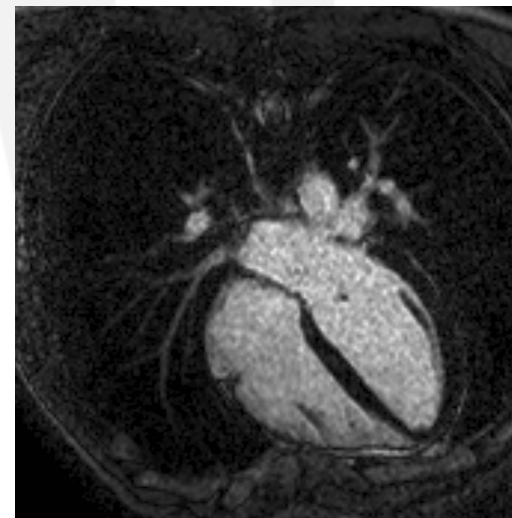
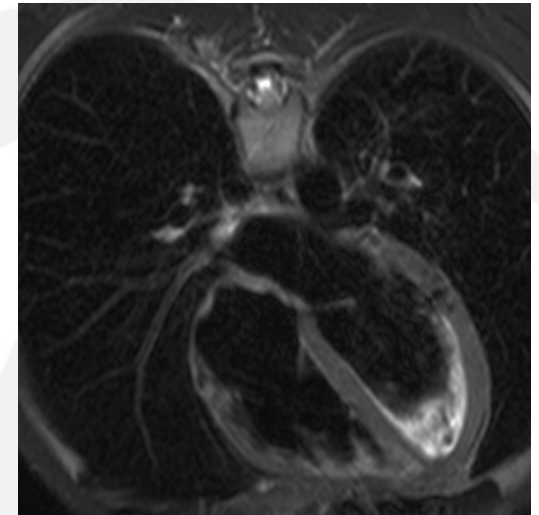
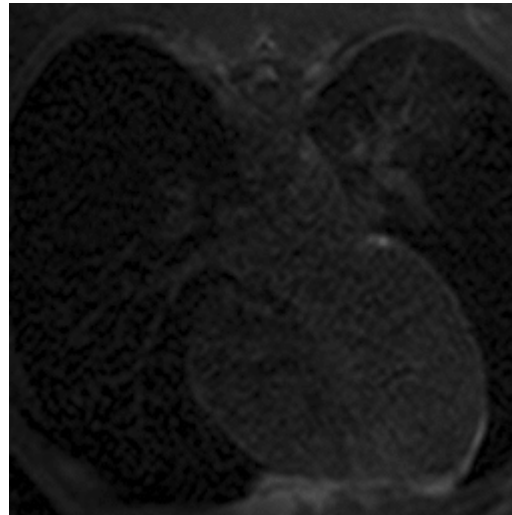
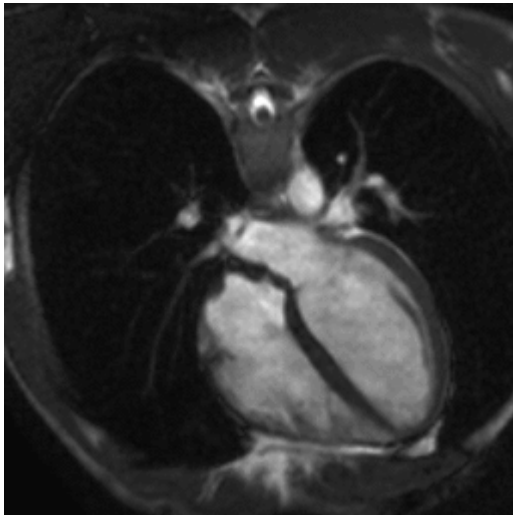


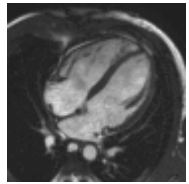
FISA visit – welcome all our guests!

**Cardiac magnetic resonance in athletes -
normal and abnormal examples**

Spartathlon: 246km (Pheidippides)



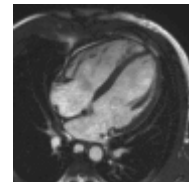
Sudden cardiac death in athletes



- H(O)CM
- ARVD/C
- Anomalous coronary origins
- Coronary runoff anomalies
 - Bridging
 - Tunelling
- Myocarditis



H(O)CM



- **Myocardial mass**
- Wall thickness
- Fibrotic degeneration of the myocardium
 - Close correlation with arrhythmias
- Maximal end-diastolic wall thickness – end-diastolic volume index ratio
 - JCMR 7:551 - cutoff value: 0,14



Left ventricular evaluation

The screenshot displays the QMass MR 7.2 software interface for cardiac MRI analysis. The main window shows a 2D MRI slice of the heart with a red and green contour around the left ventricle. A 3D Viewer window is open, showing a 3D reconstruction of the ventricle with red and green outlines. The interface includes a Study Matrix, Active View, Scan Lines, and a grid of image thumbnails.

Study Matrix (Phases [25]):

	ALL	1	2	3	4	5	6	7	8	9	ES	11	12	13	14	15	16	17	18	19	20	21	22	23	ED	25
15																										
14																										
13																										
12																										
11																										
10																										
9																										
8																										
7																										
6																										
5																										
4																										
3																										
2																										
1																										

3D Viewer (S801) Settings:

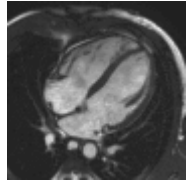
- Named Settings: Default
- Movie Type: Phases
- Buttons: Movie, Reload, Print Preview, Print, Settings, Close

Active View: Main 2D MRI slice with left ventricular contour.

Scan Lines: Three smaller 2D MRI slices showing different views of the heart.

Grid: A grid of 15x5 image thumbnails showing various slices of the heart.

ARVD/C



- Task Force lead by McKenna
 - Criteria system
- Cardiac MR should show
 - **Right ventricular volume and EF**
 - Bulging, aneurysma, dyskinesis?
 - Fatty infiltration: no longer necessary
- Late enhancement (fibro-fatty)
 - Really arrhythmogenic: not yet necessary



Right ventricular evaluation

The screenshot displays the QMass MR 7.2 software interface for cardiac MRI analysis. The main window shows a cardiac MRI slice with a yellow and blue outline of the right ventricle. A 3D Viewer window (S801) is open, showing a yellow 3D model of the right ventricle with labels for Basal, Apical, Sept, and Lat. The interface includes a Study Matrix, Active View, Scan Lines, and a grid of image thumbnails.

Study Matrix	Phases (25)
ALL	1 2 3 4 5 6 7 8 9 ES 11 12 13 14 15 16 17 18 19 20 21 22 23 ED 25
15	
14	
13	
12	
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	

3D Viewer (S801) labels: Basal, Apical, Sept, Lat.

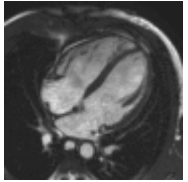
Named Settings: Default

Movie Type: Phases

Buttons: Movie, Reload, Print Preview, Print, Settings, Close

System tray: Start, 1. DJ Naggy - Run, Zom..., RDO Alath - Belépés - M..., QMass MR 7.2, mc [alath@stoth]:~/save, 18:57

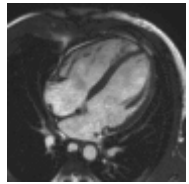
Other



- Anomalous coronary origin
 - Clinical significance under debate
- Coronary runoff anomalies
 - No evidence
- Myocarditis
 - MR can pretty clearly visualize



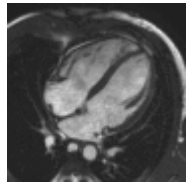
Study population



- 48 Volunteers
- 88 Elite athletes
 - 23 water-polo player
 - 21 kayakers
 - 15 canoers
 - 9 cyclers
 - 5 ultra-marathon runners
 - 15 rowers
- Parolimpic athletes
 - 6 goalball players



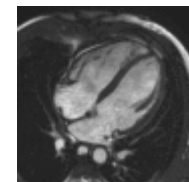
Protokoll



- Functional measurement – EF, volumes
- STIR-like measurement – edema
- Rest first-pass perfusion
- Late enhancement
- MRCA: before or long after contrast administration
- Additional sequences optionally



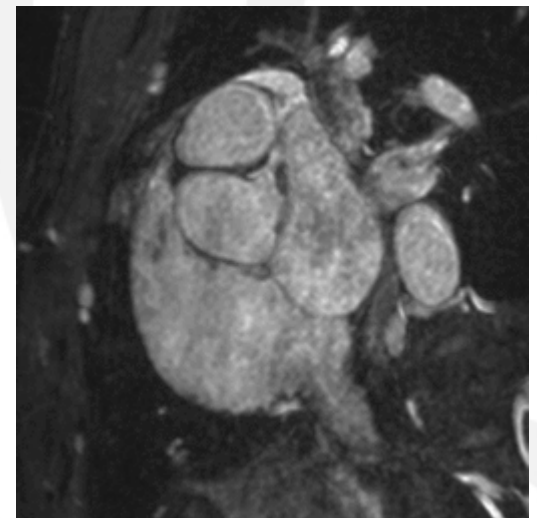
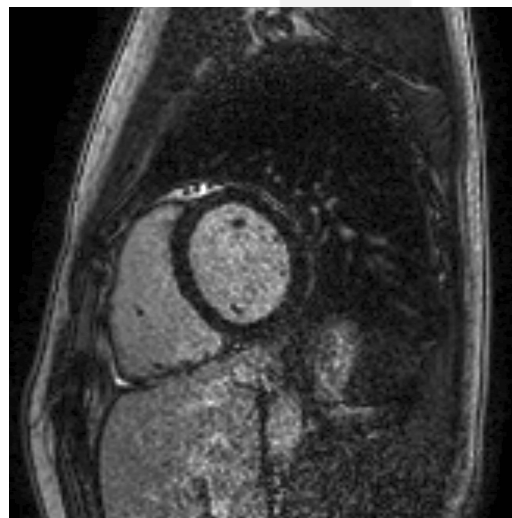
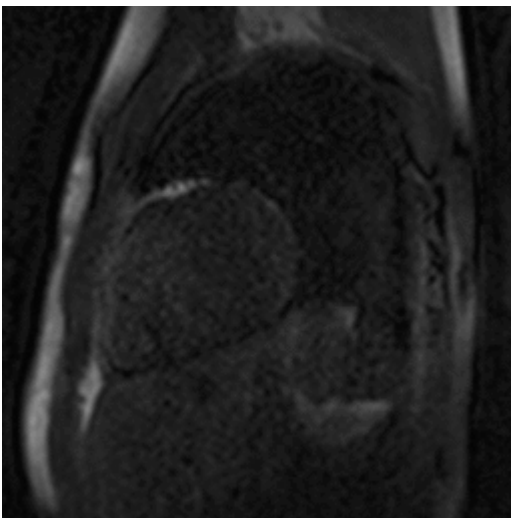
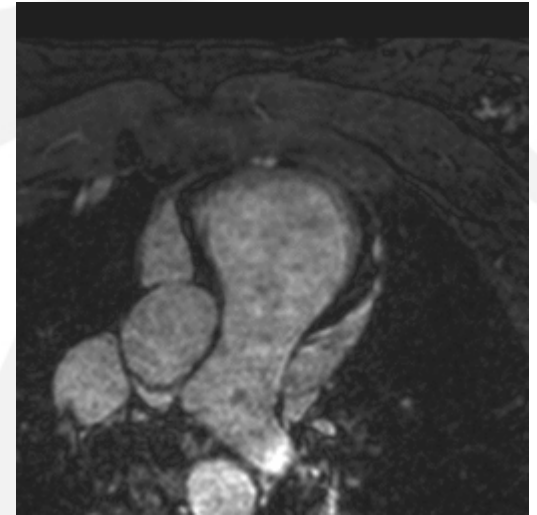
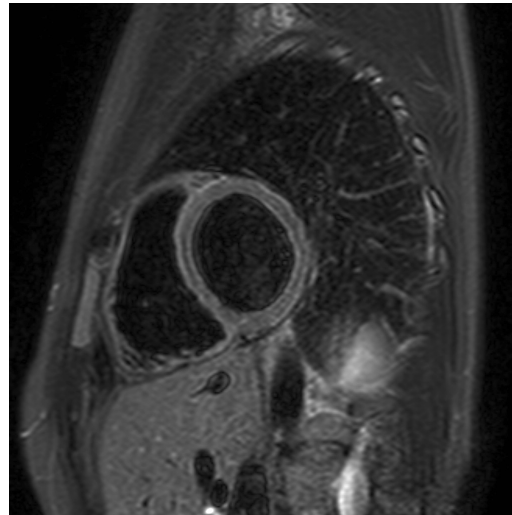
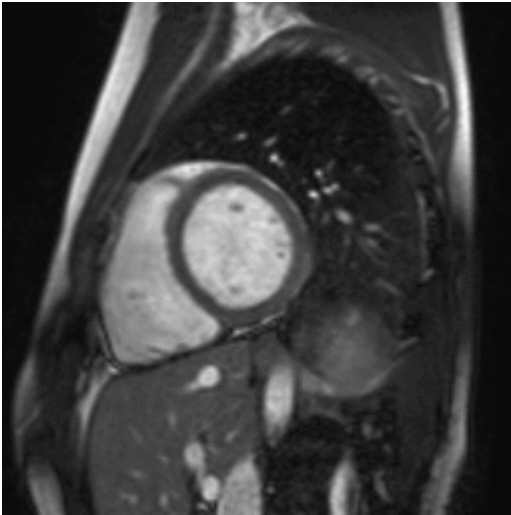
Measured parameters



- HR, BSA
- LVEF, RVEF
- LVESV(i), LVEDV(i), LVSV(i), LVM(i)
- RVESV(i), RVEDV(i), RVSV(i), RVM(i)
- Maximal end-diastolic wall thickness
- Diastolic wall thickness ratio
- Maximal end-diastolic wall thickness – end-diastolic volume index ratio (sport index)

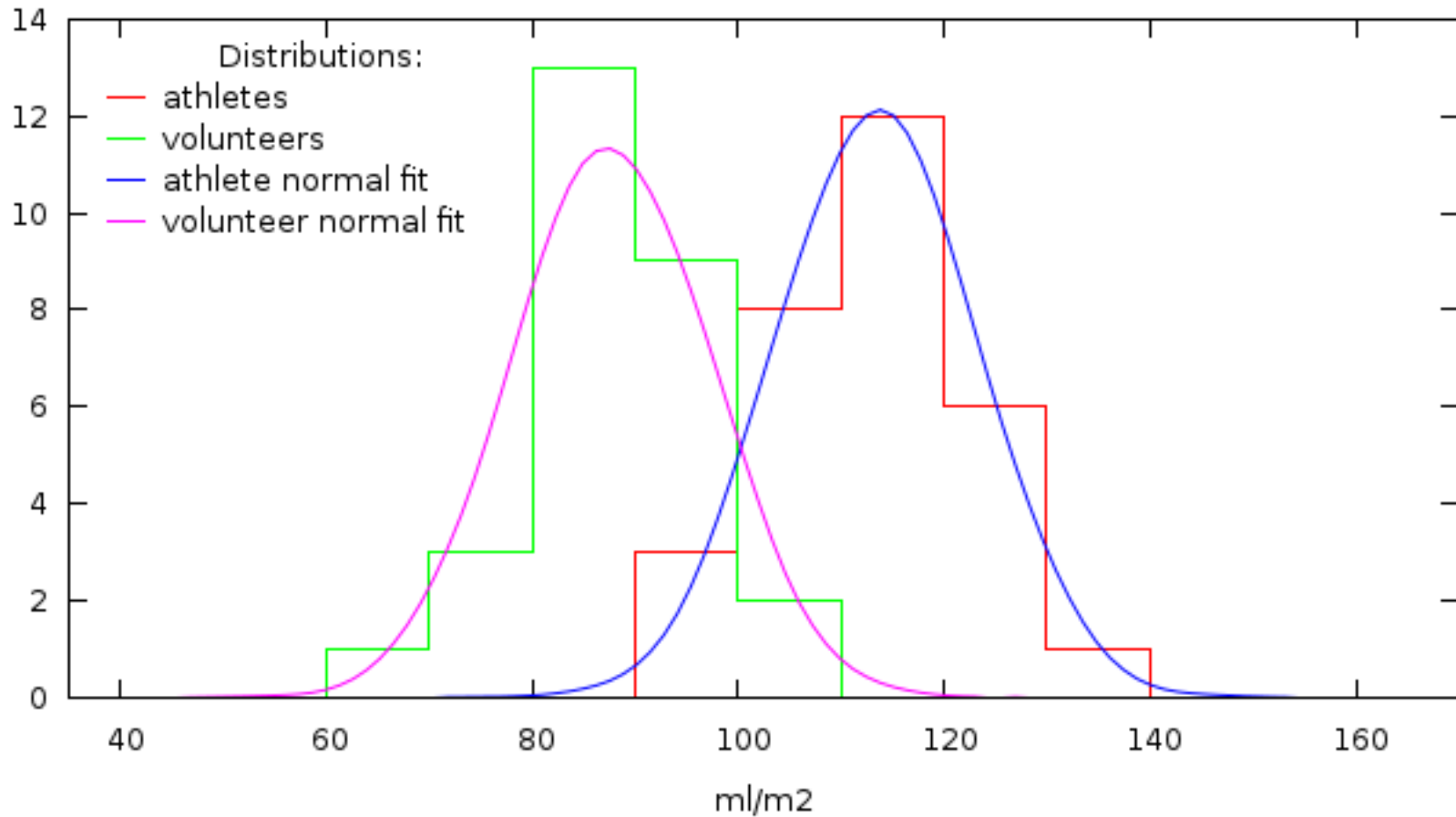


Female water-polo player: normal study

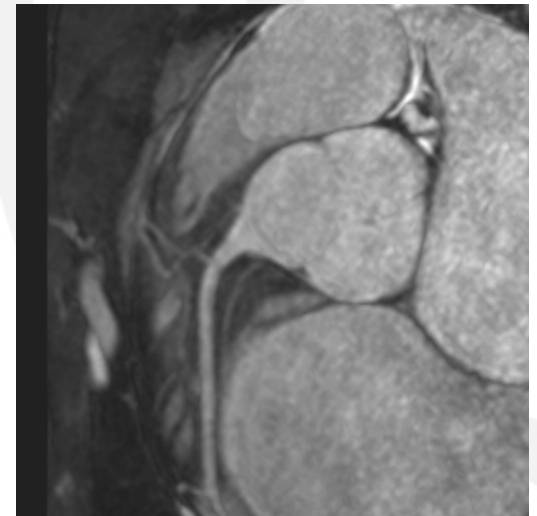
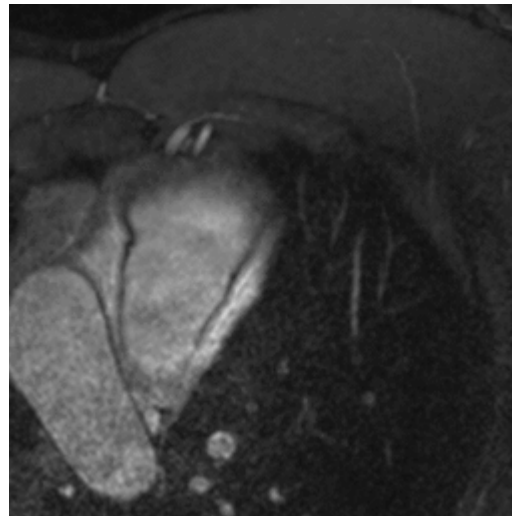
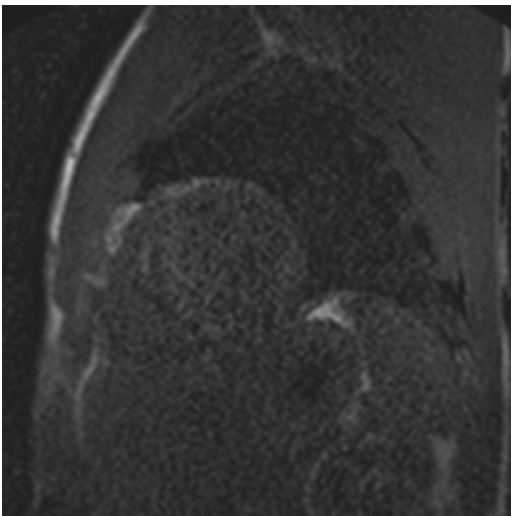
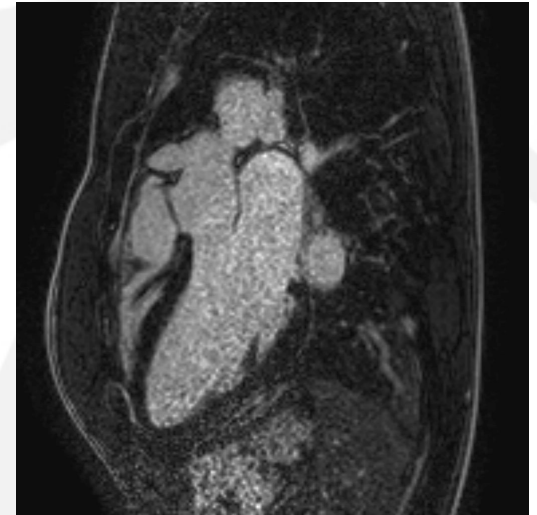
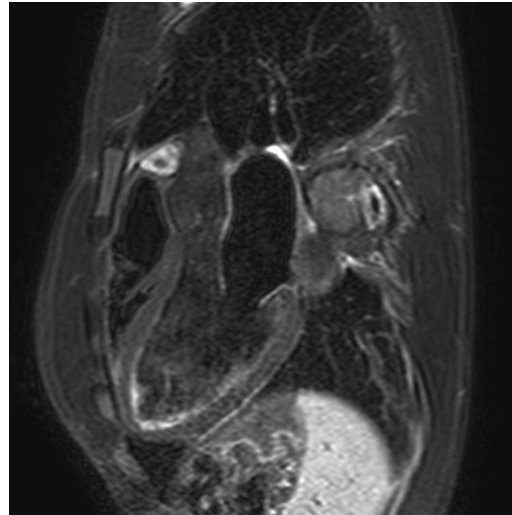


Left ventricular end-diastolic vol. index

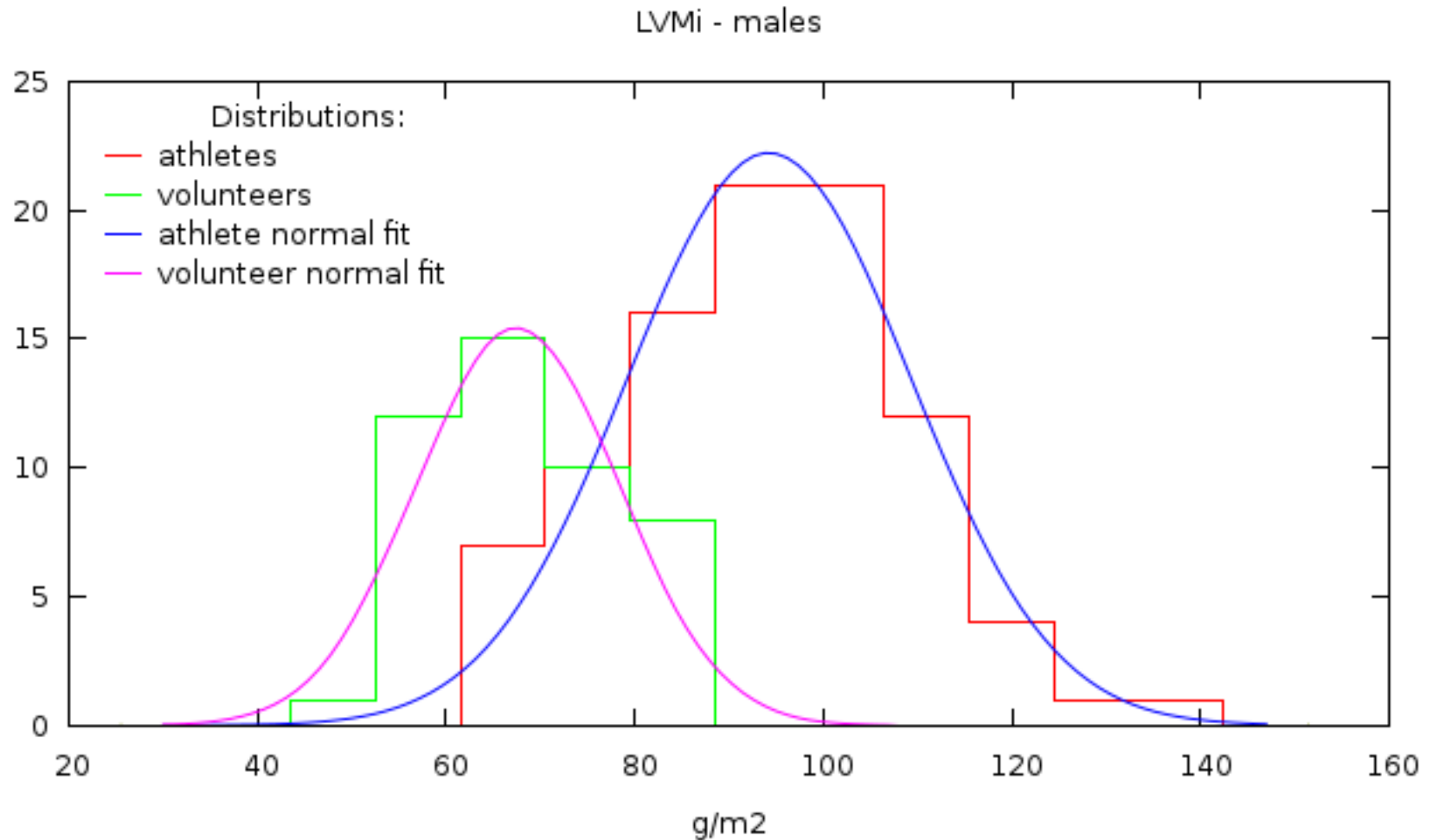
LVEDVi - females



Male kayaker: normal exam



Left ventricular myocardial mass index



Male averages

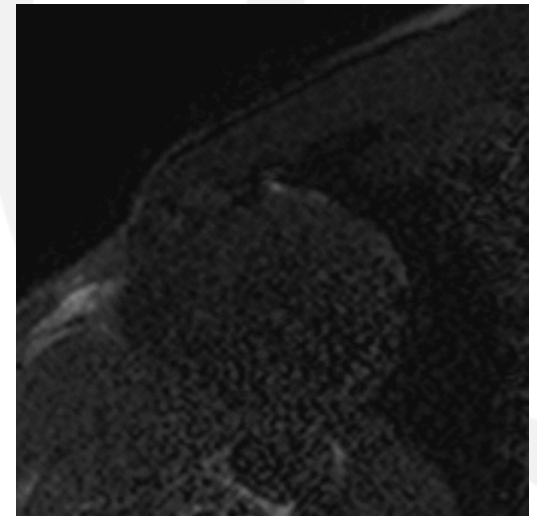
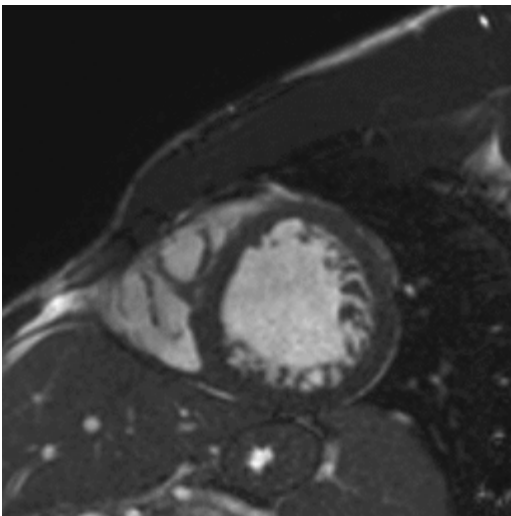
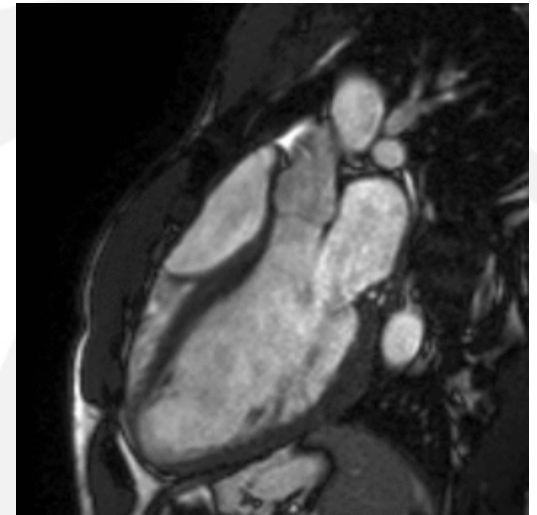
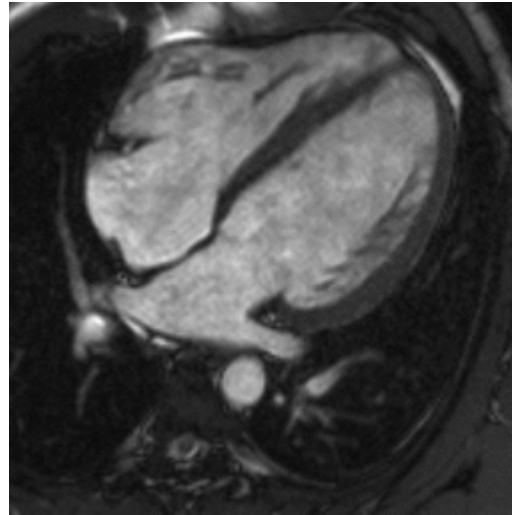
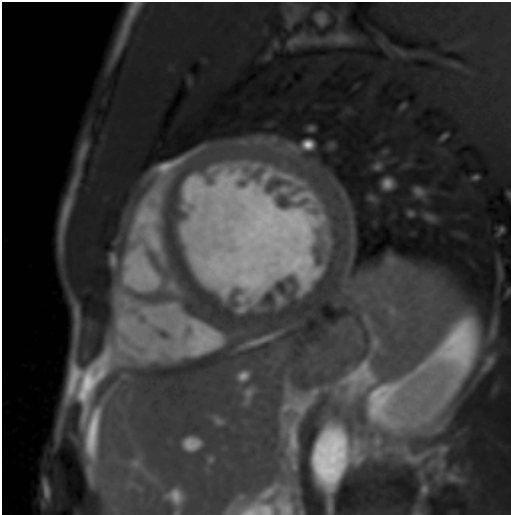
Parameter	Volunteer (48)	Waterpolo (N = 23)	Kayaker (N = 21)	Canoer (N = 15)	Cyclor (N = 9)	Ultrarunner (N = 5)	Rower (N = 15)	Goalball (N = 6)
BSA (m ²)	2.04 ± 0.18	2.33 ± 0.09	2.08 ± 0.13	2.00 ± 0.08	1.87 ± 0.10	1.82 ± 0.08	2.00 ± 0.11	2.13 ± 0.19
LVEF	60.2 ± 5.3	57.0 ± 3.4	57.7 ± 4.8	56.9 ± 3.4	56.8 ± 3.5	58.1 ± 3.5	56.2 ± 4.0	58.7 ± 4.4
LVESVi	38.1 ± 8.3	53.0 ± 8.0	52.2 ± 10.5	56.5 ± 8.7	54.3 ± 5.9	46.9 ± 2.8	54.8 ± 9.2	41.6 ± 8.0
LVEDVi	95.2 ± 12.1	123.0 ± 13.3	122.5 ± 14.7	131.0 ± 14.6	125.3 ± 6.4	112.1 ± 5.0	124.5 ± 12.5	99.8 ± 12.2
LVSVi	57.1 ± 7.0	70.0 ± 7.8	70.3 ± 7.6	74.5 ± 8.2	71.1 ± 4.8	65.2 ± 6.3	69.6 ± 5.9	58.3 ± 6.0
LVMi	63.5 ± 10.3	86.4 ± 14.7	95.7 ± 11.1	102.2 ± 13.4	78.1 ± 15.4	79.5 ± 9.7	90.2 ± 9.0	62.6 ± 7.2
RVEF	59.1 ± 4.8	56.2 ± 4.4	55.7 ± 4.3	53.6 ± 3.9	55.1 ± 4.8	57.9 ± 3.0	54.6 ± 3.9	57.1 ± 1.2
RVESVi	40.1 ± 8.3	56.3 ± 11.6	58.1 ± 11.6	64.3 ± 8.9	60.1 ± 10.1	51.4 ± 10.5	59.8 ± 9.4	42.1 ± 5.2
RVEDVi	97.5 ± 13.2	127.7 ± 17.4	130.4 ± 16.7	138.5 ± 14.4	133.3 ± 9.6	122.1 ± 10.5	131.0 ± 12.9	98.3 ± 12.7
RVSVi	57.4 ± 7.7	71.4 ± 8.5	72.3 ± 7.8	74.2 ± 9.0	73.2 ± 5.3	70.7 ± 8.3	71.2 ± 6.2	56.2 ± 7.6
RVMi	24.9 ± 3.6	30.6 ± 3.7	34.2 ± 5.2	34.5 ± 4.9	34.5 ± 4.4	28.2 ± 2.8	33.6 ± 2.7	22.0 ± 2.4
LVED WT	11.02 ± 1.38	13.17 ± 1.64	13.52 ± 1.91	12.87 ± 1.60	12.00 ± 1.23	12.25 ± 1.26	13.07 ± 1.39	10.50 ± 0.55
Sport index	.118 ± .0246	.107 ± .0149	.112 ± .0231	.099 ± .0181	.096 ± .0122	.109 ± .0119	.106 ± .0150	.106 ± .0115



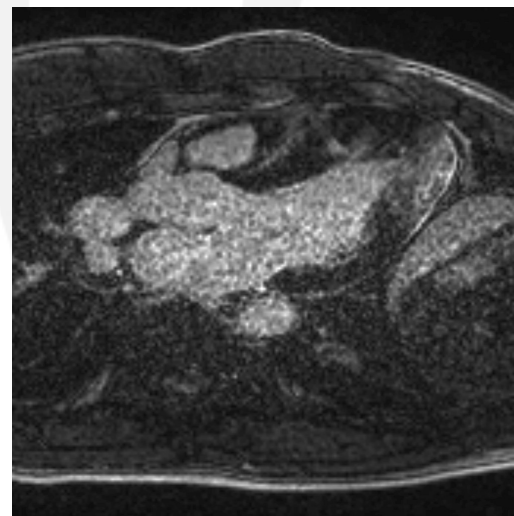
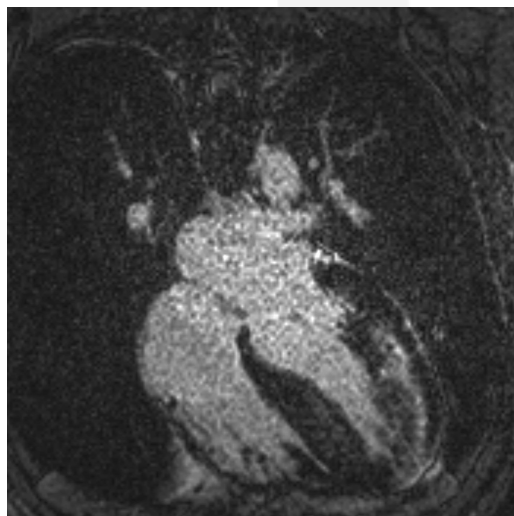
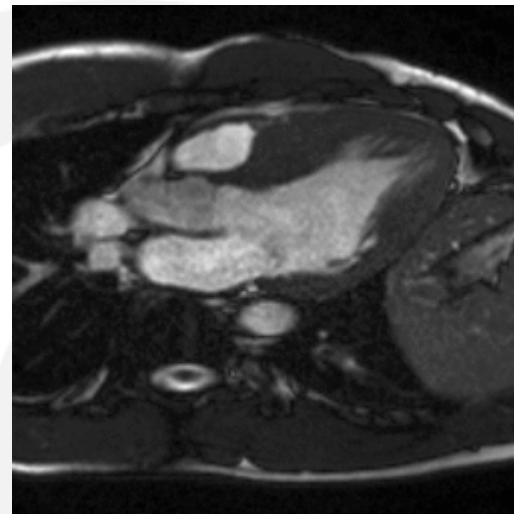
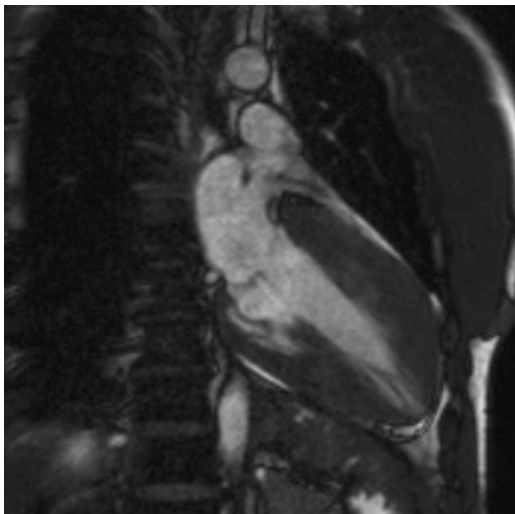
HCM and DCM example

Parameter	Volunteer	Elite athletes	DCM	HCM
HR	66,74 (11,24)	59,52 (10,10)	46	53
BSA	2,056 (0,191)	2,046 (0,184)	2,08	2,04
LVEF	59,53 (5,57)	57,51 (4,26)	40,4	63,78
LVESVi	38,72 (8,69)	53,50 (9,63)	112,45	39,99
LVEDVi	95,09 (12,77)	125,25 (13,87)	188,57	110,41
LVSVi	56,37 (7,53)	71,76 (7,21)	76,13	70,42
LVMi	62,93 (11,21)	88,09 (17,66)	125,98	160,90
RVESVi	41,30 (8,10)	59,19 (11,45)	68,52	36,86
RVEDVi	98,37 (13,61)	132,66 (15,40)	144,45	102,08
RVSVi	57,08 (8,33)	73,46 (7,28)	75,94	65,22
RVMi	25,11 (3,97)	34,16 (5,17)	34,30	36,17
ED WT	11,09 (1,46)	12,78 (1,93)	–	29
Sport index	0,119 (0,026)	0,103 (0,021)	–	0,26

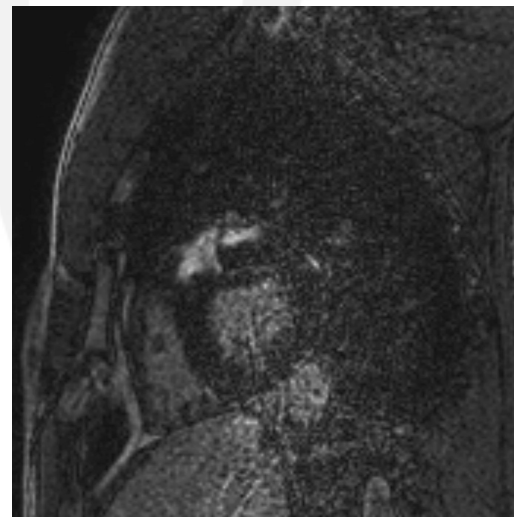
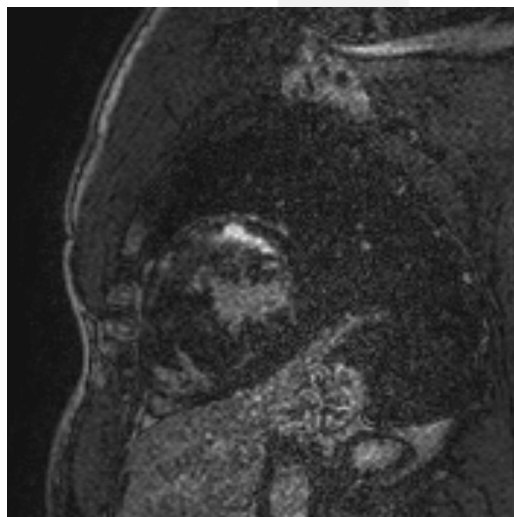
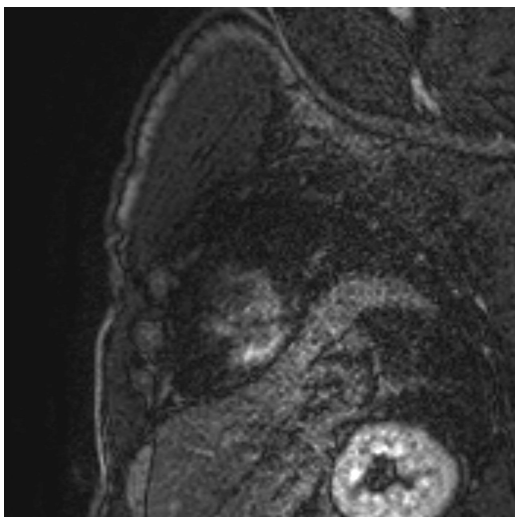
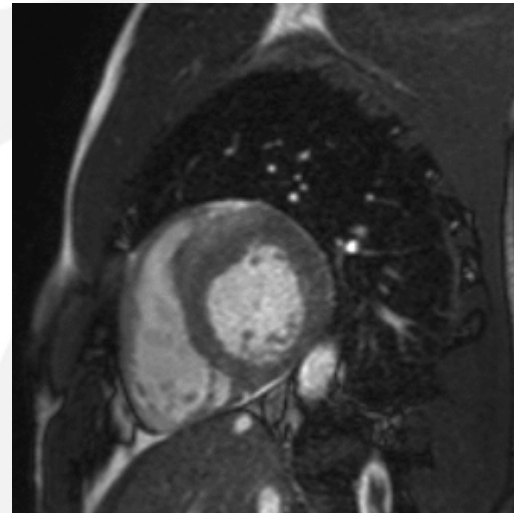
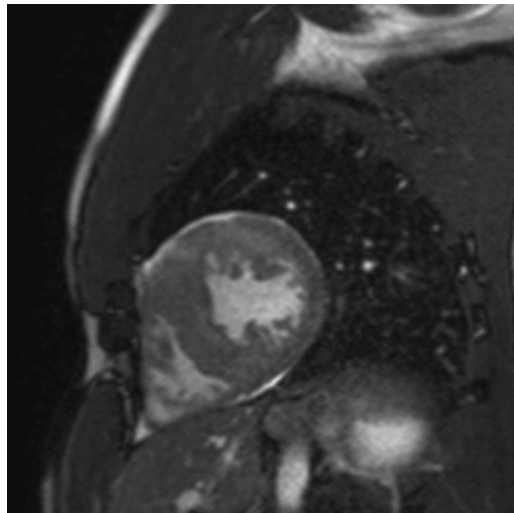
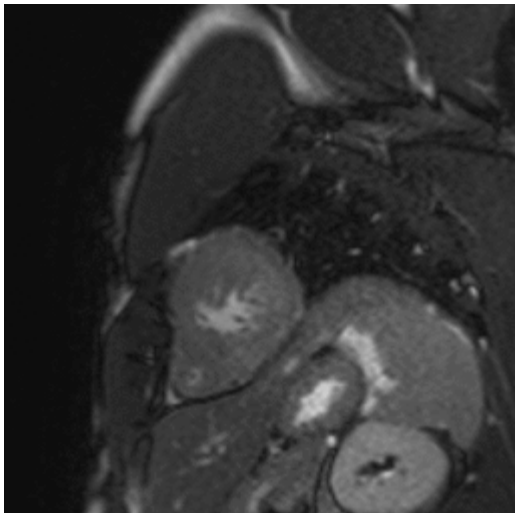
Ice hockey player



LA cine and DE



SA cine and DE



DE quantification: 63g scar out of 360g

QMass MR 7.2

File Edit View Analysis Settings Tools Help

Study Matrix DSI Analysis Wizard

Step 4: Specifying Transmurality Threshold and Placing Reference Point

1. If you want to change the default transmurality threshold, you can specify it under **Transmurality Threshold**. The transmurality threshold is used to calculate non-viable tissue.
2. Click in the Active View to place the reference point at the posterior septum.

If you want to place the reference point at the anterior septum, refer to the user manual.

Transmurality Threshold [%]
50

Result Dialogs: Reference Point

The DSI results

Total myocardial mass:	360.33 g
Scar tissue mass:	63.20 g
Scar tissue volume:	60.19 ml
Scar tissue percentage:	18 %
Nonviable mass:	5.33 g
Nonviable volume:	5.08 ml
Nonviable percentage:	1 %
Transmurality threshold:	50 %

SE Kardiológiai Központ
Philips Medical Systems
2010.03.20.

TR: 5.49ms
TE: 2.52ms
TI: 0.00ms
TD: 773ms
SLs: 12
PH: 1
SP: 88.00mm
SI th: 8mm

Total mass: 360.33g
Scar tissue: 63.20g / 18%

WW: 138
WL: 2 090
Zoom: 175%

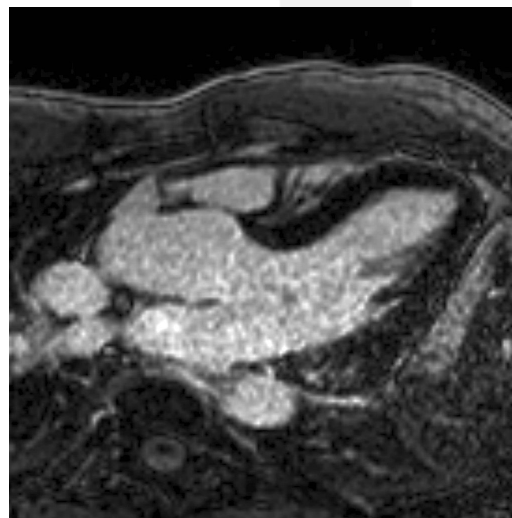
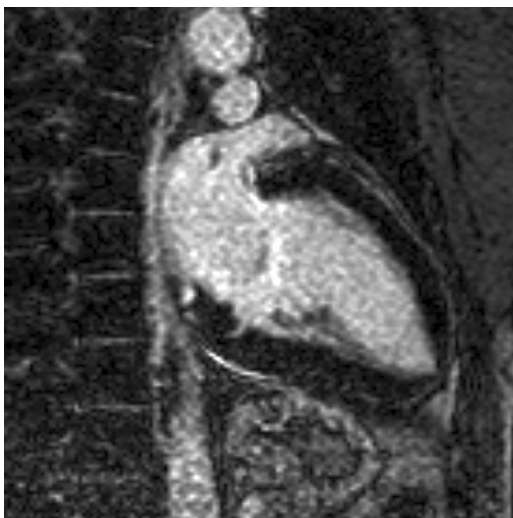
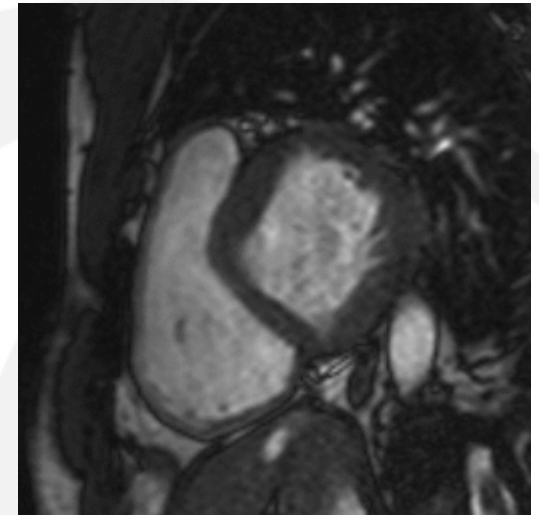
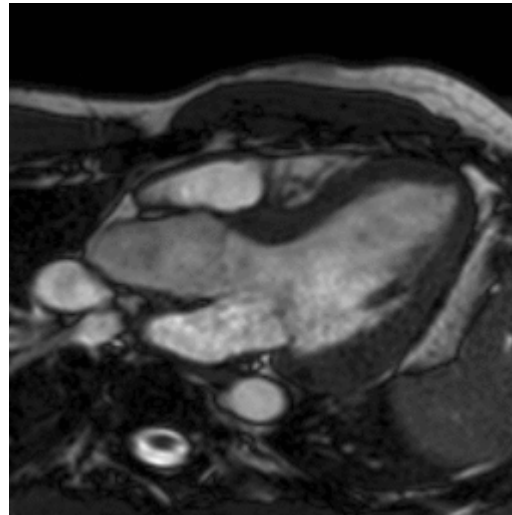
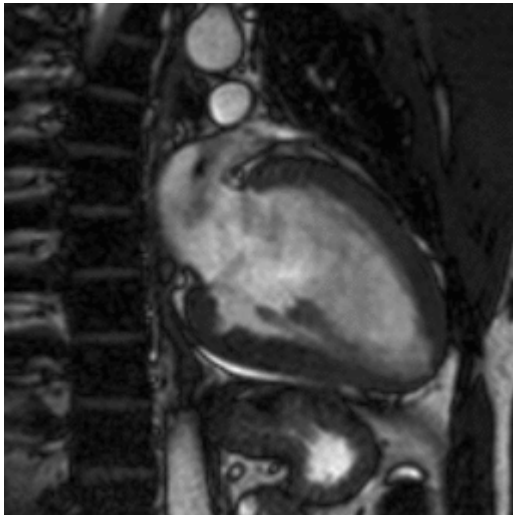
< Back Done Cancel

S1p1 773ms S2p1 773ms S3p1 773ms S4p1 773ms S5p1 773ms S6p1 773ms S7p1 773ms S8p1 773ms S9p1 773ms S10p1 773ms
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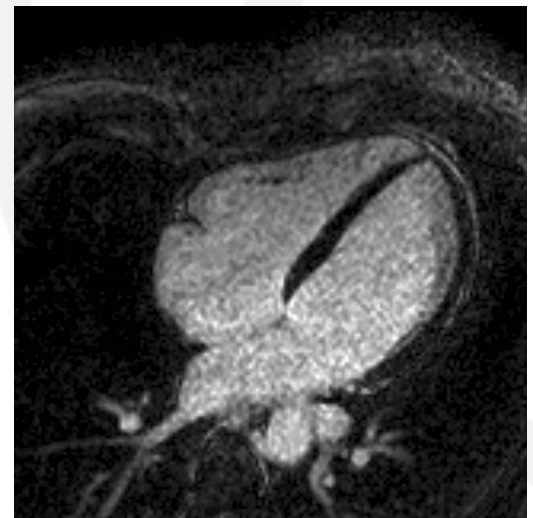
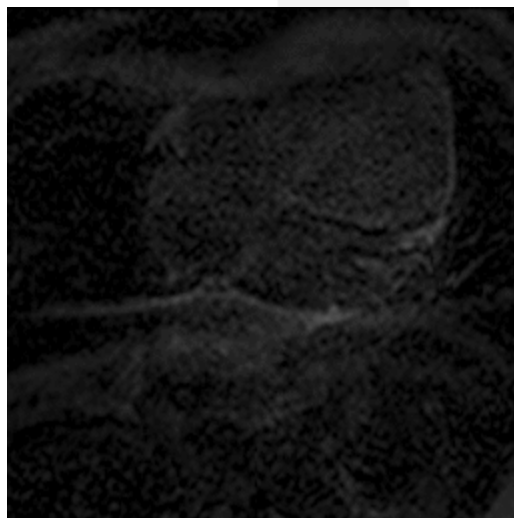
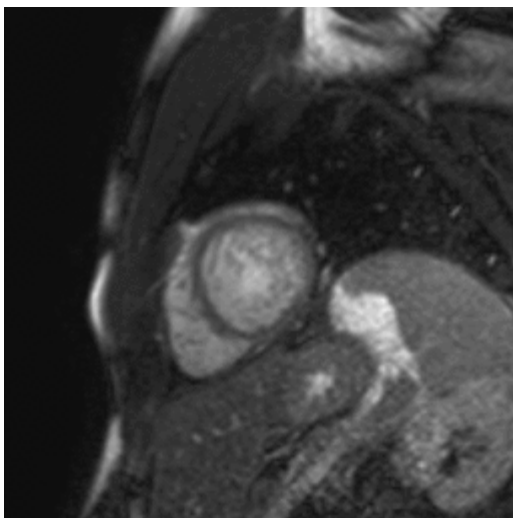
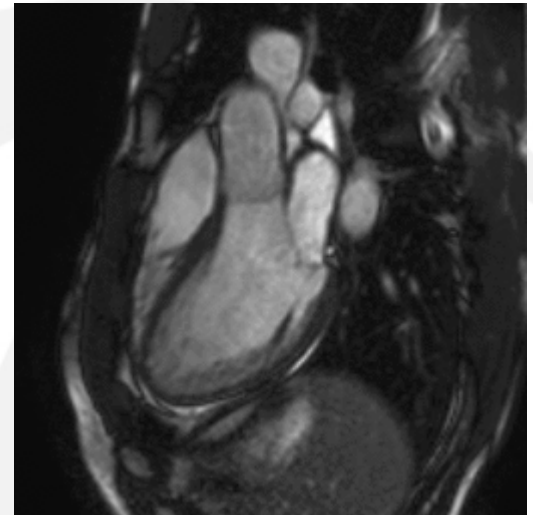
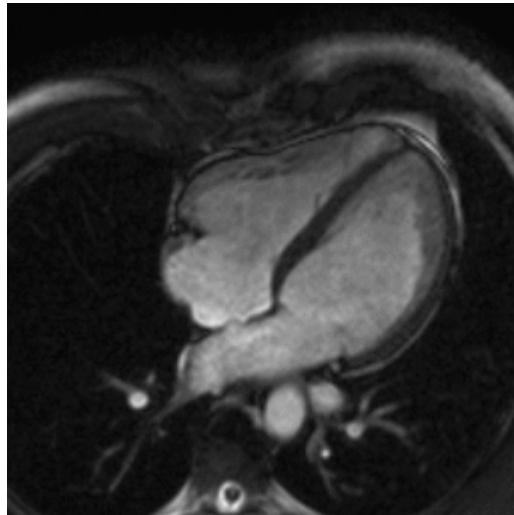
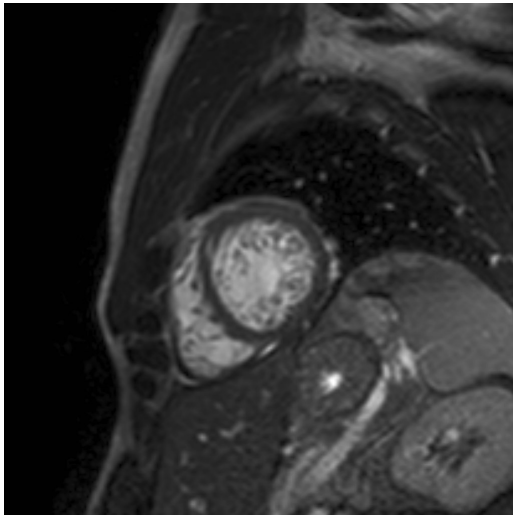
L: 0,2, A: 91,4, I: 13,4, Gray value=2048

Start Atoth SquireMail 1.4.1... e-MedSolution - Mozilla F... 1. Axiom b2b Virtual xtc... mc [atoh@atoh]:~/jsa... nr QMass MR 7.2 mr - atoh[atoh].sote.h... 21:21

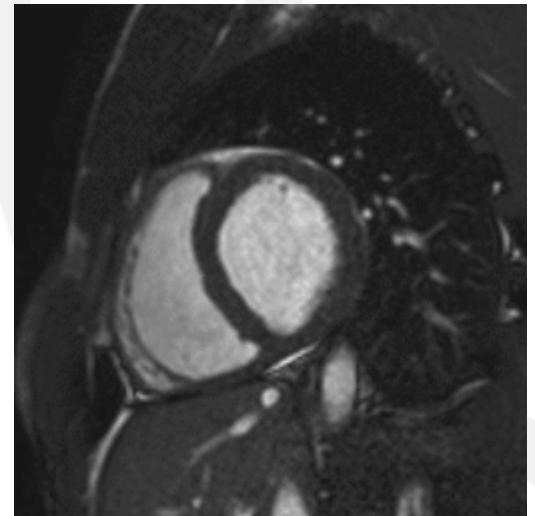
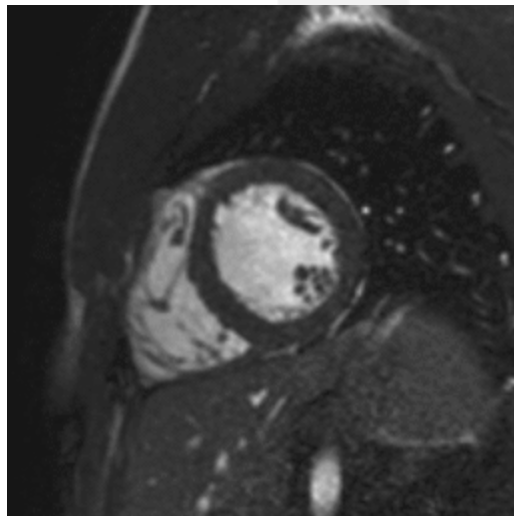
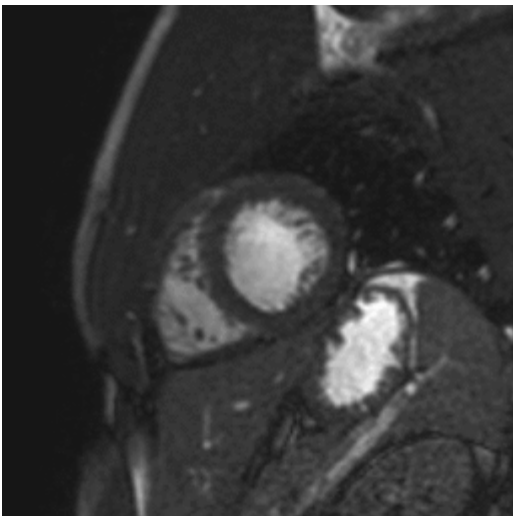
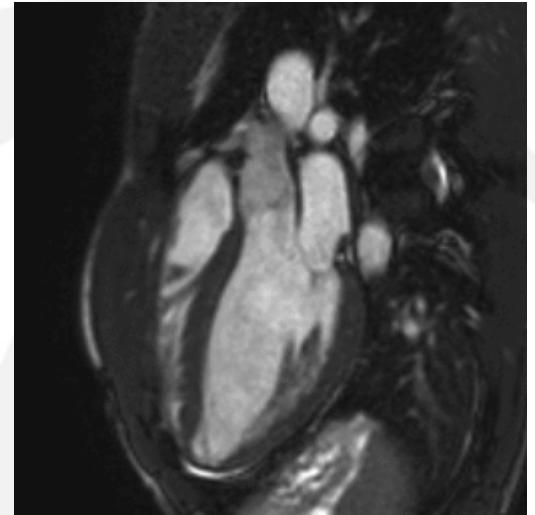
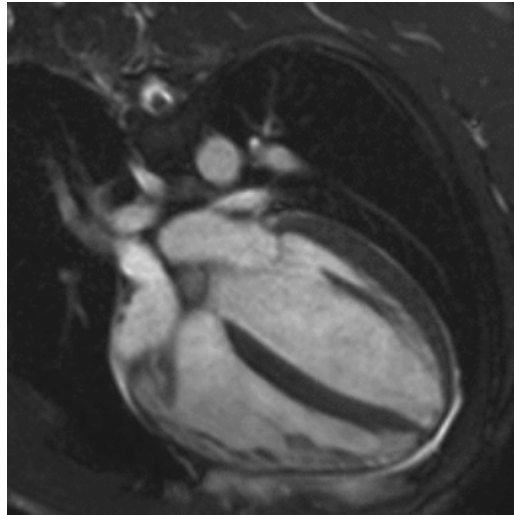
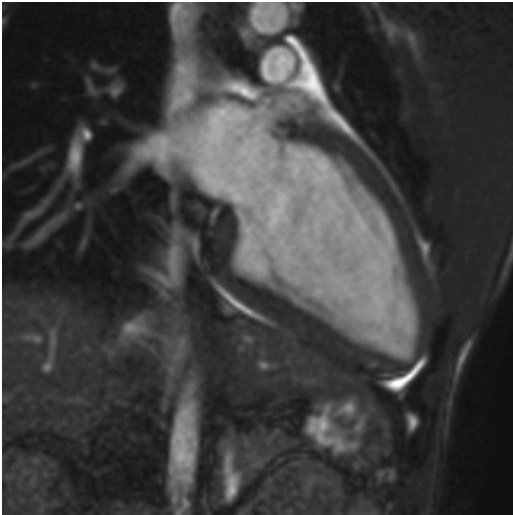
Muaj thai: Anderson-Fabry (19mm)



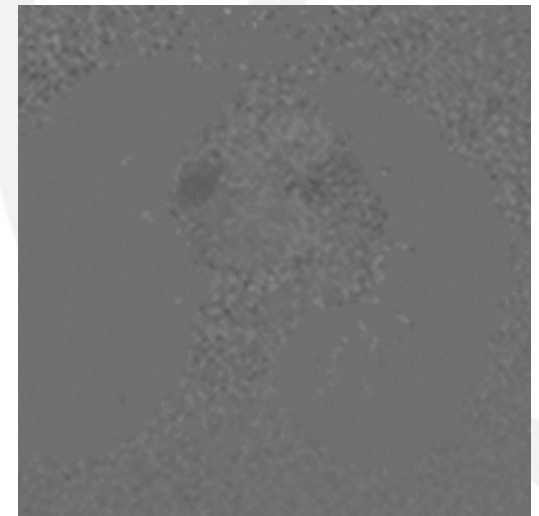
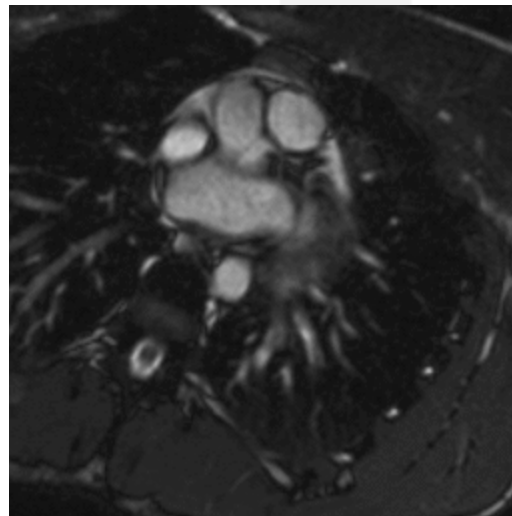
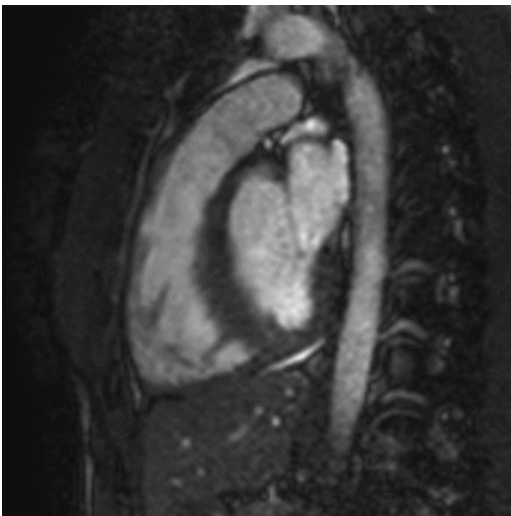
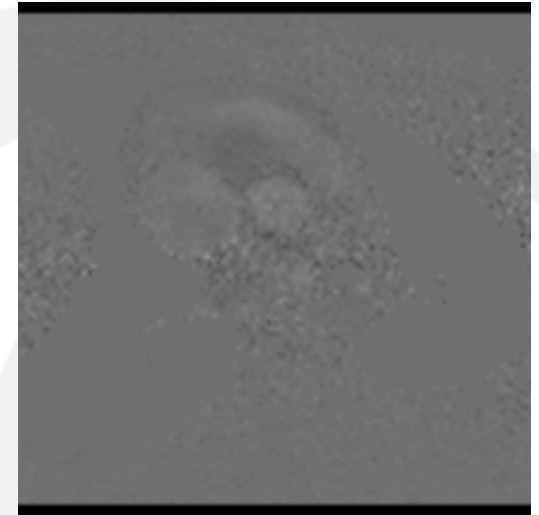
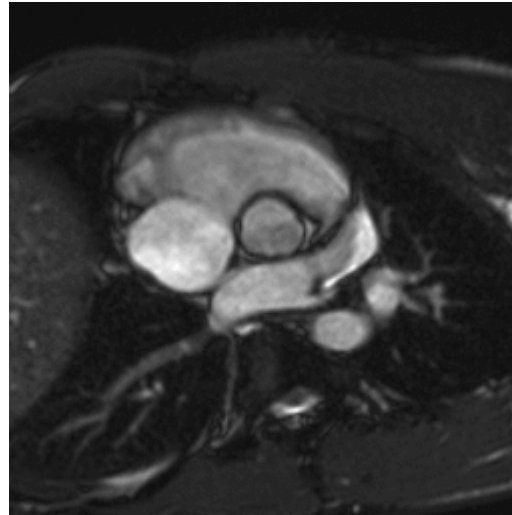
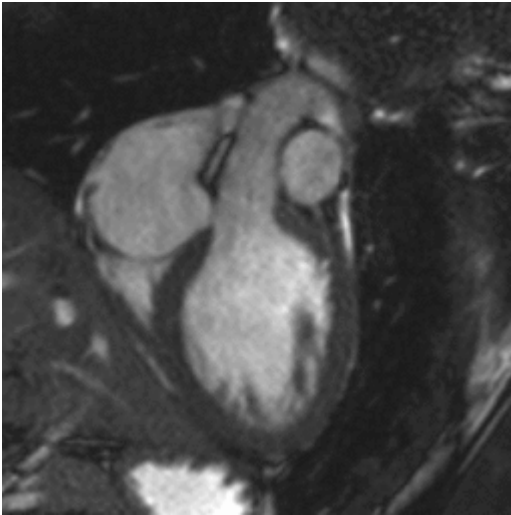
EKG abnormalities



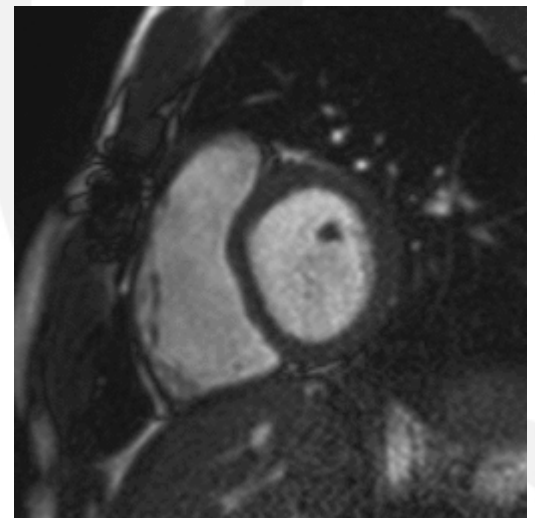
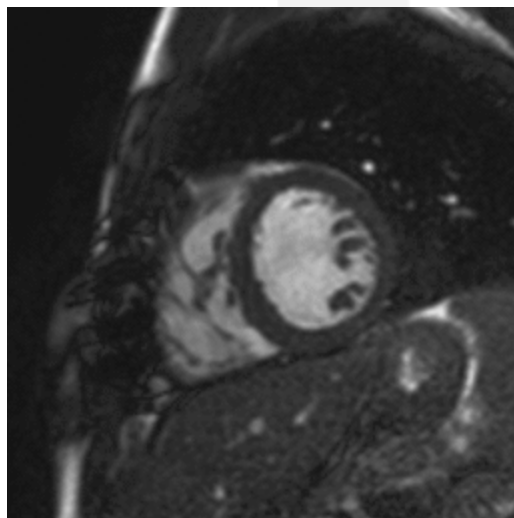
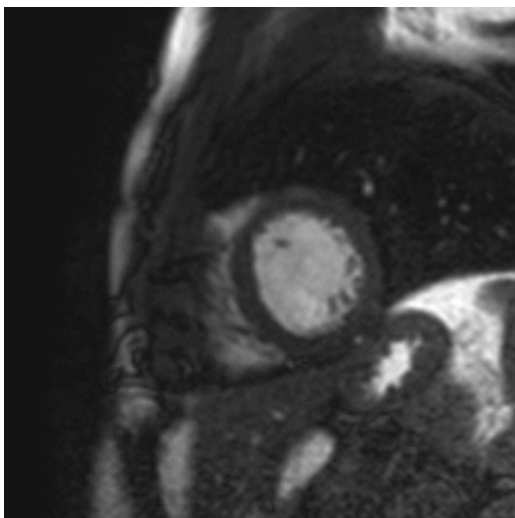
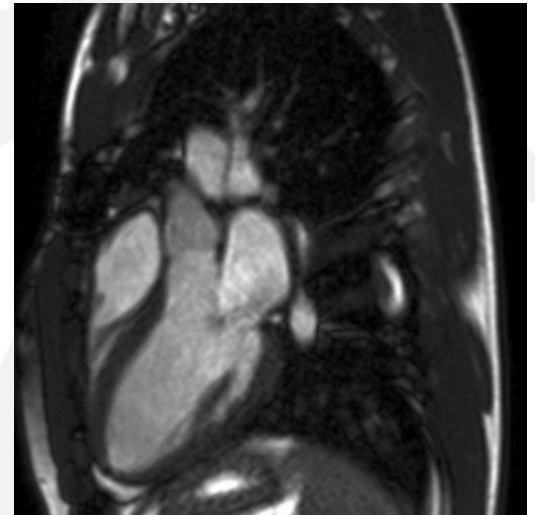
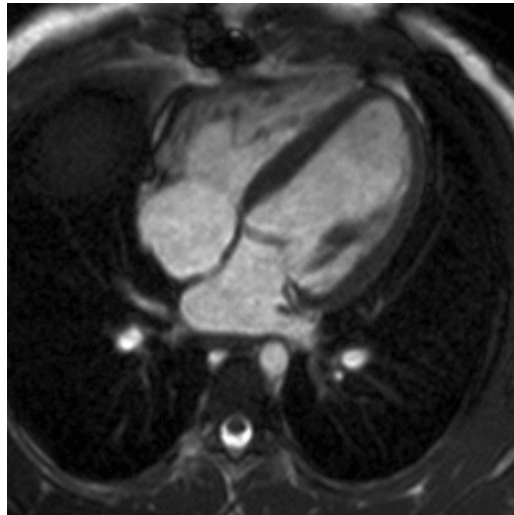
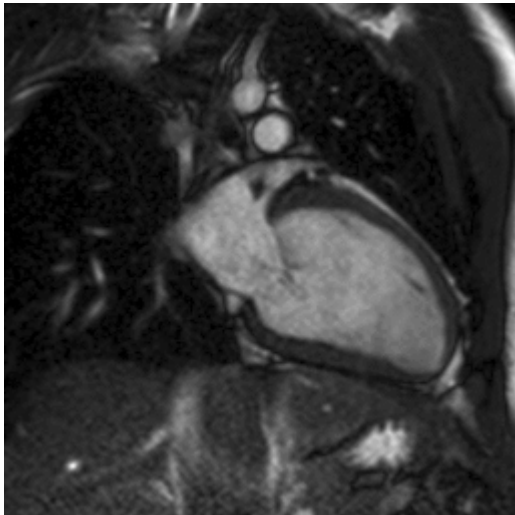
LA and SA: kayaker with known ASD



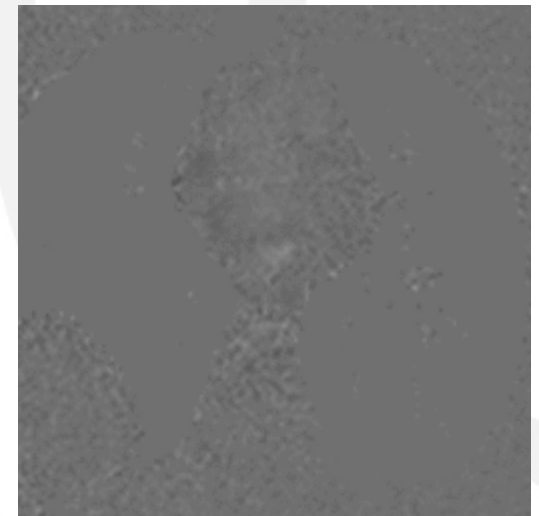
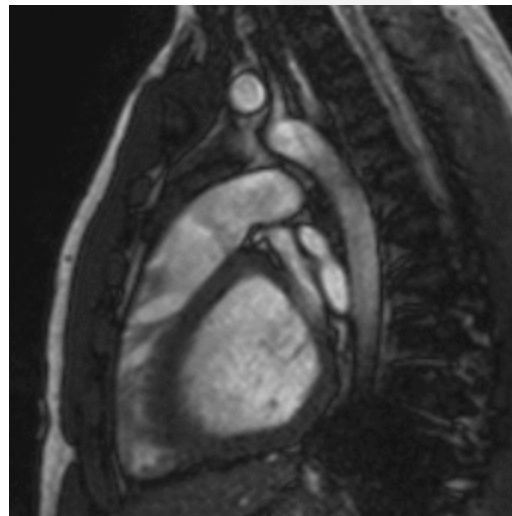
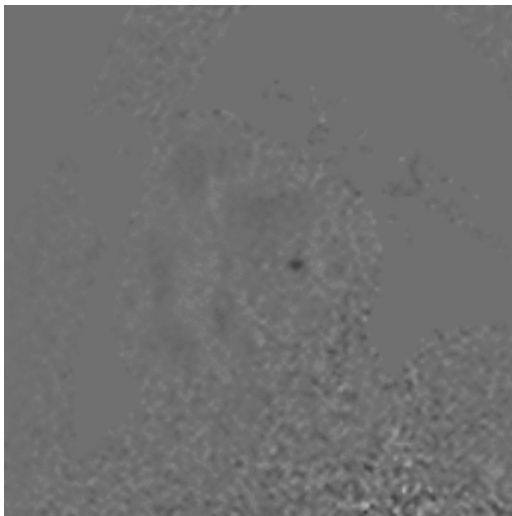
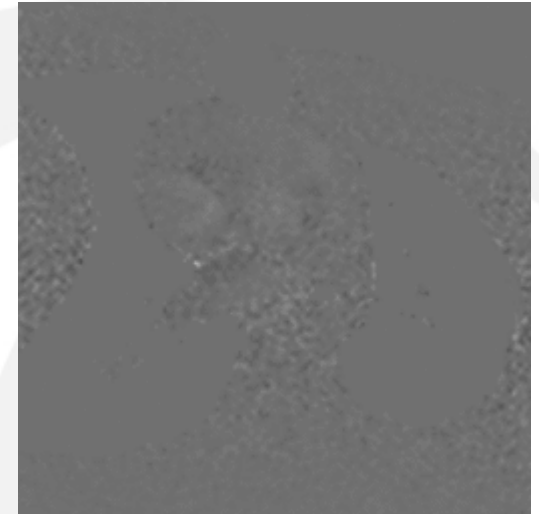
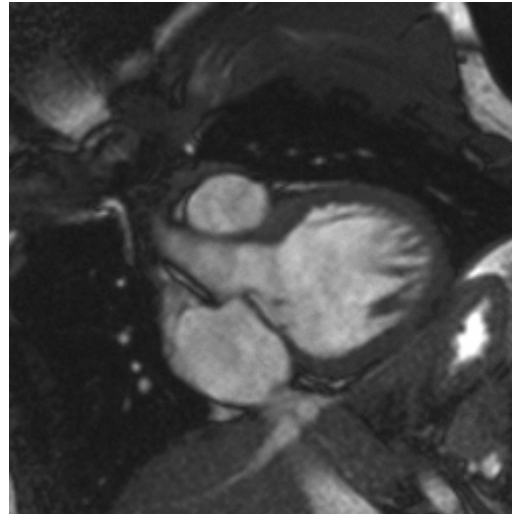
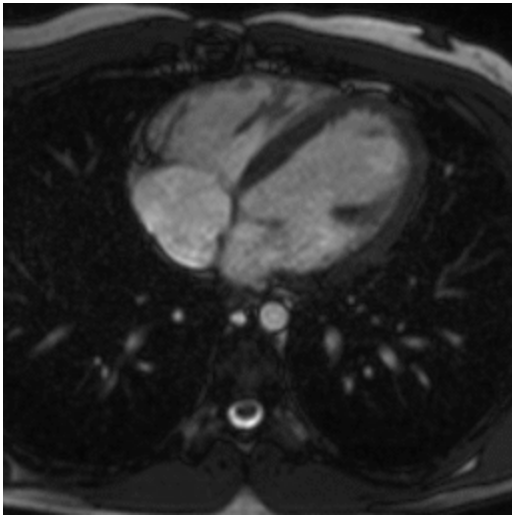
Flow: Q_p/Q_s 1.15



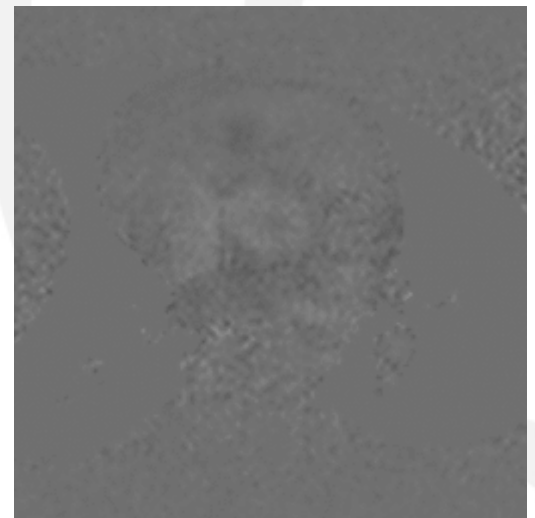
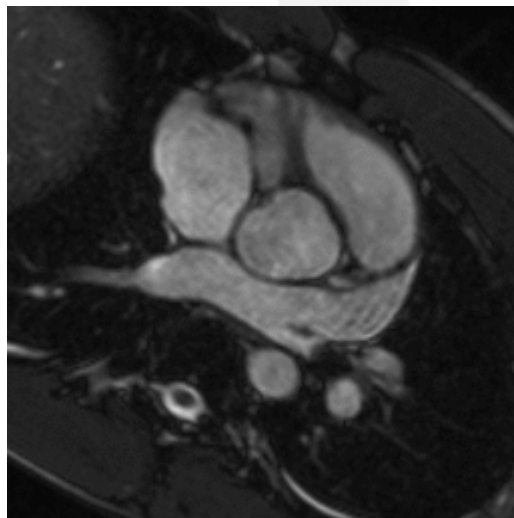
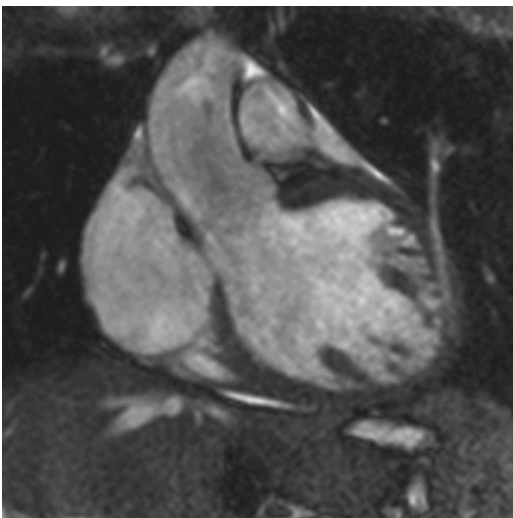
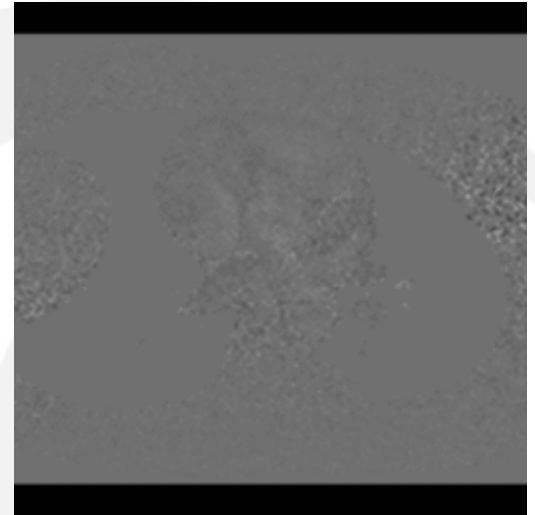
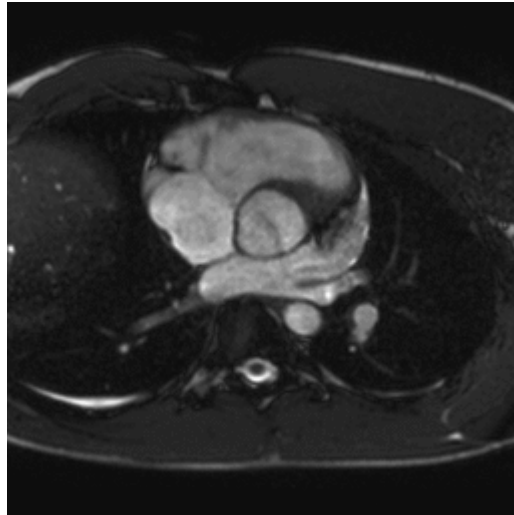
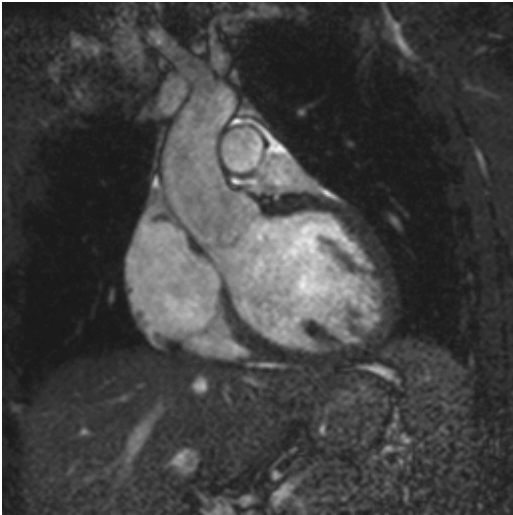
LA and SA cine II.



Flow II.: Qp/Qs 0.93, MI Rf: 4% (5ml)



Kayaker – AO Rf I.: 23%, II.: 19%



Navigator

PHILIPS

Patient System Help 19:11

1968 07 13 M
SURVEY_BFFE FOV 450
2009 11 12,18:12 Slice 16/20

Planscan

Geometry: Navigator A

Delete Copy

Volume Stack Slab

All midplanes 3PPS

System Ready 20

HC Screen HC Case
Compose Compose

Scan: 1

More... All

View Window RAL

VCG+Resp 5 s 63

3D_BTFE_BH

Remaining scan time: 00:00:59

56%

Autoview... Start Scan Stop Scan

HAJNI VIAB II(2) 00:03:45

9,1	SA_movie	SA(1)
10,1	LL F8 TD150	LA(1)
SA_VIA-3D	SA(1)	
11,1	SA_VIA-3D	SA(1)
12,1	LA_LE_IR	LA(1)
13,1	LA_LE_IR	LA
14,1	SA_LE_IR	SA
15,1	IRTFE_3D_NA...	SA
16,1	BTFE_FB_50	4CH
17,1	3D_BTFE_WH	WH
18,1	BTFE_FB_50	LA
3D_BTFE_BH	CORON	
3D_BTFE_BH	CORON	

initial	geometry	contrast	motion	dyn/ang	postproc	offc/ang	conflicts
Coil selection	SENSE-Cardiac					Total scan duration	02:45.7
element selection	12345					Ret. signal level (%)	100
connection	d					Act. TR/TE (ms)	4.9 / 2.4
Dualcoil	no					ACQ matrix M x P	228 x 182
CLEAR	yes					ACQ voxel MPS (mm)	1.10 / 1.11 / 1.10
FOV	FH (mm)	250				REC voxel MPS (mm)	0.49 / 0.49 / 1.10
AP (mm)	200					Scan percentage (%)	98.9
RL (mm)	25					TFE shots	172
Voxel size	FH (mm)	1.1				TFE dur. shot / acq (ms)	270.9 / 112.5
AP (mm)	1.1					TFE shot interval (beats)	1
RL (mm)	1.1					Entered heartrate	63
Recon voxel size (mm)	0.5					Trigger delay max. / act...	904.8 / 630.0
Fold-over suppression	yes					Max. heart phases	1
Slice oversampling	default					Act. WFS (pix) / BW (Hz)	0.223 / 974.7
Reconstruction matrix	512					Min. WFS (pix) / Max. B...	0.222 / 980.4
SENSE	no					SAR / whole body	< 32% / 1.3 W/kg
k-tBLAST	no					Whole body / level	< 1.3 W/kg / normal
Overcontiguous slices	no					B1 rms [uT]	2.6
Stacks	1					PNS / level	59% / normal
slices	23					Sound Pressure Level (...)	14.5
slice orientation	sagittal (coronal)						
fold-over direction	AP (RL)						

3D_BTFE_BH

3D Balanced TFE coronary scan

Navigator Display

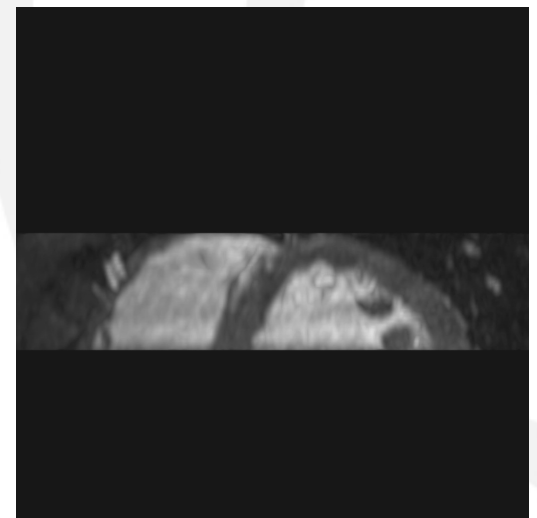
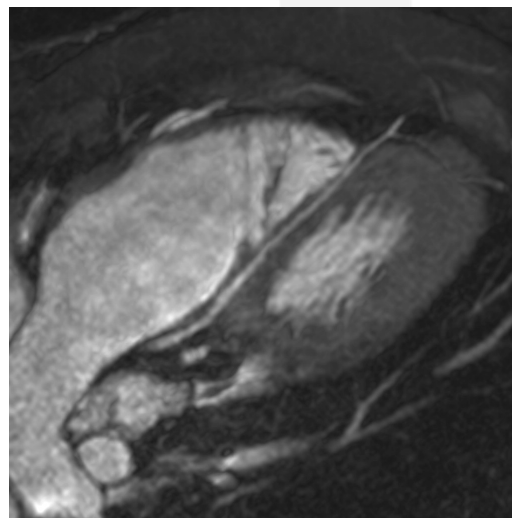
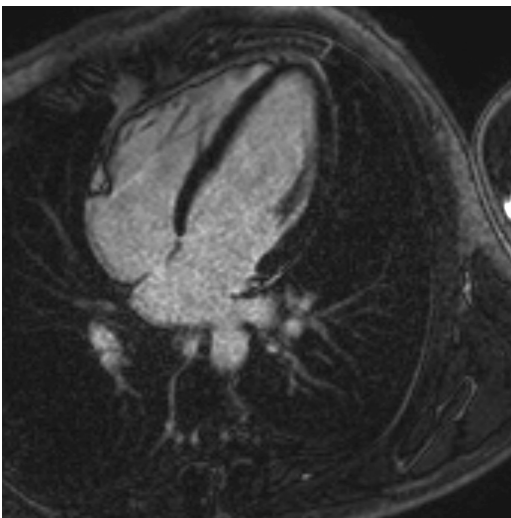
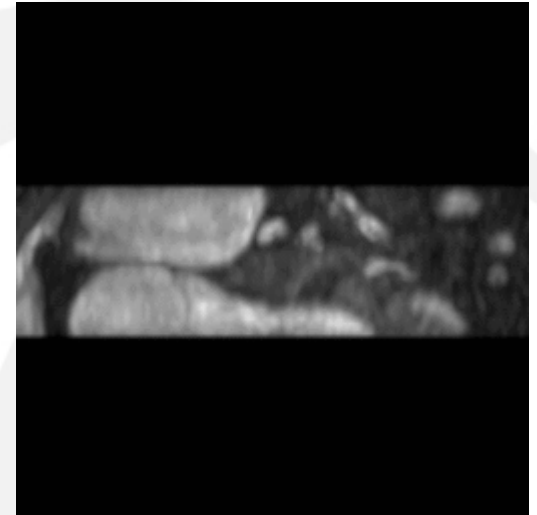
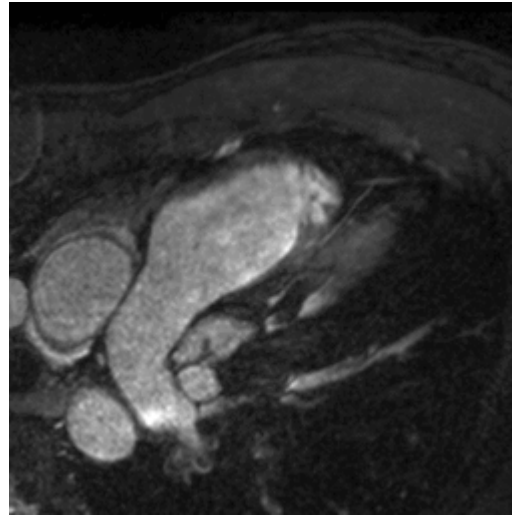
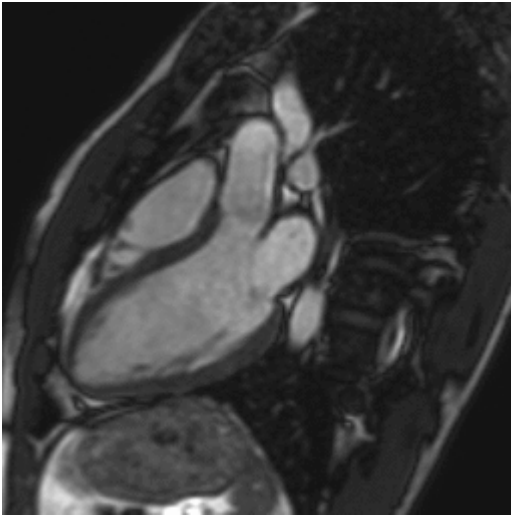
Leading navigator, beam 1

artery and the
en the arteries
asure the precise

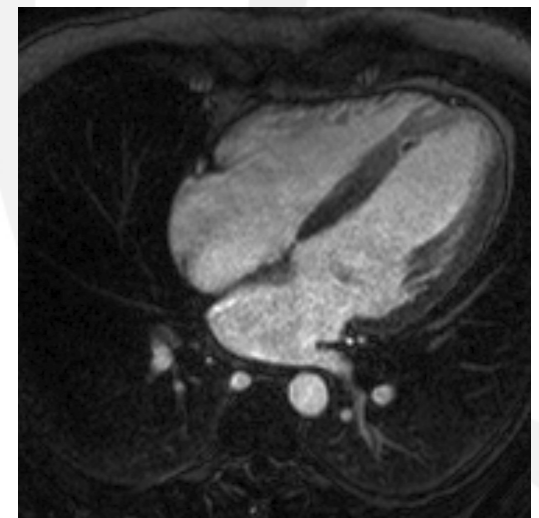
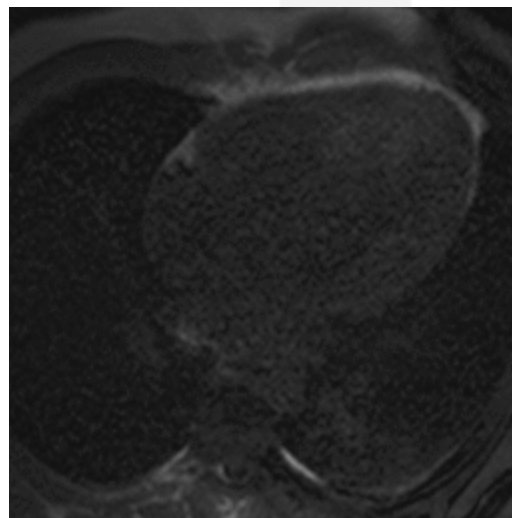
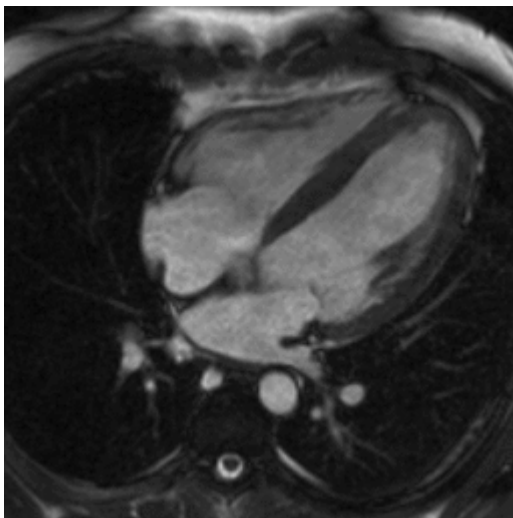
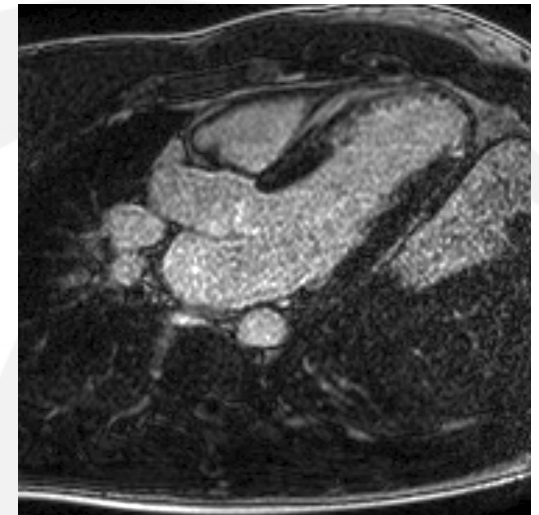
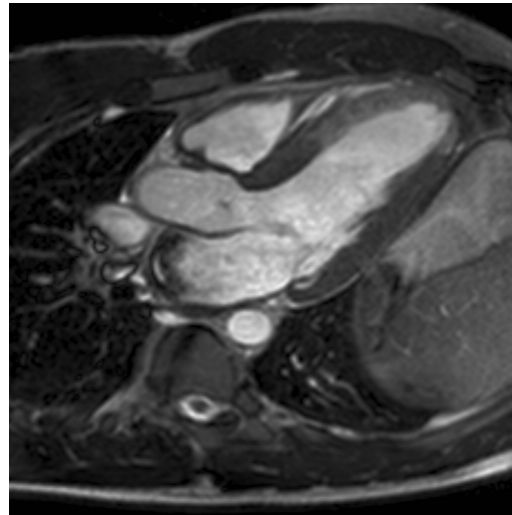
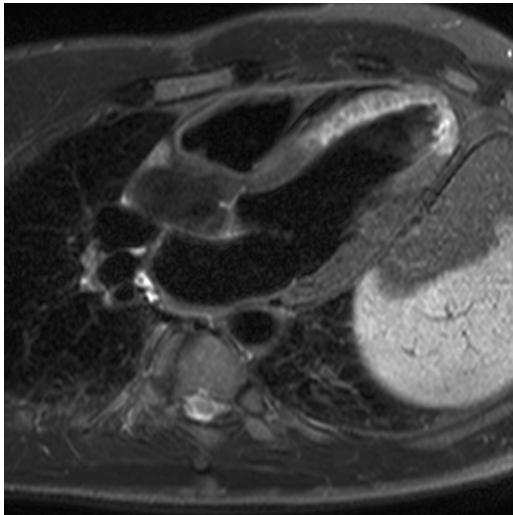
Save Hide

19:11 Gating efficiency is 57% over the last 60s.

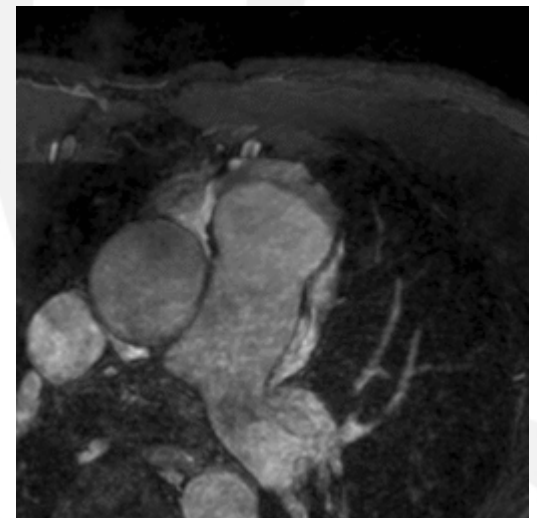
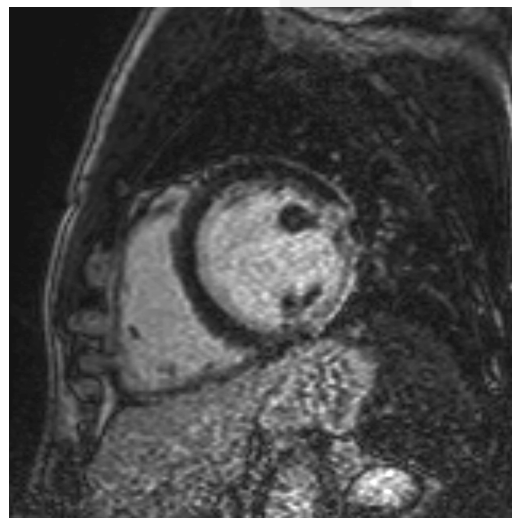
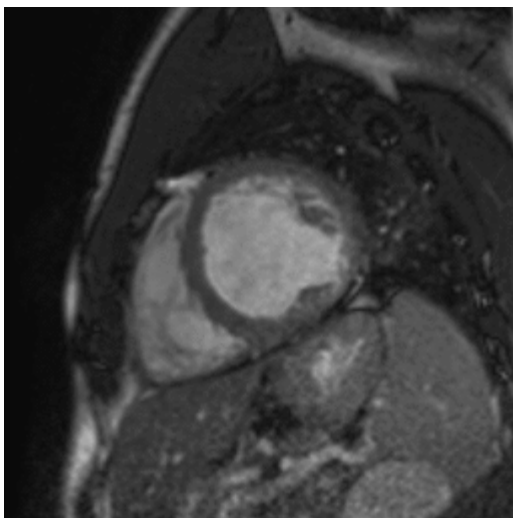
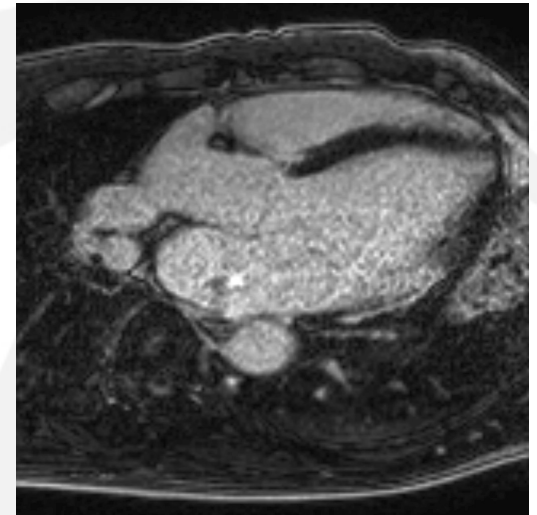
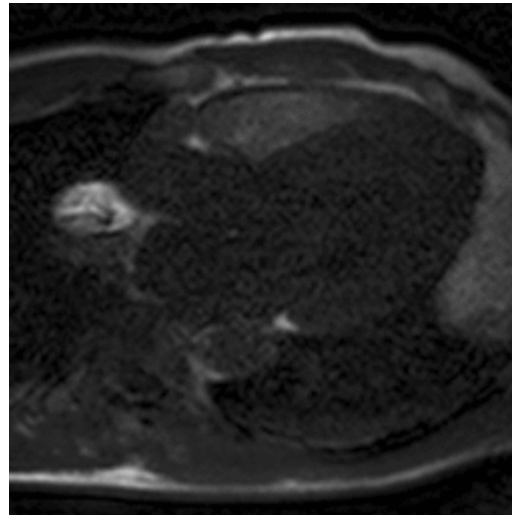
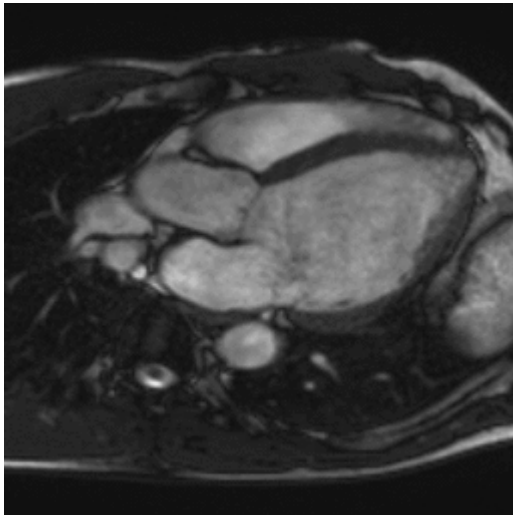
Complains on exercise: LAD bridge



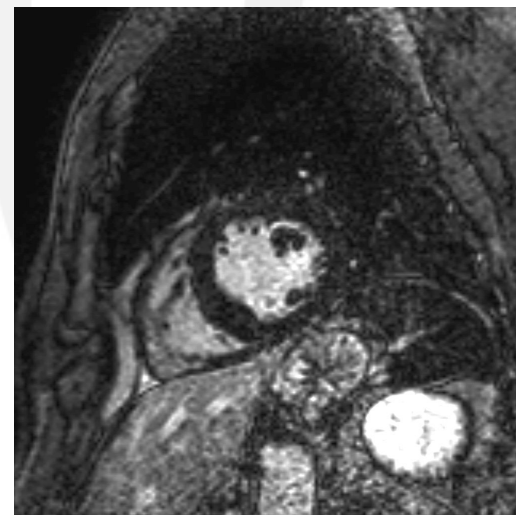
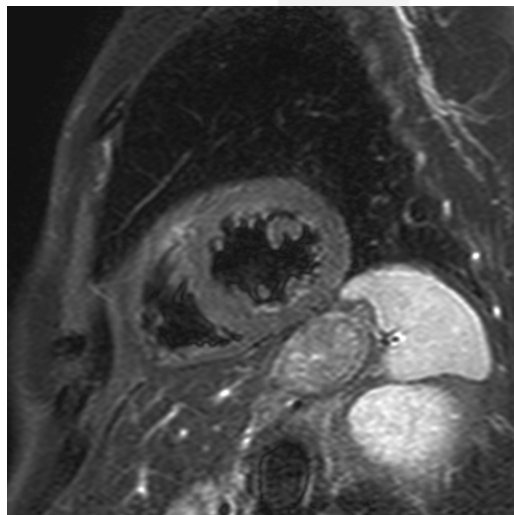
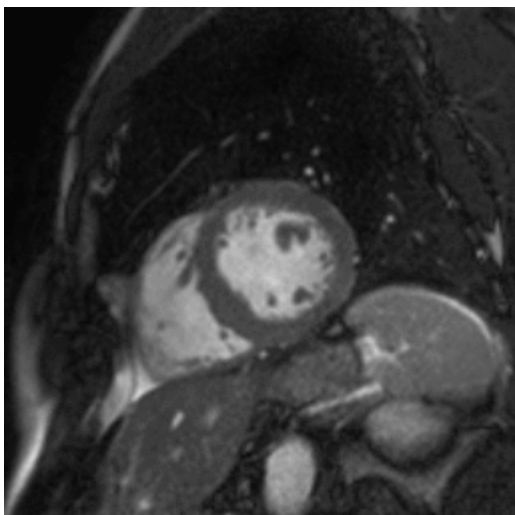
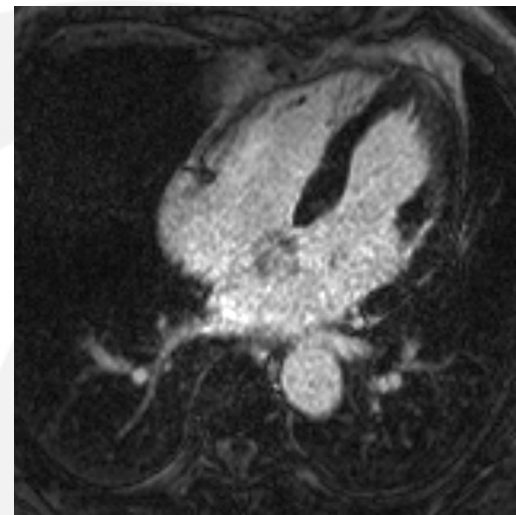
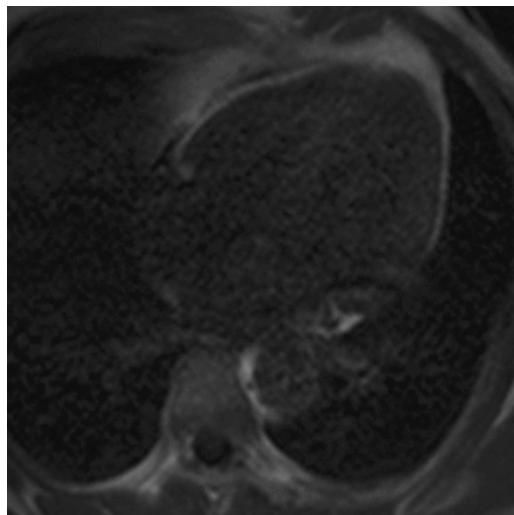
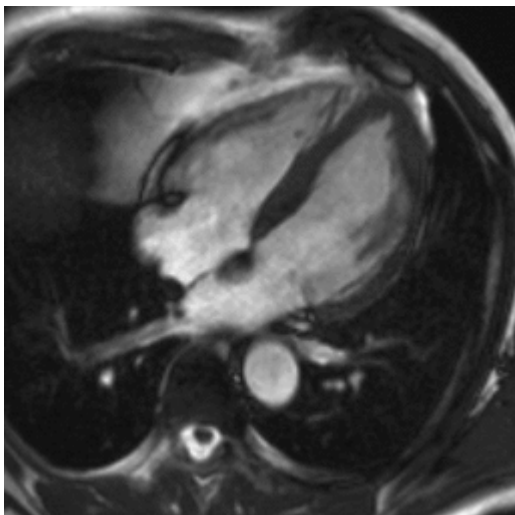
Acute MI: 21% non-viable



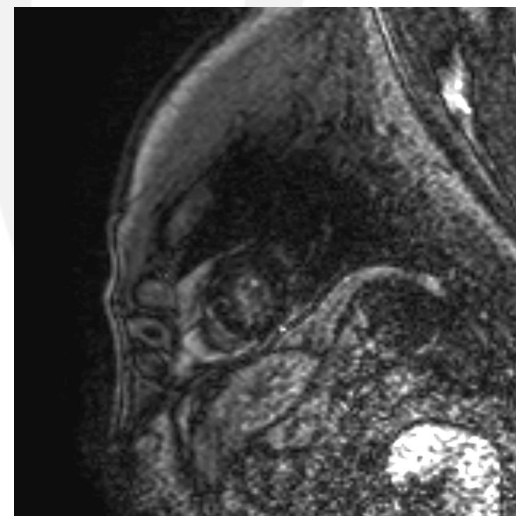
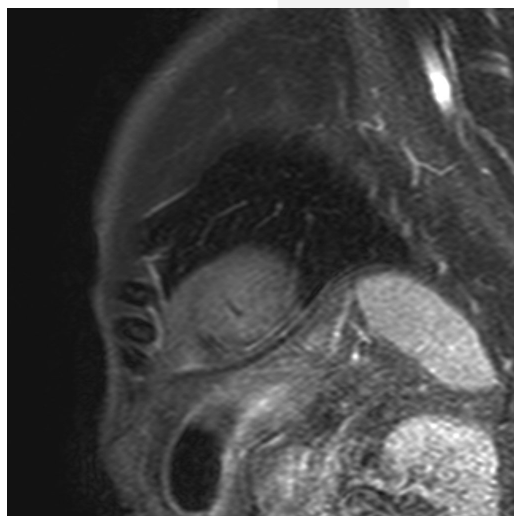
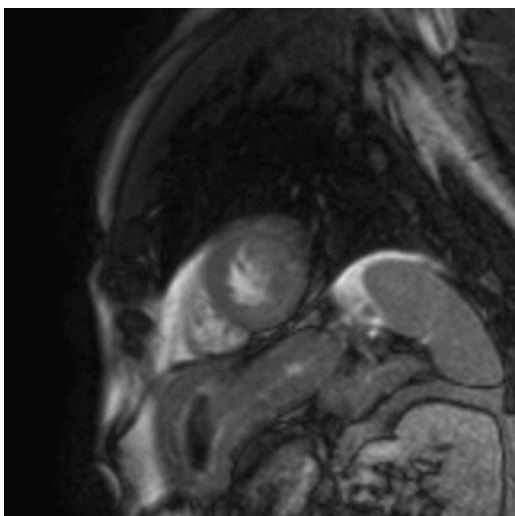
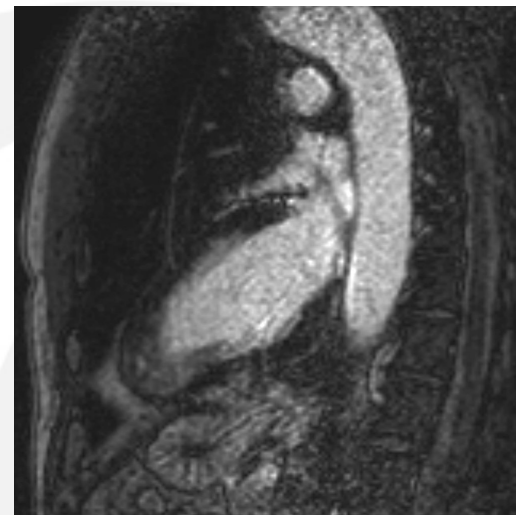
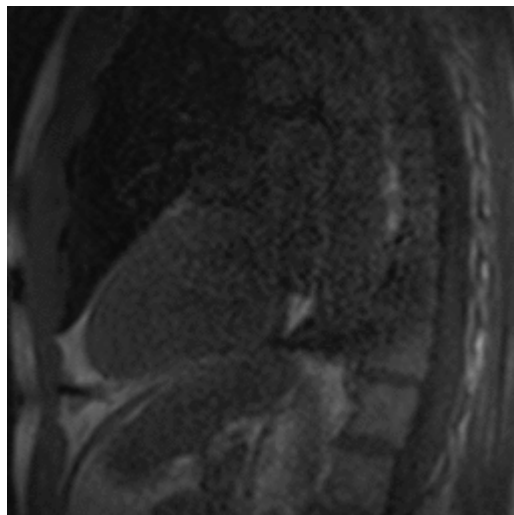
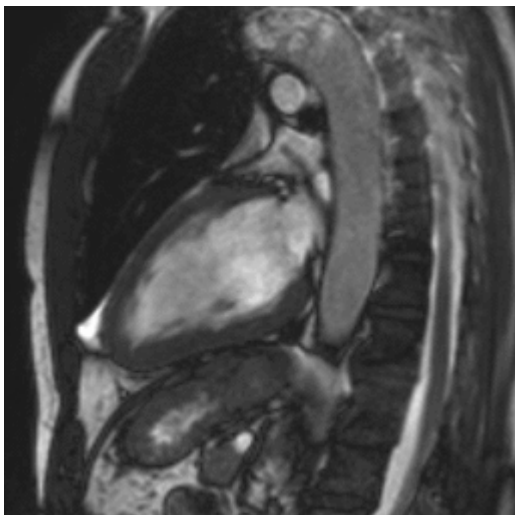
Duathlon, ultra-marathon



MI? Myocarditis?, EKG+, Trop+, CXA-, SPECT+



MI? Myocarditis?, EKG+, Trop+, CXA-, SPECT+



Thank you for your attention

