Pitfalls in Imaging for Liver Tumors

Jens Ricke

ORIGINAL ARTICLE

Gut and Liver, Vol. 8, No. 3, May 2014, pp. 292-297

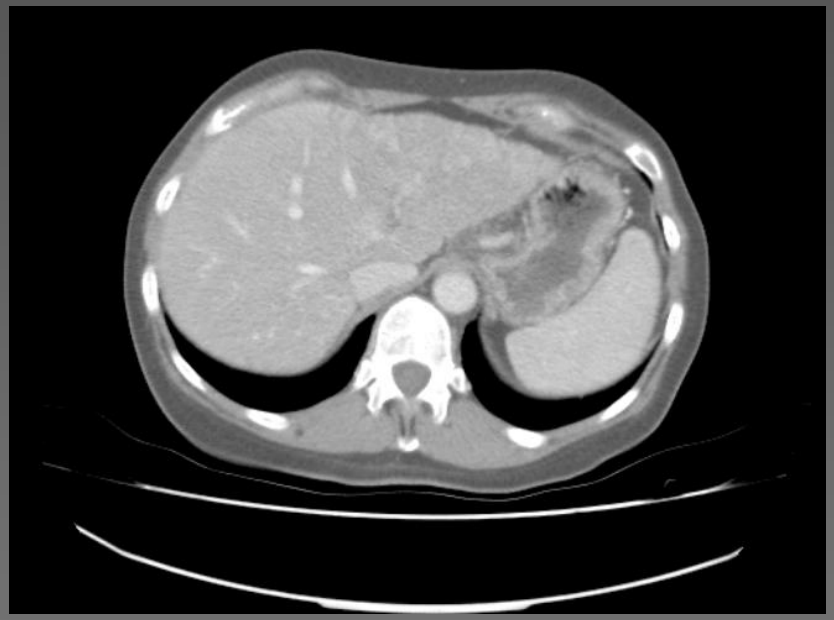
Clinically Useful Diagnostic Tool of Contrast Enhanced Ultrasonography for Focal Liver Masses: Comparison to Computed Tomography and Magnetic Resonance Imaging

Sung Woo Ryu, Gene Hyun Bok, Jae Young Jang, Soung Won Jeong, Nam Seok Ham, Ji Hye Kim, Eui Ju Park, Jin Nyoung Kim, Woong Cheul Lee, Kwang Yeun Shim, Sae Hwan Lee, Sang Gyune Kim, Sang-Woo Cha, Young Seok Kim, Young Deok Cho, Hong Soo Kim, and Boo Sung Kim

	Sensitivity	Specificity
CEUS	83/95 %	88 %
CT	95 %	88 %
MR	95 %	83 %

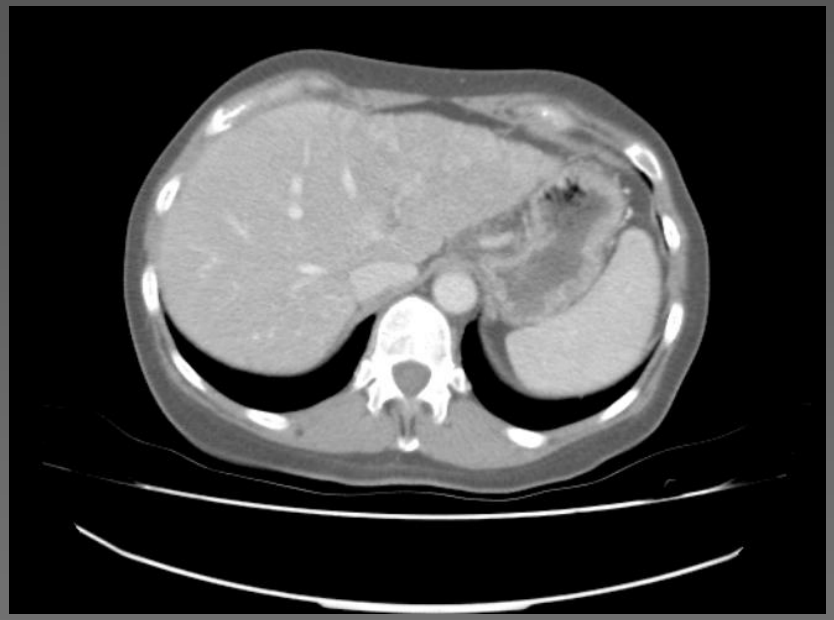
Ryu, Gut and Liver 2014

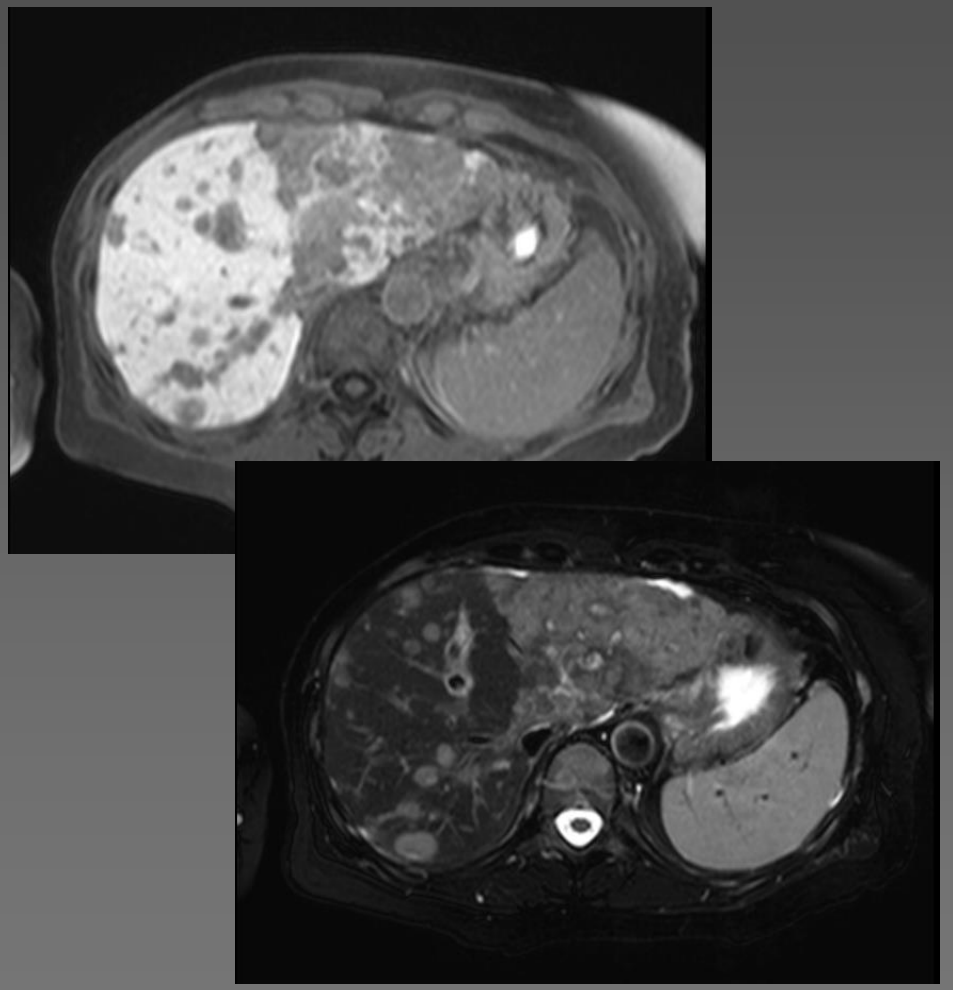
Advantages of MRI



52y female,
CRC

Advantages of MRI





52y female,
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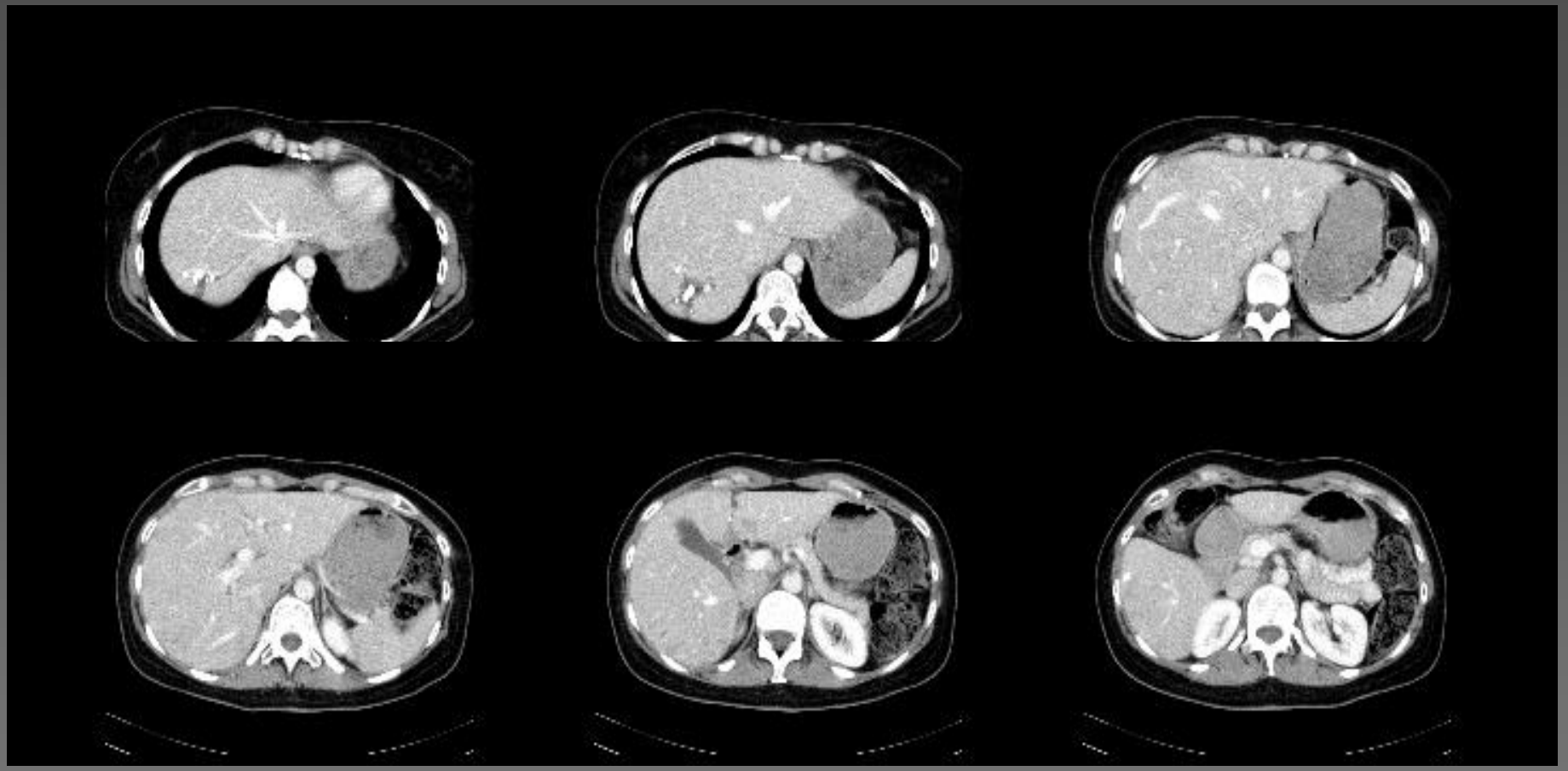
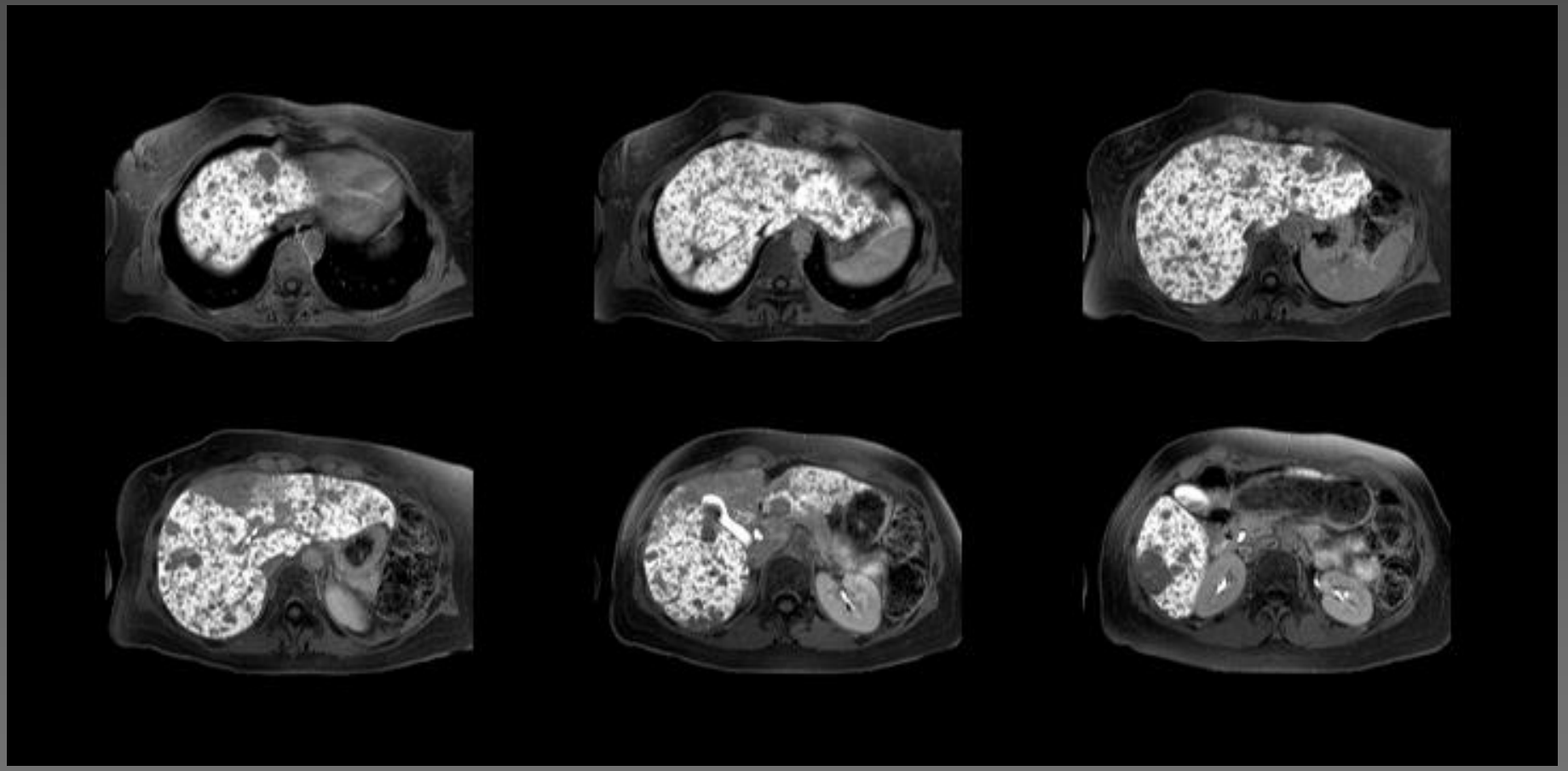
Advantages of MRI



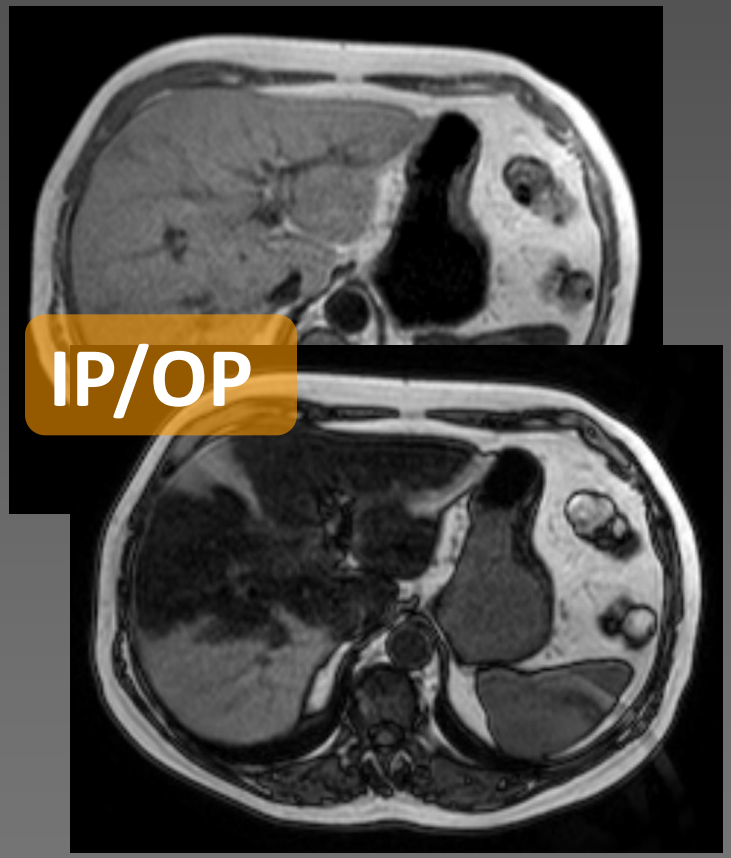
58y female,
breast cancer

Advantages of MRI

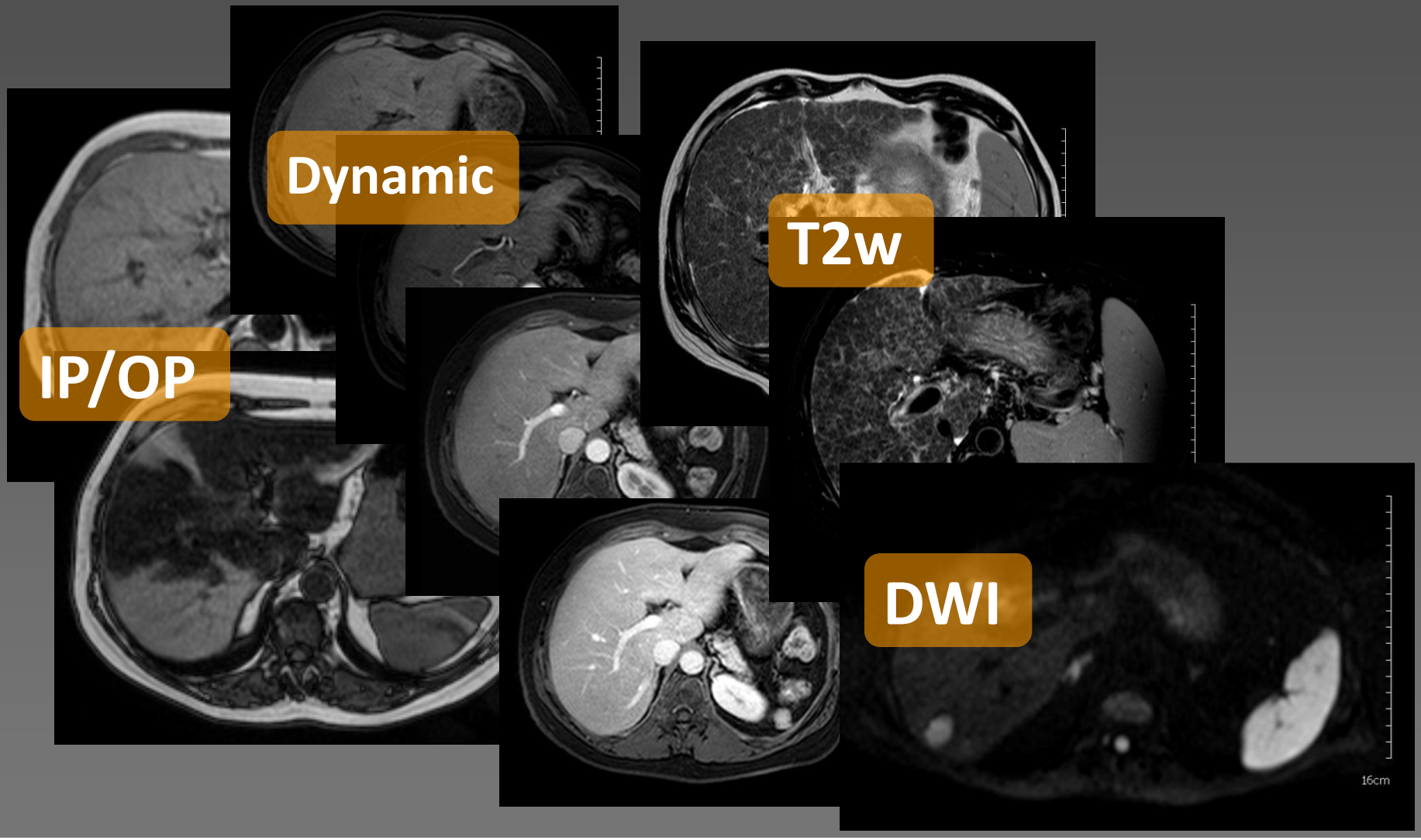


58y female,
breast cancer

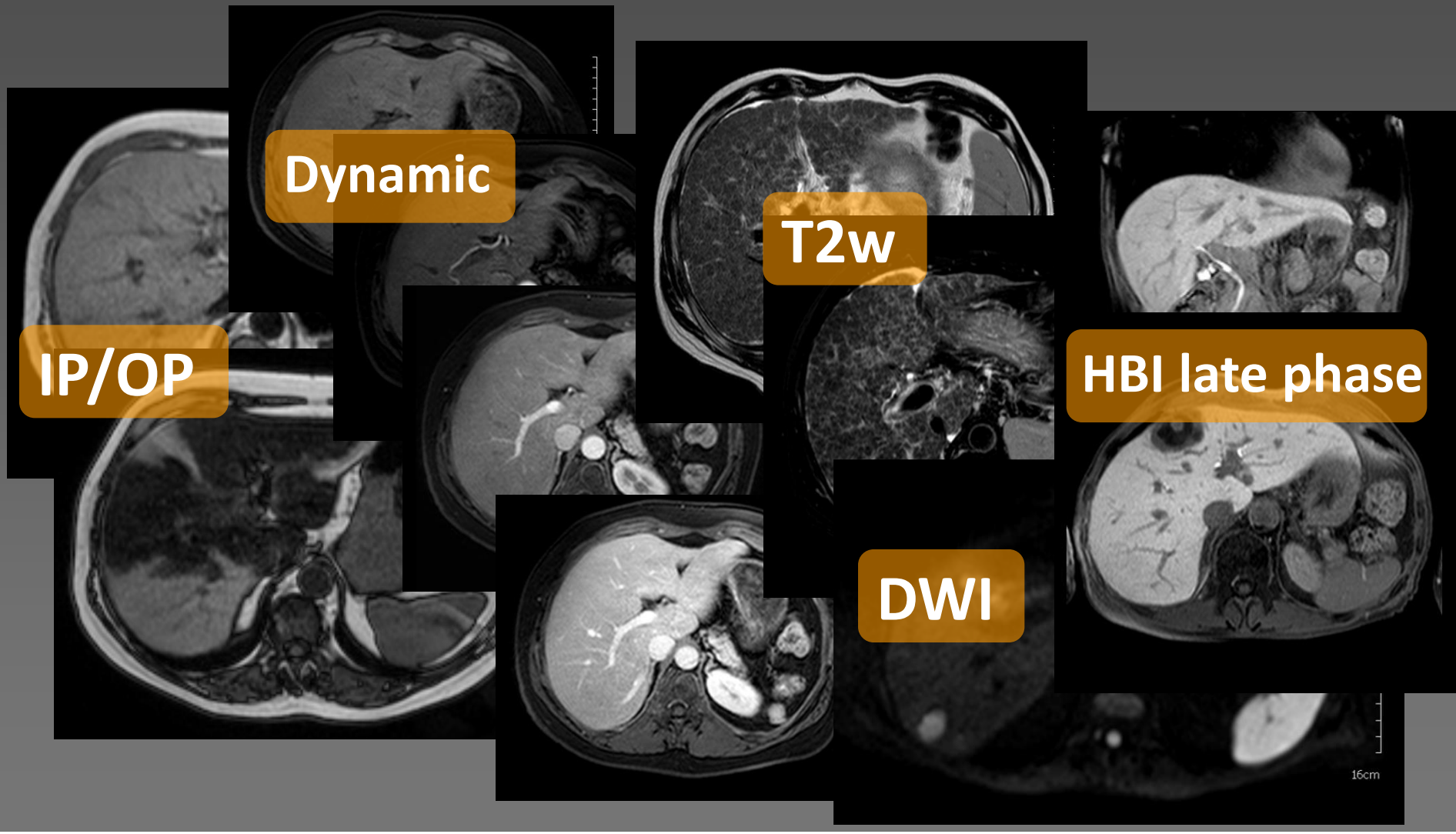
Liver imaging with MRI



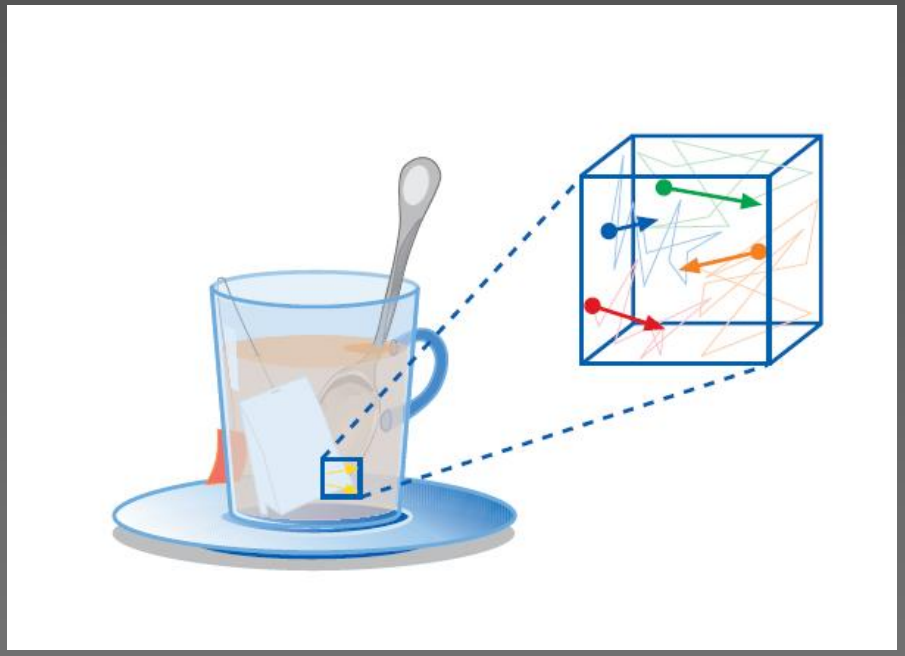
Liver imaging with MRI



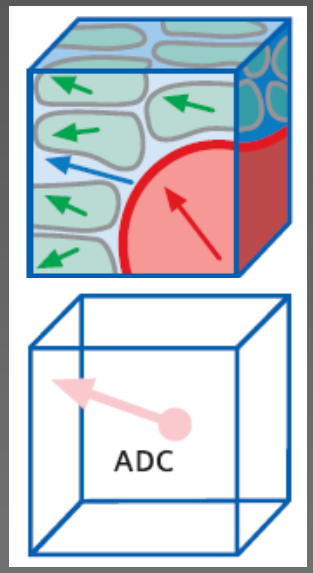
Liver imaging with MRI



Diffusion-weighted MRI

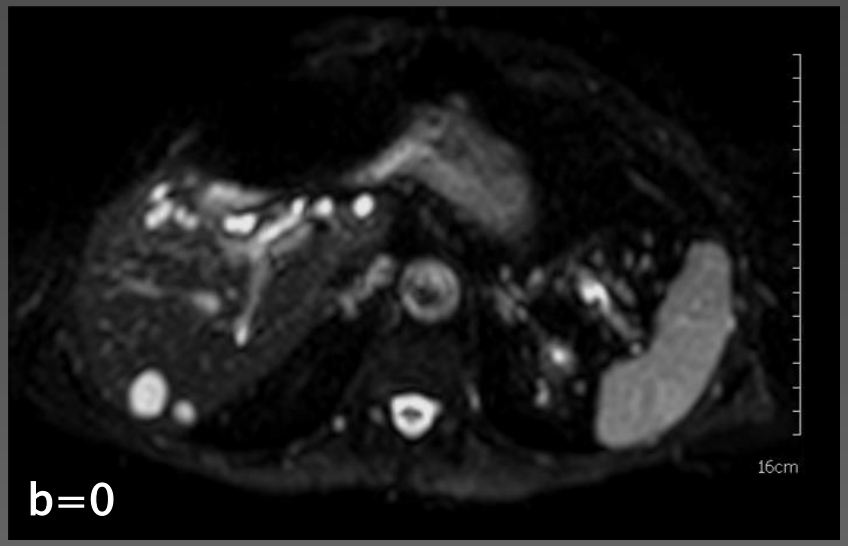


[Magnete, Fluss und Artefakte, *Siemens Manual*]



x 10^{-3} mm^2/sec]

Diffusion



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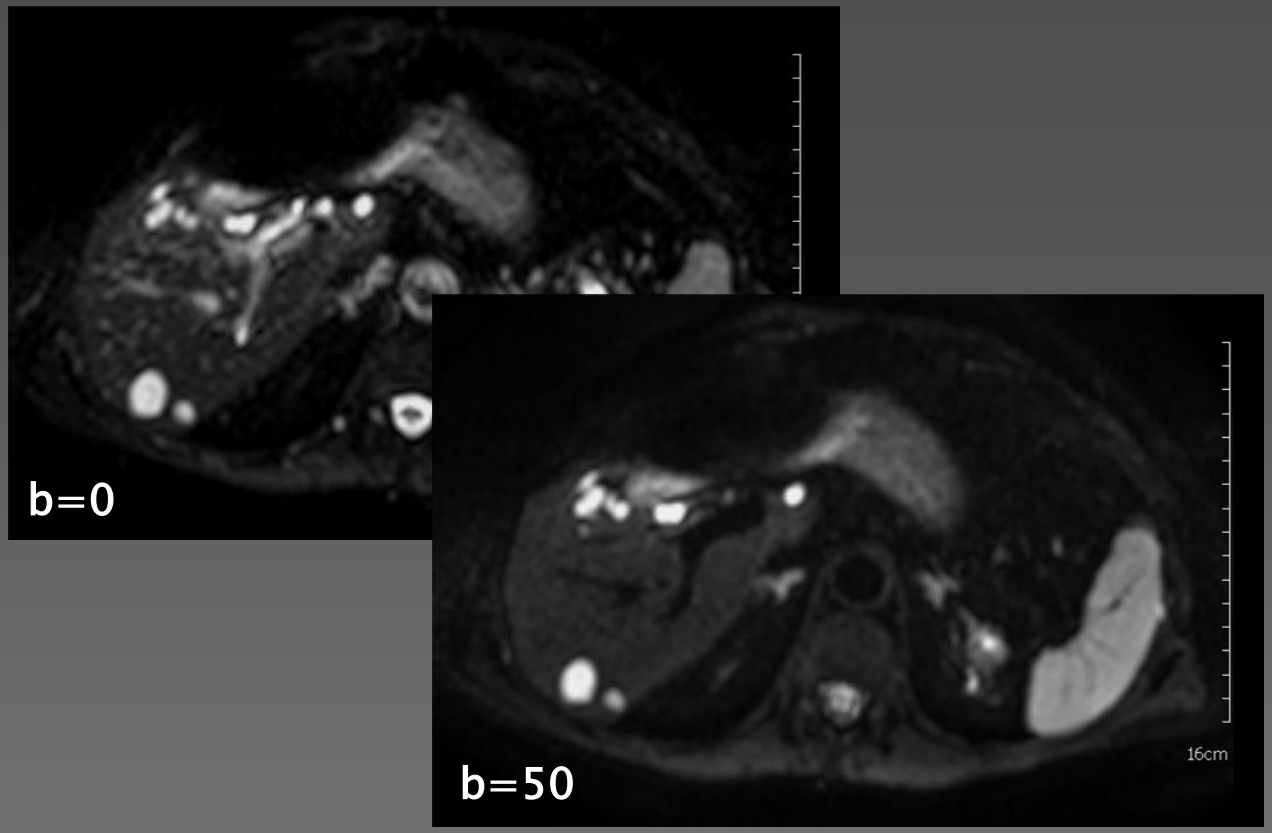

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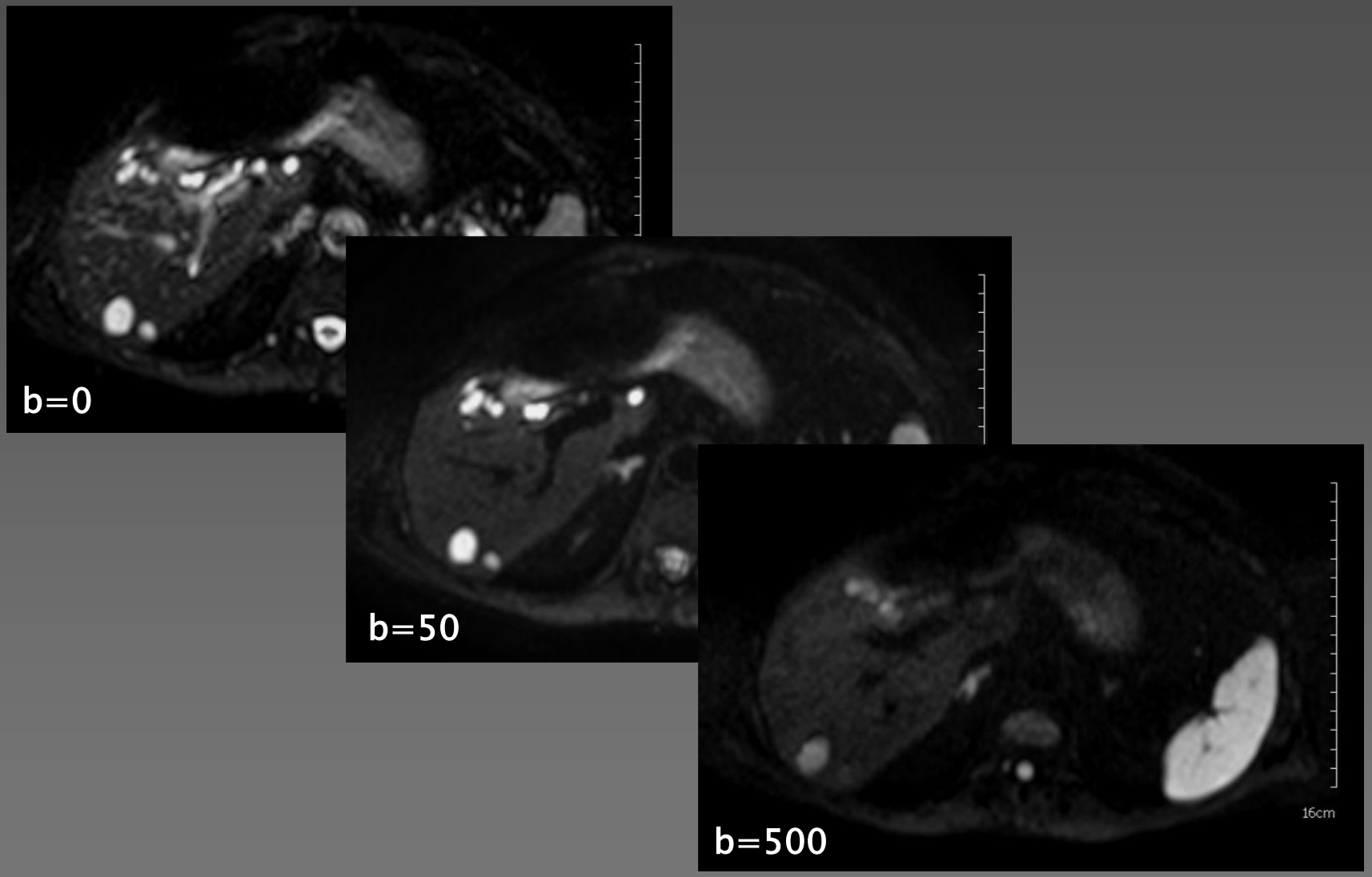
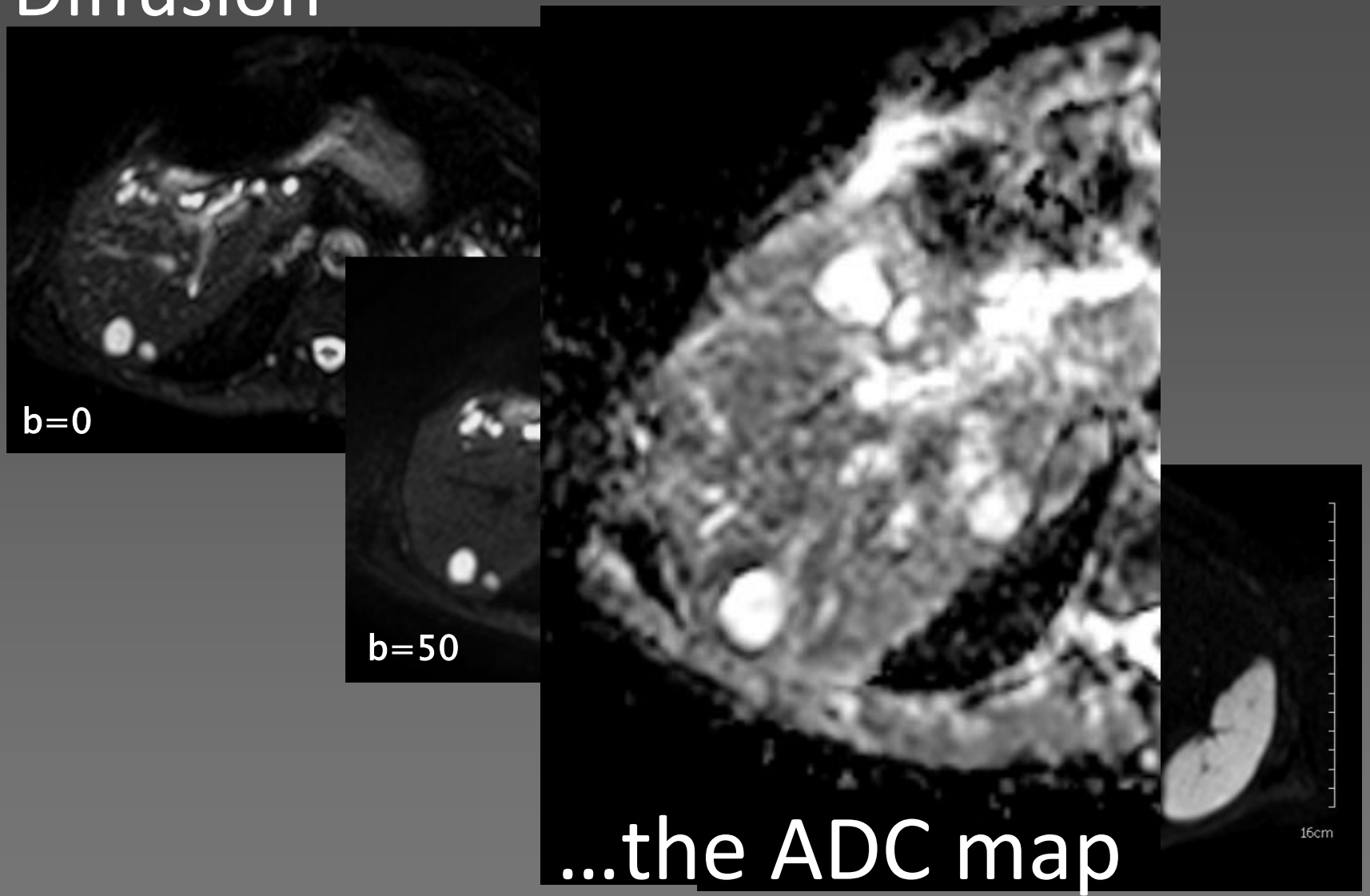
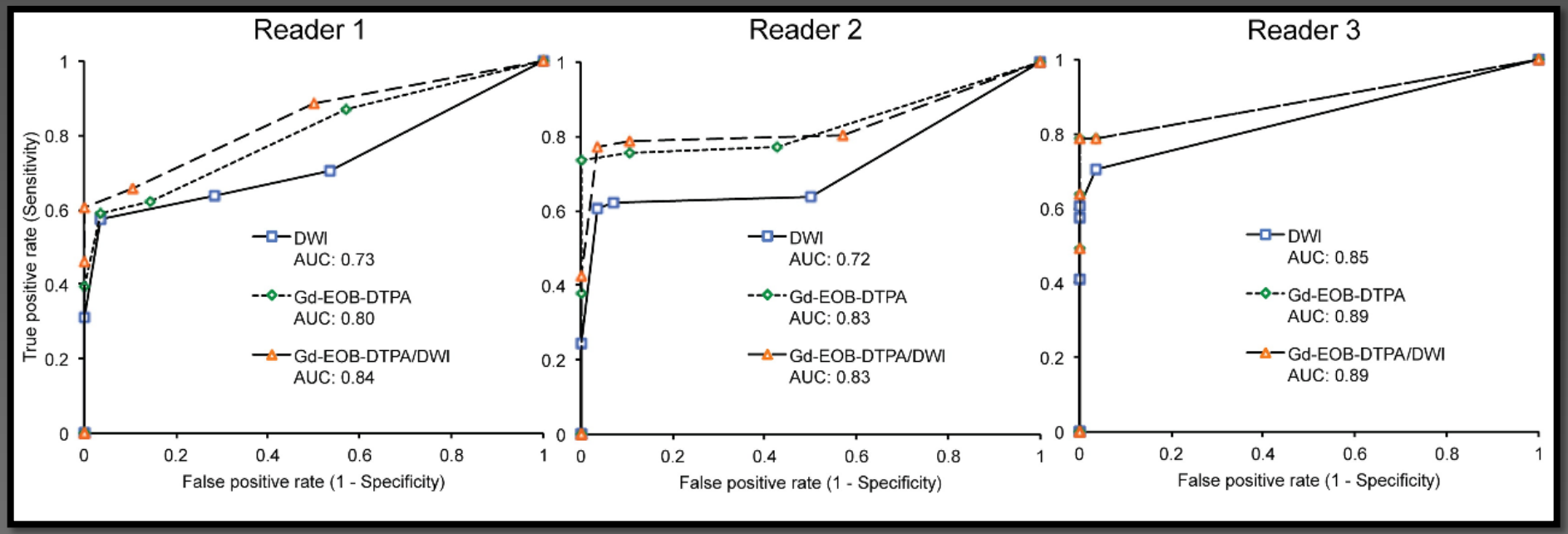


Diffusion



…the ADC map

Diffusion MRI and lesion detection



Donati, EJR 2013

World Journal of Gastroenterology

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ISSN 1007-9327 (print) ISSN 2219-2840 (online)

ORIGINAL ARTICLE

Observational Study

Predicting liver metastasis of gastrointestinal tract cancer by diffusion-weighted imaging of apparent diffusion coefficient values

De-Xian Zheng, Shu-Chun Meng, Qing-Jun Liu, Chuan-Ting Li, Xi-Dan Shang, Yu-Seng Zhu, Tian-Jun Bai, Shi-Ming Xu

- n=86 pts, 156 lesions
- Gastrointestinal metastases undergoing chemotherapy
- Comparator: tumor size at 2 and 12 weeks

Zheng DX WJG 2016

Table 1 Comparison of clinical data between the effective and ineffective groups

Groups	Average age (yr)	Maximum tumor diameter (cm)		
		Before treatment	After 2 wk of treatment	After 12 wk of treatment
Effective group (n = 73)	57.7 ± 5.9	3.45 ± 0.81	3.29 ± 0.75	1.87 ± 0.38
Ineffective group (n = 83)	59.6 ± 6.2	3.62 ± 0.85	3.47 ± 0.88	3.45 ± 0.62
t value	1.953	1.274	1.365	18.874
P value	0.053	0.205	0.174	0

Table 2 Changes in apparent diffusion coefficient values before and after chemotherapy treatment between the effective and ineffective groups

Groups	Before treatment	After 2 wk of treatment	After 12 wk of treatment	After 2 wk of treatment		After 12 wk of treatment	
				t value	P value	t value	P value
Effective group	1.01 ± 0.06	1.26 ± 0.11	1.34 ± 0.18	17.047	0.000	14.86	0.000
Ineffective group	1.24 ± 0.08	1.26 ± 0.05	1.22 ± 0.17	1.931	0.055	0.97	0.334
t value	2.747	1.491	1.783	/	/	/	/
P value	0.007	0.138	0.077	/	/	/	/

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

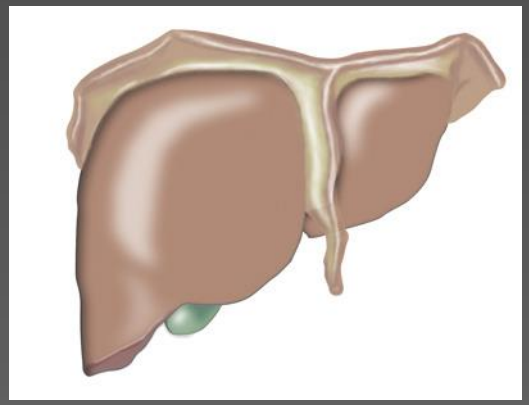
Zheng DX WJG 2016

Hepatobiliary MRI with Gadoxetate

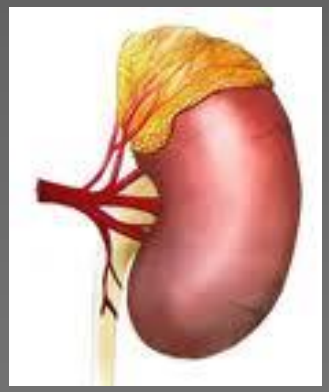
Gd-EOB-DTPA

50%

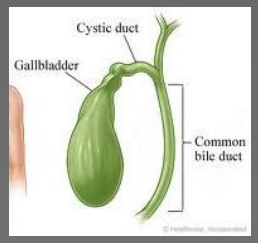
OATP



50%

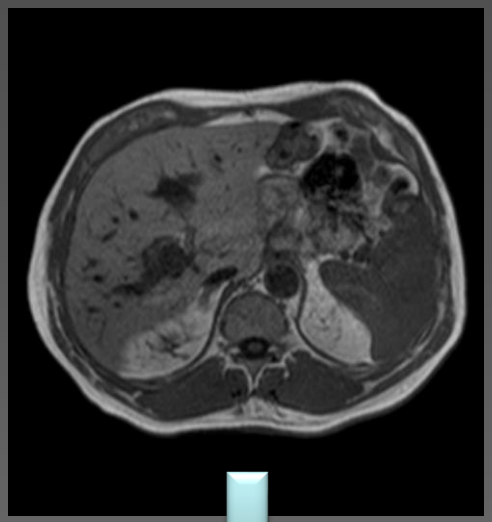


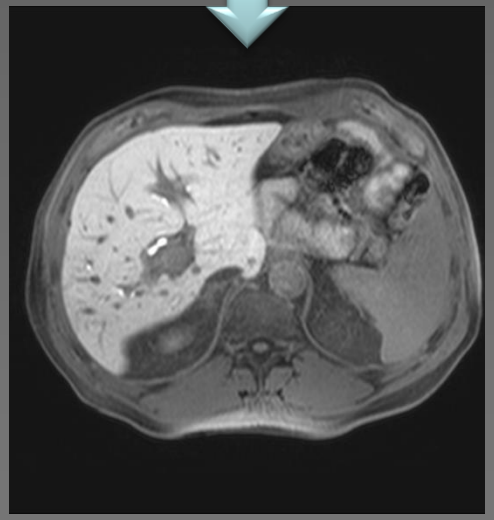
cMOAT



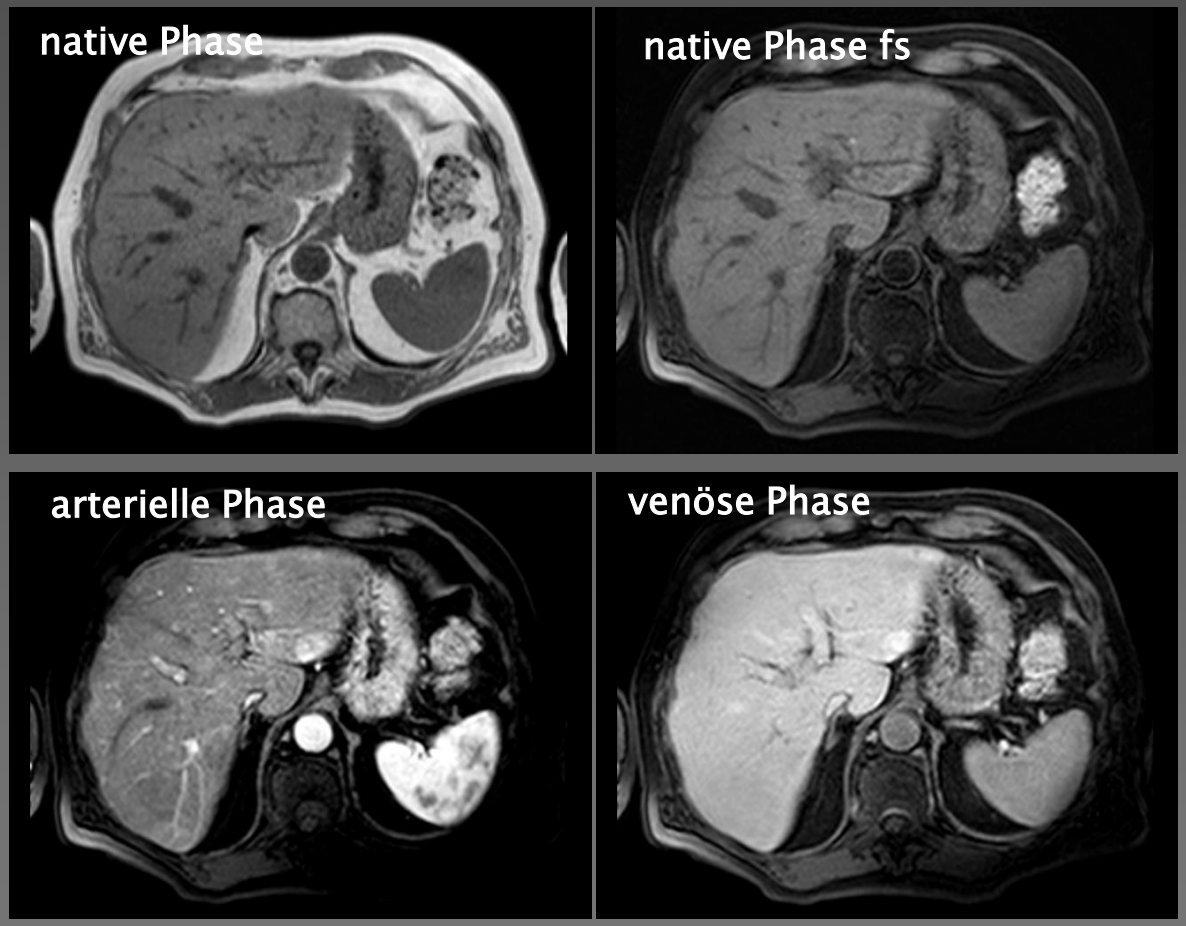
Urine

Faeces





Hepatobiliary MRI with Gadoxetate

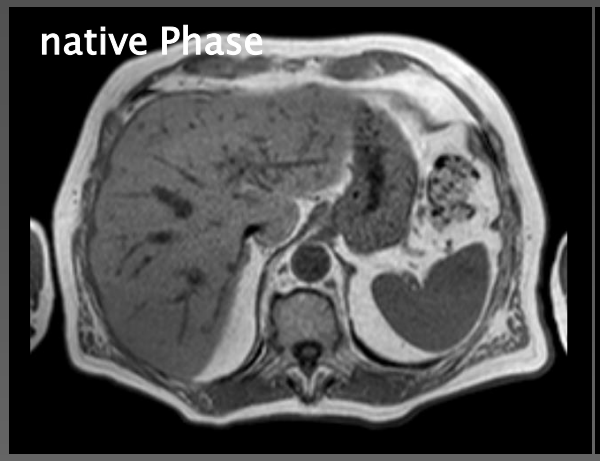


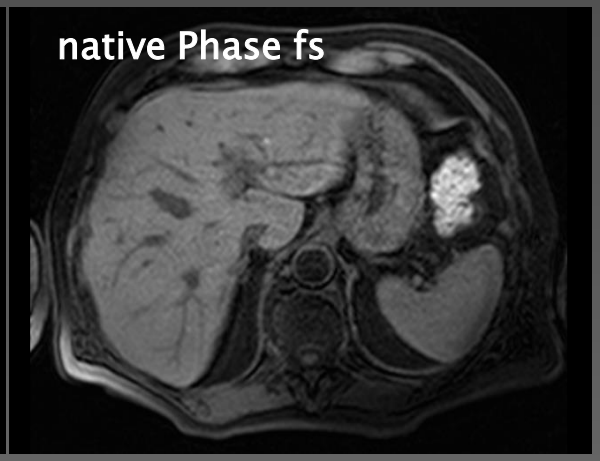
74y male

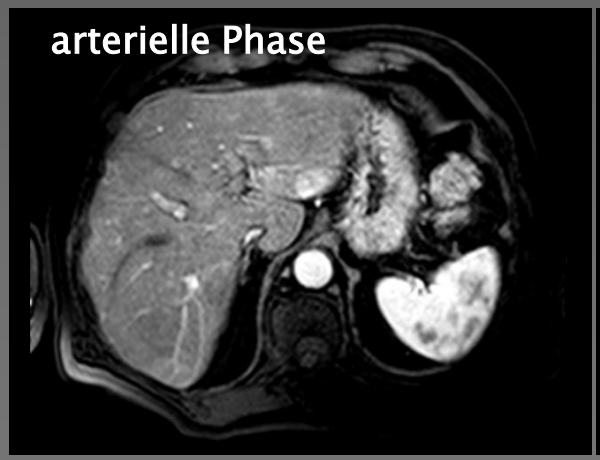
Uveal melanoma

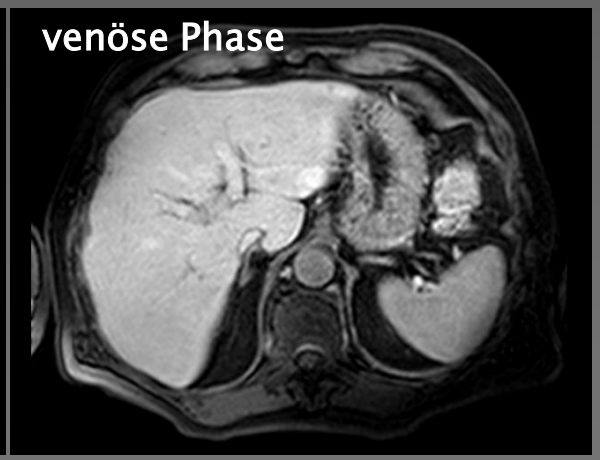
Liver mets?

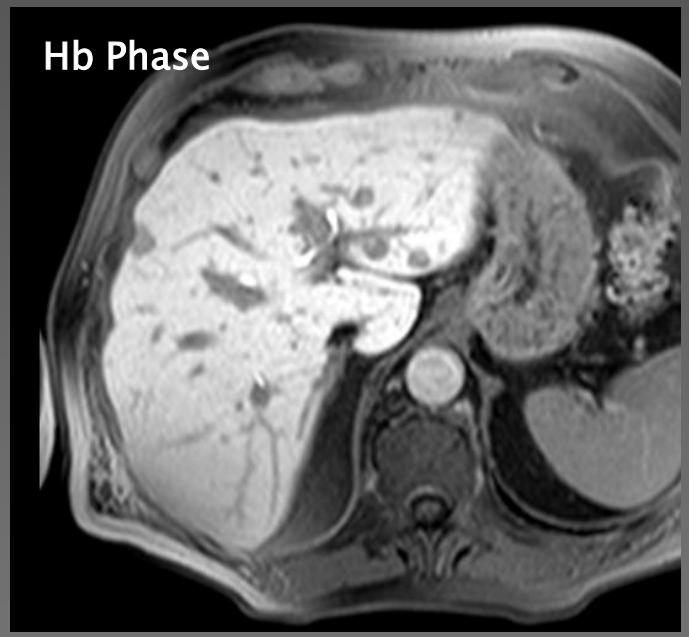
Hepatobiliary MRI with Gadoxetate











Hepatobiliary MRI with Gadoxetate

Table 5. Diagnostic Performance for Detection of Liver Metastases Equal to or Less than 1 cm in Diameter

Statistic and Reader	Lesion-by-Lesion Analysis: Lesions ≤ 10 mm			*P*-Value		
	CT[a]	Dynamic MRI Set[b]	Combined HBP Set[c]	a vs. b	a vs. c	b vs. c
JAFROC FOM*						
Reader 1	0.461 (0.333, 0.589)	0.757 (0.669, 0.846)	0.878 (0.800, 0.954)	< 0.0001	< 0.0001	0.01
Reader 2	0.404 (0.287, 0.521)	0.664 (0.518, 0.810)	0.777 (0.663, 0.892)	< 0.0001	< 0.0001	0.007
Sensitivity (%)†						
Reader 1	35.4 (28/79)	68.4 (54/79)	89.9 (71/79)	< 0.0001	< 0.0001	< 0.0001
Reader 2	17.7 (14/79)	53.2 (42/79)	72.2 (57/79)	< 0.0001	< 0.0001	< 0.0001
Specificity (%)†						
Reader 1	75.7 (56/74)	91.9 (68/74)	75.7 (56/74)	0.02	1	0.002
Reader 2	90.5 (67/74)	82.4 (61/74)	79.7 (59/74)	0.18	0.06	0.5

Lee, KJR 2013

Randomized clinical trial

Randomized multicentre trial of gadoxetic acid-enhanced MRI *versus* conventional MRI or CT in the staging of colorectal cancer liver metastases

C. J. Zech[1,3], P. Korpraphong[4], A. Huppertz[2], T. Denecke[2], M.-J. Kim[6], W. Tanomkiat[5], E. Jonas[7] and A. Ba-Ssalamah[8] on behalf of the VALUE study group

HEPATOBILIARY-PANCREAS

Cost evaluation of gadoxetic acid-enhanced magnetic resonance imaging in the diagnosis of colorectal-cancer metastasis in the liver: Results from the VALUE Trial

Christoph J. Zech[1] · Nahila Justo[2] · Andrea Lang[2] · Ahmed Ba-Ssalamah[3] · Myeong-Jin Kim[4] · Harald Rinde[5] · Eduard Jonas[6]

Zech C BJS 2014; 101 Zech C Eur Radiol. 2016 Feb 24.

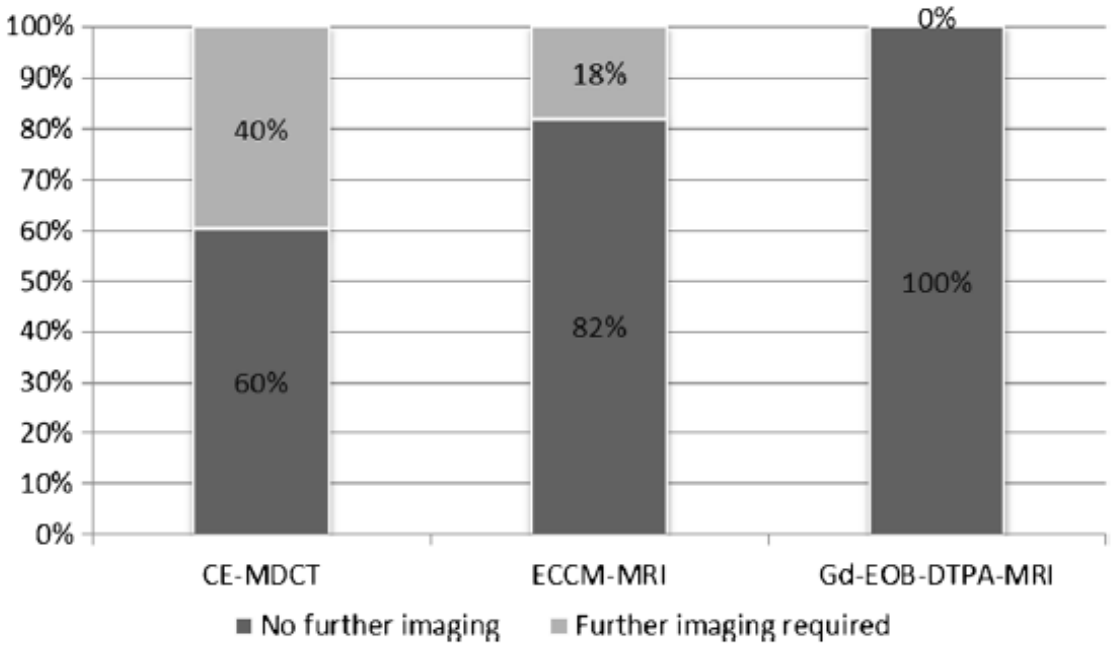


Fig. 3 Further imaging required, percentage of patients

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Zech C BJS 2014; 101 Zech C Eur Radiol. 2016 Feb 24.

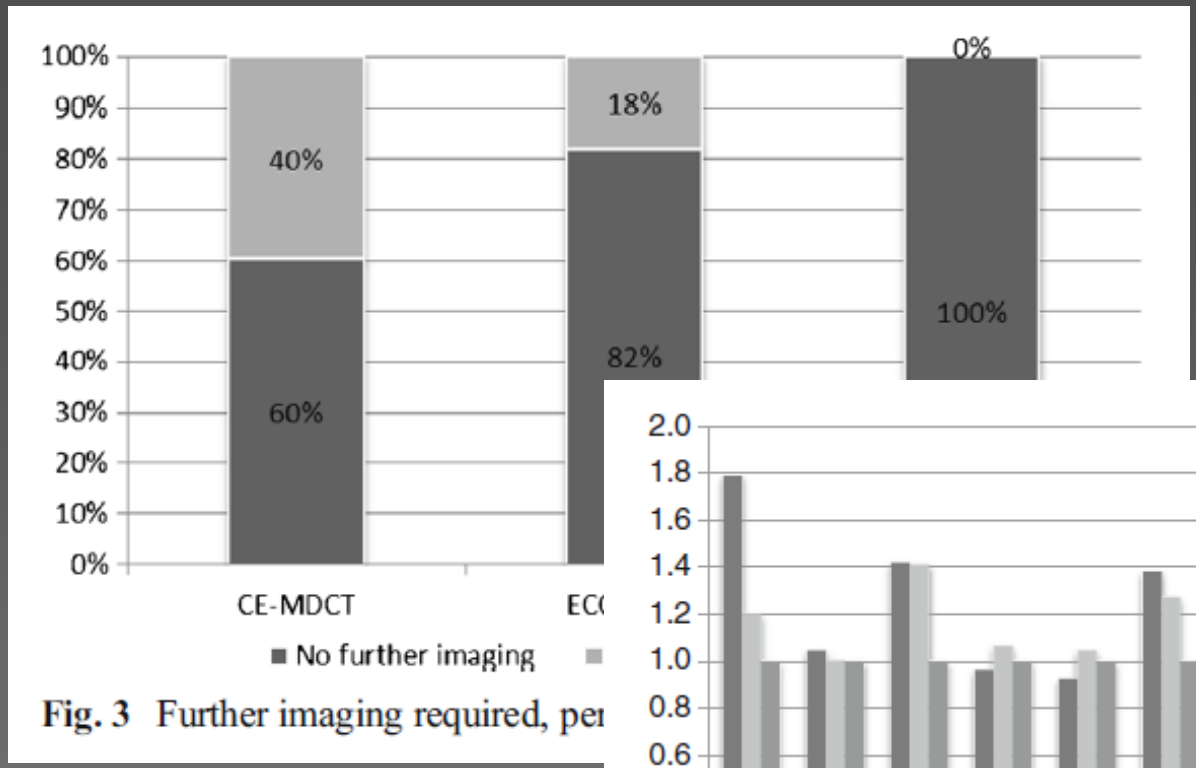


Fig. 3 Further imaging required, per

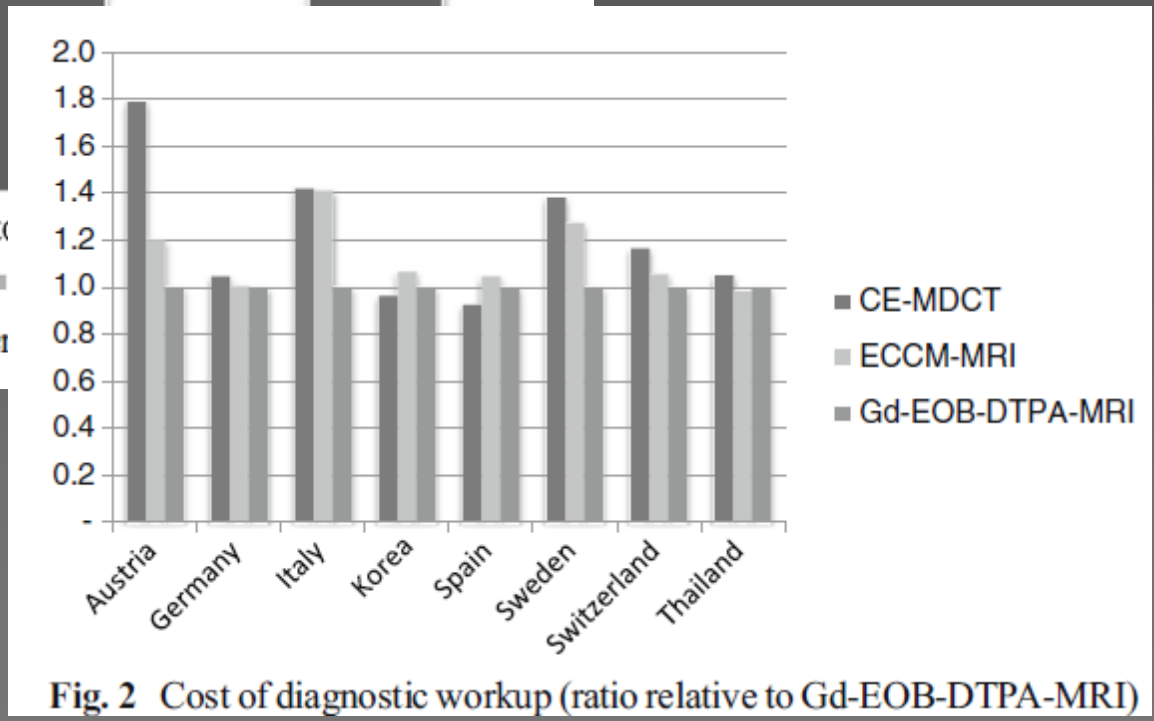
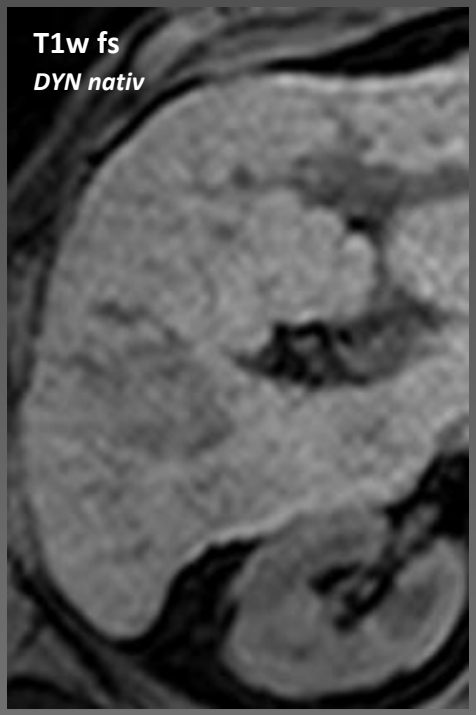
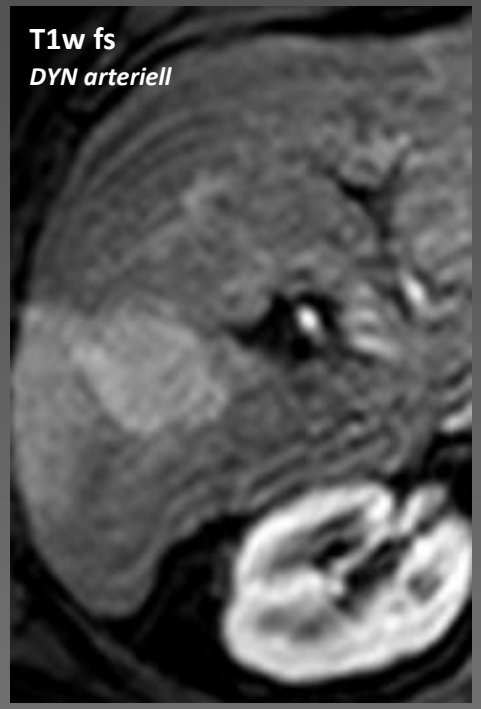


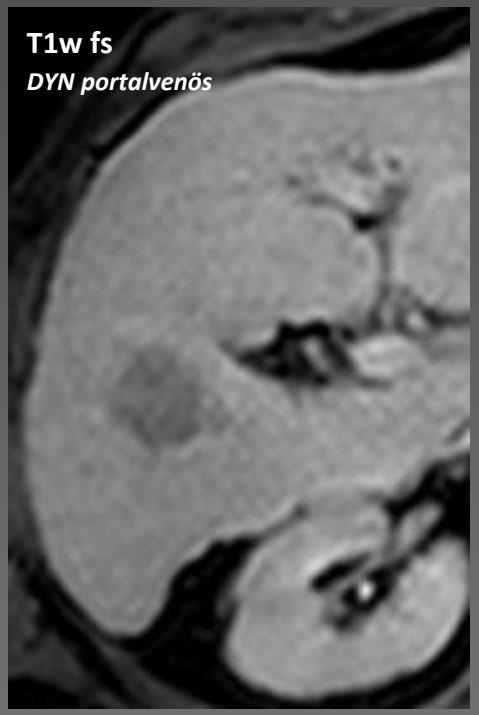
Fig. 2 Cost of diagnostic workup (ratio relative to Gd-EOB-DTPA-MRI)

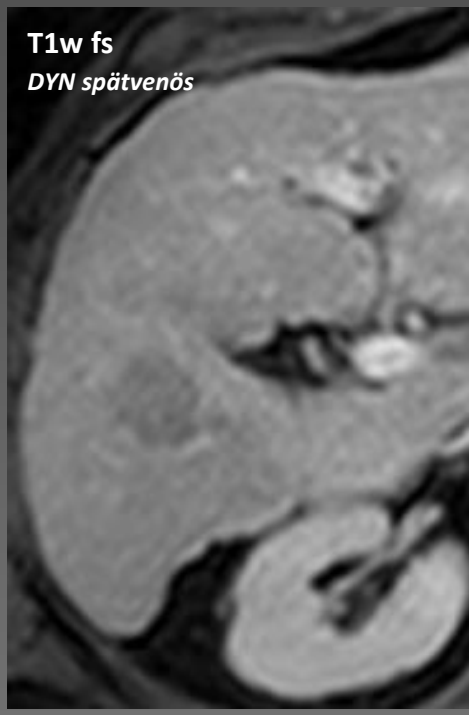
Zech C BJS 2014; 101 Zech C Eur Radiol. 2016 Feb 24.

Liver cirrhosis and HCC









arterial CM ⇧ venous CM

= washout

EASL-EORTC guidelines J Hepatol 2012

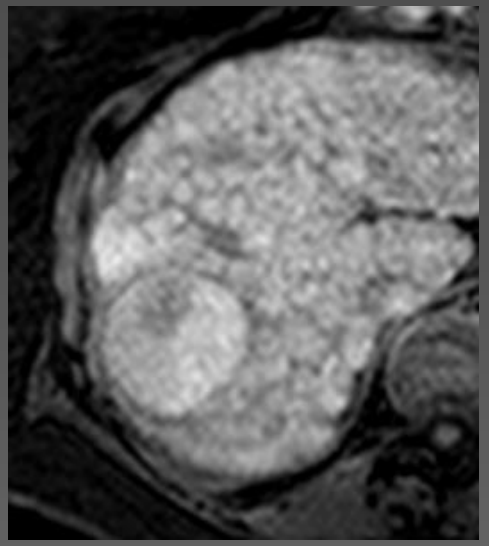
Liver cirrhosis and HCC

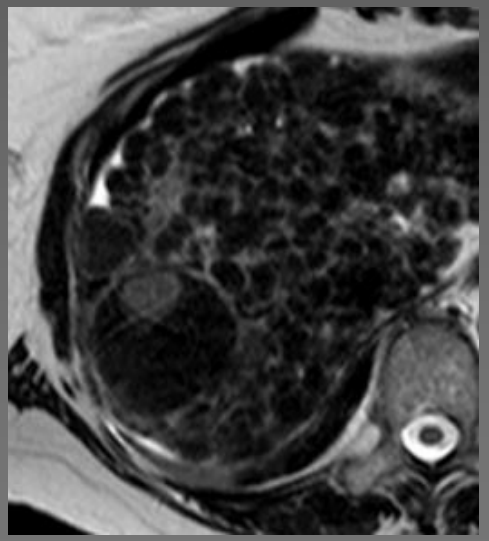
Regenerative nodule

Cirrhosis

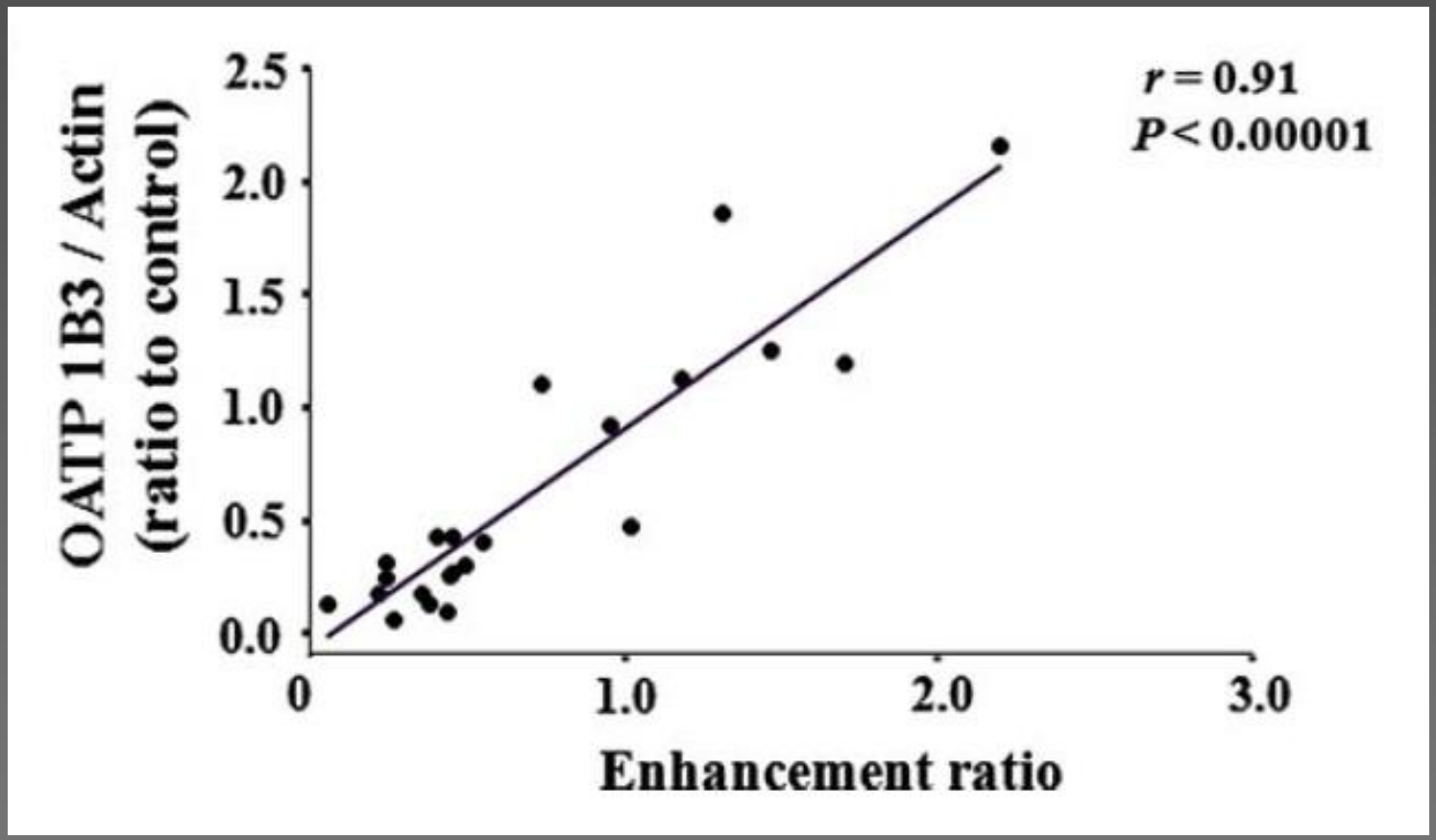
Dysplastic nodule

Overt HCC



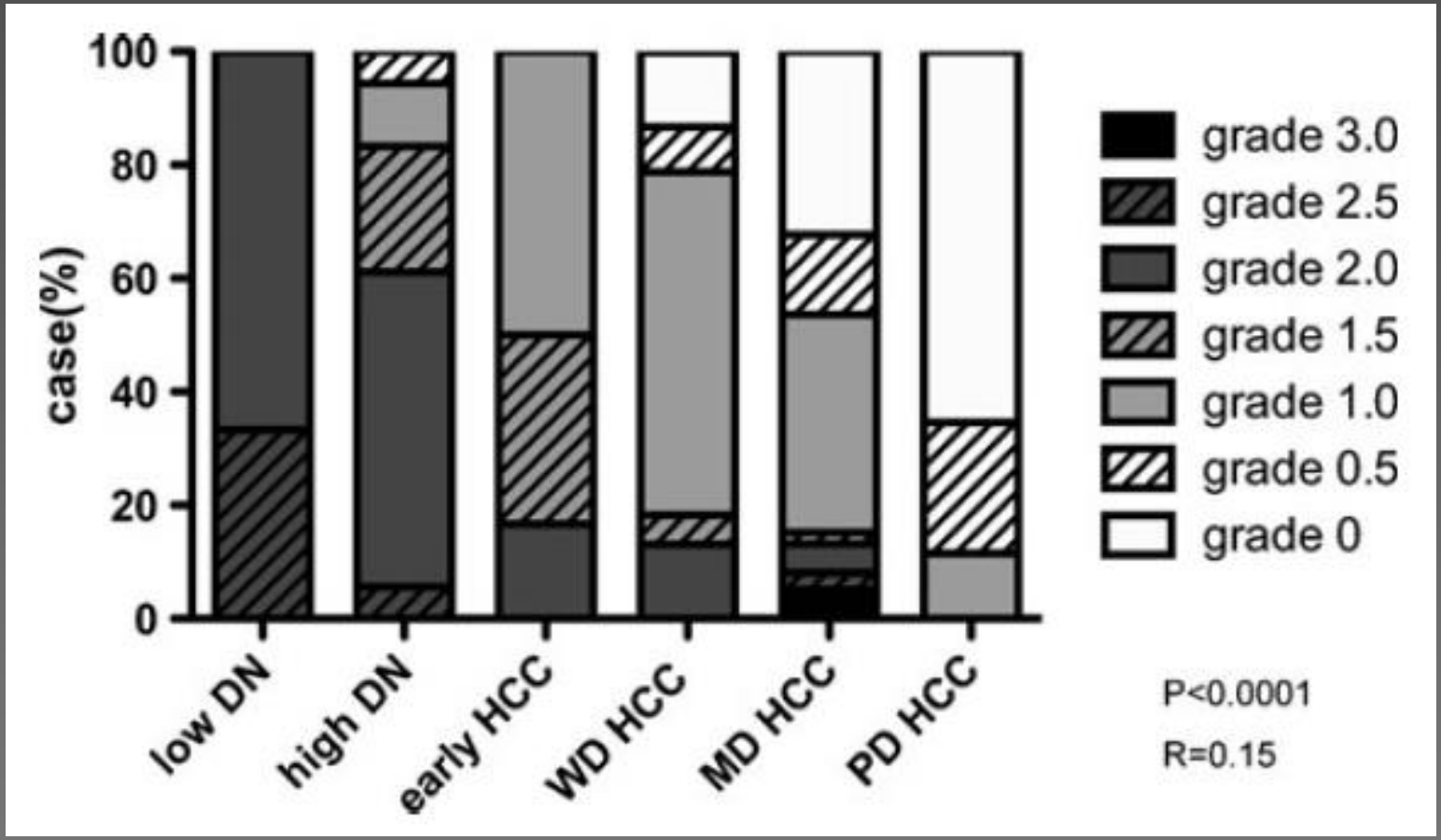


OATP 1B3 and EOB-DTPA (Gadoxetate)



Narita M et al. J Gastroenterol 2009

OATP 1B3 (8) & hepatocarcinogenesis



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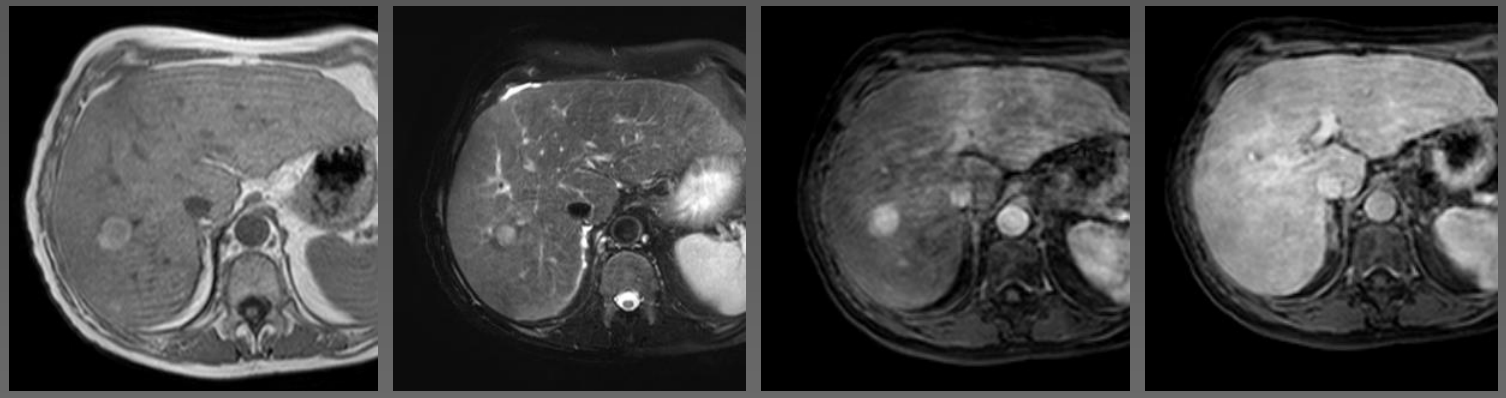
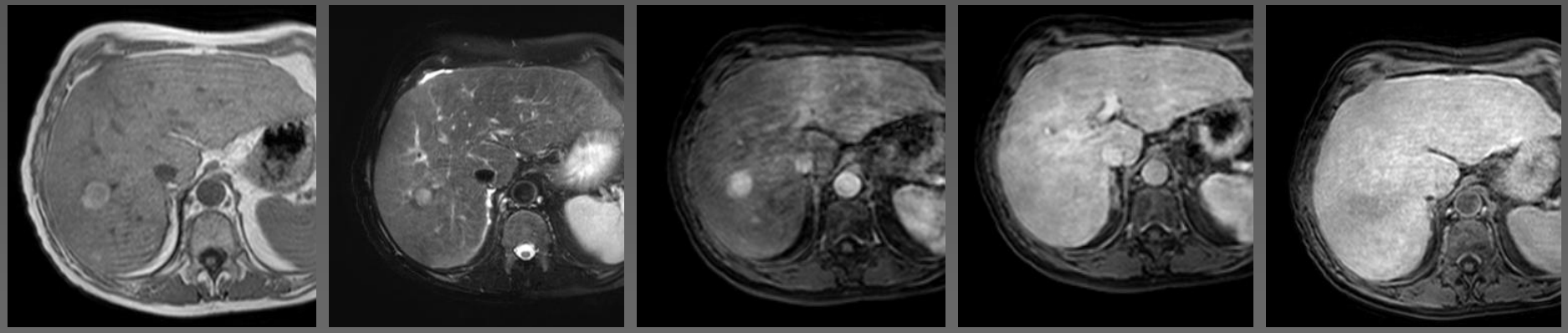
Kitaro A et al. Eur Radiol 2011

Transition from HGDN to small HCC



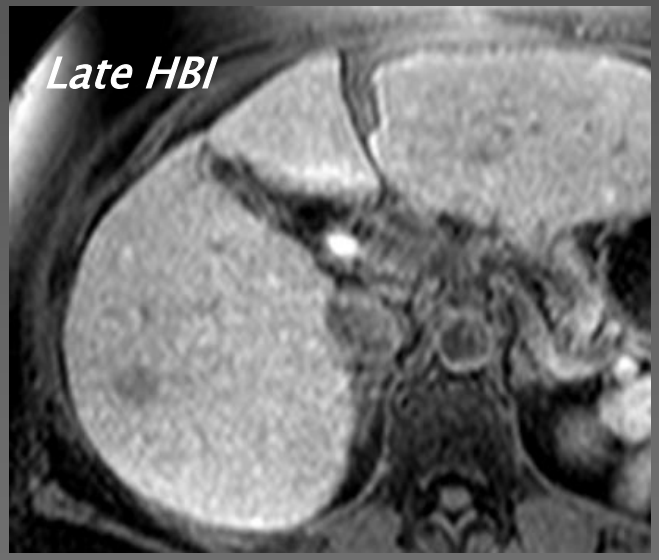
- Steatosis due to hypoxia in plain imaging
- Arterial wash-in, *no* wash-out

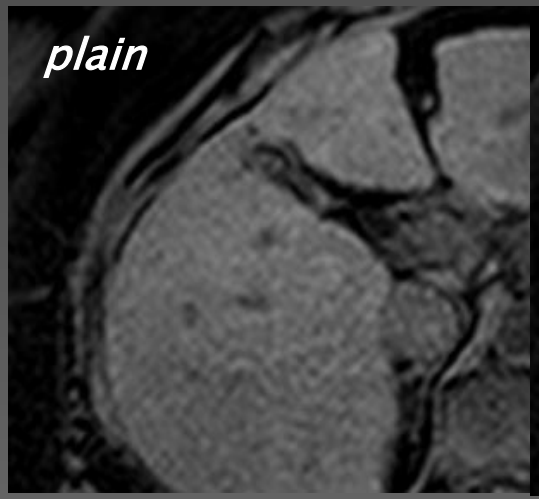
Transition from HGDN to small HCC

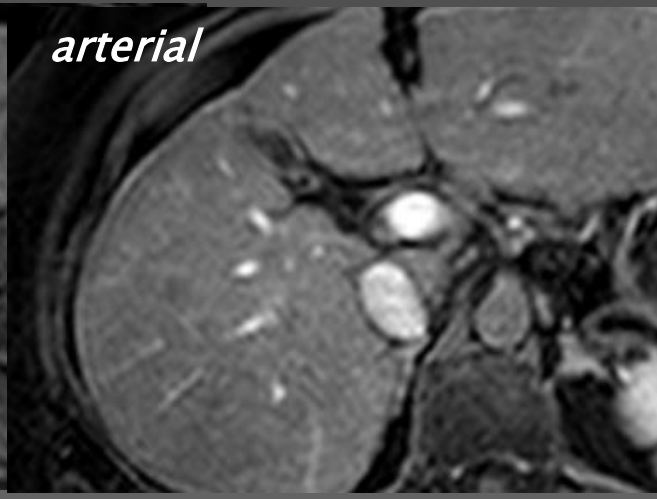


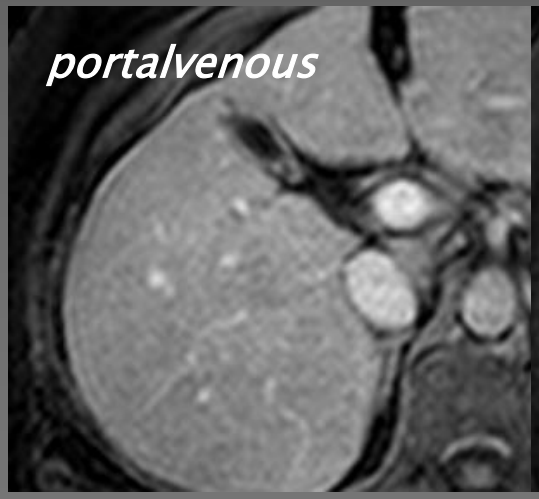
- Steatosis due to hypoxia in plain imaging
- Arterial wash-in, *no* wash-out
- Discrete loss of EOB-DTPA uptake

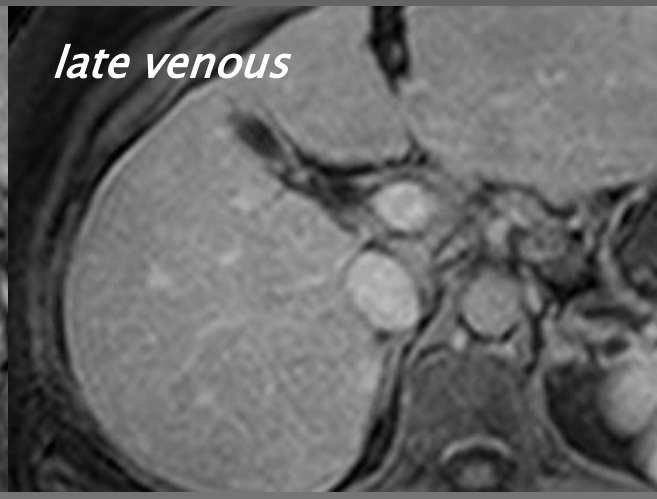
The problem: hypoperfused HCC*











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* up to 39% of HCC nodules 1-2cm acc. Bolondi Hepatology 2005

AJR FOCUS ON:

Evolution of Hypointense Hepatocellular Nodules Observed Only in the Hepatobiliary Phase of Gadoxetate Disodium–Enhanced MRI

Takashi Kumada[1]
Hidenori Toyoda[1]
Toshifumi Tada[1]
Yasuhiro Sone[2]
Masashi Fujimori[2]
Sadanobu Ogawa[3]
Teruyoshi Ishikawa[3]

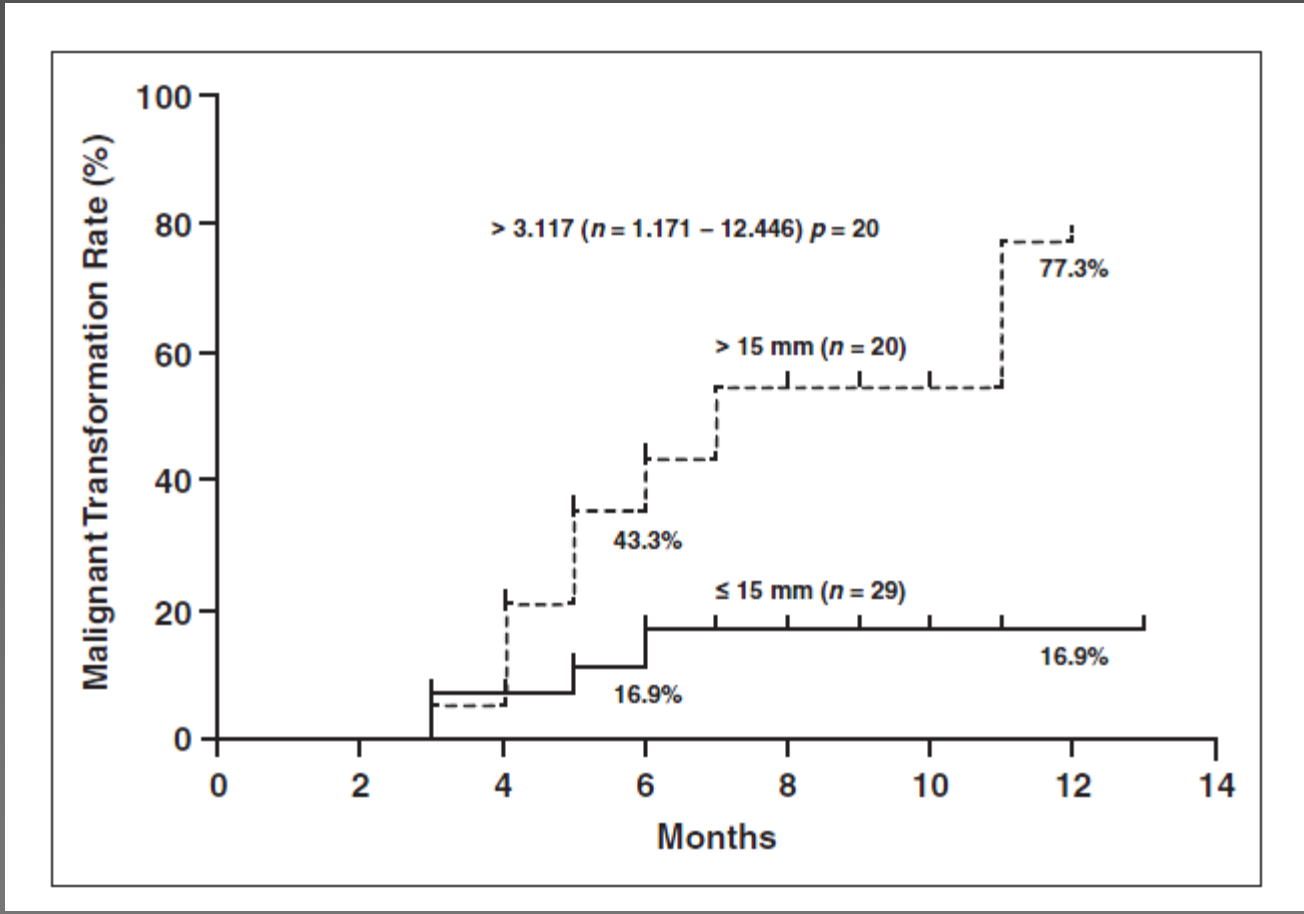
OBJECTIVE. We sought to determine whether hypointense hepatocellular nodules observed in the hepatobiliary phase of MRI enhanced with gadolinium–ethoxybenzyl–diethylenetriamine pentaacetic acid (gadoxetate disodium) progress to hypervascular hepatocellular carcinoma.

MATERIALS AND METHODS. Gadoxetate disodium–enhanced MRI was repeated for 30 patients with 49 nodules determined to be hypointense in the hepatobiliary phase but nonenhancing in the arterial phase of dynamic MRI. The correlation between characteristics of hypointense nodules with slightly or markedly low signal intensity relative to surrounding liver parenchyma and their progression to hypervascular hepatocellular carcinoma was analyzed in cirrhotic livers. All patients underwent angiography-assisted CT before MRI. The rate of progression to classic hepatocellular carcinoma was calculated by the Kaplan-Meier method.

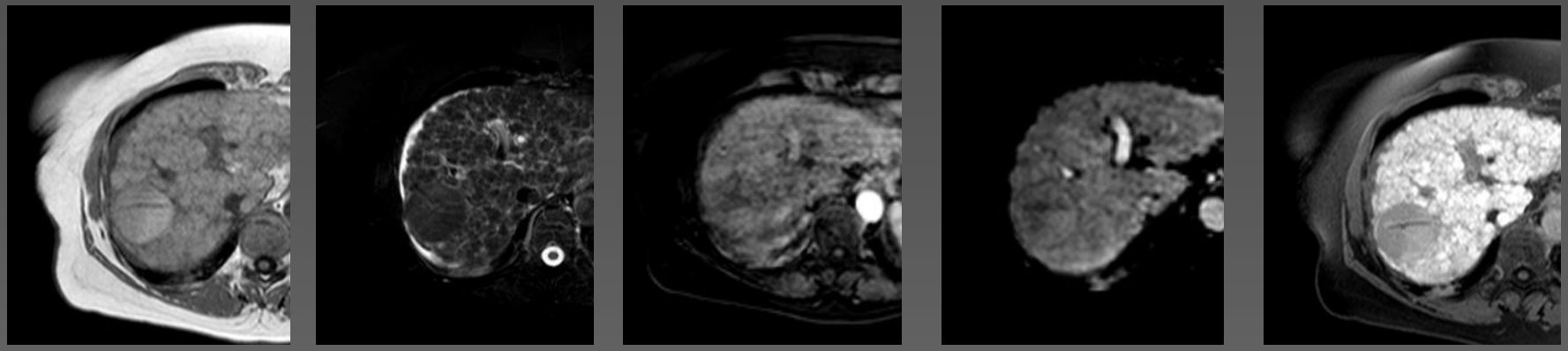
Kumada AJR 2011; 197: 58-63

Malignant transformation rate acc. to lesion size

*n=49 lesions visible in late venous or HBI MRI



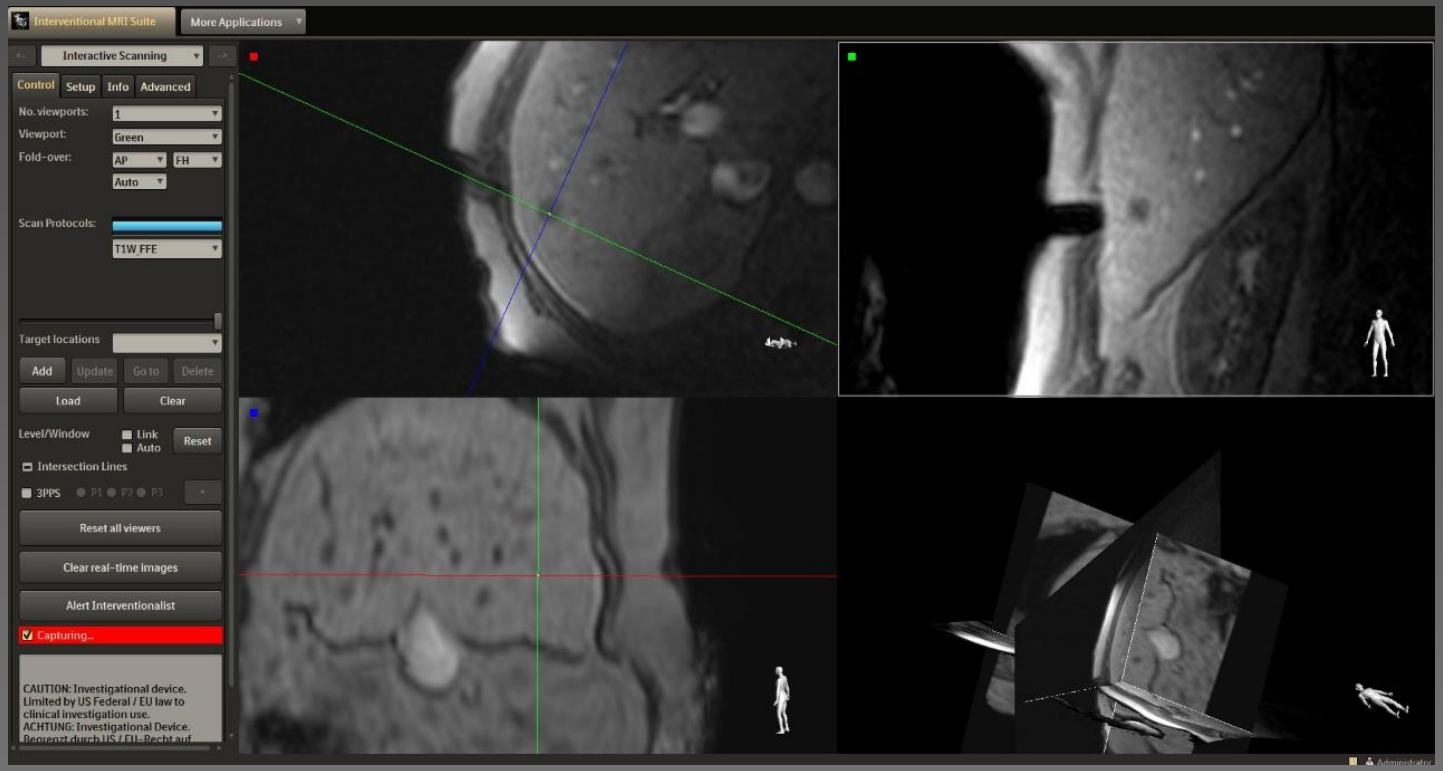
Kumada AJR 2011; 197: 58-63



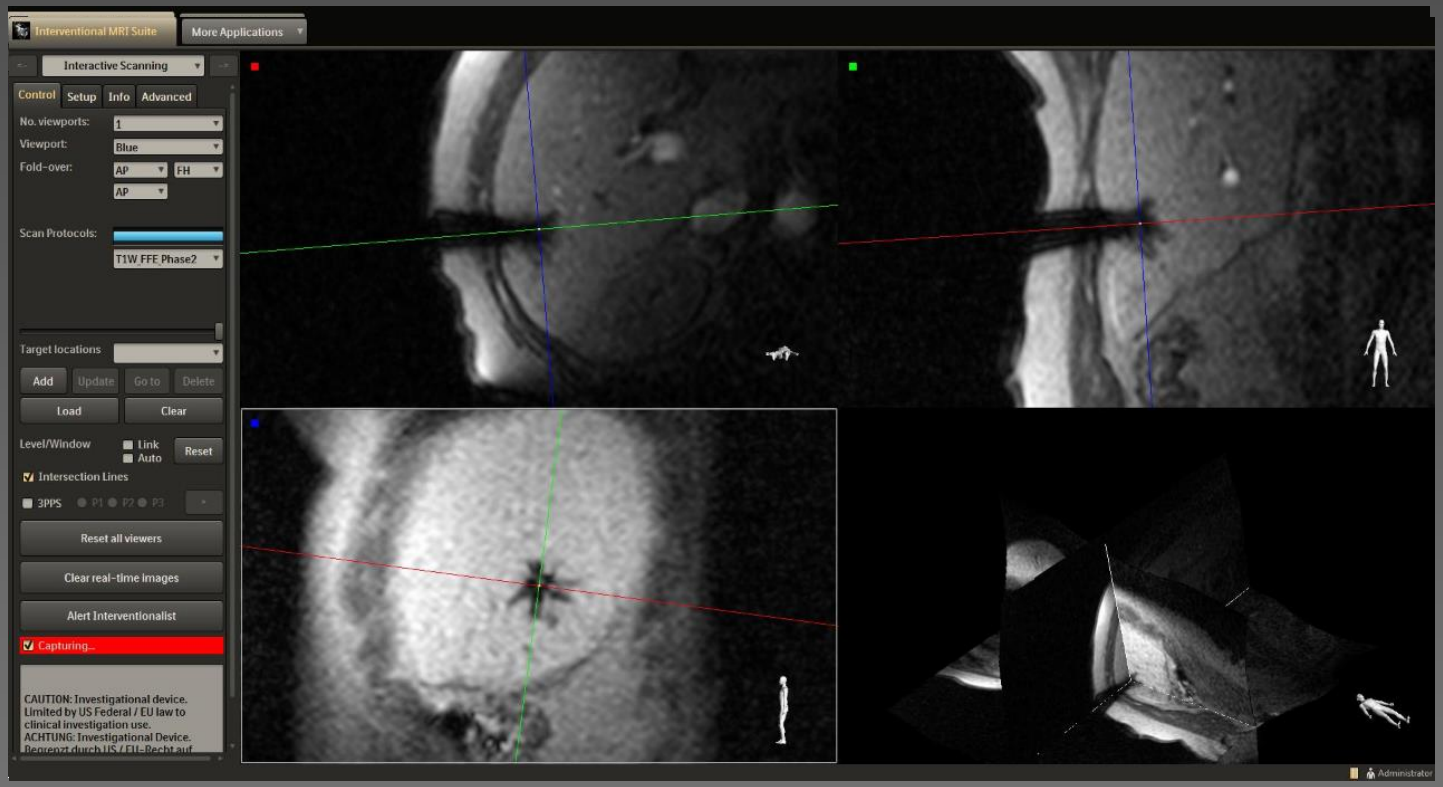
Biopsy: high grade dysplastic nodule

Resection: large islets of HCC in HGDN

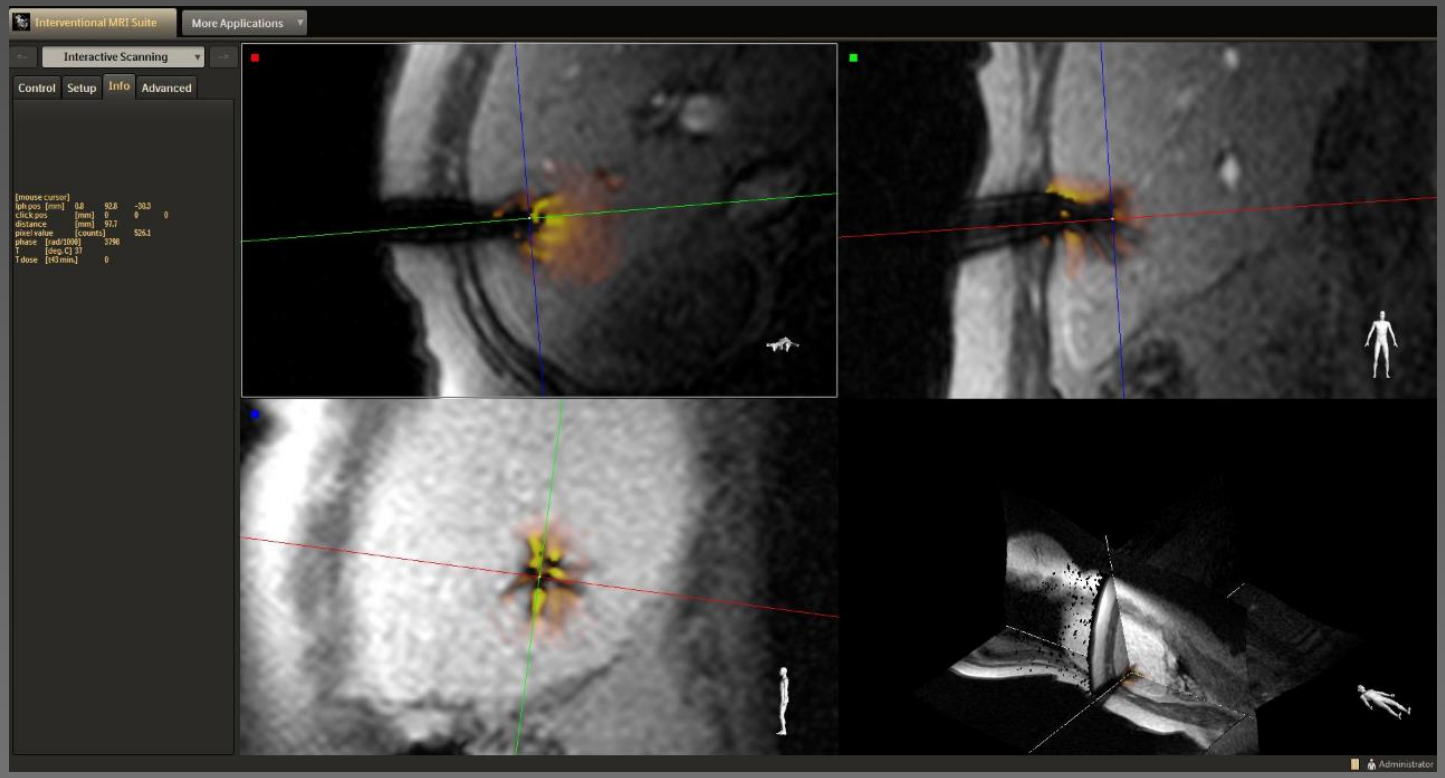
RFA under MR fluoroscopy



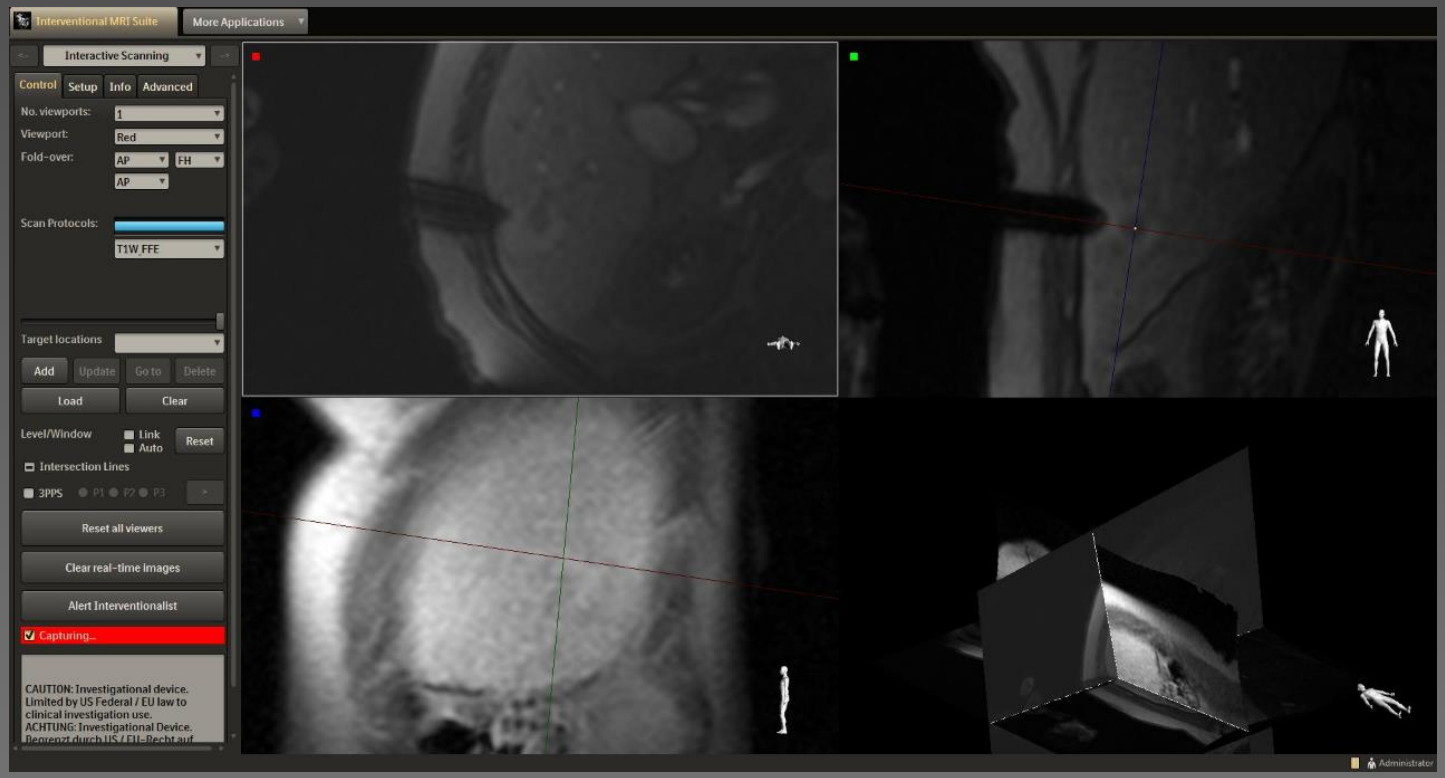
RFA under MR fluoroscopy



RFA under MR fluoroscopy



RFA under MR fluoroscopy



MICRON study: RCT MRI vs CT guidance for mCRC; current accrual: 180 lesions

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

Wybranski Radiation Oncol 2015,
Fischbach CVIR 2013, Will Proc. IEEE 2010

Take home

- MRI (incl. DWI and HBI with Gadoxetate) is superior for lesion detection and characterization
- Diffusion MR: strong potential for therapy monitoring
  - Insist on applying DW-MRI in RCTs of systemic chemo!
- Hepatobiliary imaging of hepatocarcinogensis offers new options for therapeutic guidance in HCC
- MRI is the future of *interventional* oncology