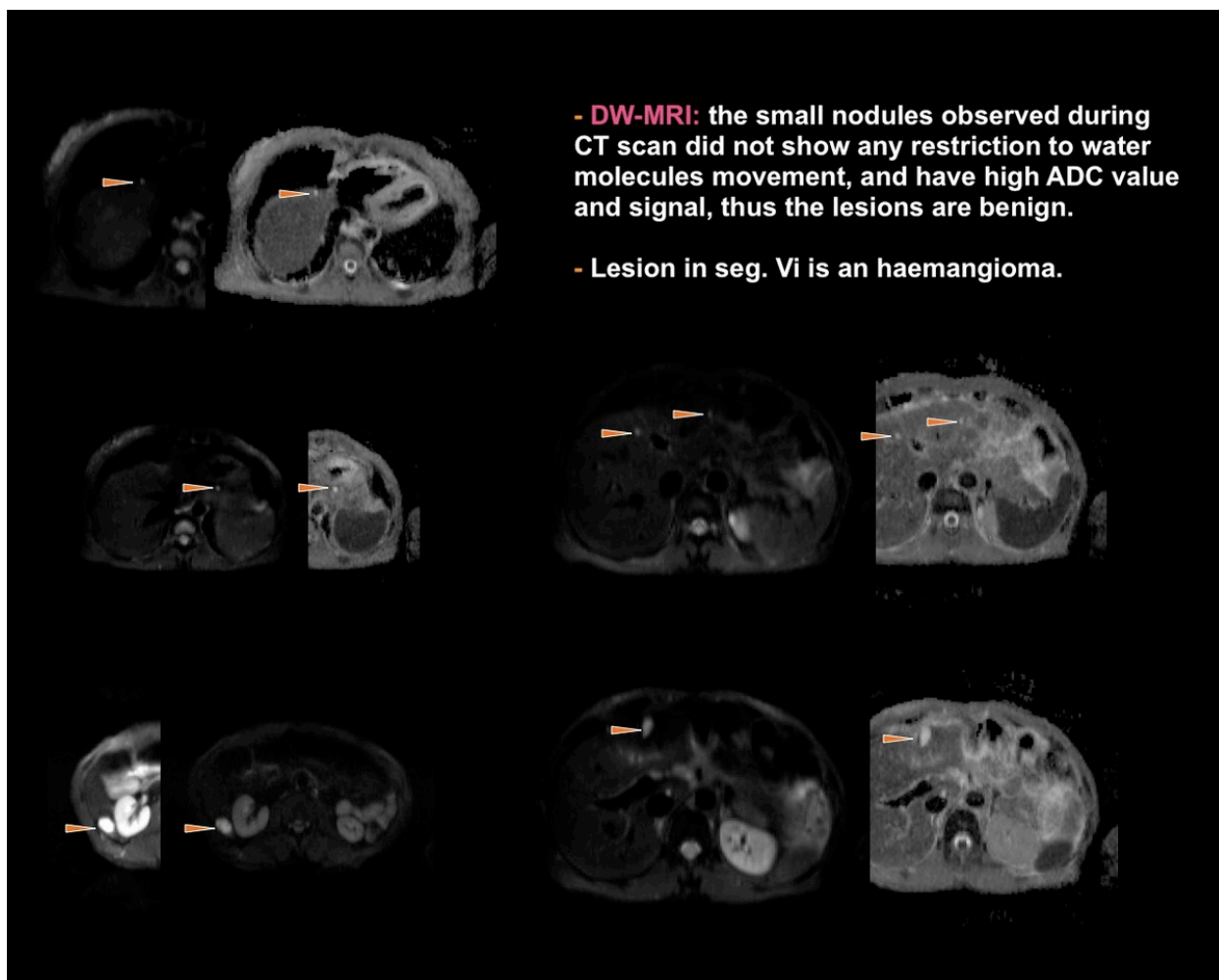


Fig. 13

- Patient with known HCC (seg VI and VII). Pre-surgical CT reveals a small hypodense nodule in the segment IV.
- MRI-DWI was performed in this patient.

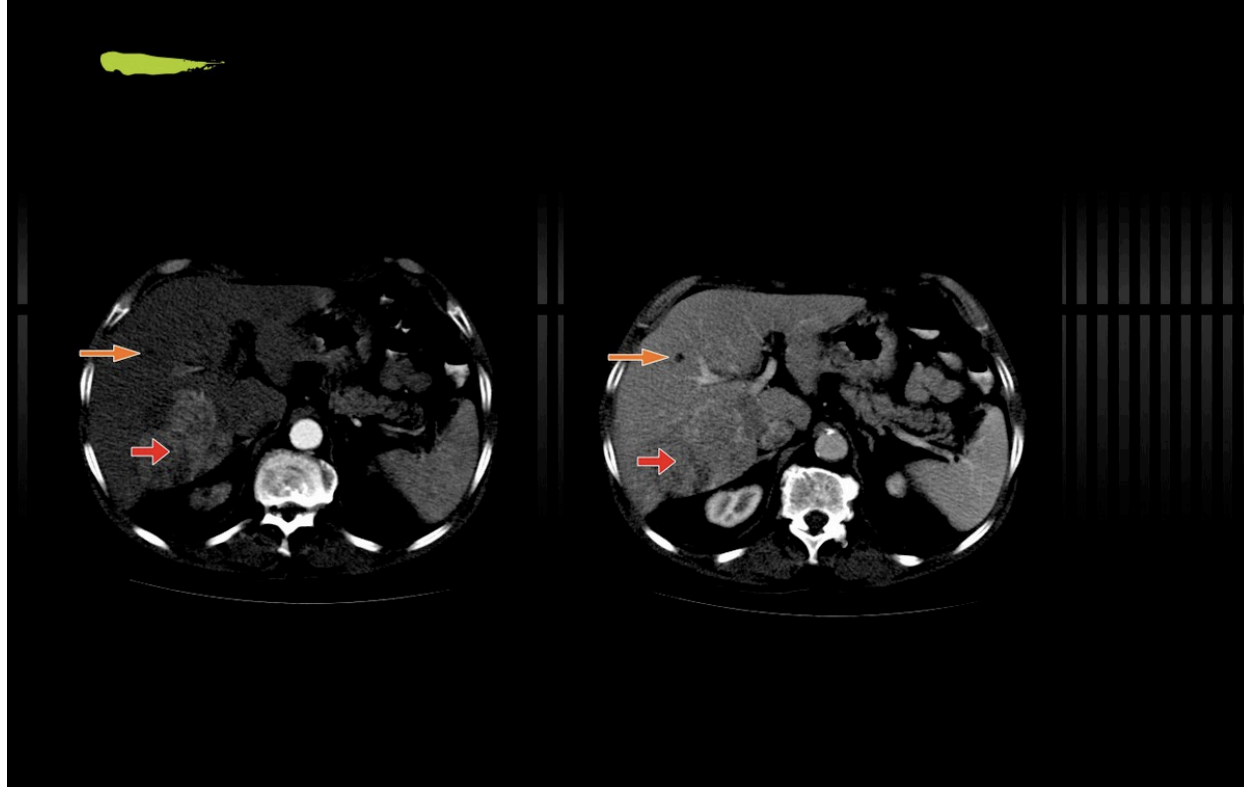


Fig. 14: Case 7. Please see image n°15

- **DW-MRI:** the small nodule did not show any restriction to water molecules movement, and a high ADC value and signal is observed, thus the lesion is benign, probably cystic.

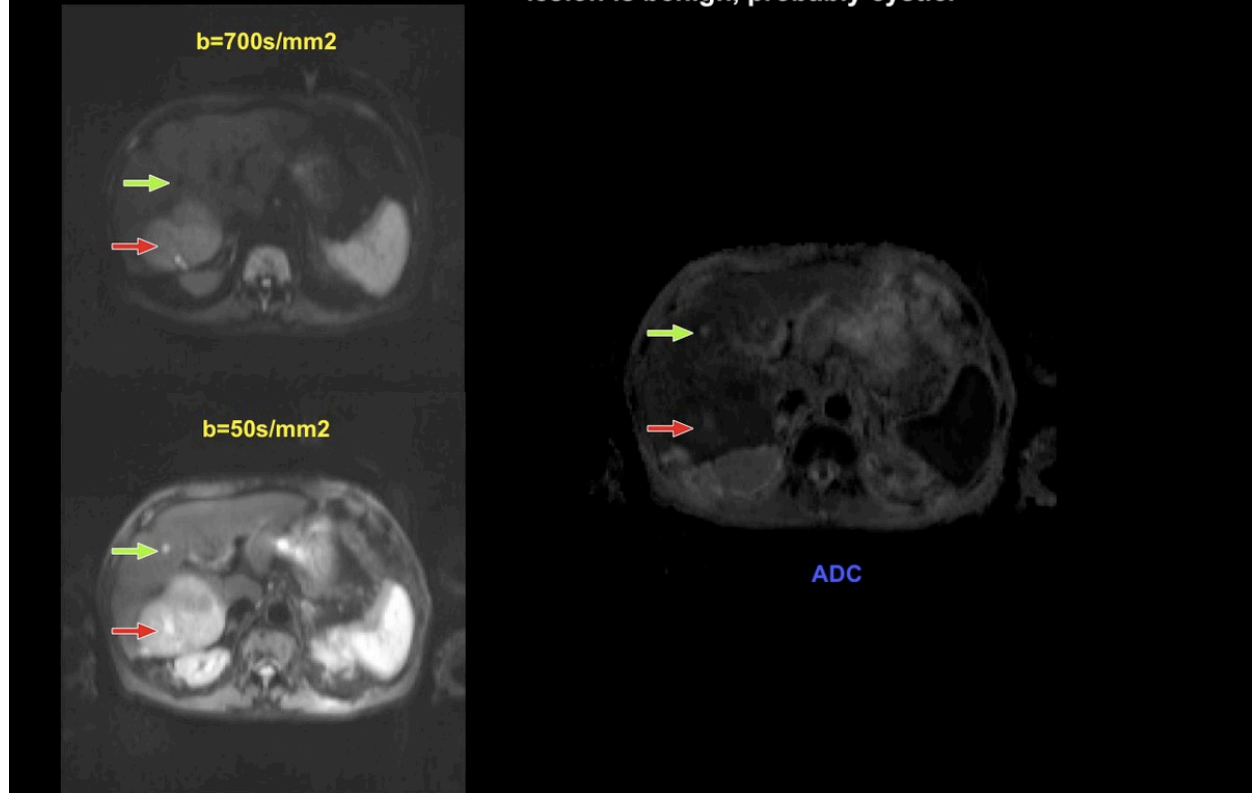


Fig. 15

- Patient with rectal cancer history and right lobe hepatectomy (metastatic disease).
- Enhanced CT (portal phase) detects 1 hypodense solid nodule too small to be characterized. This nodule was not visible during arterial and late venous scans.
- MRI-DWI was performed in this patient: the dynamic enhanced MRI study did not show any nodule within the hepatic parenchyma.

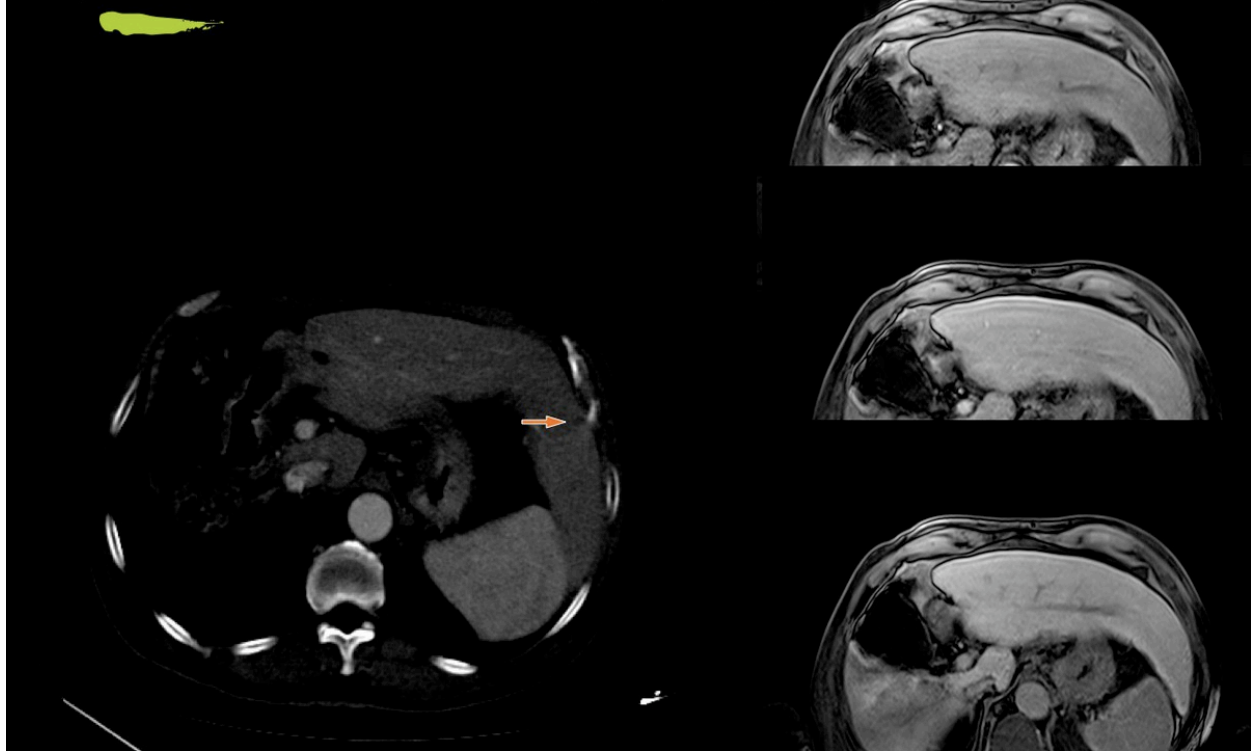


Fig. 16: Case 8. Please see image n°17

- DW-MRI was unremarkable.
- CT scan performed 3 months after, was also unremarkable and no nodule was detected.

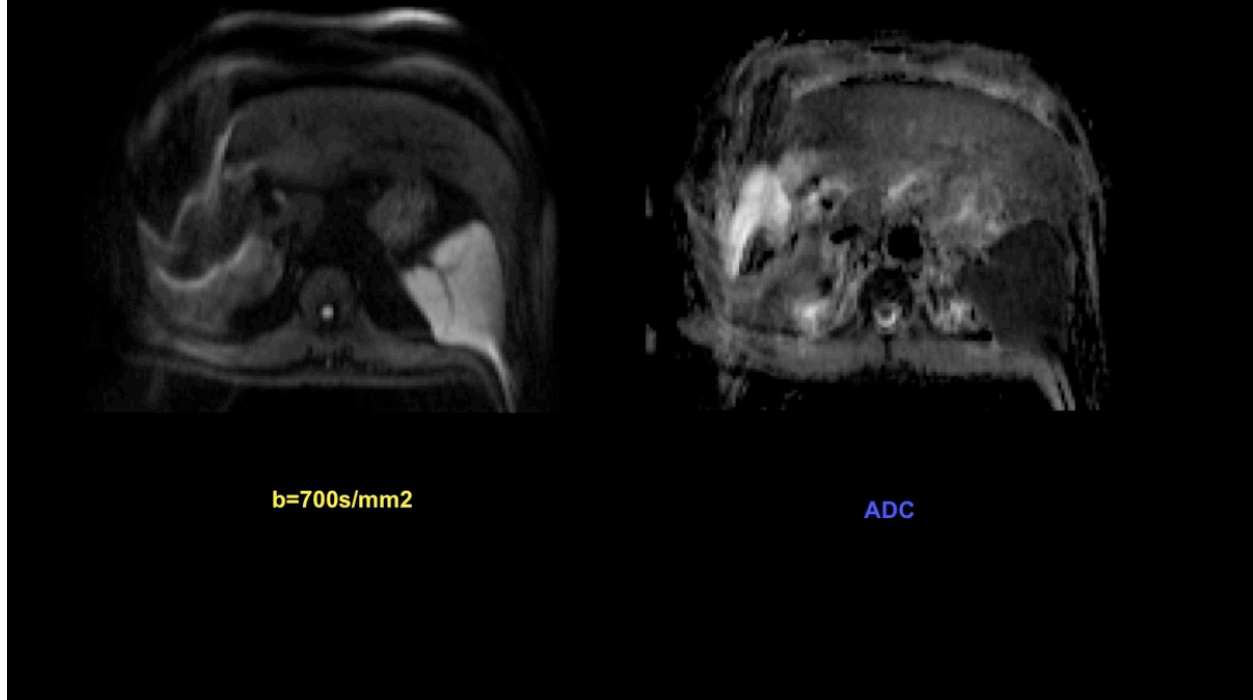


Fig. 17

- Young patient with colonic cancer background and known left lobe hepatocellular adenoma (presence of fat tissue well demonstrated with GRE ph and op-phase series)
 - Enhanced CT scan shows uncharacterizable small hepatic nodule (seg V) hypodense in arterial and portal venous phase.
- MRI-DWI was performed in this patient to determine if the nodule was malignant.

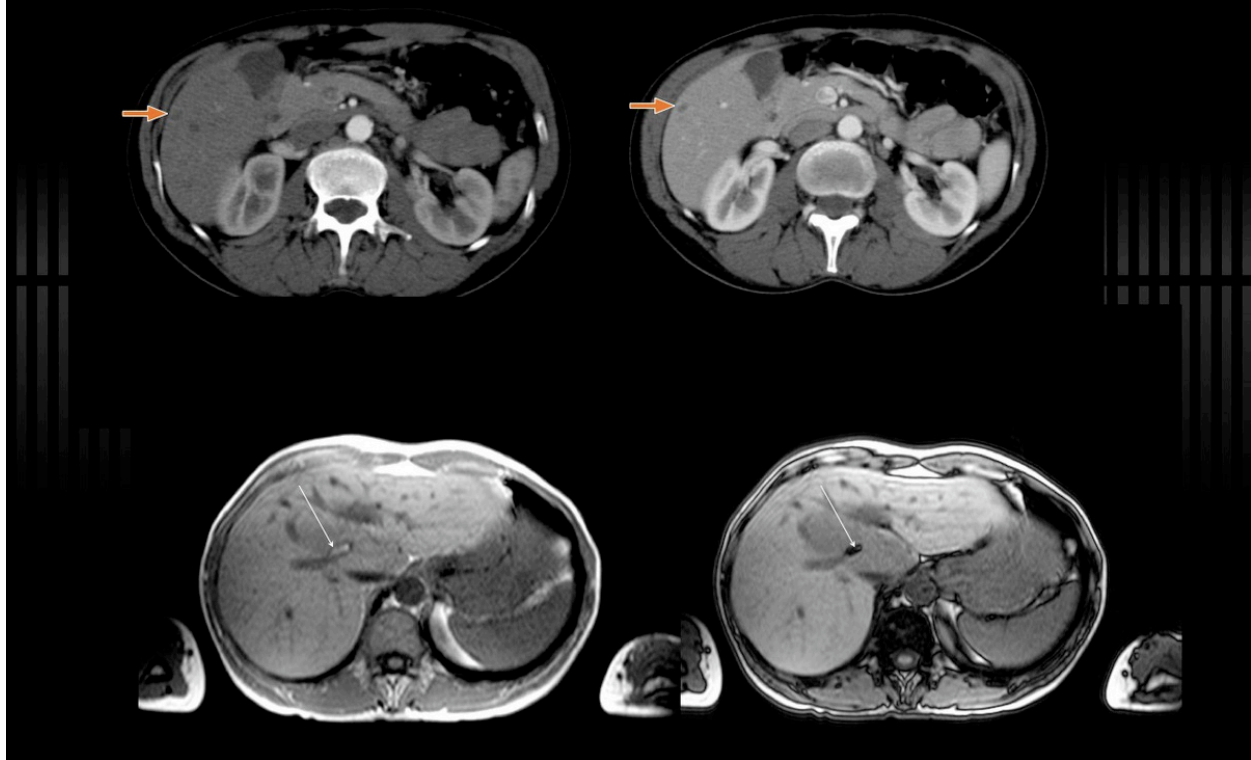


Fig. 18: Case 9. Please see image n°19

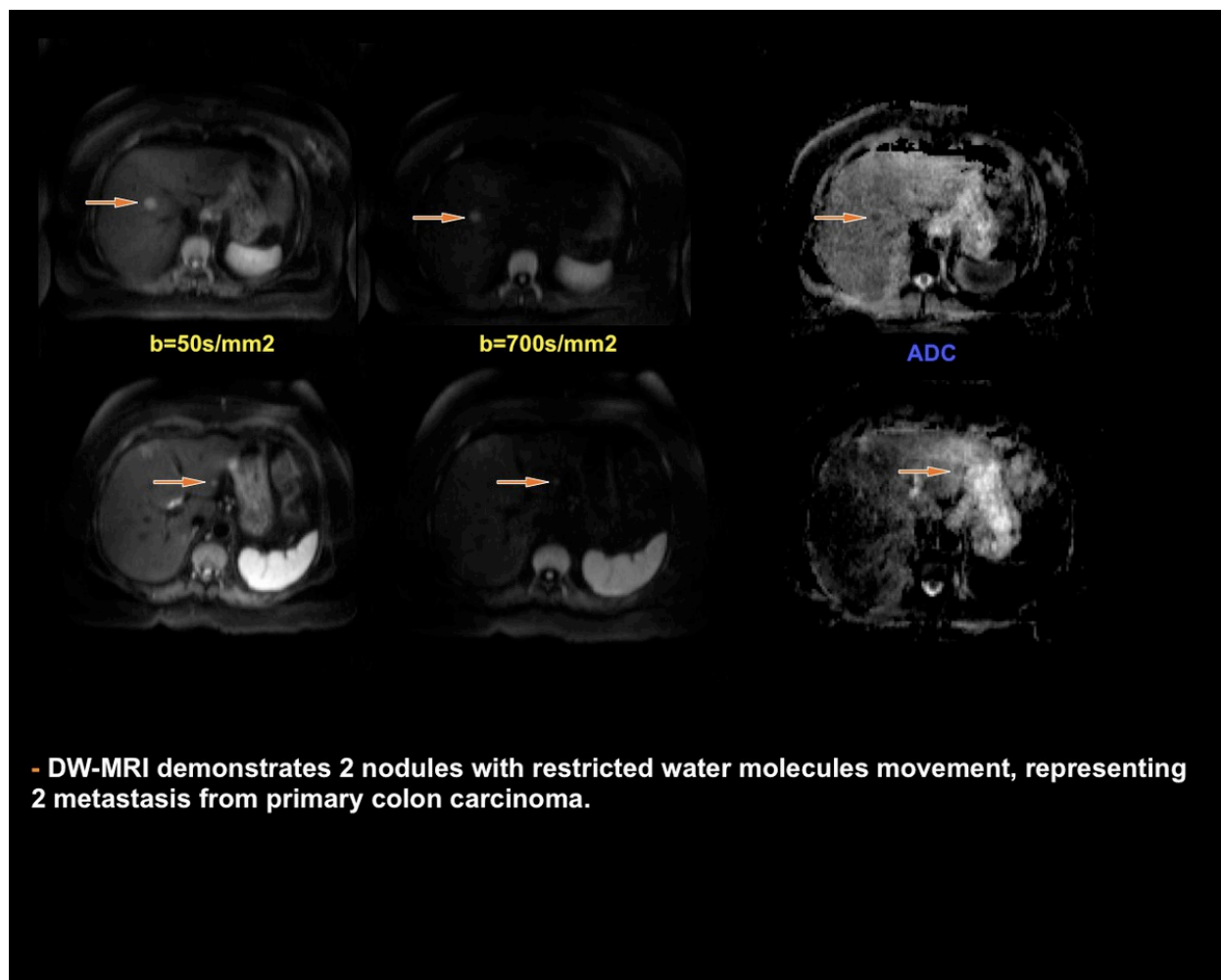


Fig. 19

- Patient with colon cancer background and increased CEA levels.
- CT scan was unremarkable (small residual calcification in the right lobe).
- MRI-DWI was preformed in this patient.

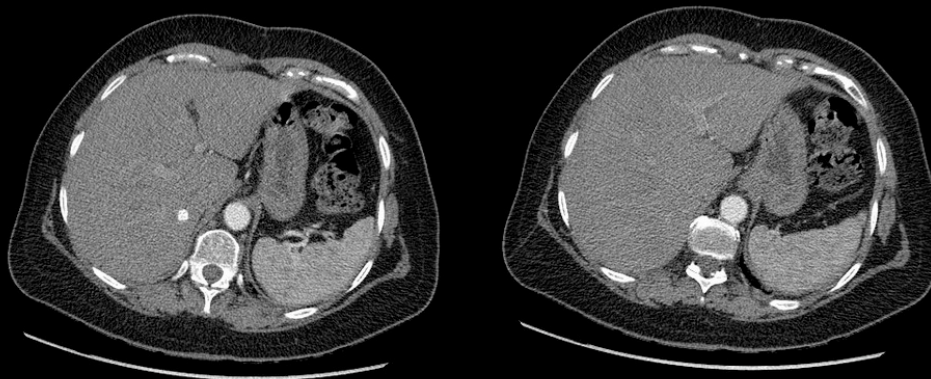


Fig. 20: Case 10. Please see image n°21

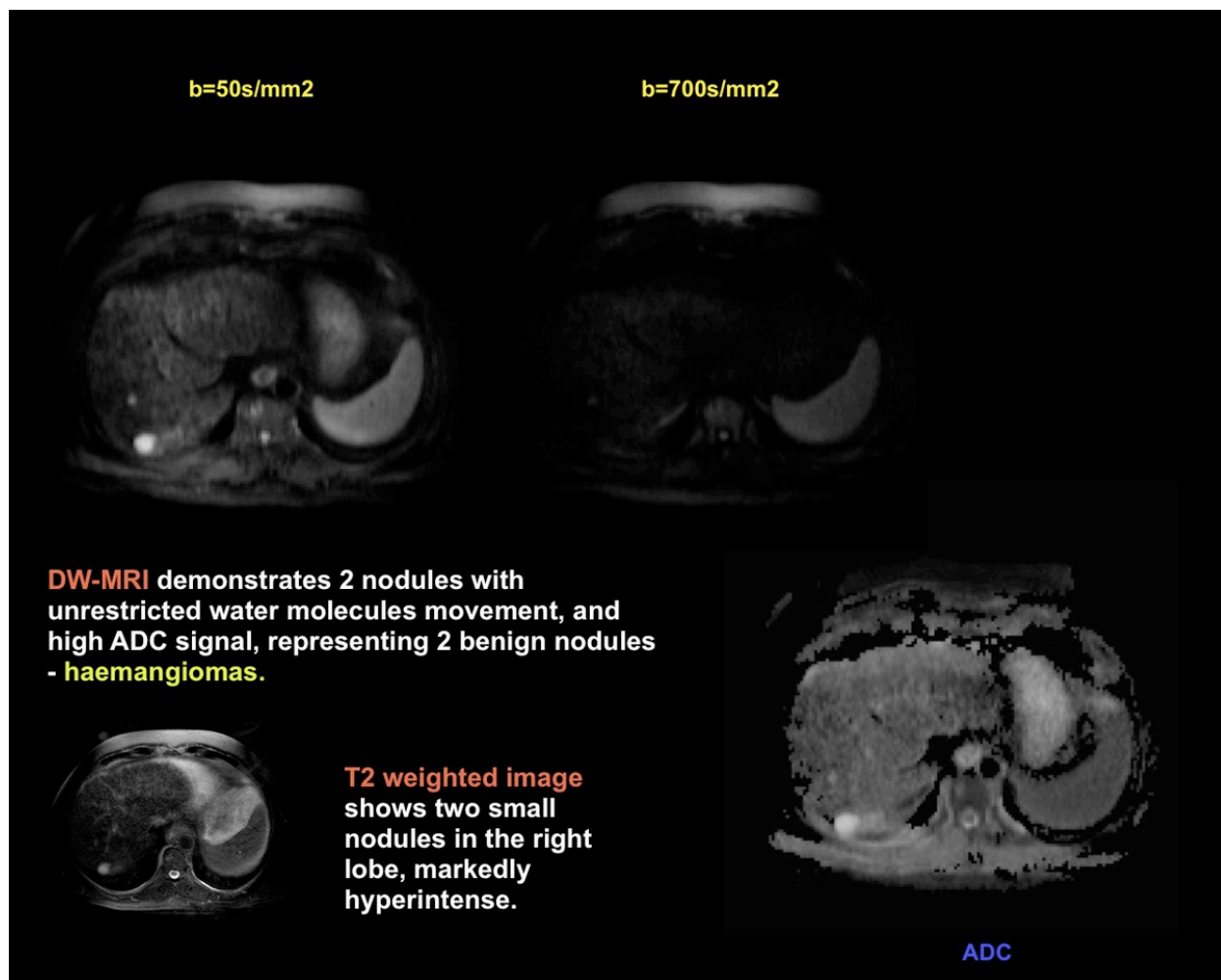


Fig. 21

- Patient with alcoholic cirrhosis and right abdominal pain. Allergic to iodine products.
- Routine sonography demonstrate 2 hyperecogenic and homogeneous nodules (haemangiomas?).
- MRI-DWI was performed in this patient, due to his liver background and abdominal pain.

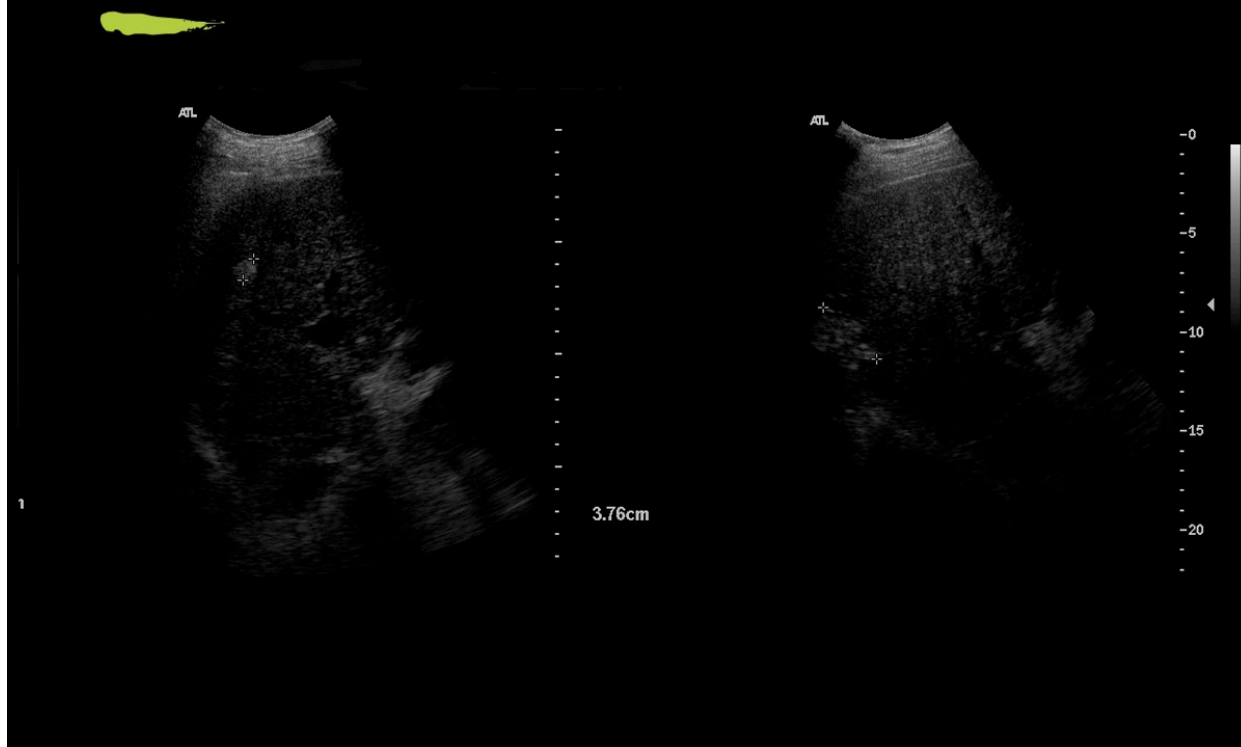


Fig. 22: Case 11. Please see image n°23

- **Dynamic 3D sequence** demonstrate a large hypovascular nodule (seg VIII), suspicious for metastasis.
- **DW-MRI** detects a hyperintense nodule that doesn't increase its signal intensity with greater "b" values, but it's slightly hypointense in the ADC map.
- Surgical resection confirms the diagnosis of metastatic liver nodule from rectal carcinoma.

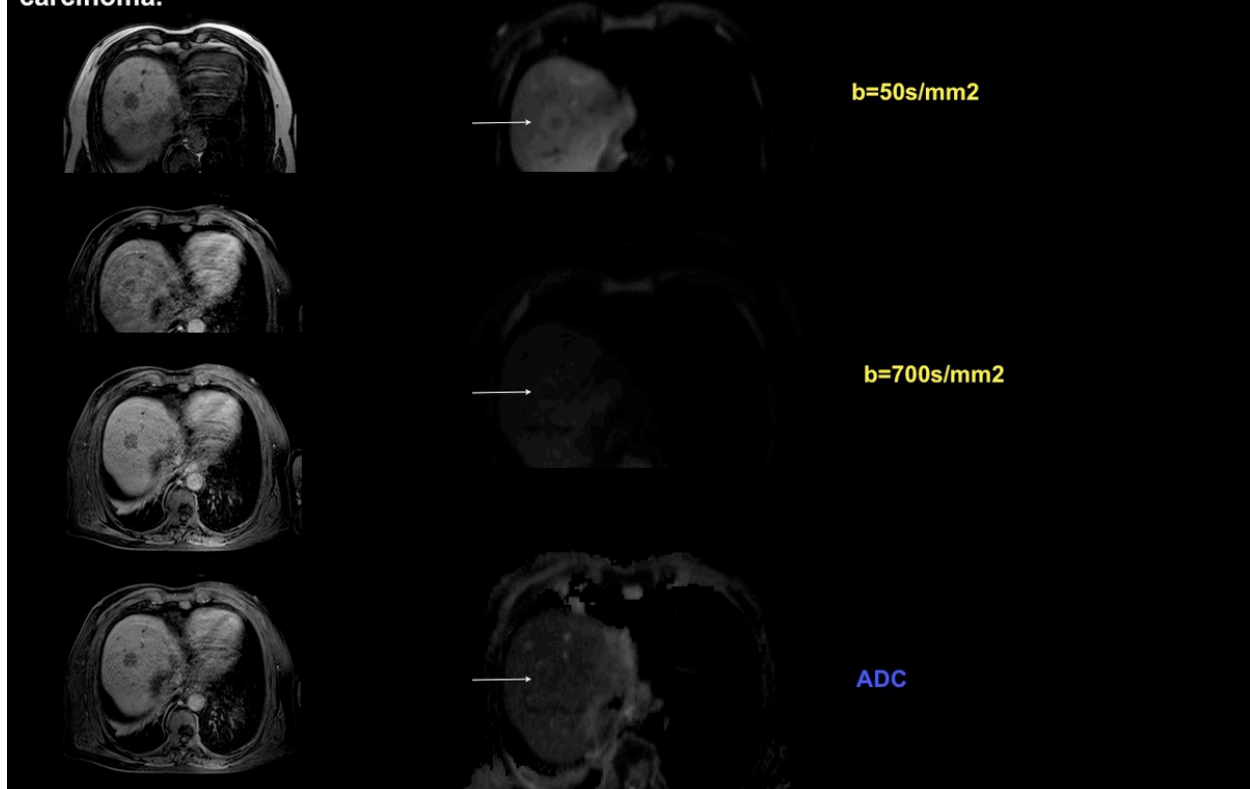


Fig. 23

- Patient with rectal cancer history and psychiatric disorder.
- Patient was very agitated and no venous catheterization was possible.
- Unhanced CT detects at least 2 nodules (seg VIII), intrahepatic biliary dilatation and some punctate calcifications within a very heterogenous parenchyma.
- MRI-DWI was performed in this patient.

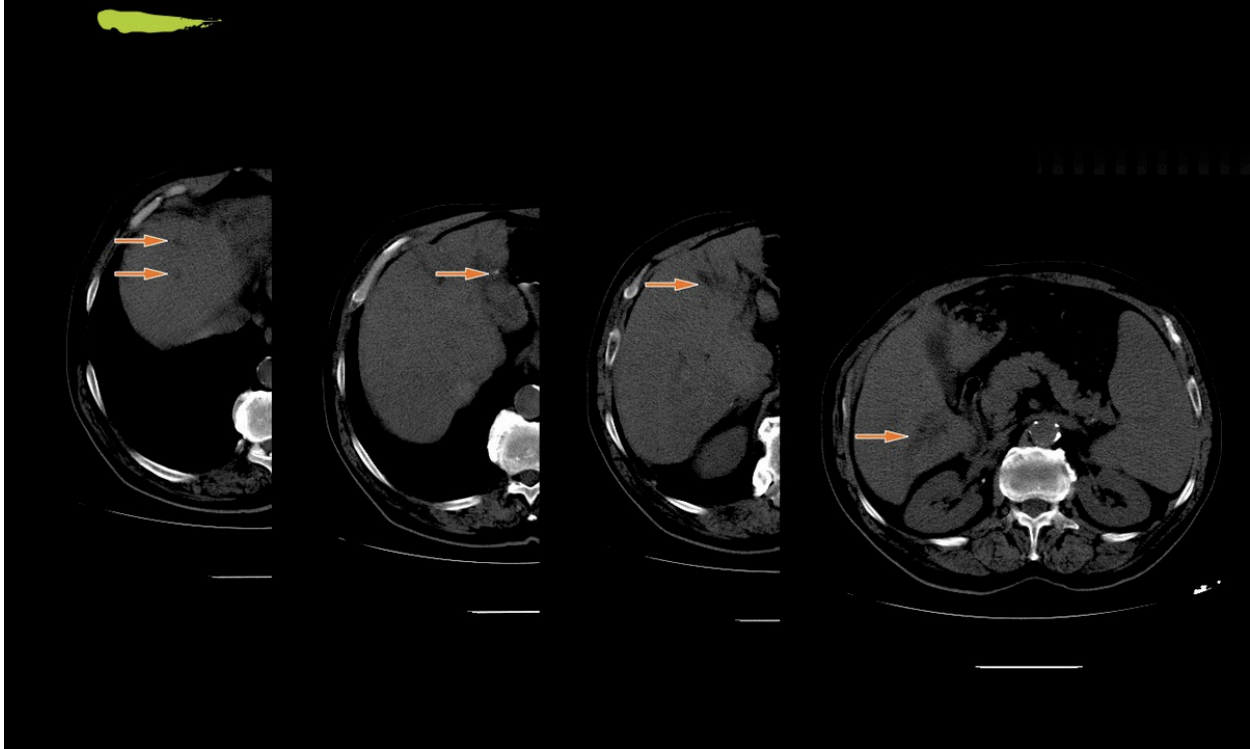


Fig. 24: Case 12. Please see image n°25

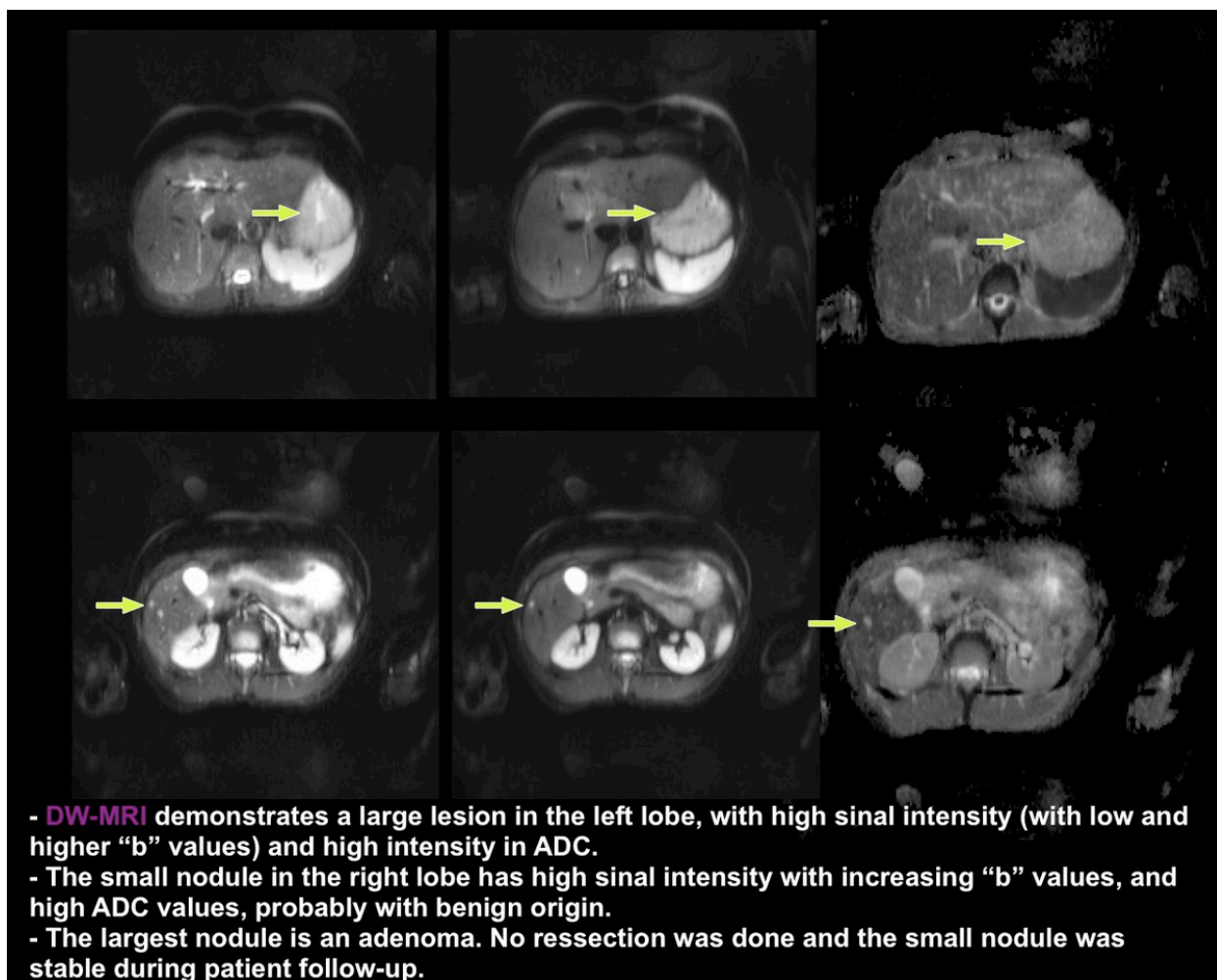


Fig. 25

- Patient with colorectal cancer background.
- Sonography and CT scan reveals a solid nodule, segment VI. The patient was allergic to iodine products so no contrast was given.
- Diffusion weighted study shows 3 small nodules with restricted water diffusion, low ADC values, compatible with metastasis.

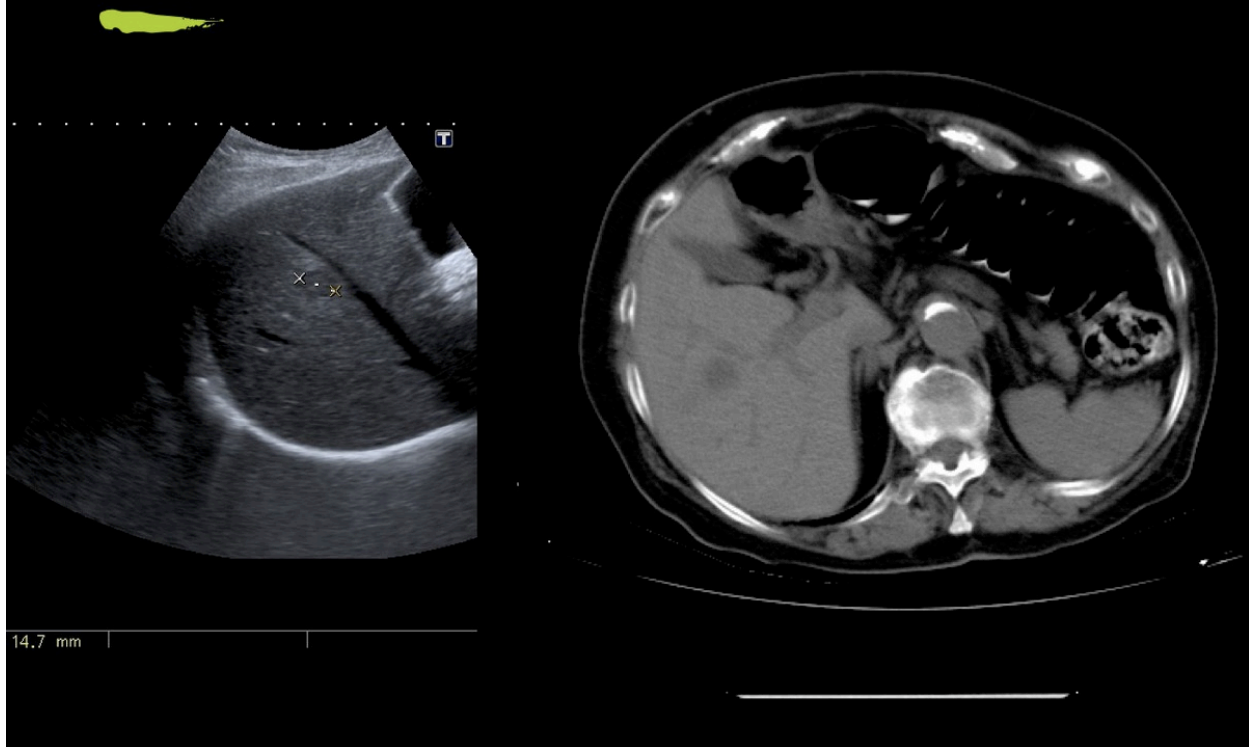


Fig. 26: Case 13. Please see image n°27

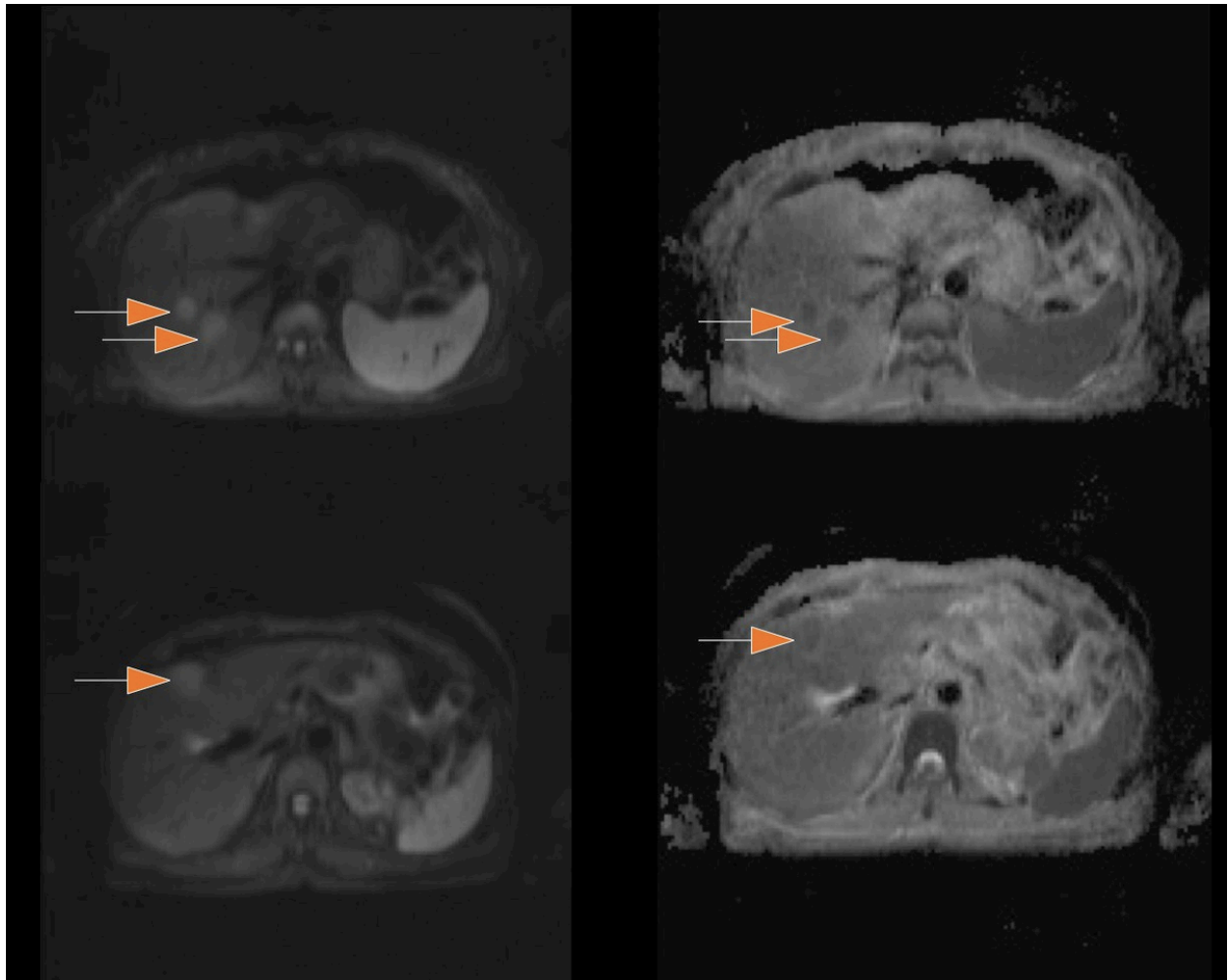


Fig. 27

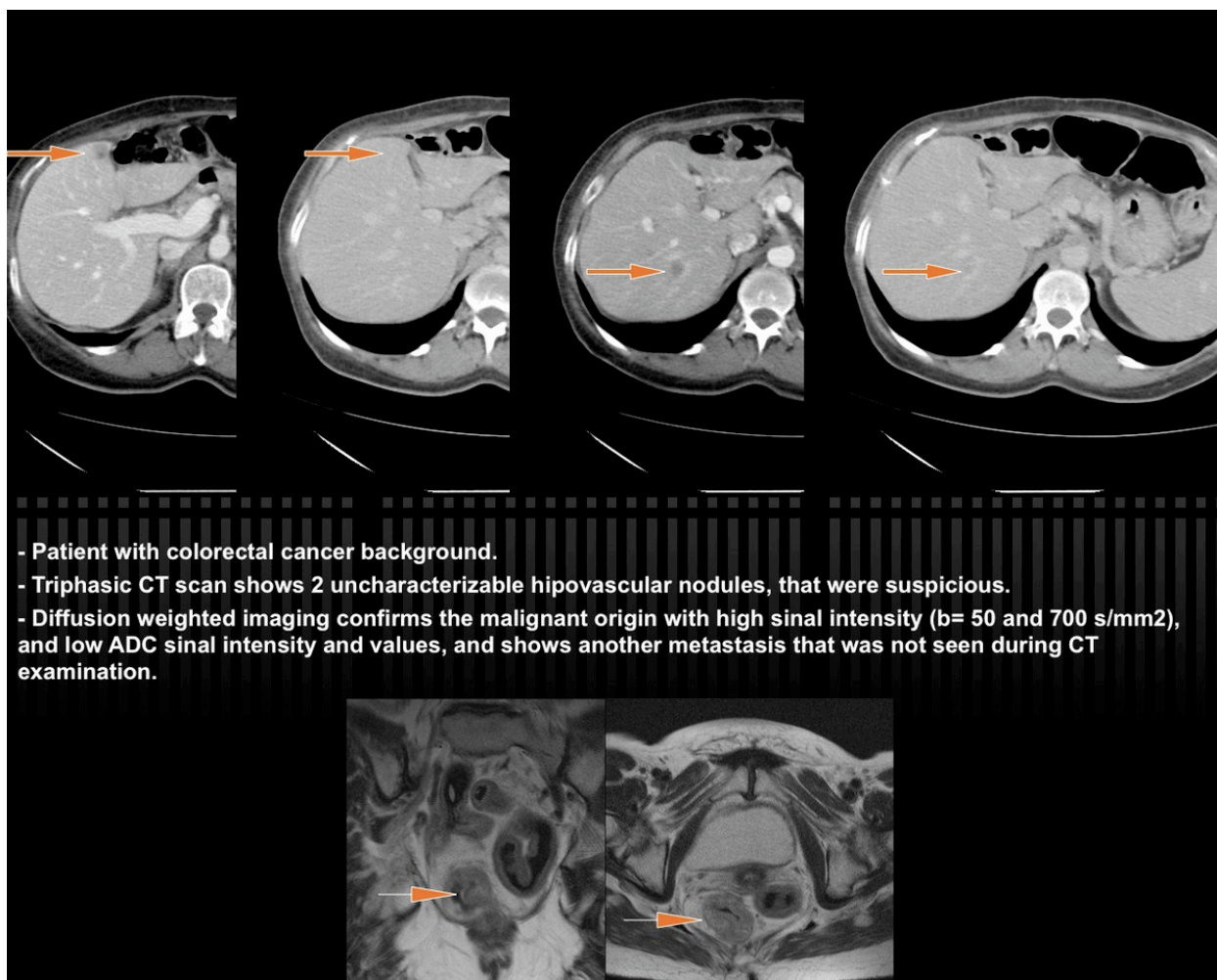


Fig. 28: Case 14. Please see image n°29

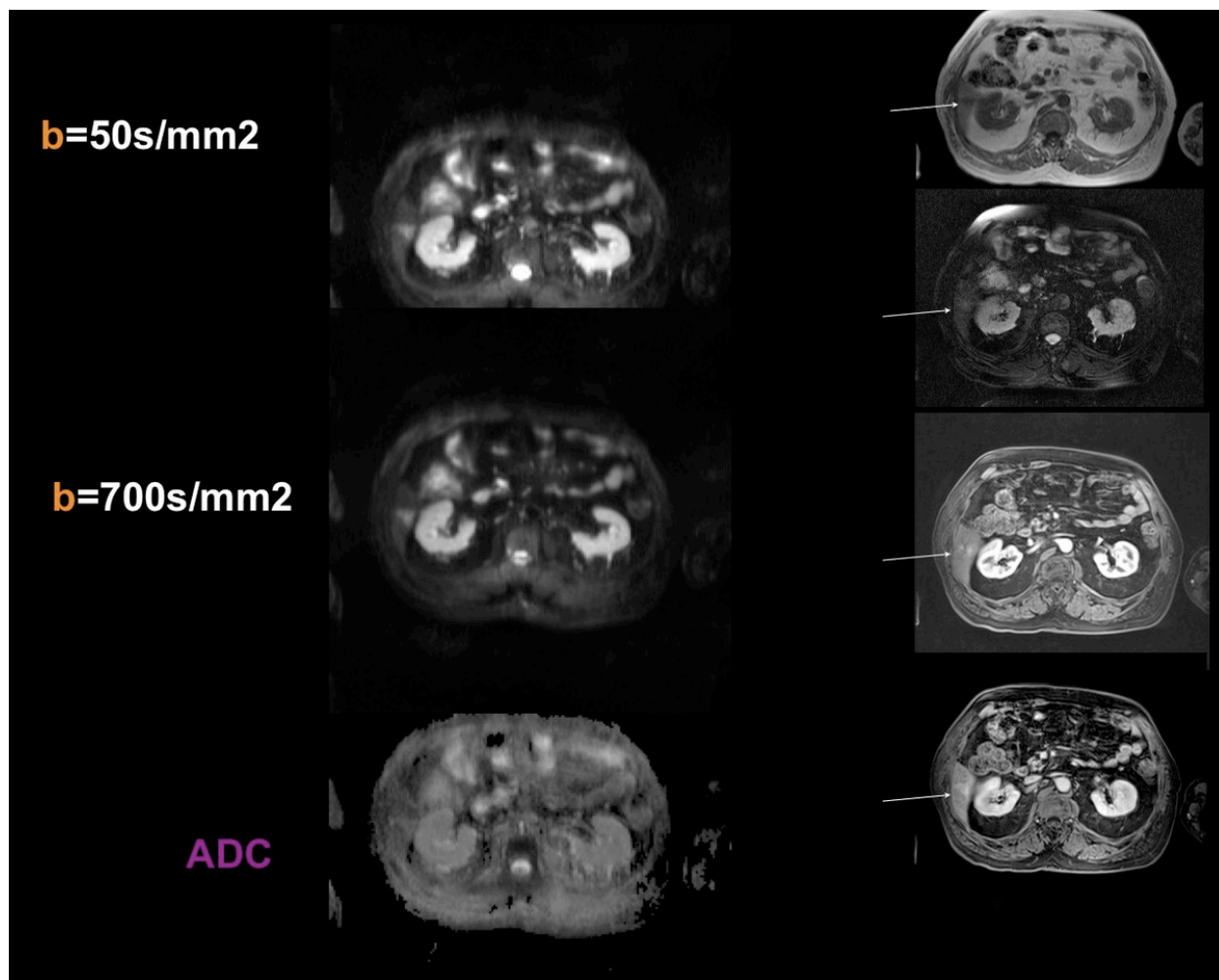


Fig. 29

- Patient with colorectal cancer background.
- Triphasic CT scan shows 1 uncharacterizable nodule, seg. VI, with discrete peripheral arterial enhancement and isodense in portal and venous phase.
- Diffusion weighted images demonstrating the benign origin of the nodule, with high sinal intensity ($b = 50$ and $=700$ s/mm²), and high ADC sinal intensity and values (haemangioma?). The patient was follow with sonography and CT studies.

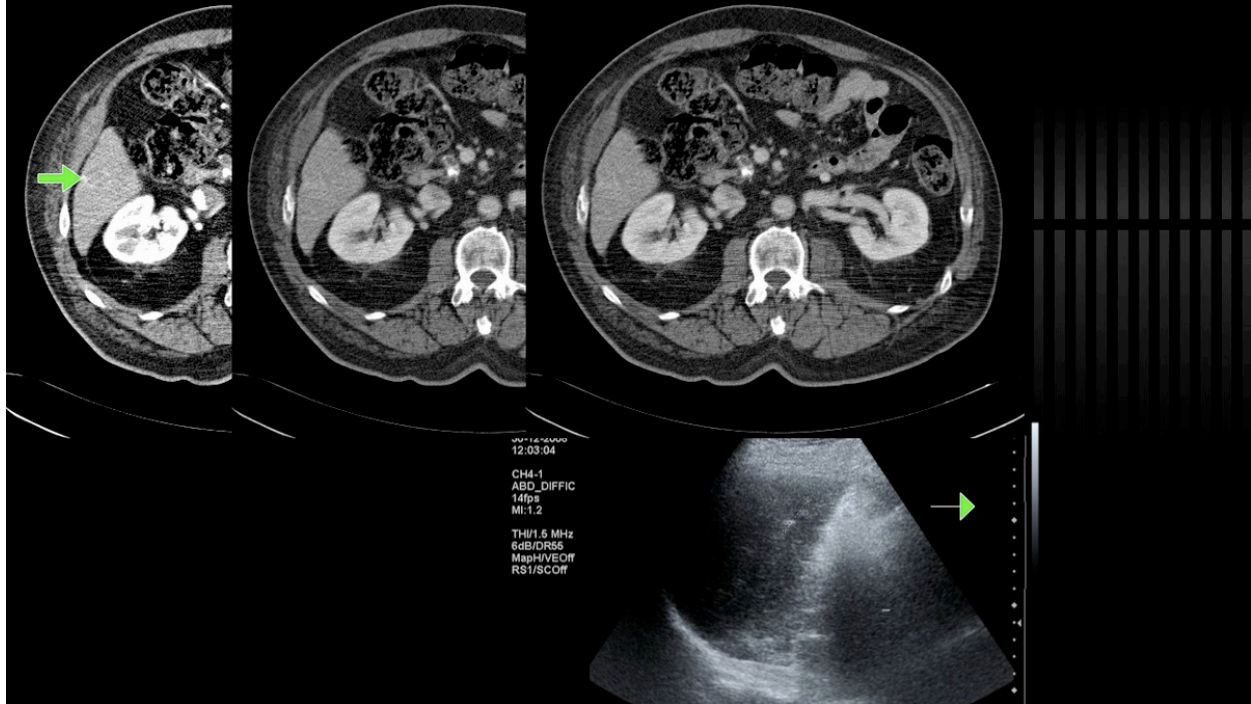


Fig. 30: Case 15. Please see image n°31

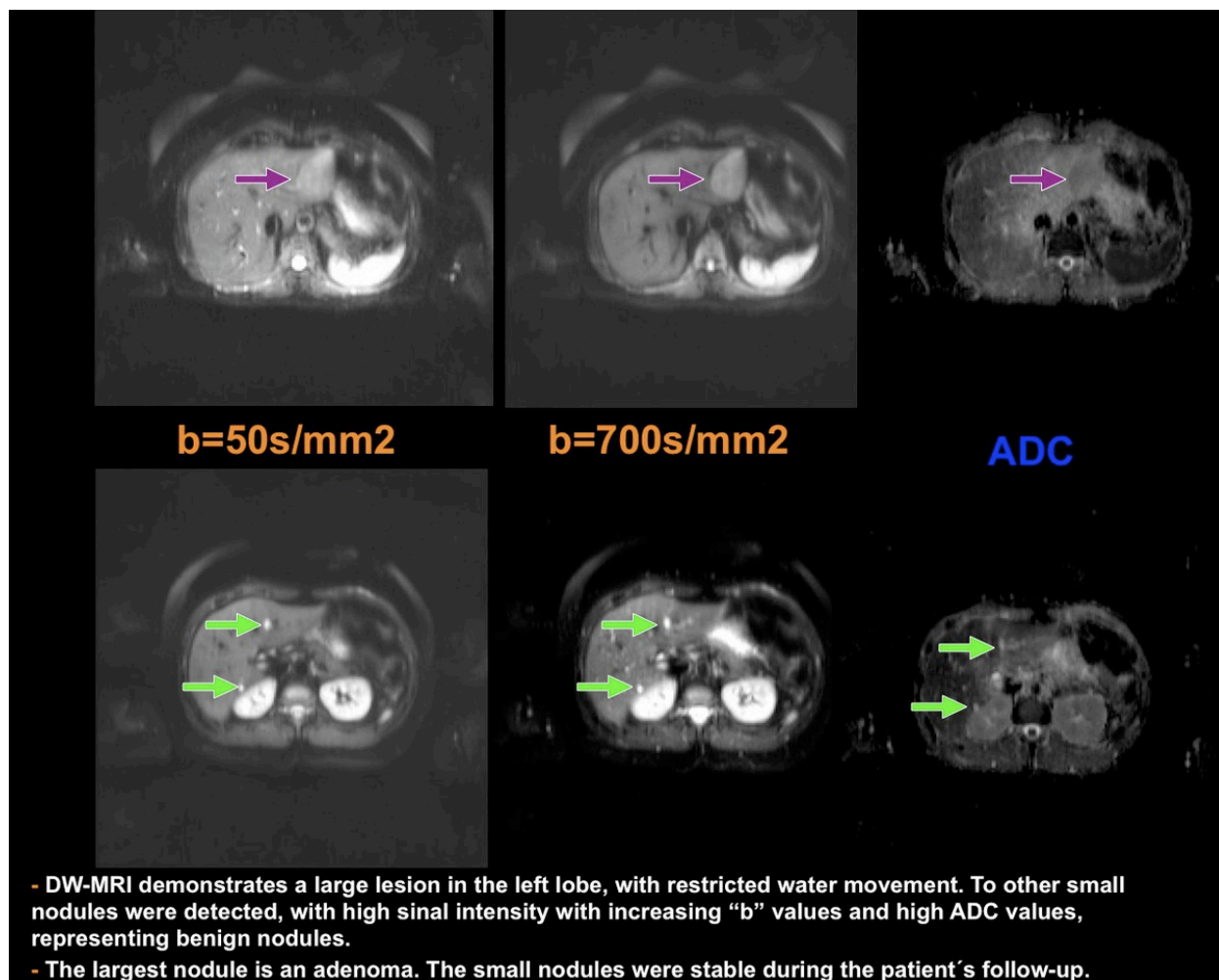


Fig. 31

- Patient with no cancer background. Diagnostic virtual colonoscopy reveals a 10mm colon polyp, which was proven to represent a small carcinoma.
- Non enhanced CT scan performed with the colonoscopy shows several small solid hepatic nodules. Patient underwent MRI -DWI

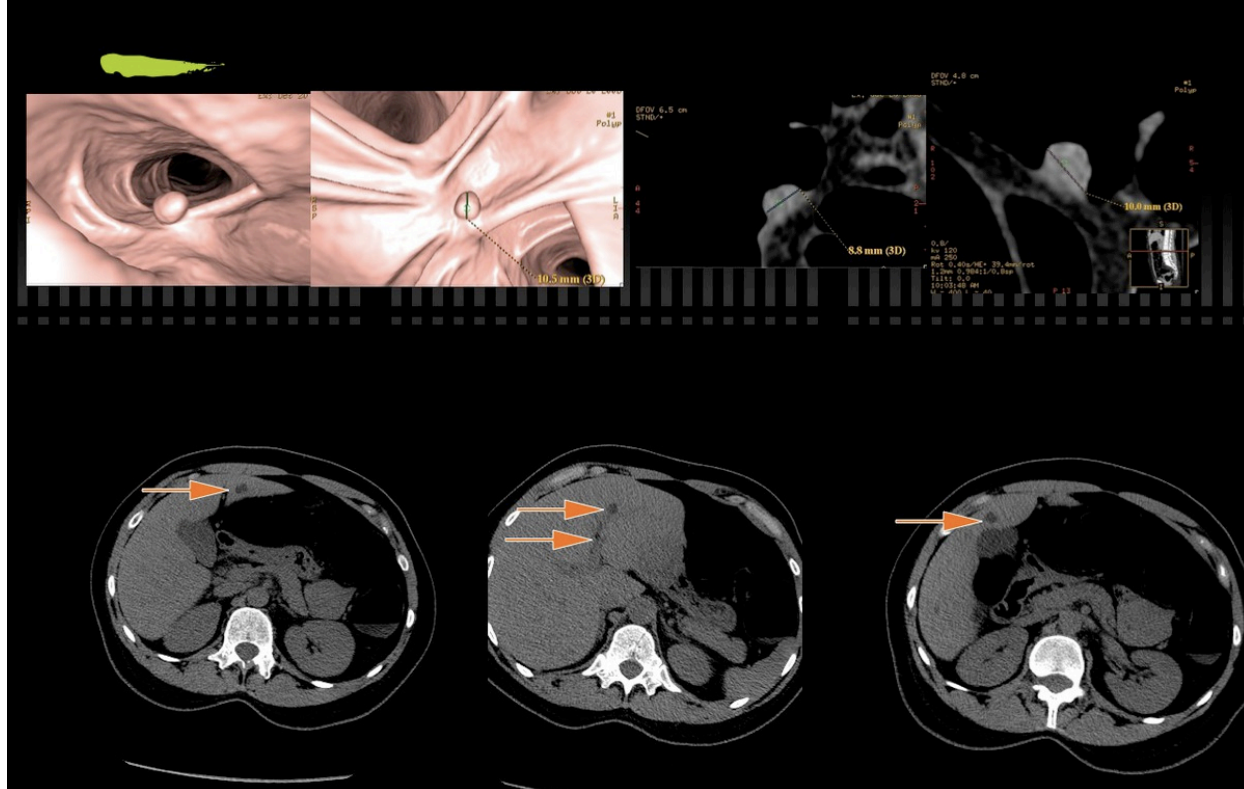


Fig. 32: Case 16. Please see image n°33

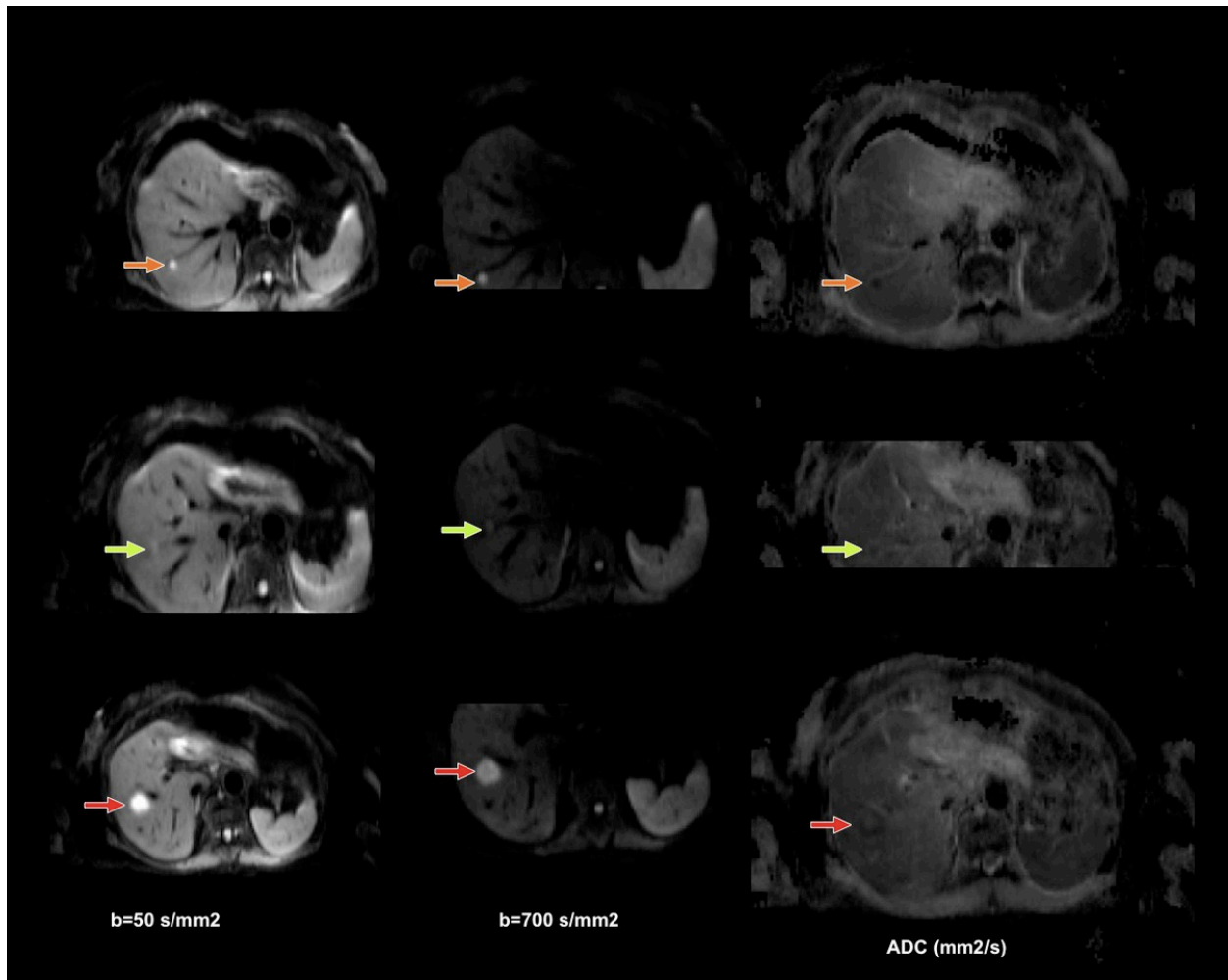


Fig. 33

Conclusion

This technique can give qualitative and quantitative information that reflects changes at a cellular level and therefore tumor cellularity.

DW-MRI is a major tool that can help radiologists to "give a name" to the uncharacterizable small liver nodule.

Personal Information

This work comes from:
Clínica Universitária de Imagiologia



Hospitais da Universidade de Coimbra
Portugal

Fig.

References: F. A. G. V. Cavalheiro; Radiology, Hospital Universidade Coimbra, Coimbra, PORTUGAL

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