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<1cm.

- 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.

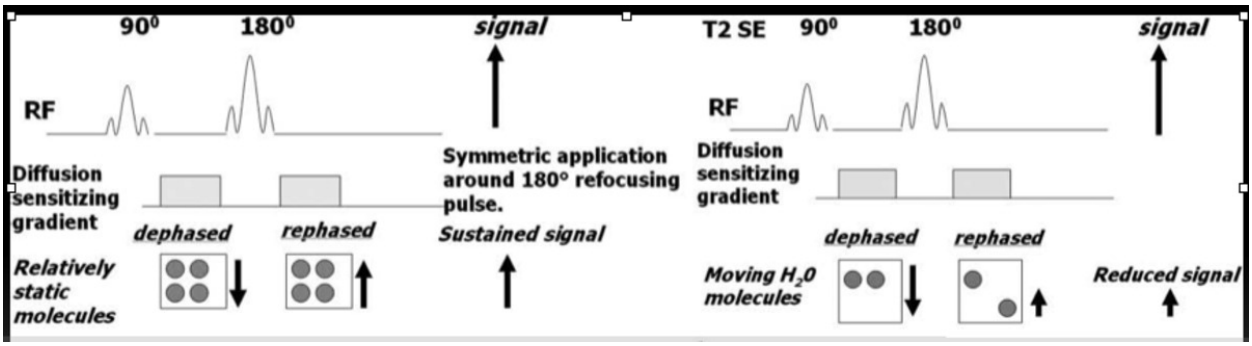

Fig.
References: Aliya Qayyum et al,Diffusion-Weighted Imaging in tha abdomen and pelvis: Concepts and applications, RadioGraphics 2009;29:1797-1810

- 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.

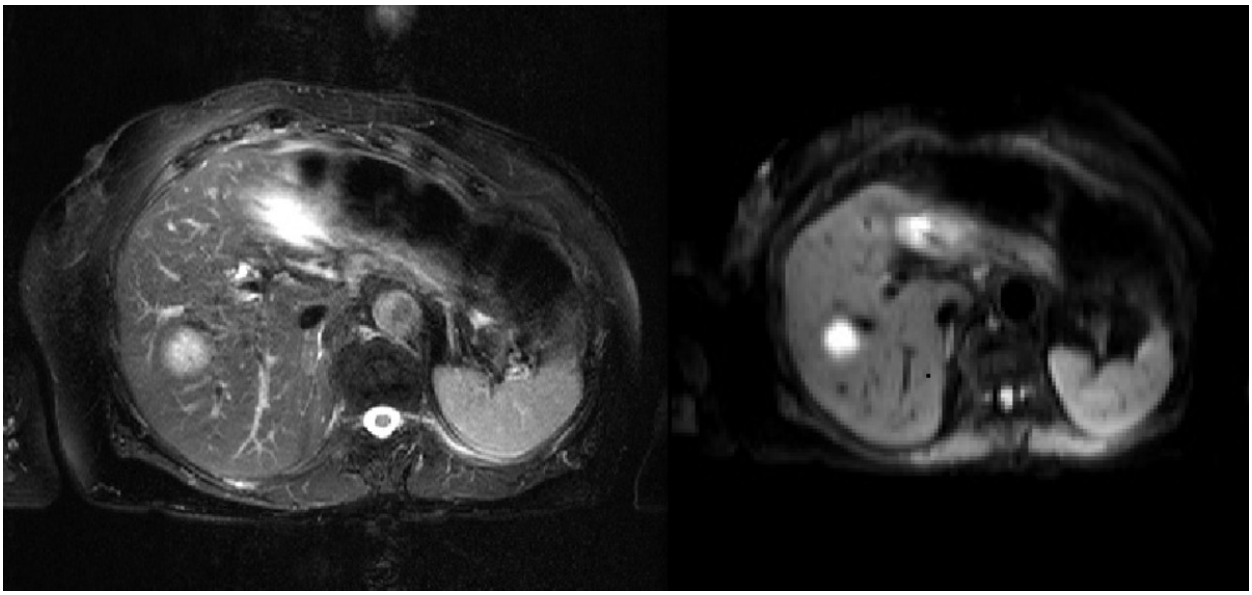

Fig.: T2 TSE FS and Diffusion-weighted image (b=50)
References: F. A. G. V. Cavalheiro; Radiology, Hospital Universidade Coimbra, Coimbra, PORTUGAL

- 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:

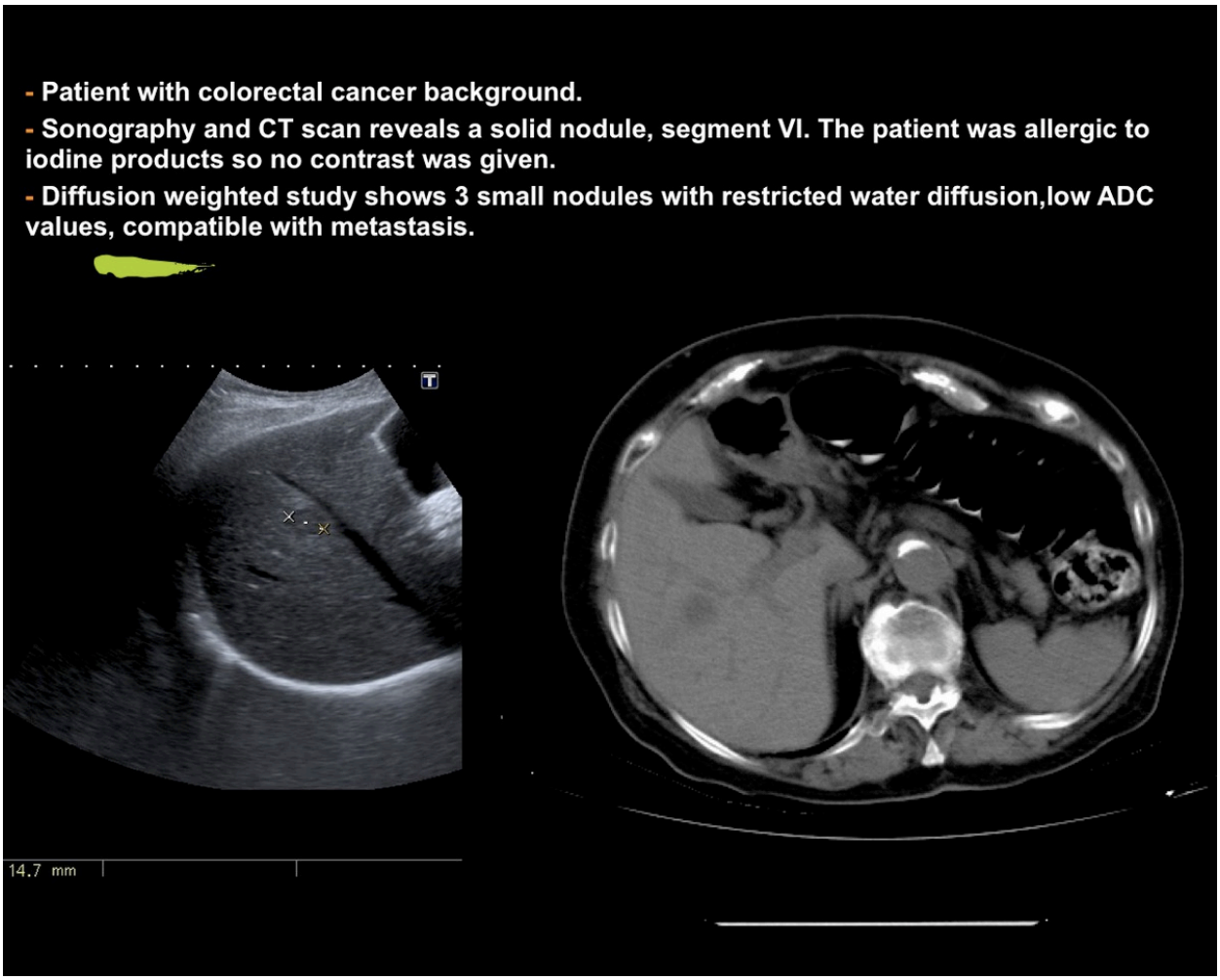

Fig. 1: Please see image nº2

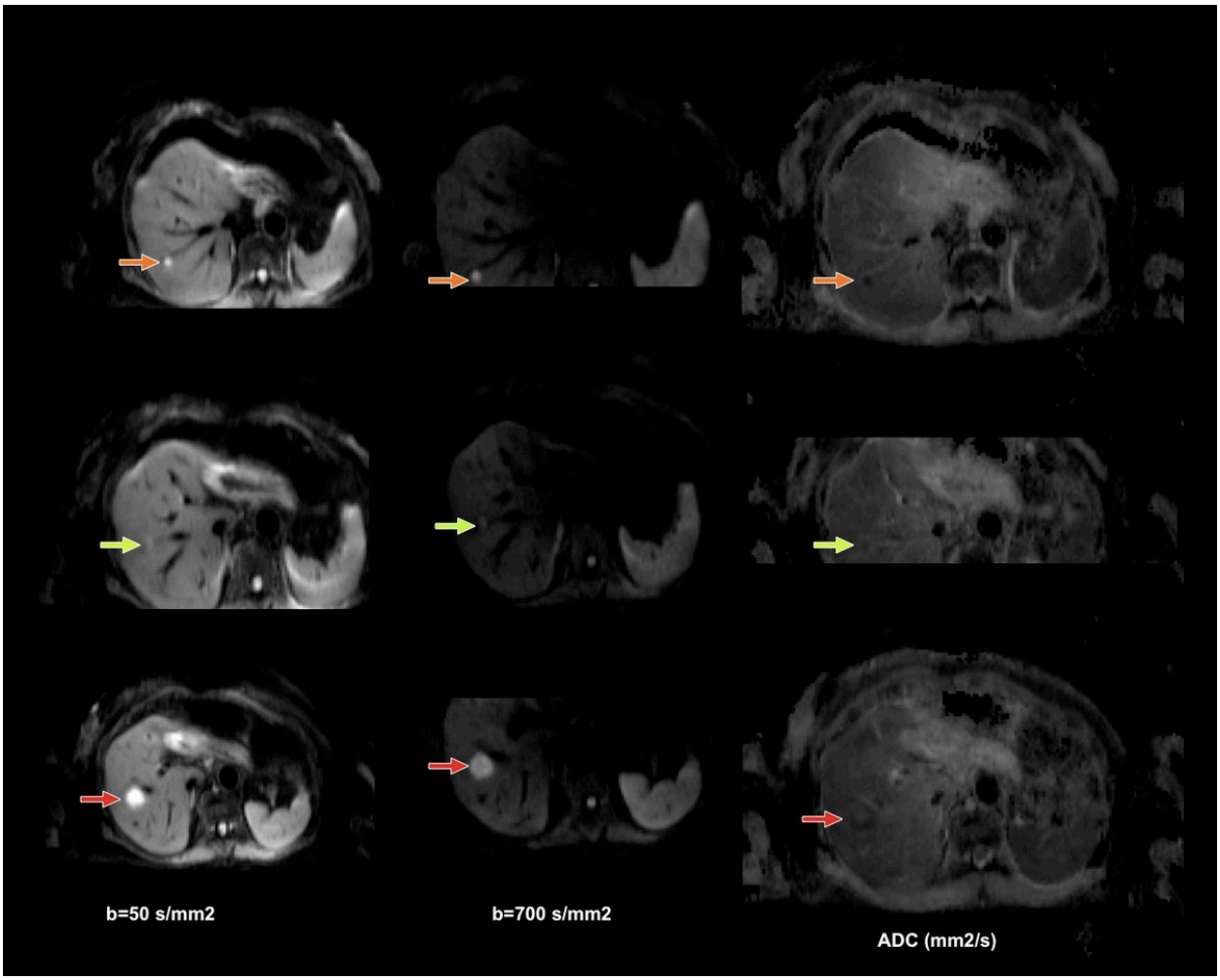

Fig. 2

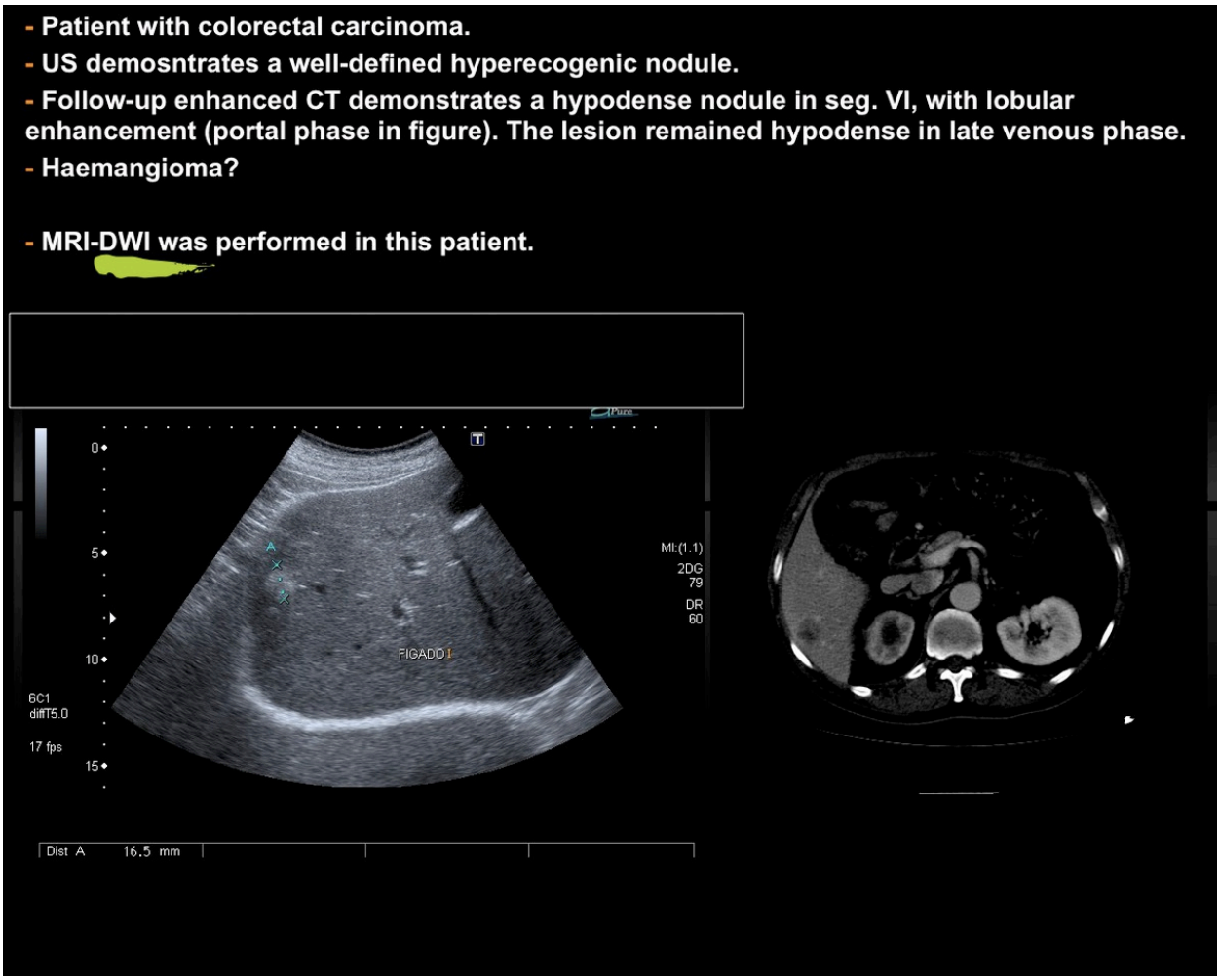

Fig. 3: Case 2. Please see image nº3

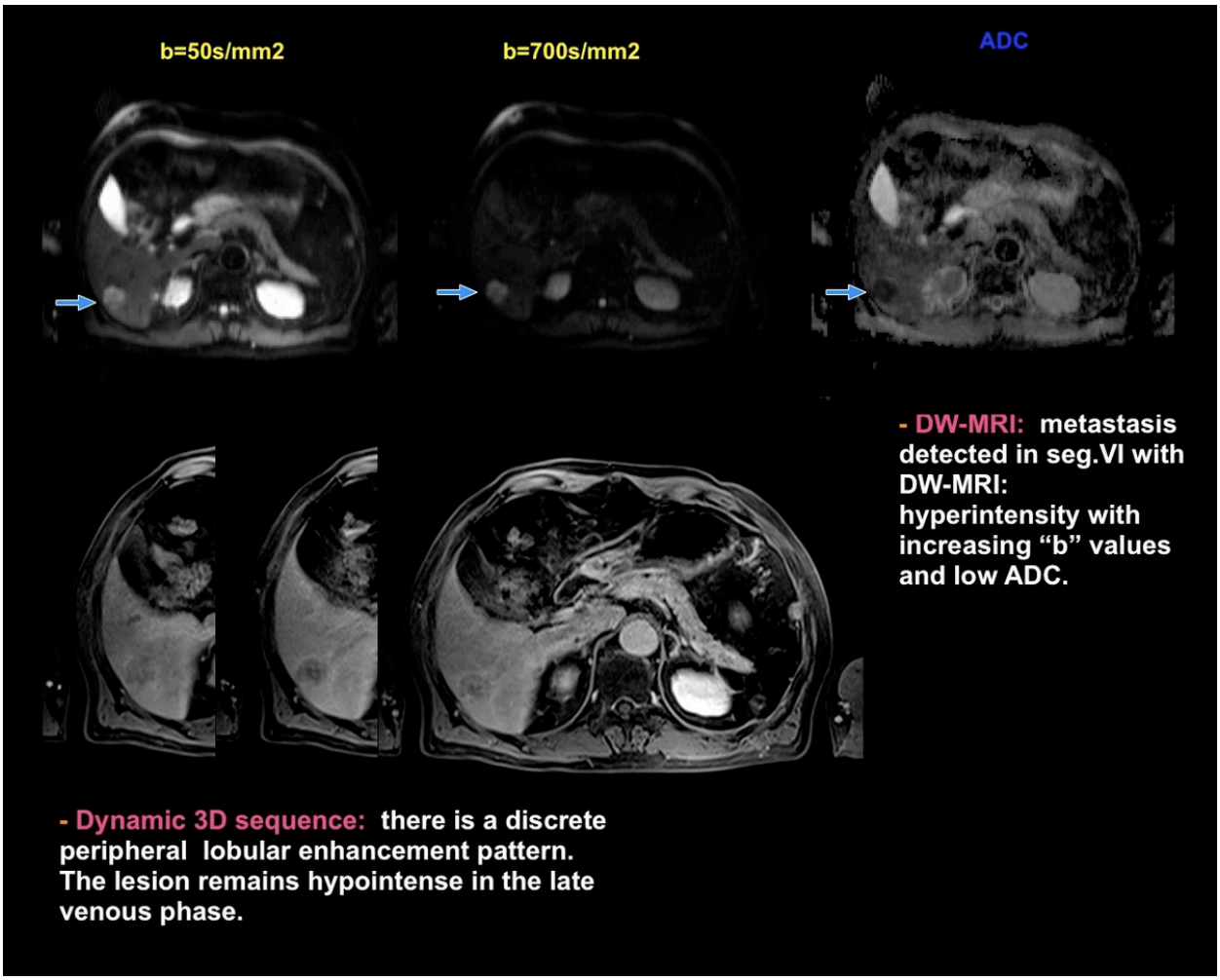
b=50s/mm2
b=700s/mm2
ADC
- DW-MRI: metastasis detected in seg.VI with DW-MRI: hyperintensity with increasing "b" values and low ADC.
- Dynamic 3D sequence: there is a discrete peripheral lobular enhancement pattern. The lesion remains hypointense in the late venous phase.

Fig. 4

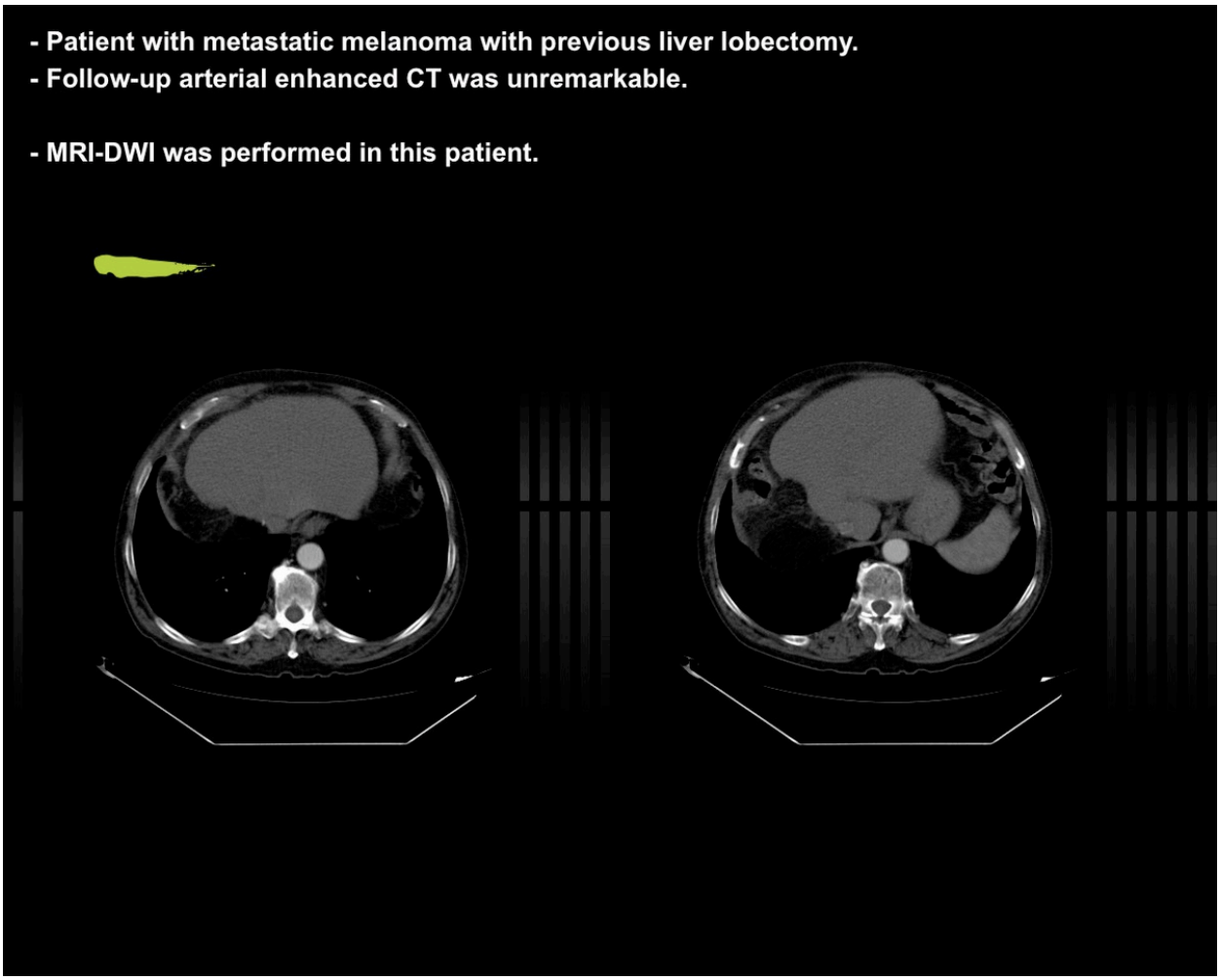

Fig. 5: Case3. Please see image nº5

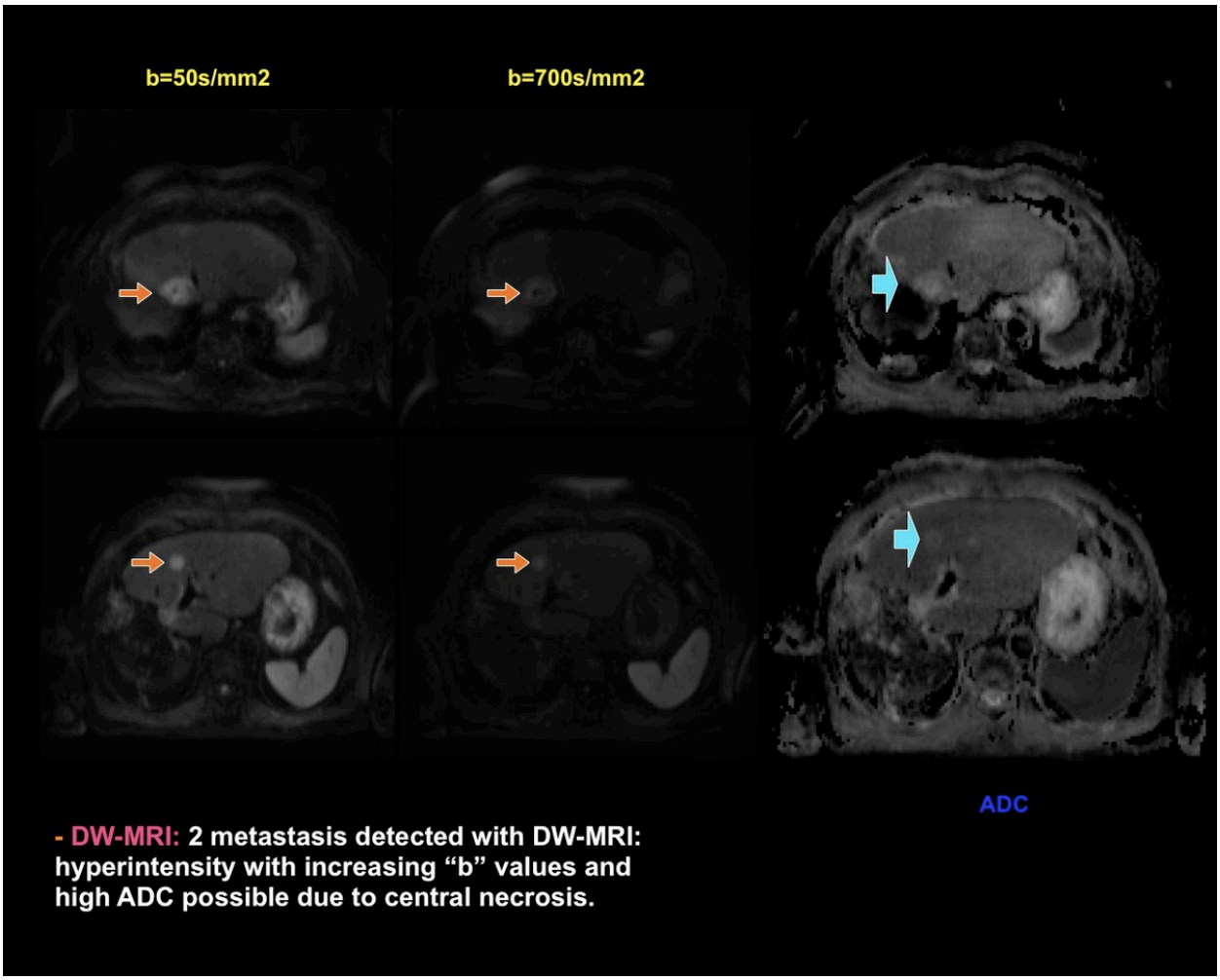
b=50s/mm2
b=700s/mm2
ADC
- DW-MRI: 2 metastasis detected with DW-MRI: hyperintensity with increasing "b" values and high ADC possible due to central necrosis.

Fig. 6

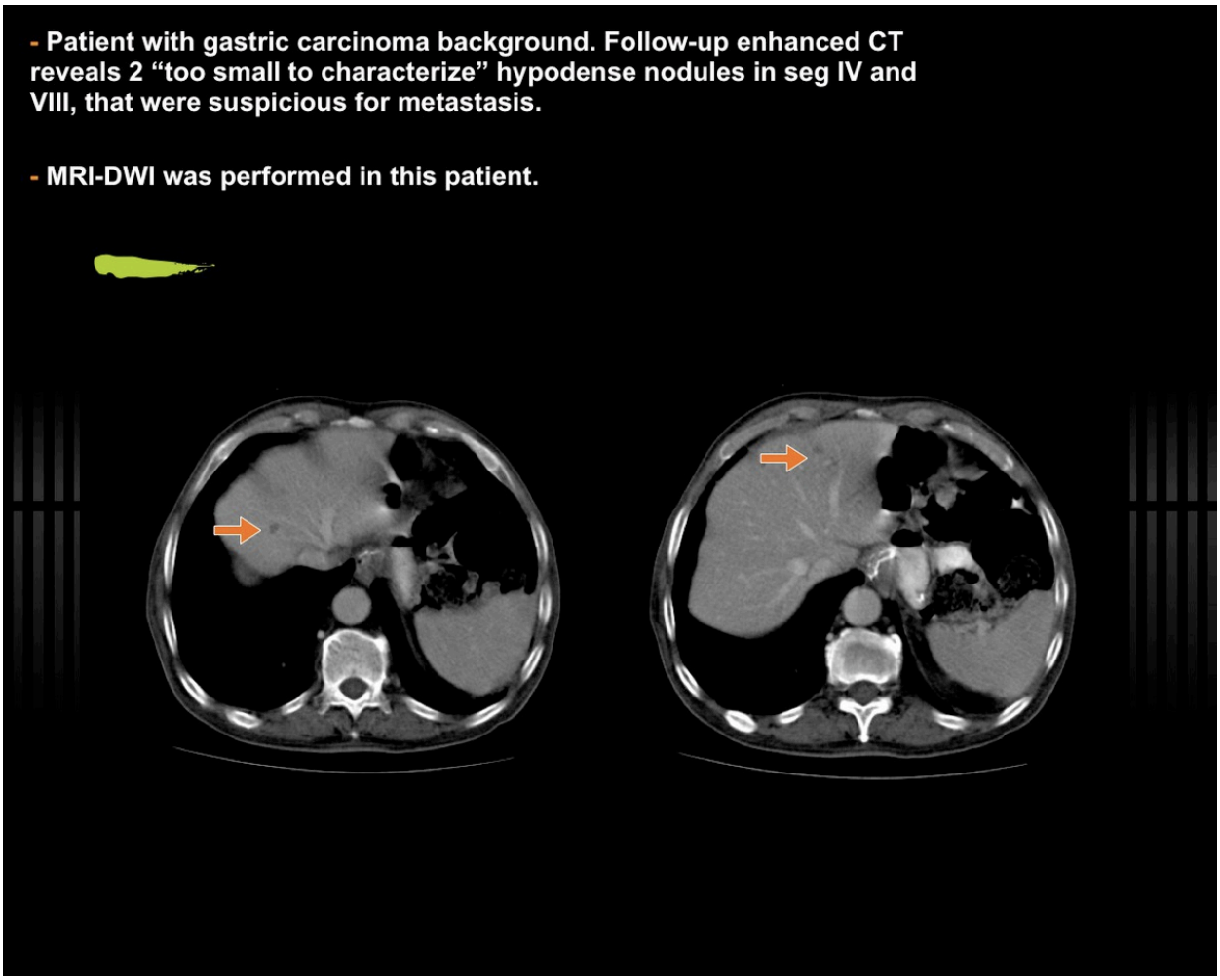

Fig. 7: Case 4. Please see image nº8

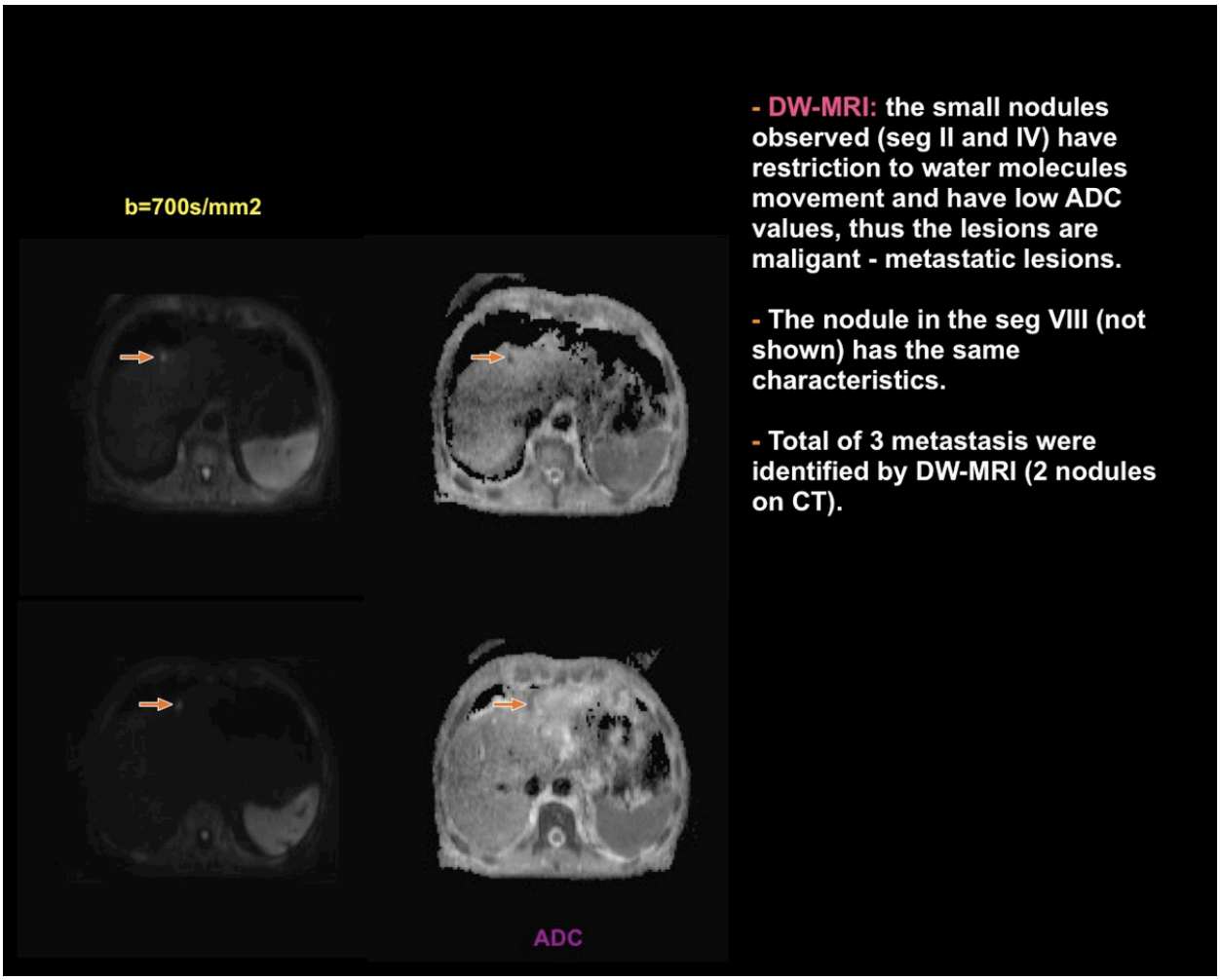
b=700s/mm2
ADC
- DW-MRI: the small nodules observed (seg II and IV) have restriction to water molecules movement and have low ADC values, thus the lesions are maligant - metastatic lesions.
- The nodule in the seg VIII (not shown) has the same characteristics.
- Total of 3 metastasis were identified by DW-MRI (2 nodules on CT).

Fig. 8

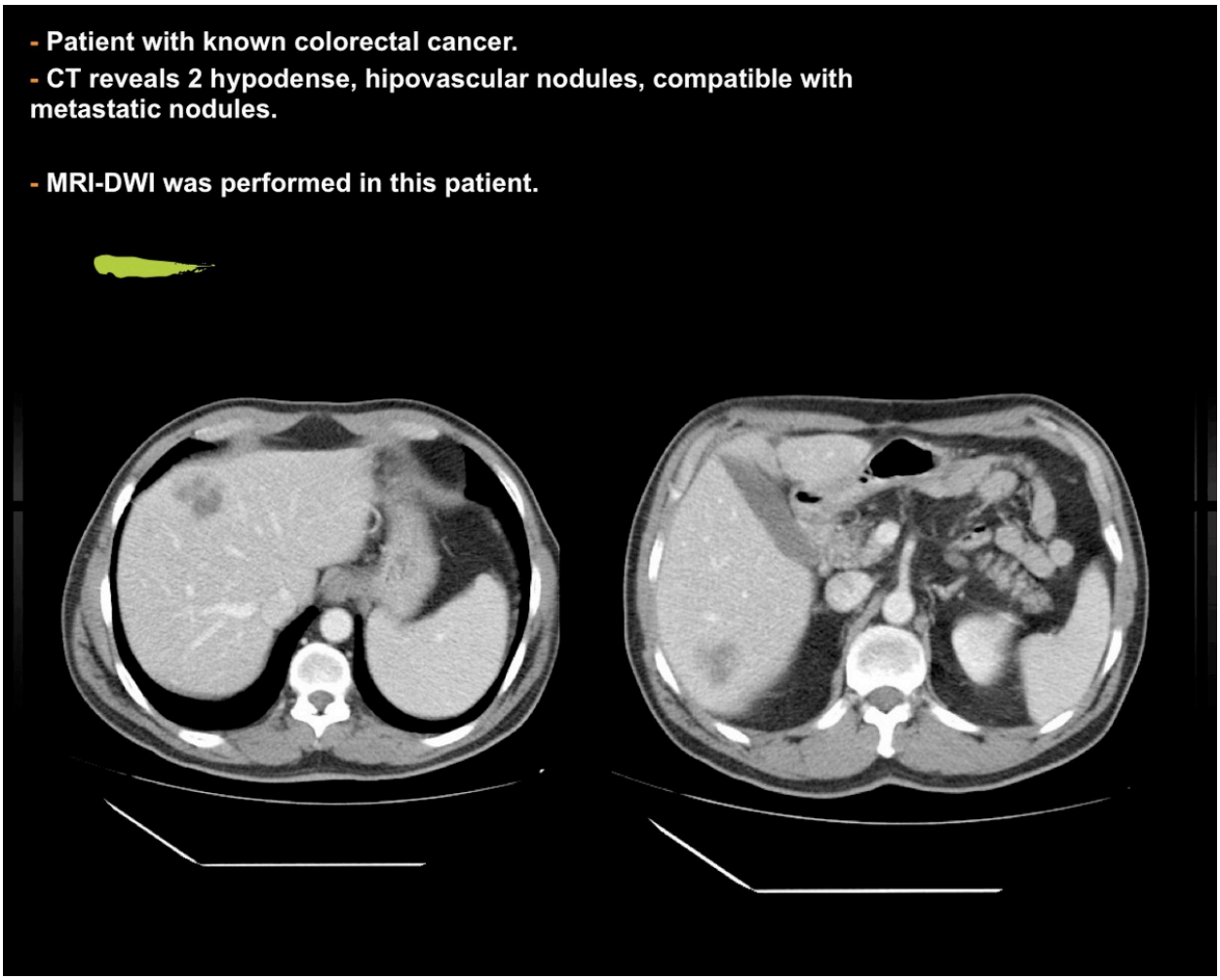

Fig. 9: Case5. Please see image nº10 and 11

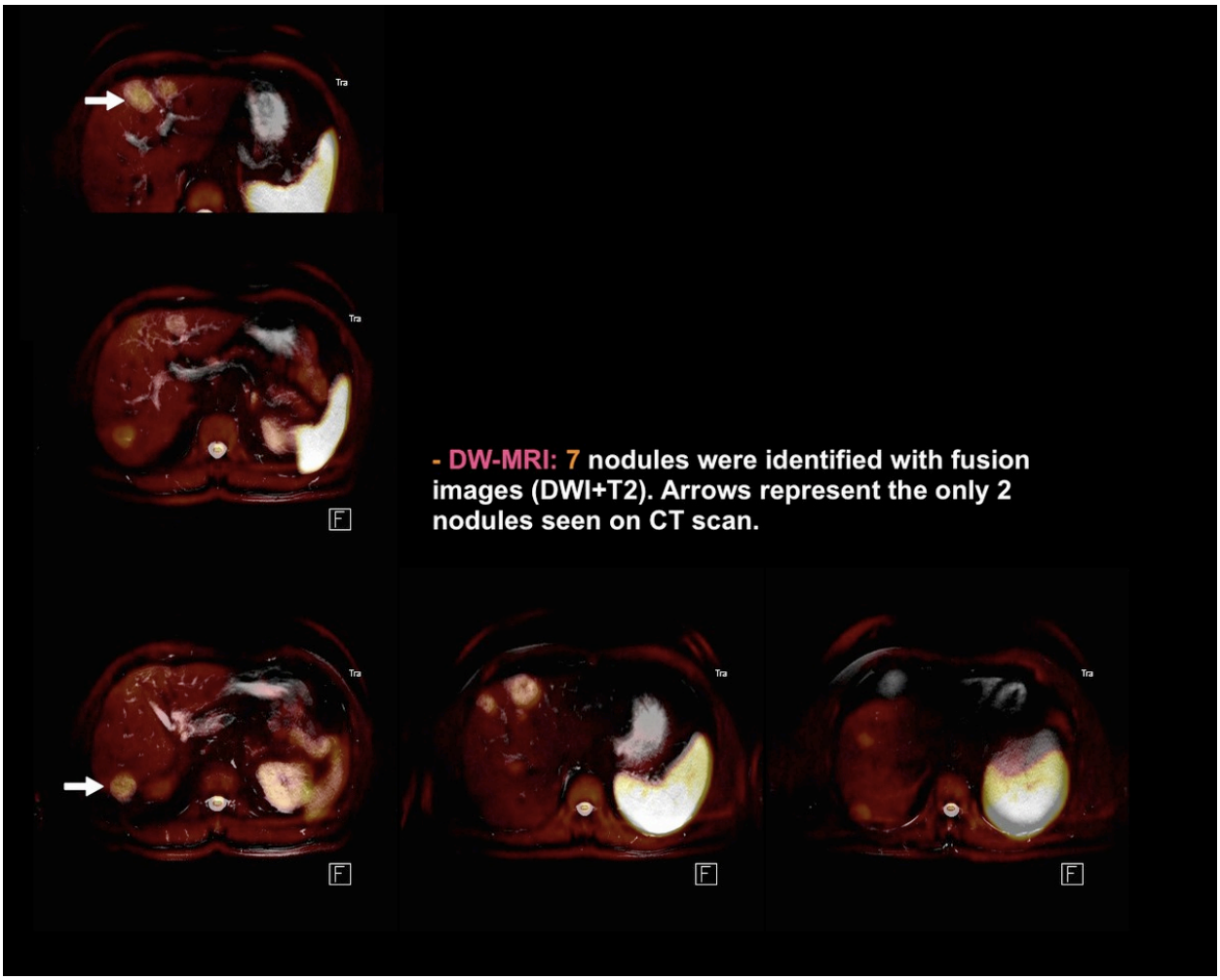
- DW-MRI: 7 nodules were identified with fusion images (DWI+T2). Arrows represent the only 2 nodules seen on CT scan.

Fig. 10

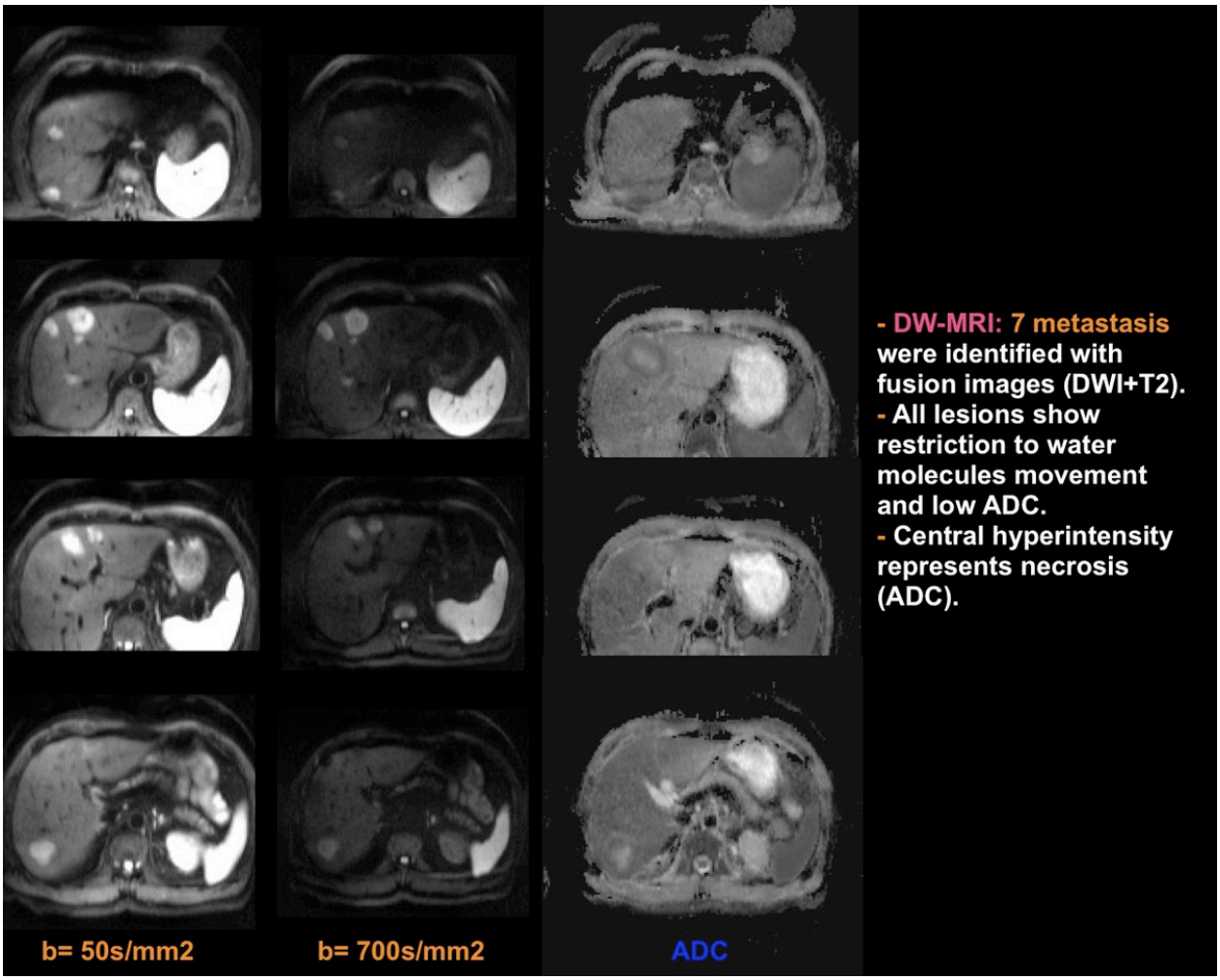
- DW-MRI: 7 metastasis were identified with fusion images (DWI+T2).
- All lesions show restriction to water molecules movement and low ADC.
- Central hyperintensity represents necrosis (ADC).
b= 50s/mm2
b= 700s/mm2
ADC

Fig. 11

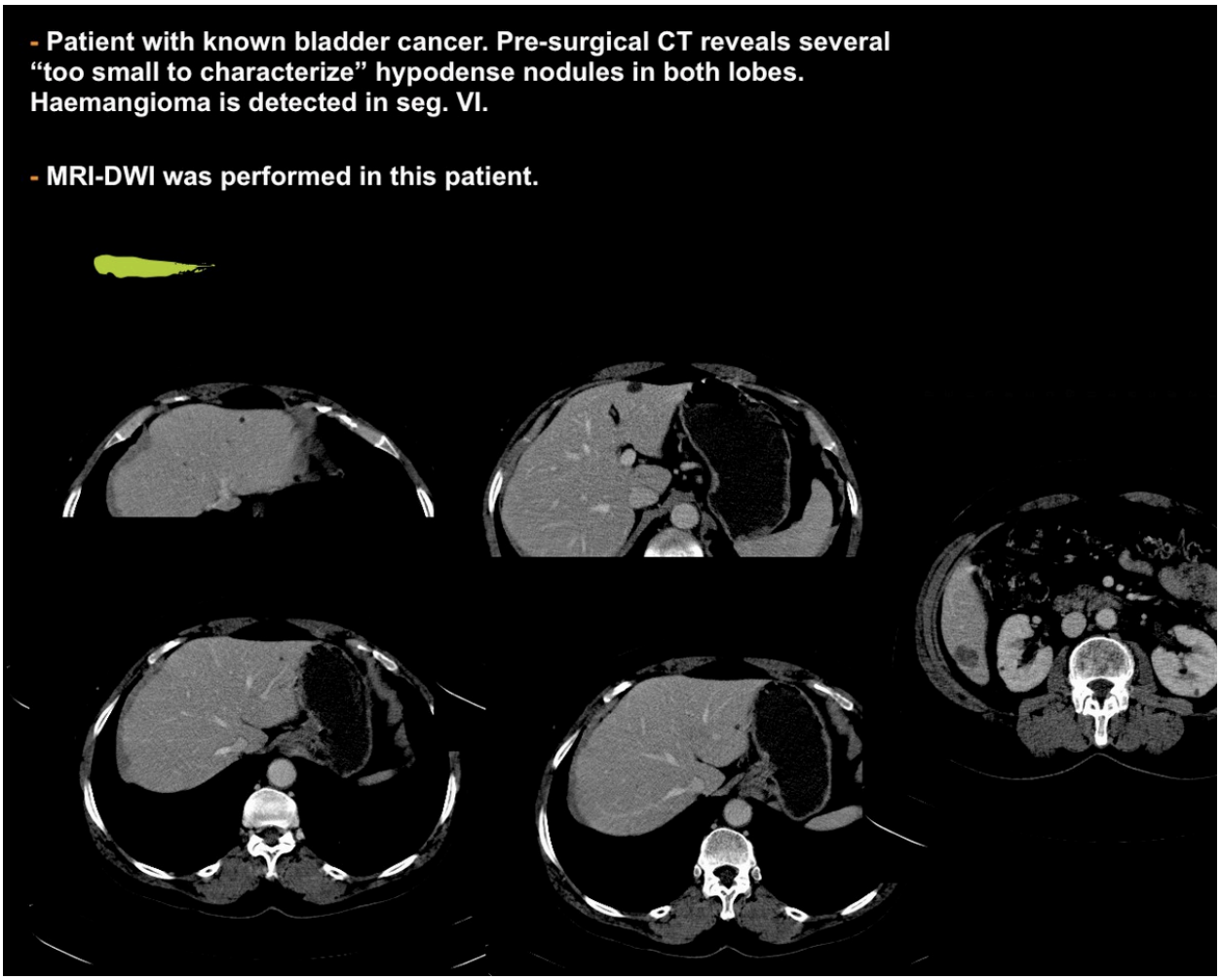

Fig. 12: Case 6. Please see image nº13

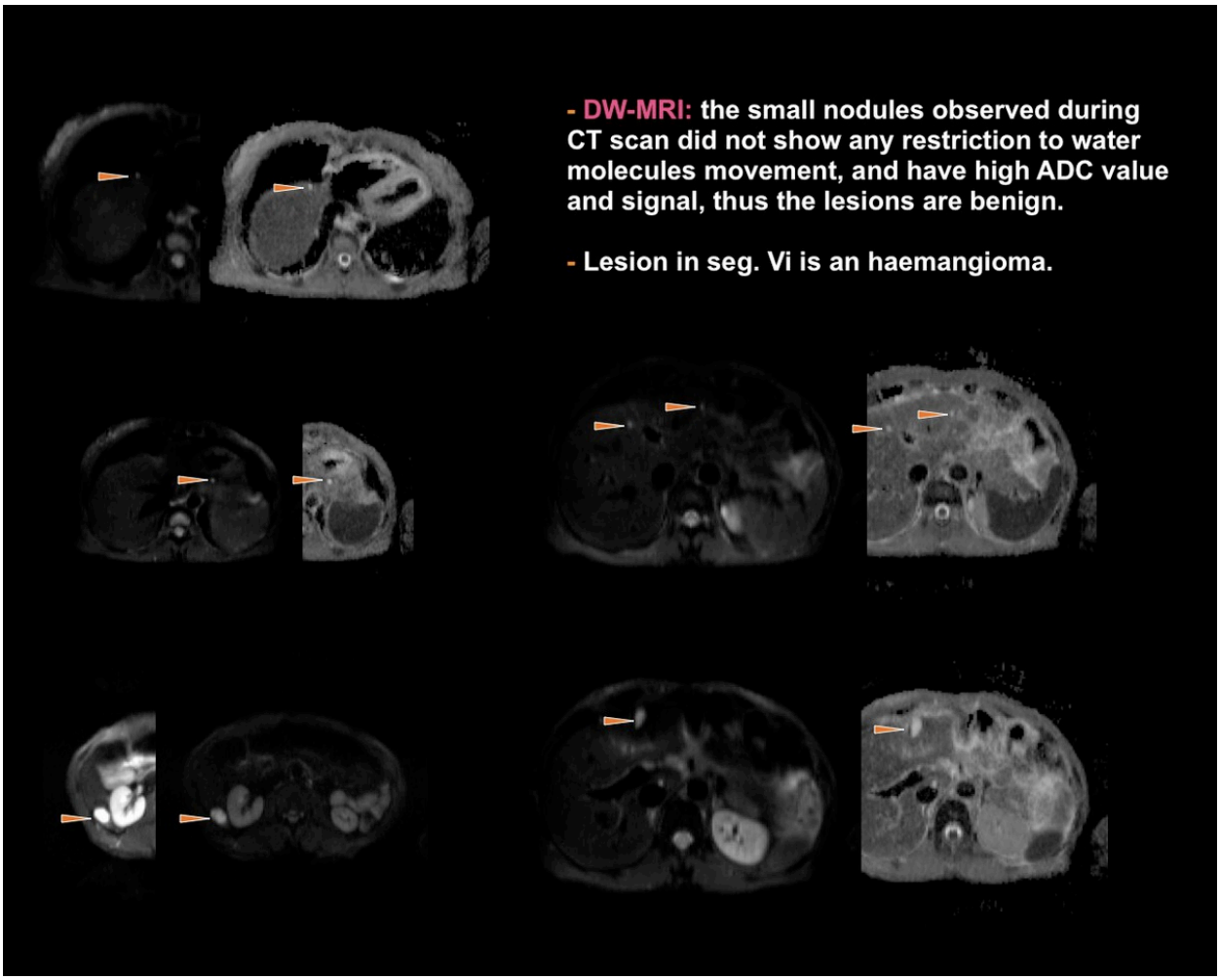
- DW-MRI: the small nodules observed during CT scan did not show any restriction to water molecules movement, and have high ADC value and signal, thus the lesions are benign.
- Lesion in seg. Vi is an haemangioma.

Fig. 13

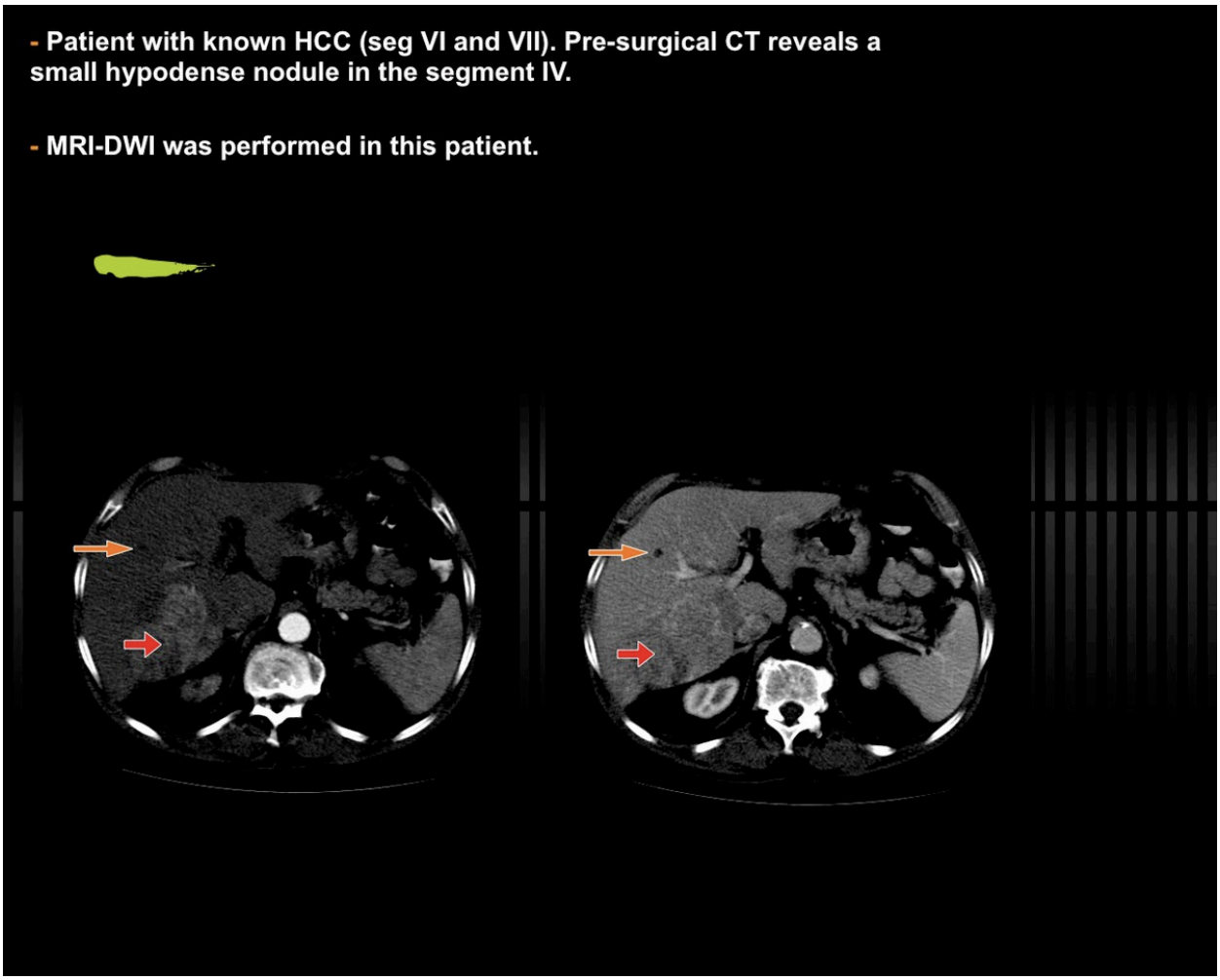

Fig. 14: Case 7. Please see image nº15

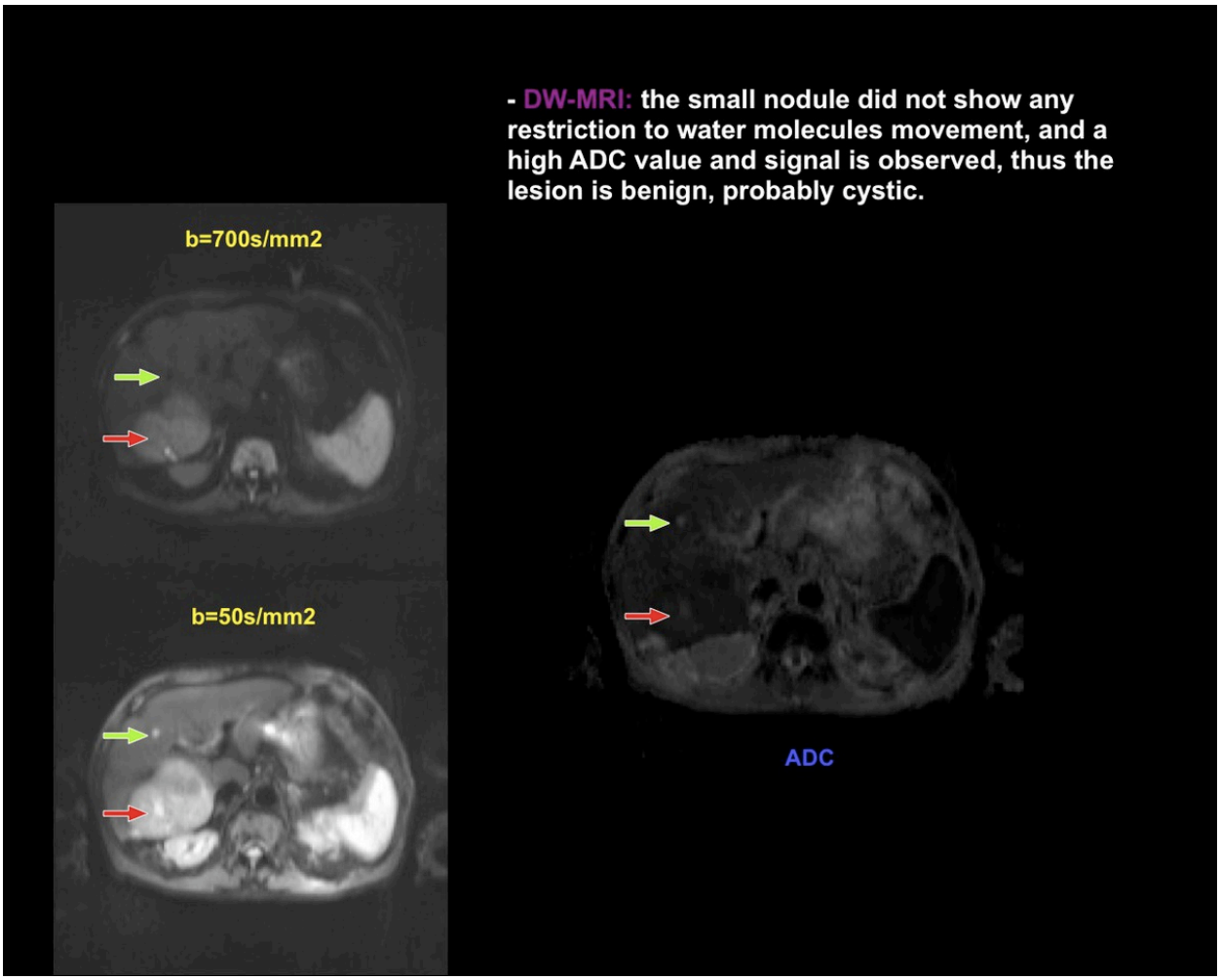
- DW-MRI: the small nodule did not show any restriction to water molecules movement, and a high ADC value and signal is observed, thus the lesion is benign, probably cystic.
b=700s/mm2
b=50s/mm2
ADC

Fig. 15

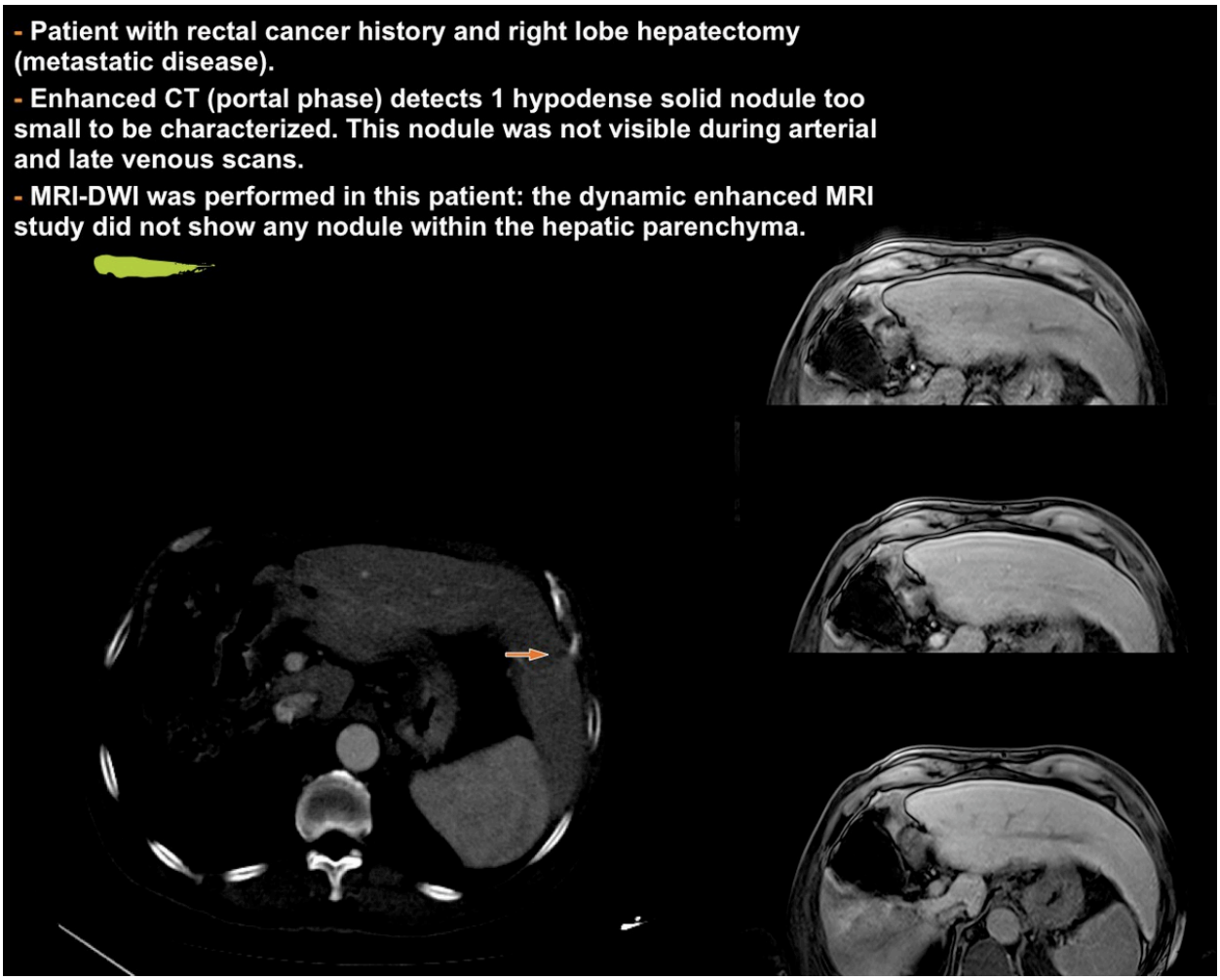

Fig. 16: Case 8. Please see image nº17

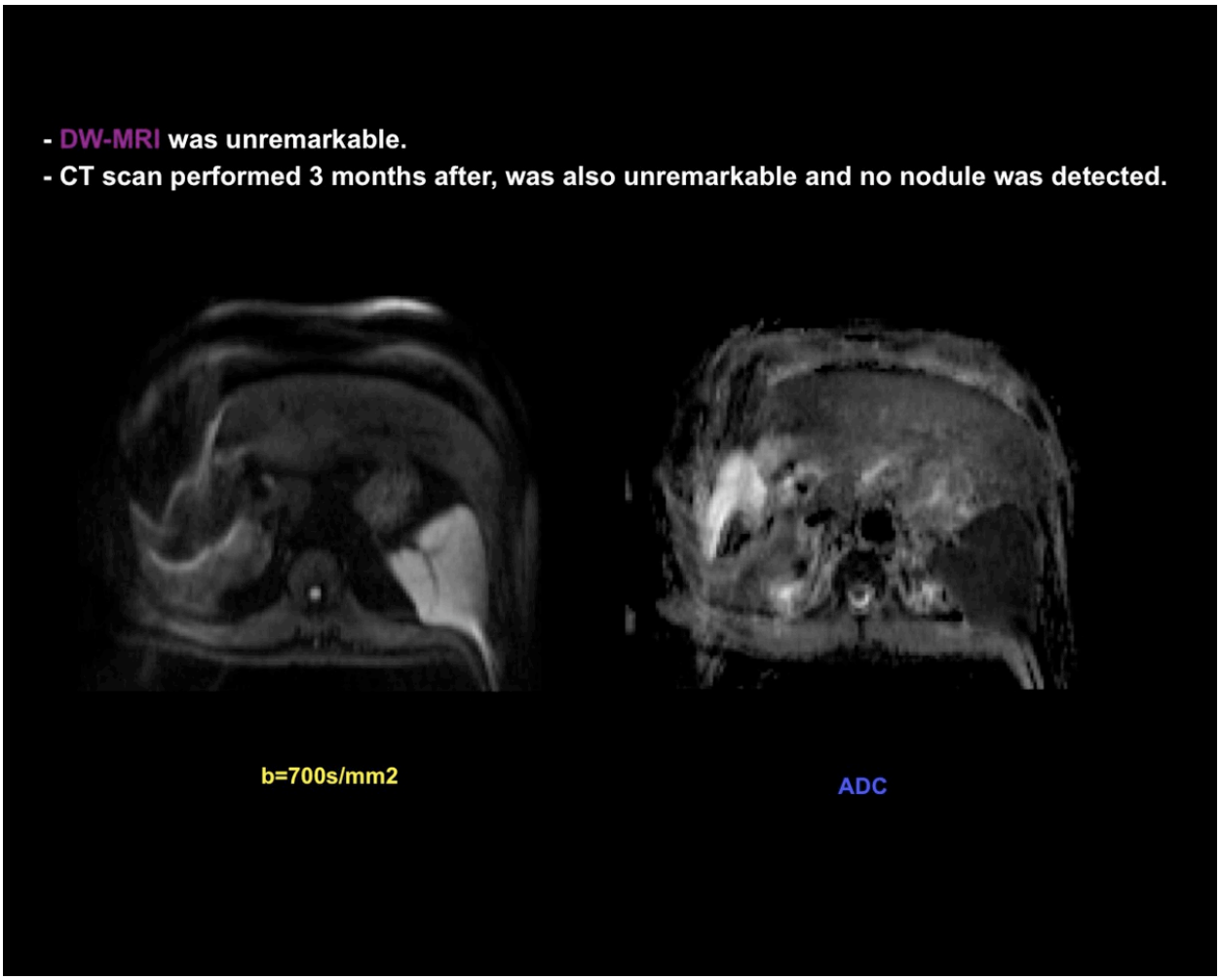
- DW-MRI was unremarkable.
- CT scan performed 3 months after, was also unremarkable and no nodule was detected.
b=700s/mm2
ADC

Fig. 17

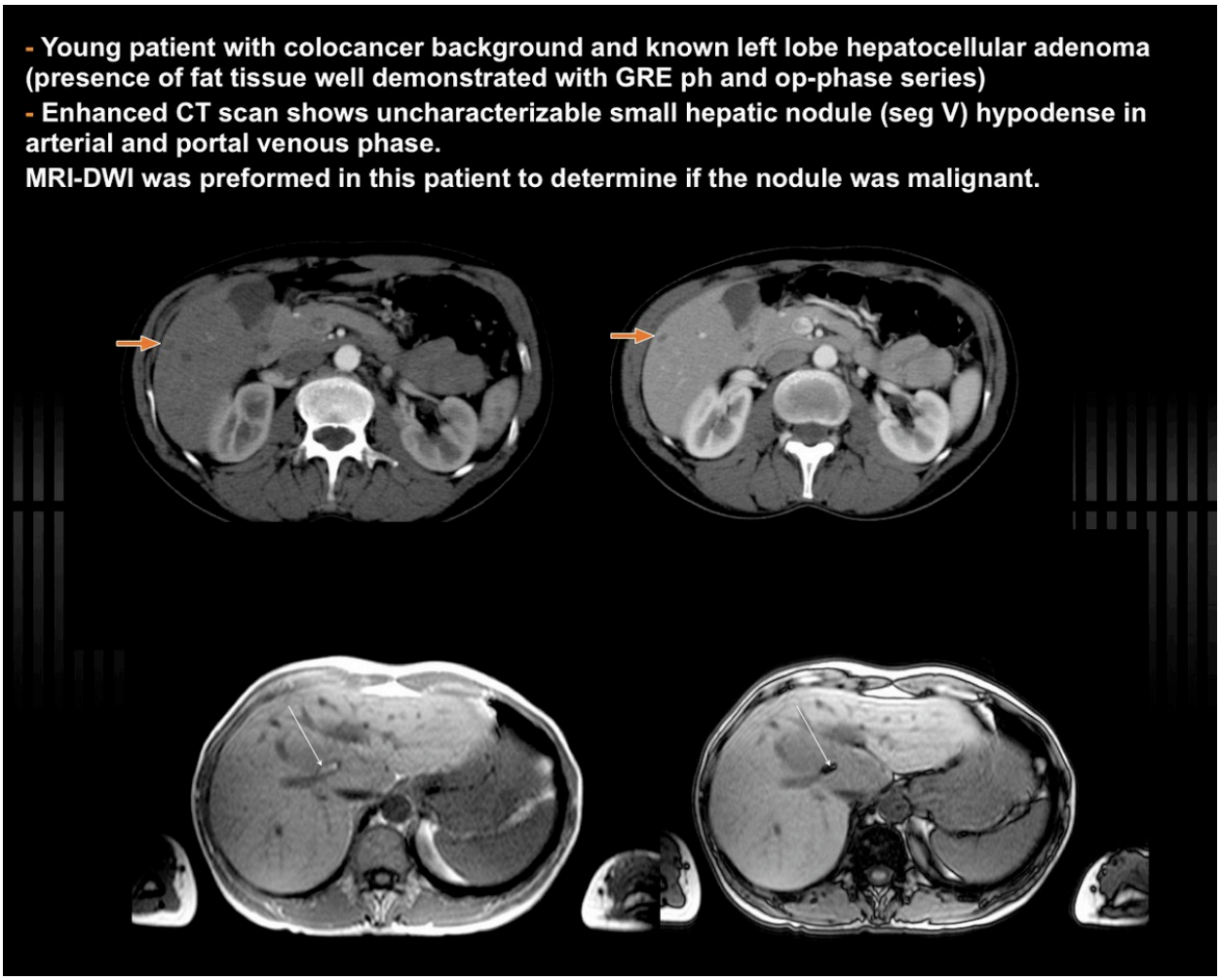

Fig. 18: Case 9. Please see image nº19

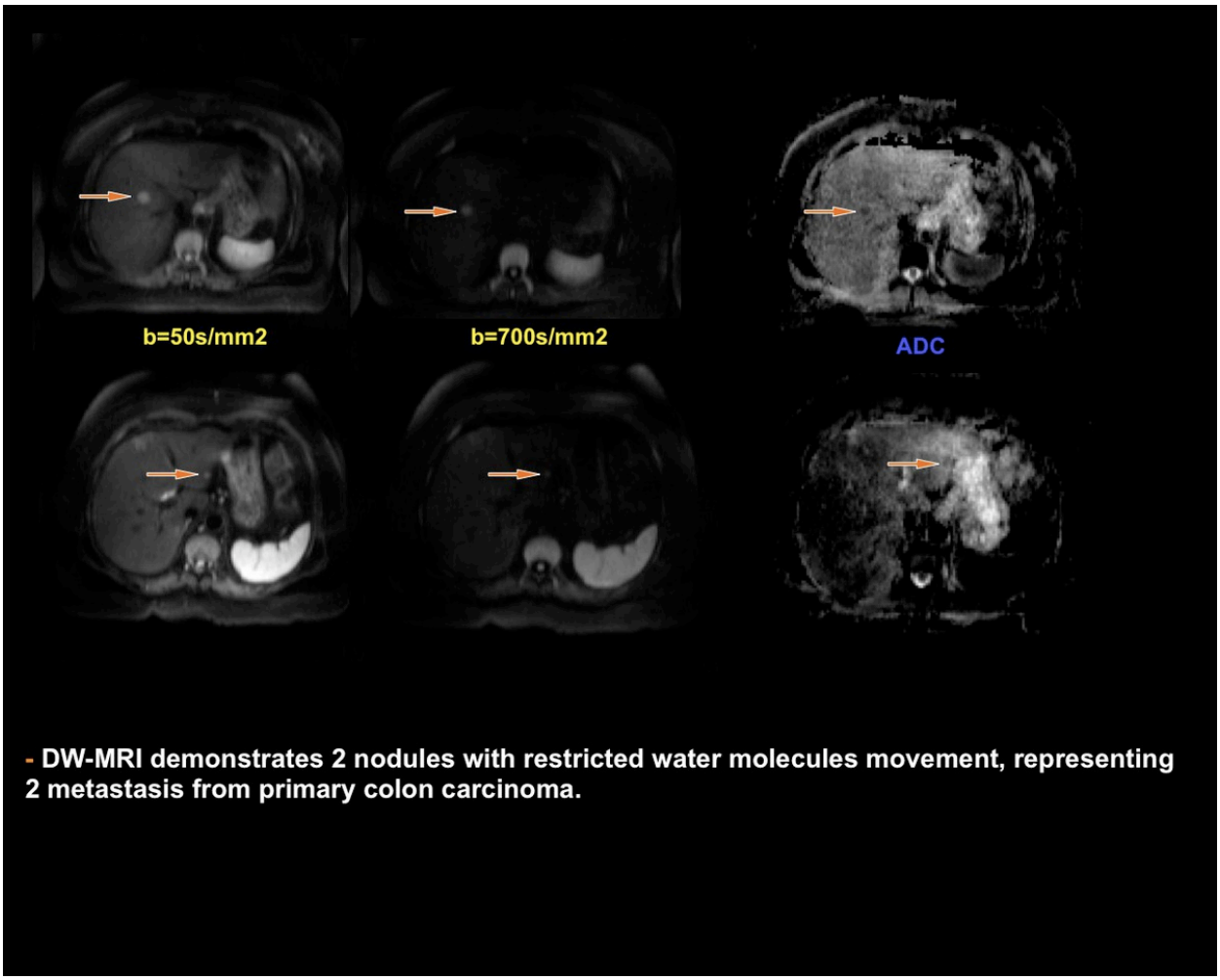
b=50s/mm2
b=700s/mm2
ADC
- DW-MRI demonstrates 2 nodules with restricted water molecules movement, representing 2 metastasis from primary colon carcinoma.

Fig. 19

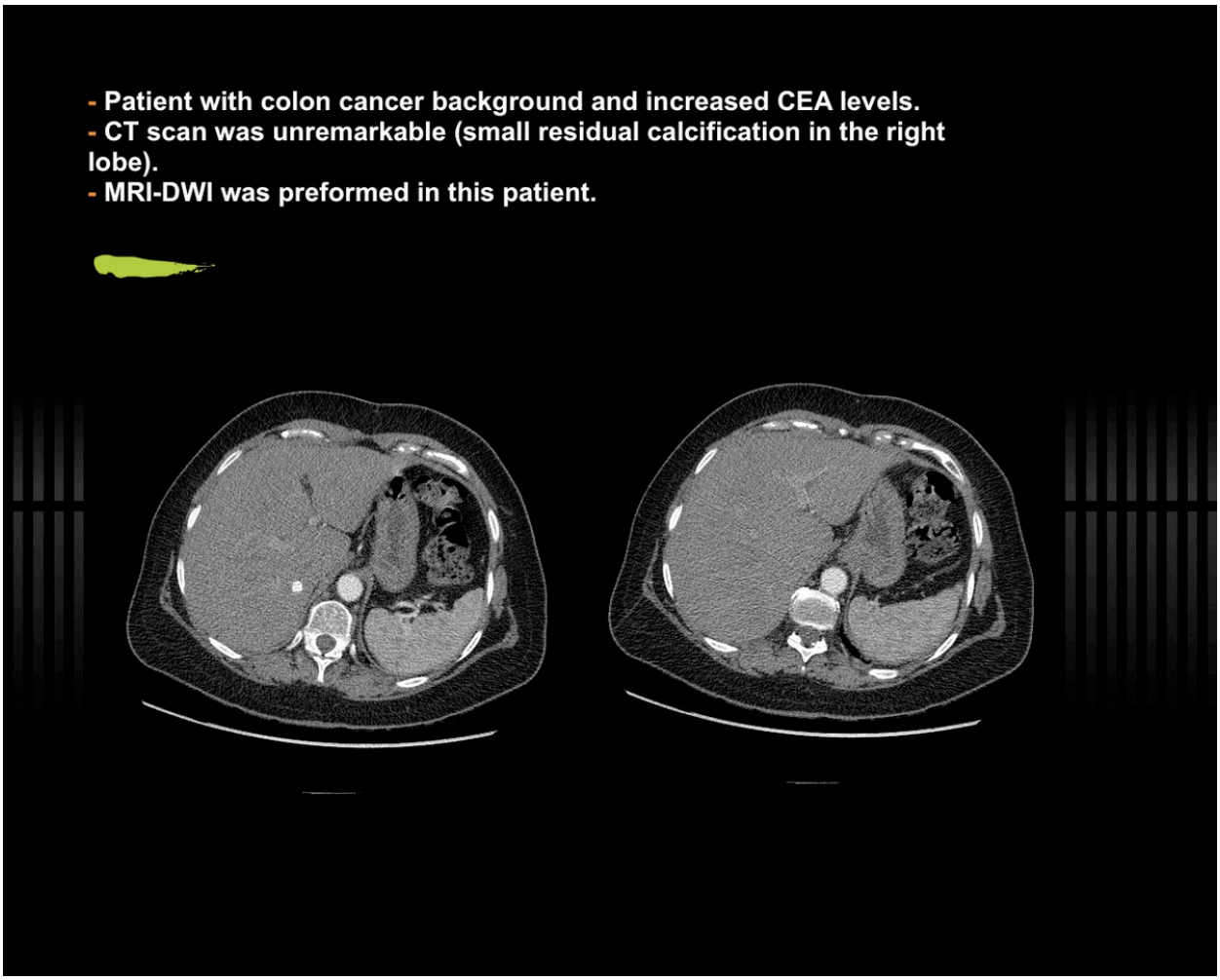

Fig. 20: Case 10. Please see image nº21

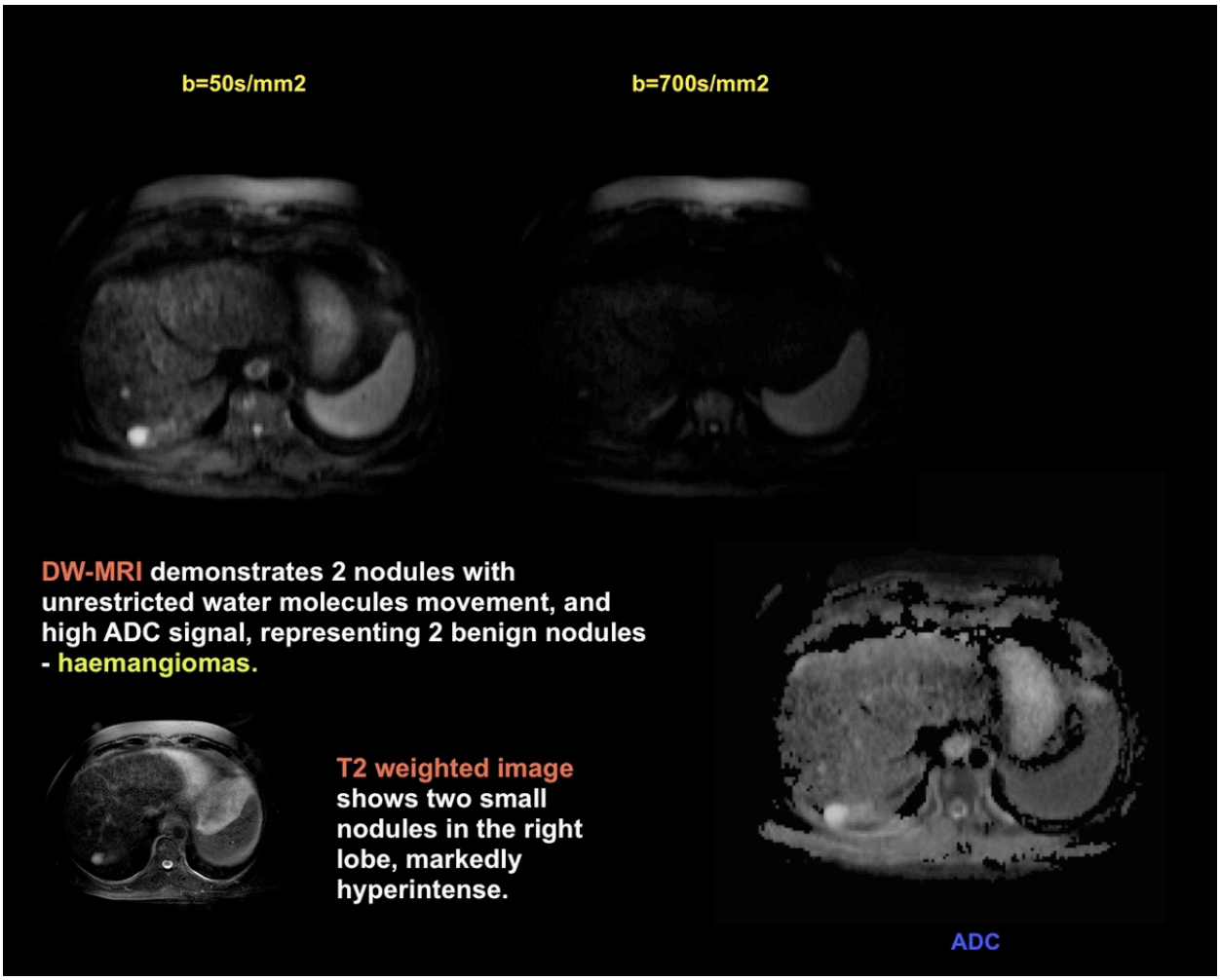
b=50s/mm2
b=700s/mm2
DW-MRI demonstrates 2 nodules with unrestricted water molecules movement, and high ADC signal, representing 2 benign nodules - haemangiomas.
T2 weighted image shows two small nodules in the right lobe, markedly hyperintense.
ADC

Fig. 21

Fig. 22: Case 11. Please see image nº23

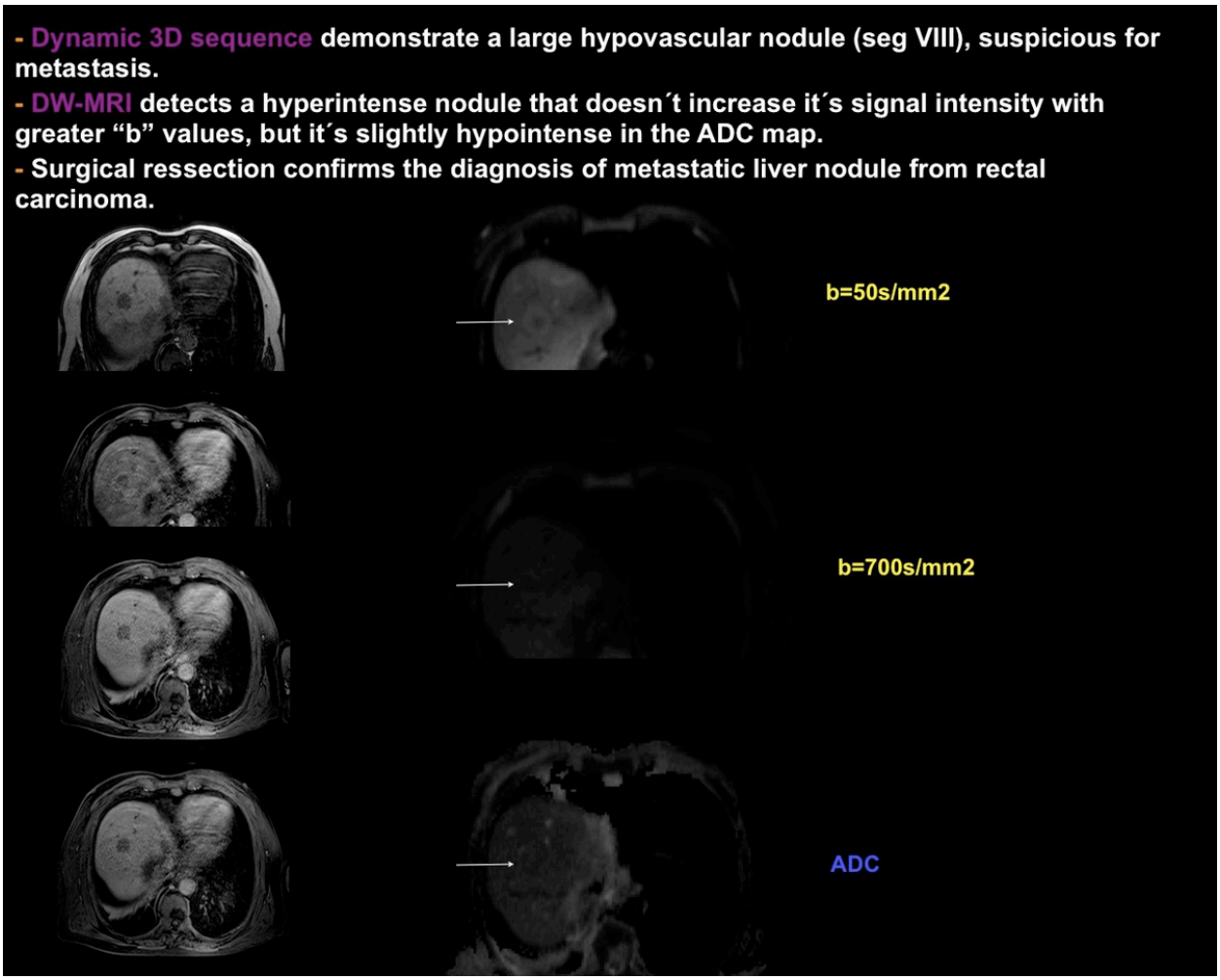
- Dynamic 3D sequence demonstrate a large hypovascular nodule (seg VIII), suspicious for metastasis.
- DW-MRI detects a hyperintense nodule that doesn´t increase it´s signal intensity with greater "b" values, but it´s slightly hypointense in the ADC map.
- Surgical ressection confirms the diagnosis of metastatic liver nodule from rectal carcinoma.
b=50s/mm2
b=700s/mm2
ADC

Fig. 23

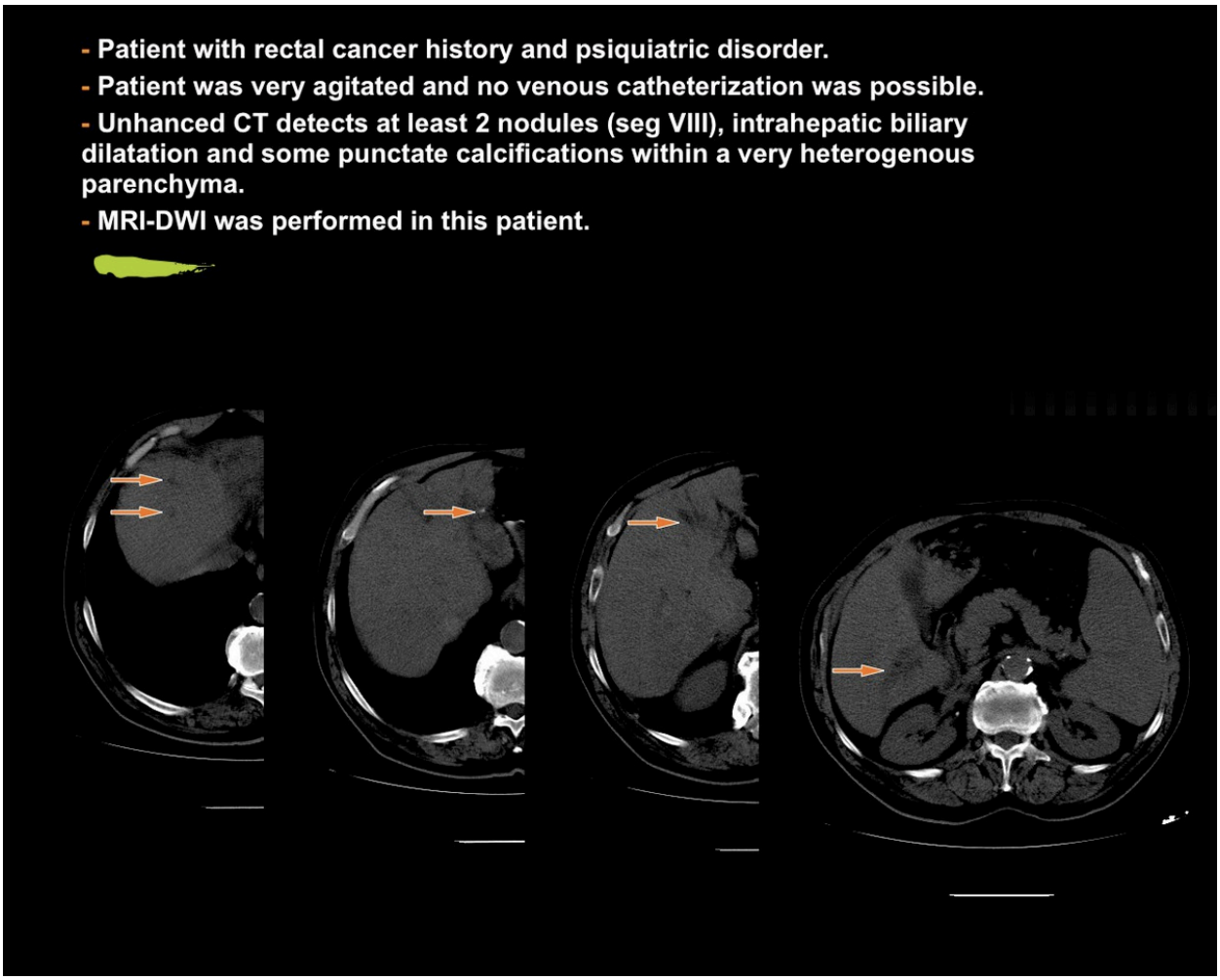

Fig. 24: Case 12. Please see image nº25

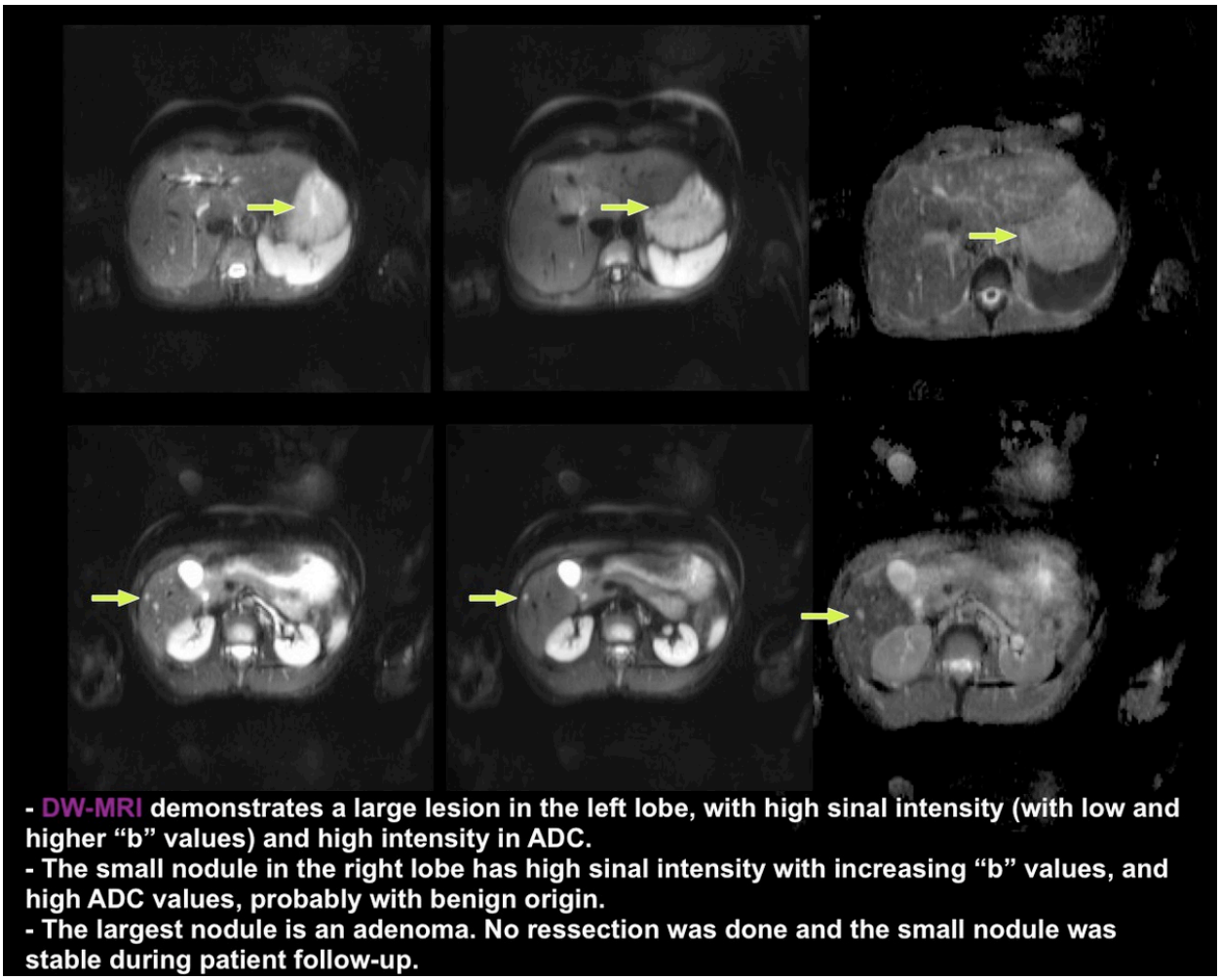
- DW-MRI demonstrates a large lesion in the left lobe, with high sinal intensity (with low and higher “b” values) and high intensity in ADC.
- The small nodule in the right lobe has high sinal intensity with increasing “b” values, and high ADC values, probably with benign origin.
- The largest nodule is an adenoma. No ressection was done and the small nodule was stable during patient follow-up.

Fig. 25

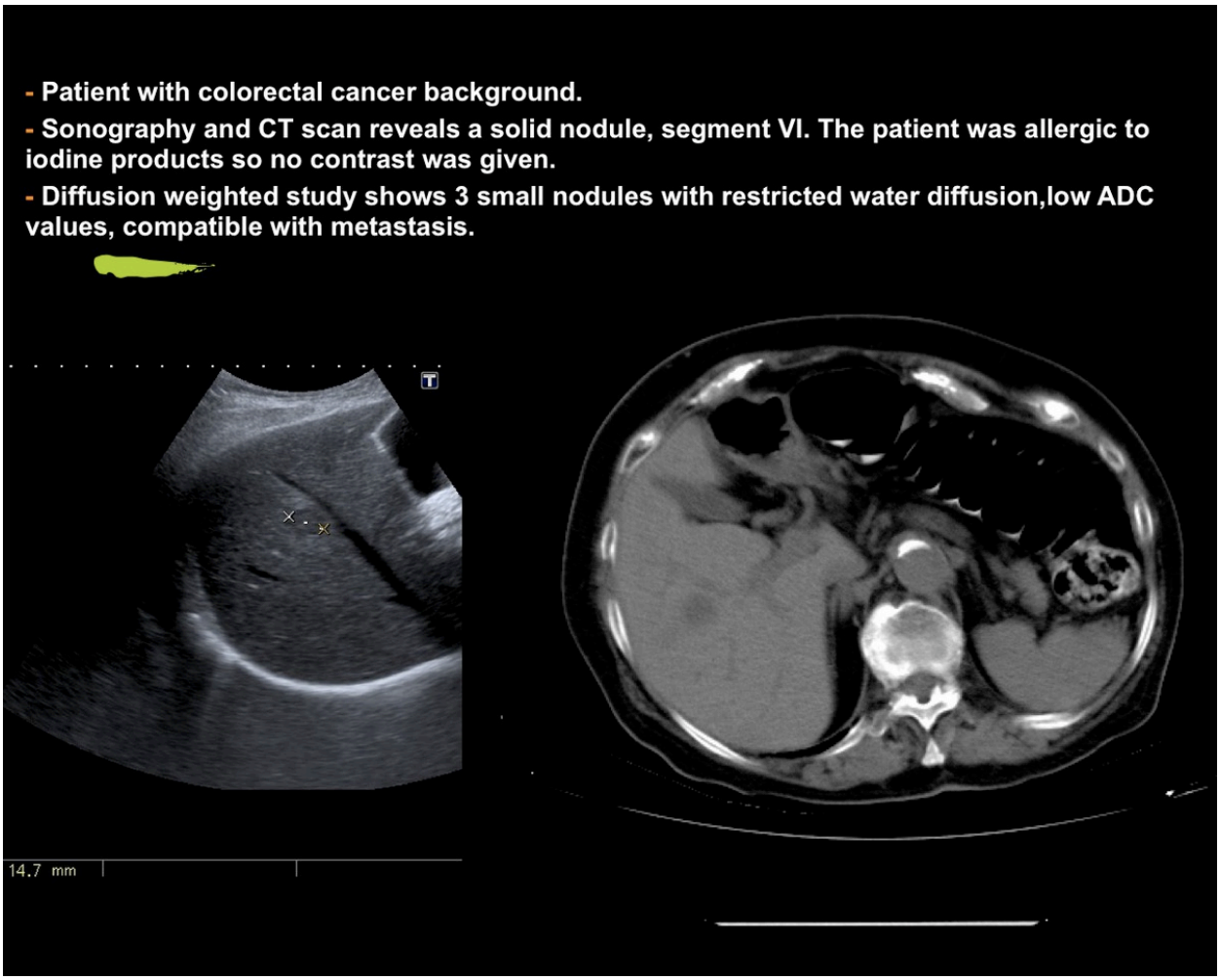

Fig. 26: Case 13. Please see image nº27

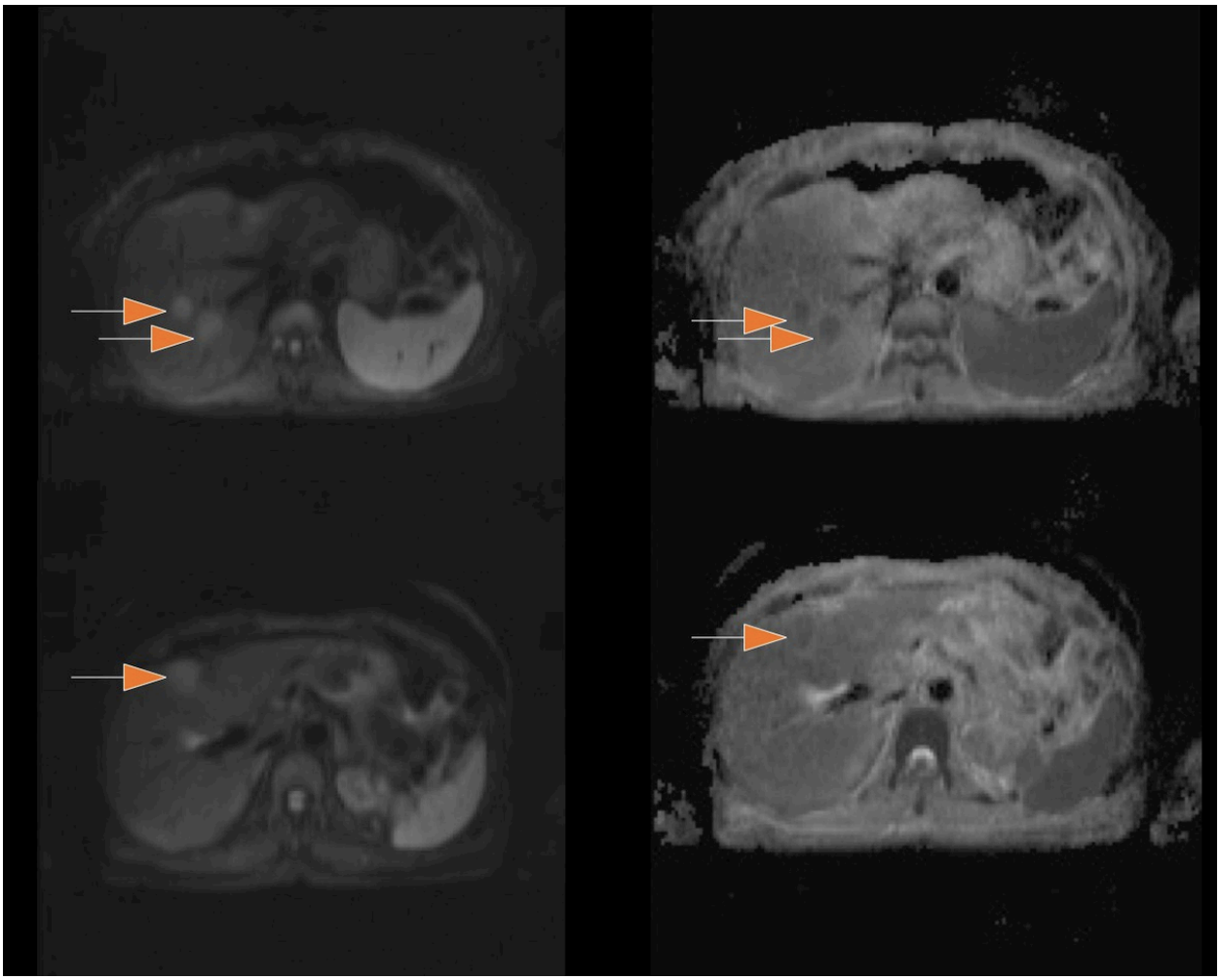

Fig. 27

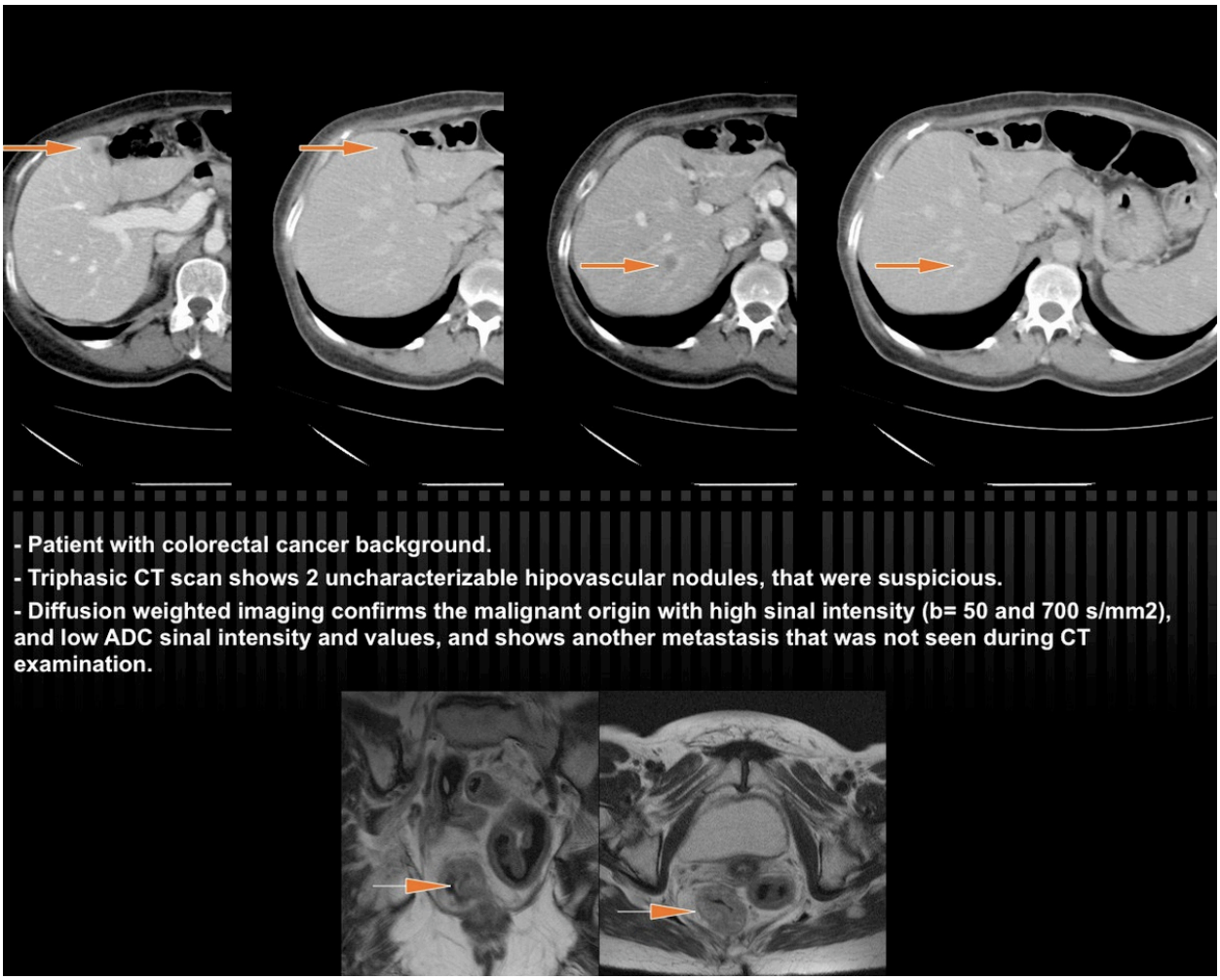

Fig. 28: Case 14. Please see image nº29

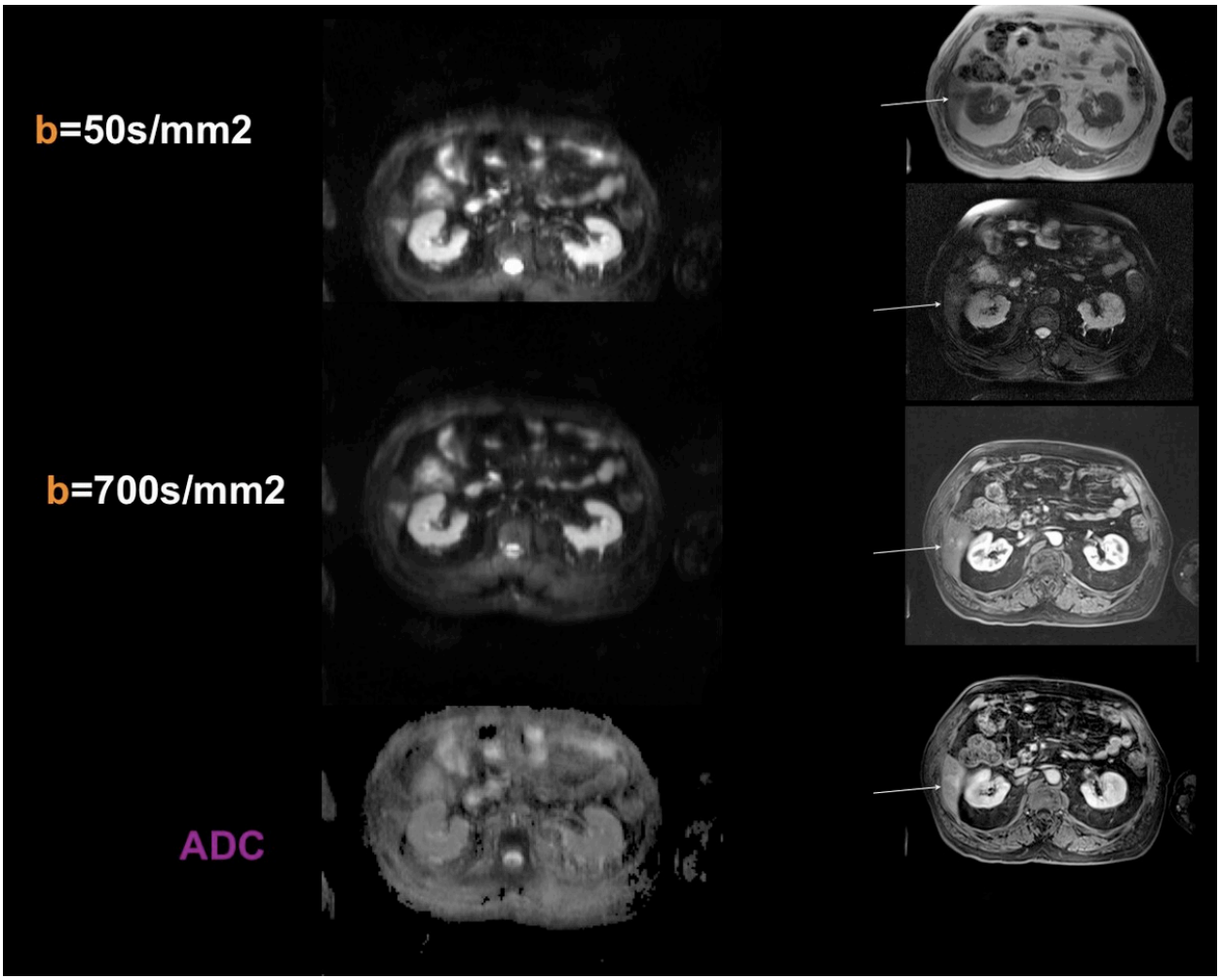

Fig. 29

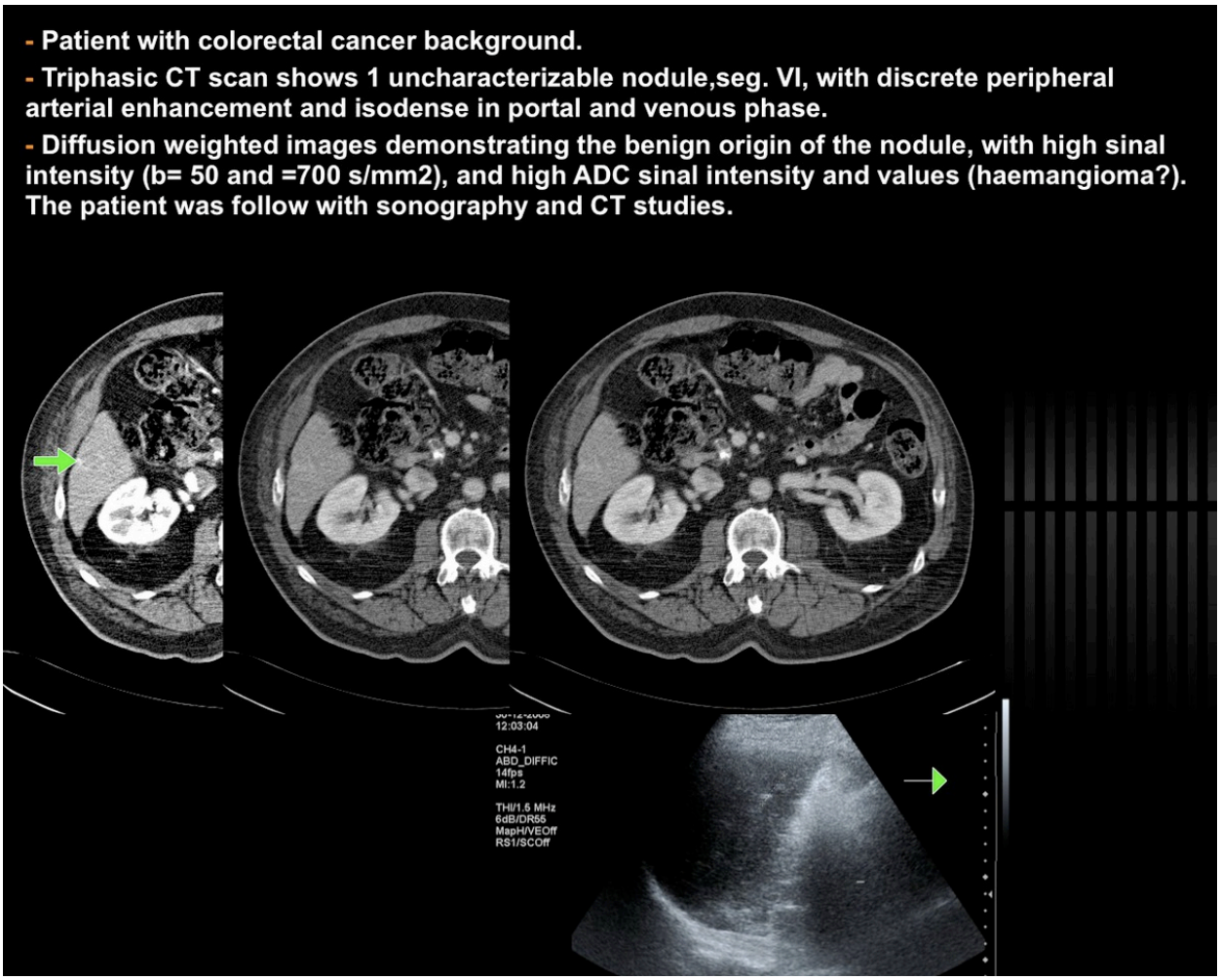

Fig. 30: Case 15. Please see image nº31

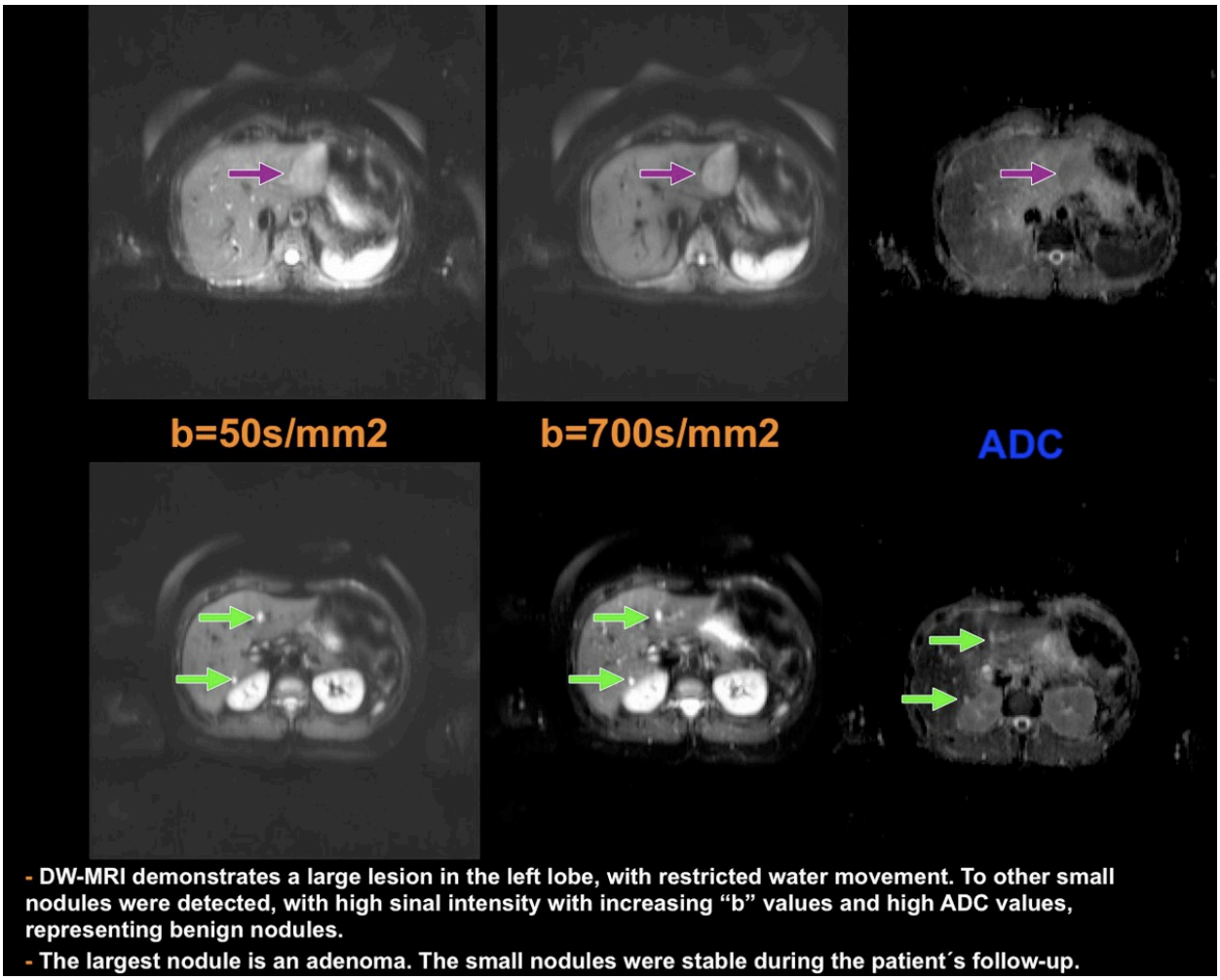
b=50s/mm2
b=700s/mm2
ADC
- DW-MRI demonstrates a large lesion in the left lobe, with restricted water movement. To other small nodules were detected, with high sinal intensity with increasing “b” values and high ADC values, representing benign nodules.
- The largest nodule is an adenoma. The small nodules were stable during the patient´s follow-up.

Fig. 31

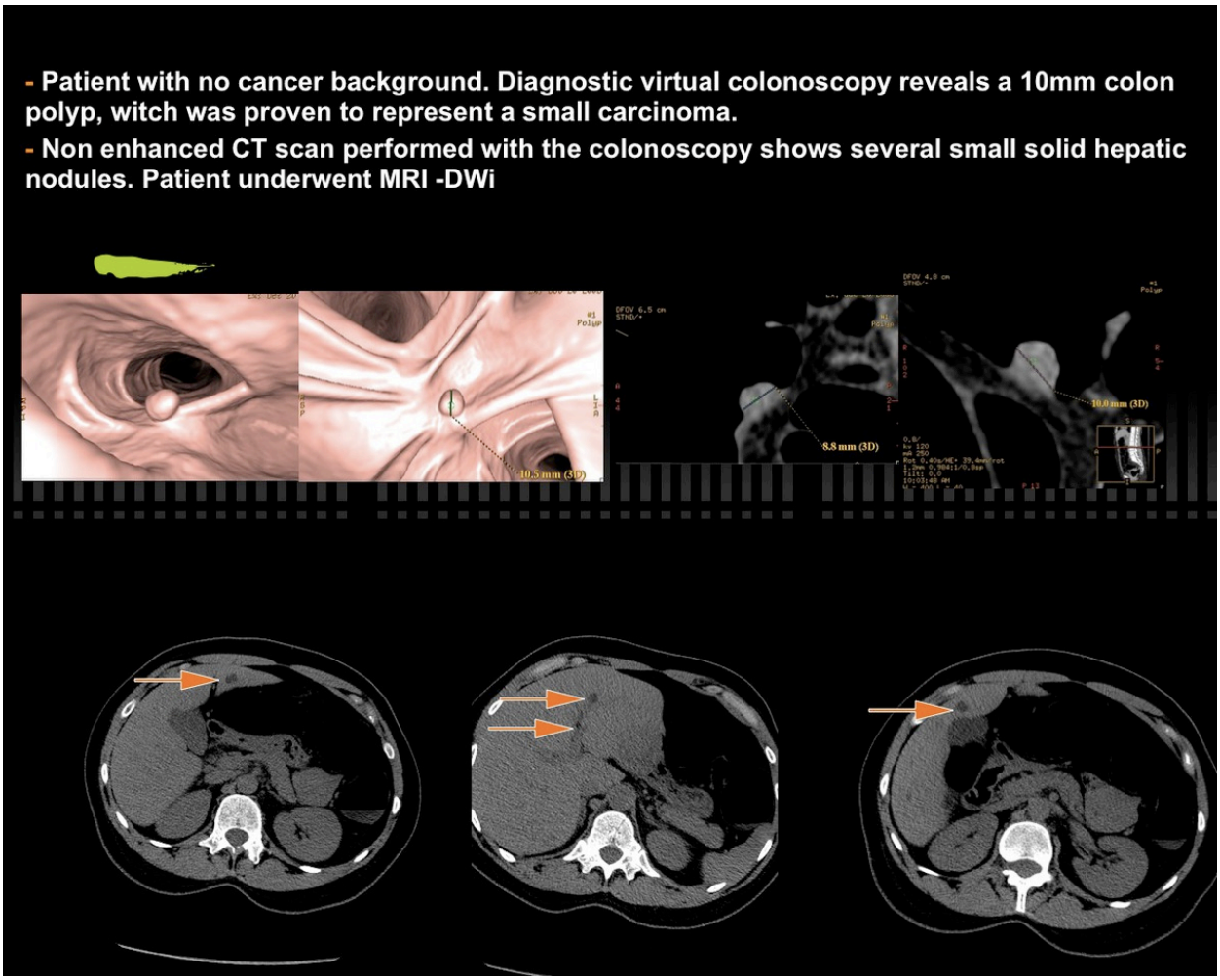

Fig. 32: Case 16. Please see image nº33

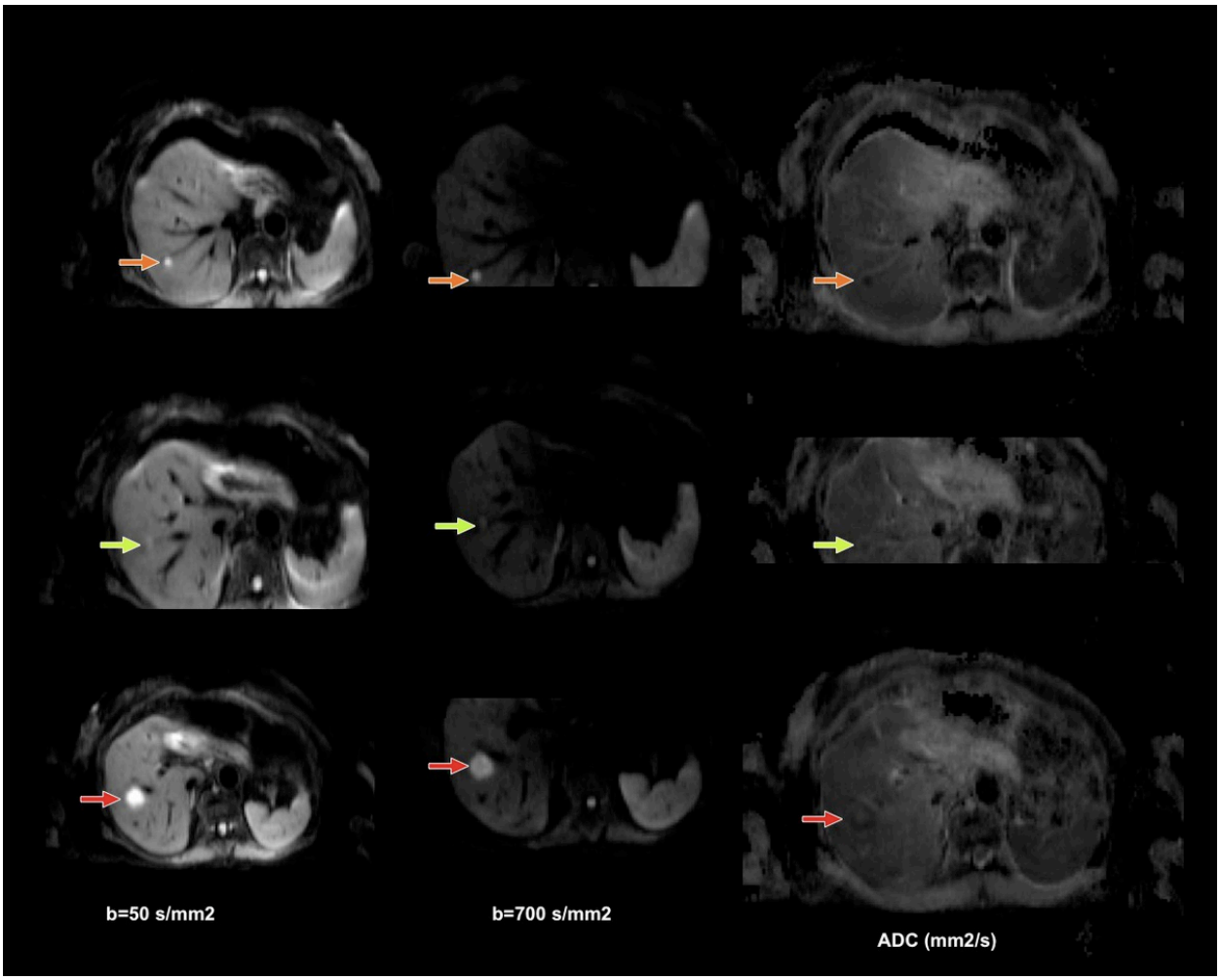

Fig. 33

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 radiologyst to "give a name" to the uncharacterizable small liver nodule.

Personal Information

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

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