

# 高弛豫率对比剂（莫迪司）在肝脏增强扫描中的应用优势

福建医科大学附属第一医院影像科  
曹代荣

# MR肝脏增强钆剂分类

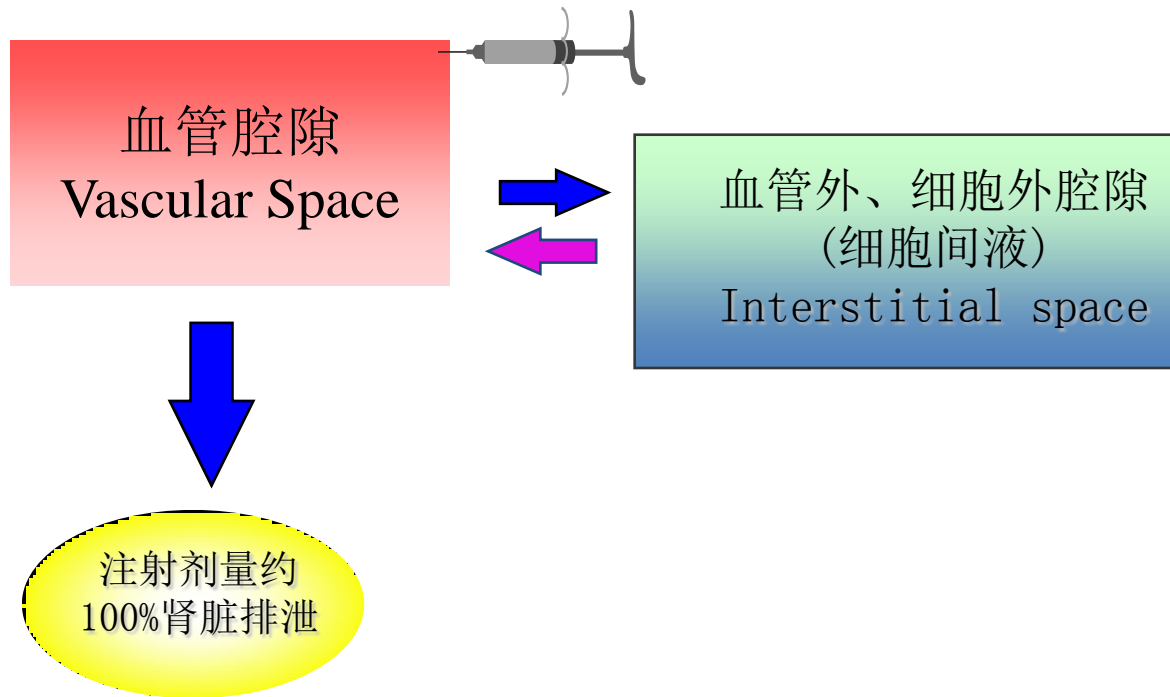
- 细胞外液钆剂

钆贝葡胺（莫迪司）、钆喷酸葡胺（马根维显）、钆双胺（欧乃影）、钆特酸葡胺（多它灵）、钆布醇（加乐显）和钆特醇（普海司）

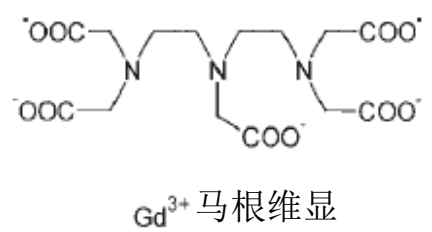
- 肝特异性钆剂

钆贝葡胺（莫迪司）、钆塞酸二钠（普美显）

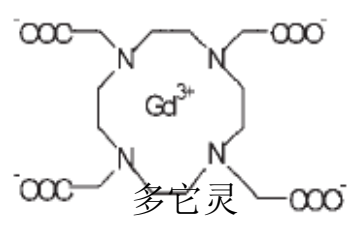
# 细胞外钆剂的药代动力学



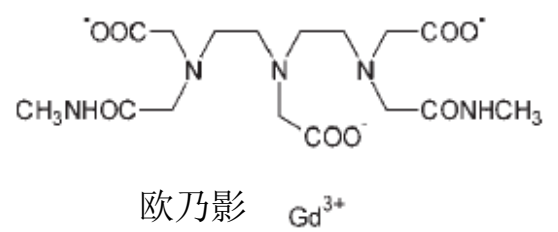
# 钆剂分子结构不同---弛豫率差异:



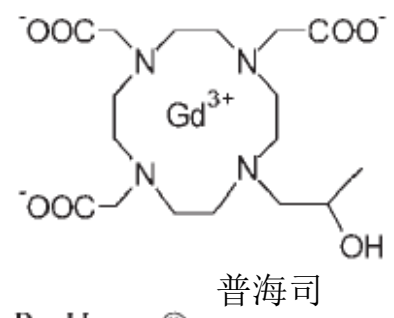
Magnevist®  
Gd-DTPA



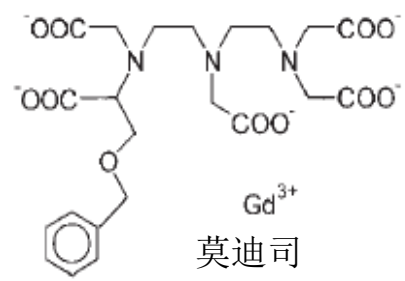
Dotarem®  
Gd-DOTA



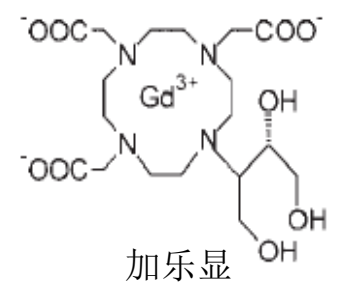
Omniscan®  
Gd-DTPA-BMA



ProHance®  
Gd-HP-DO3A



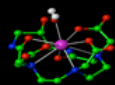
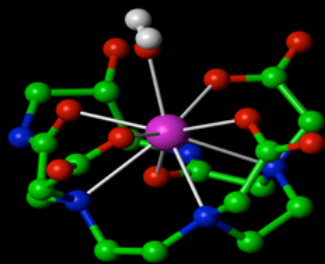
MultiHance®  
Gd-BOPTA



Gadovist®  
Gd-DO3A-butrol

# 莫迪司---弱/瞬时与蛋白相互作用

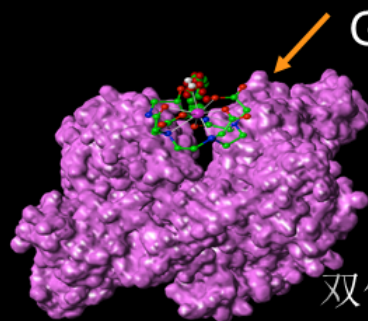
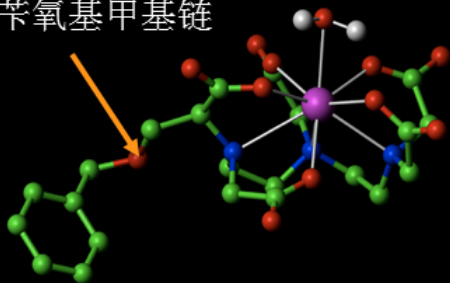
常规钆剂



$Gd^{+3}$  &  $H_2O$

莫迪司

苄氧基甲基链



$Gd^{+3}$  &  $H_2O$  & 蛋白

双倍增加弛豫率 ( $r_1$ 、 $r_2$ )

弱/瞬时与蛋白相互作用

## 钆对比剂---弛豫率

商品名	化学名	r1 (1.5 T)	r1 (3.0T)	浓度	批准剂量
马根维显	Gd-DTPA 钆喷酸葡胺	4.25	3.76	0.5M	0.1mmol/kg
普海司	Gd-HP-DO3A 钆特醇	4.39	3.46	0.5M	0.1mmol/kg
欧乃影	Gd-DTPA-BMA 钆双胺	4.47	3.89	0.5M	0.1mmol/kg
莫迪司	Gd-BOPTA 钆贝 葡胺	6.2	5.37	0.5M	0.1mmol/kg
加乐显	Gd-BT-DO3A 钆布醇	4.6	4.46	1.0M	0.1mmol/kg
多它灵	Gd-DOTA 钆特酸	3.9	3.43	0.5M	0.1mmol/kg
普美显	Gd-EOB-DTPA 钆塞酸二钠	7.24	5.45	0.25M	0.025mmol/kg

Shen et al, Invest Radiol 2015; 50(5):330-8

# 莫迪司与欧乃影腹部增强比较研究

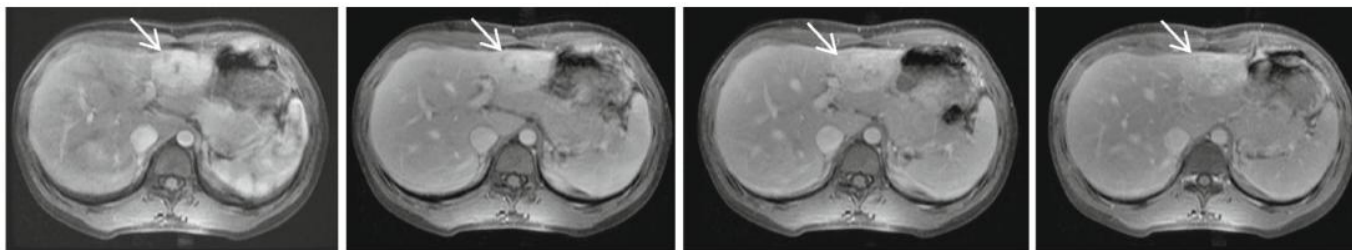
0.05mmol/kg 钆贝葡胺

20秒

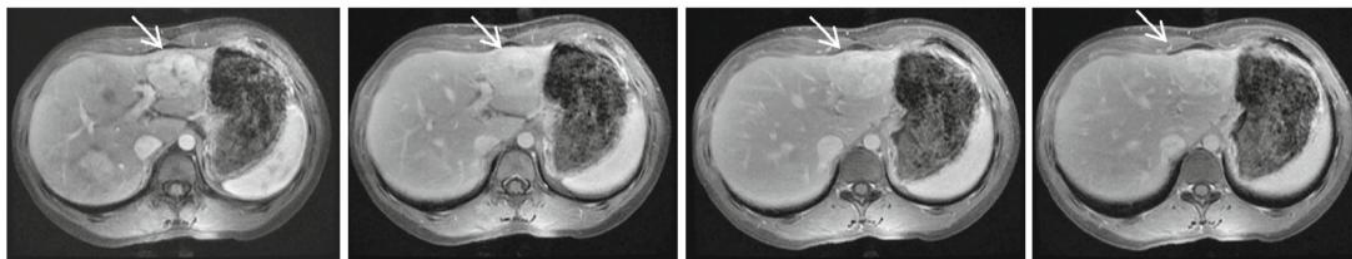
1分钟

3分钟

5分钟



半剂量钆贝葡胺和标准剂量钆双胺增强效果无差别



0.1mmol/kg 钆双胺

20秒

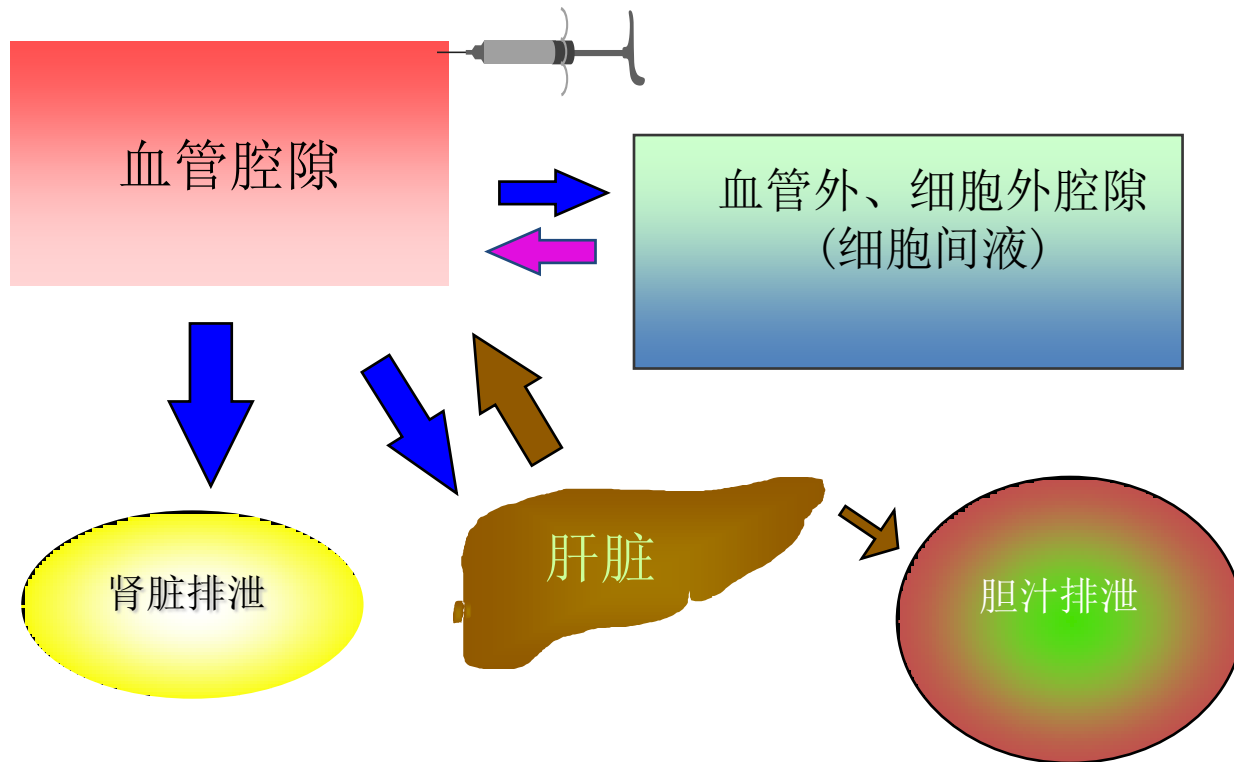
1分钟

3分钟

5分钟

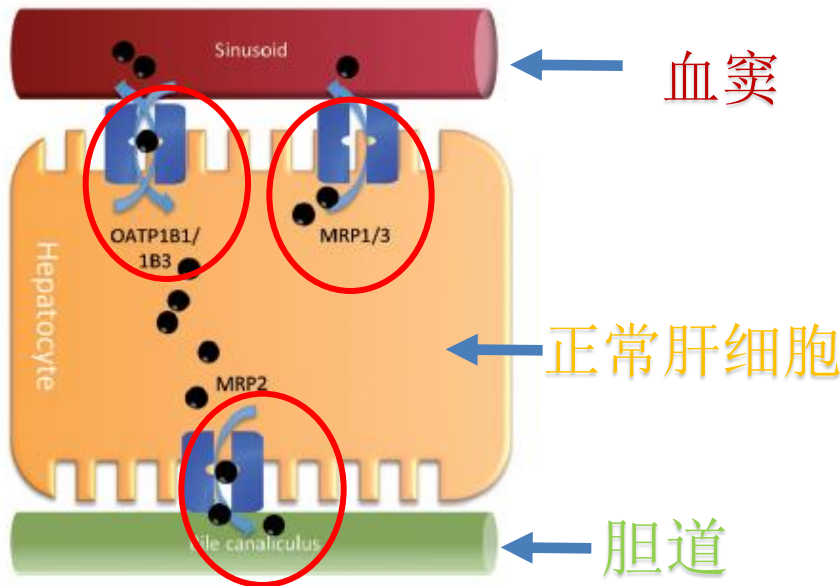
Homayoon, B et al, Abdom Imaging 2014; 39 (5): 955-62

# 肝特异性对比剂的药代动力学





# 肝胆期摄取机制



肝脏细胞内含高于胆道分泌的量

OATP1B1/1B3 (有机阴离子转运多肽)

生理: 非结合胆红素转运至肝细胞内

Gd-BOPTA和Gd-EOB-DTPA转运至肝细胞内

MRP2 (多药抑制蛋白2)

生理: 结合胆红素转运至胆管

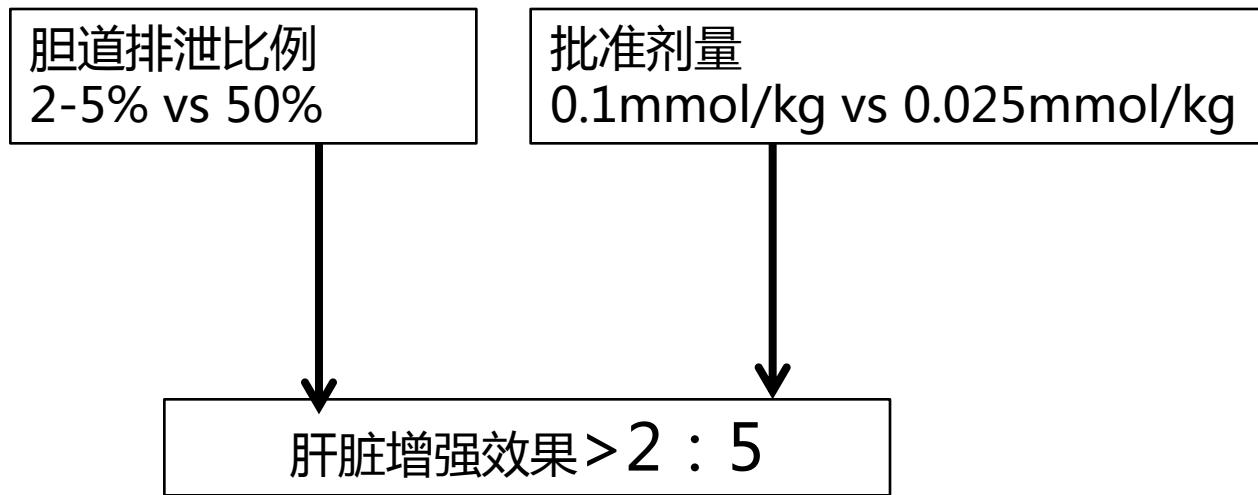
Gd-BOPTA和Gd-EOB-DTPA转运至胆道

MRP1/3 (多药抑制蛋白1/3)

生理: 结合胆红素转运回血窦

Gd-BOPTA和Gd-EOB-DTPA转运回血窦

# 钆贝葡胺（莫迪司）VS 钆塞酸二钠（普美显）



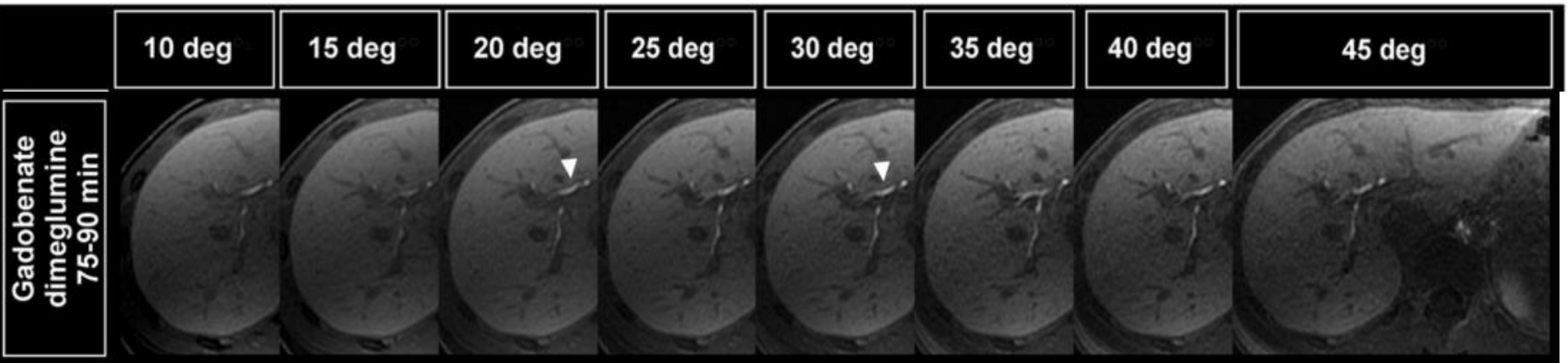
# 莫迪司与普美显比较研究

Table 1. Average signal intensity  $\pm$  1 standard deviation of the portal vein, common hepatic artery, middle hepatic vein, and liver parenchyma at the different contrast phases

Signal intensity	Native	Arterial	Portal venous	10 min	20 min	30 min	40 min	130 min
<i>Hepatic artery</i>								
Gd-BOPTA	84 $\pm$ 28	279 $\pm$ 63	259 $\pm$ 55	230 $\pm$ 47	212 $\pm$ 46	197 $\pm$ 48	190 $\pm$ 45	121 $\pm$ 35
Gd-EOB-DTPA	75 $\pm$ 14	228 $\pm$ 54	192 $\pm$ 131	114 $\pm$ 28	106 $\pm$ 27	97 $\pm$ 26	95 $\pm$ 28	79 $\pm$ 24
<i>Middle hepatic vein</i>								
Gd-BOPTA	83 $\pm$ 25	105 $\pm$ 33	352 $\pm$ 86	282 $\pm$ 64	260 $\pm$ 64	239 $\pm$ 58	226 $\pm$ 57	152 $\pm$ 46
Gd-EOB-DTPA	80 $\pm$ 24	92 $\pm$ 34	236 $\pm$ 62	131 $\pm$ 34	116 $\pm$ 38	109 $\pm$ 34	103 $\pm$ 33	97 $\pm$ 40
<i>Portal vein</i>								
Gd-BOPTA	64 $\pm$ 15	175 $\pm$ 71	305 $\pm$ 74	242 $\pm$ 49	219 $\pm$ 48	198 $\pm$ 41	187 $\pm$ 40	122 $\pm$ 36
Gd-EOB-DTPA	65 $\pm$ 17	169 $\pm$ 45	195 $\pm$ 45	115 $\pm$ 29	94 $\pm$ 20	90 $\pm$ 28	86 $\pm$ 22	73 $\pm$ 22
<i>Liver parenchyma</i>								
Gd-BOPTA 莫迪司	131 $\pm$ 24	158 $\pm$ 46	236 $\pm$ 54	234 $\pm$ 48	238 $\pm$ 50	238 $\pm$ 49	235 $\pm$ 49	226 $\pm$ 55
Gd-EOB-DTPA 普美显	130 $\pm$ 22	158 $\pm$ 35	199 $\pm$ 44	234 $\pm$ 51	242 $\pm$ 54	243 $\pm$ 51	242 $\pm$ 51	201 $\pm$ 42

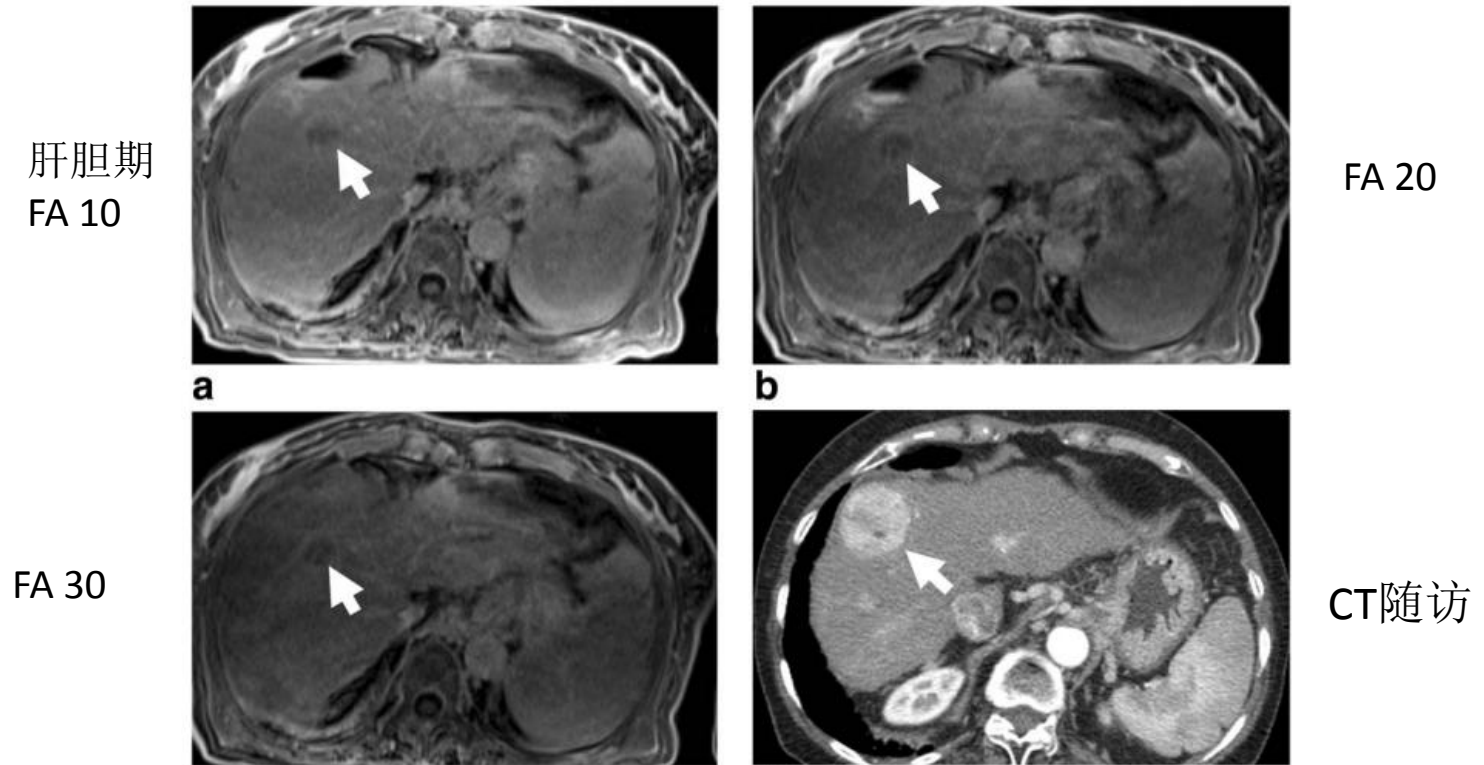
# 如何改进肝胆期成像？

- 选择合适的成像时间
- 通过增加反转角改进CNR



增加反转角有利于胆道系统显示

# 如何改进莫迪司肝胆期成像？



20° 平衡SINR和CINR有利于低信亏显示

# 扫描方案比较

## 莫迪司

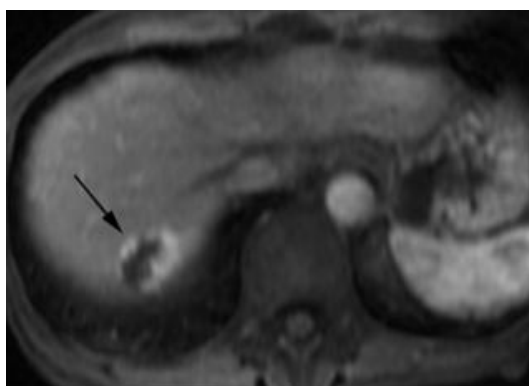
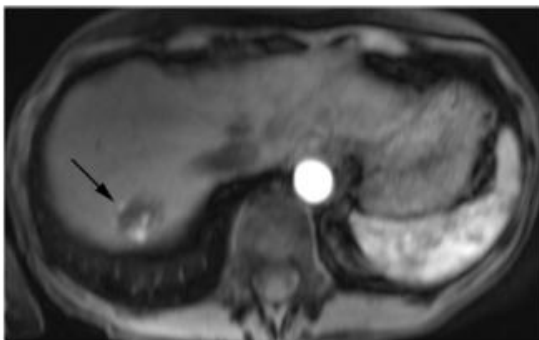
- T2W\_FS
- In Phase & Out Phase
- DWI
- T2W\_Cor
- VIBE, LAVA or e-Thrive
- 注射莫迪司
- VIBE, LAVA or e-Thrive  
(动态增强成像) 扫描时间12-15分钟  
病人下检查床休息90分钟后  
采集VIBE, LAVA 或 e-Thrive  
(肝胆期成像) 扫描时间2分钟

## 普美显

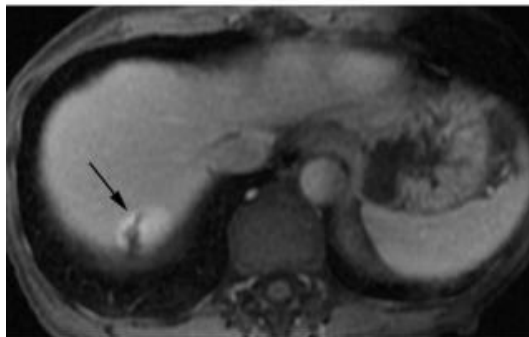
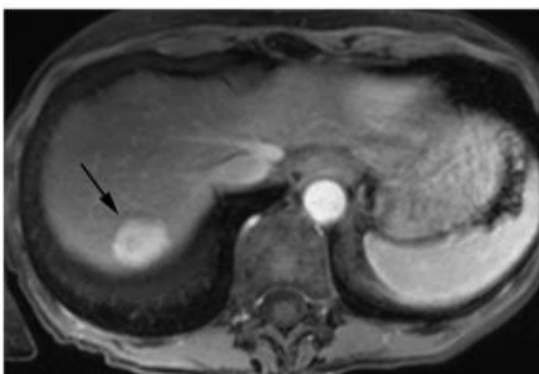
- In Phase & Out Phase
- VIBE, LAVA or e-Thrive
- 注射普美显
- 动态增强VIBE, LAVA or e-Thrive
- T2W\_FS
- DWI
- T2W\_Cor  
(动态增强成像) 扫描时间12-15分钟
- 等待至18分钟左右采集连续采集VIBE  
LAVA 或 e-Thrive  
(肝胆期成像)  
扫描时间共25分钟

## 莫迪司

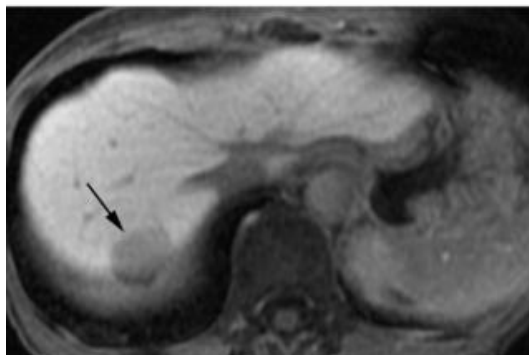
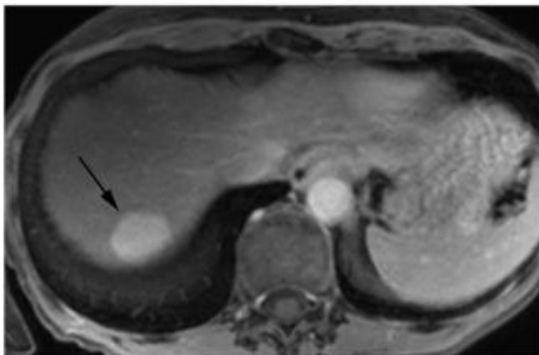
## 普美显



25秒 ✓ 血管瘤在莫迪司增强后与其它常规钆剂一样，延迟30分钟仍可见强化



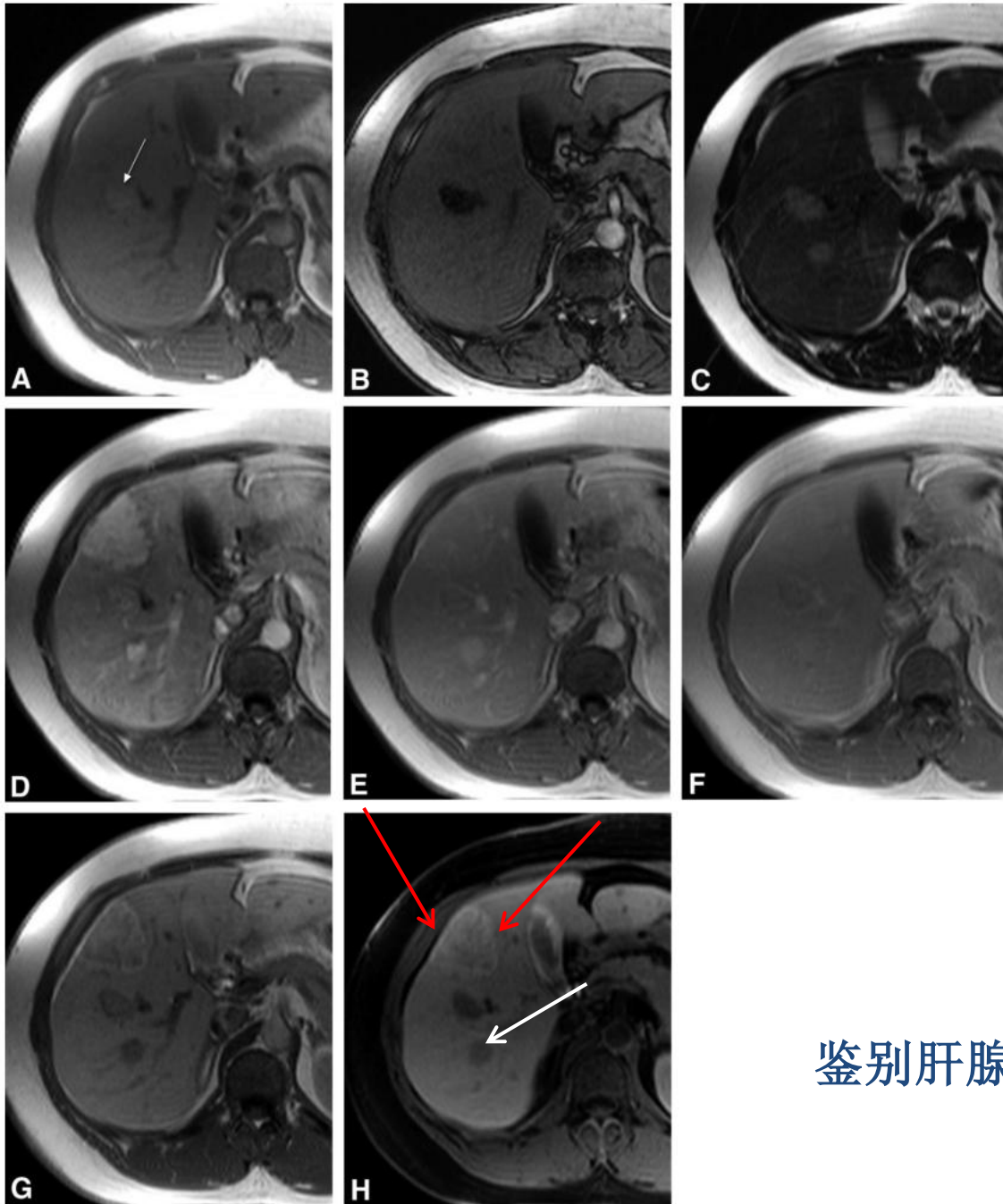
90秒 ✓ 普美显增强后延迟期与其它钆剂具有不同的药动力学；血管瘤从8分钟开始呈低信号；诊断需依靠T2WI上高信号进行鉴别



8分钟

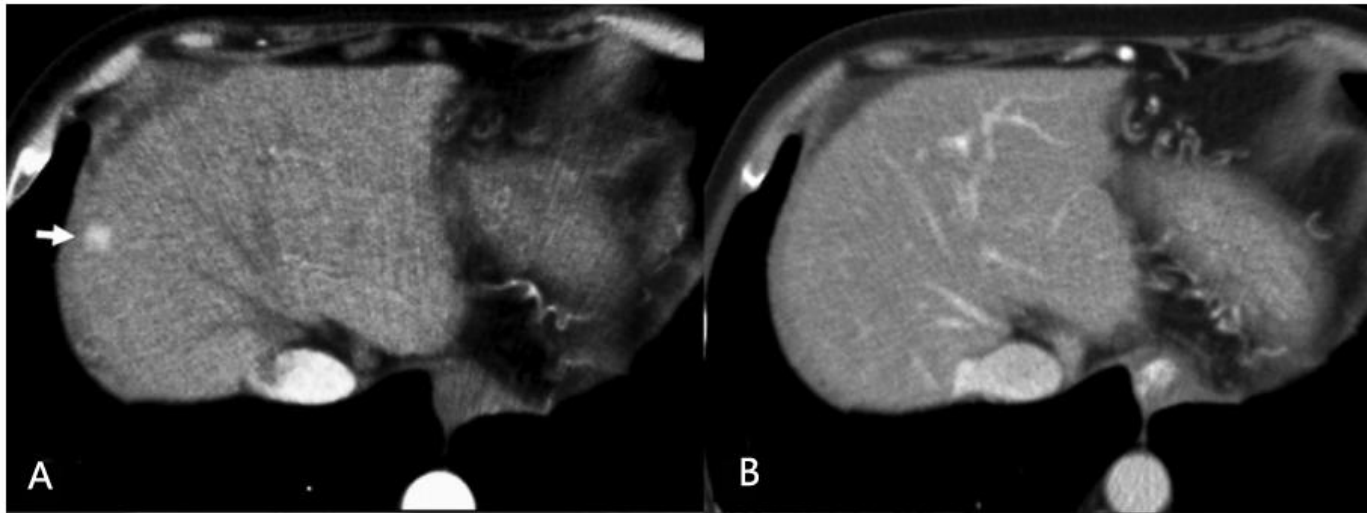


33岁女性  
肝脏FNH和腺瘤病



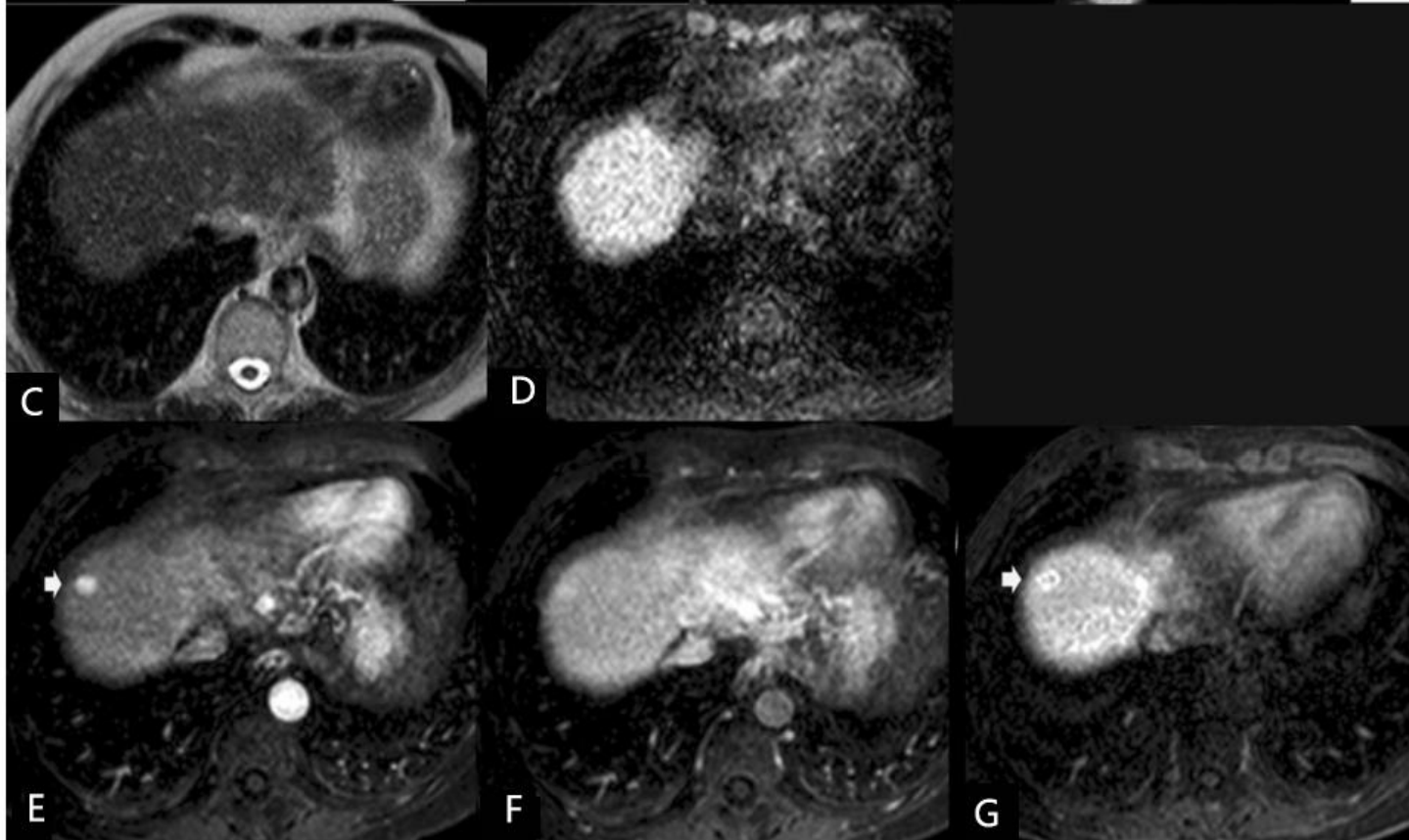
鉴别肝腺瘤和FNH

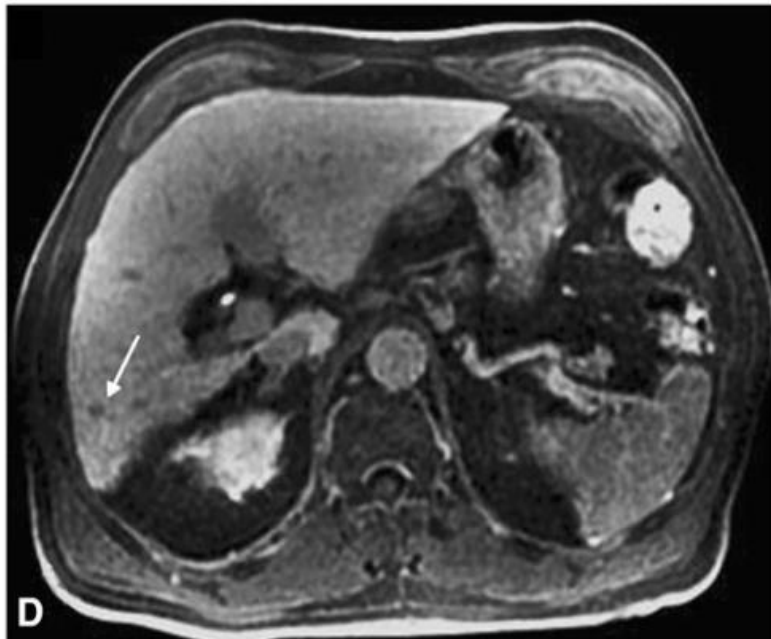
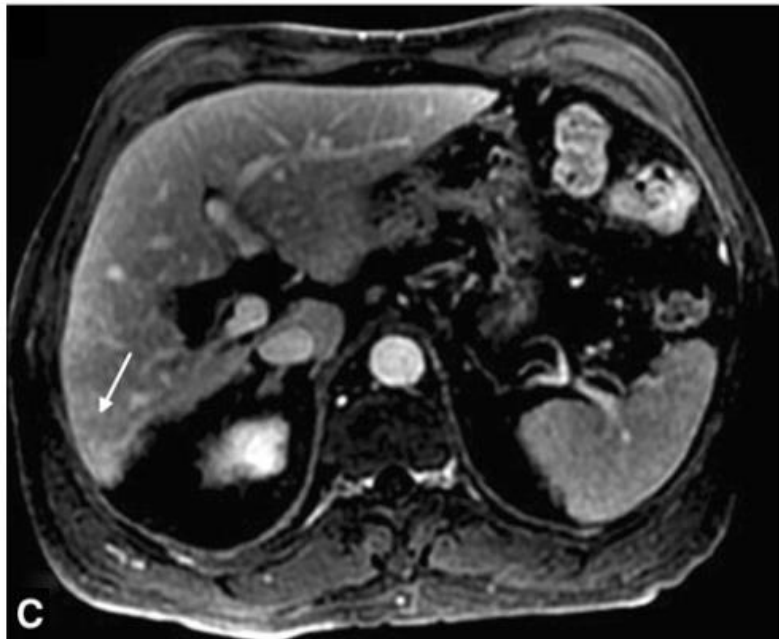
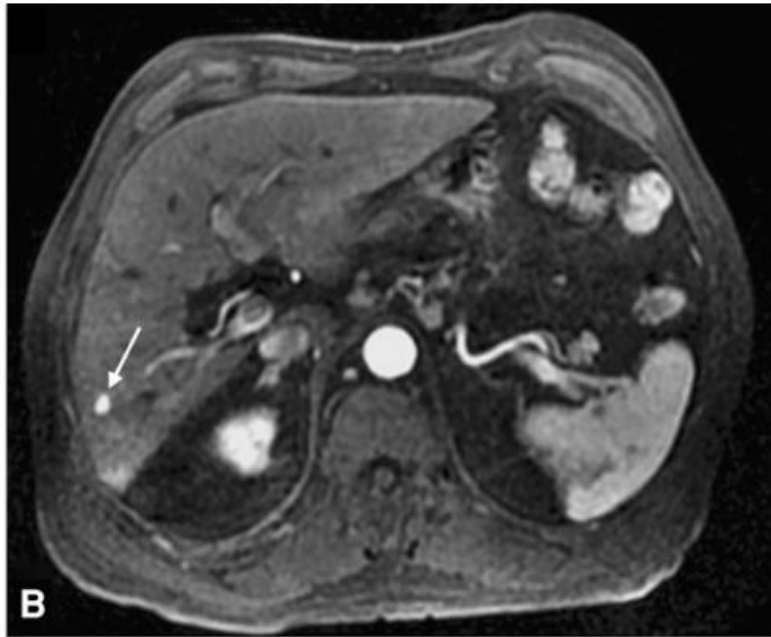
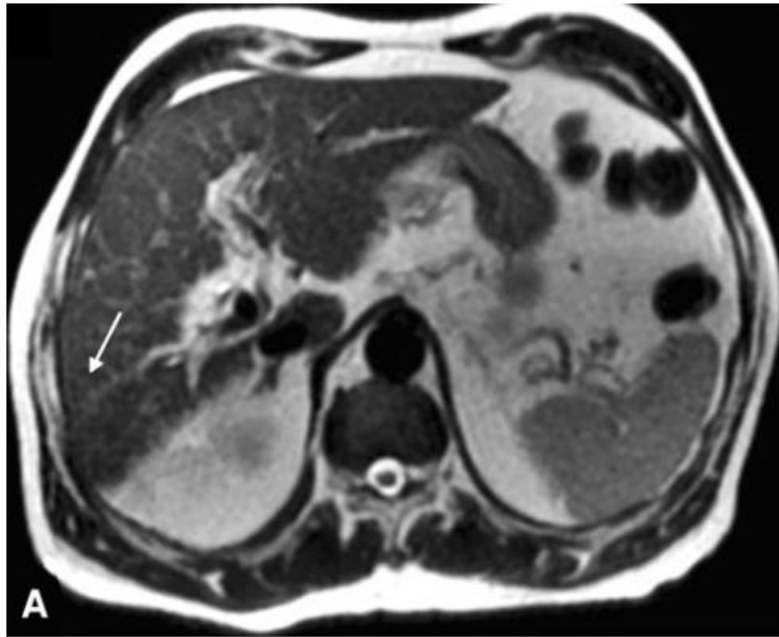




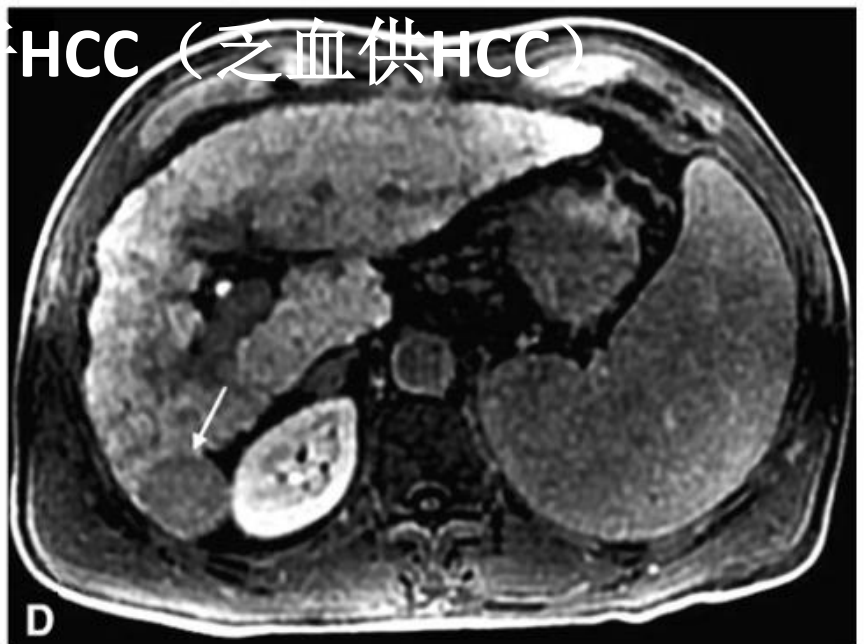
62岁女性，  
肝硬化

CT穿刺：  
低级别不典型  
增生结节

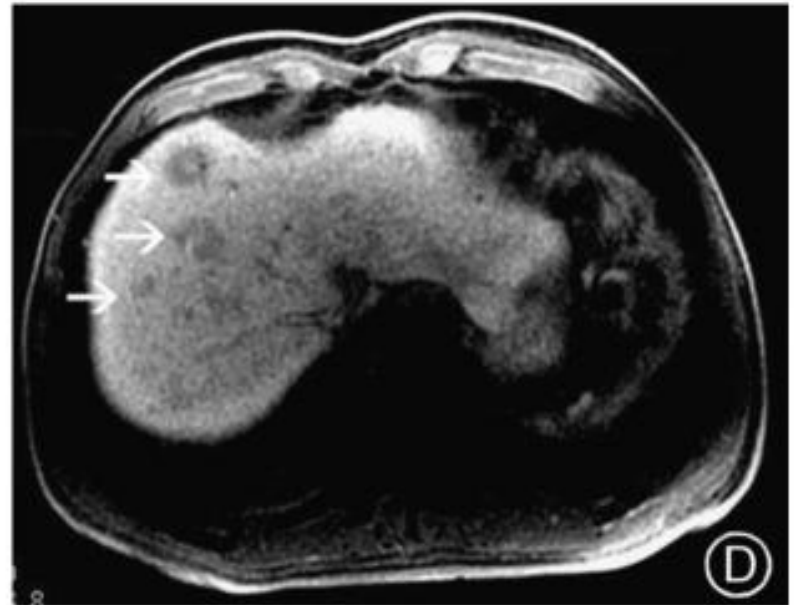
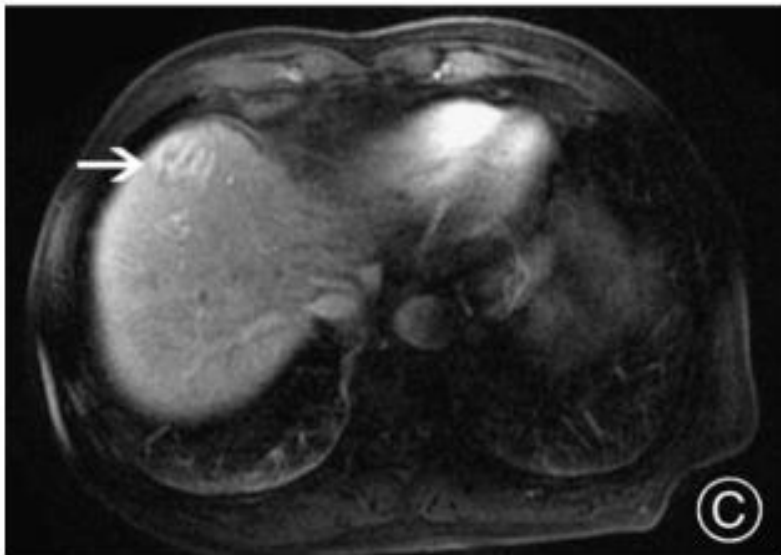
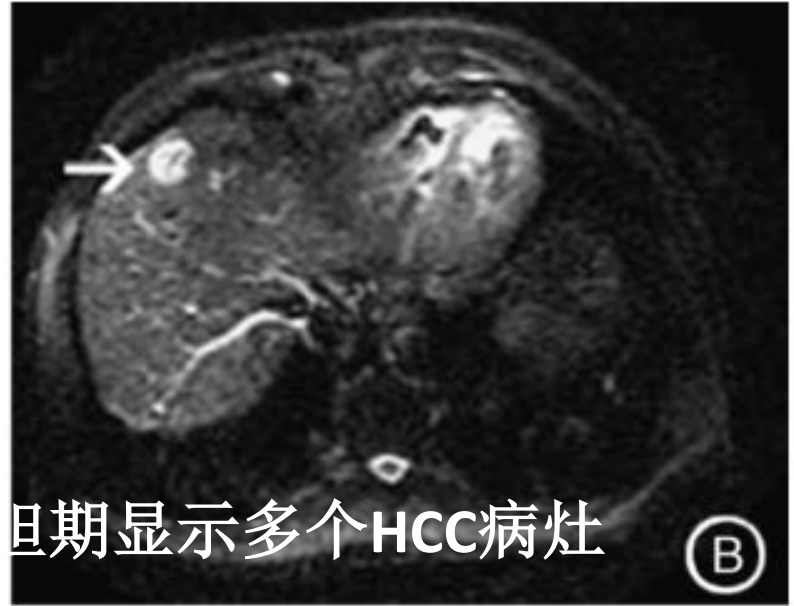
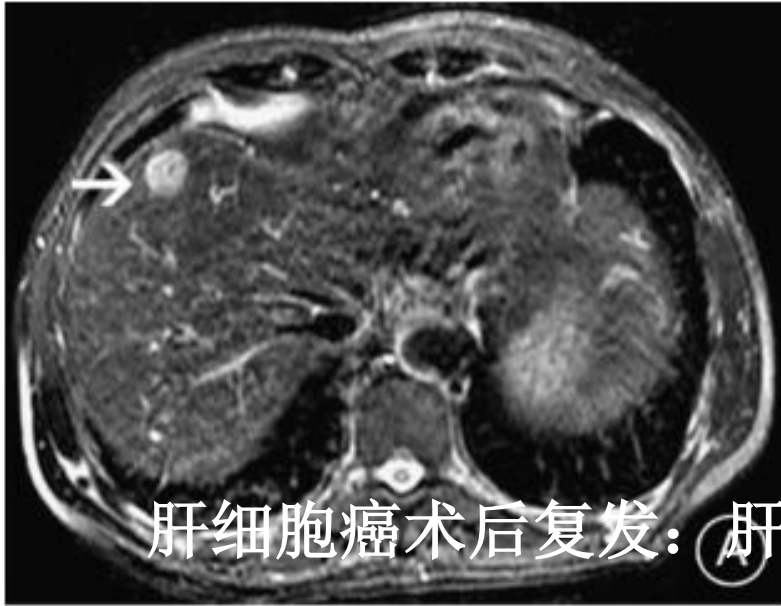




高级别不典型增生结节



病理结果：分化良好HCC（乏血供HCC）



# 肝胆期成像意义

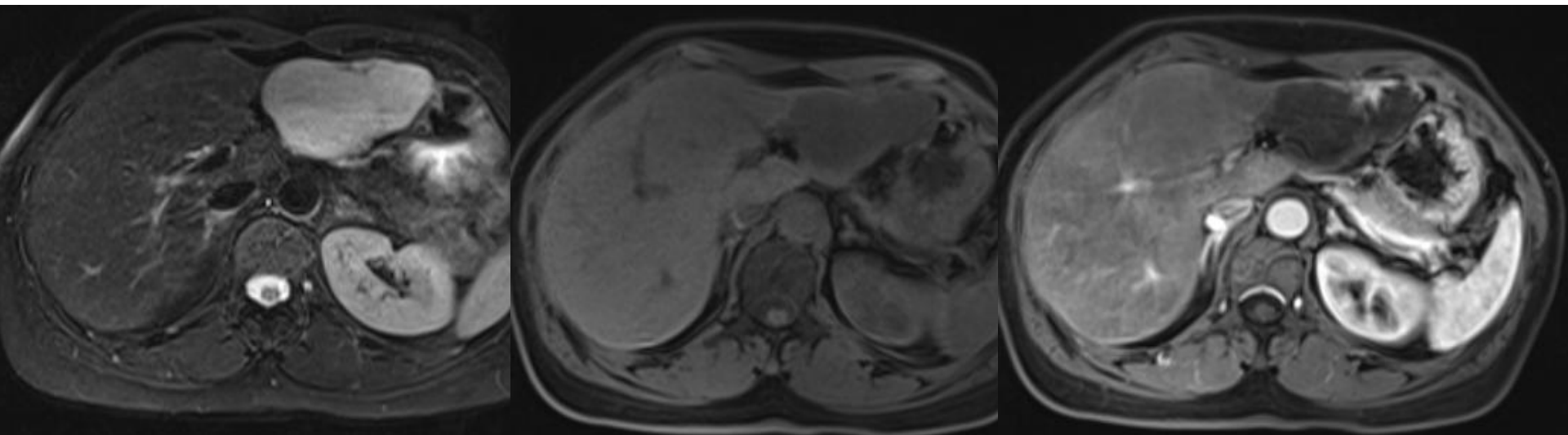
信号特征	提示	备注
低信号	肝细胞肝癌、肝脏其他恶性肿瘤和良性病变	肝胆期的低信号只能作为肝细胞肝癌和恶性肿瘤的辅助征象，而不能作为诊断肝细胞肝癌的主要征象
等信号	良性病变	用于鉴别肝细胞肝癌和由于结节样的动脉走形或良性的灌注改变所引起的动脉期肝脏局部强化
高信号	良性病变和恶性病变	部分的再生结节和良性肝细胞结节例如局灶性结节增生在肝胆期均可表现为稍高信号； 大约5%-10%的肝细胞肝癌在肝胆期可表现为高信号，通常信号增加非常明显。

**过分依赖肝胆期成像，  
忽略肝脏动态增强的重要性。**

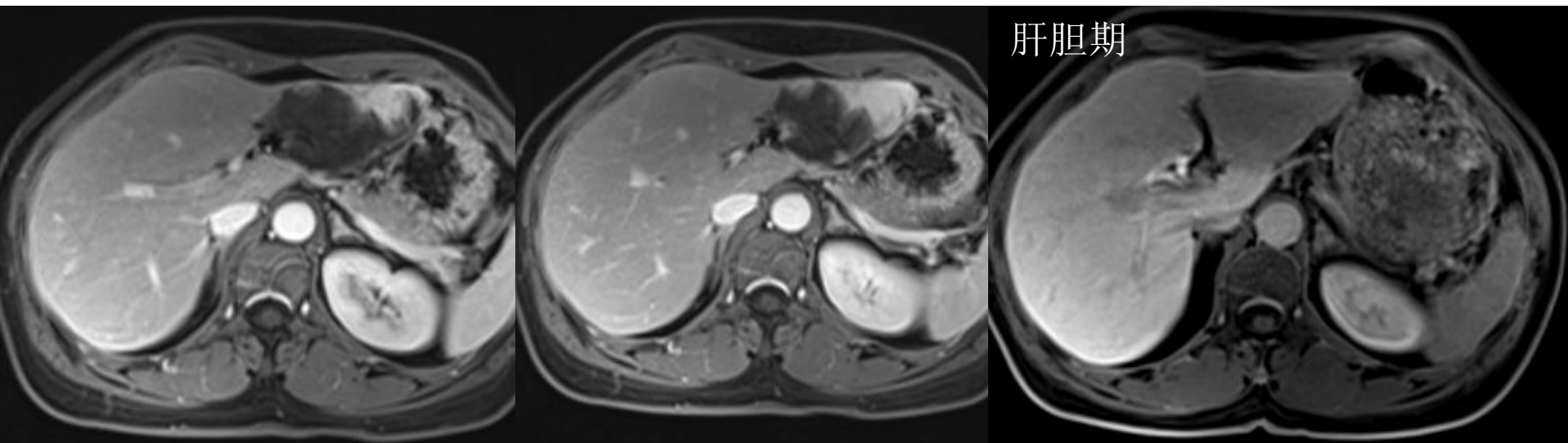


# 莫迪司增强突出的临床意义

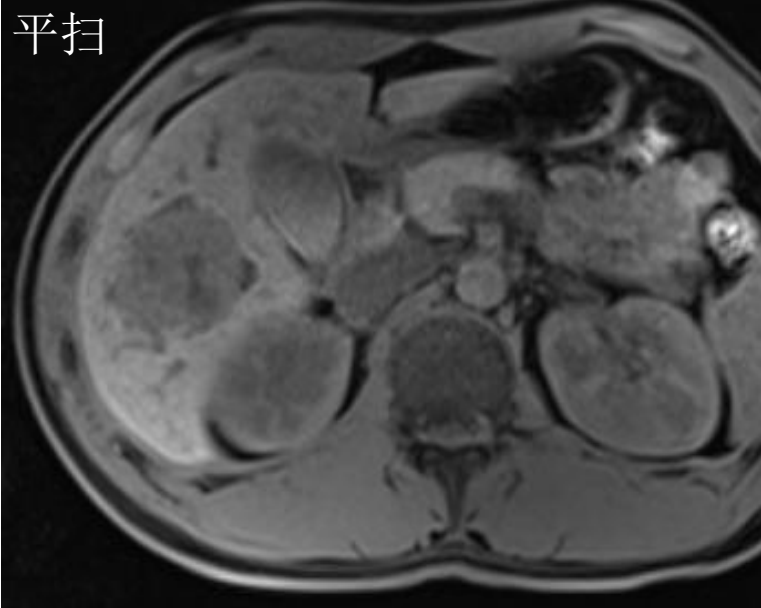
- 部分肝细胞肝癌常规动态增强仅见动脉期强化，无典型“快进快出”征象，肝胆期成像呈低信号
- 鉴别肝腺瘤和FNH
- 区别低级别不典型增生结节、高级别不典型增生结节和肝细胞癌
- 显示更多肝内病灶
- 进行胆管成像



MR0301636, 女, 49岁, 海绵状血管瘤, 莫迪司



平扫

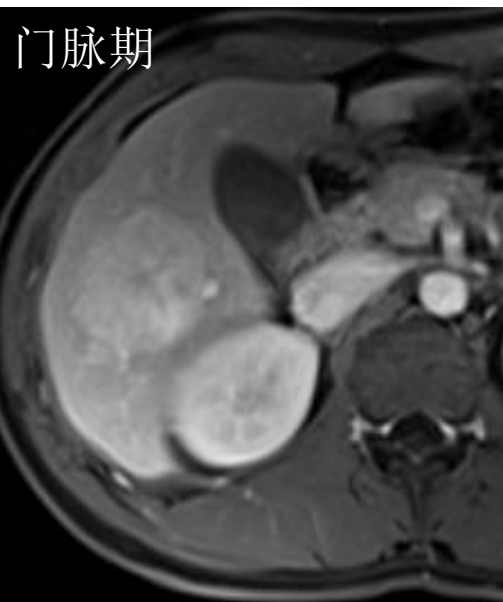


动脉期

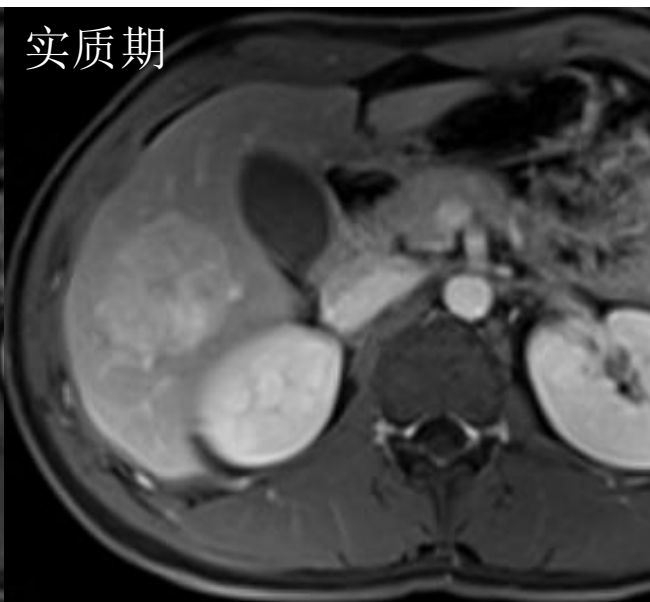


**FNH**

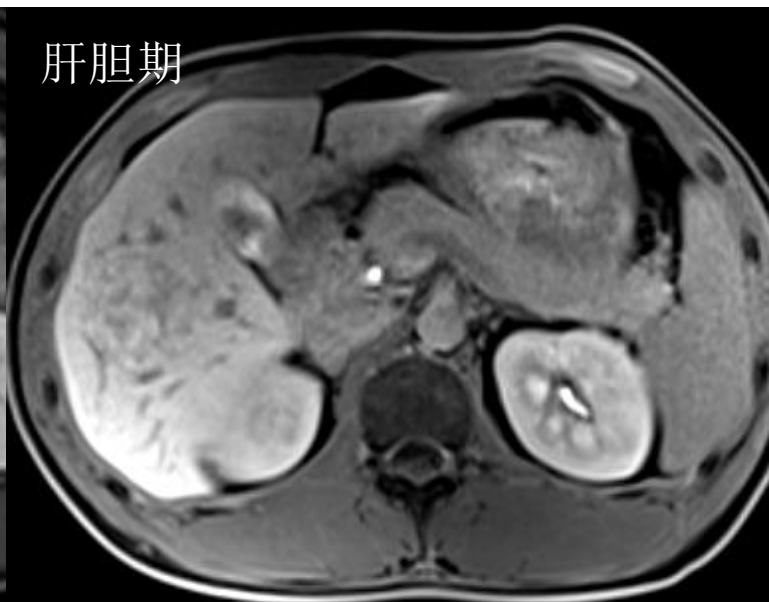
门脉期



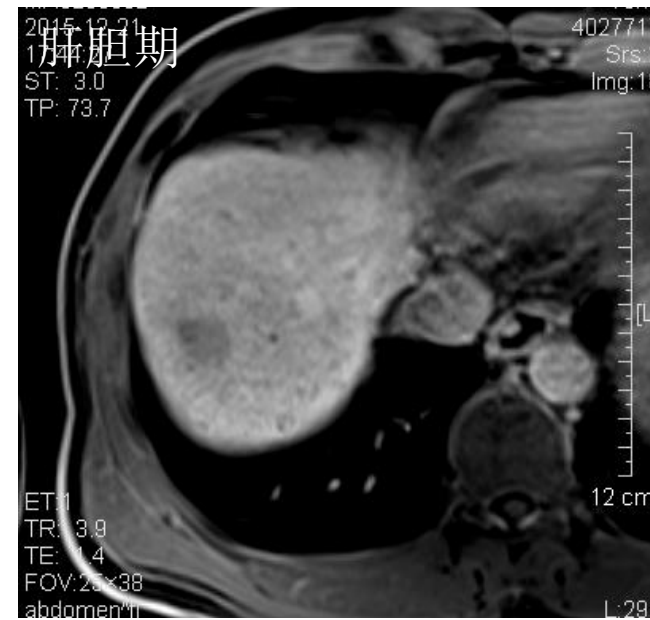
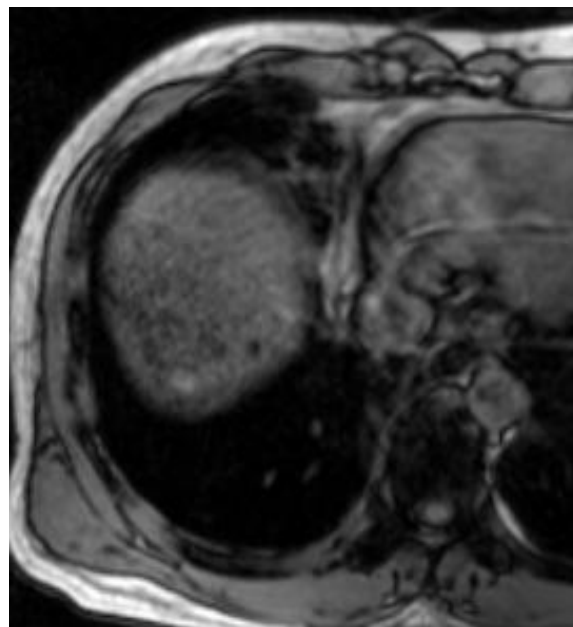
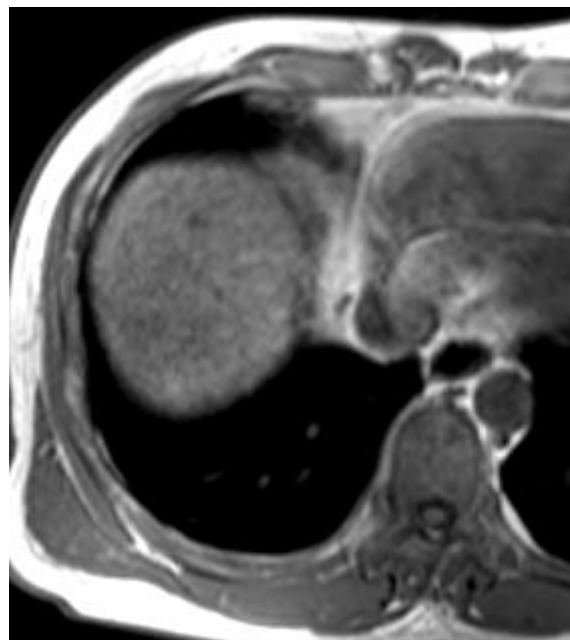
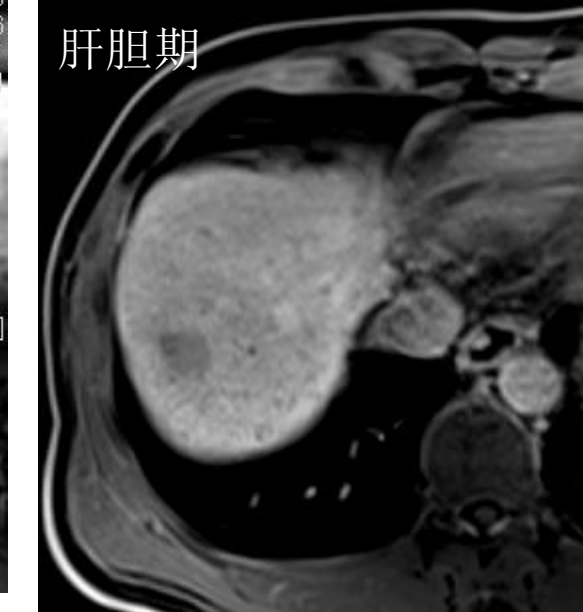
实质期

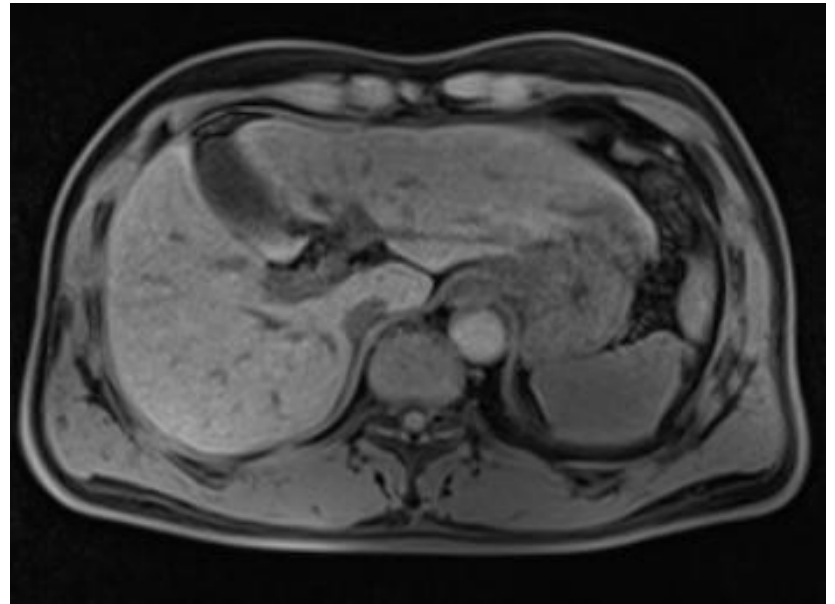
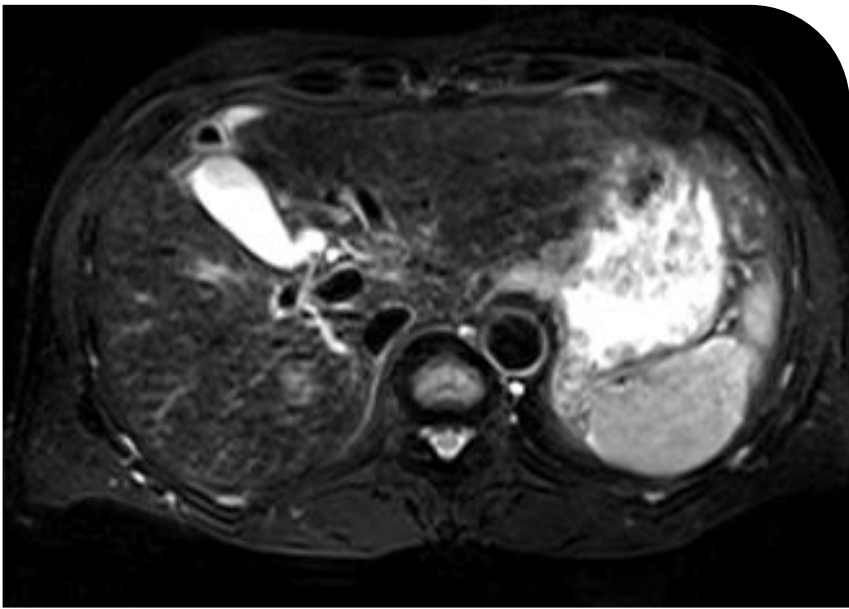


肝胆期

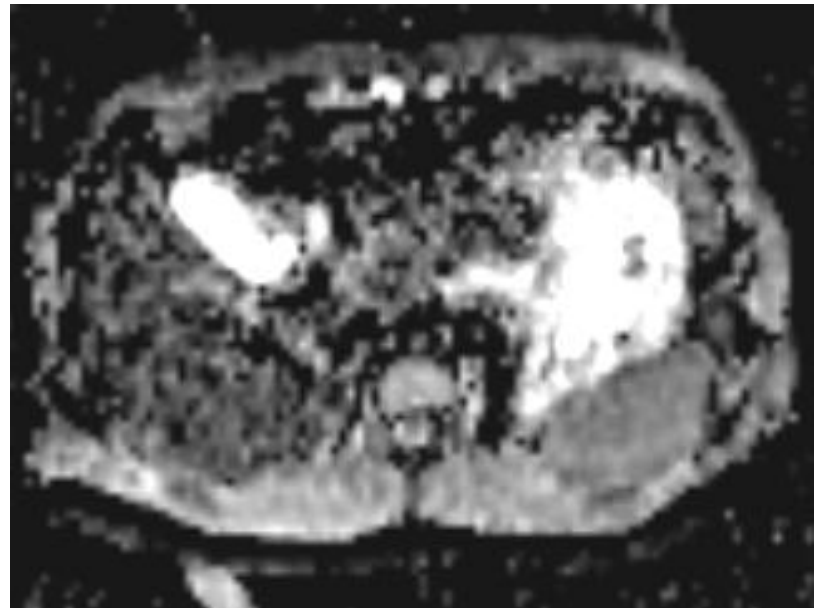
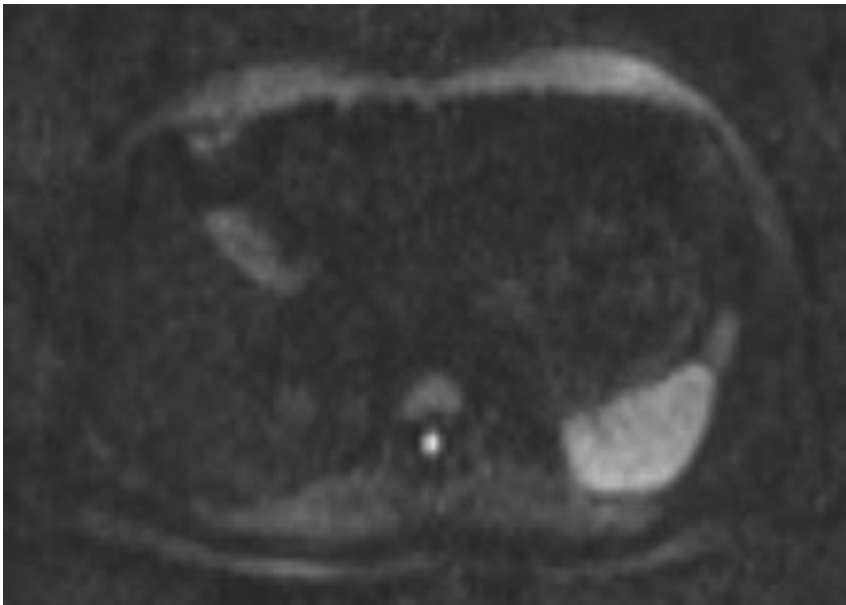








**男性，57岁，反复乏力10余年，再发20天，乙肝病史十余年。**



# 增强扫描肝胆期病变显示最清晰

动脉期

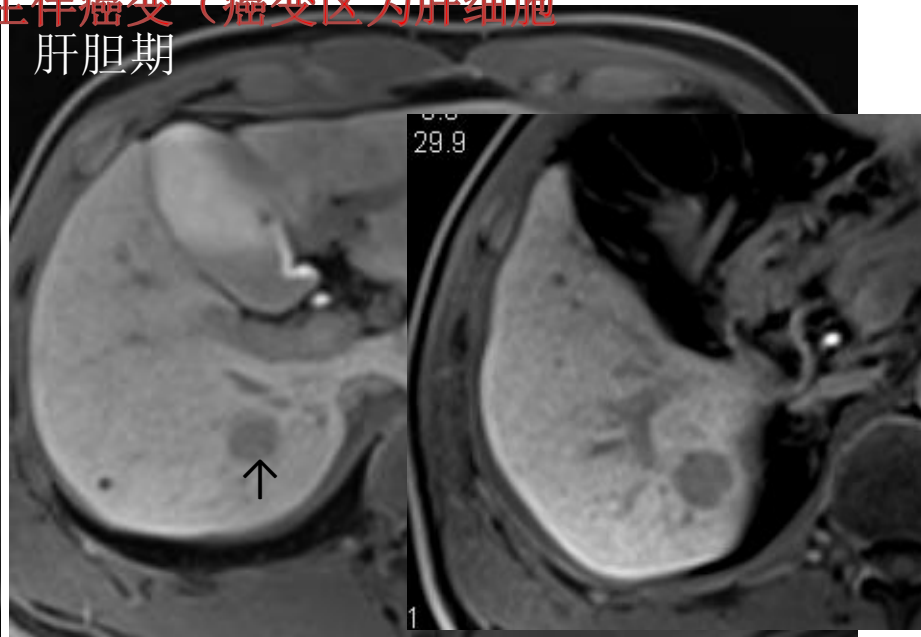
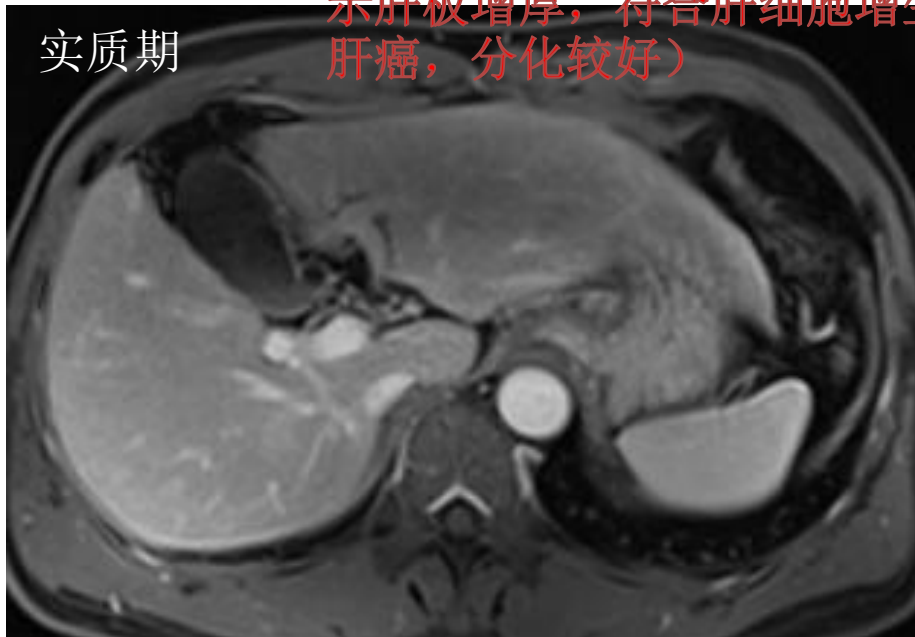
门脉期

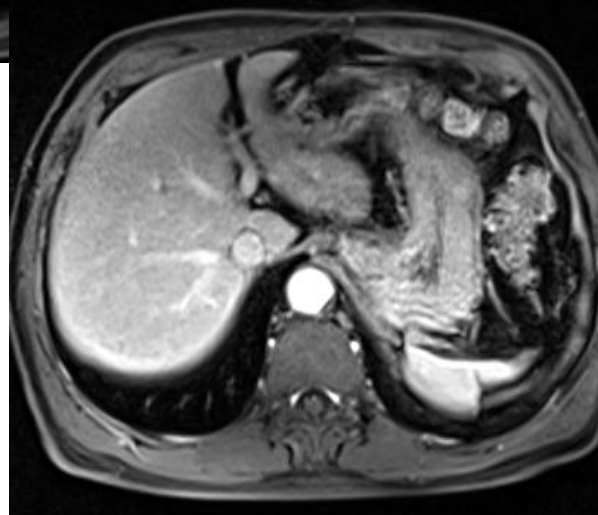
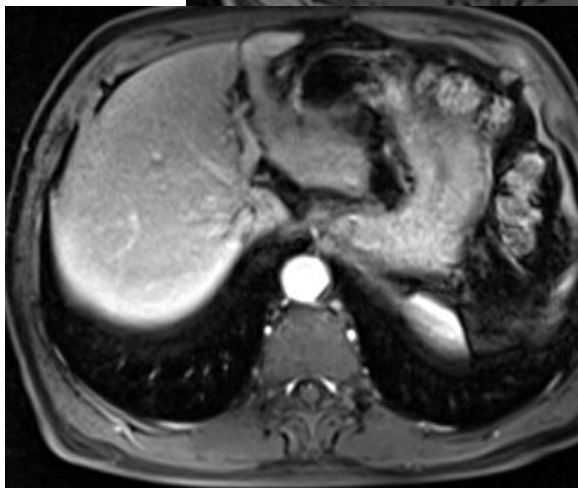
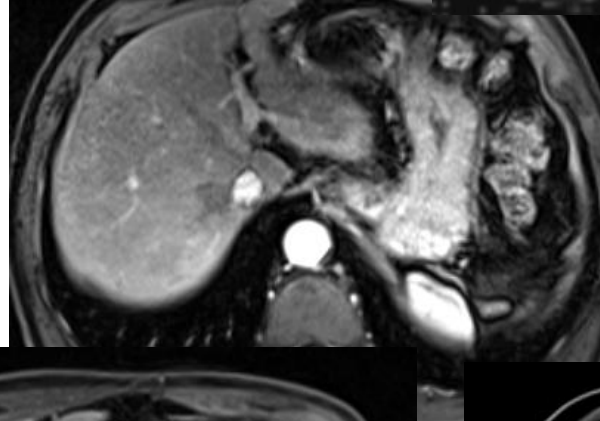
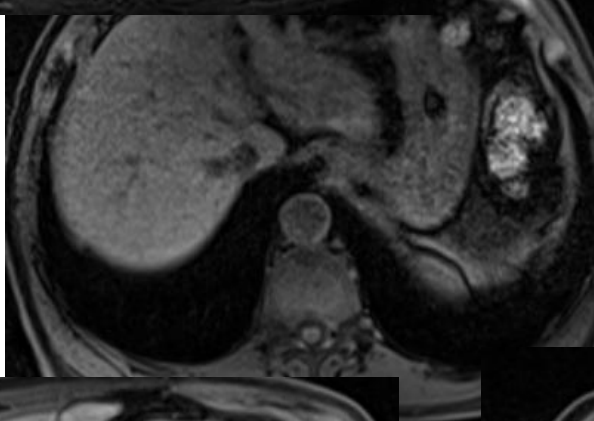
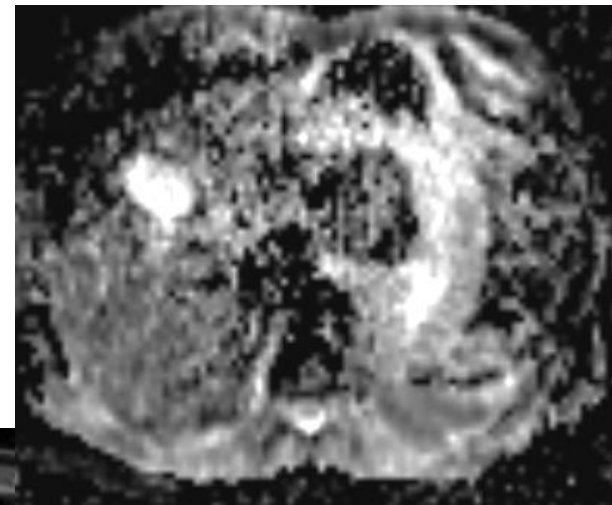
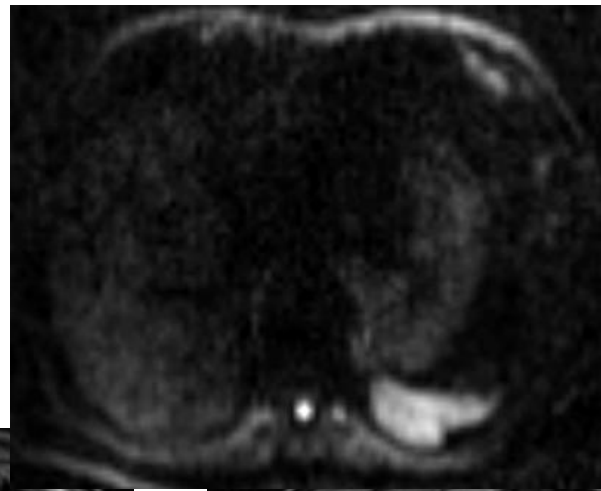
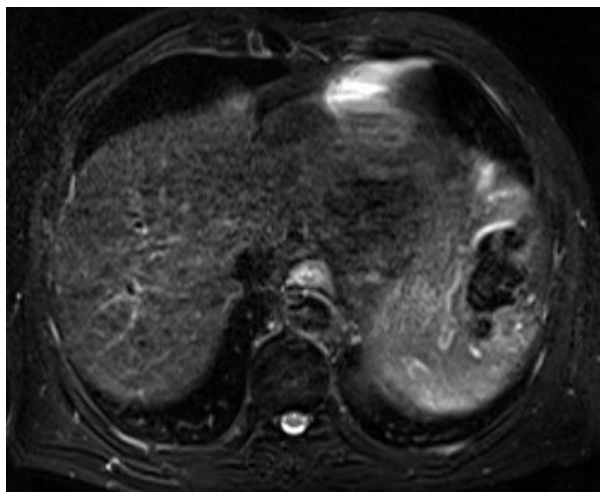
实质期

病理：（肝脏）肝细胞增生性病变，部分区域假腺样结构形成，CD34显示局灶血窦明显增生，网状纤维染色显示肝板增厚，符合肝细胞增生伴癌变（癌变区为肝细胞肝癌，分化较好）

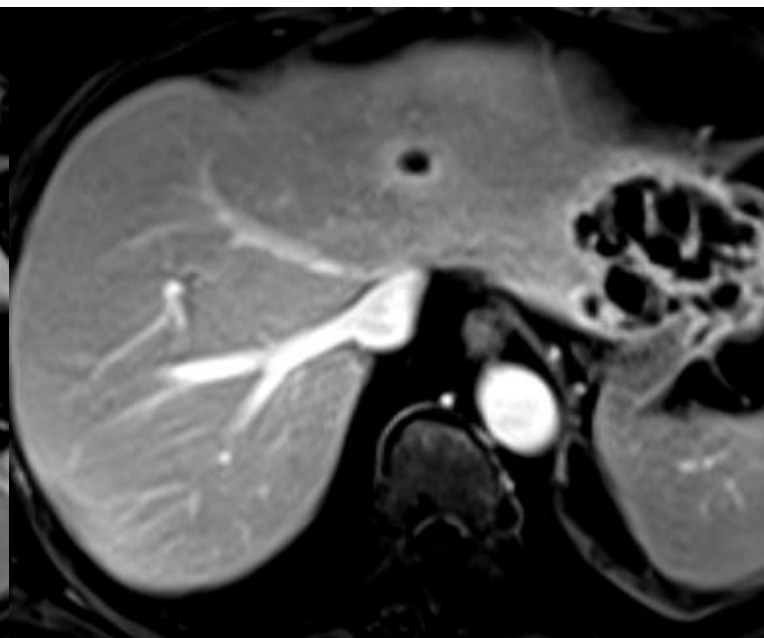
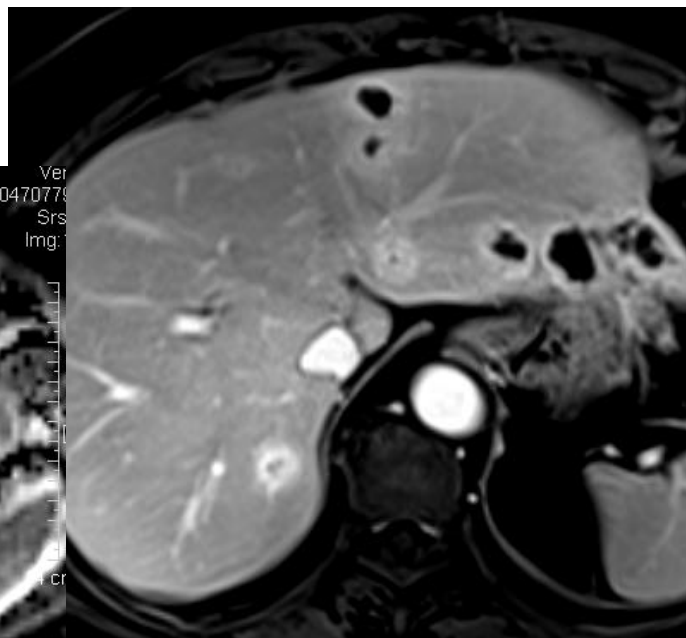
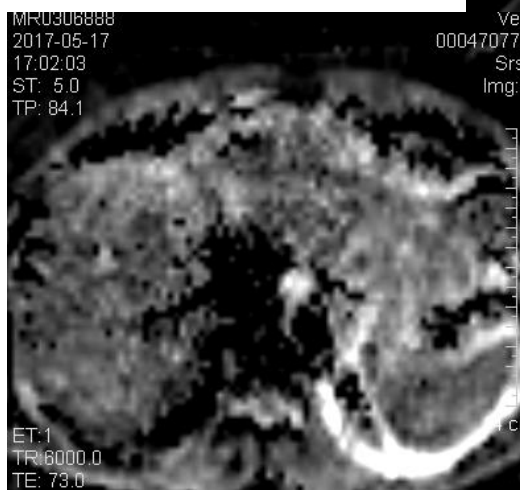
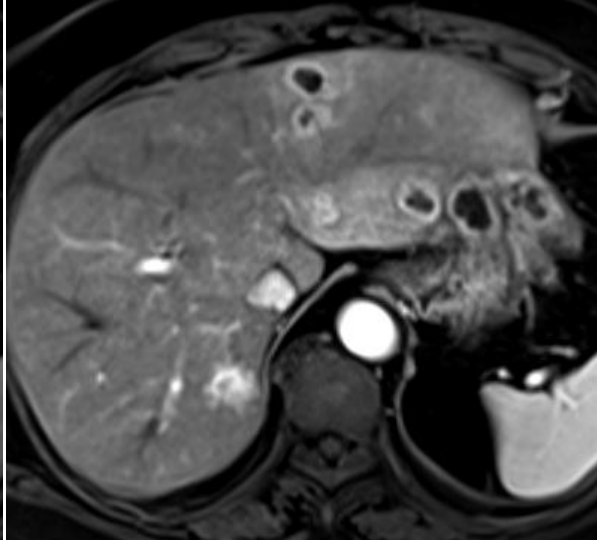
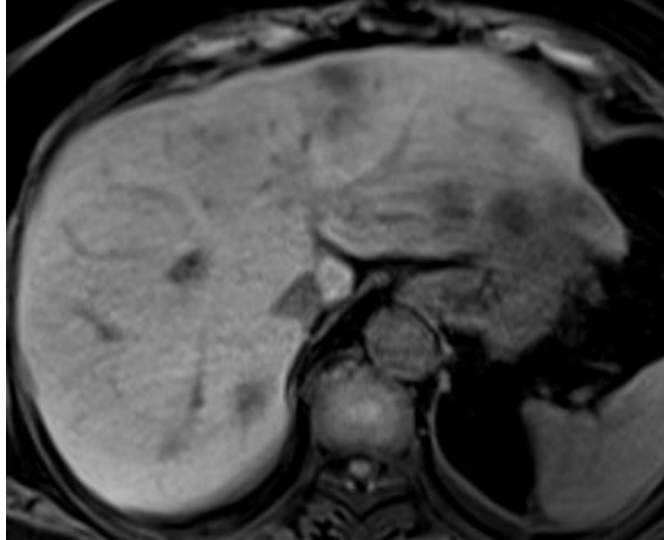
实质期

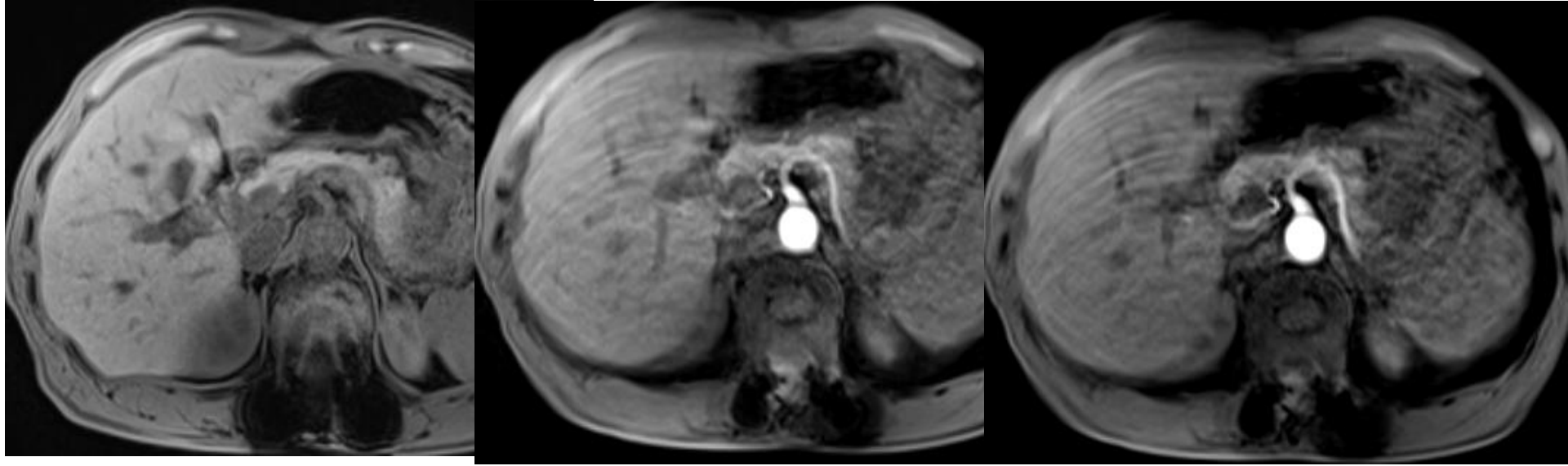
肝胆期



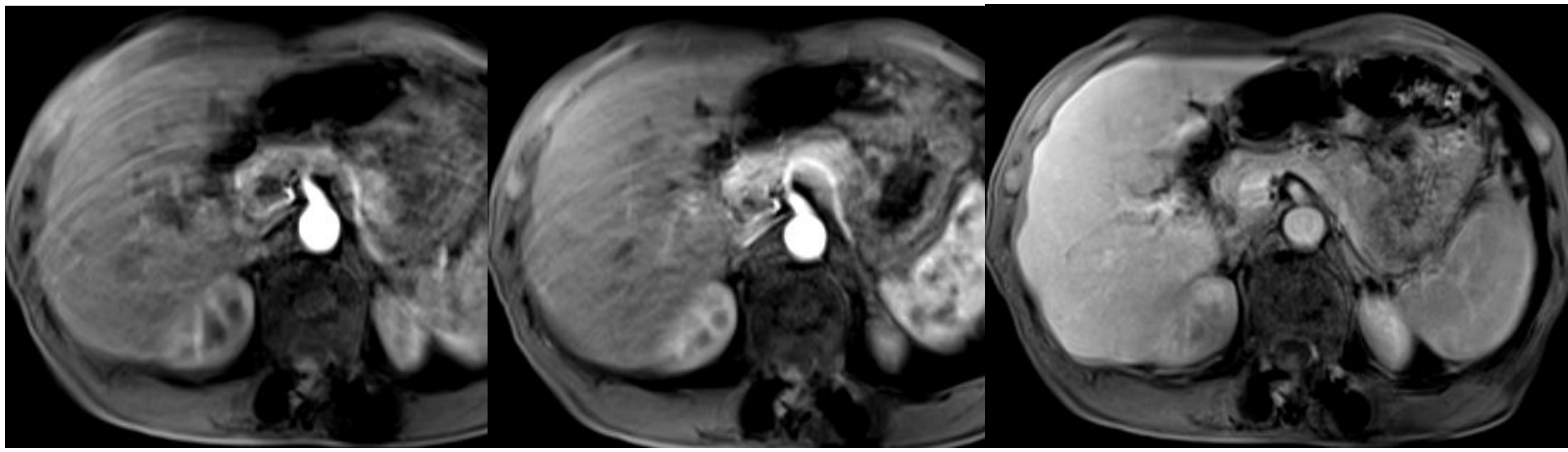


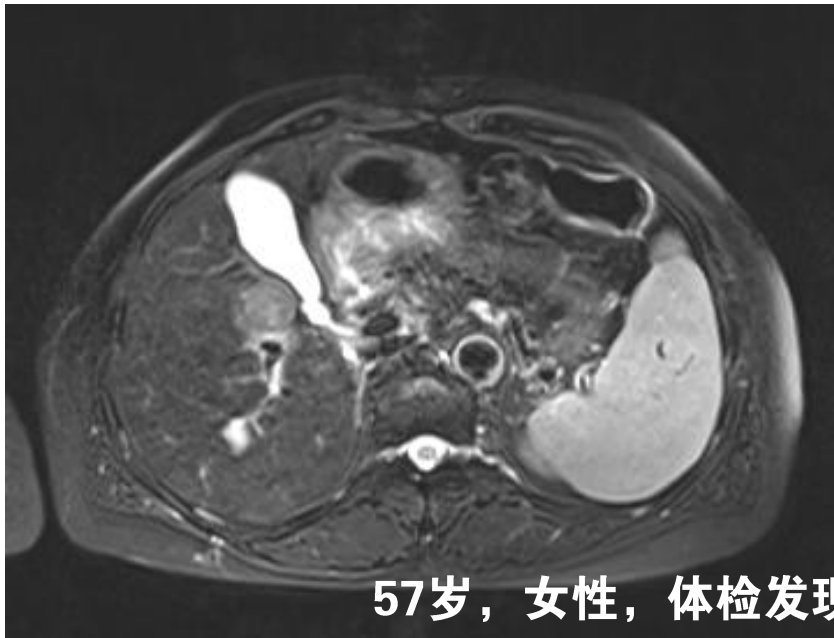




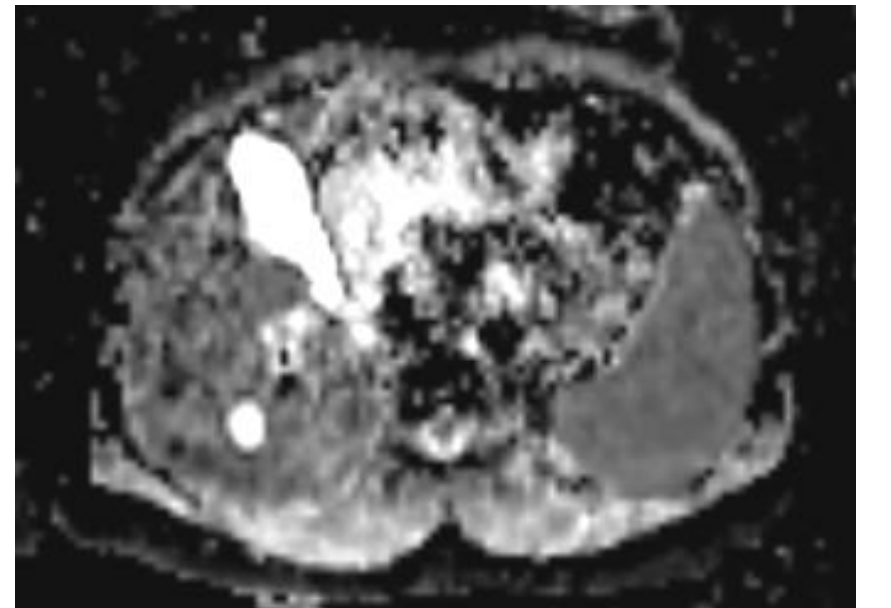
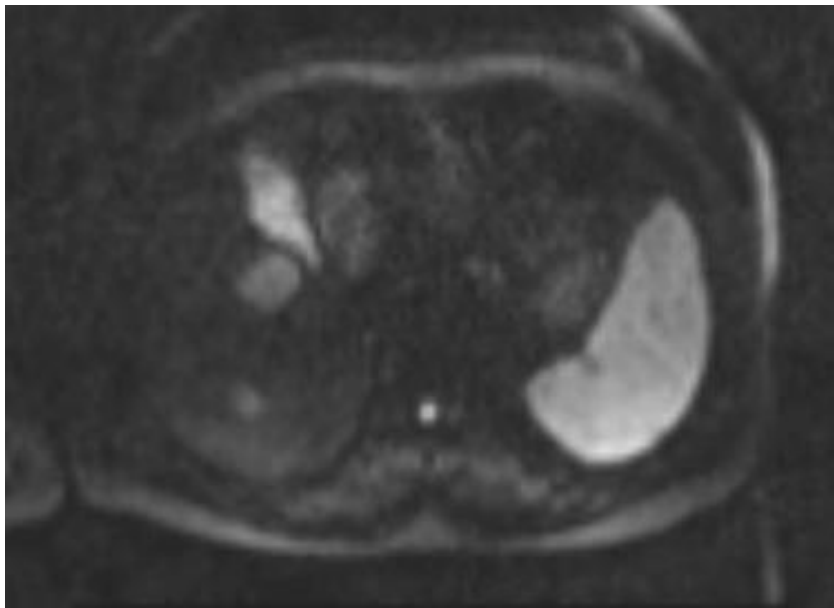


MR0300437, 男, 62岁, AFP大于1200, 普美显

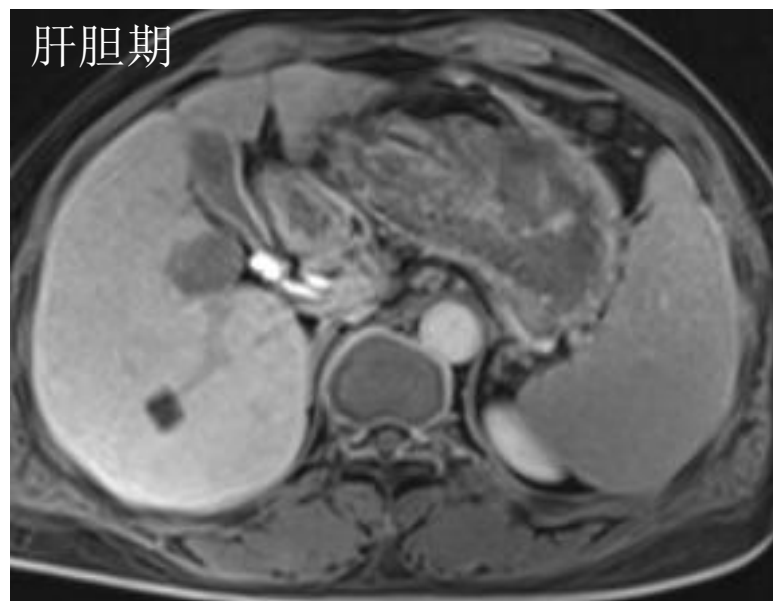
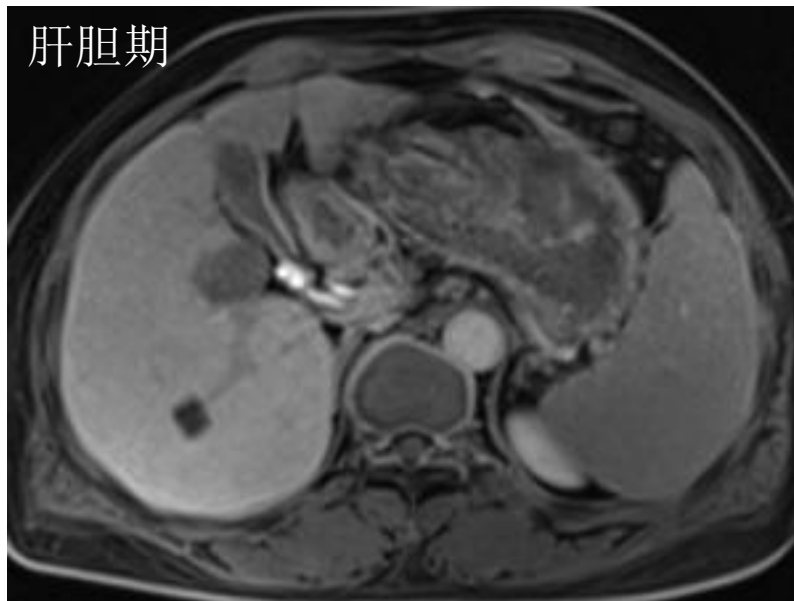
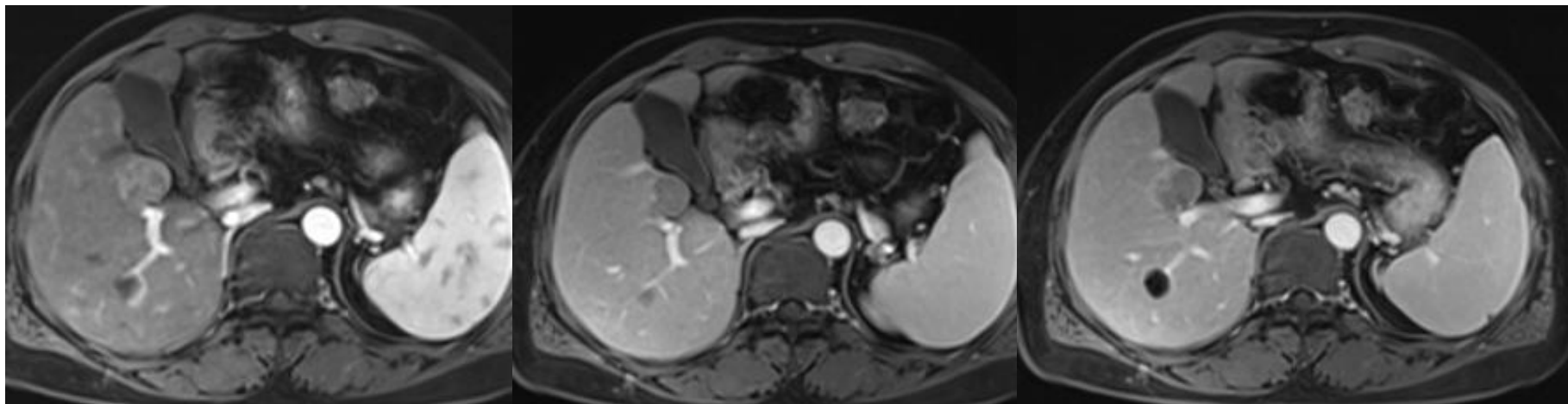




57岁，女性，体检发现“右肝占位”2个月

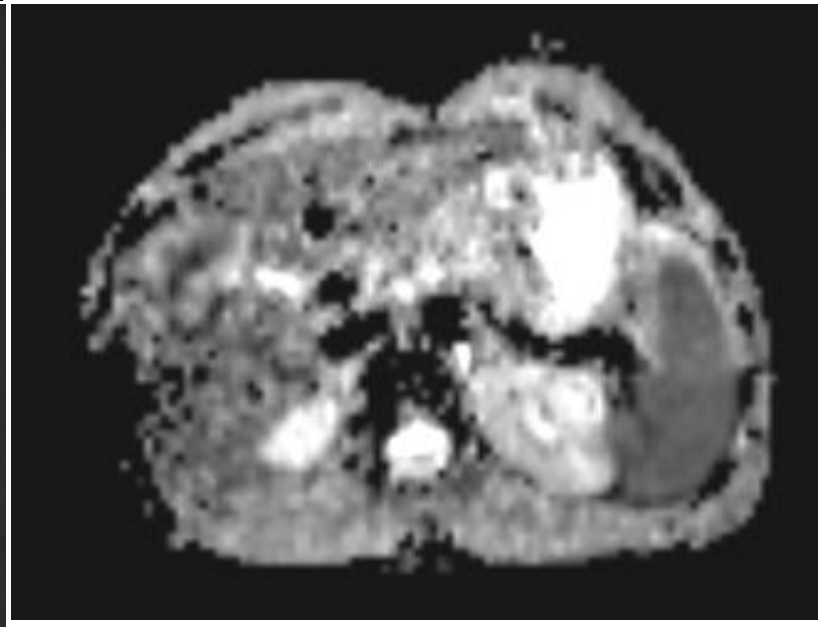
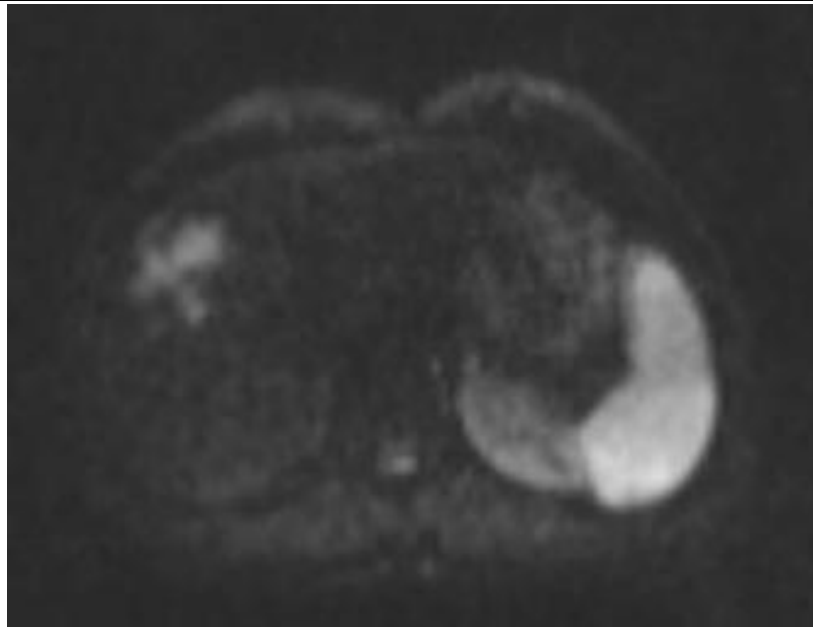
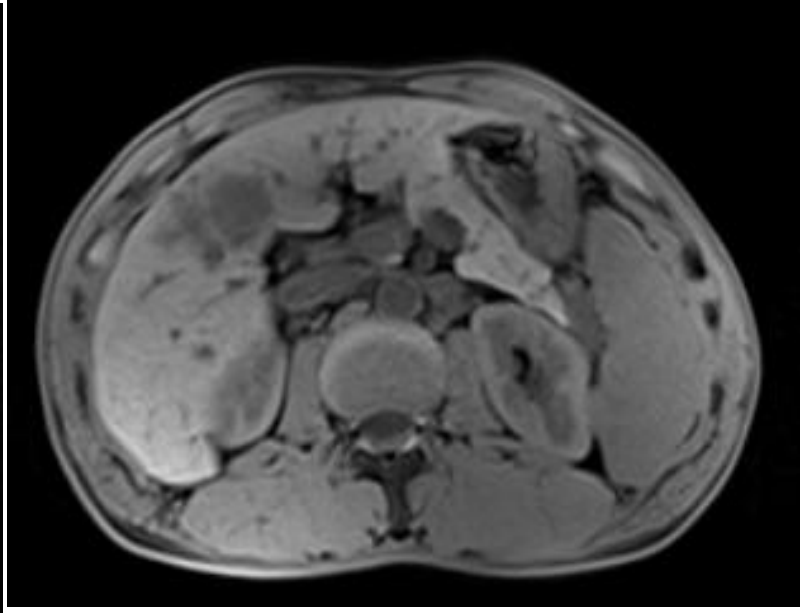
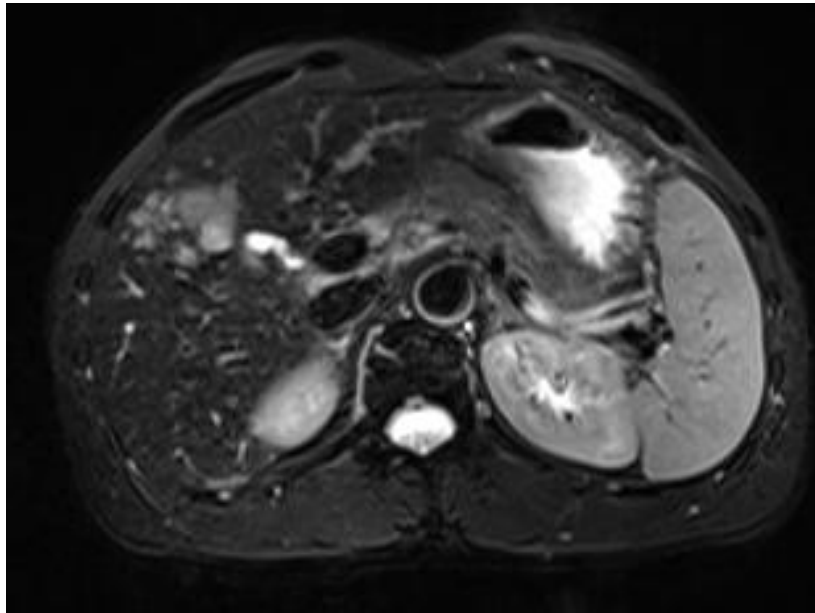


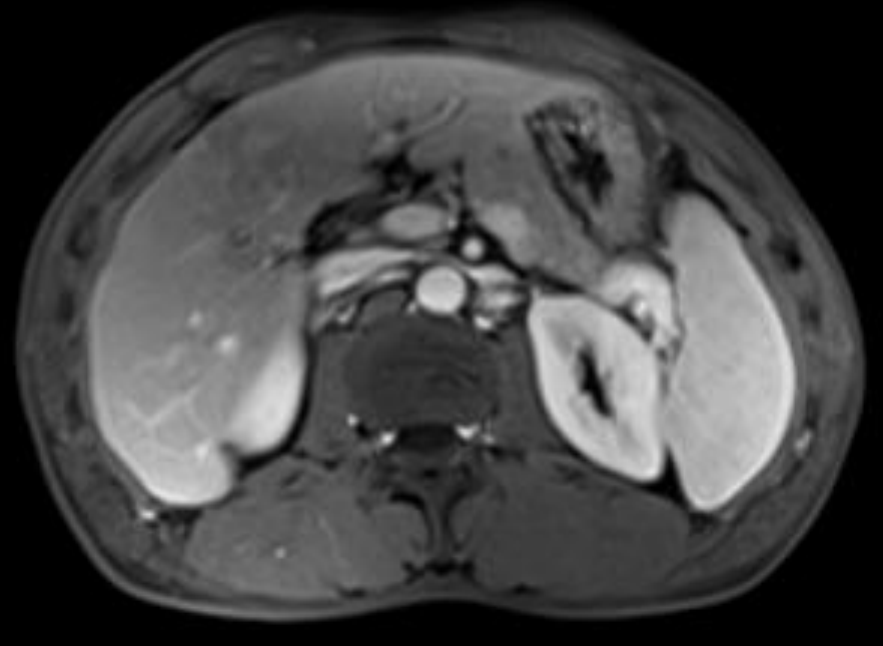
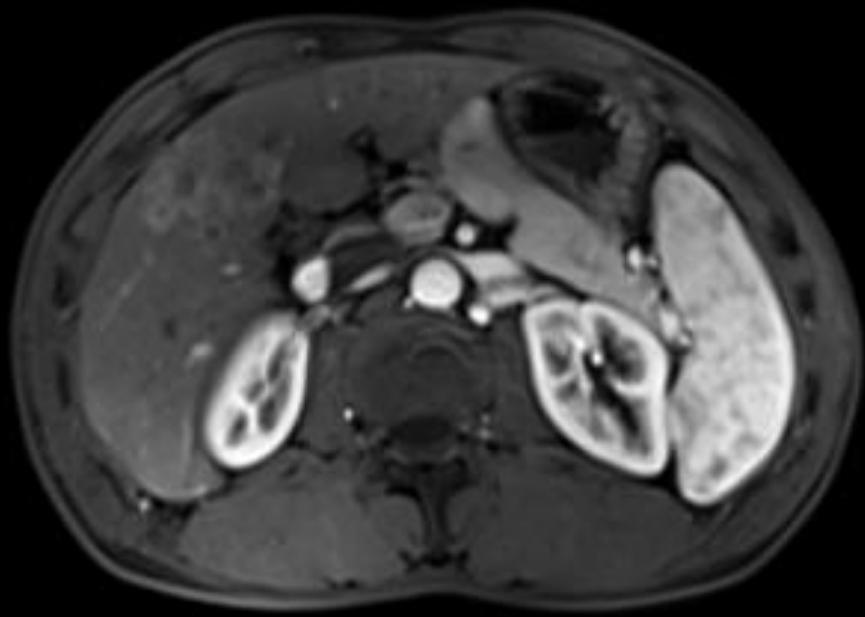
病理（右肝肿物）：结节型中分化肝细胞癌



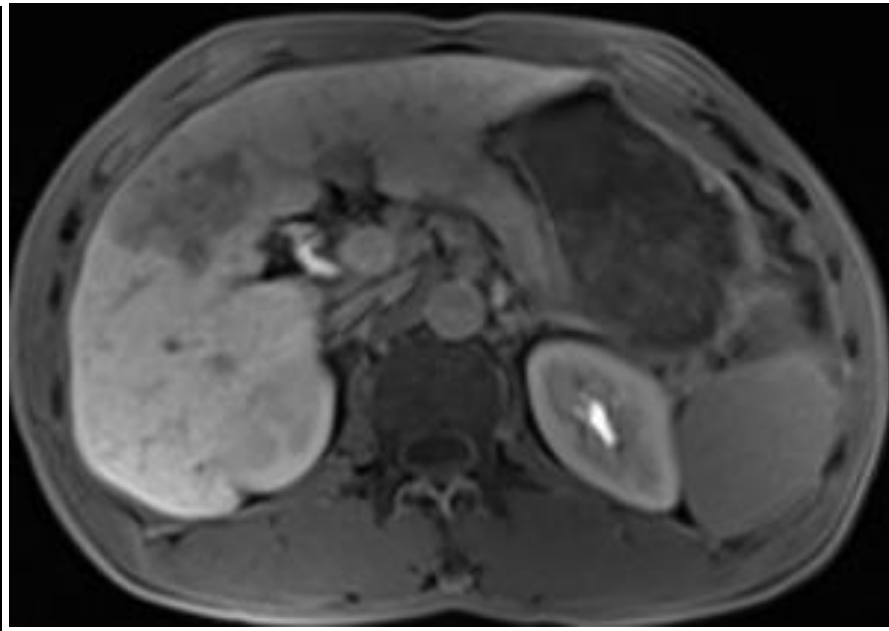
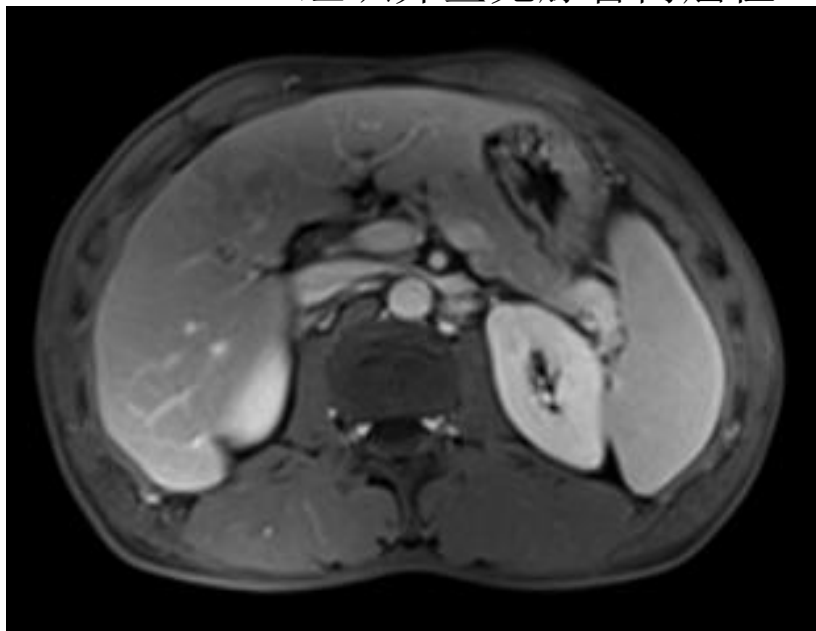


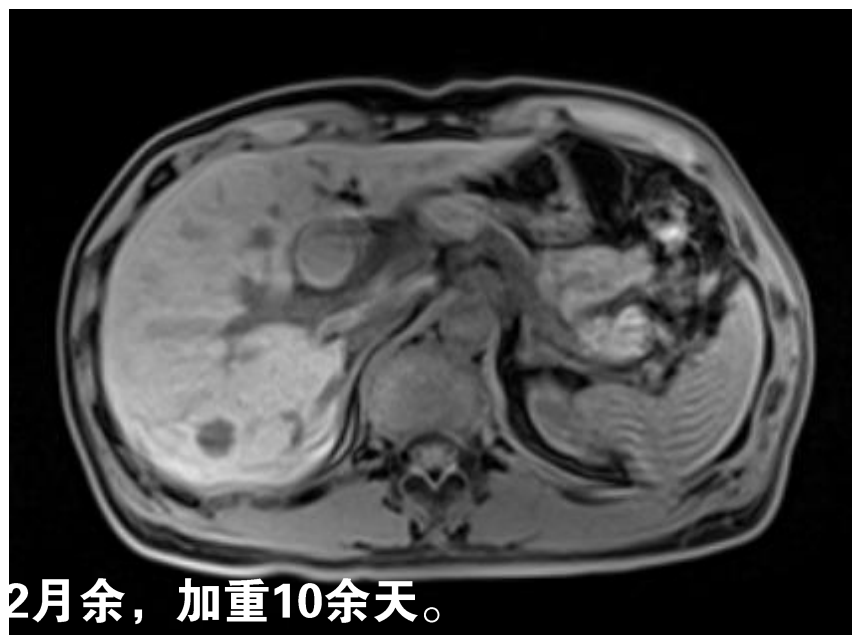
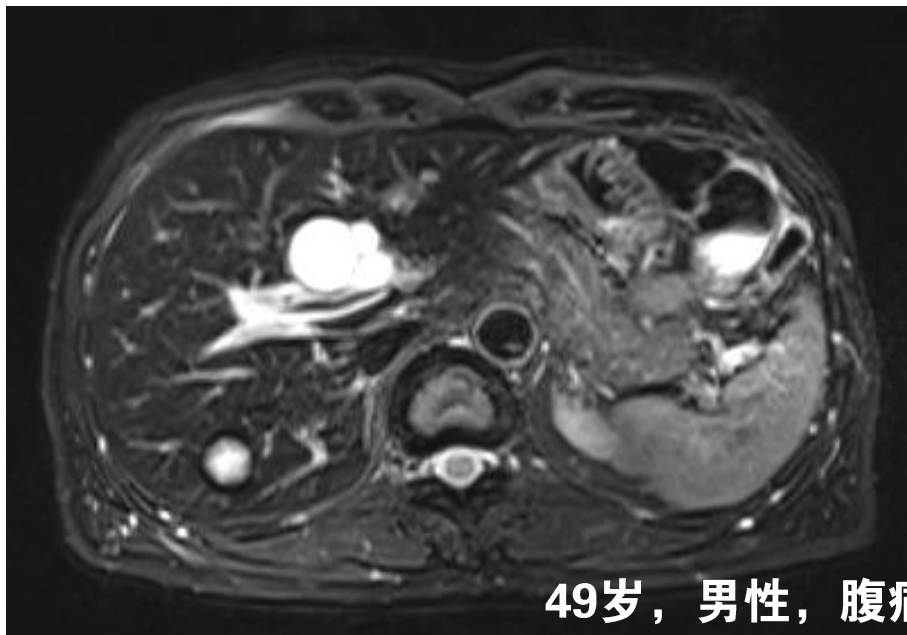
41岁，男性，发现肝内占位4天



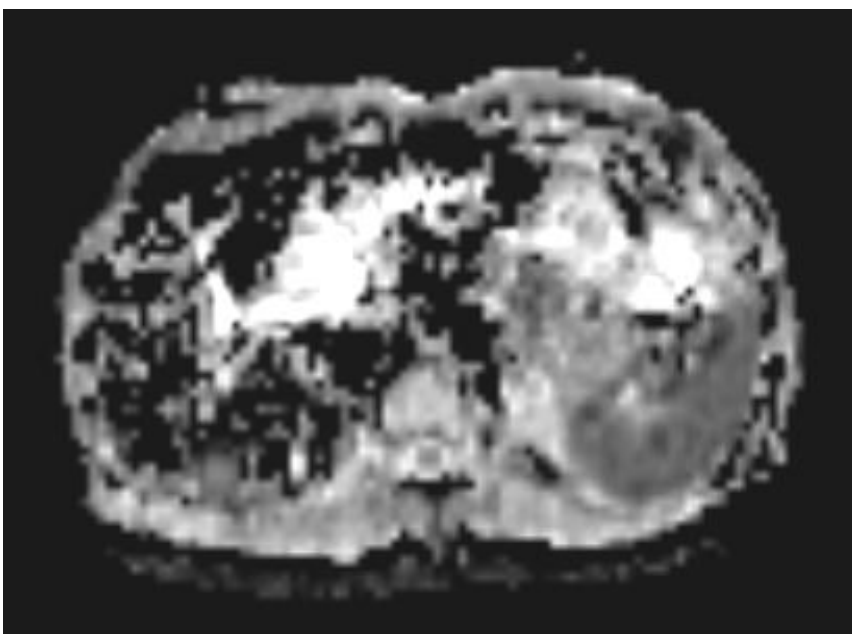
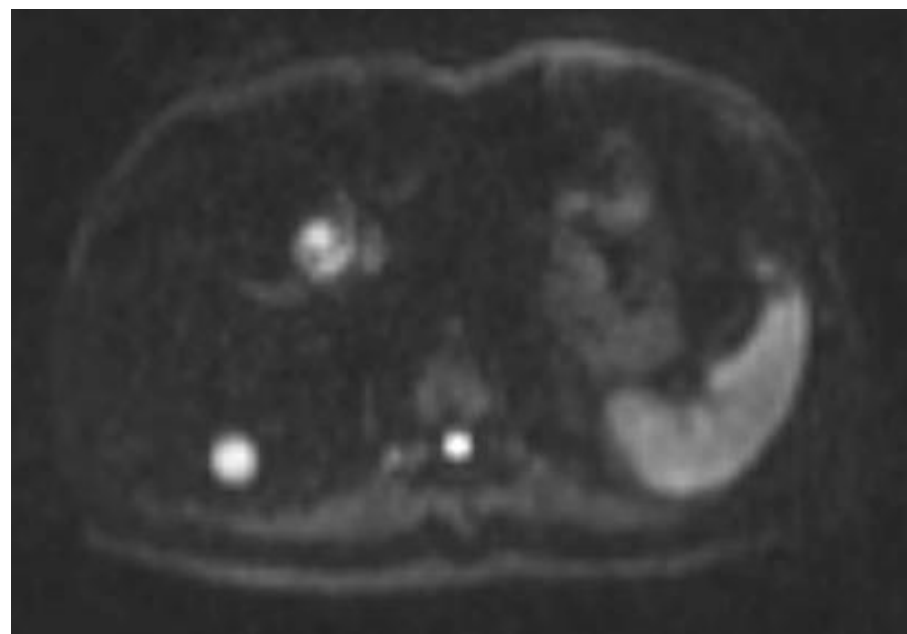


病理：低分化肝细胞癌伴大片坏死，侵犯周围肝组织并查见脉管内癌栓

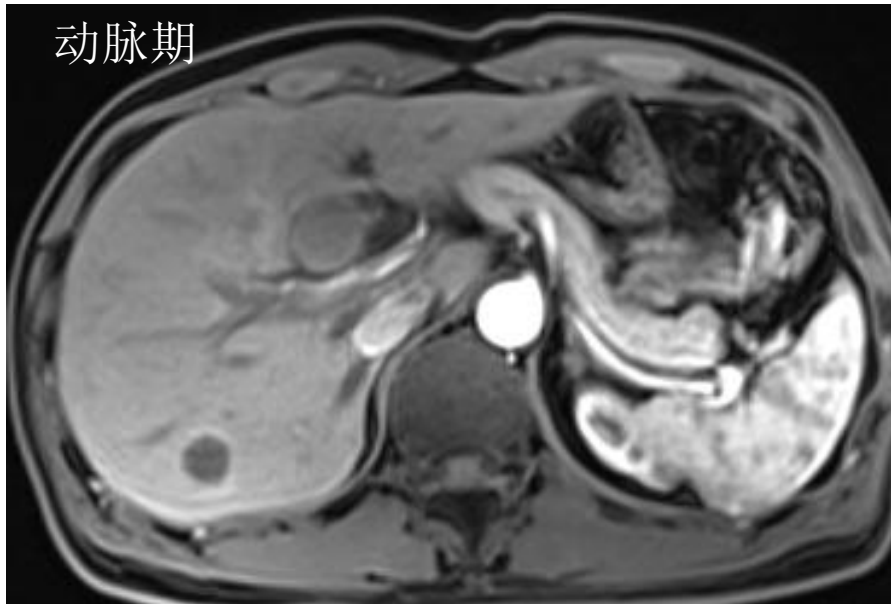




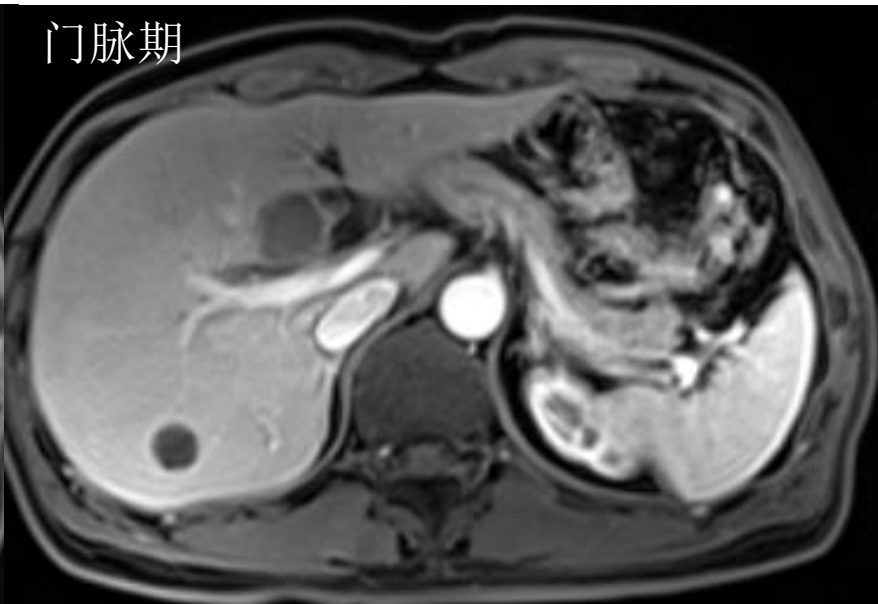
49岁，男性，腹痛2月余，加重10余天。



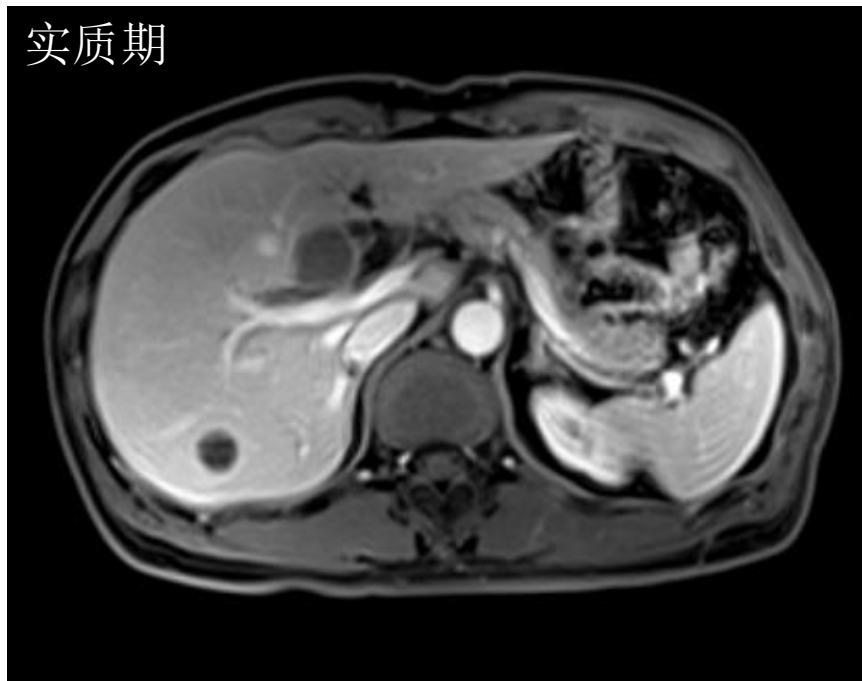
动脉期



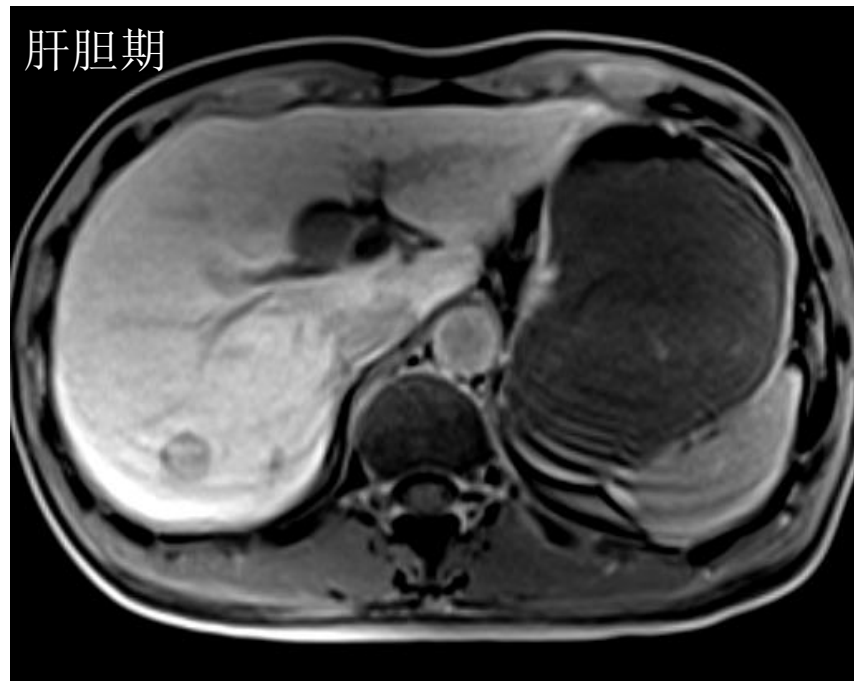
门脉期



实质期



肝胆期

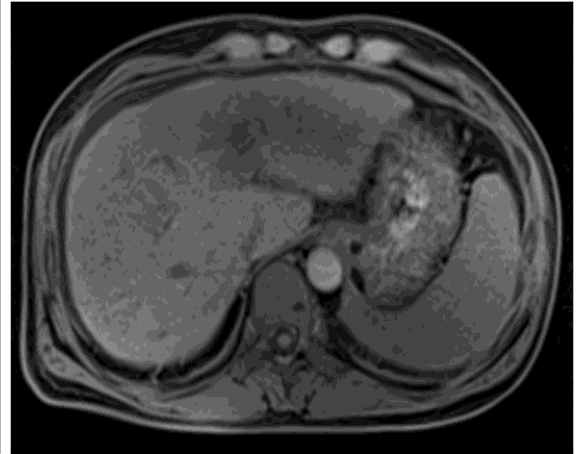
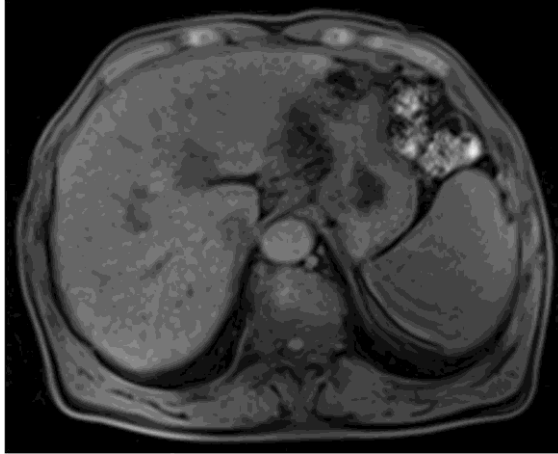
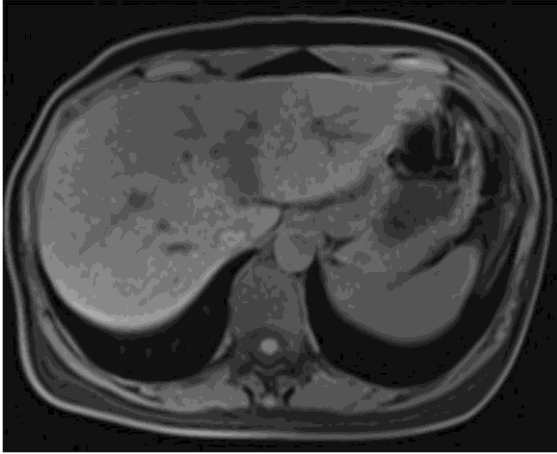


- Gd-BOPTA 增强 MRI 肝胆期肝实质的强化程度能一定程度反映肝功能情况

A级

B级

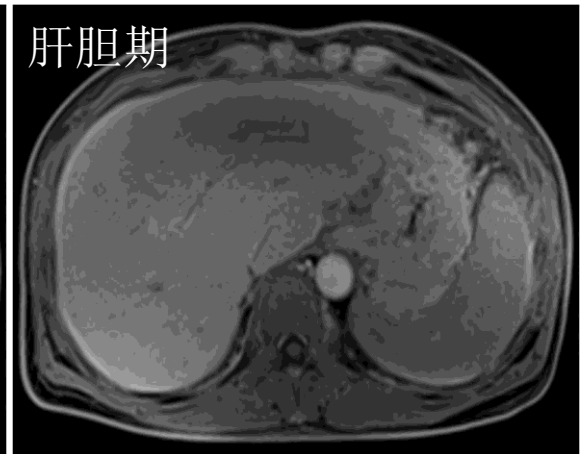
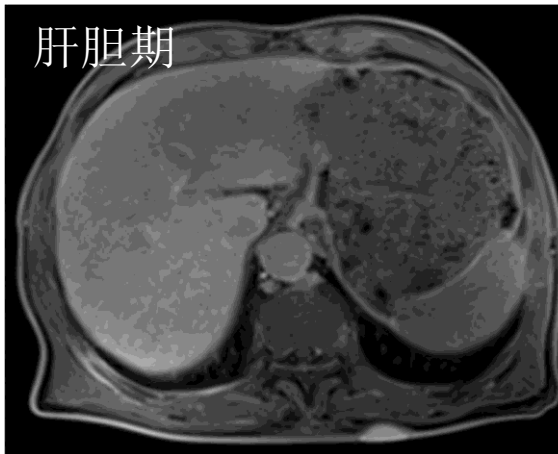
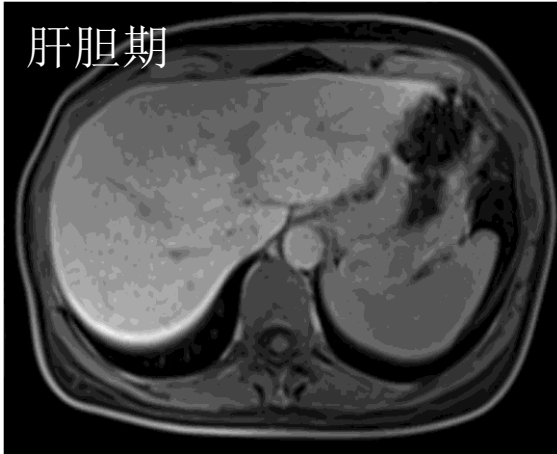
C级



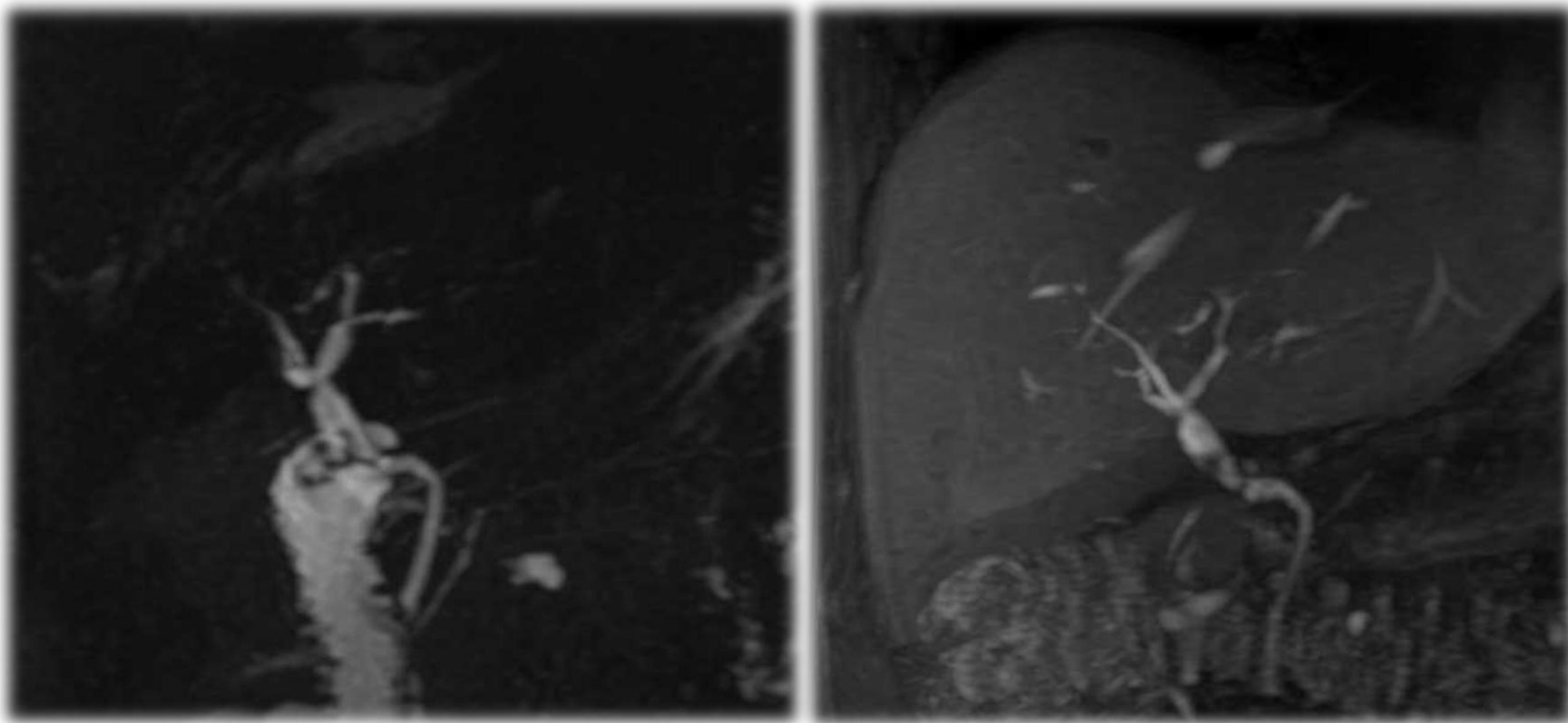
肝胆期

肝胆期

肝胆期



肝硬化Child-Pugh A、B、C级



胆道吻合口狭窄在肝移植受体

# 莫迪司在肝脏增强扫描中优势

- 1、可作为常规对比剂全身应用
- 2、兼具肝胆期诊断优点
- 3、性价比高

一家之言，不妥之处敬请指正。

谢谢！