

心脏MR检查技术及应用

内容提要

MR检查前准备

检查中定位技术

检查扫描序列方案的选择

各种序列手段能够解决的问题

黑血技术 白血技术 首次灌注 延迟强化 技术血流成像病例

检查前的准备 ——病人的筛选

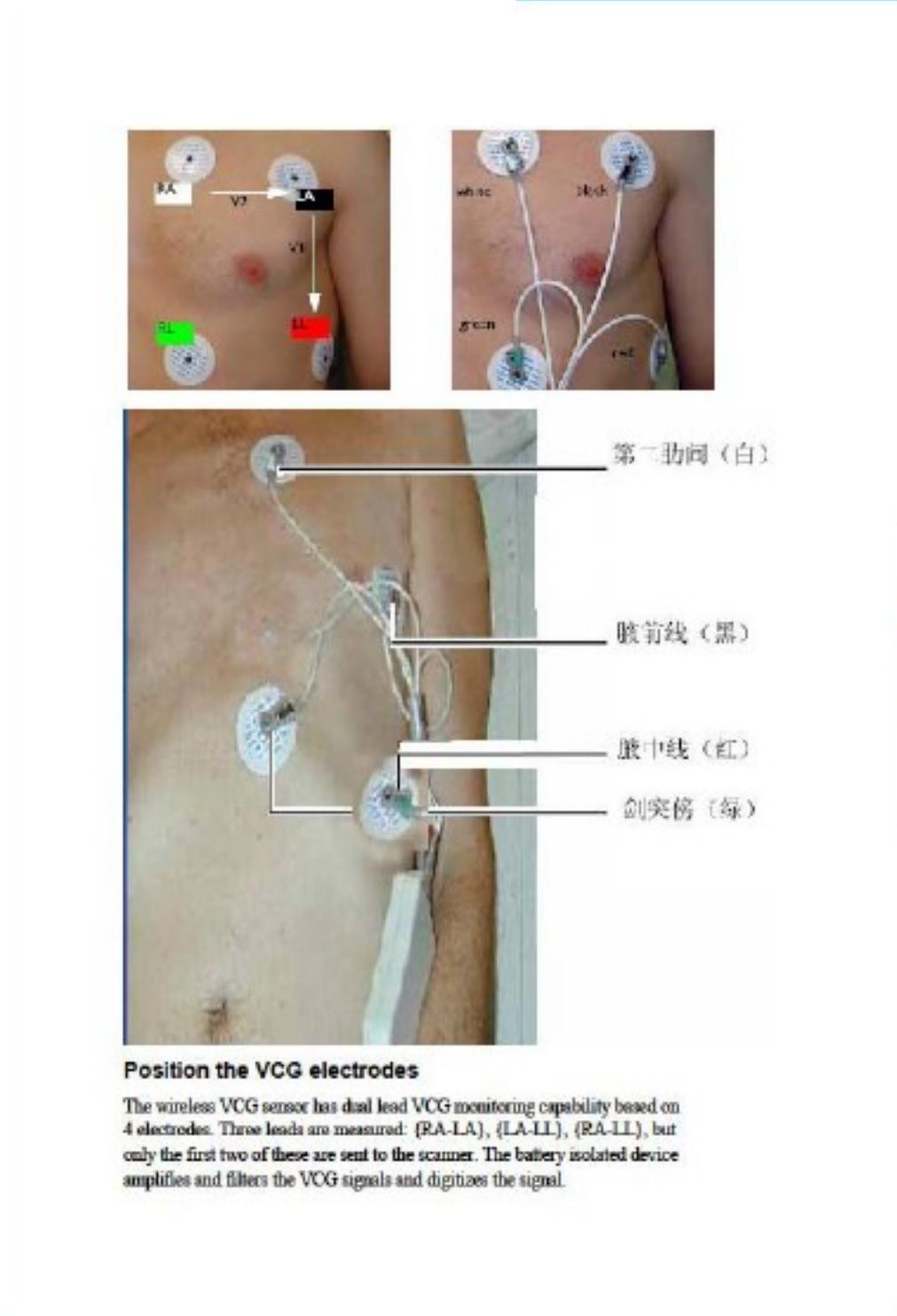
心率控制，心律的要求

心功能能否耐受长时间检查及呼吸配合问题

是否有恐惧症

检查时间长 病人吸收的SAR高 发热

小儿镇静



放置、连接ECG电极



放置
电极
连接
传感器

扫描前准备

线圈摆放

常见问题：线圈摆放位置过低

线圈中心平第三前肋间，能同时兼顾心脏及大血管

心电门控

VCG

指脉（用酒精棉签清洗病人手指）

呼吸门控

抑制心跳运动影响

概述：心电同步方法

	(预期) 触发	门控	回顾性
采集方法	触发	连续；门控内接收数据	连续（全 RR 窗）
相关参数	TR [次], TR [ms] RR 窗 触发延迟 相位数量	RR 窗 门控延迟 门宽 心律失常拒绝	RR 窗 心律失常拒绝 相位百分比

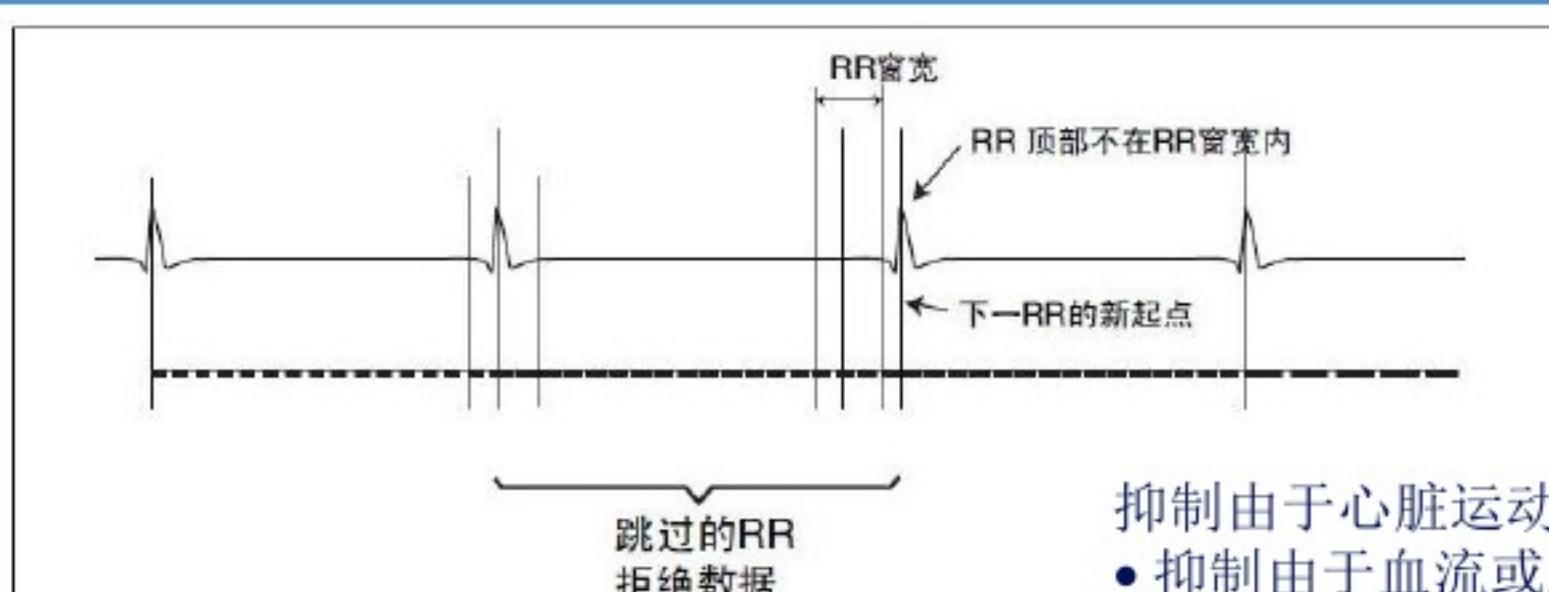


图 2.12 回顾性触发时的心律失常拒绝。

- 抑制由于心脏运动导致的伪影
- 抑制由于血流或脑脊液流动导致的伪影
- 在心跳周期的不同相位进行心脏成像

● 呼吸抑制和补偿，屏气（练习呼吸）

● 导航技术

导航光束定位

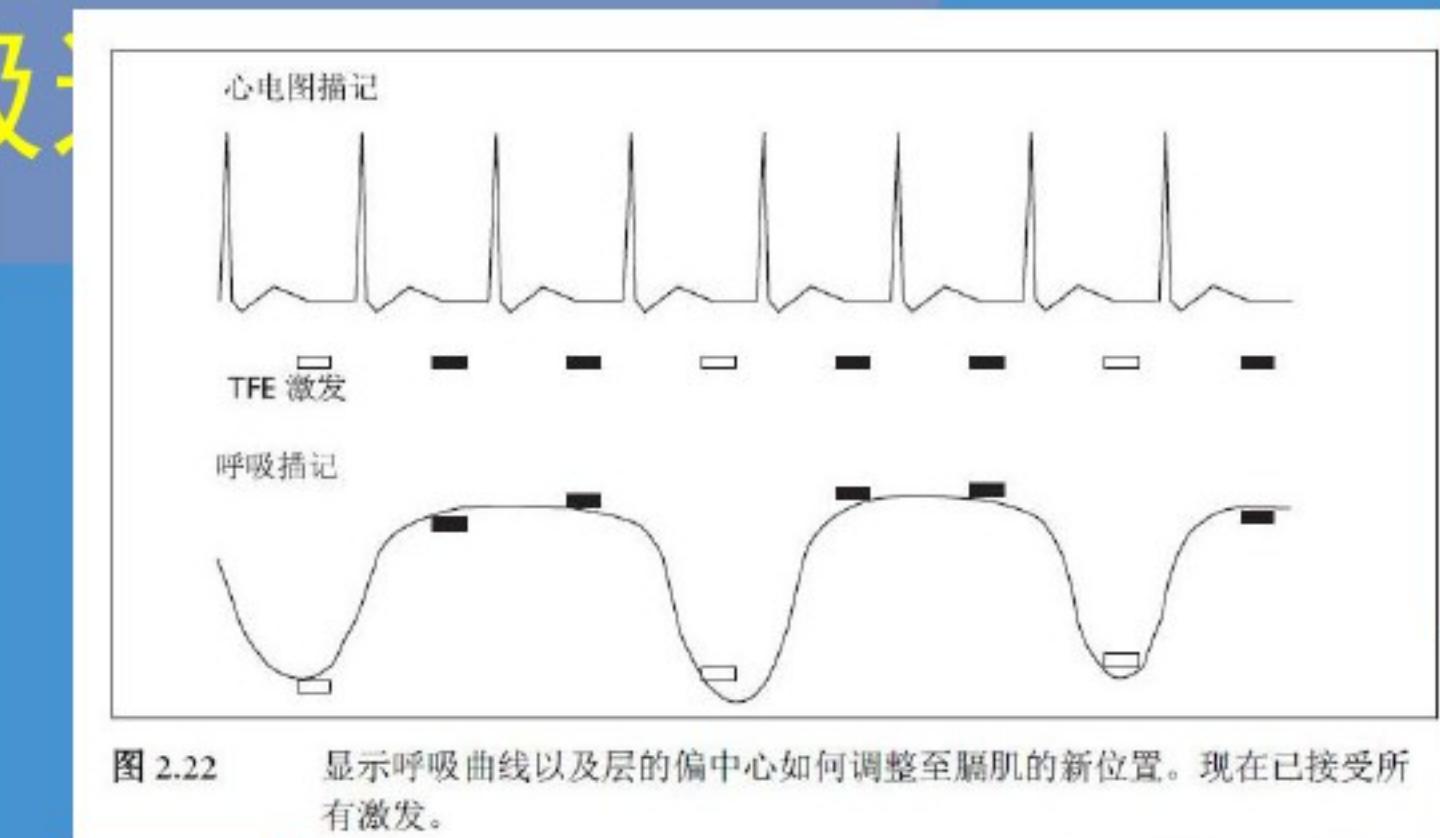
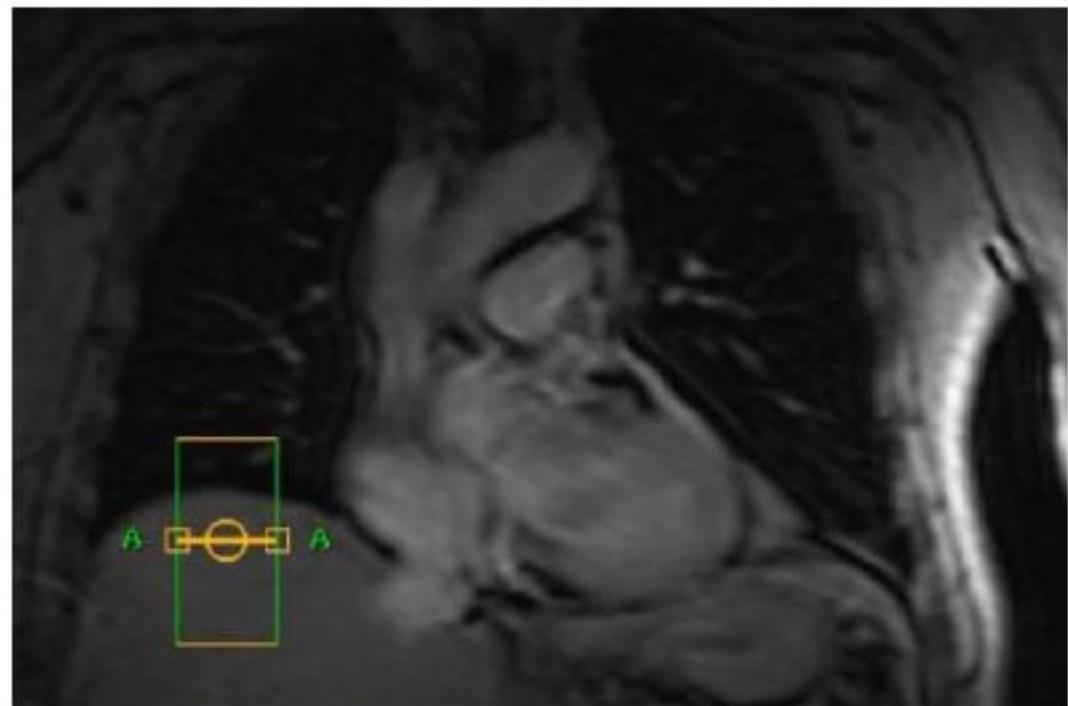
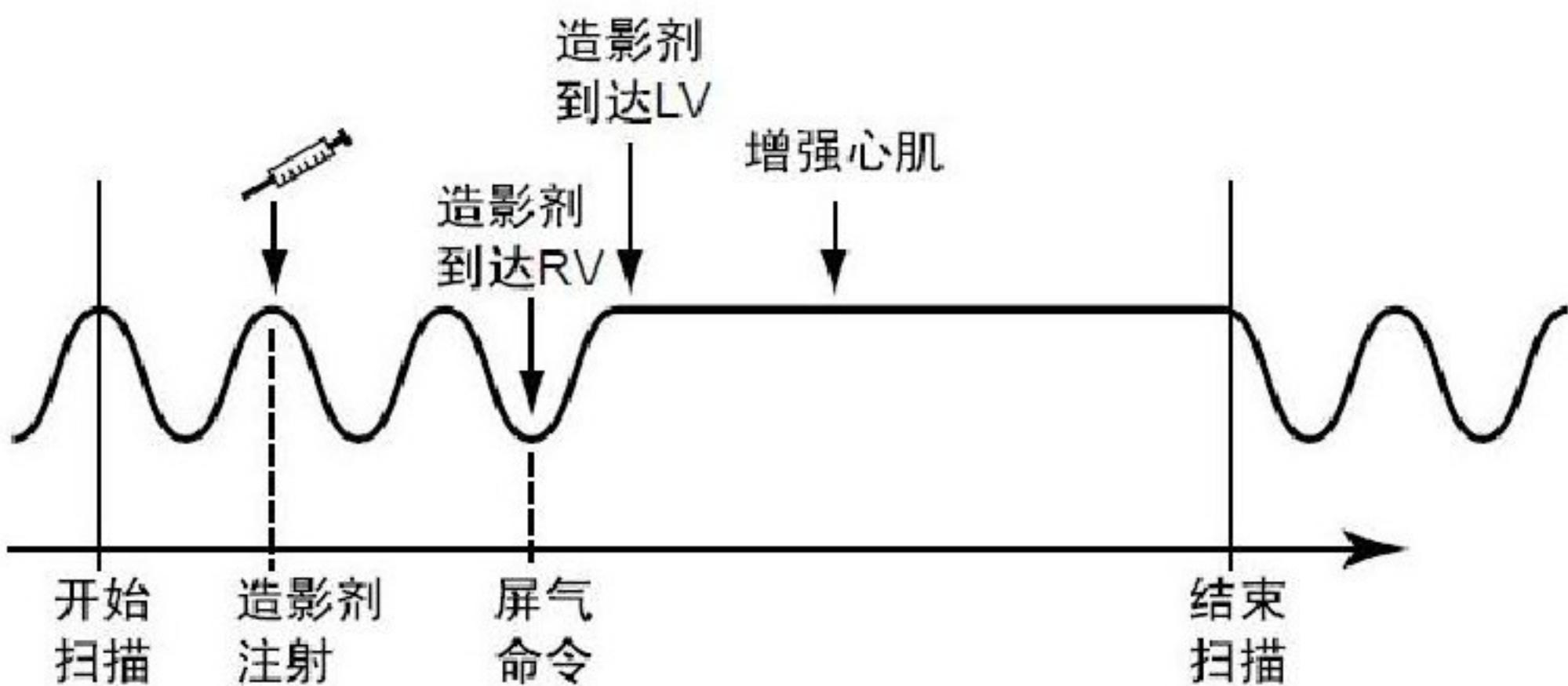
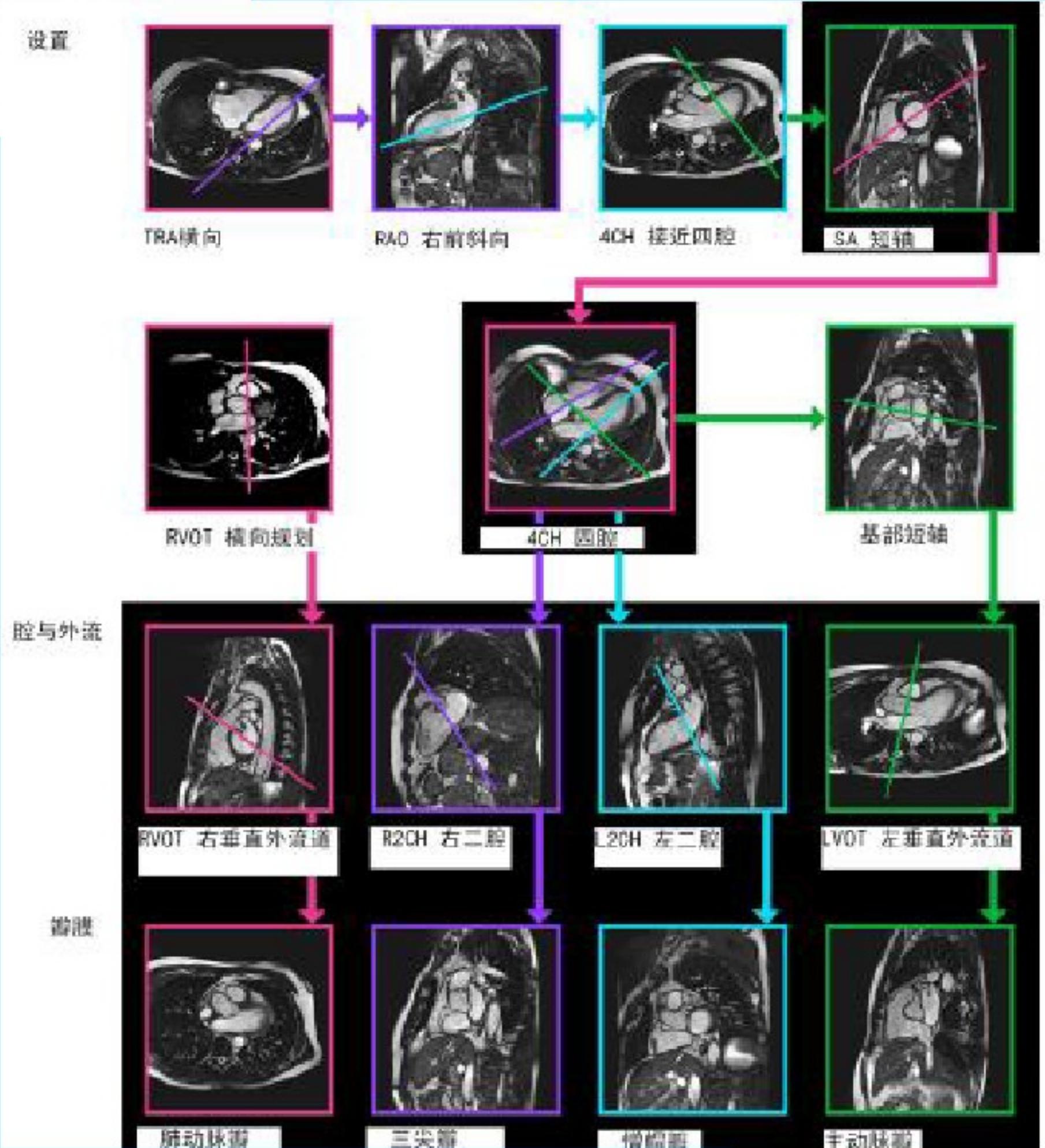
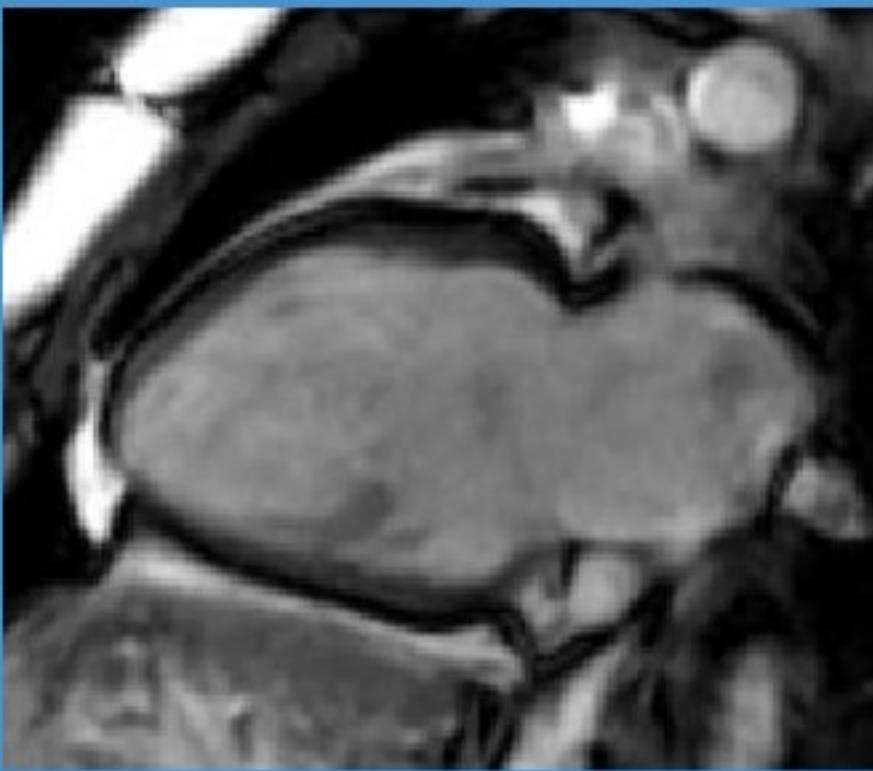
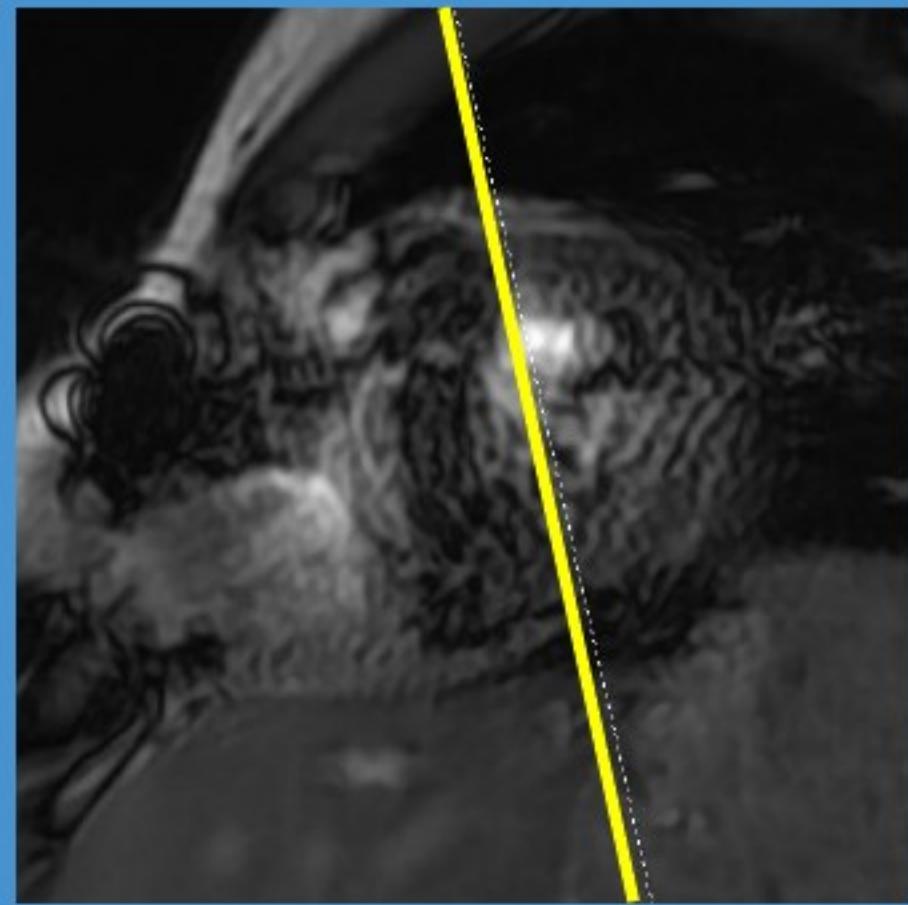
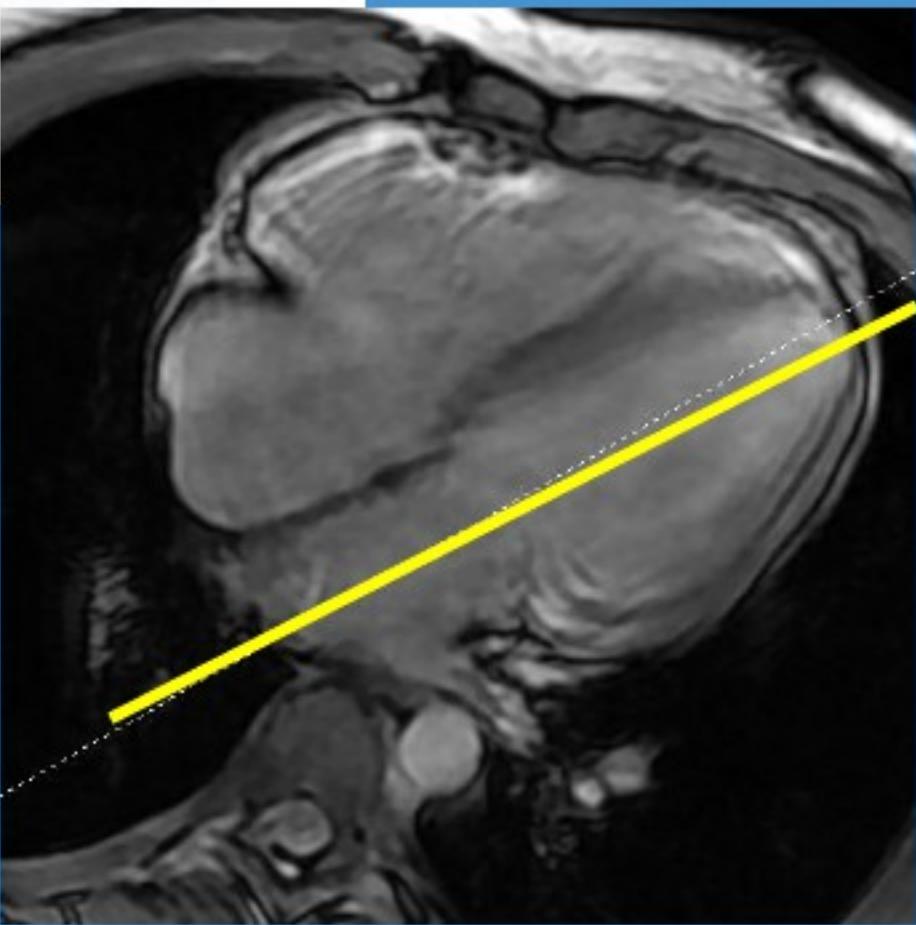


图 2.22 显示呼吸曲线以及层的偏中心如何调整至膈肌的新位置。现在已接受所有激发。



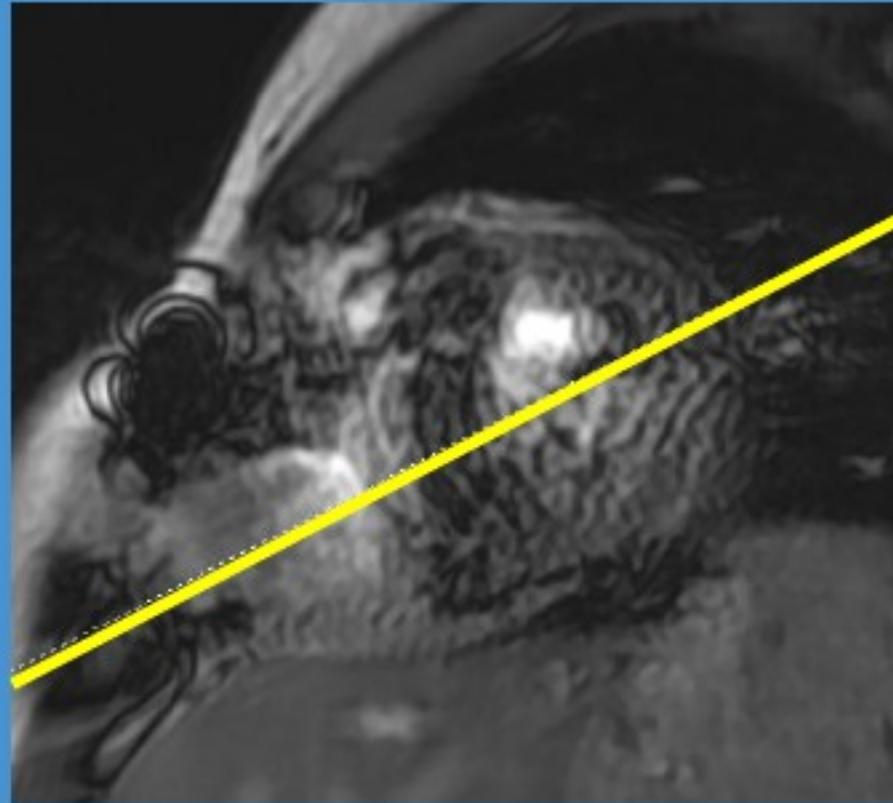
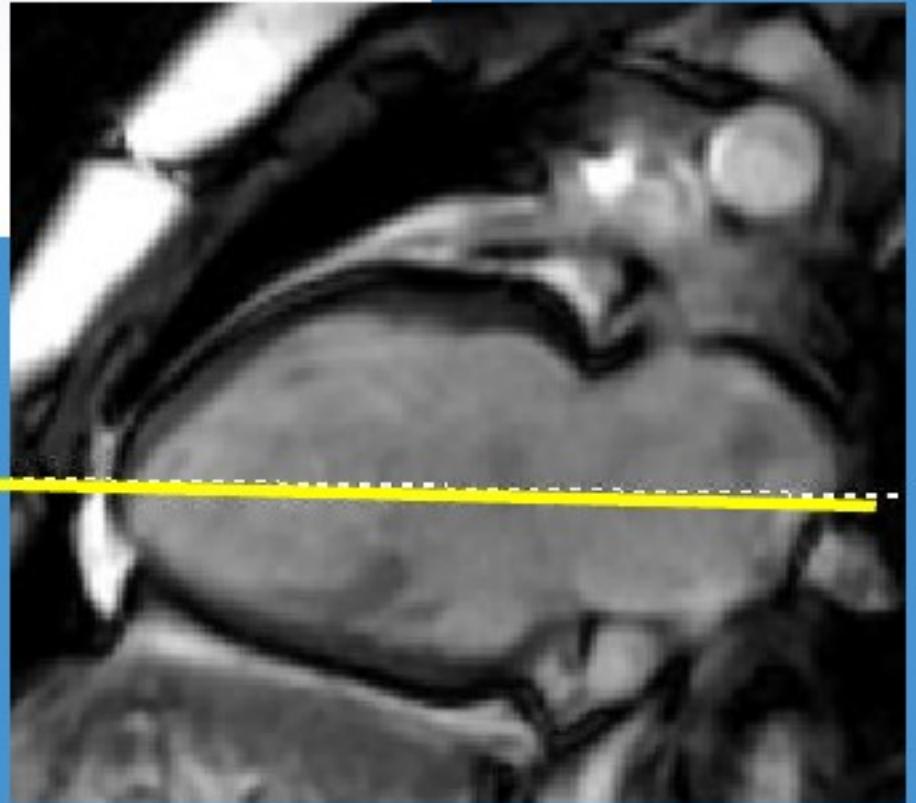
定位技术





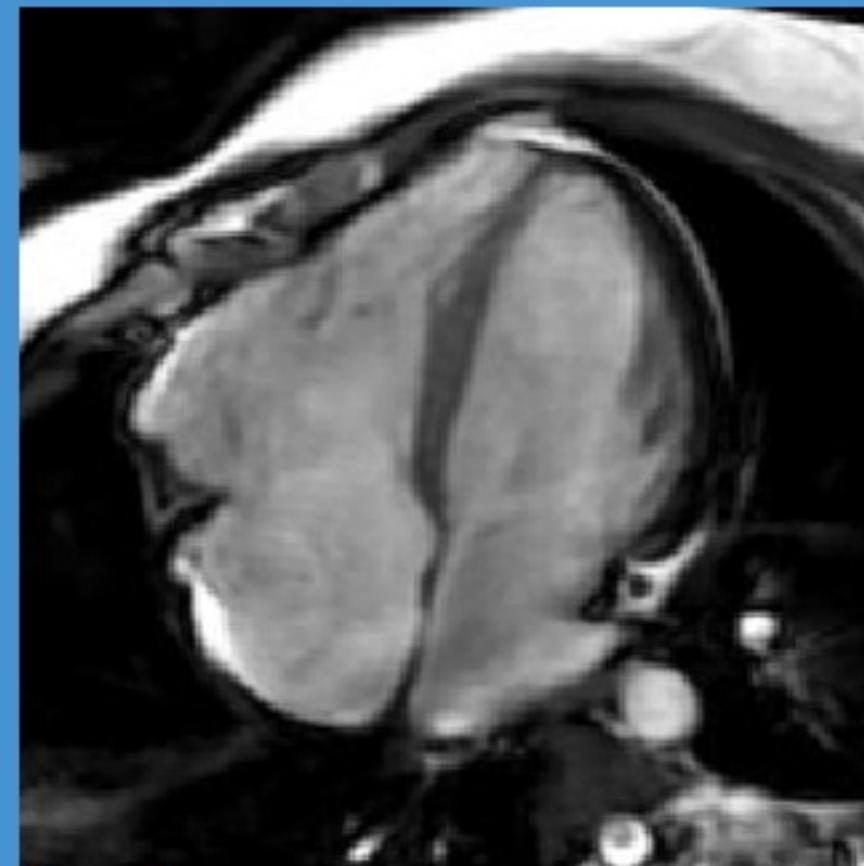
左室长轴2腔心电影

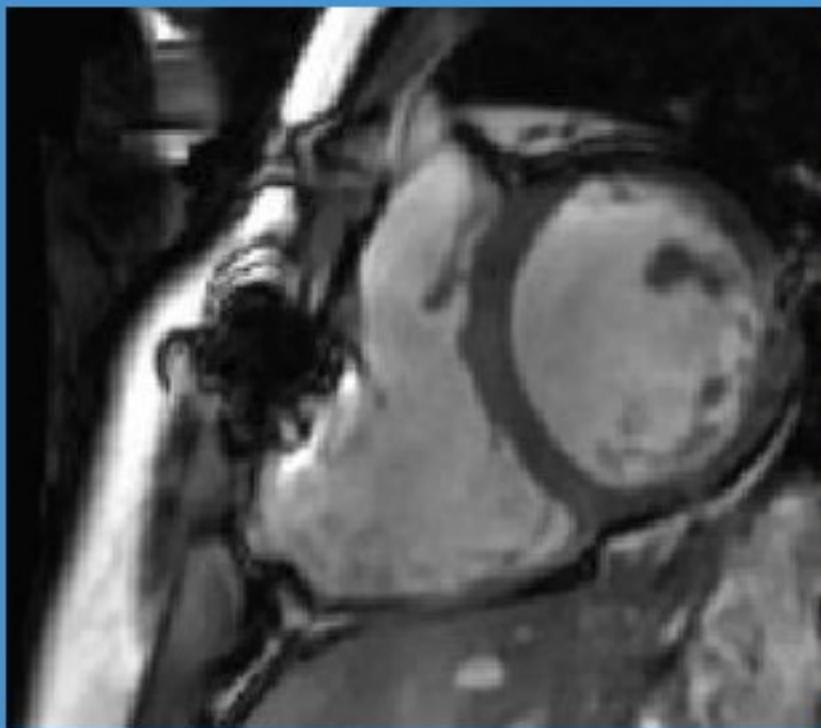
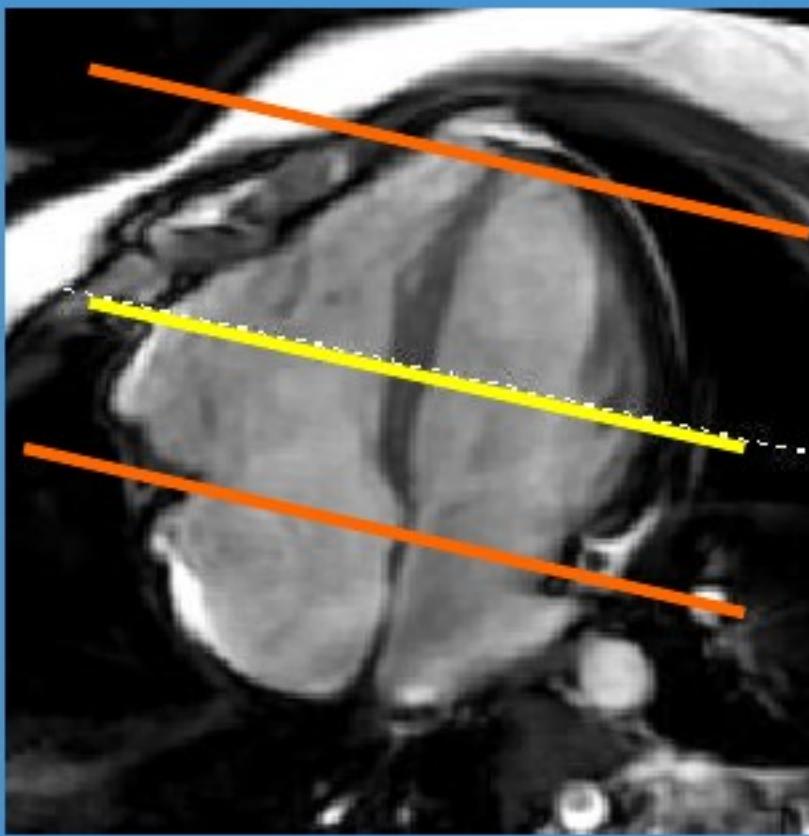
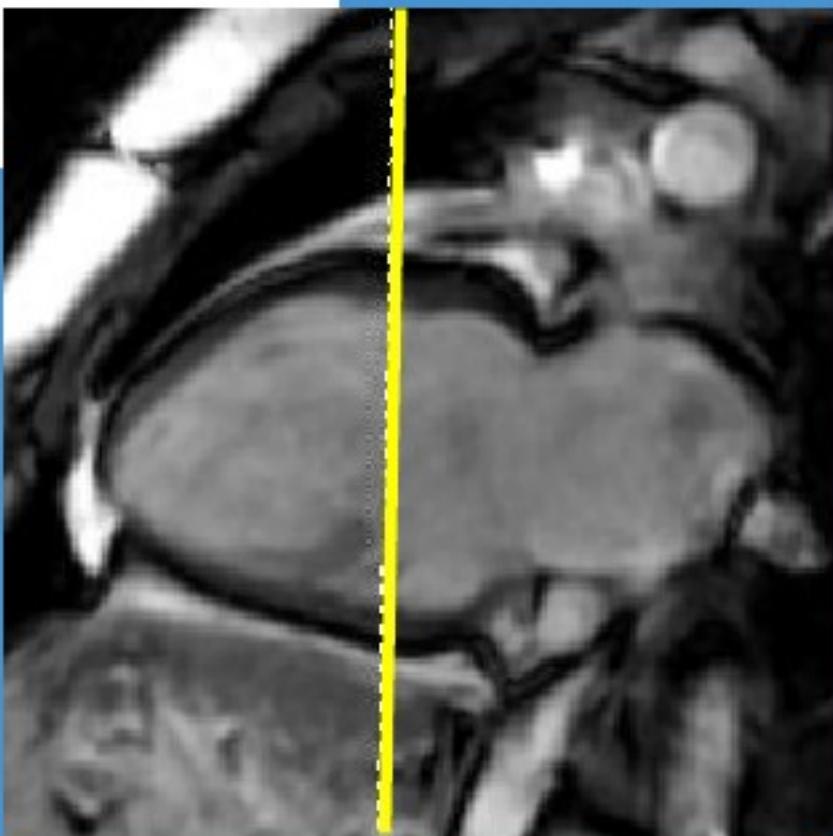
● 通过心尖，平行于室间隔



四腔心

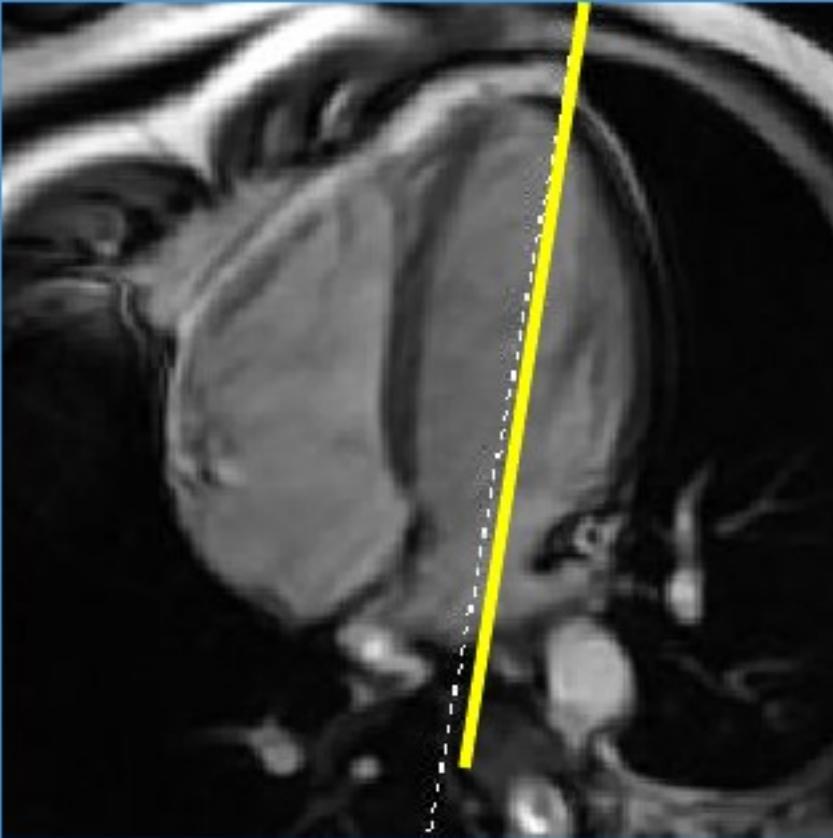
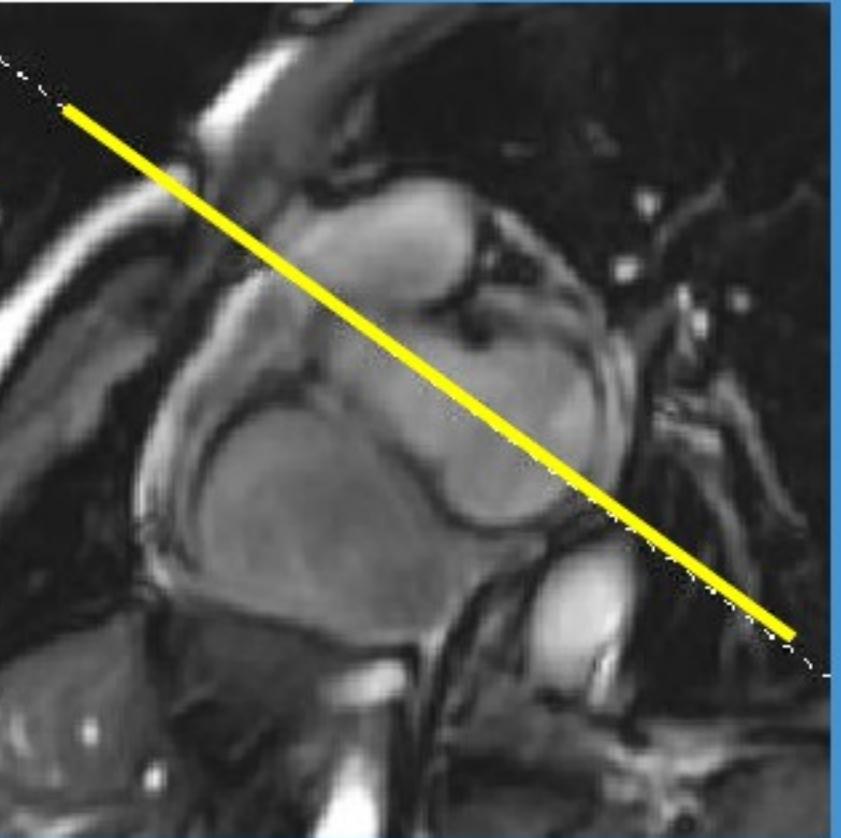
- 舒张期定位
- 通过二尖瓣中点与左室心尖
- 要求包括右室心尖；不包含主动脉根部





多层短轴

- 垂直四腔心及左室长轴两腔心从整

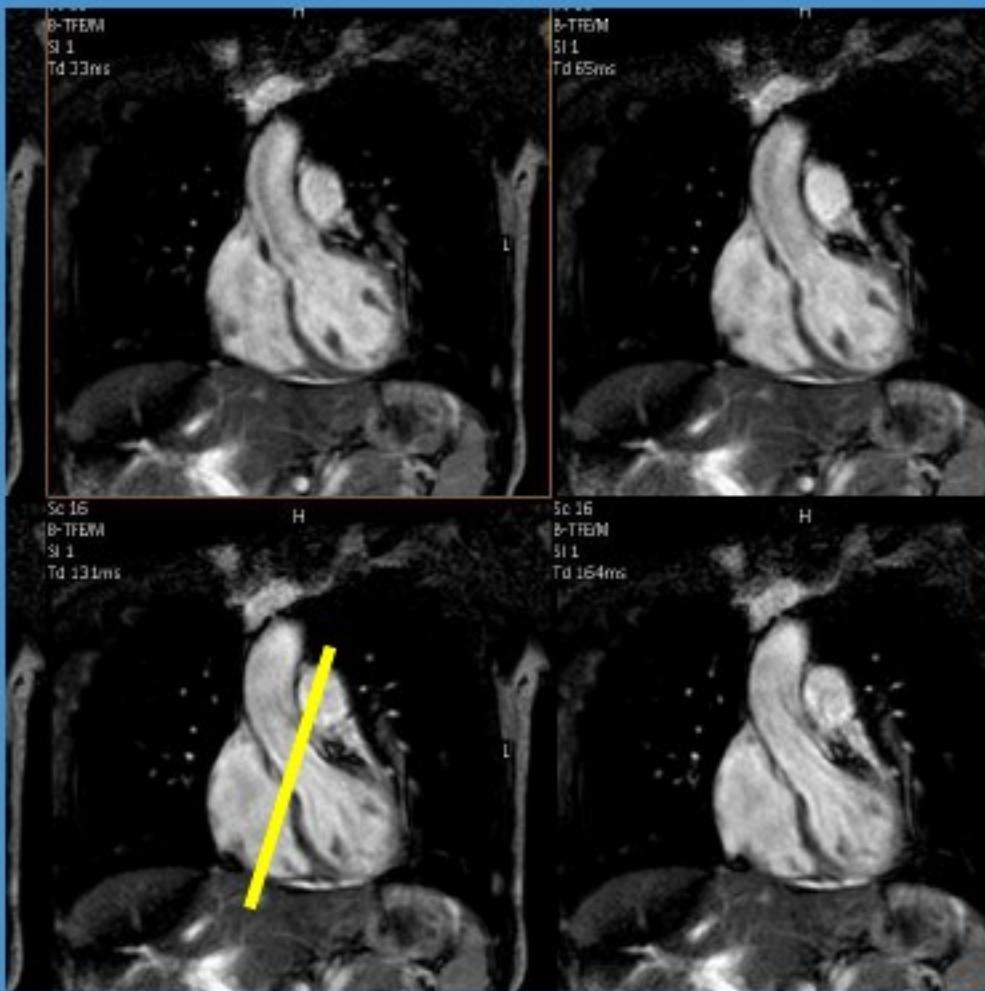
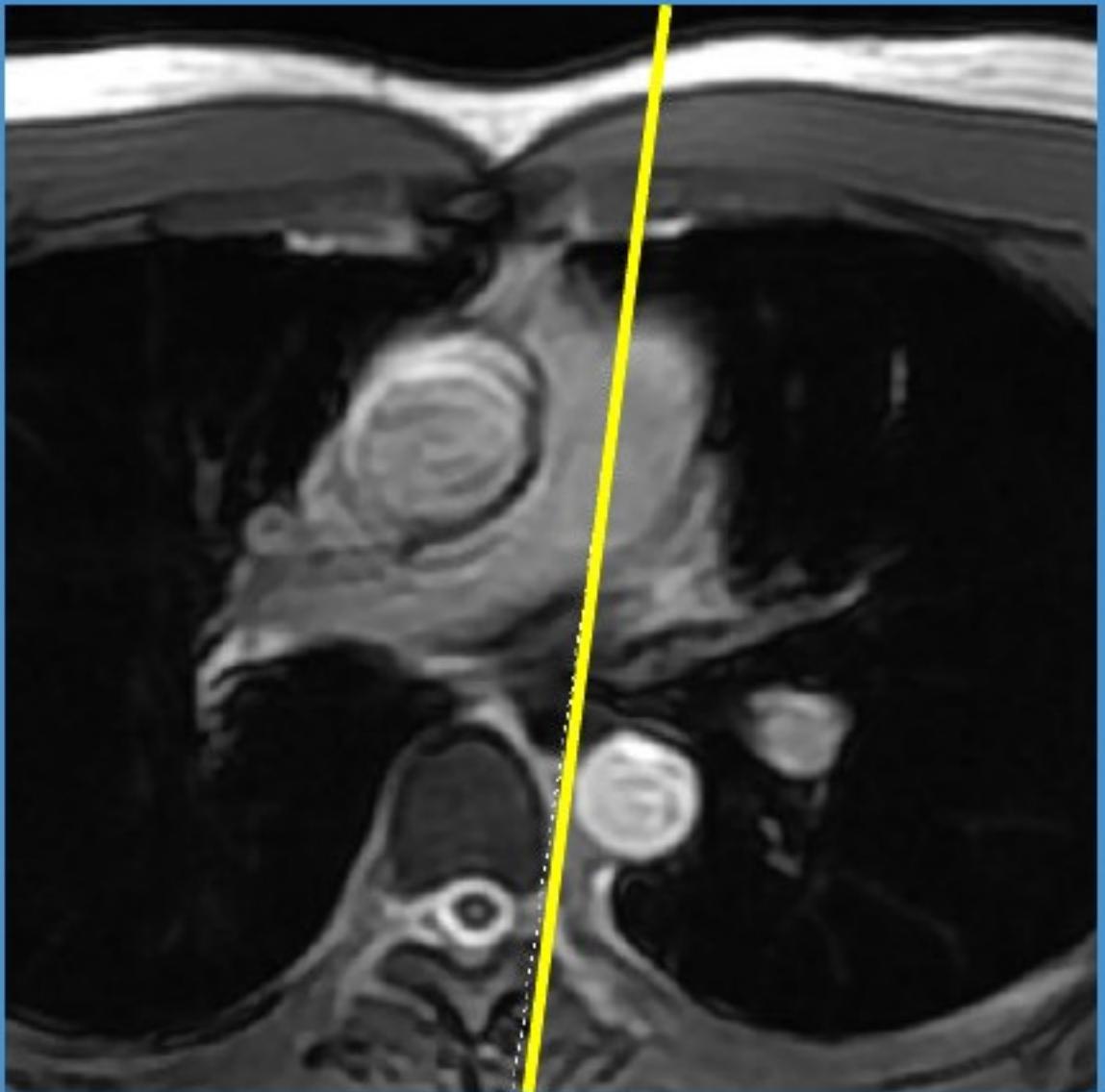


三腔心或主动脉流出道

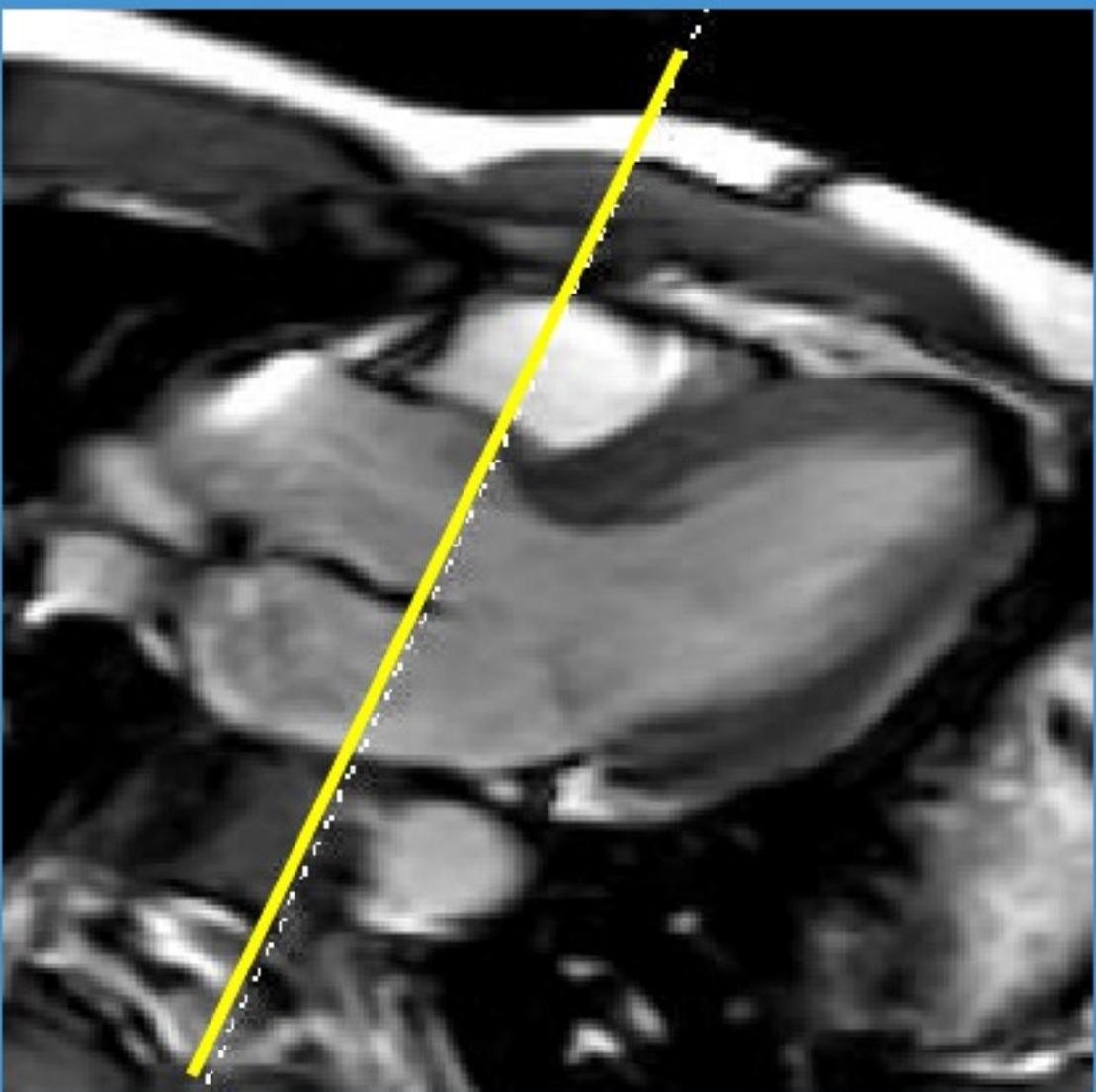
- 心底部短轴，通过二尖瓣中点及主动脉瓣中点连线作为扫描基线



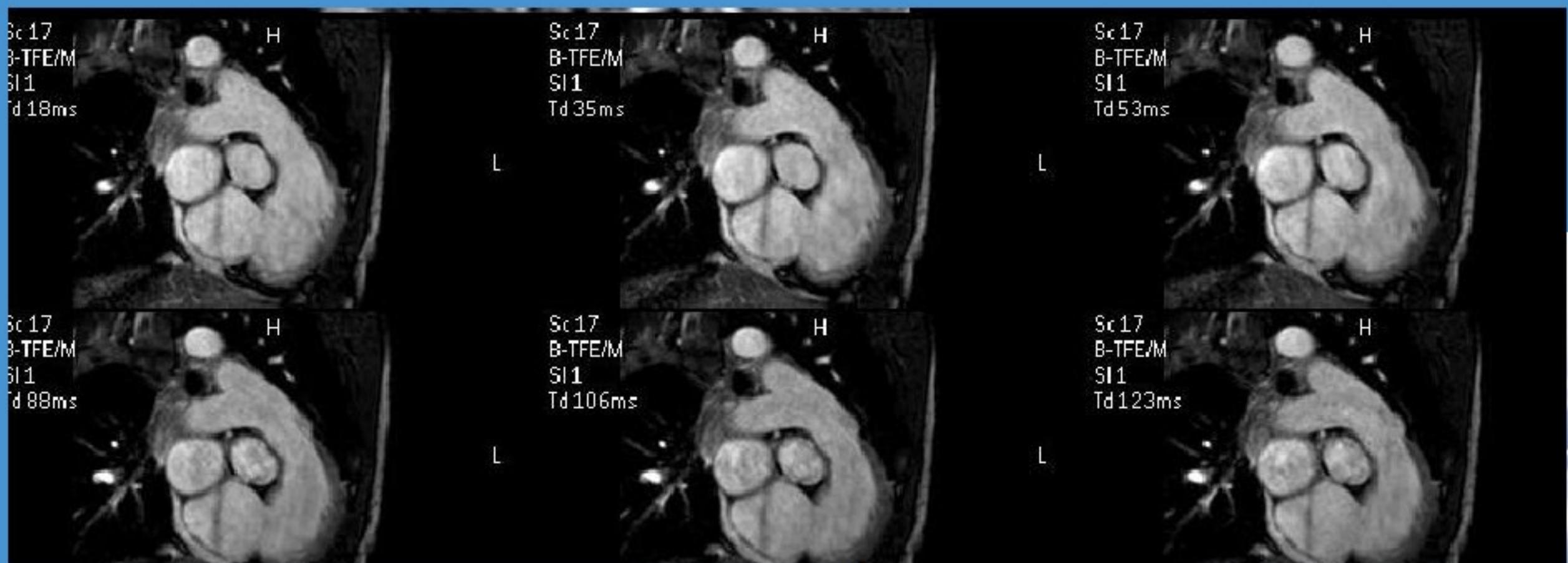
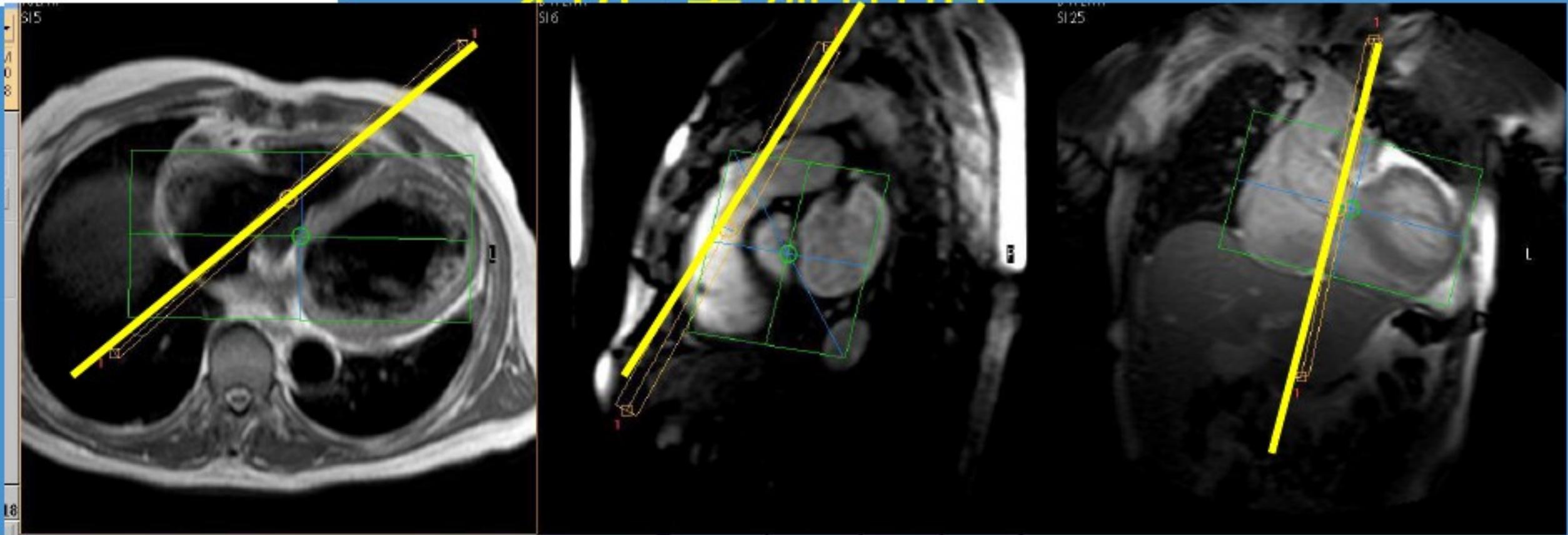
右心室流出道



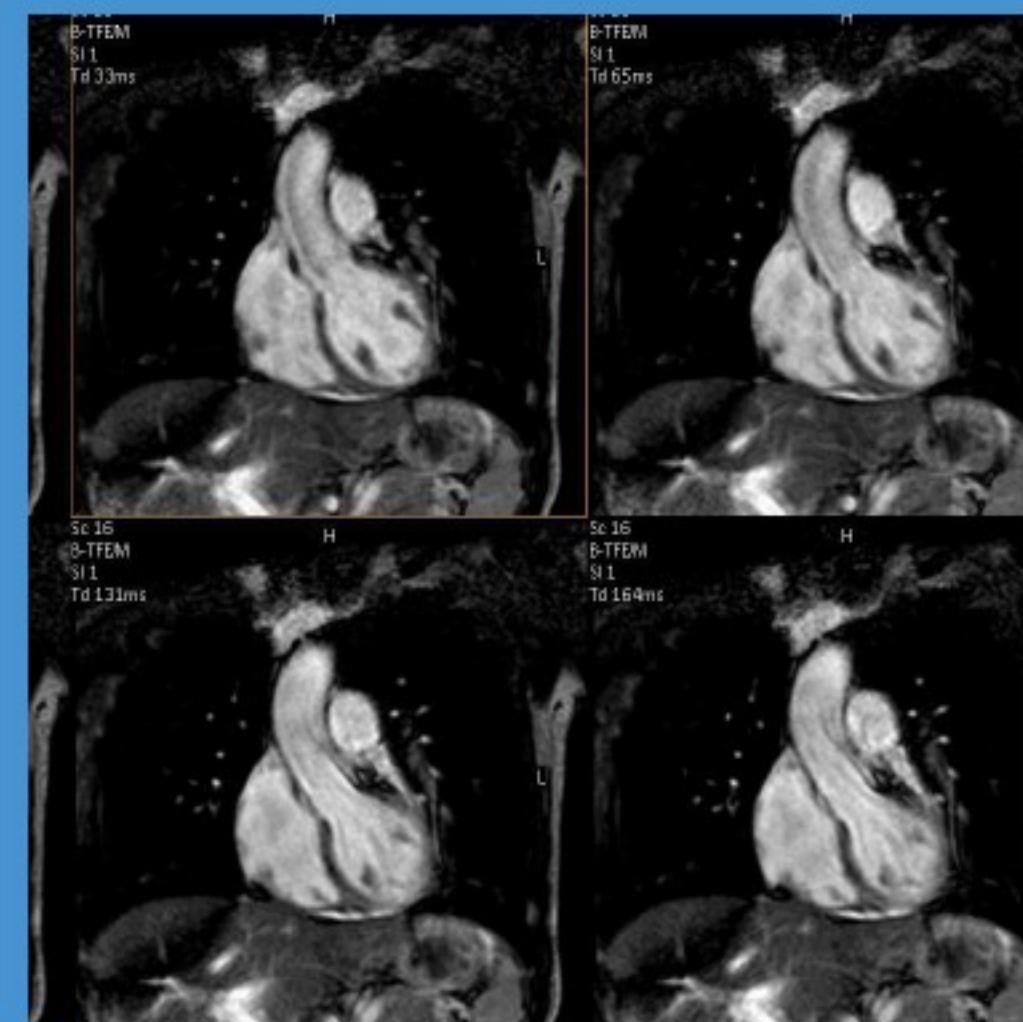
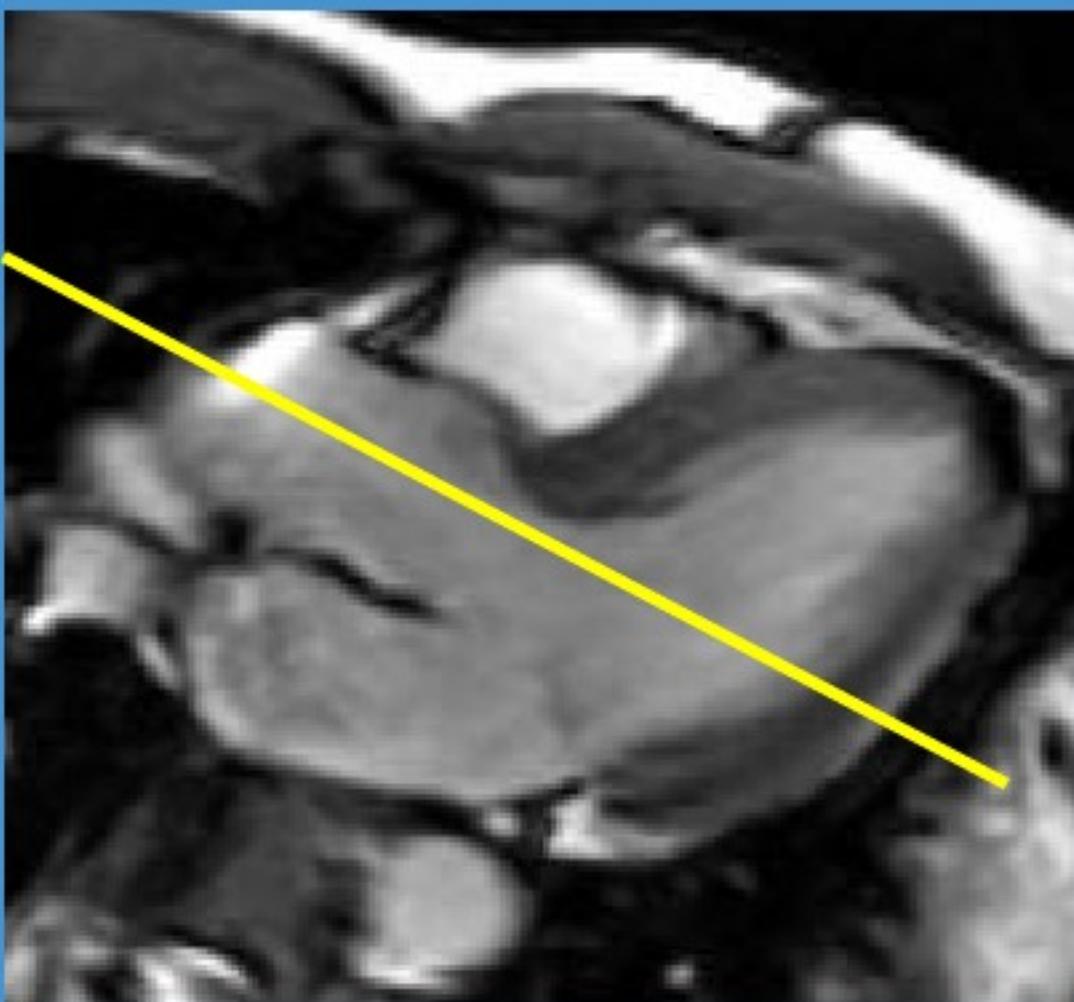
右心室流出道



右心室流出道



左心室流出道



临床申请单

——决定了扫描序列方案

心肌病扫描序列（肥厚型心肌病、扩张型心肌病、限制型心肌病）

致心律失常性右室心肌病扫描序列

心脏肿瘤扫描序列

胸部大血管扫描序列

小儿先心扫描序列

心包（主要为缩窄性心包炎）扫描序列

心包肿瘤序列

临床医生开出合格申请单，根据申请单给予正确的扫描序列

心脏扫描序列

SURVEY

Ref_Cardiac

INTERACTIVE

TRA1



BB_SSh_RTrig

TRA

T2_aTSE_BB

SA

T2_aTSE_BB

4CH

注射器图标 DYN_sTFE_3sl

SA

B-TFE_BH

RAO



B-TFE_BH_M2D

SA

B-TFE_BH

4CH

B-TFE_BH

3CH

B-TFE_BH

LVOT

B-TFE_BH

RVOT

Philips

Hospital

Cardiomyopathy

STIR_BH

RVOT

B-TFE_BH_M2D

SA

B-TFE_BH

4CH

B-TFE_BH

3CH

B-TFE_BH

LVOT

B-TFE_BH

RVOT

IR_TFE_LL_2b...

SA

IR_TFE_BH_2...

SA

PSIR_TFE_BH

SA

PSIR_TFE_BH

4CH

IR_TFE_BH_2...

4CH

s3D_IR-TFE_S...

Geo2

IR_SSh_sBTF...

Geo1

心肌活性

心肌病扫描序列（肥厚型心肌病
肌病、限制型心肌病）

		SameScan	ScanAlign	Cancel	Proceed
		Philips	Hospital		
	ARVC				
SURVEY					
Ref_Cardiac					
INTERACTIVE	TRA1				
BB_SSh_RTrig	TRA				
PD_aTSE_BB	SA				
PD_aTSE_BB	4CH				
PD_aSTIR_BB	SA				
PD_aSTIR_BB	4CH				
DYN_sTFE_3sl	SA				
B-TFE_BH	RAO				
B-TFE_BH_M2D	SA				
B-TFE_BH	4CH				
B-TFE_BH	3CH				
B-TFE_BH	LVOT				
B-TFE_BH	RVOT				
B-TFE_BH	RVOT1				
IR_TFE_LL_2b...	SA				
IR_TFE_BH_2...	SA				
IR_TFE_BH_2...	4CH				

致心律失常性右室心肌病（或叫右室

Scans		Scans	Cancel	Proceed
Philips	Hospital			
Cardiac tumor scan 20110225				
SURVEY				
Ref_Cardiac				
INTERACTIVE	TRA1			
BB_SSh_RTrig	TRA			
PD_aTSE_BB	SA			
T2_aSTIR_BB	SA			
PD_aTSE_BB	4CH			
T2_aSTIR_BB	4CH			
e-THRIVE_BH...	TRA			
T1_aTSE_BB+...	SA			
B-TFE_BH	4CH			
B-TFE_BH	RAO			
B-TFE_BH_M2D	SA			
B-TFE_BH	3CH			
B-TFE_BH	LVOT			
B-TFE_BH	RVOT			
T1_aTSE_BB+...	4CH			
IR_TFE_LL_2b...	SA			
IR_TFE_BH_2...	SA			
IR_TFE_BH_2...	4CH			

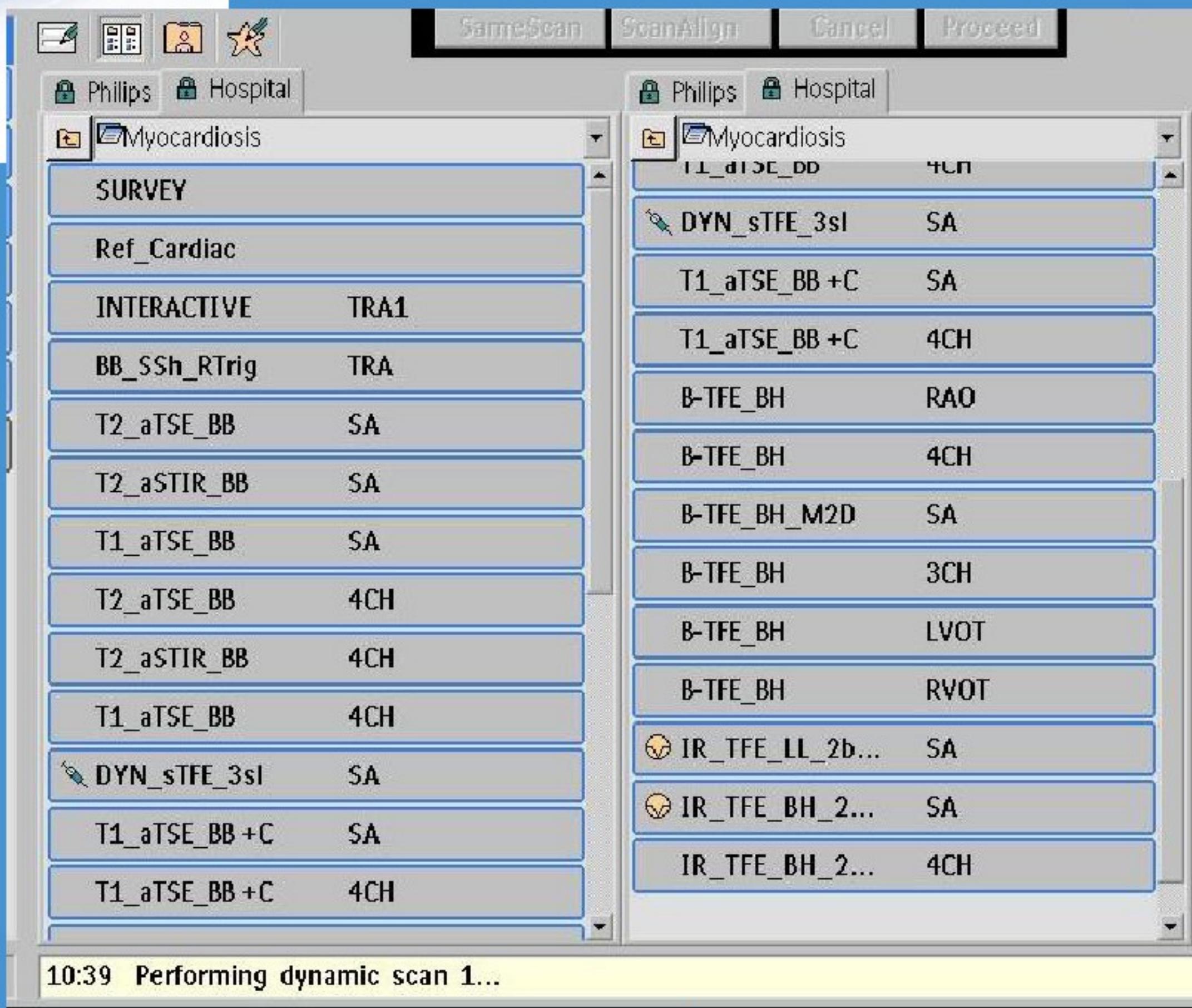
10:35 FWHM of peak 85 Hz

Cardiac tumor scan 20110225

		SameScan	ScanAlign	Cancel	Proceed
Philips	Hospital				
Pediatric cardiac 2010.12.3					
SURVEY					
Ref_Cardiac					
BB_SSH_RTrig	axial				
BB_SSH_RTrig	SAG				
BB_SSH_RTrig	COR				
s3D_RENAL	keyhole				
2D_BOLUSTRAK	BT				
s3D_RENAL	keyhole				
INTERACTIVE	TRA				
B-TFE_BH	RAO				
B-TFE_BH	4CH				
B-TFE_BH_M2D	SA				
B-TFE_BH	3CH				
B-TFE_BH	RVOT				

10:35 FWHM of peak 85 Hz

小儿先心扫描序列



心肌炎、非炎性心肌变性病

		SameScan	ScanAlign	Cancel	Proceed
Philips	Hospital				
Pericardial disease					
SURVEY					
Ref_Cardiac					
INTERACTIVE	TRA1				
BB_SSh_RTrig	axial				
BB_SSh_RTrig	sag				
BB_SSh_RTrig	COR				
PD_aTSE_BB	SA				
PD_aTSE_BB	4CH				
T2_aTSE_BB	SA				
T2_aTSE_BB	4CH				
T2_aSTIR_BB	SA				
T1_TFE_BB +C	SA				
T1_TFE_BB +C	4CH				

10:35 FWHM of peak 85 Hz

心包（主要为缩窄性心包炎）

序列的5个组成部分及其应用

一般定位图——心脏标准位图

黑血技术——心脏、大血管结构初步观察

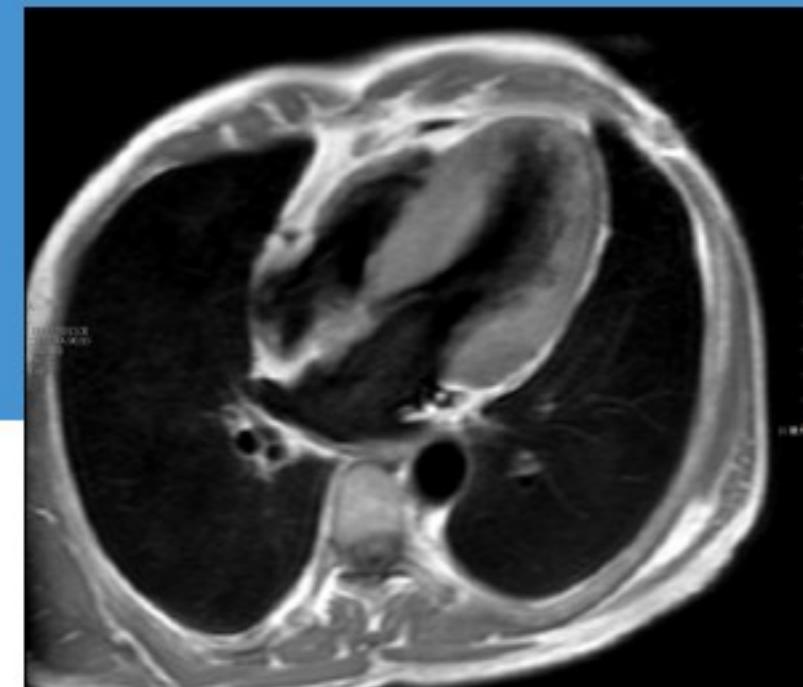
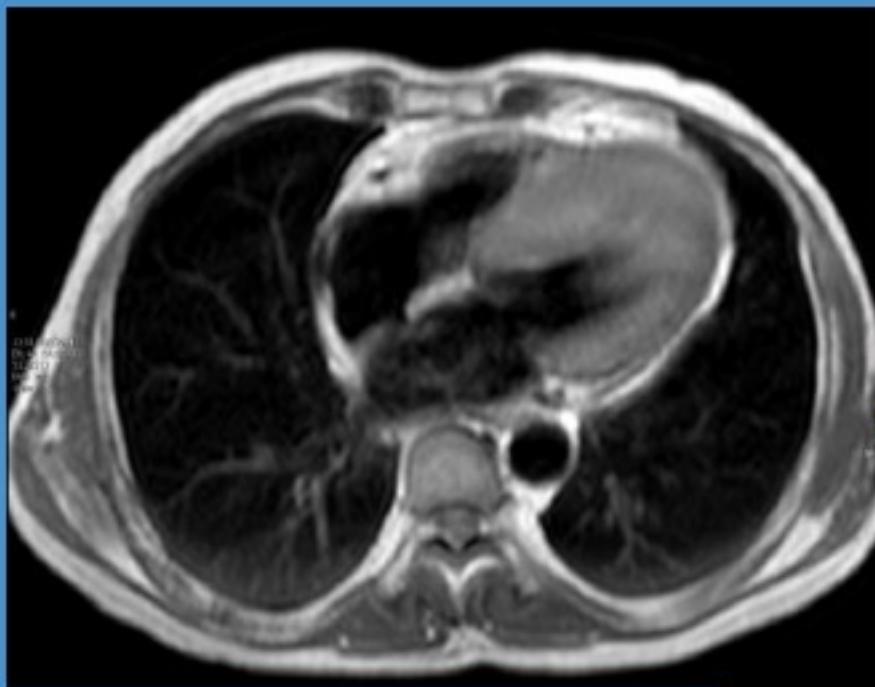
白血技术——心脏电影:解剖结构的观察, 心功能分析

灌注检查——心肌缺血

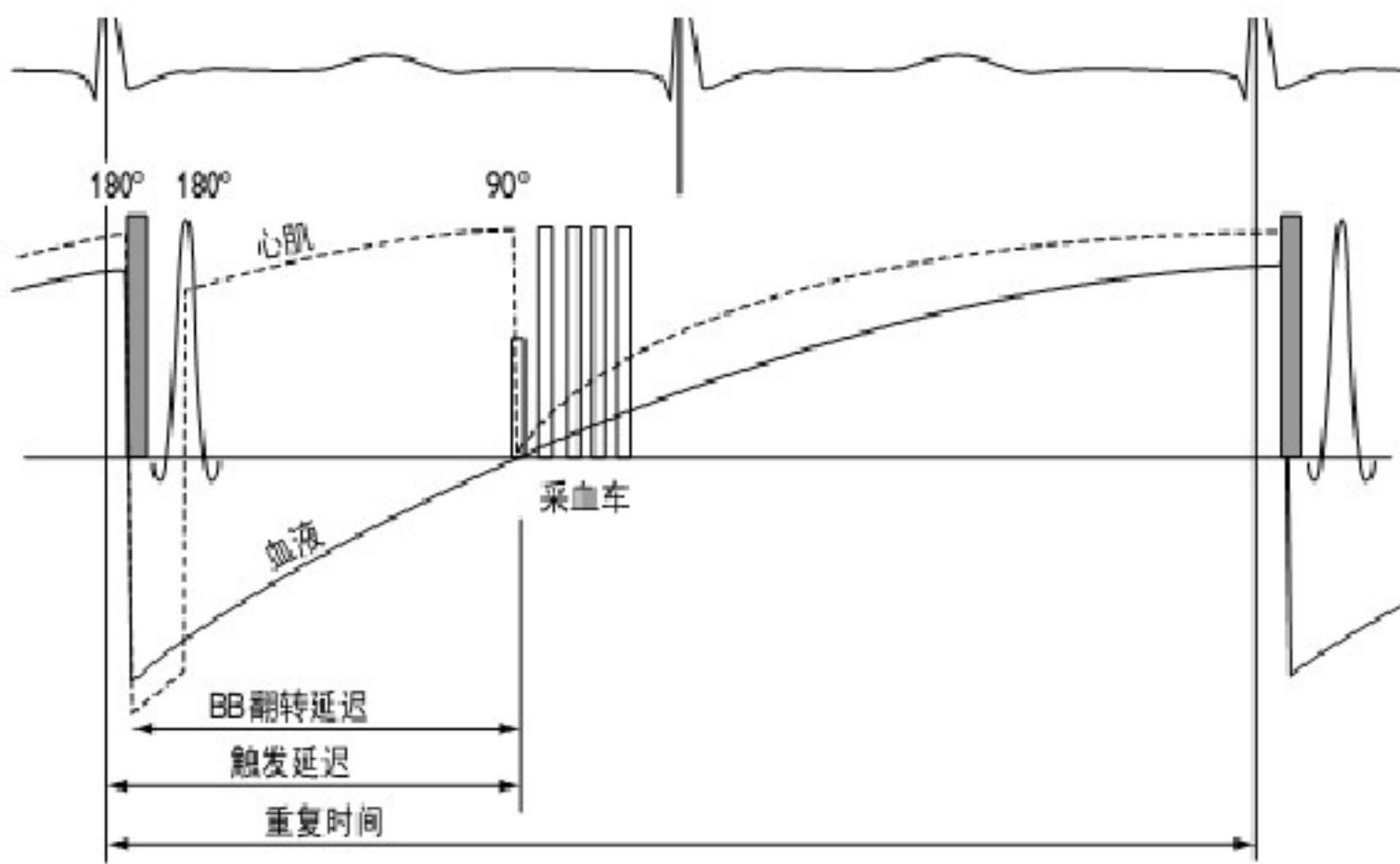
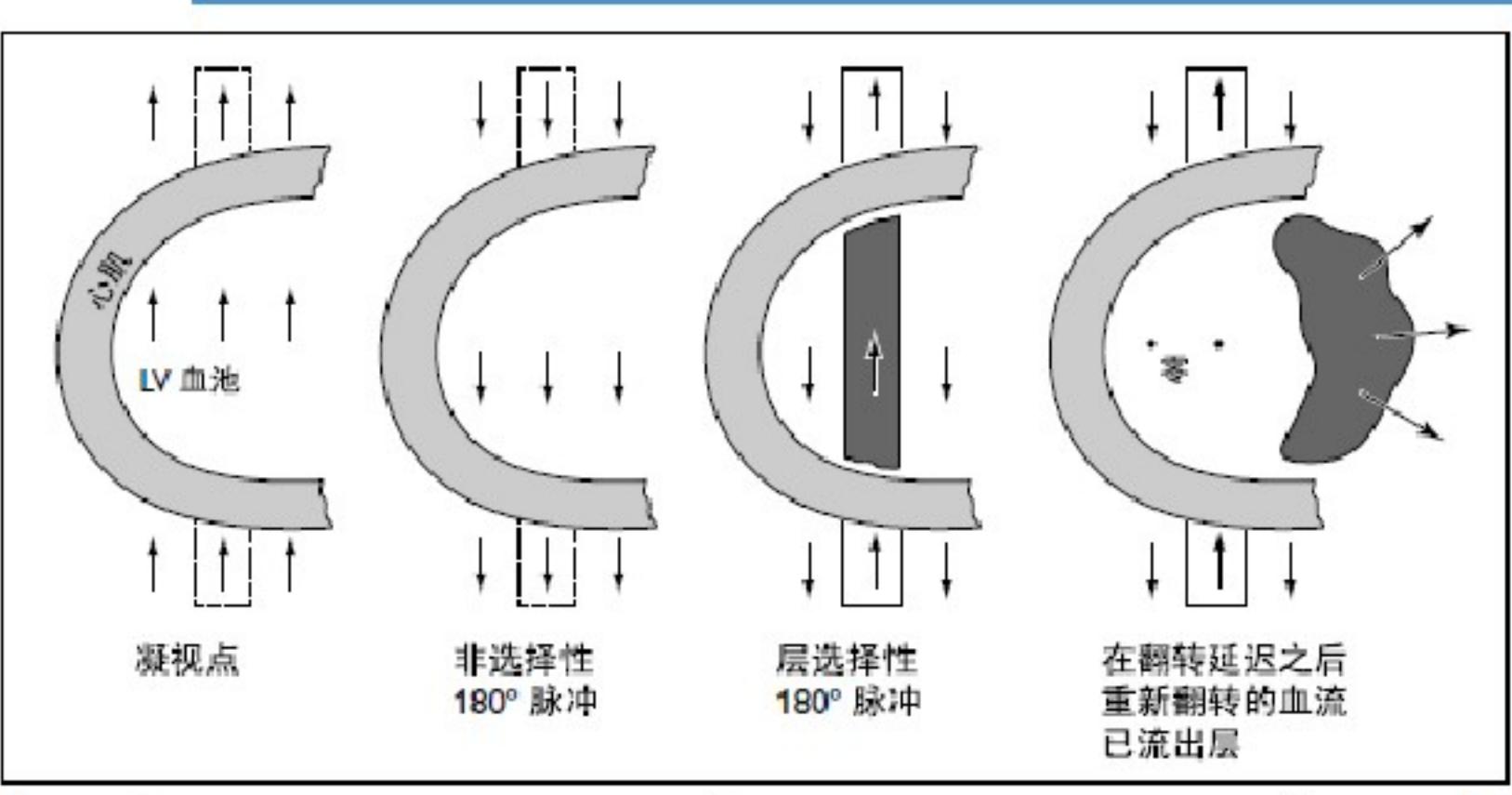
延迟增强——纤维化、瘢痕等

黑血技术——初步解剖结构显示

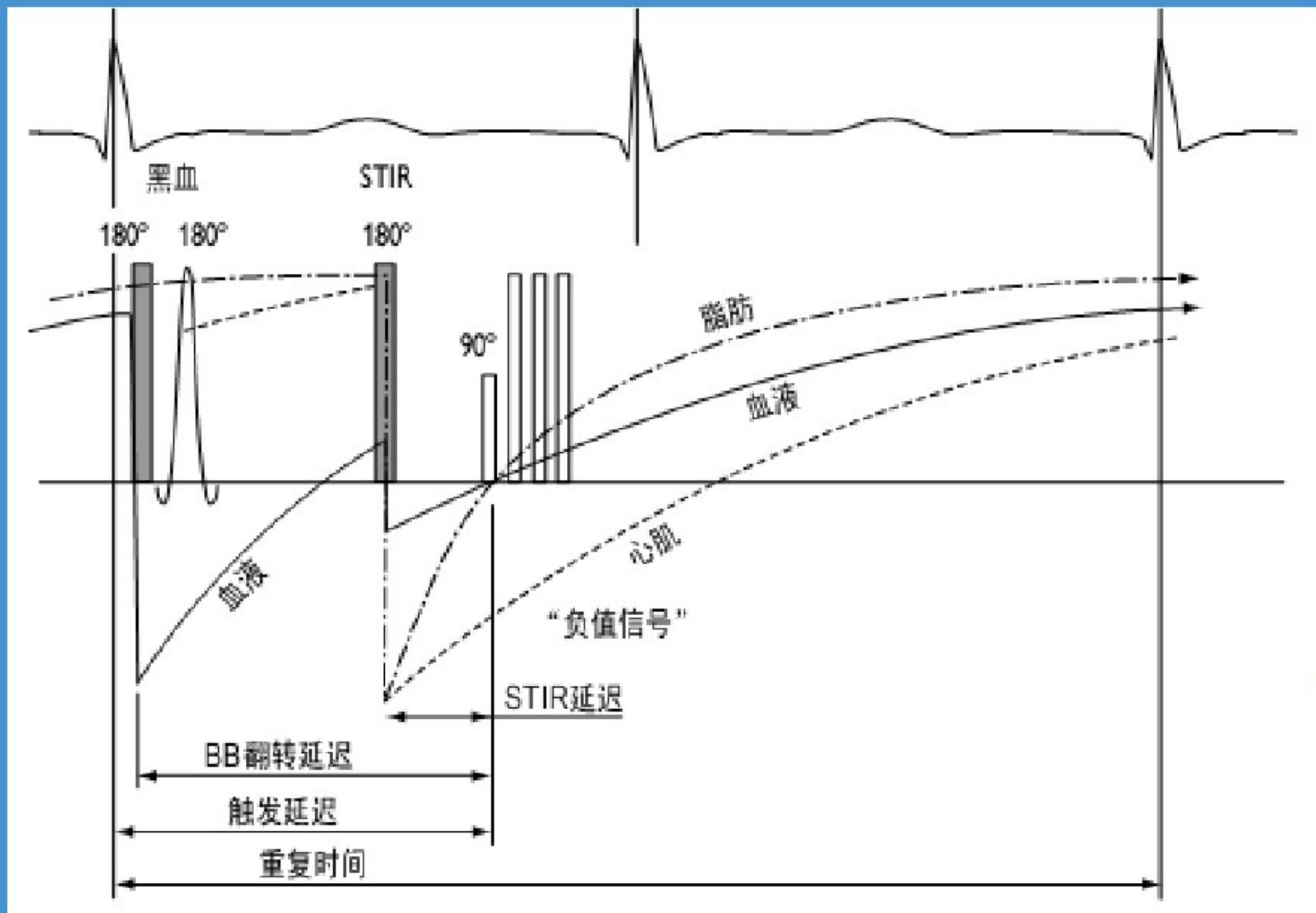
- Double-IR、Triple-IR
- 心腔内血液信号得到抑制——黑色
- 显示心肌形态、心腔大小

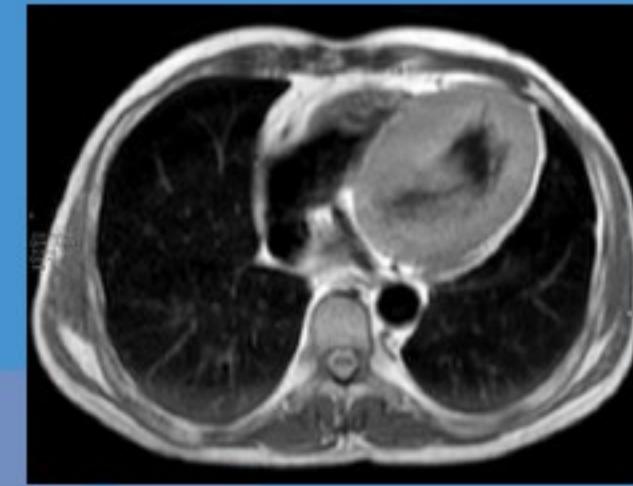
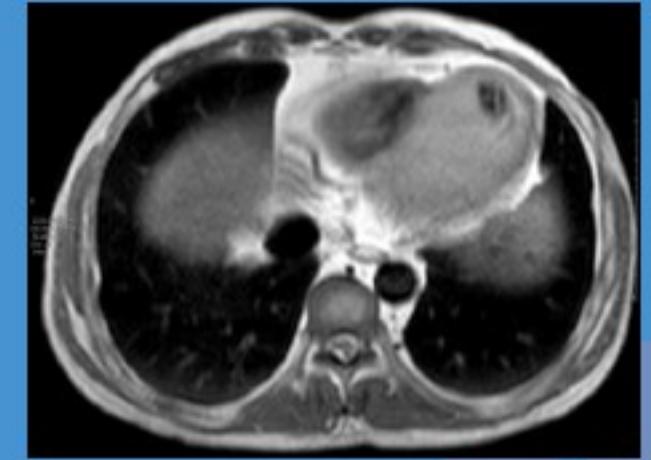


双翻转黑血序列：血液信号恢复曲线

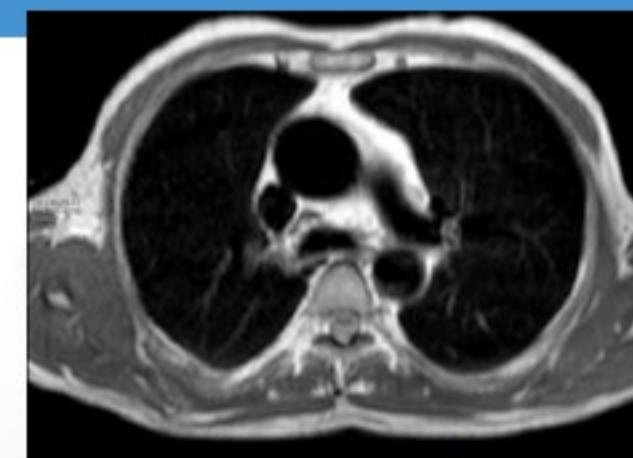
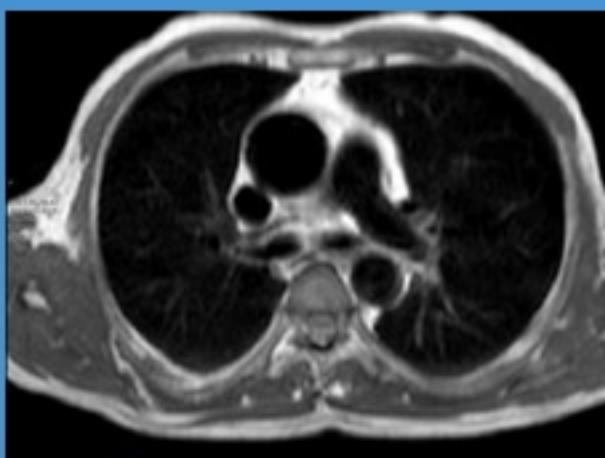
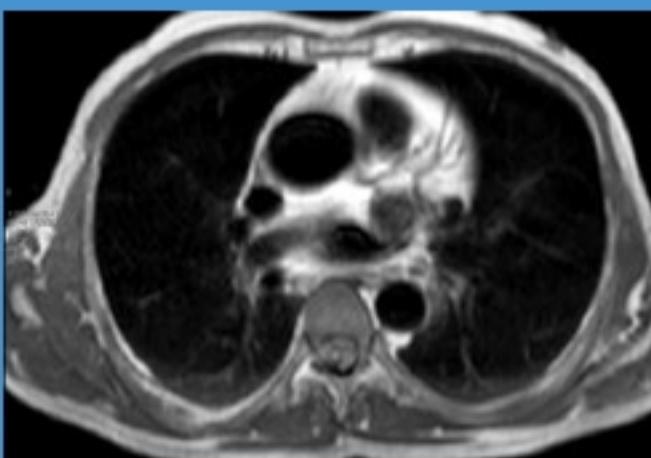
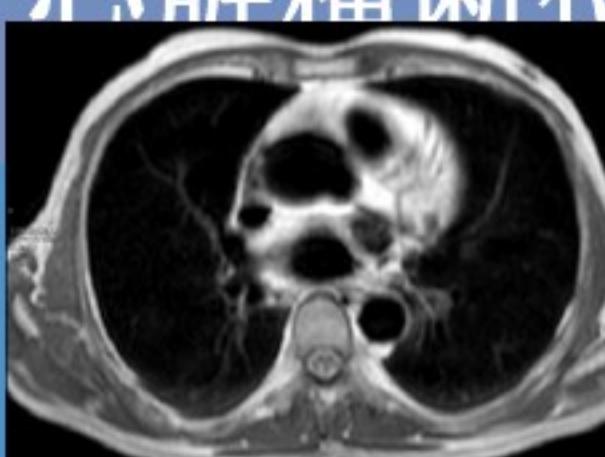
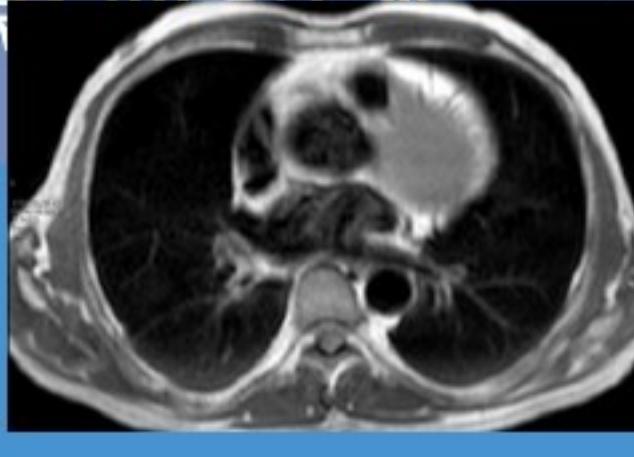
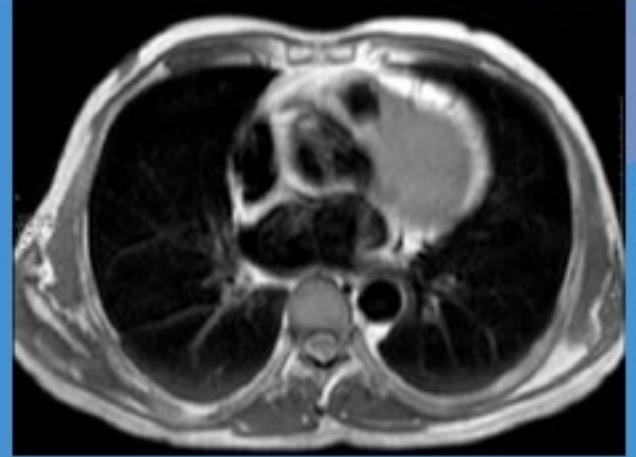


三翻转黑血序列：血液、脂肪和肌肉的信号曲线





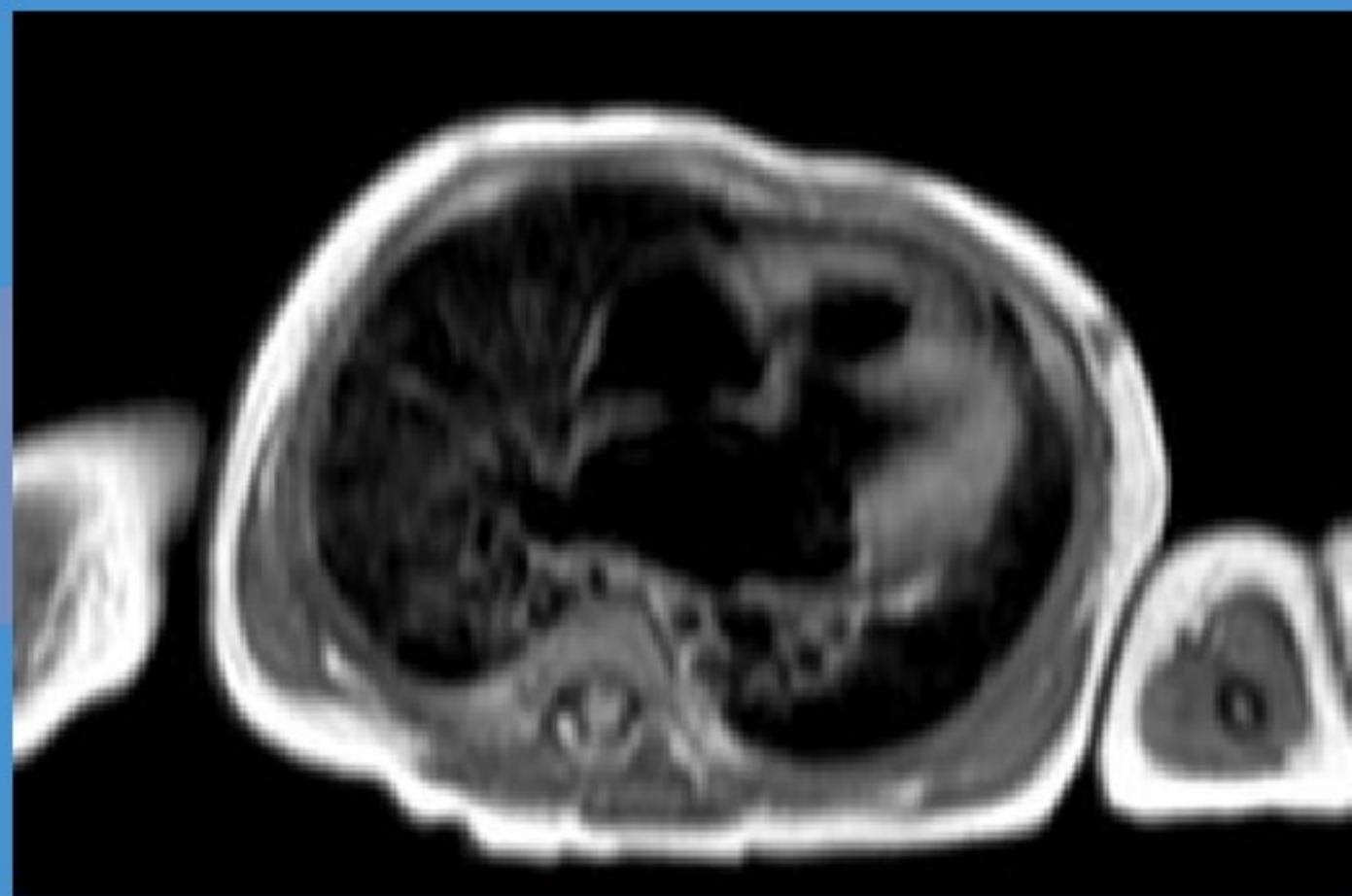
黑血技术——心脏横断位



黑血技术——解剖结构

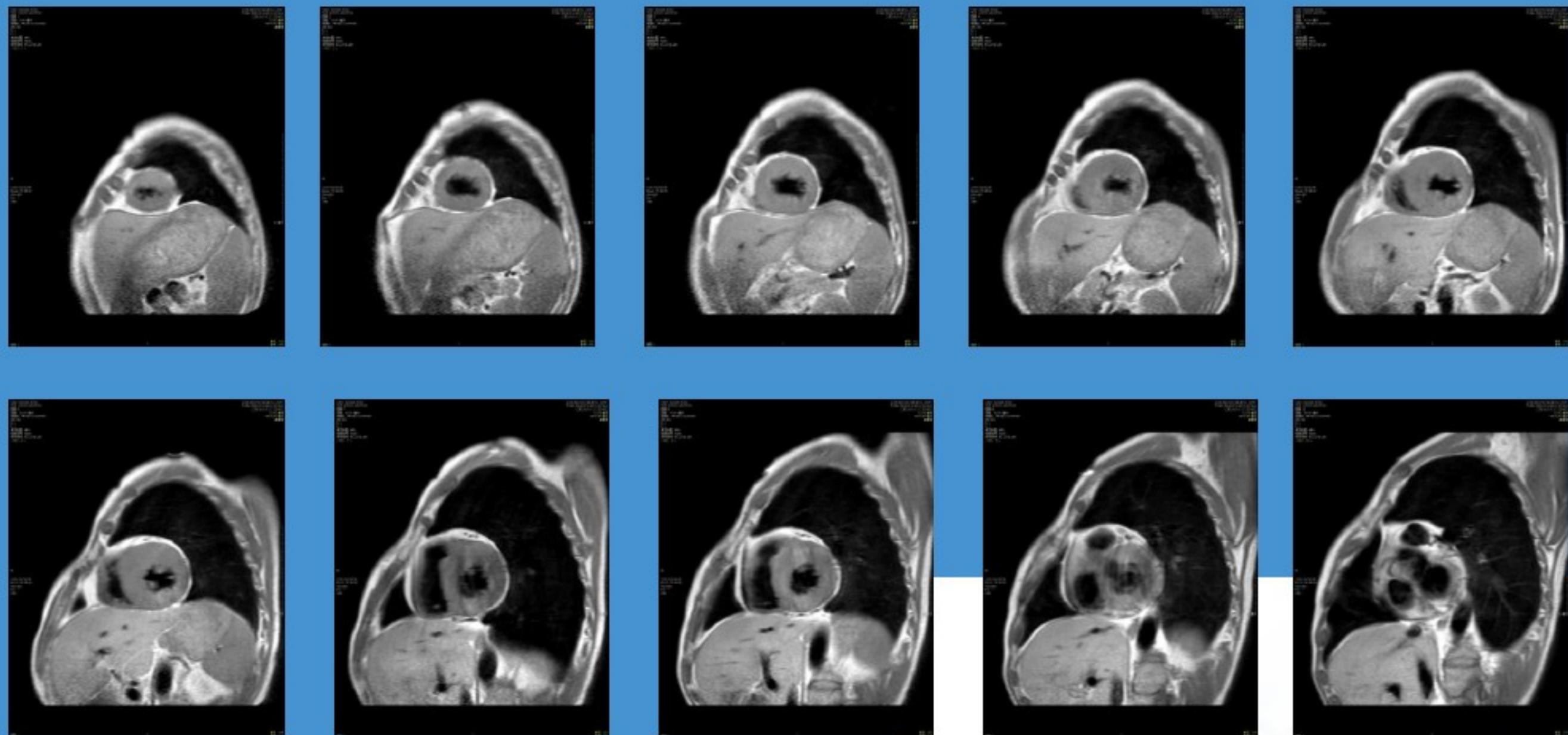


VSD



VSD ASD

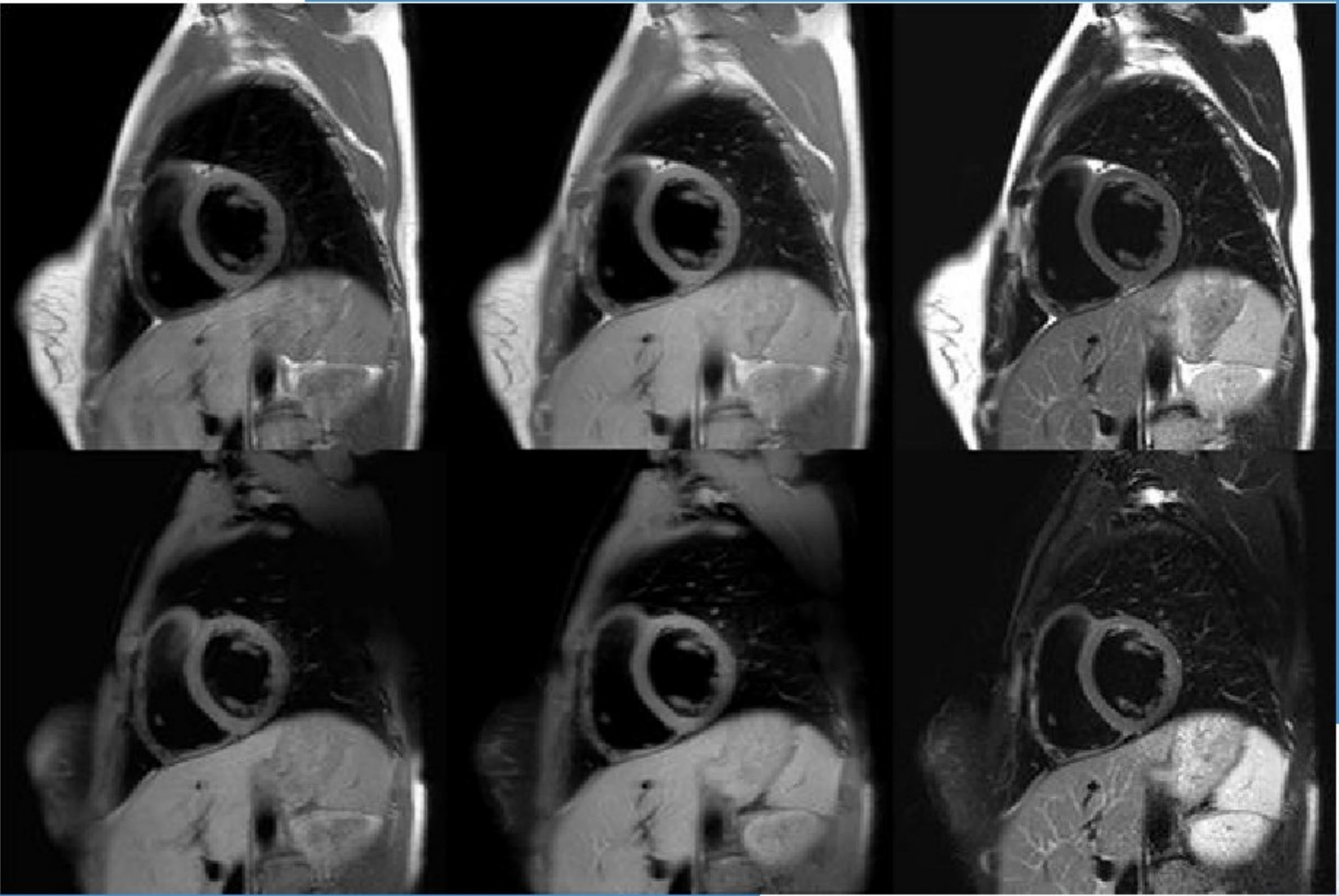
黑血技术——心脏短轴位



T1W_BB

PDW_BB

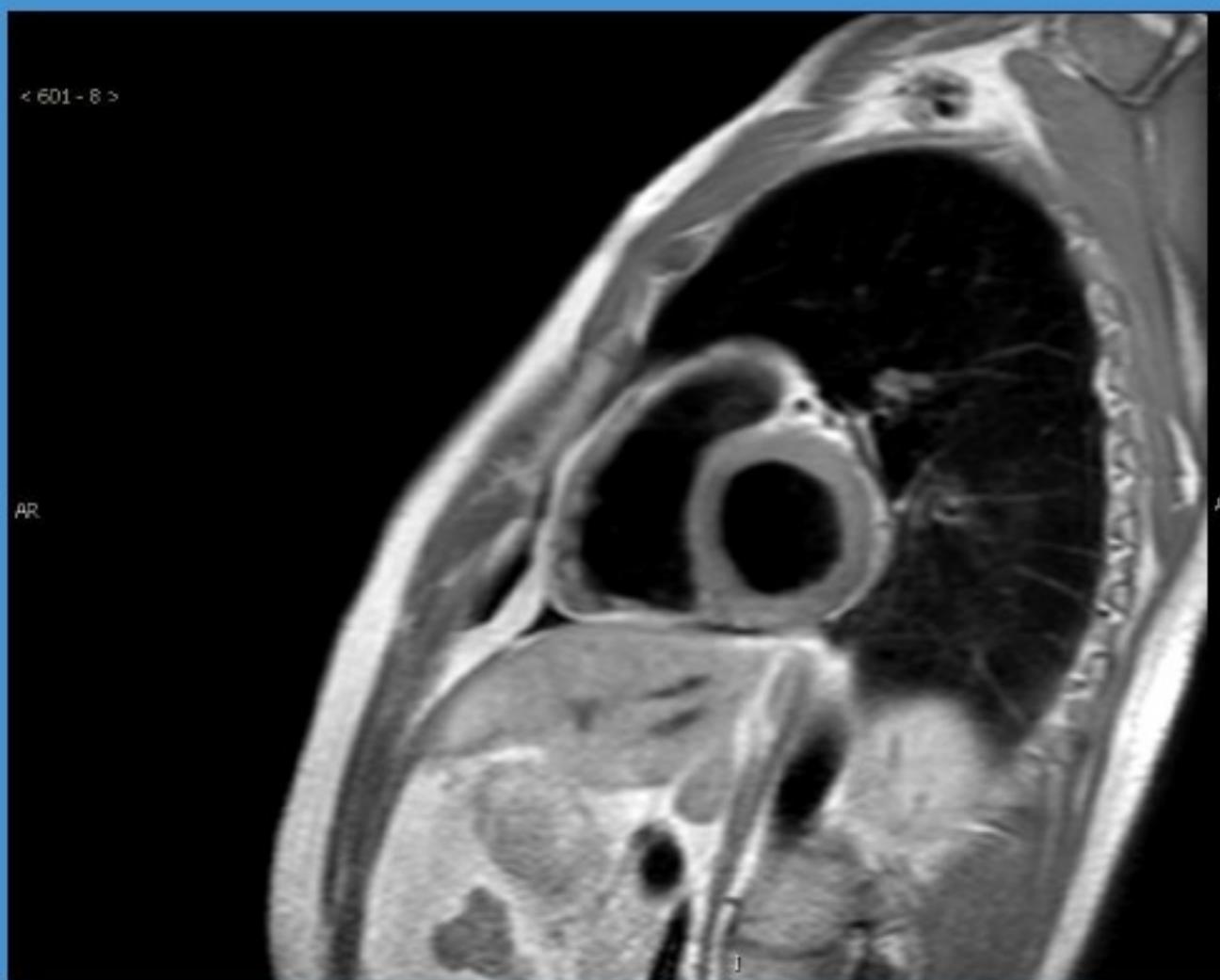
T2W_BB



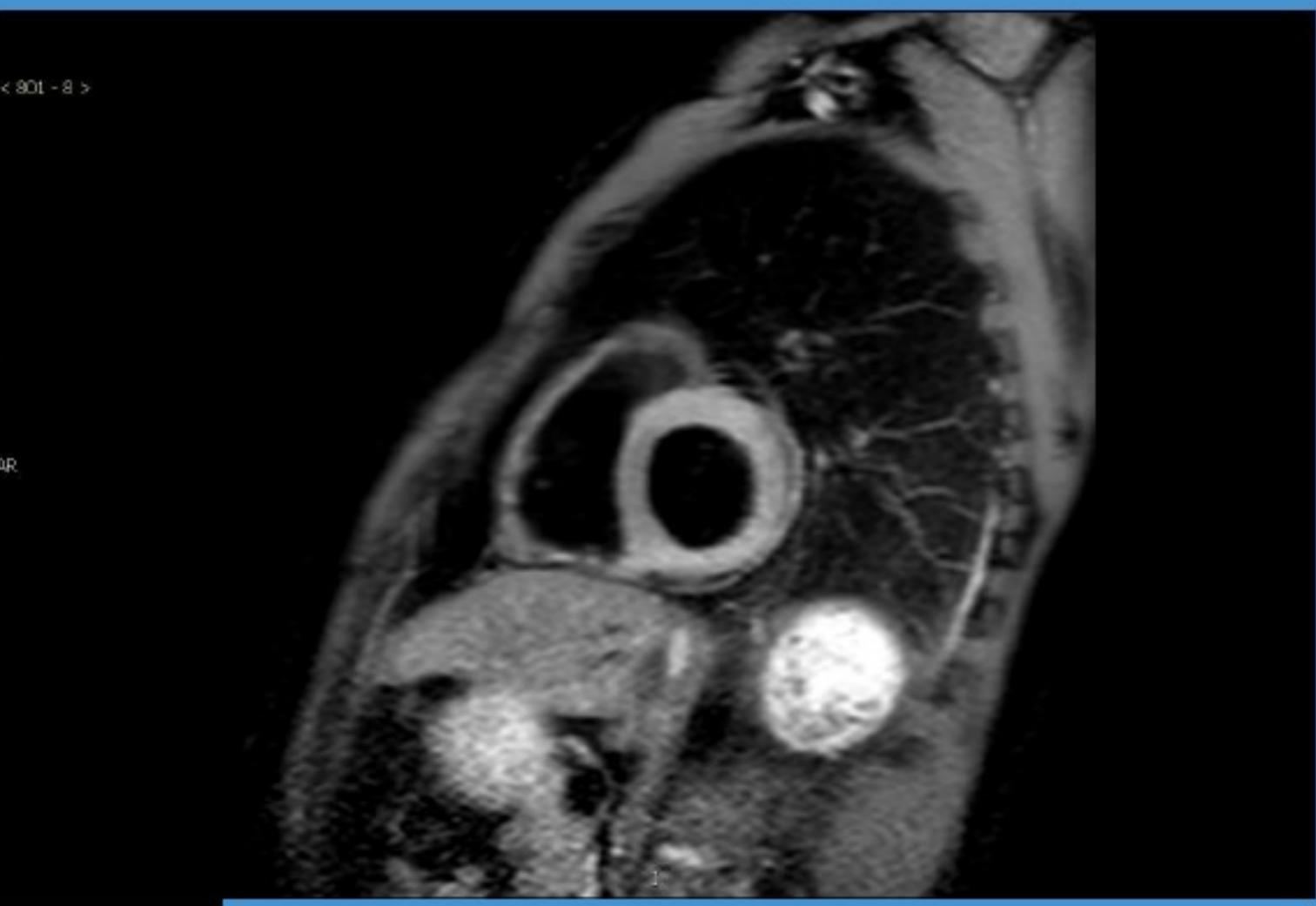
T1W_BB

PDW_BB

T2W_BB+STIR



PDW_BB

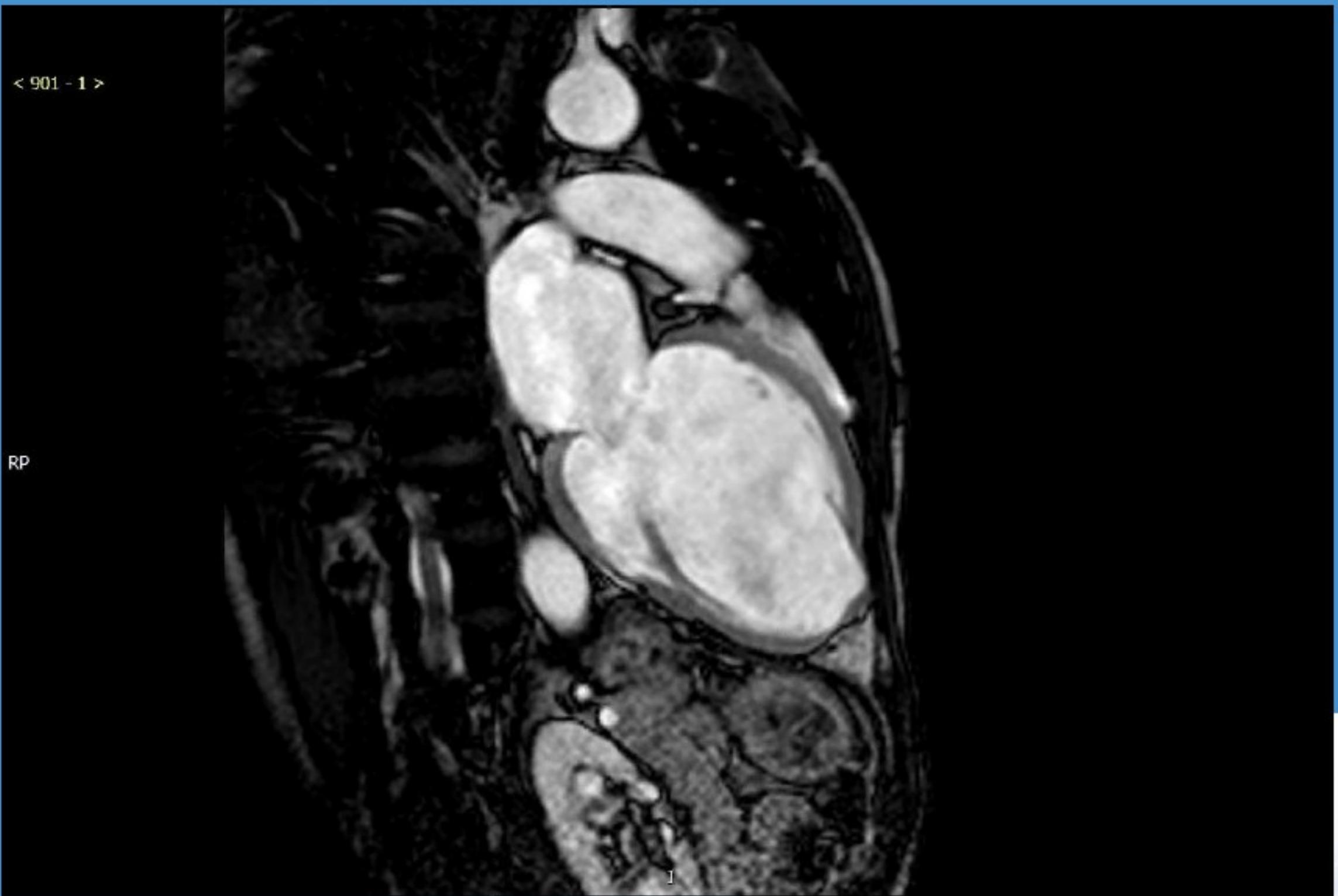


PDW_BB +STIR

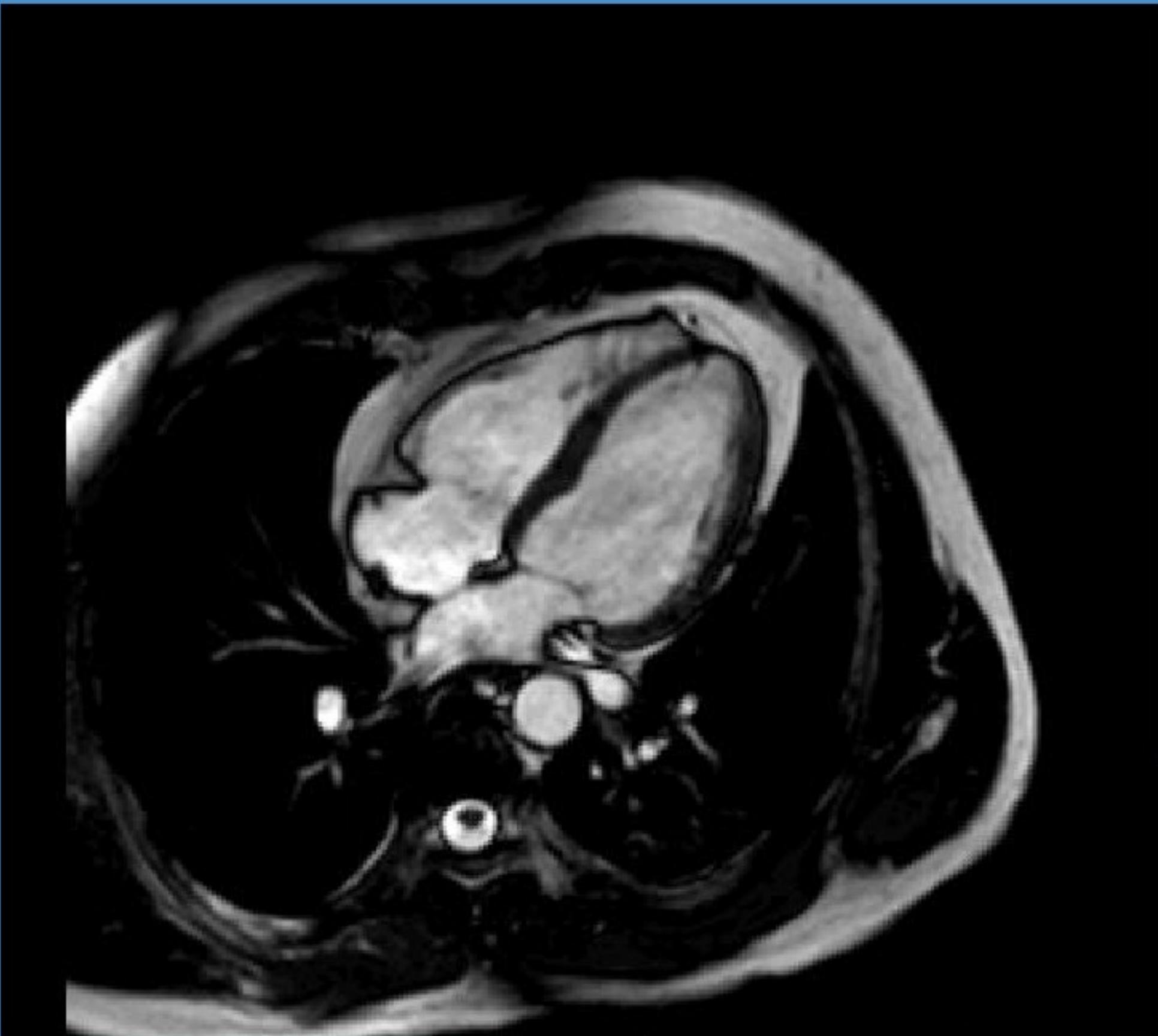
白血描序列构成---心功能及形态分析

- ✓ 左室长轴2CH电影
- ✓ 四腔心4CH电影
- ✓ 多层短轴SA电影
- ✓ 三腔心3CH电影
- ✓ 右室流出道RVOT电影
- ✓ 左室流出道LVOT电影

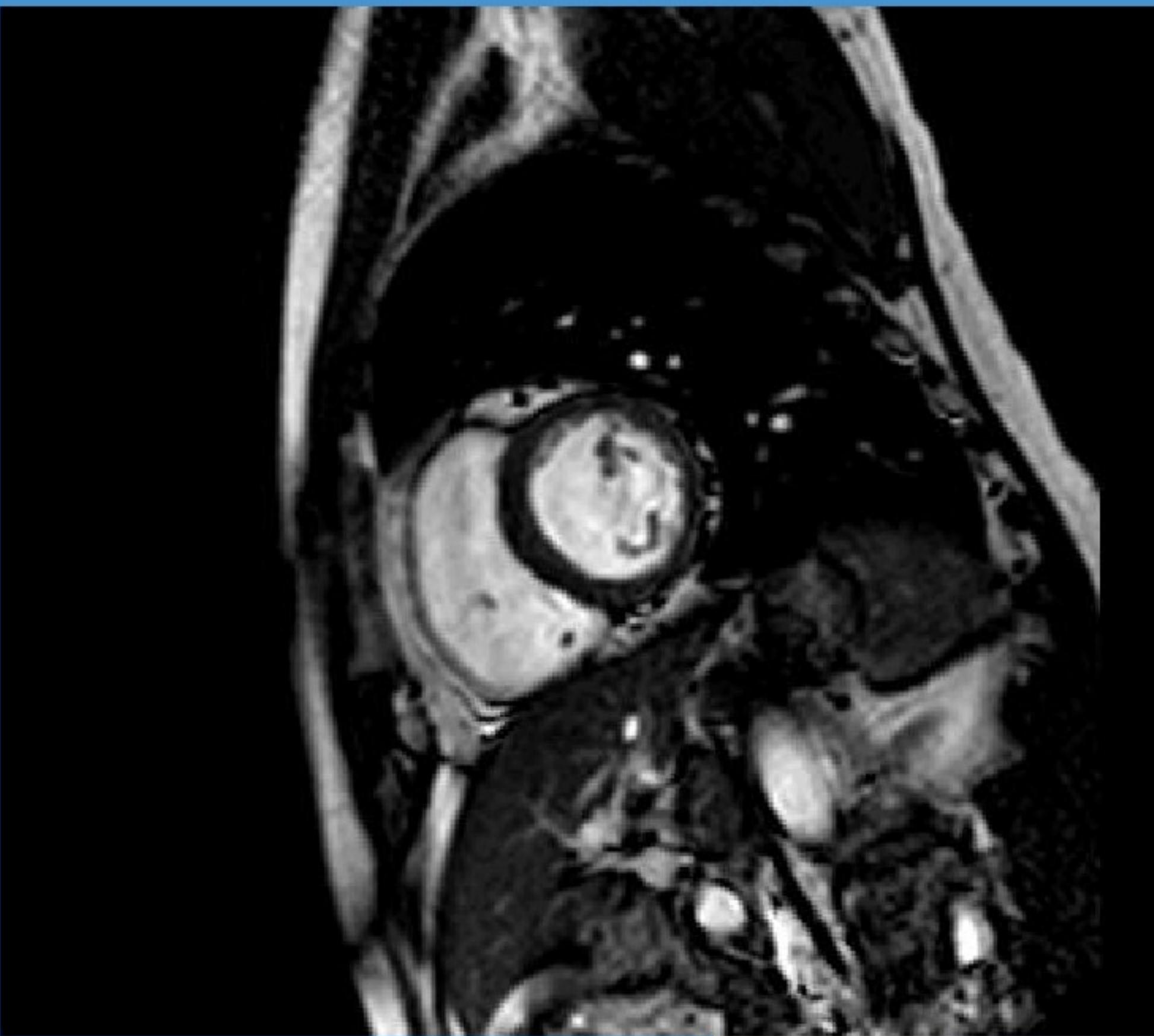
2CH单层多时相电影



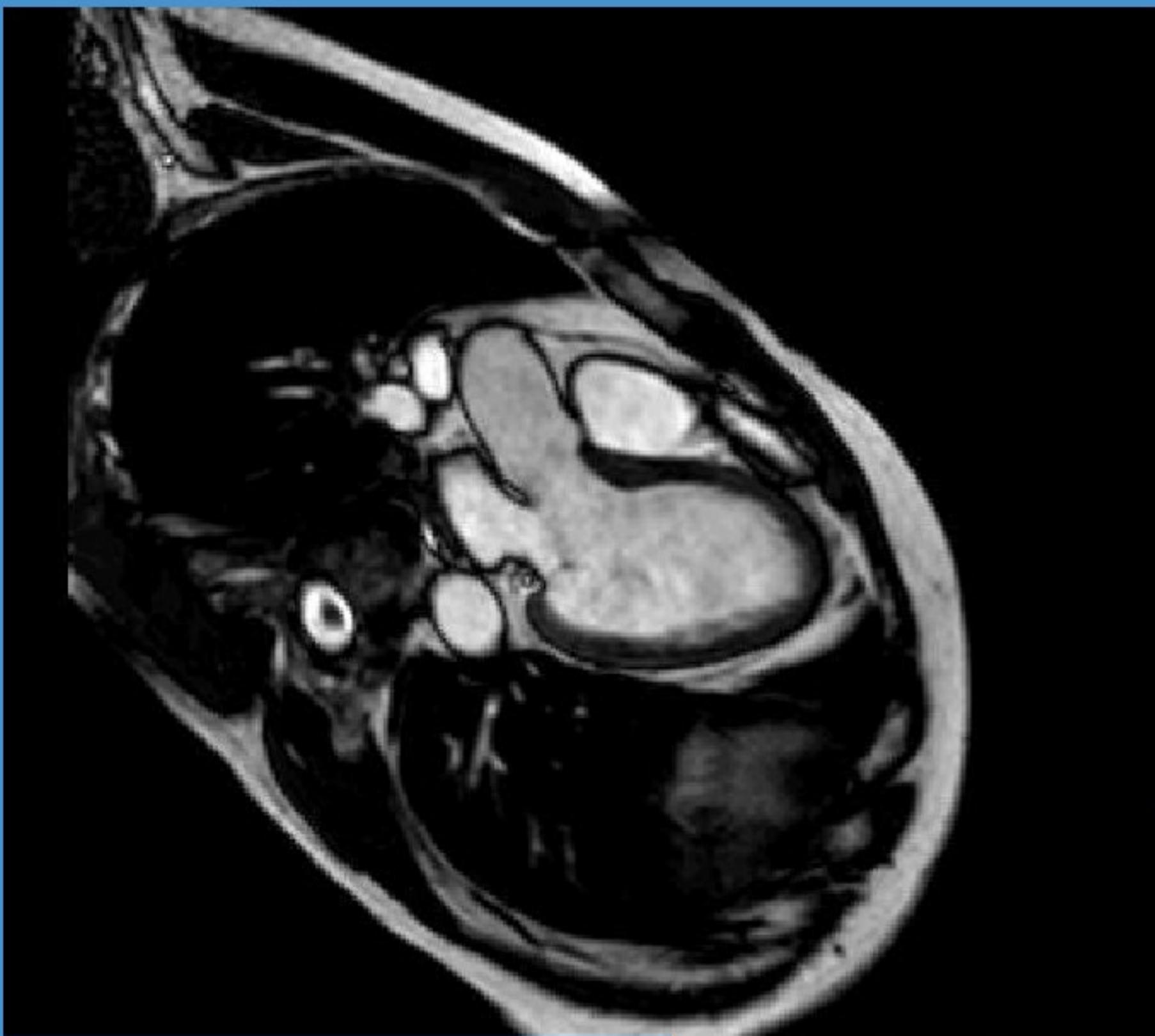
4CH多层多时相电影



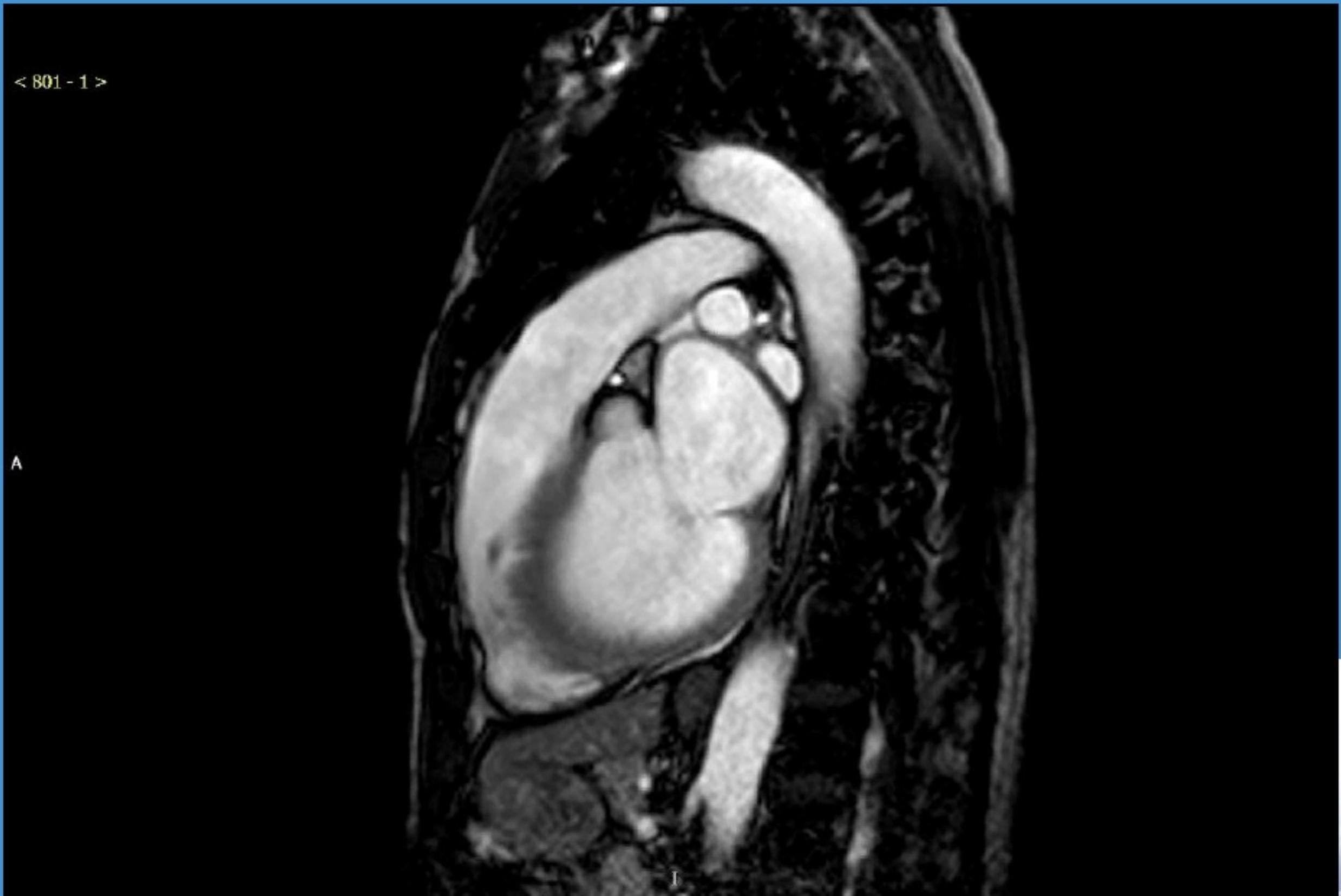
SA多层多时相电影



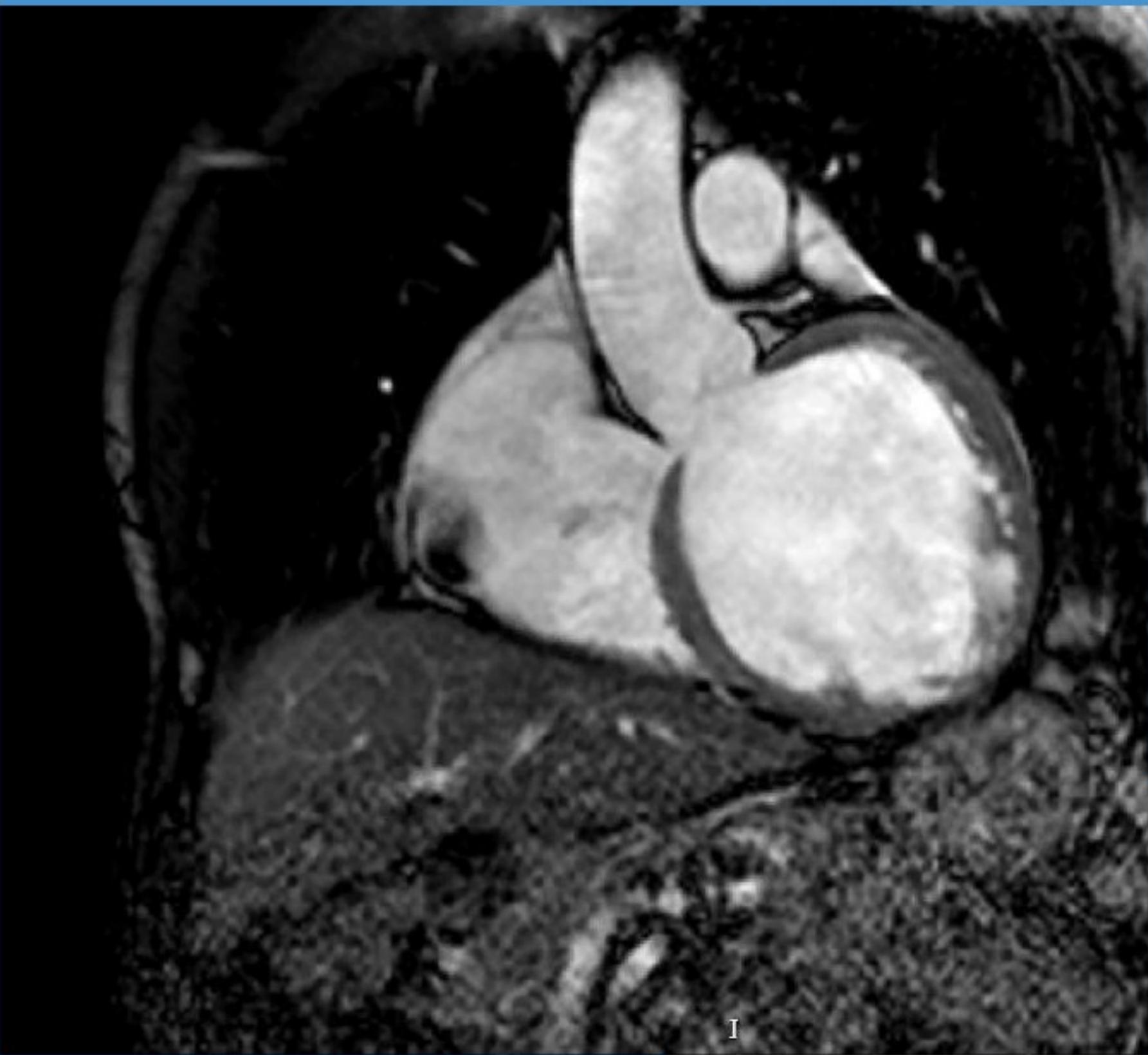
3CH单层多时相电影



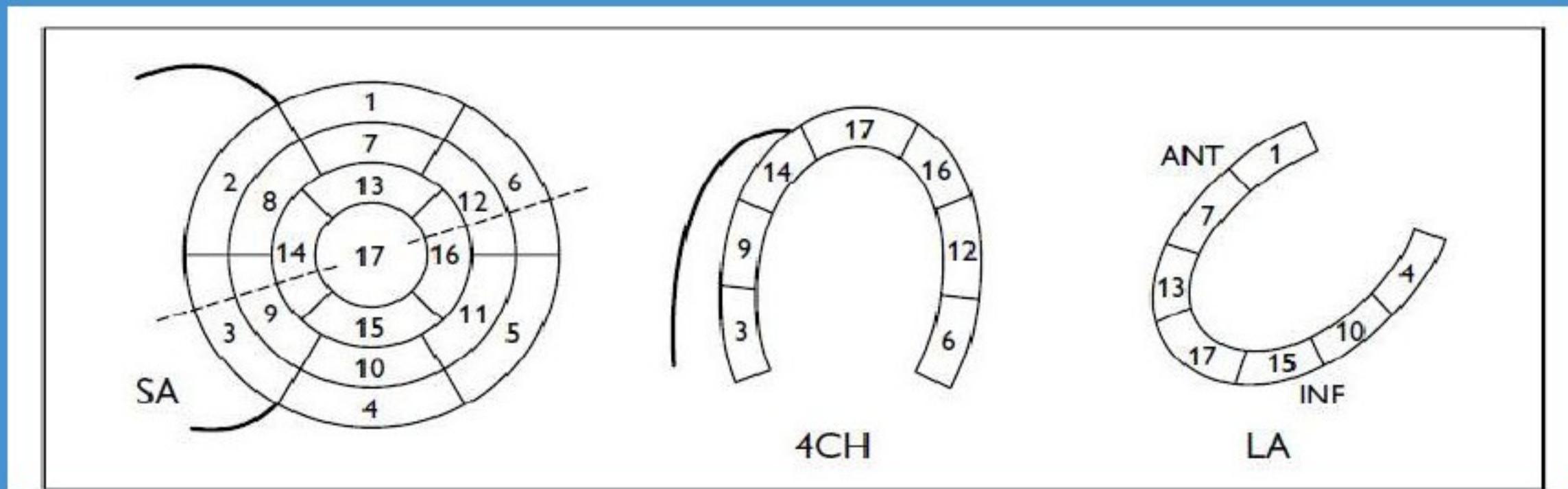
右室流出道单层多时相电影



左室流出道单层多时相电影



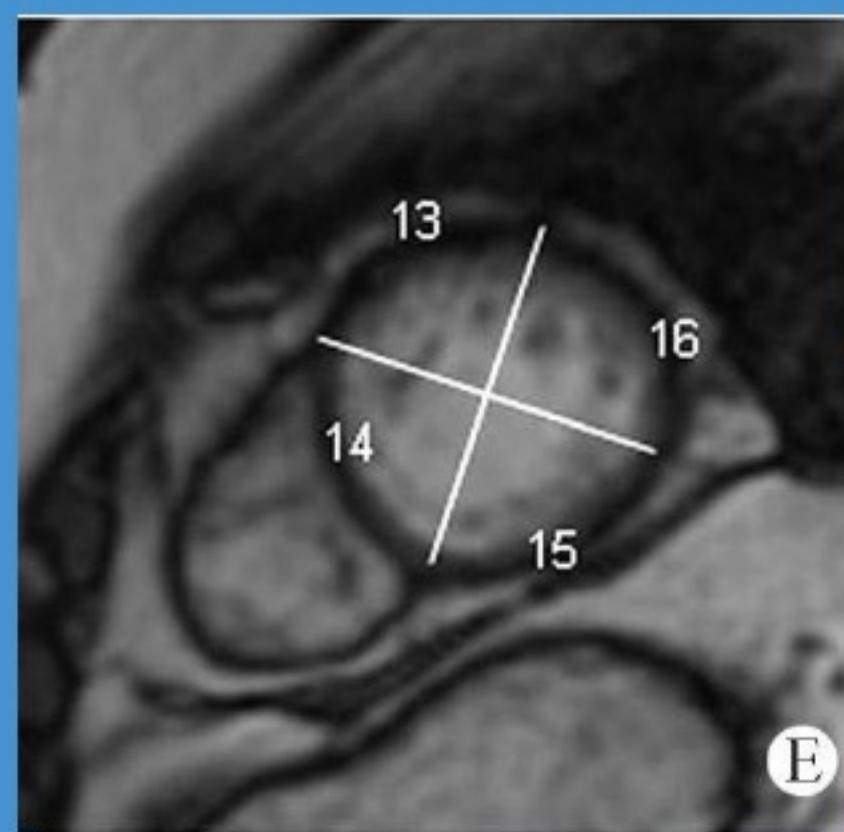
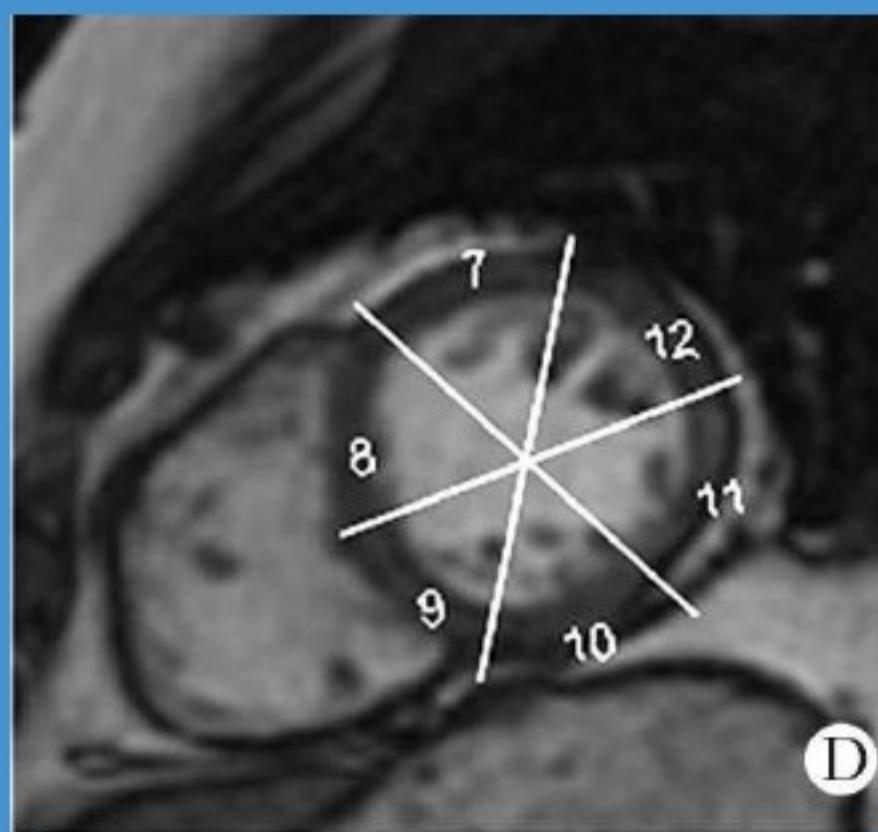
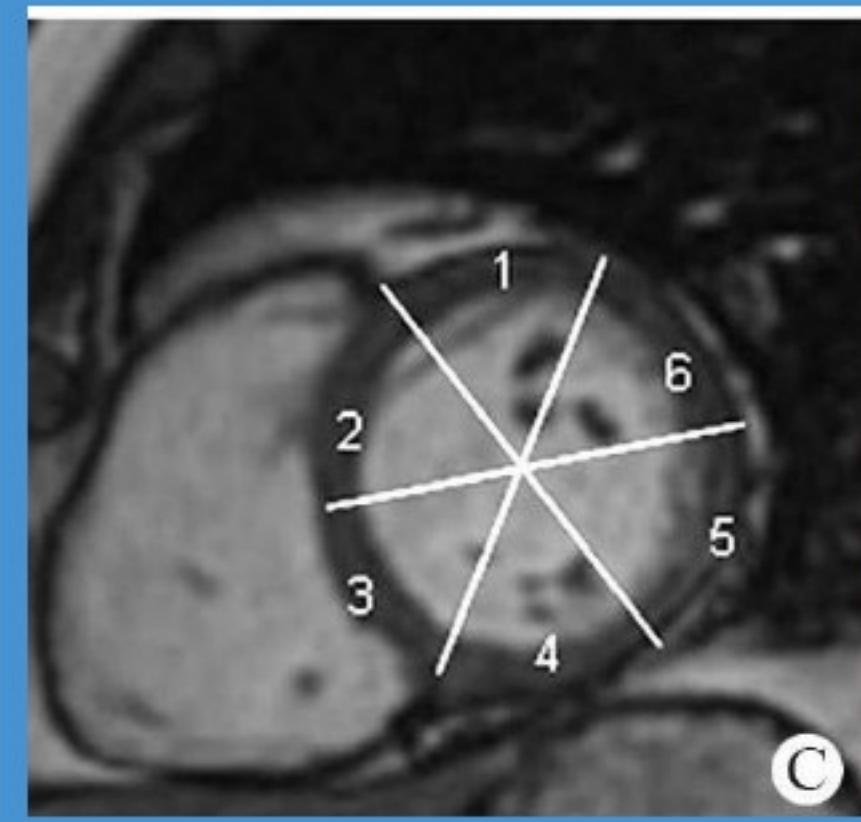
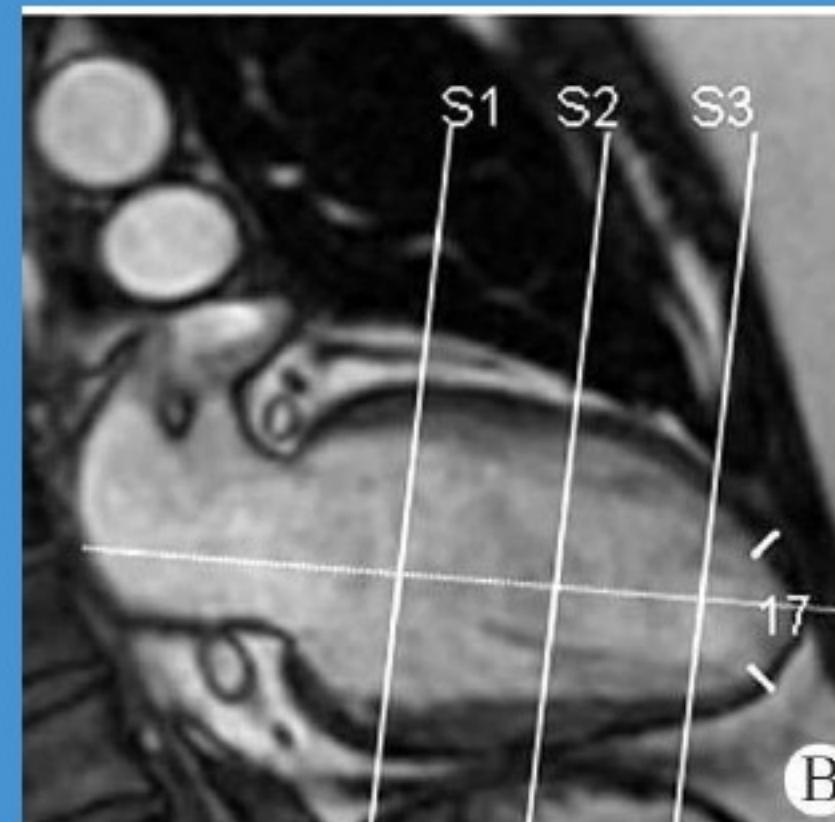
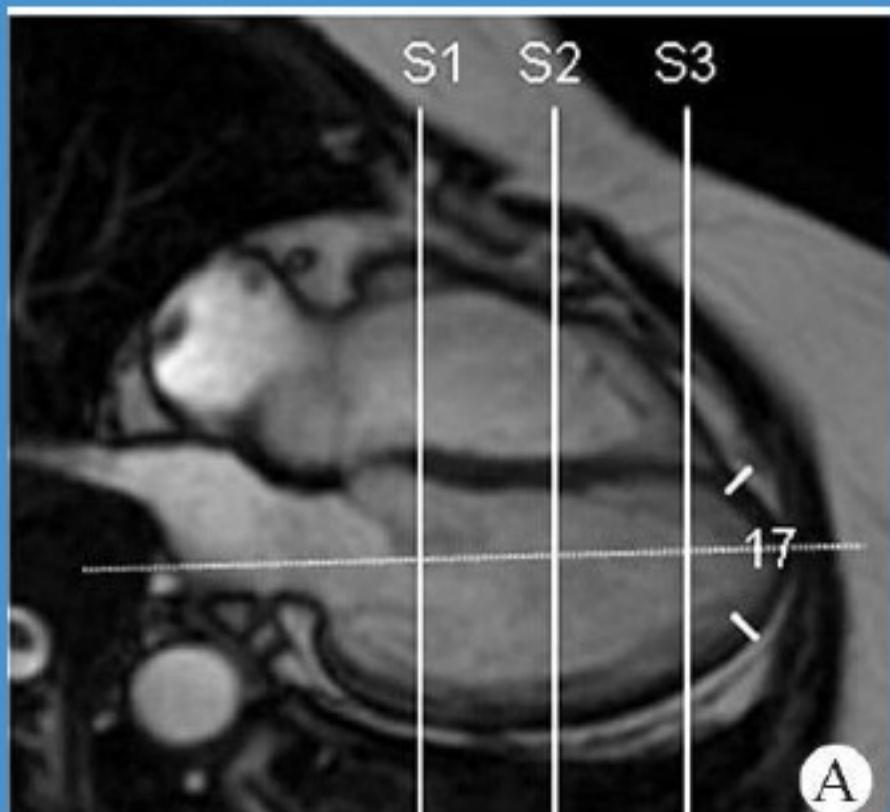
左心室分割图



- | | | |
|----------|-----------|----------|
| 1. 基部前面 | 7. 中部前面 | 13. 尖部前面 |
| 2. 基部前膈壁 | 8. 中部前膈壁 | 14. 尖部膈壁 |
| 3. 基部下膈壁 | 9. 中部下膈壁 | 15. 尖部下壁 |
| 4. 基部下壁 | 10. 中部下壁 | 16. 尖部侧面 |
| 5. 基部下侧壁 | 11. 中部下侧壁 | 17. 心尖 |
| 6. 基部前侧壁 | 12. 中部前侧壁 | |

用7个SA层面、一个四腔心层面及一个长轴层面
覆盖全部左心室17个部分

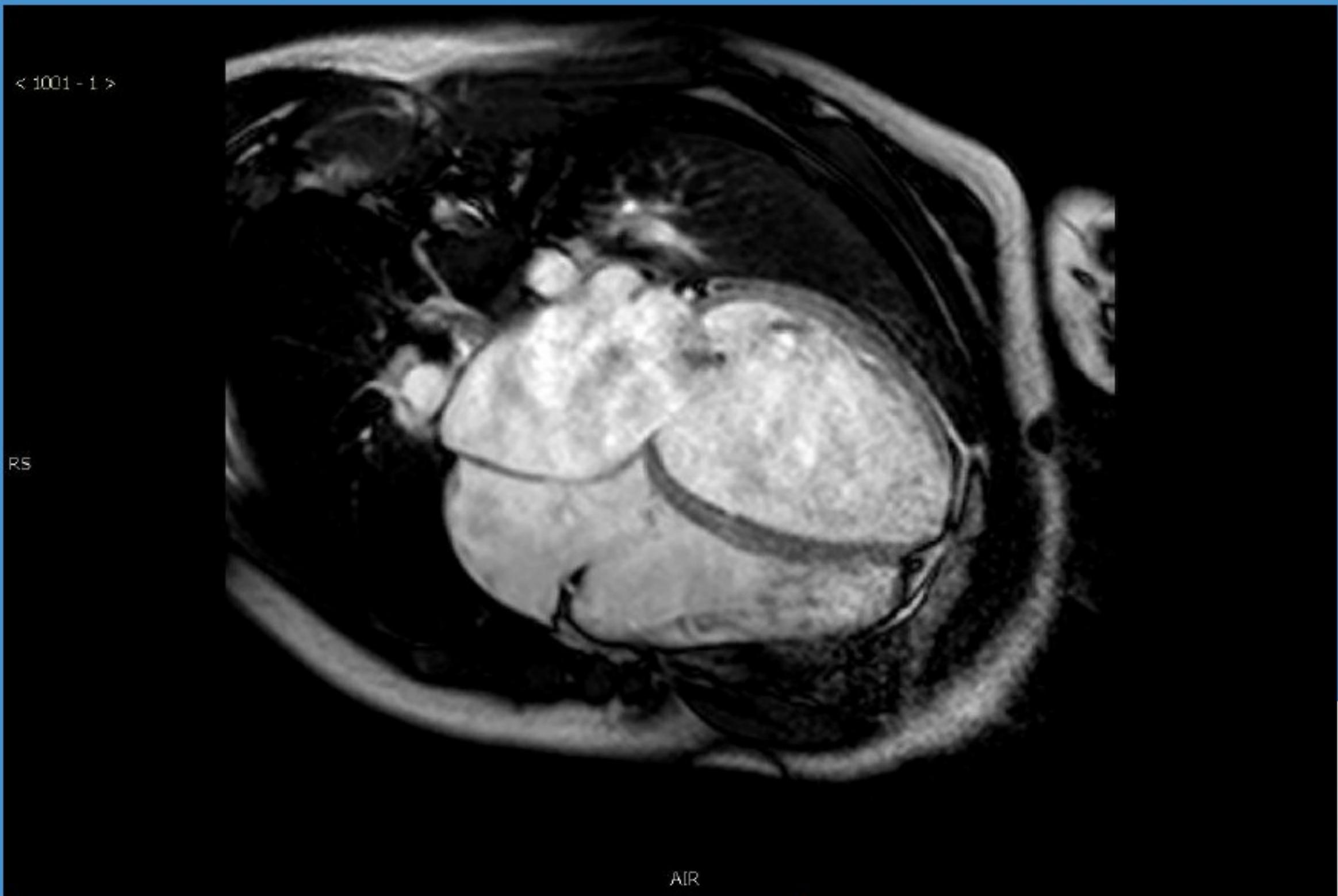
左心室心肌的分段



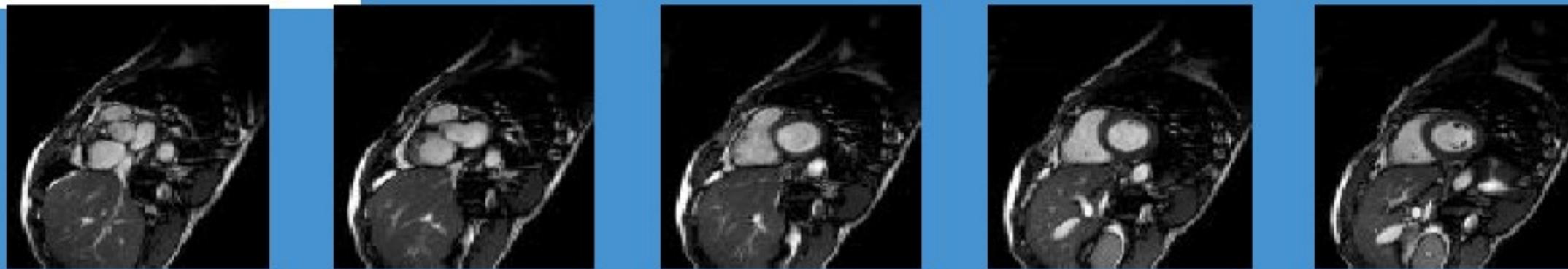
白血技术

心脏电影技术：在较短的时间内完成数据采集产生多时相图像，一次屏气可获得20帧图像，削除运动伪影。

白血技术——心脏舒张收缩功能反映



左心室收缩功能的测定



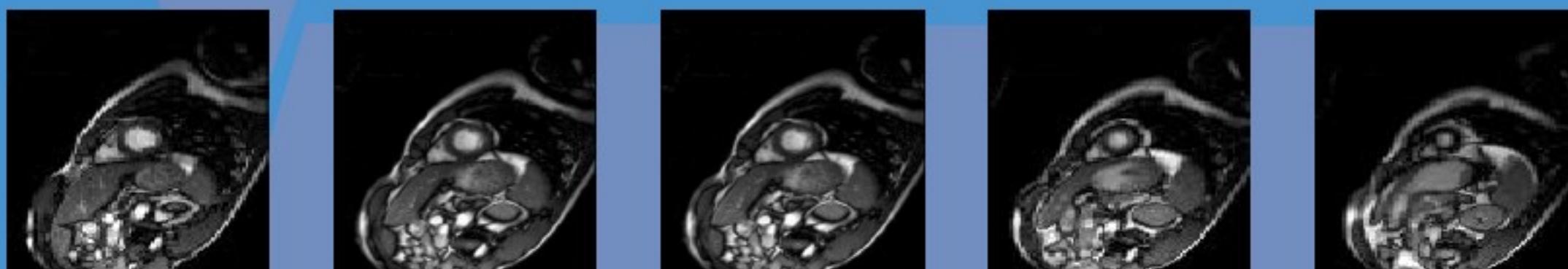
Base

+10mm

+20mm

+30mm

+40mm



+50mm

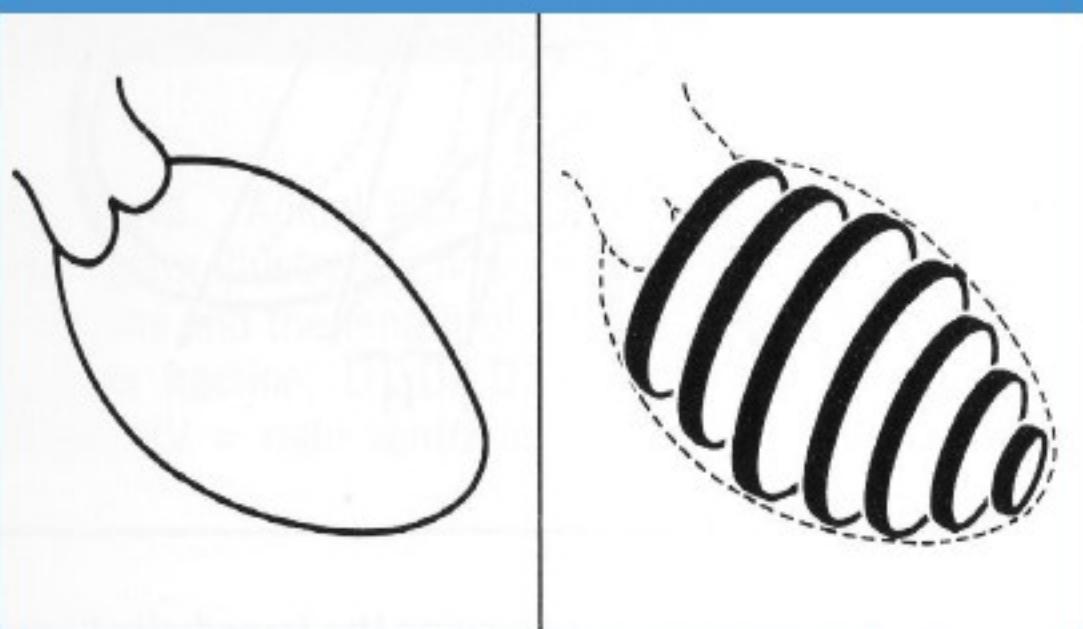
+60mm

+70mm

+80mm

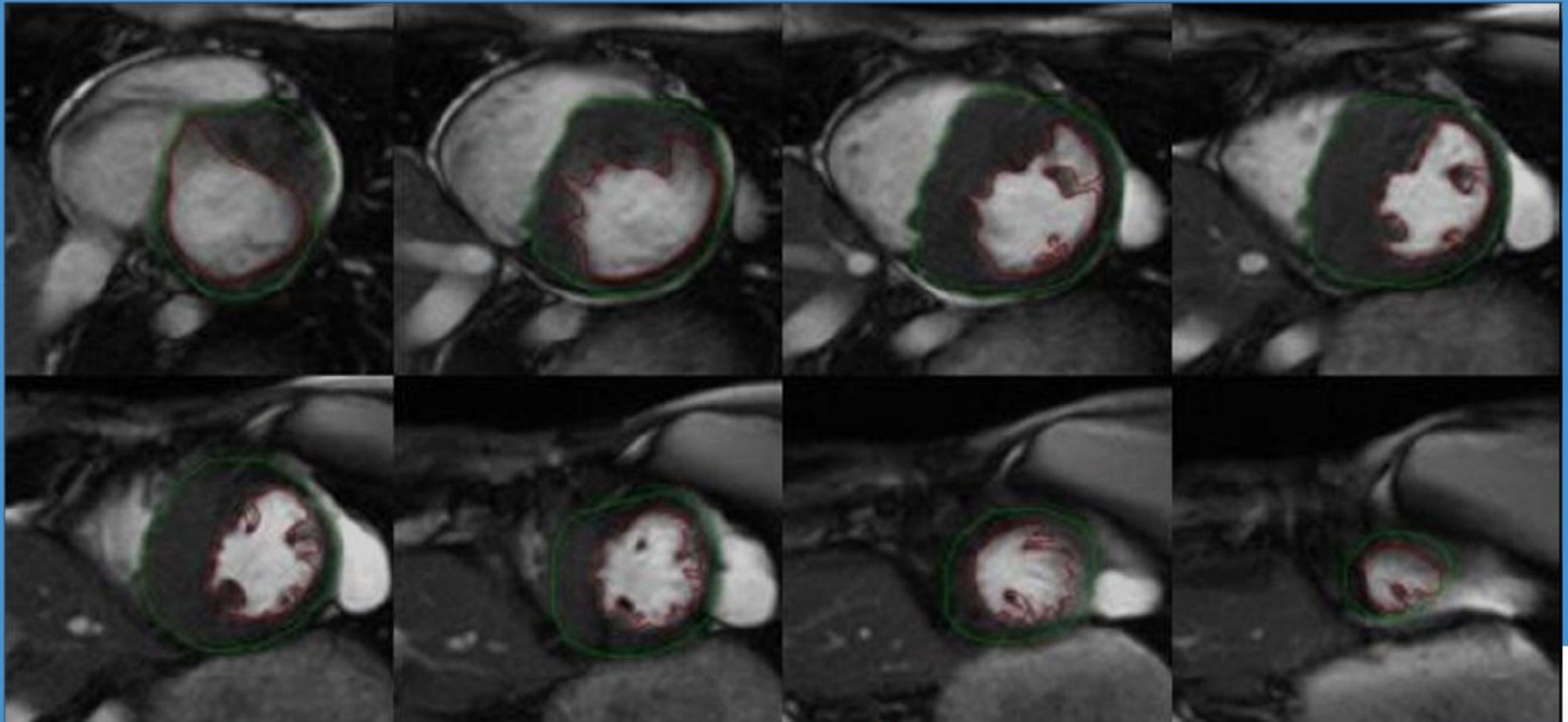
+90mm

Apex



将心底到心尖所有舒张期相加，再将所有的收缩期相加，此

即为EF值，此
计算公式

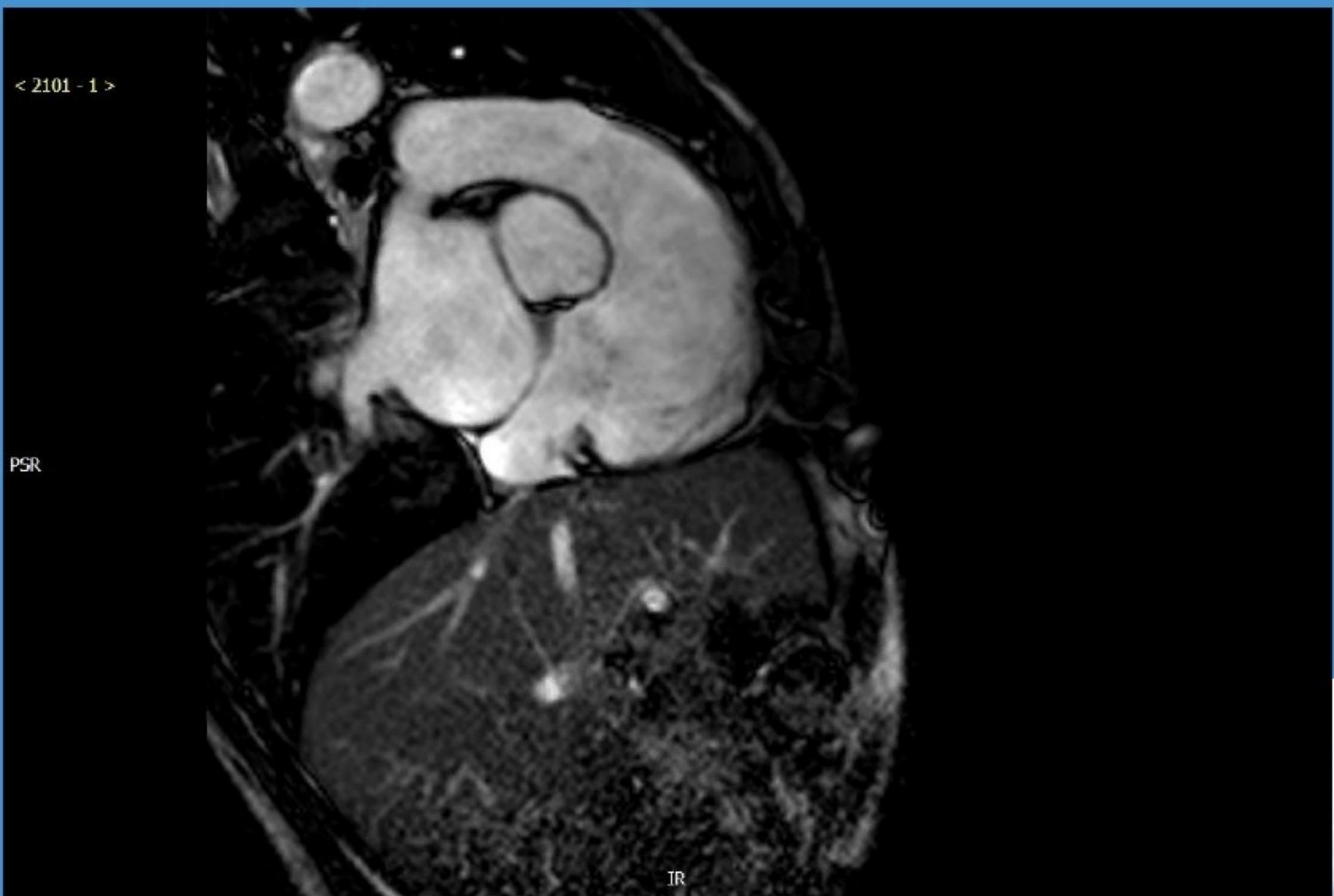


心内膜、心外膜感兴趣区

瓣膜运动动能



瓣膜运动动能



心肌灌注

- 高压注射器
- 对比剂GD-DTPA 0.1mmol/kg体重
- 流率为4ml/s
- 同总量和流速的生理盐水冲管
- 对比剂维持量
- 对比剂GD-DTPA 0.05mmol/kg体重
- 流率为1ml/s
- 同总量和流速的生理盐水冲管

心肌灌注

体位：短轴位三层

延时灌注

短轴位：扫描层面在四腔心的舒张末期定位

从心底办膜到心尖（8-10层）

+三层四腔心

PAN PEI MEI

1973 04 03 10834483

DYN_sTFE_3sl SENSE

2013 03 21,17:58

FOV 280

Slice 2/3

Review Planscan

Exit

Extended Image Information

PAN PEI MEI

1973 04 03 10834483 F

DYN_sTFE_3sl SENSE FOV 280

2013 03 21,17:58 Slice 2/3

TR 2.4 THK 10/10

TE 1.2 Echo 1/1

TFE Factor 32

Flip 25 Dynamic 5/59

PPTS 100 Td 654ms

TRANSVERSE RFOV 100% NSA 1

T1TFEM SENSE HS

SENSE-Cardiac 92/224

Total scan time: 1:00m

CT noGC

AP -21 ant Angle AP -35

RL 46 left Angle RL -40

FH 28 head Angle FH 10

WW 3235

MR201303210520 WL 1797

GUANGDONG GENERAL HOSP.

[Hide]

Scan: 10

+ -

More... Dynamic Scan

View Window RAL

+ -

+ -

PAN PEI MEI

ECG

VCG+Resp

10 s

59

IR_TFE_BH_2beats

Remaining scan time: 00:01:30

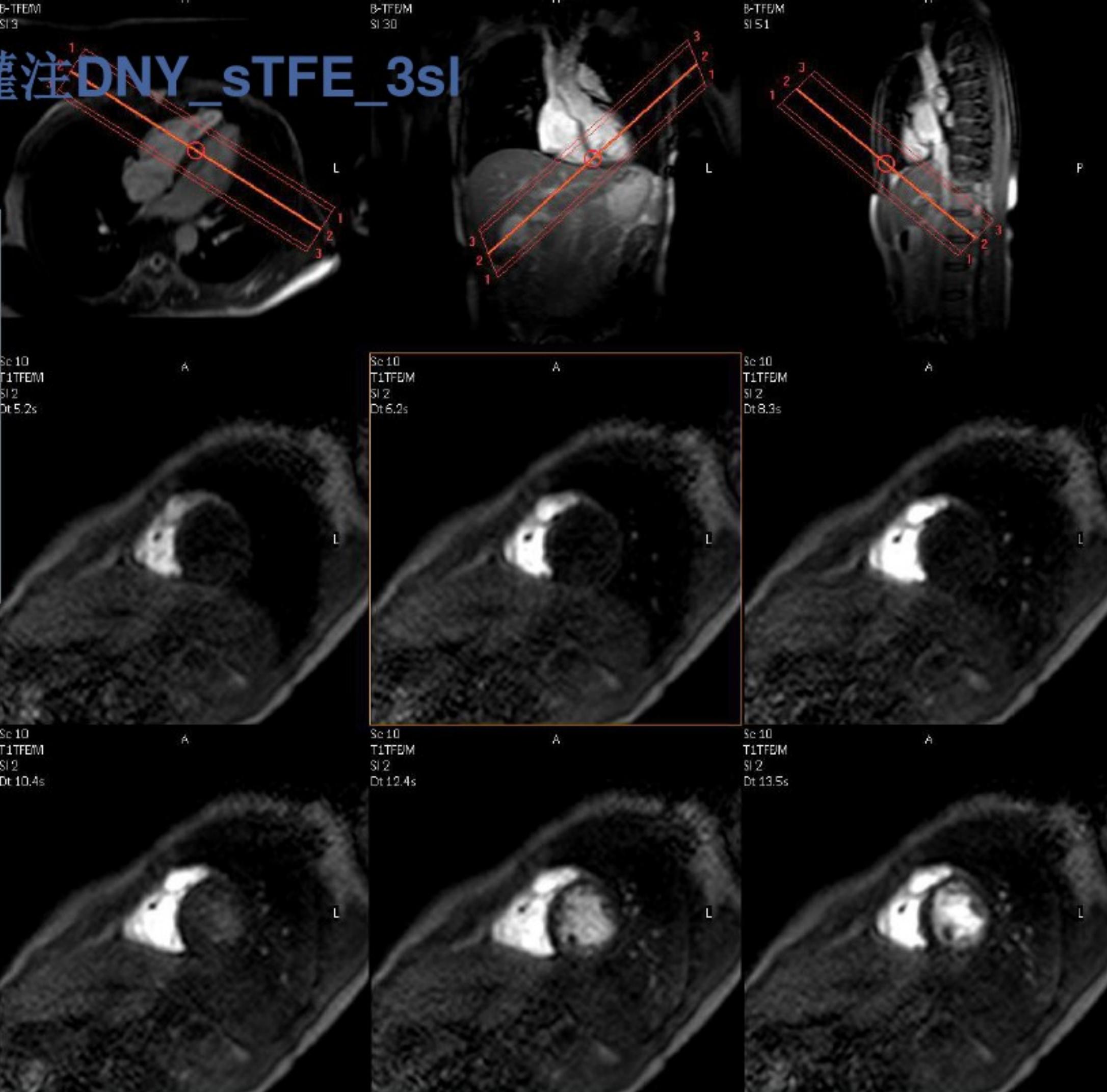
0%

Autoview...

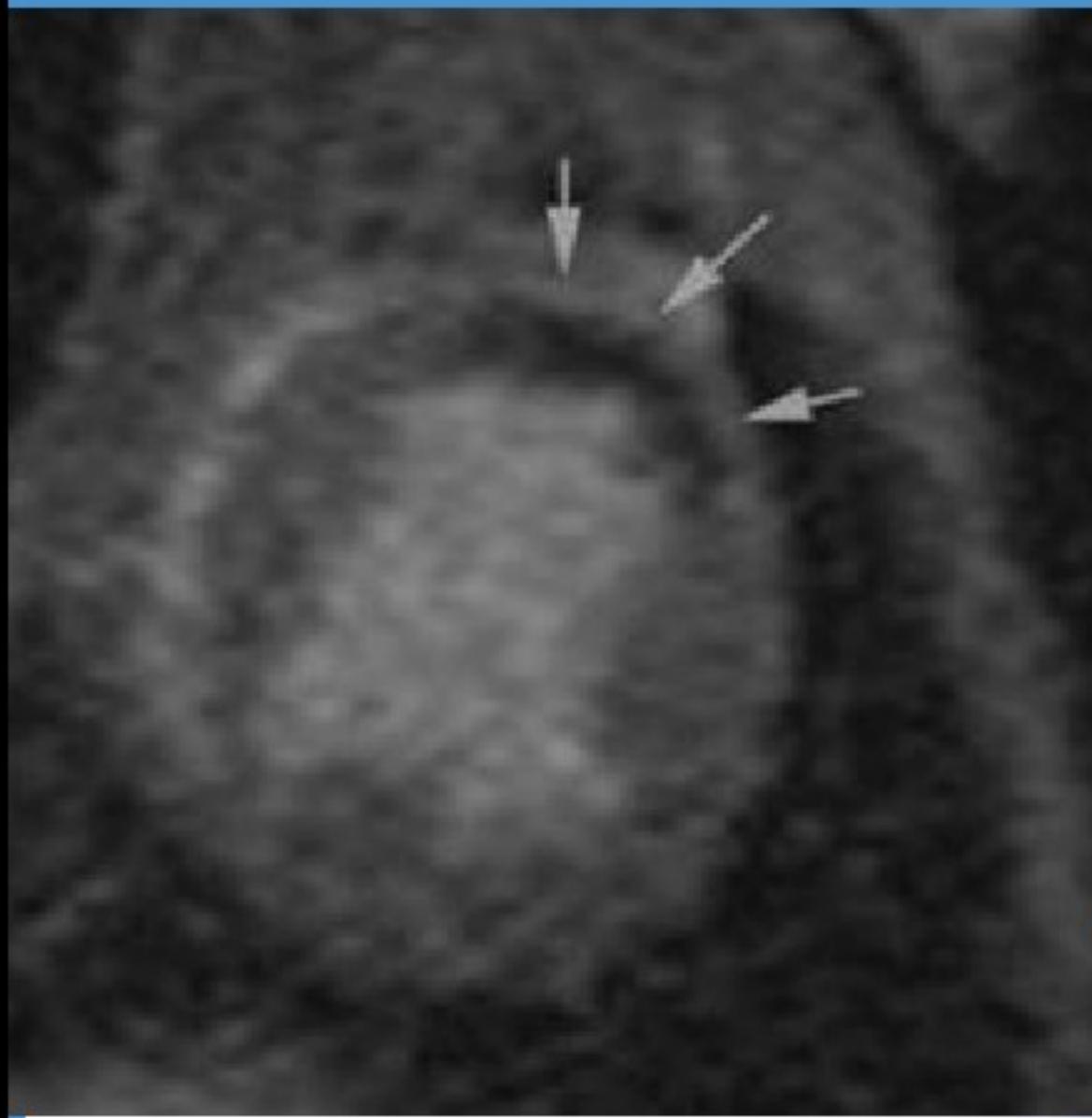
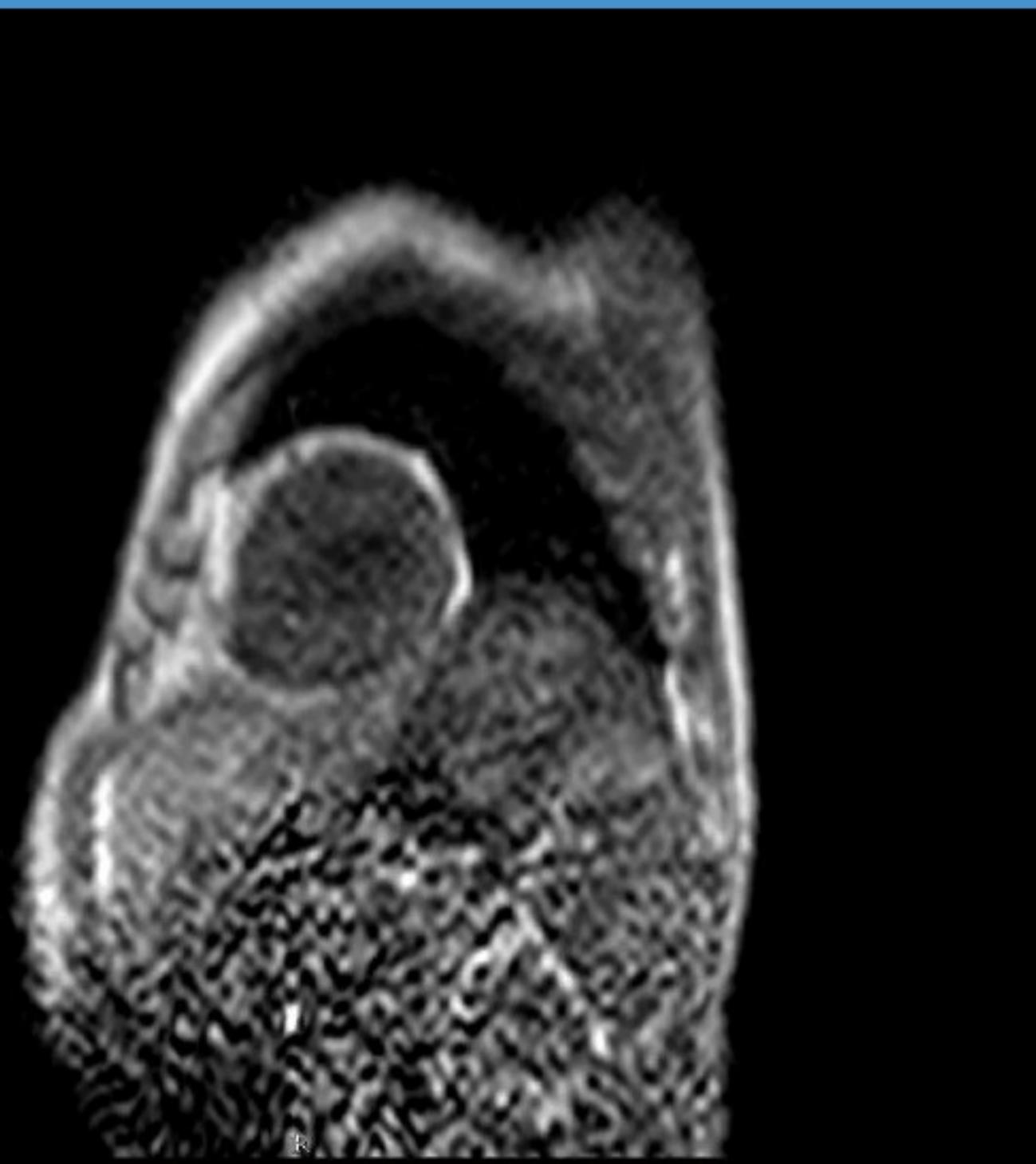
Start Scan

Stop Scan

首过灌注DNY_sTFE_3sl



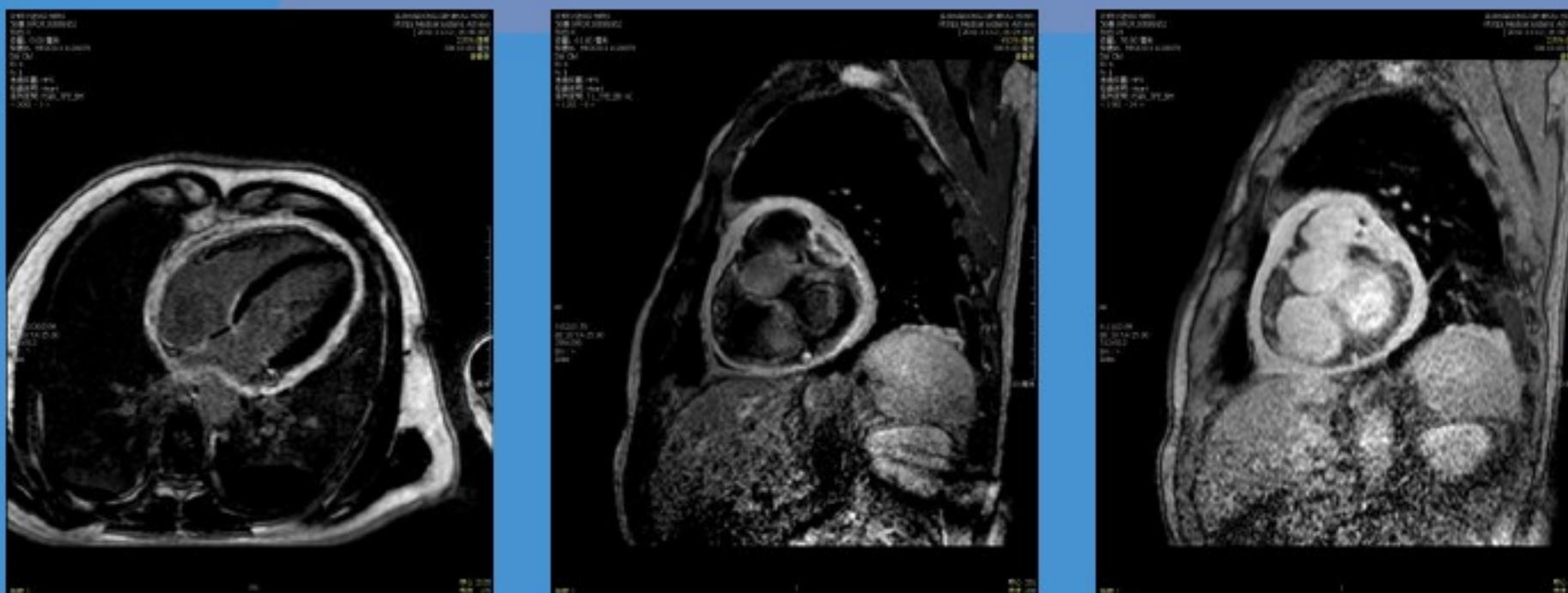
心肌组织灌注



造影剂有右心室-左心室-心肌
灌注缺损区域位于室间隔上部

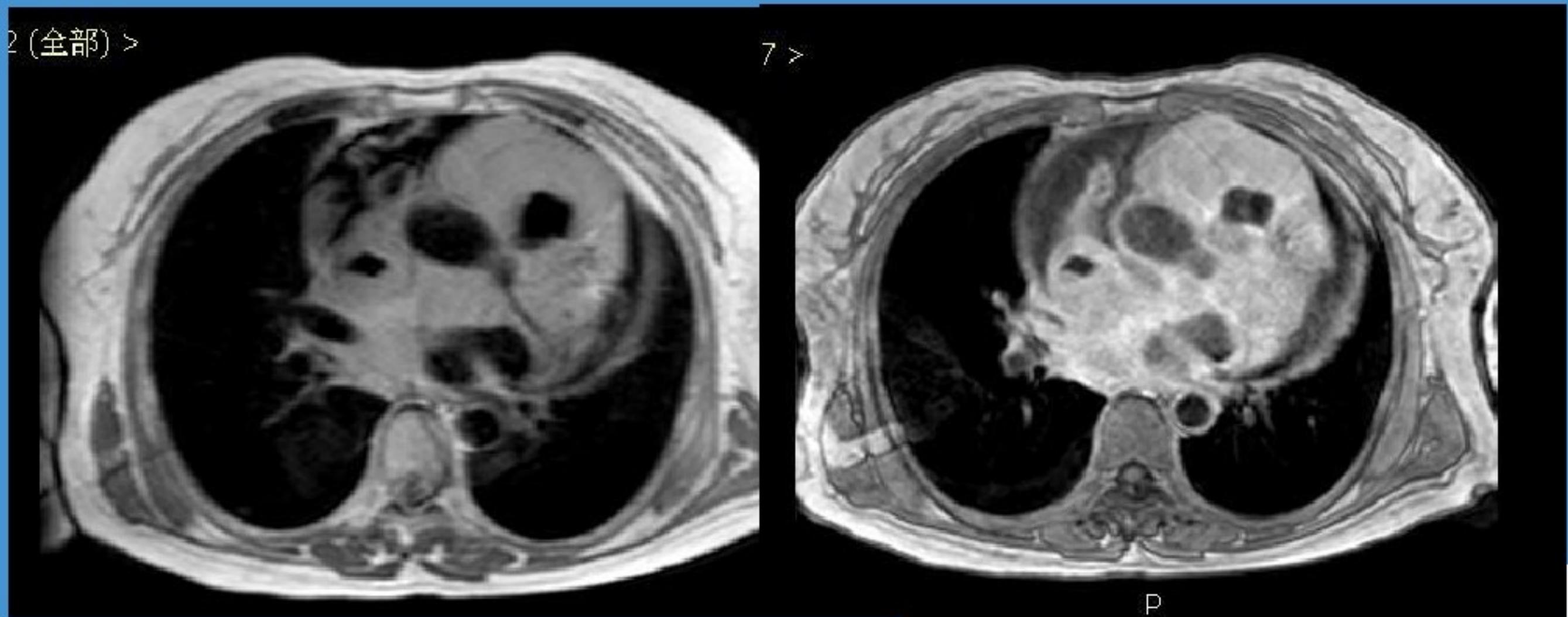


缩窄性心包炎



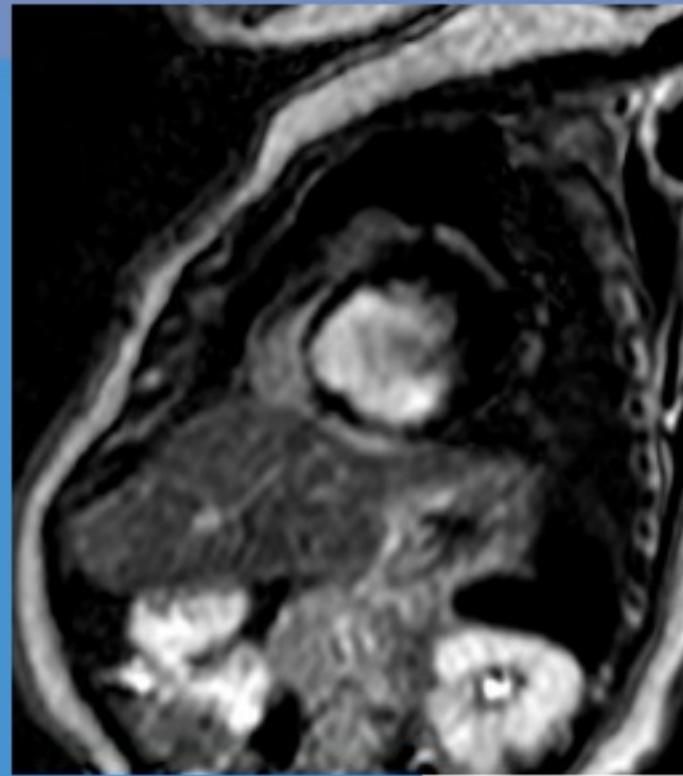
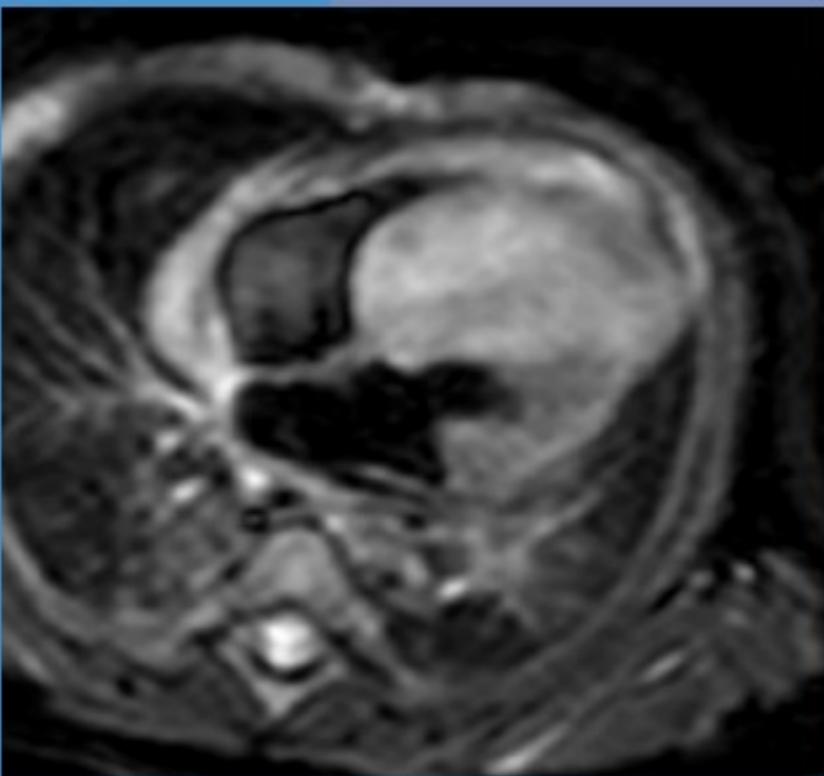
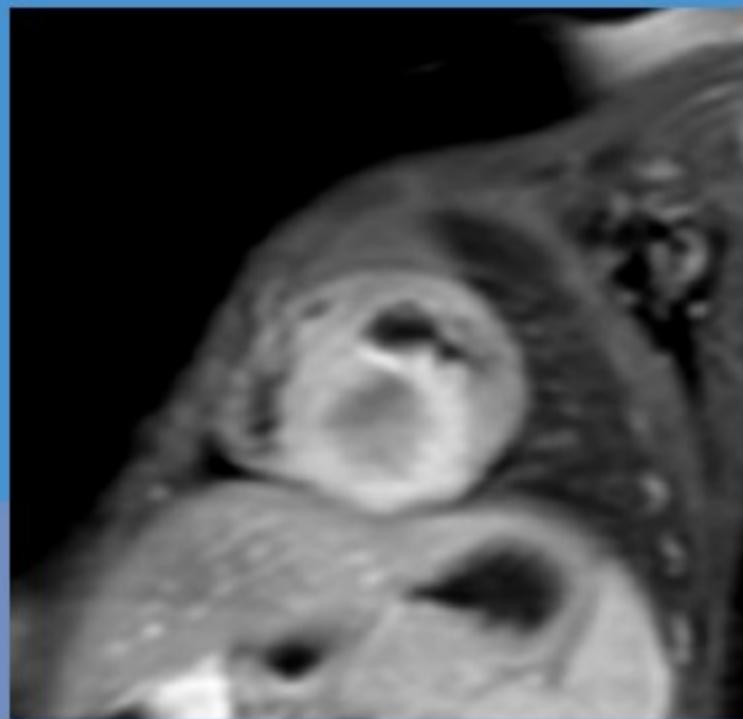
男，56岁，缩窄性
心包炎患者 强化

增强检查——心包肿瘤



淋巴瘤或恶性间皮瘤

增强检查——心脏肿瘤



男，4月，右心室游离壁和下壁纤维瘤，可见肿瘤明显强化

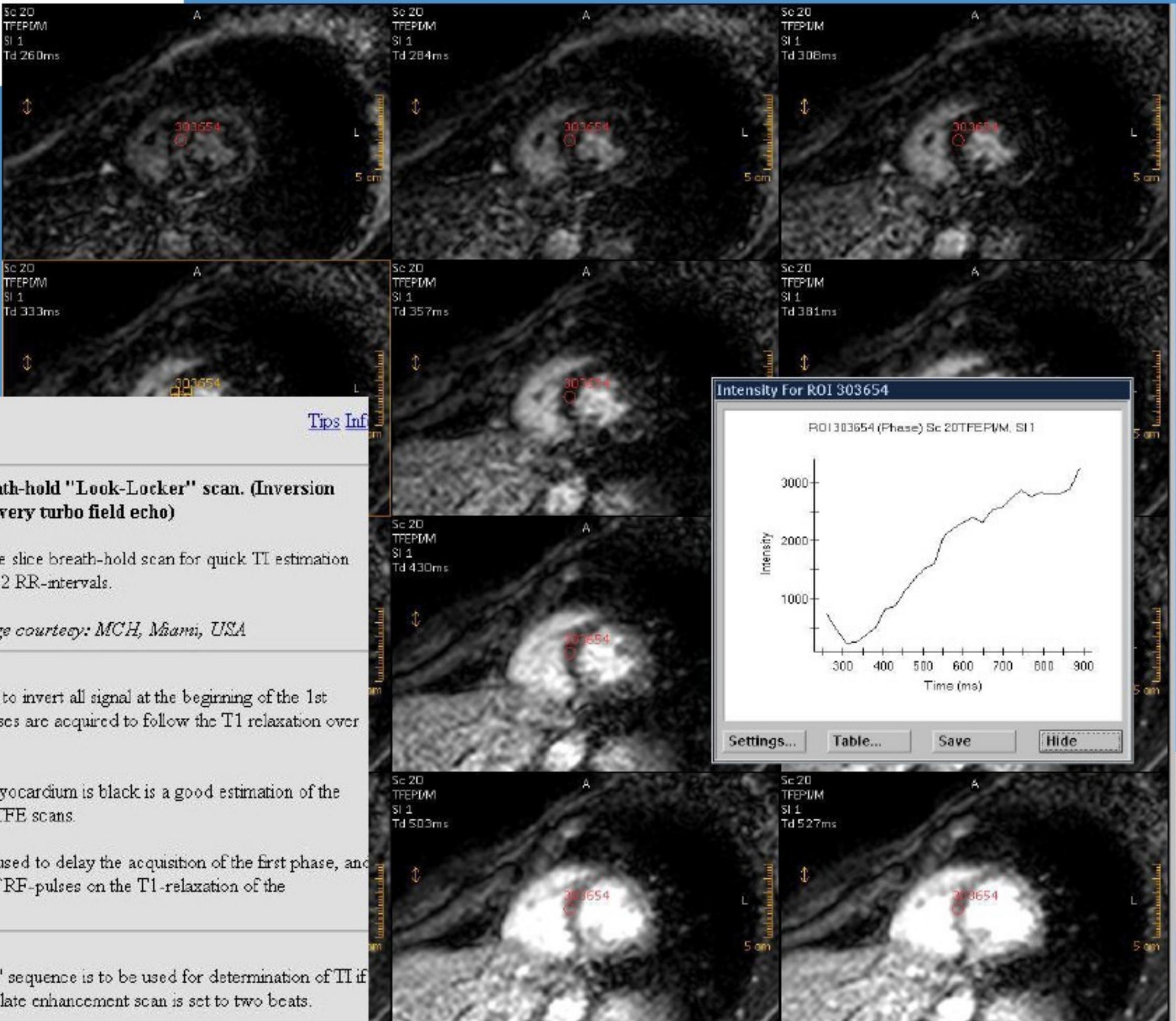
延迟强化

对比剂： Gd-DTPA

序列： T1加权二维相位敏感重建(PSIR) 磁矩预准备快速小角度梯度回波(Turbo-FLASH) 序列

扫描需屏气，一次屏气得到一个水平长轴或短轴层面
正常心肌信号被抑制，有造影剂存留心肌呈高信号
在注射对比剂后约10分钟开始采集的延迟强化图像，
并在20-30分钟内采集完毕

IR_TFE_LL_2beats决定TD时间



IR_TFE_LL_2beats



Breath-hold "Look-Locker" scan. (Inversion recovery turbo field echo)

Single slice breath-hold scan for quick TI estimation over 2 RR-intervals.

Image courtesy: MCH, Miami, USA

Info:

An *inversion pulse* is used to invert all signal at the beginning of the 1st cardiac cycle. Multiple phases are acquired to follow the T1 relaxation over time.

The time point where the myocardium is black is a good estimation of the inversion delay for the IR_TFE scans.

A *pre-pulse delay time* is used to delay the acquisition of the first phase, and as such reduce the effect of RF-pulses on the T1-relaxation of the myocardium.

Tips:

A two-beat 'Look-Locker' sequence is to be used for determination of TI if the TFE shot interval in the late enhancement scan is set to two beats.

PAN PEI MEI

1973-04-03 10834483
IR_TFE_BH_2beats CLEAR FOV 280
2013-03-21,18:11 Slice 4/10

Review Planscan Exit

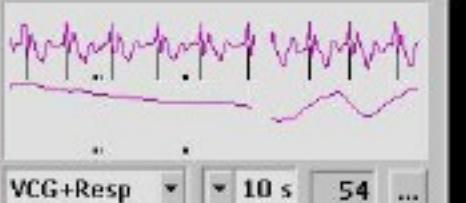
Extended Image Information

PAN PEI MEI
 1973 04 03 10834483 F
 IR TFE BH 2beats CLEAR FOV 280
 2013 03 21,18:11 Slice 4/10
 TR 3.2 THK 8.0/0.0
 TE 1.6 Echo 1/1
 TFE Factor 37
 Flip 25 PPI 330 Td 740ms
 TRANSVERSE RFOV 93% NSA 2
 T1TFEM CLEAR
 SENSE-Cardiac 176/448
 Total scan time: 3:00m
 CT noGC RC
 AP -27 ant Angle AP -35
 RL 53 left Angle RL -40
 RH 20 head Angle RH 10
 MR201303210520 WW 1914
 GUANGDONG GENERAL HOSP. WL 1101

Hide

Scan: 21 +
 More... All
 View Window RAL

PAN PEI MEI



IR_TFE_BH_2beats

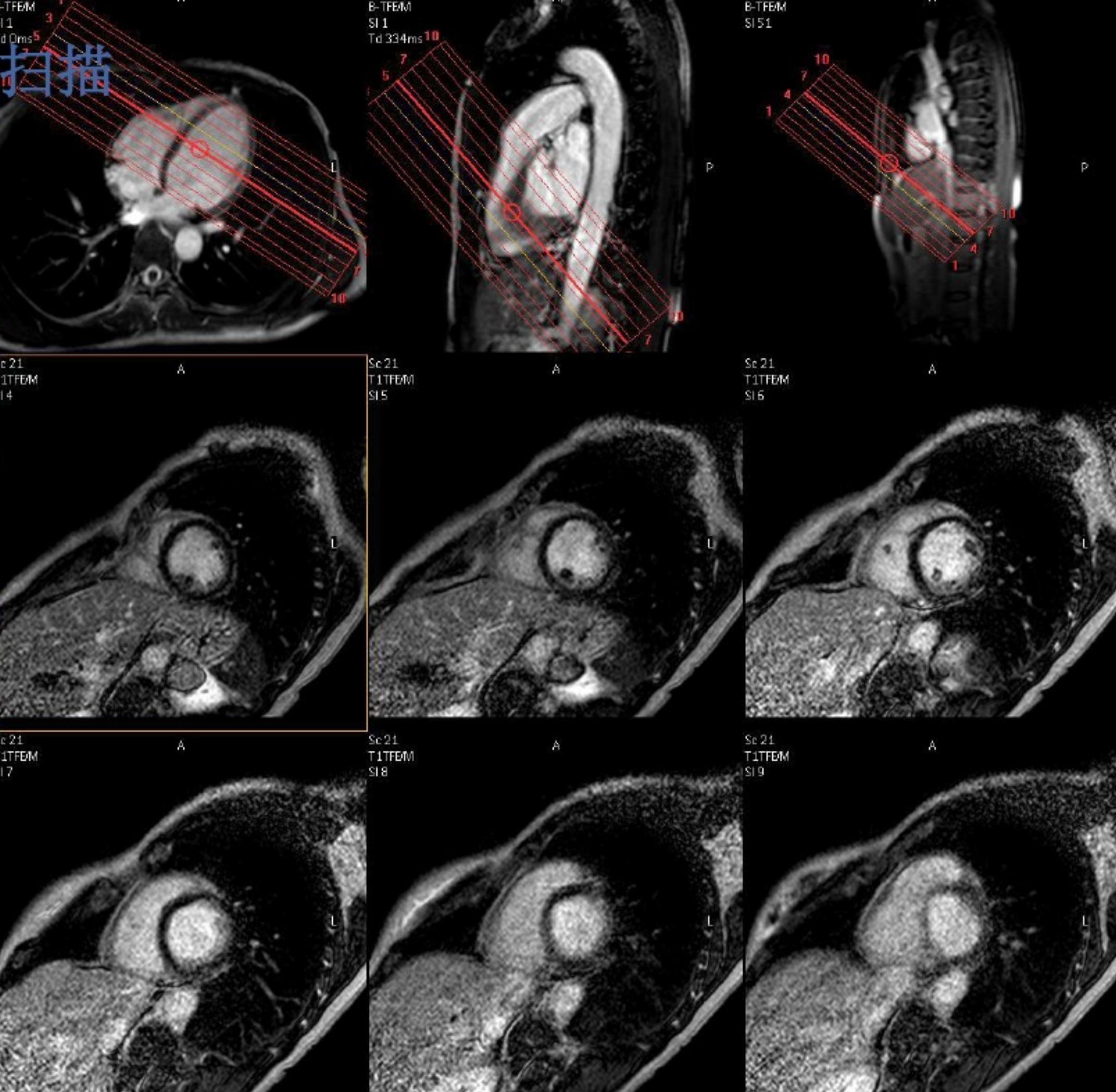
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74%

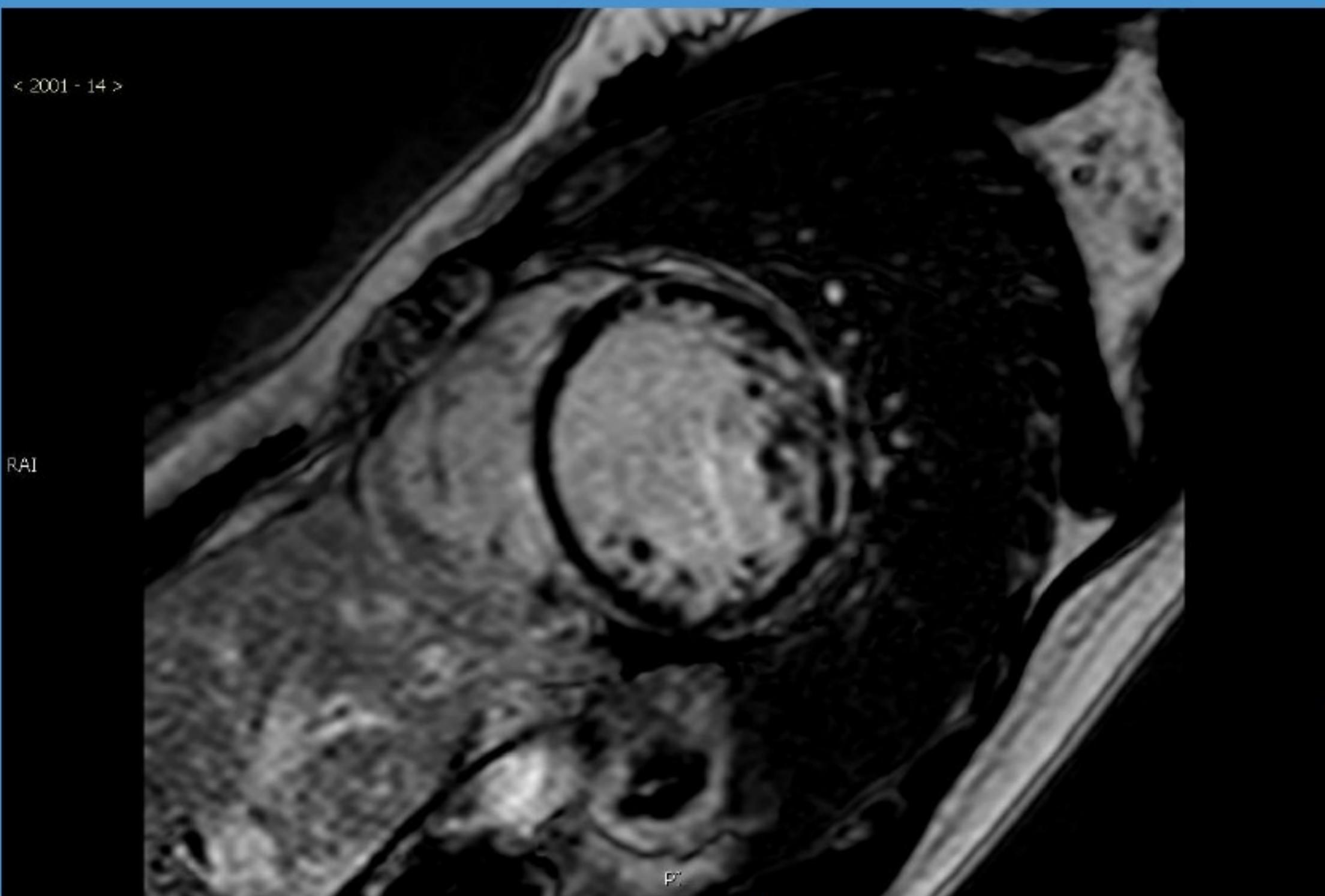
Autoview...

Start Scan

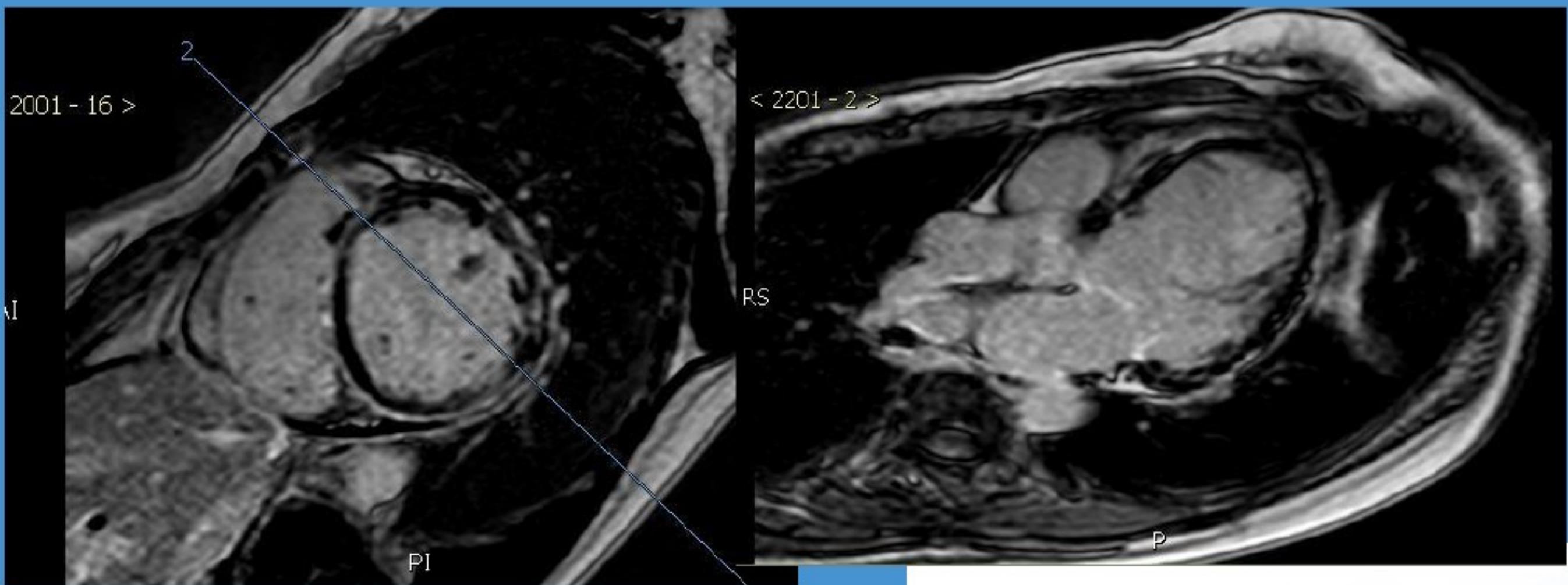
Stop Scan



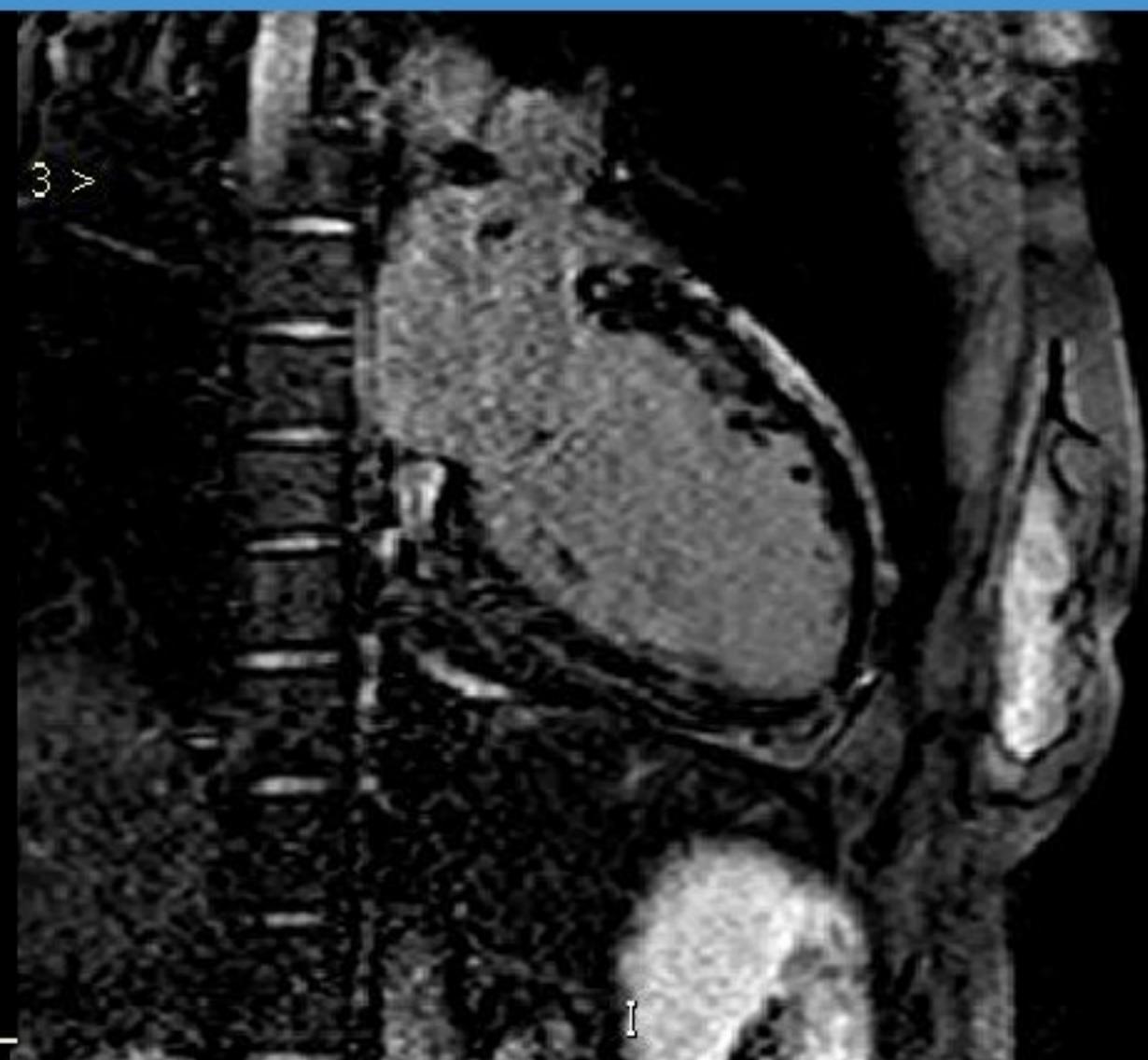
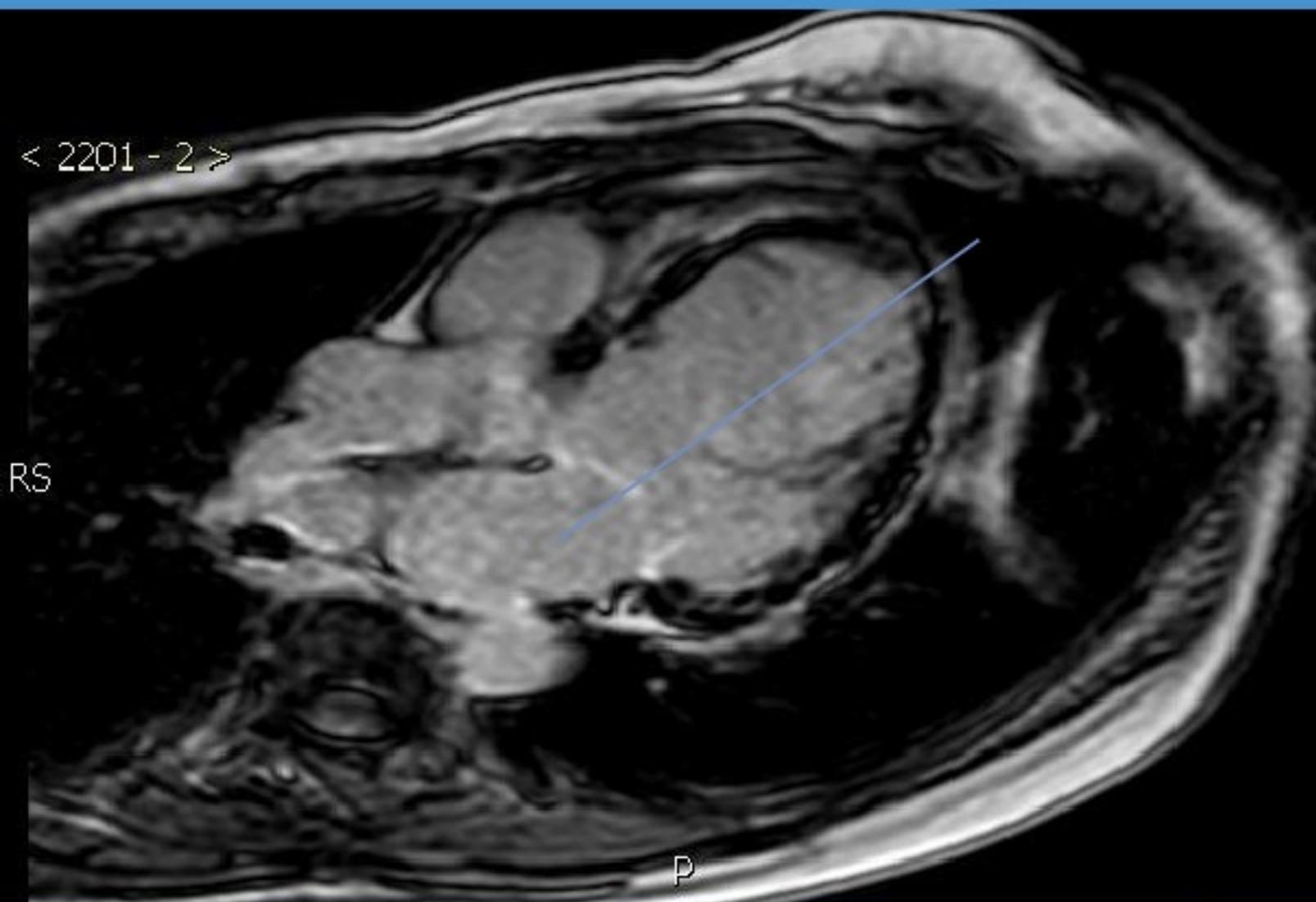
延时强化扫描—短轴位



延时强化扫描—三腔心



延时强化扫描—二腔心



小结：扫描方案规范

一般定位图——心脏标准位图

黑血技术——心脏、大血管结构初步观察

白血技术——心脏电影:解剖结构的观察，心功能分析

灌注检查——心肌缺血

延迟增强——纤维化、瘢痕等

谢谢！

