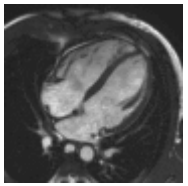
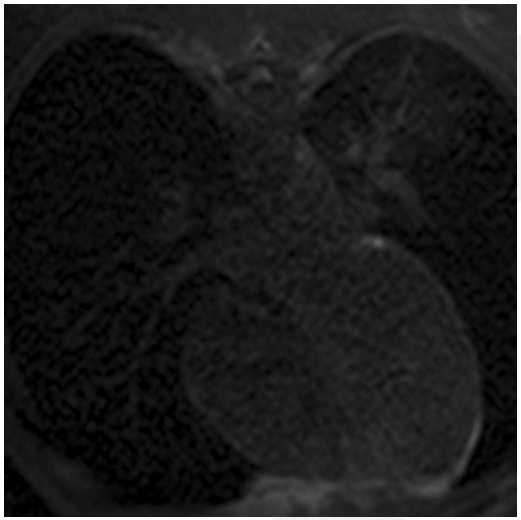
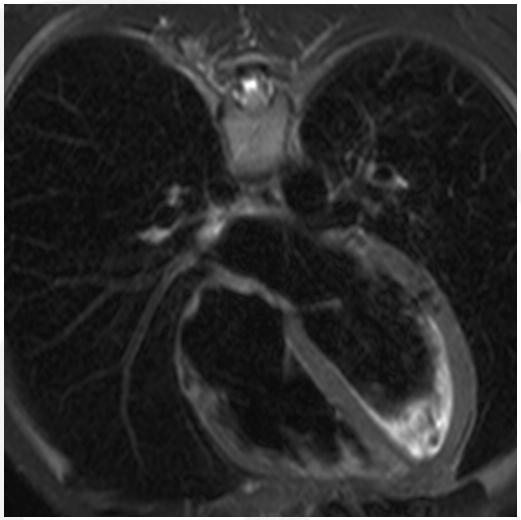


FISA visit – welcome all our guests!

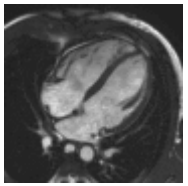
Cardiac magnetic resonance in athletes - normal and abnormal examples

cc BY NC ND

Spartathlon: 246km (Pheidippides)

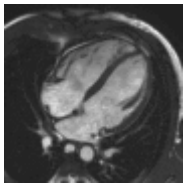



Sudden cardiac death in athletes



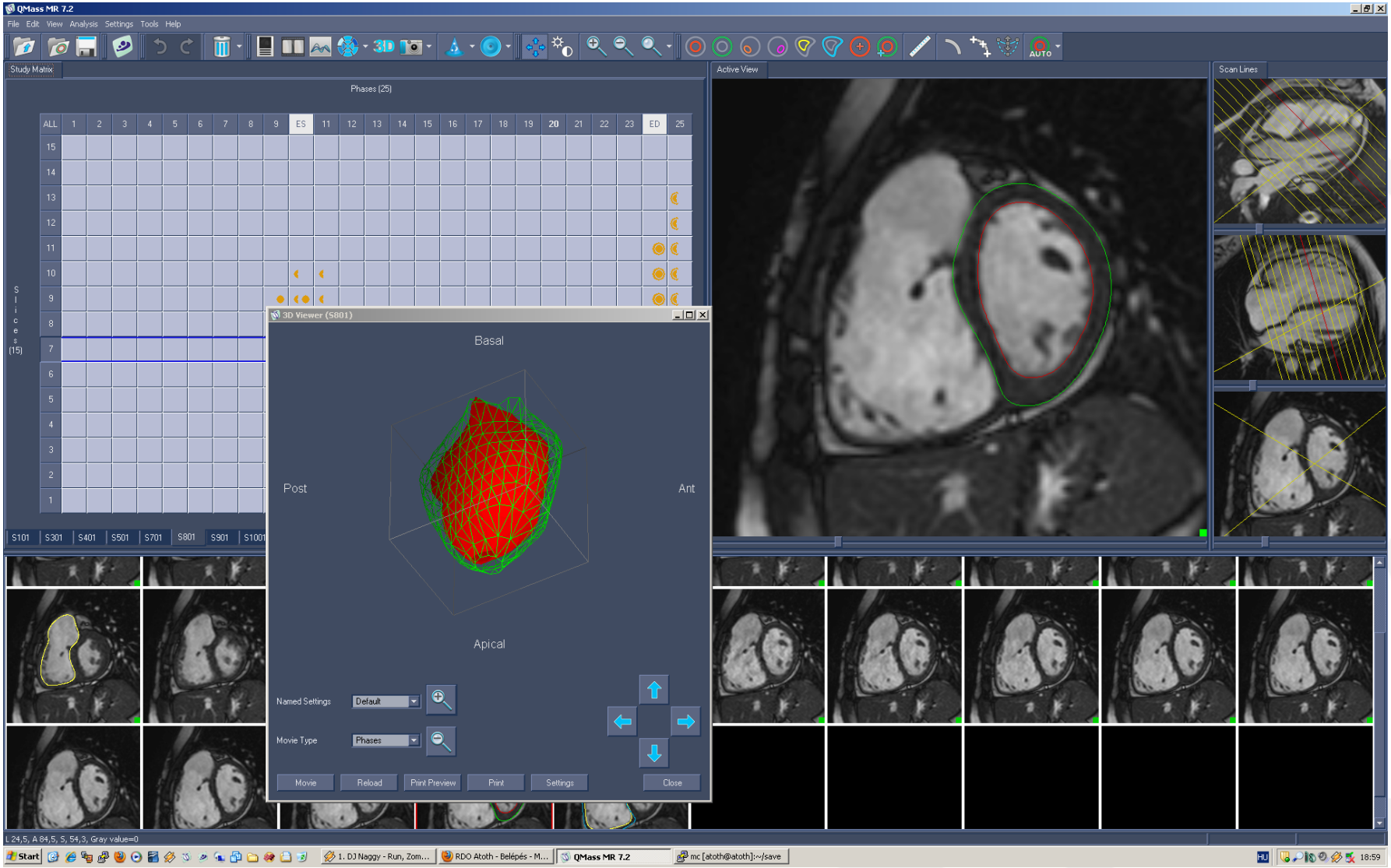
- H(O)CM
- ARVD/C
- Anomalous coronary origins
- Coronary runoff anomalies
  - Bridging
  - Tunelling
- Myocarditis

H(O)CM

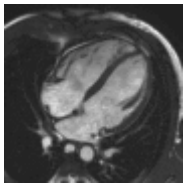


- Myocardial mass
- Wall thickness
- Fibrotic degeneration of the myocardium
  - Close correlation with arrhythmias
- Maximal end-diastolic wall thickness – end-diastolic volume index ratio
  - JCMR 7:551 - cutoff value: 0,14

Left ventricular evaluation

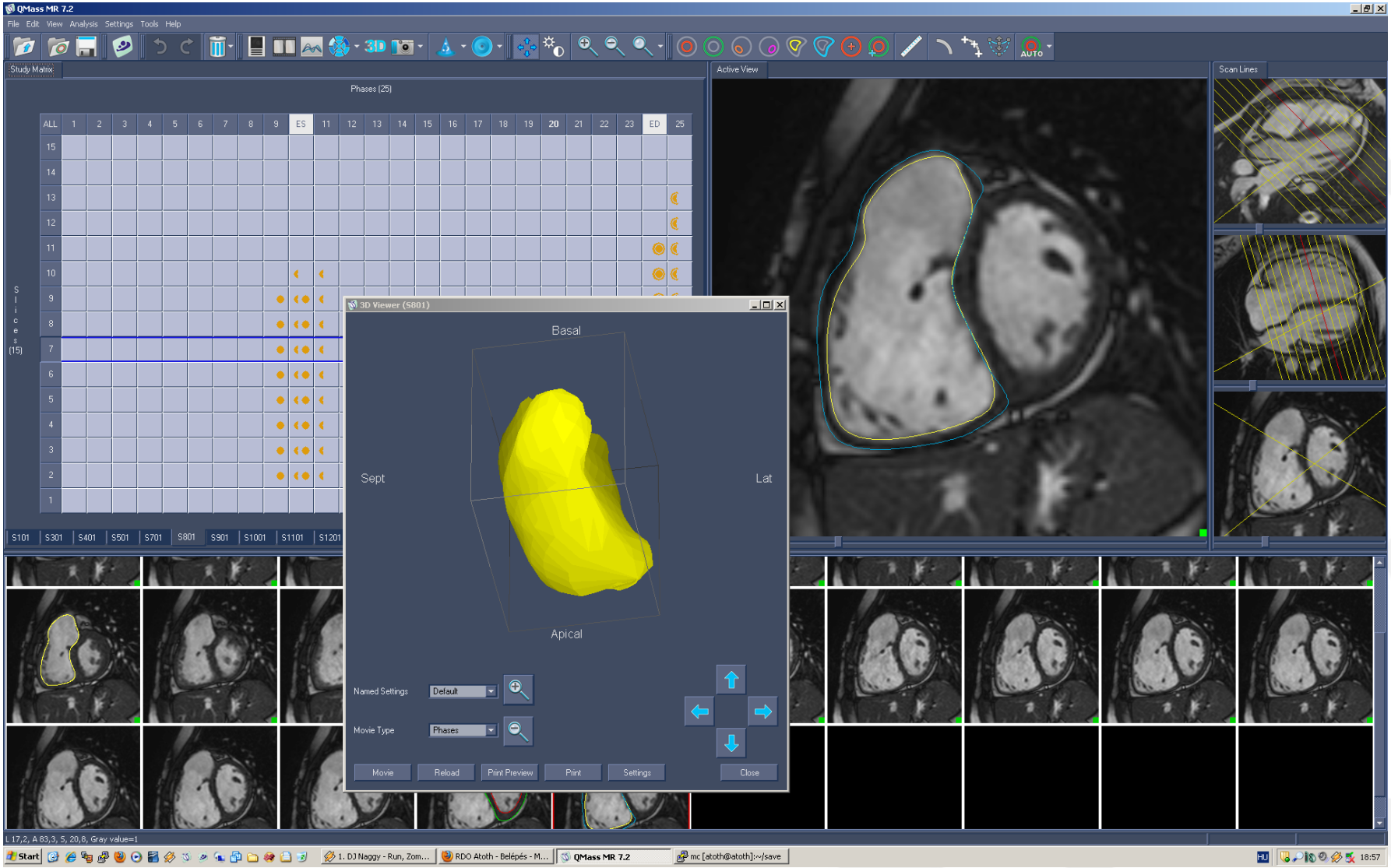


ARVD/C

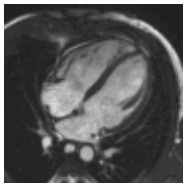


- Task Force lead by McKenna
  - Criteria system
- Cardiac MR should show
  - Right ventricular volume and EF
  - Bulging, aneurysma, dyskinesis?
  - Fatty infiltration: no longer necessary
- Late enhancement (fibro-fatty)
  - Really arrhythmogenic: not yet necessary

Right ventricular evaluation

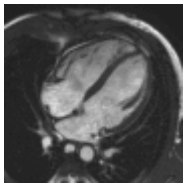


Other



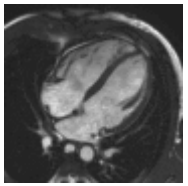
- Anomalous coronary origin
  - Clinical significance under debate
- Coronary runoff anomalies
  - No evidence
- Myocarditis
  - MR can pretty clearly visualize

Study population



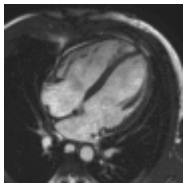
- 48 Volunteers
- 88 Elite athletes
  - 23 water-polo player
  - 21 kayakers
  - 15 canoers
  - 9 cyclers
  - 5 ultra-marathon runners
  - 15 rowers
- Parolimpic athletes
  - 6 goalball players

Protokoll



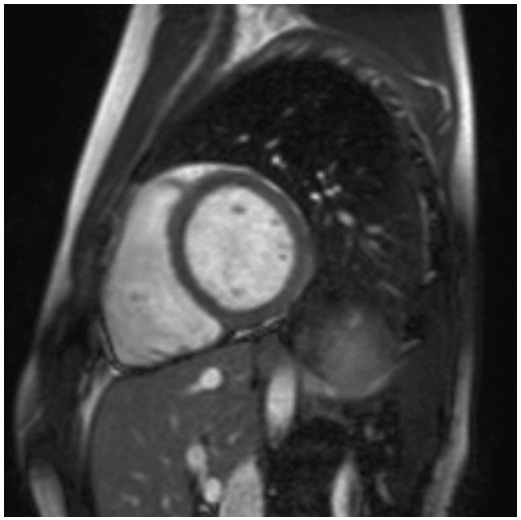
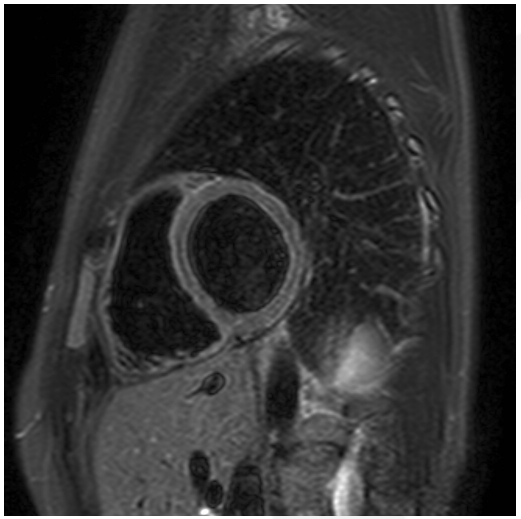
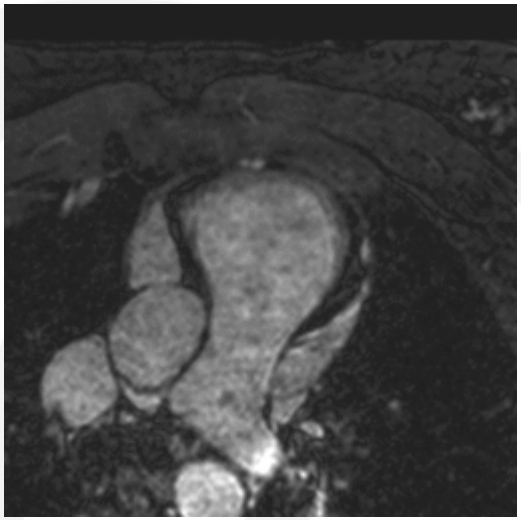
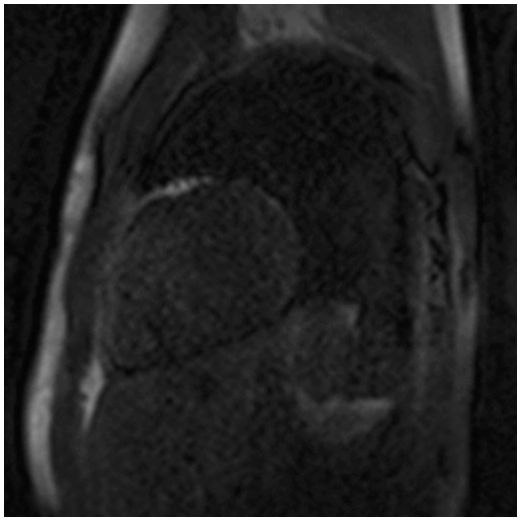
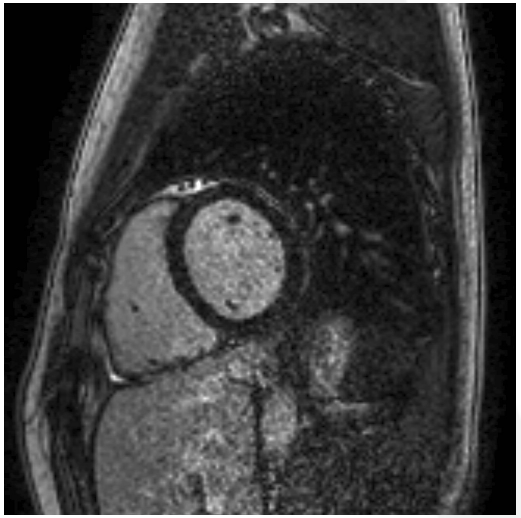
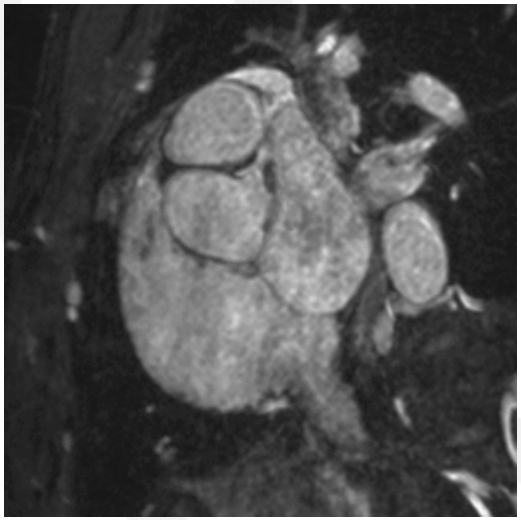
- Functional measurement – EF, volumes
- STIR-like measurement – edema
- Rest first-pass perfusion
- Late enhancement
- MRCA: before or long after contrast administration
- Additional sequences optionally

Measured parameters

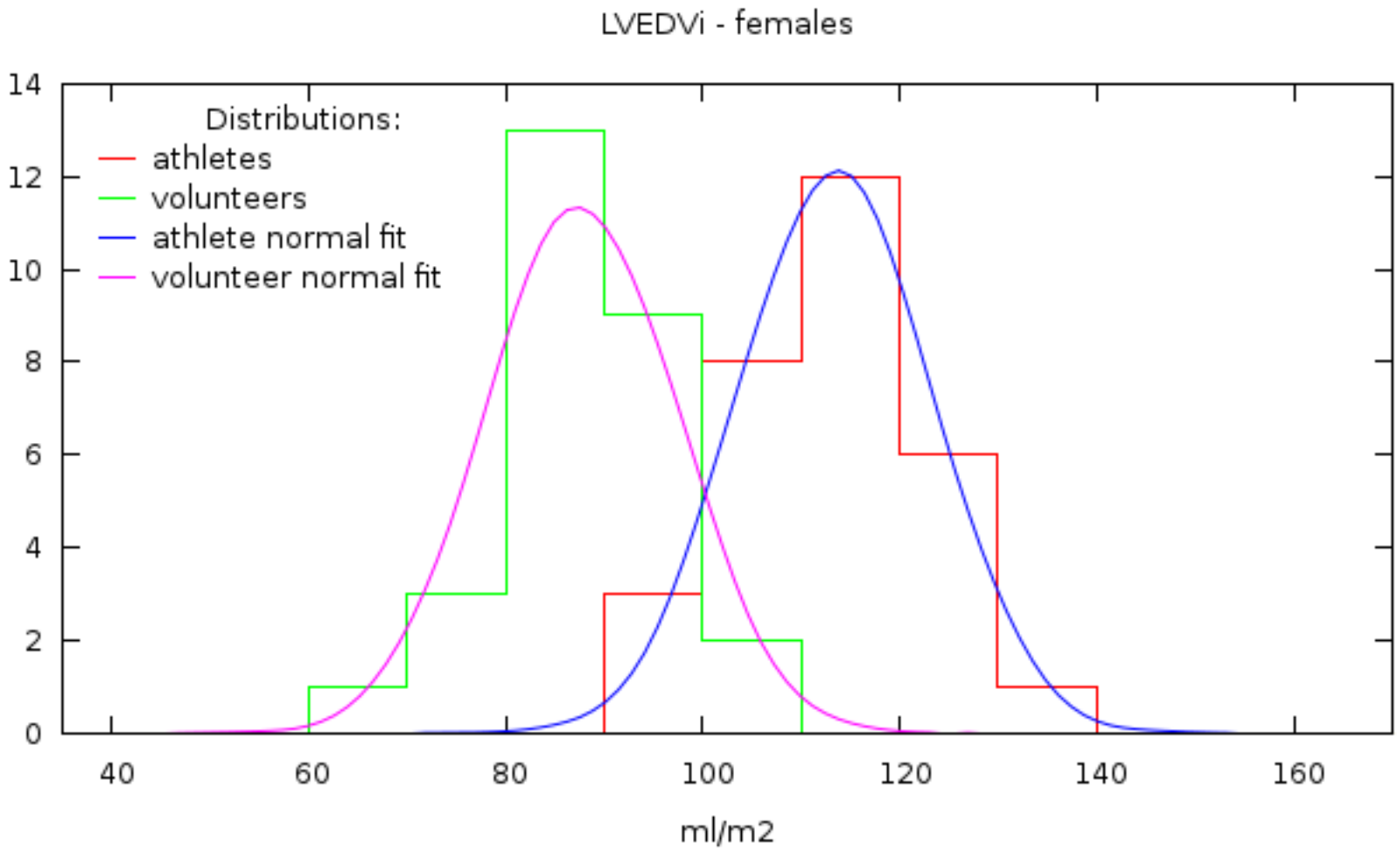


- HR, BSA
- LVEF, RVEF
- LVESV(i), LVEDV(i), LVSV(i), LVM(i)
- RVESV(i), RVEDV(i), RVSV(i), RVM(i)
- Maximal end-diastolic wall thickness
- Diastolic wall thickness ratio
- Maximal end-diastolic wall thickness – end-diastolic volume index ratio (sport index)

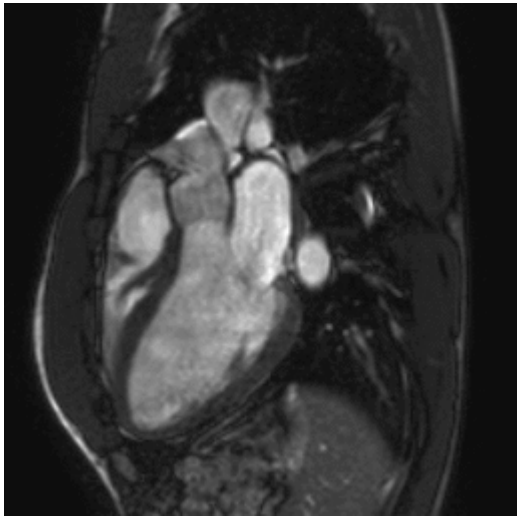
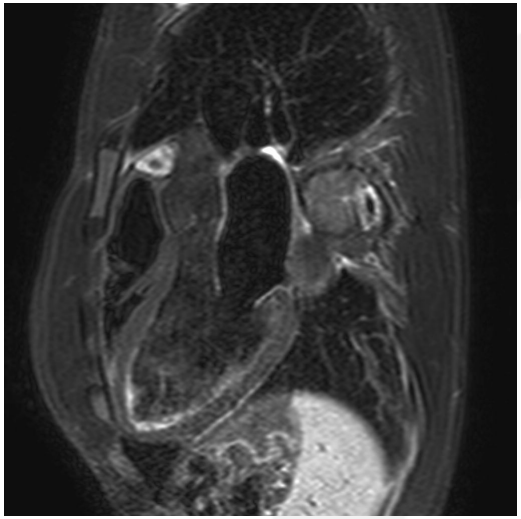
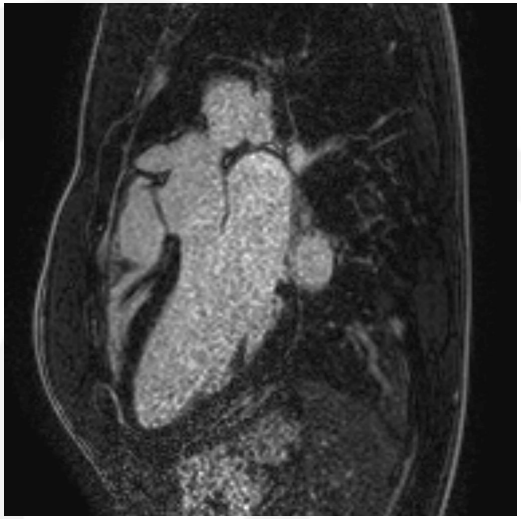
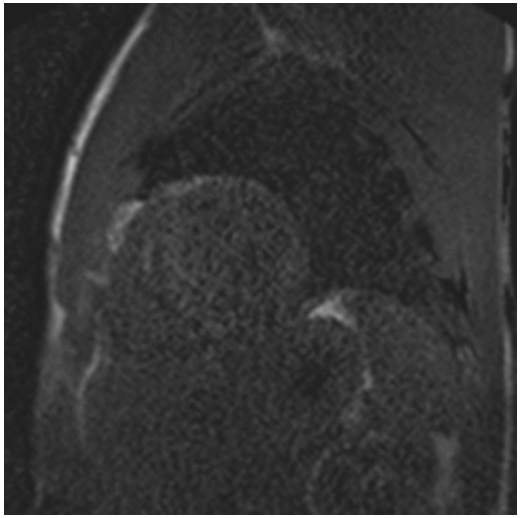
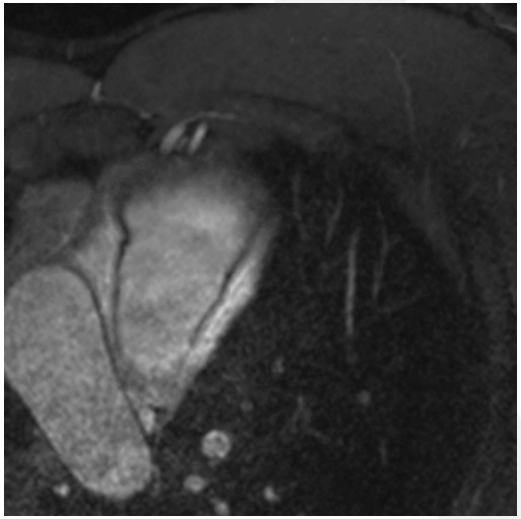
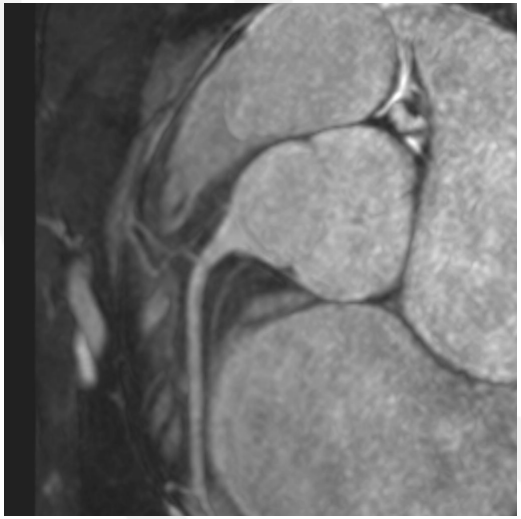
Female water-polo player: normal study

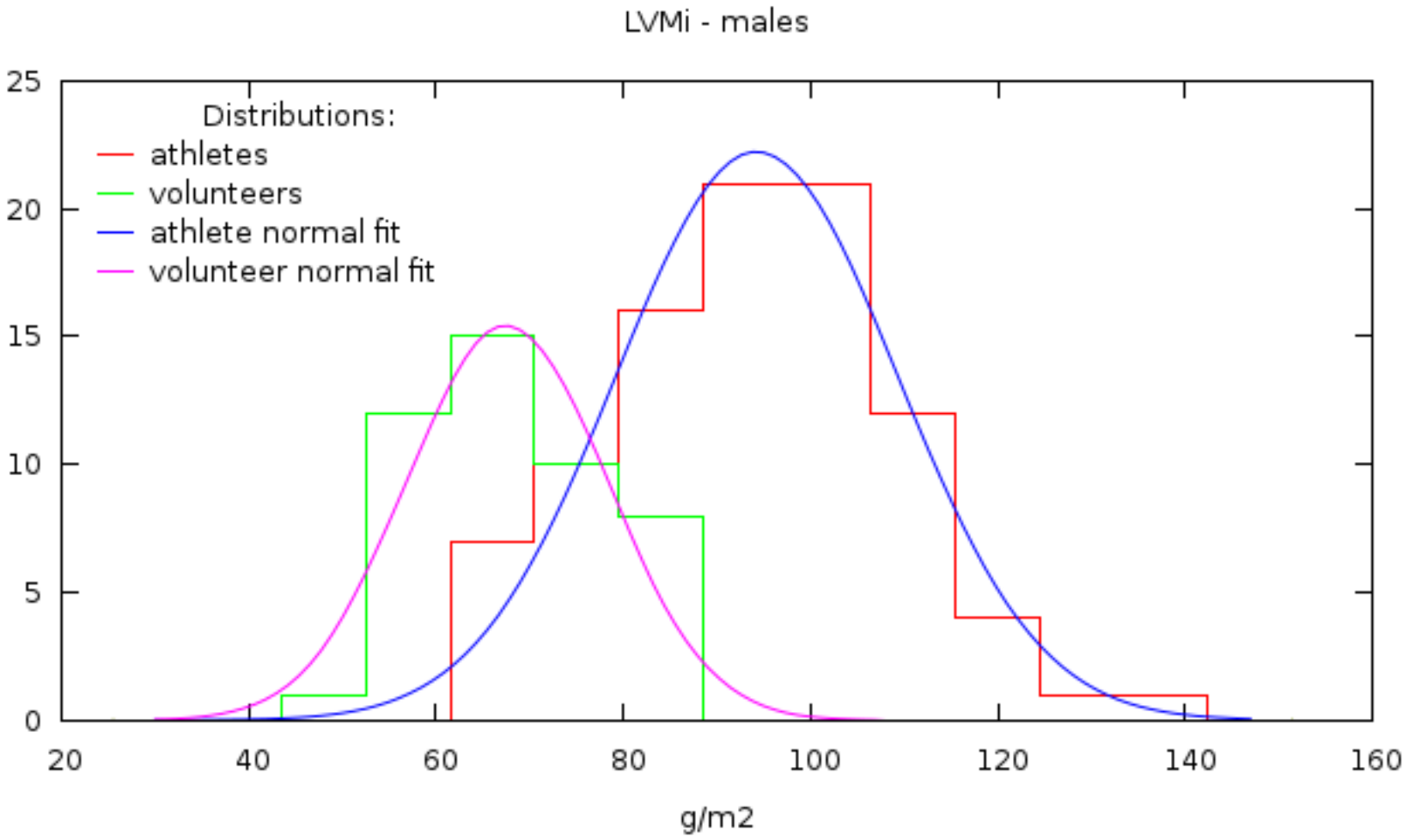
Left ventricular end-diastolic vol. index



Male kayaker: normal exam

Left ventricular myocardial mass index



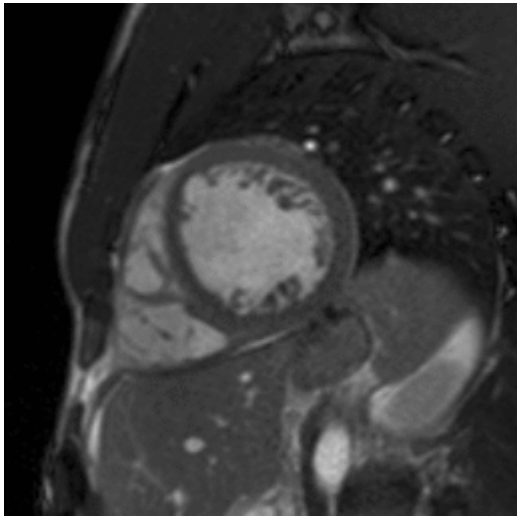
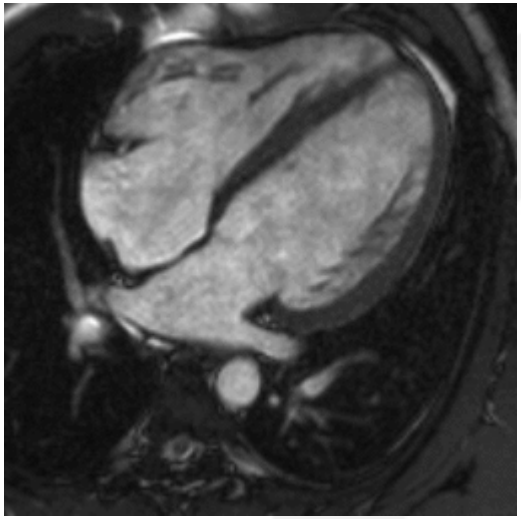
Male averages

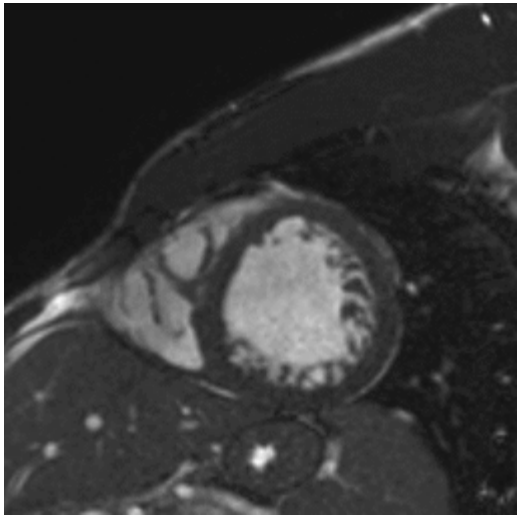
Parameter	Volunteer (48)	Waterpolo (N = 23)	Kayaker (N = 21)	Canoer (N = 15)	Cycler (N = 9)	Ultrarunner (N = 5)	Rower (N = 15)	Goalball (N = 6)
BSA (m^2)	2.04 ± 0.18	**2.33 ± 0.09**	2.08 ± 0.13	2.00 ± 0.08	**1.87 ± 0.10**	**1.82 ± 0.08**	2.00 ± 0.11	2.13 ± 0.19
LVEF	60.2 ± 5.3	57.0 ± 3.4	57.7 ± 4.8	56.9 ± 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

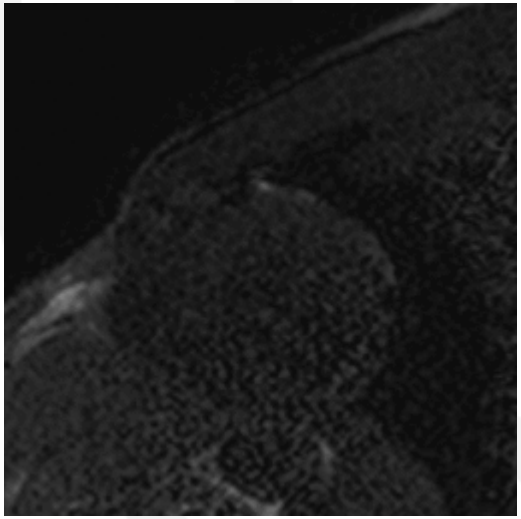
HCM and DCM example

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

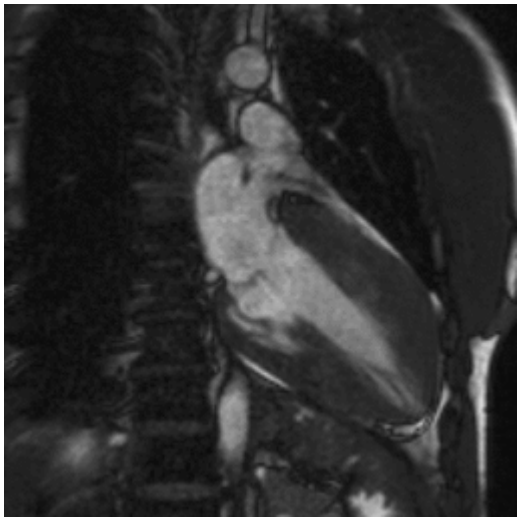
Ice hokey player

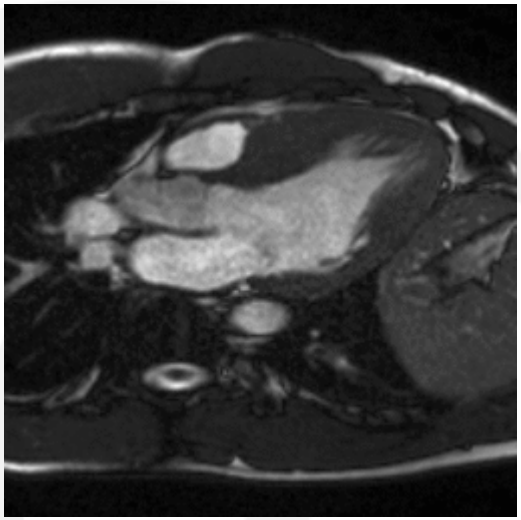



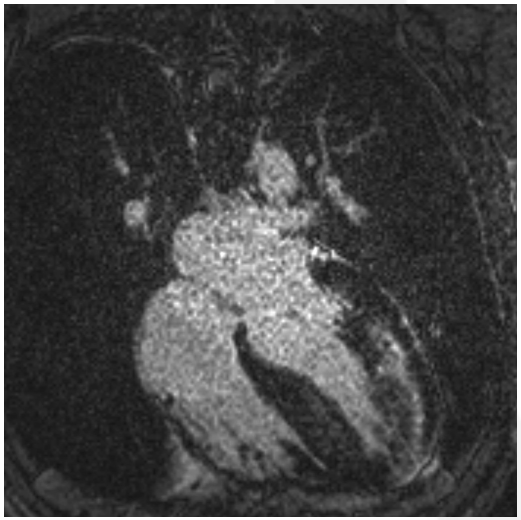
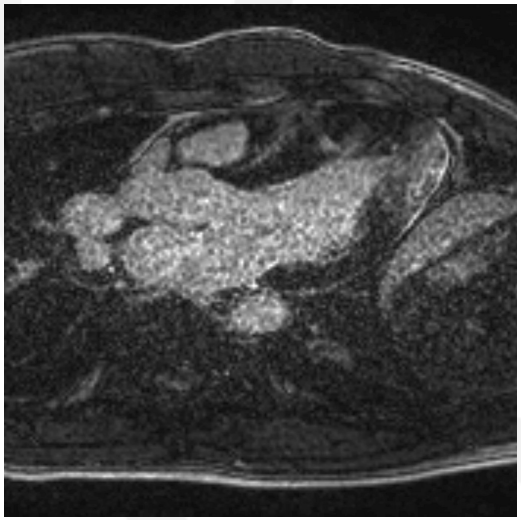




LA cine and DE





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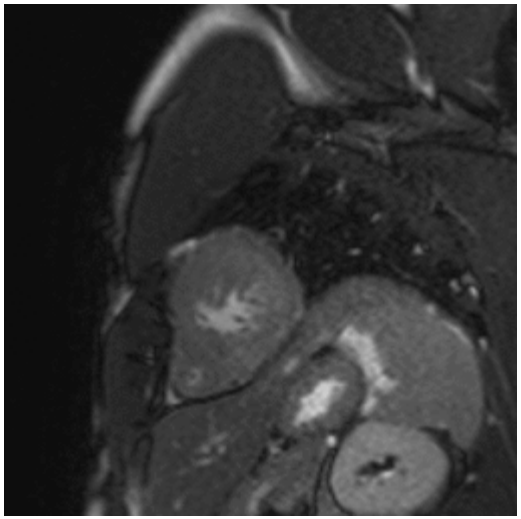
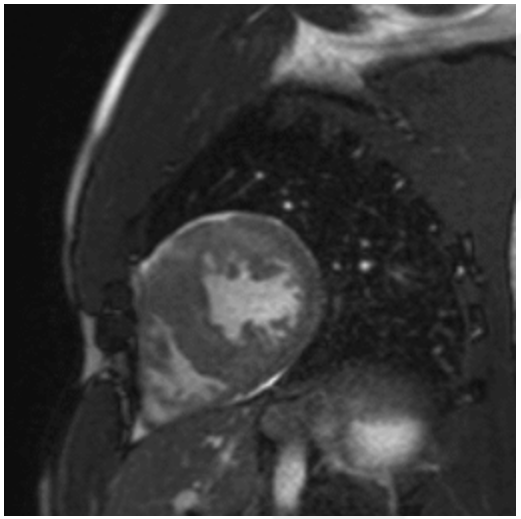
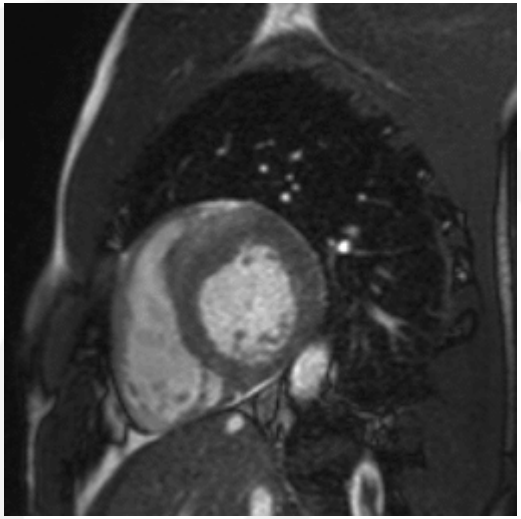
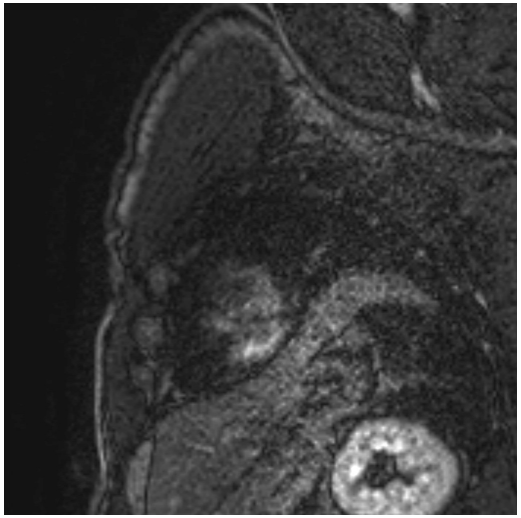
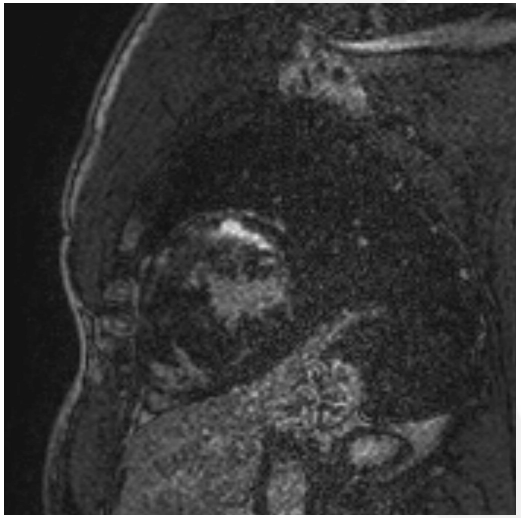
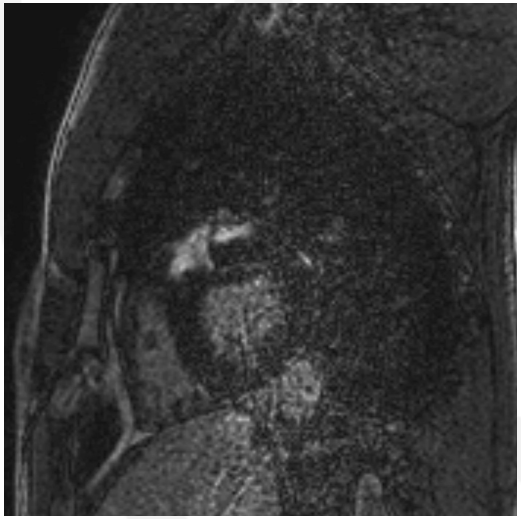
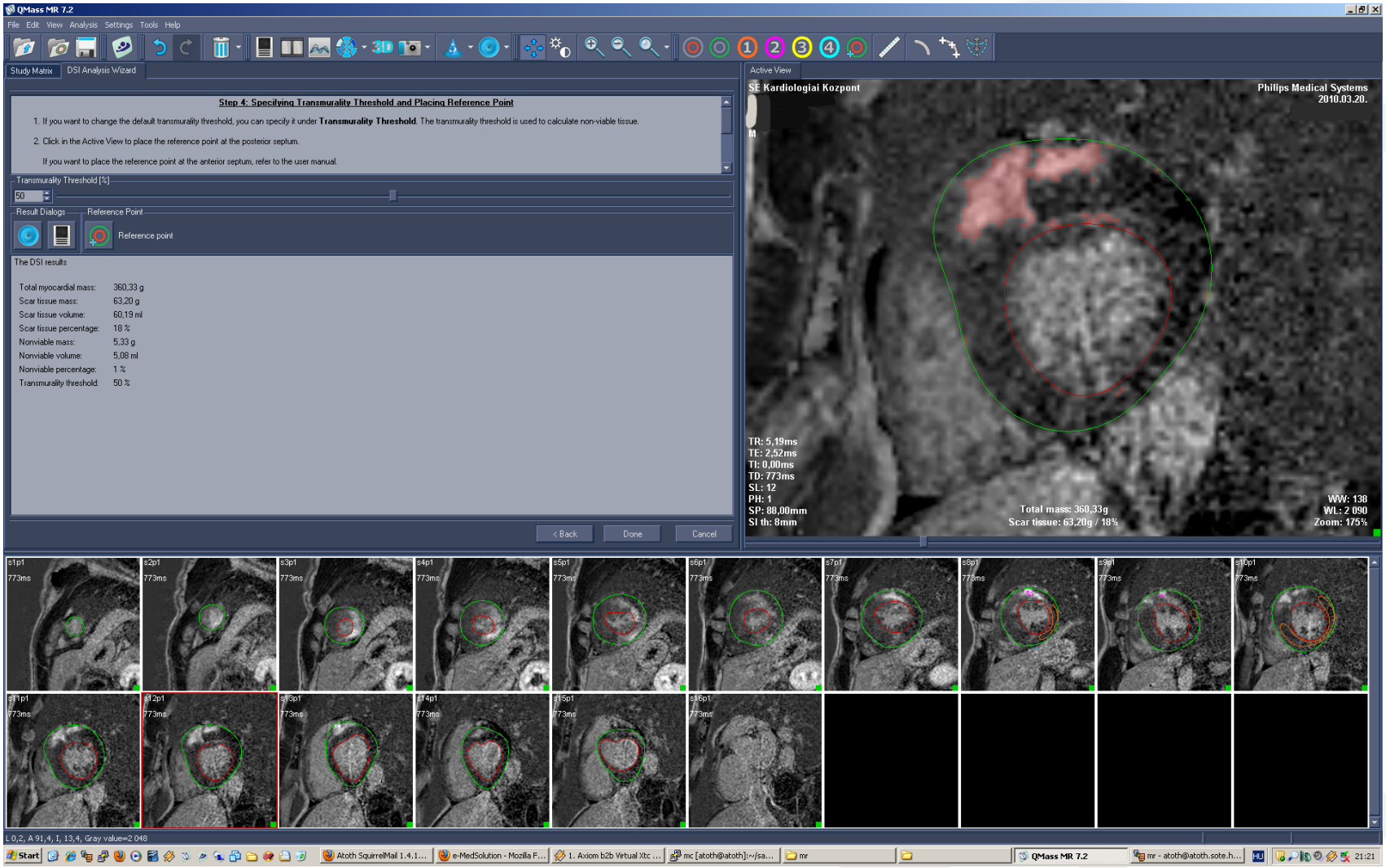
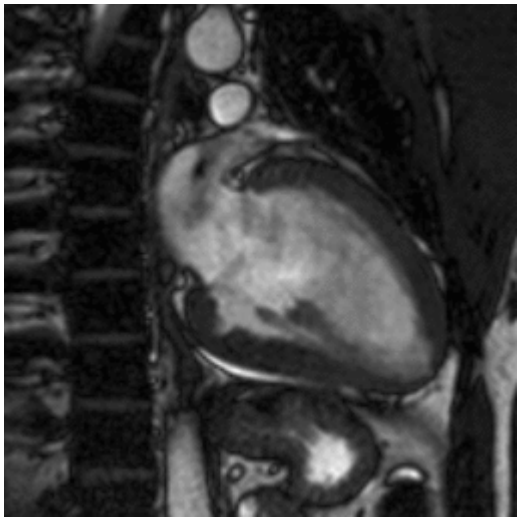
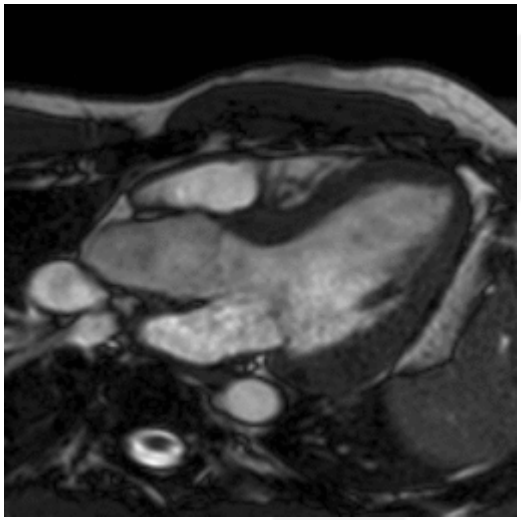
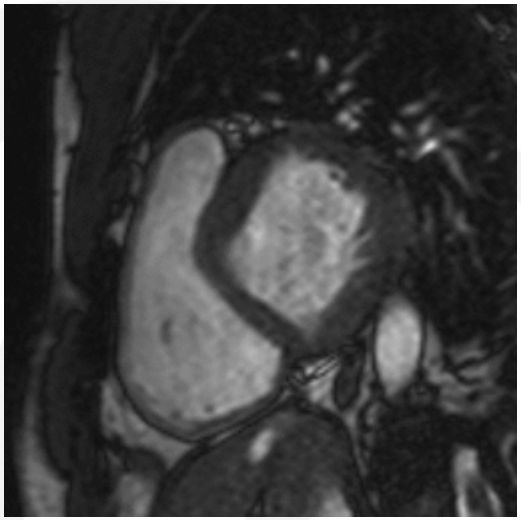
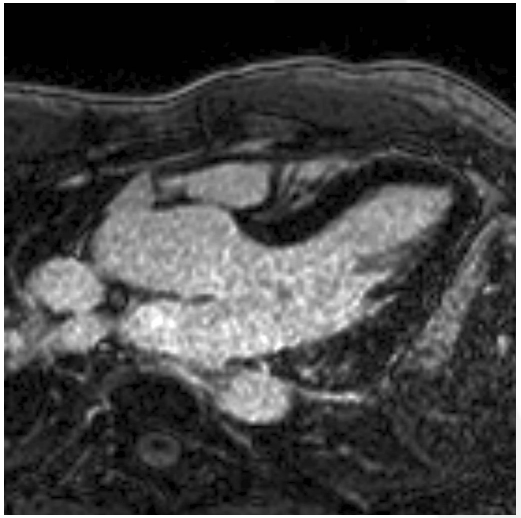
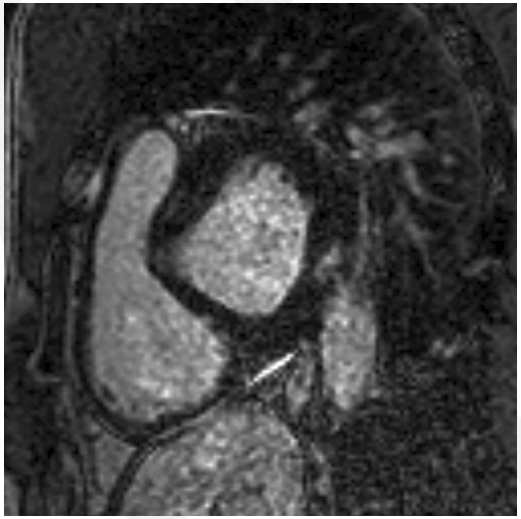







DE quatifiaction: 63g scar out of 360g



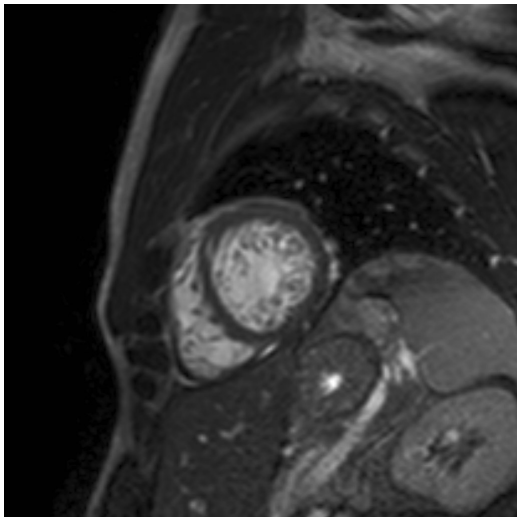
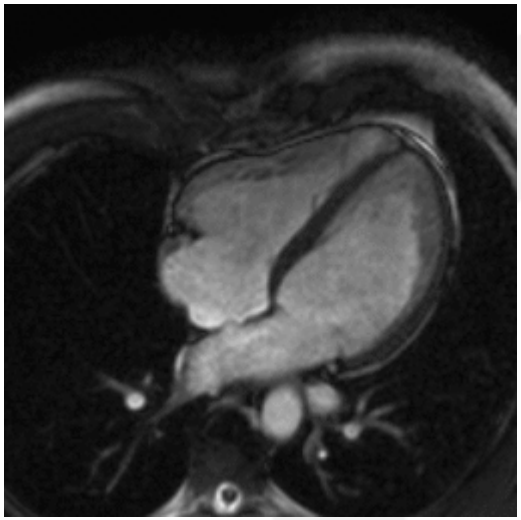
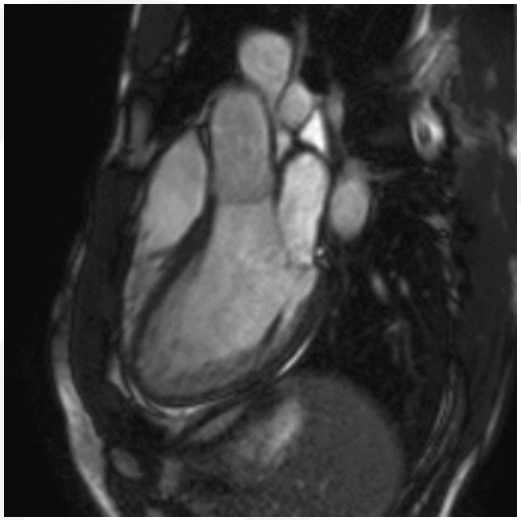
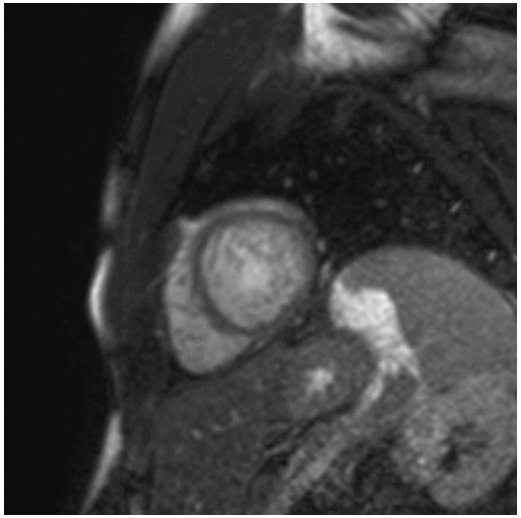
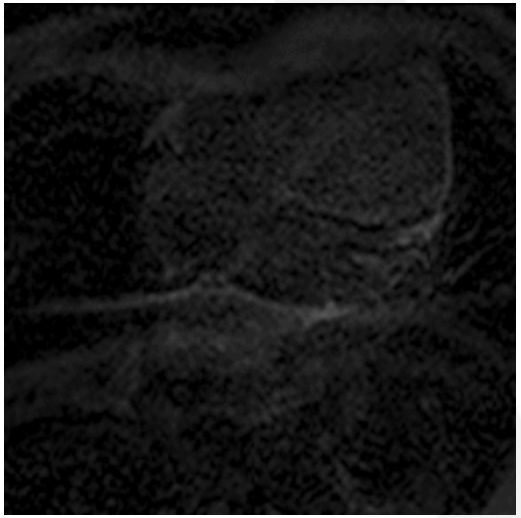
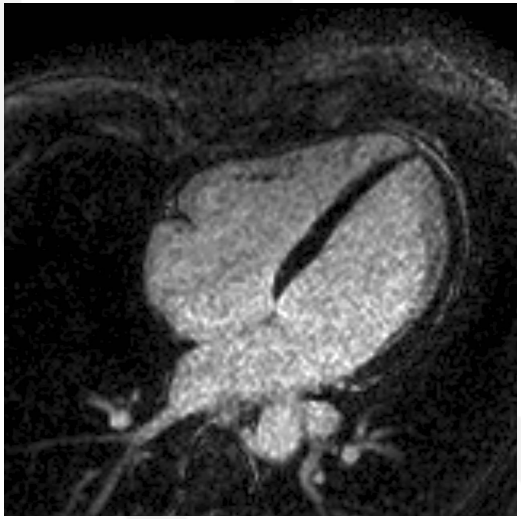
Muaj thai: Anderson-Fabry (19mm)

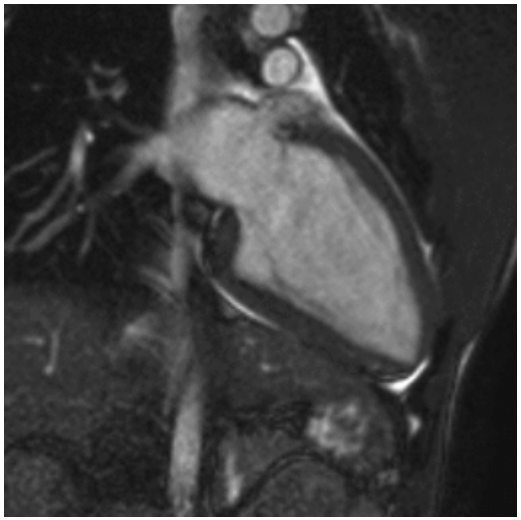
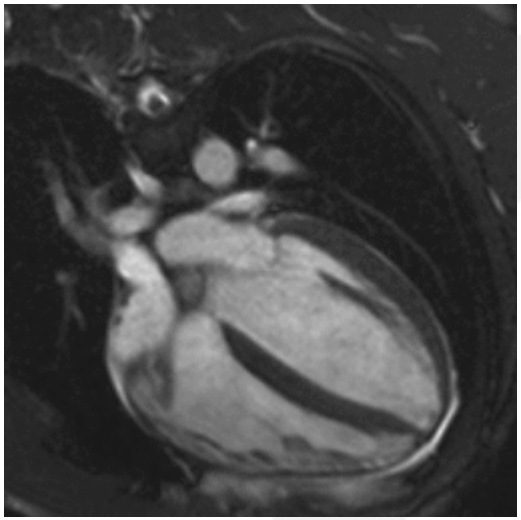
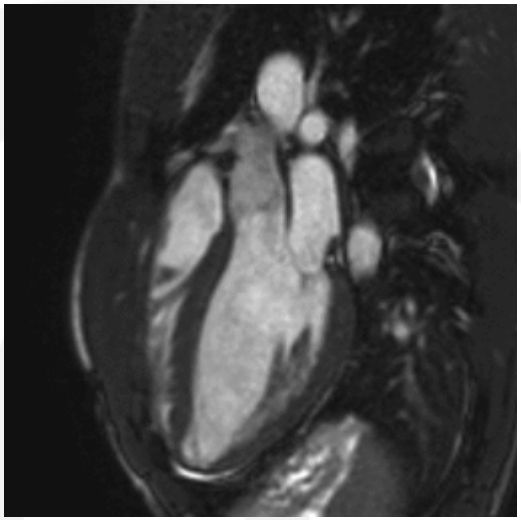
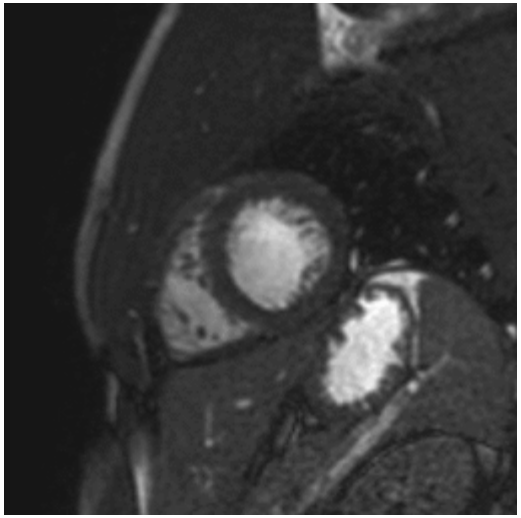
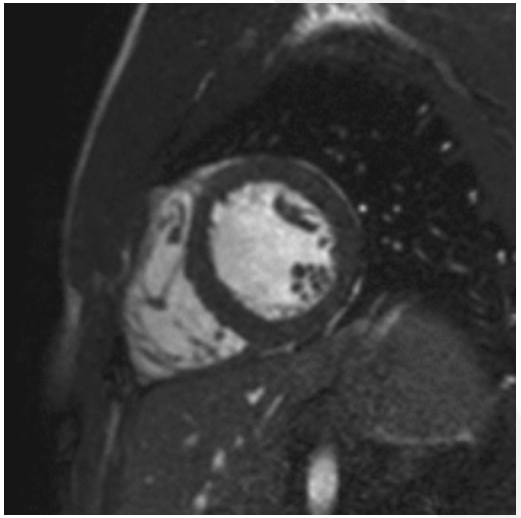
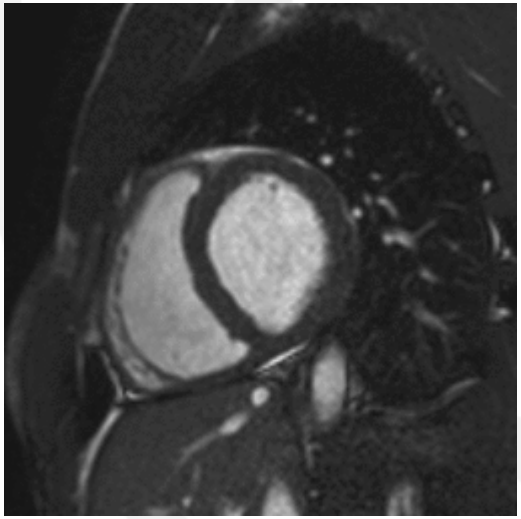
LV: EF 60, ESVi 40, EDVi 100, SVi 60, Mi 109
RV: EF 55, ESVi 50, EDVi 111, SVi 61, Mi 30

EKG abnormalities

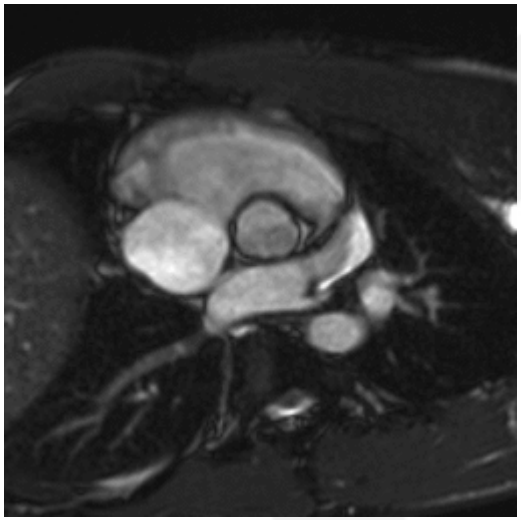
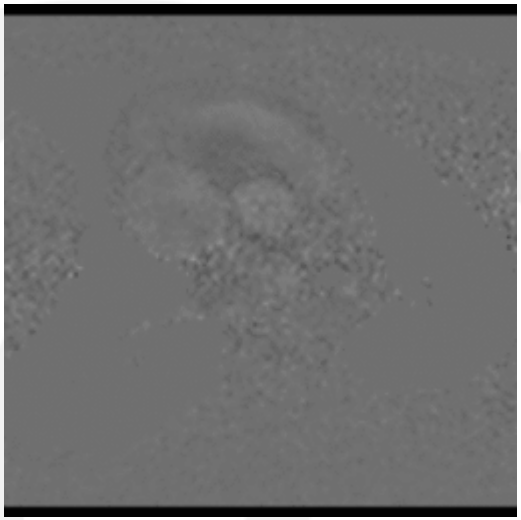
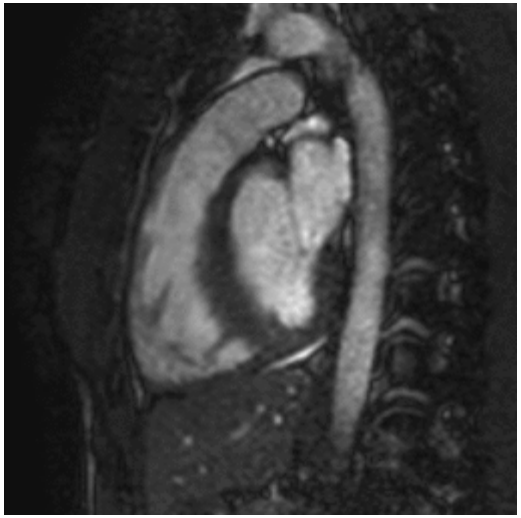
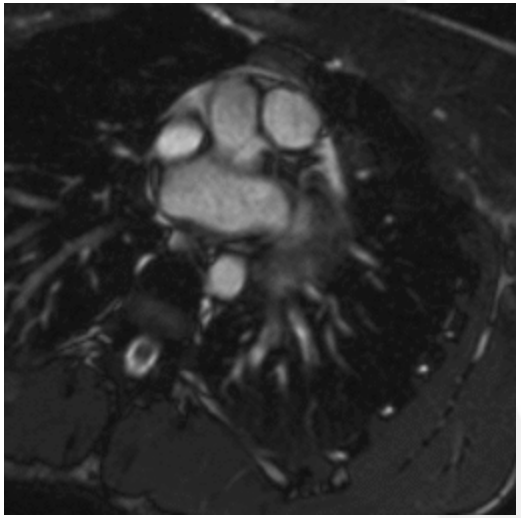
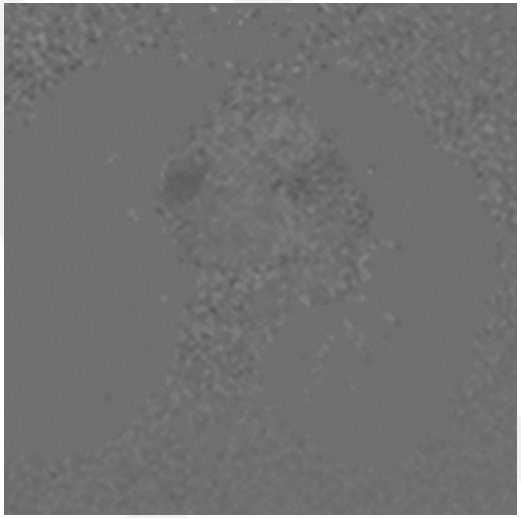







LV: EF 47, ESVi 65, EDVi 124, SVi 59, Mi 71
RV: EF 52, ESVi 65, EDVi 135, SVi 70, Mi 29

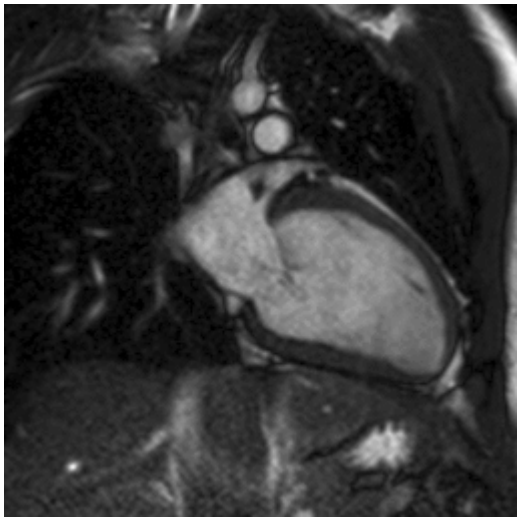
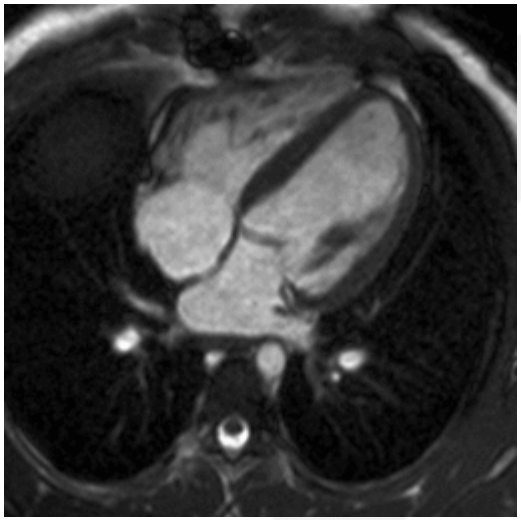
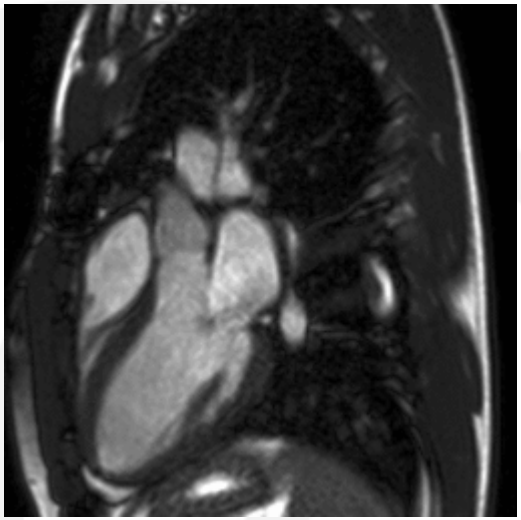
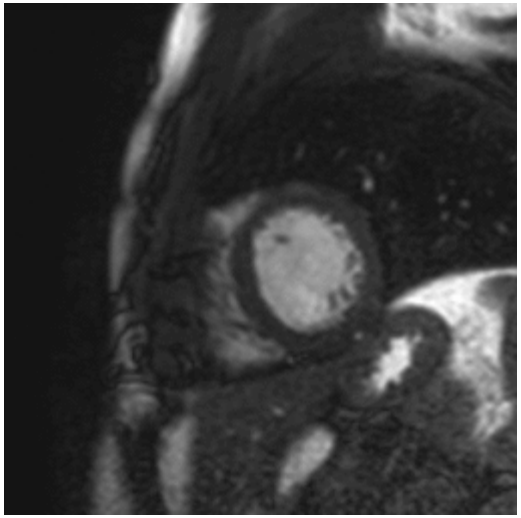
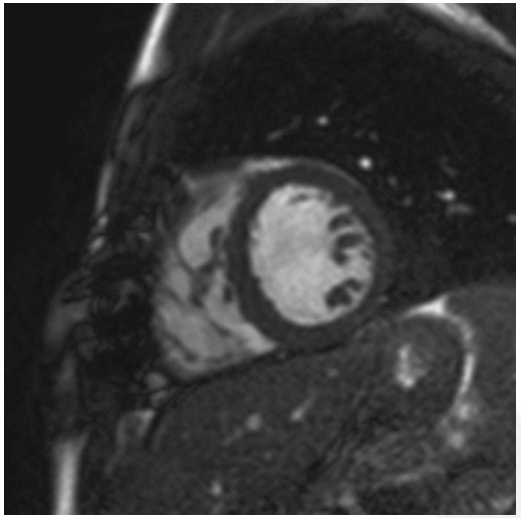
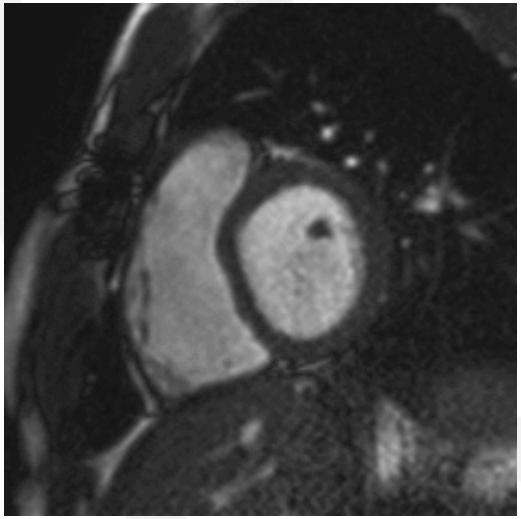
LA and SA: kayaker with known ASD

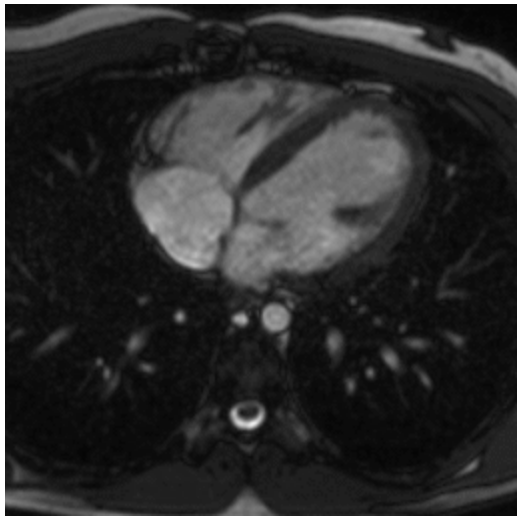
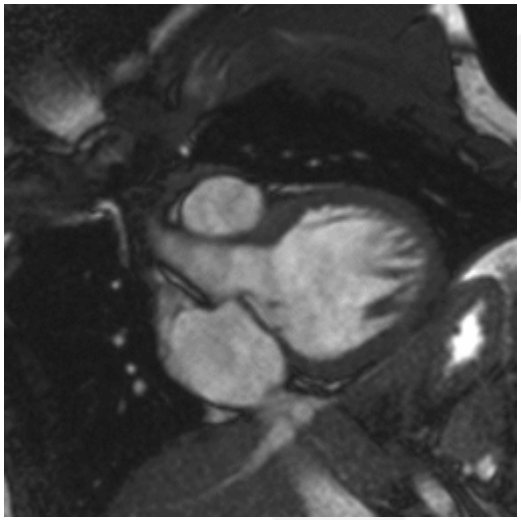
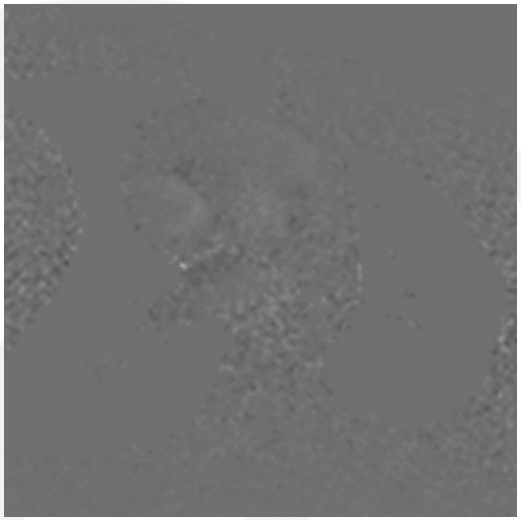
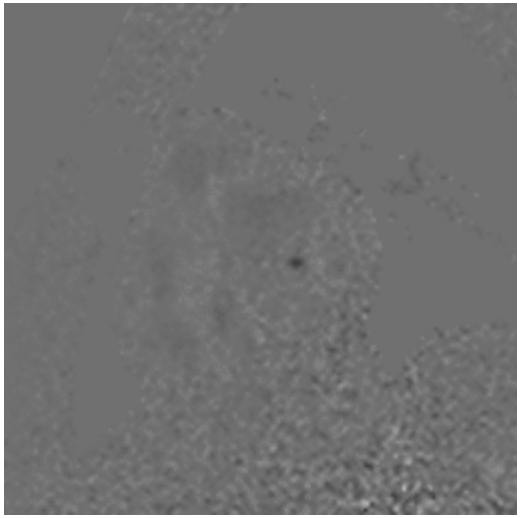
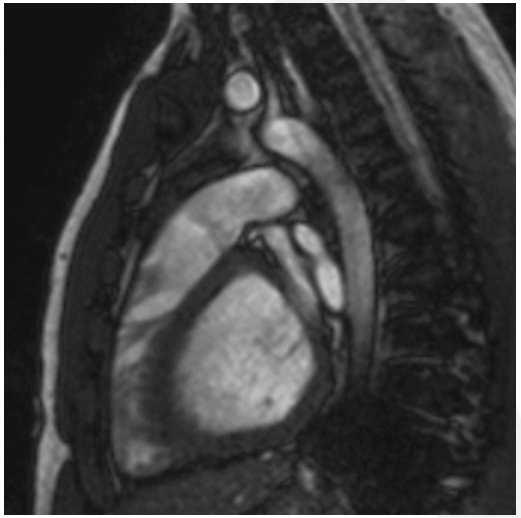
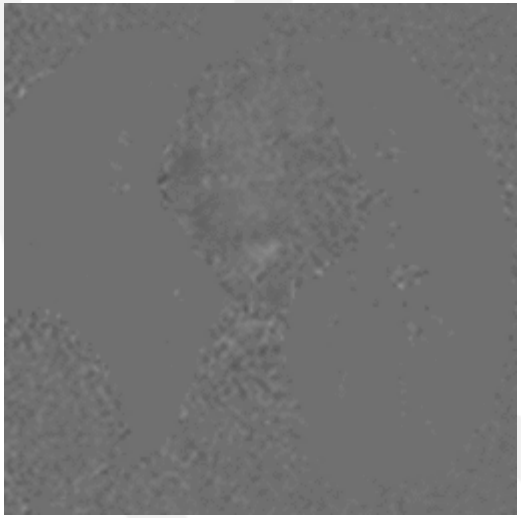
Flow: Qp/Qs 1.15

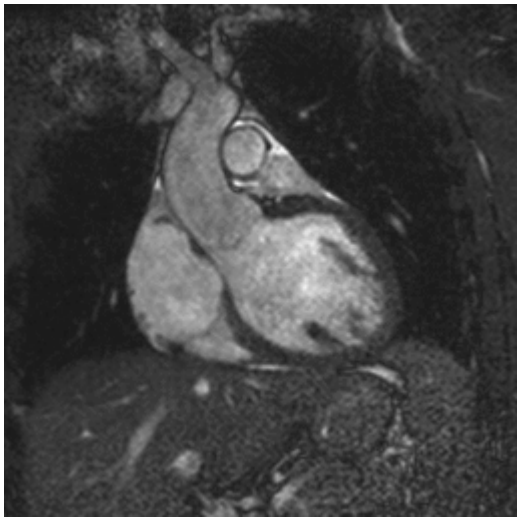
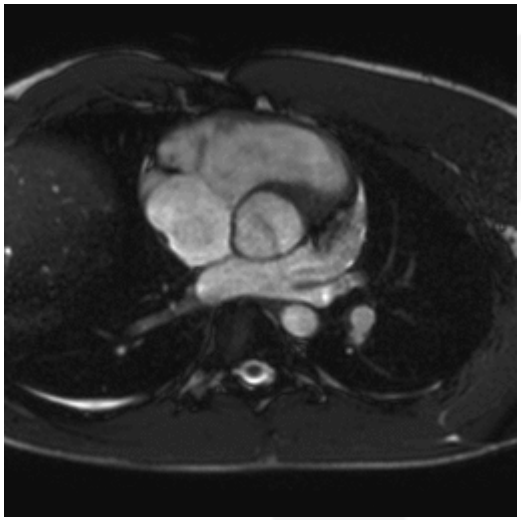
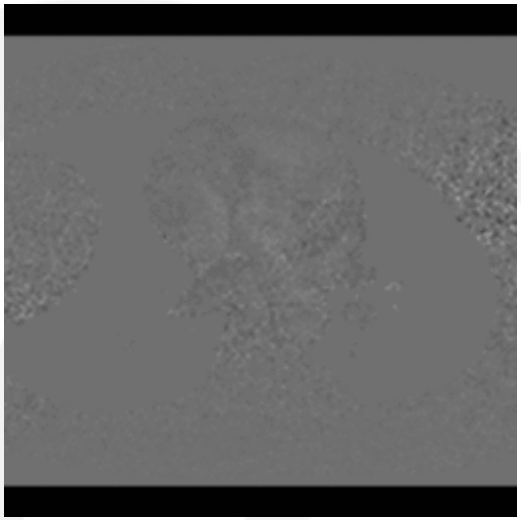
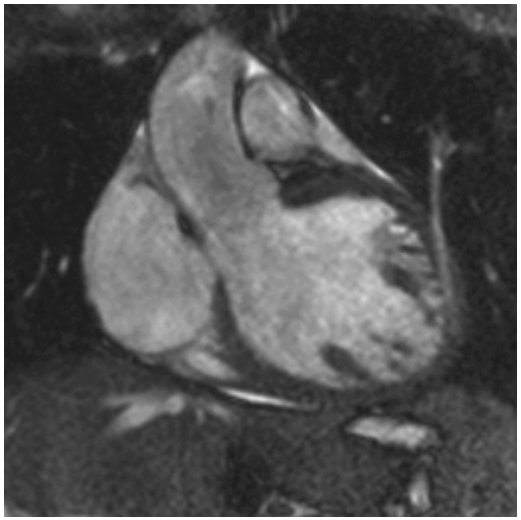
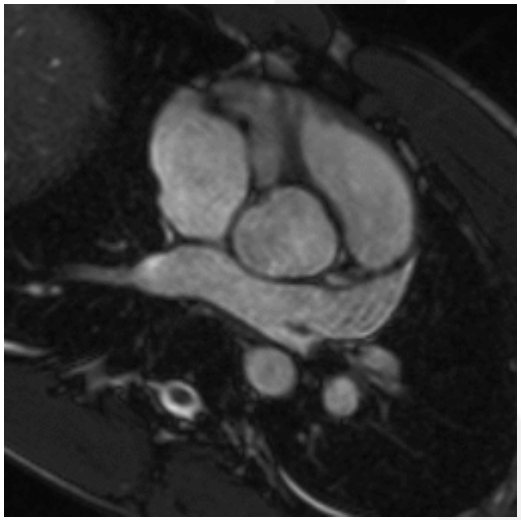
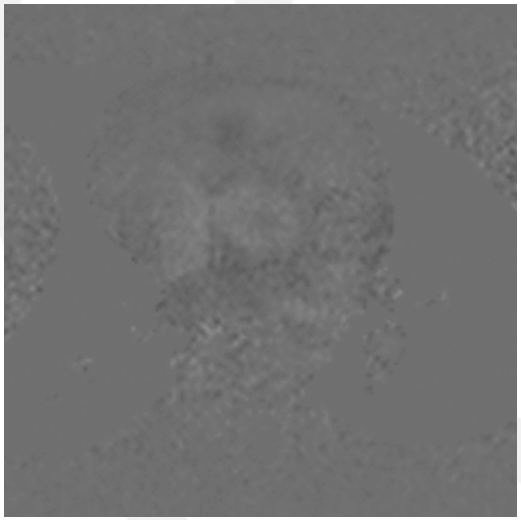
LA and SA cine II.

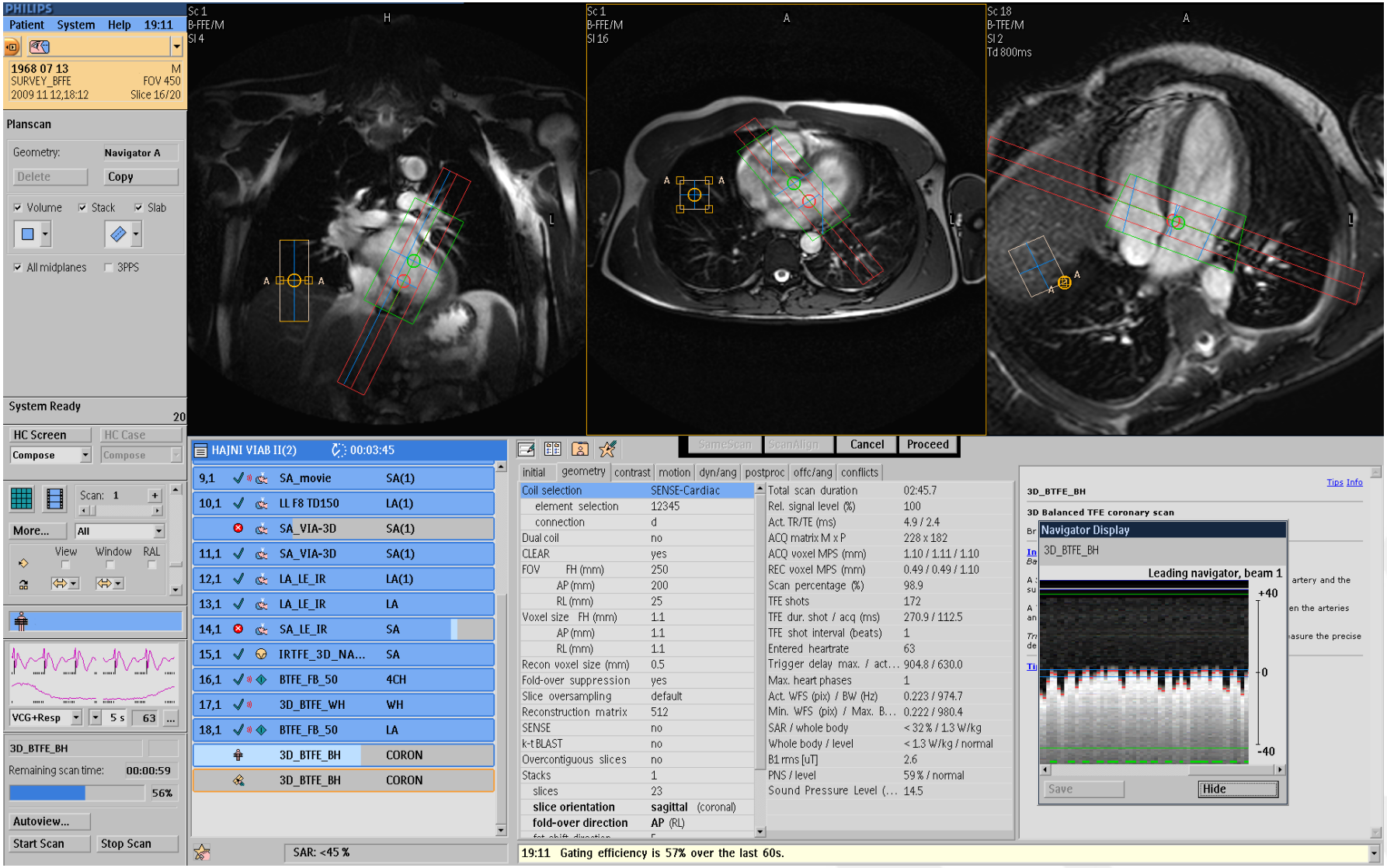
Flow II.: Qp/Qs 0.93, MI Rf: 4% (5ml)

Kayaker – AO Rf I.: 23%, II.: 19%

Navigator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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
Sc 1
B-FFE/M
SI 4
Sc 1
B-FFE/M
SI 16
Sc 18
B-TFE/M
SI 2
Td 800ms
HAJNI VIAB II(2) 00:03:45
9,1 SA_movie SA(1)
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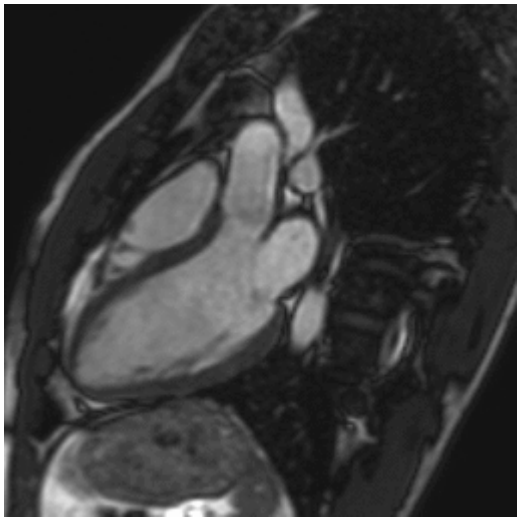
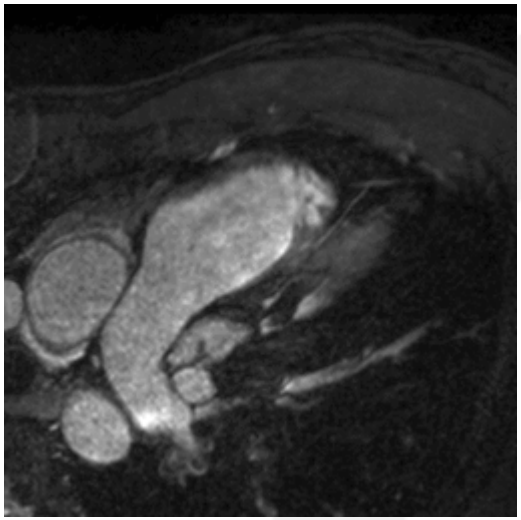
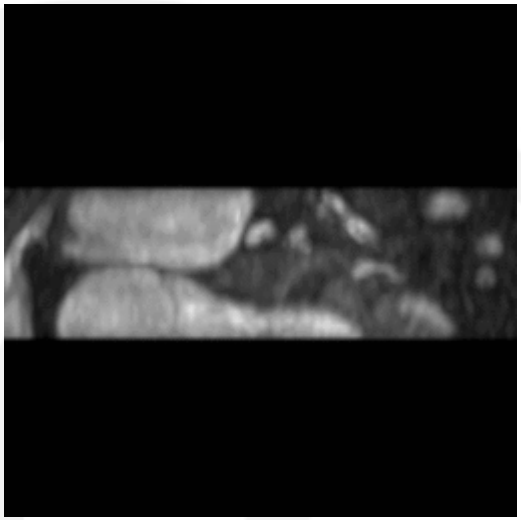
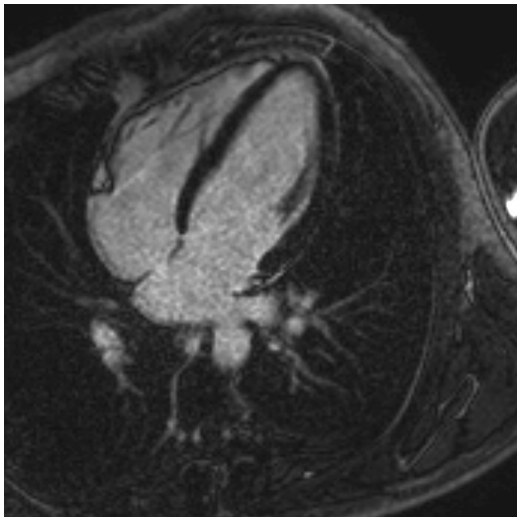
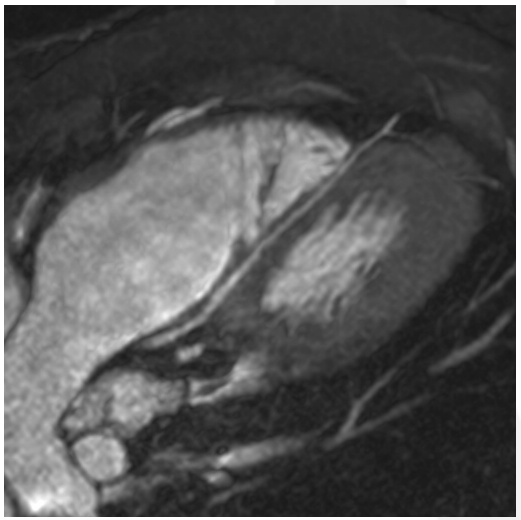
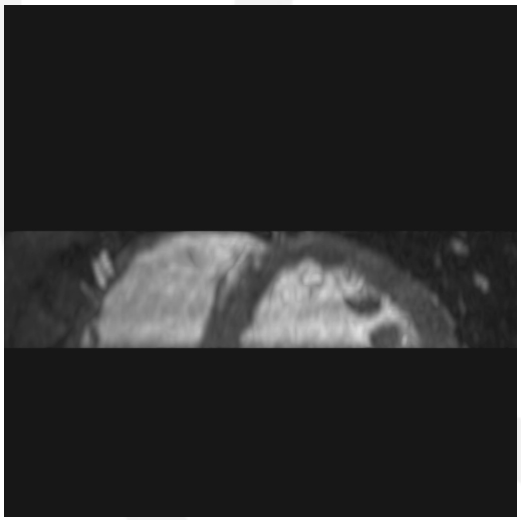
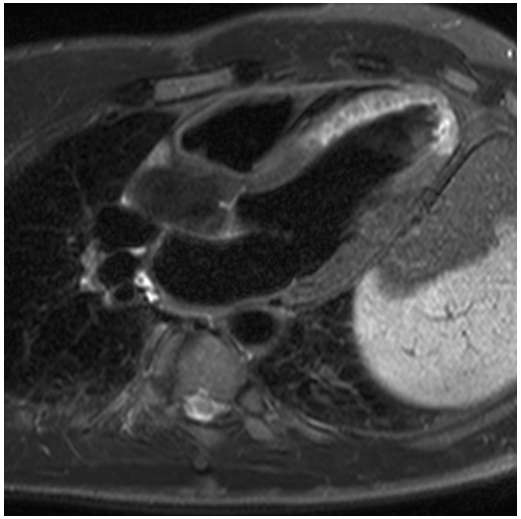
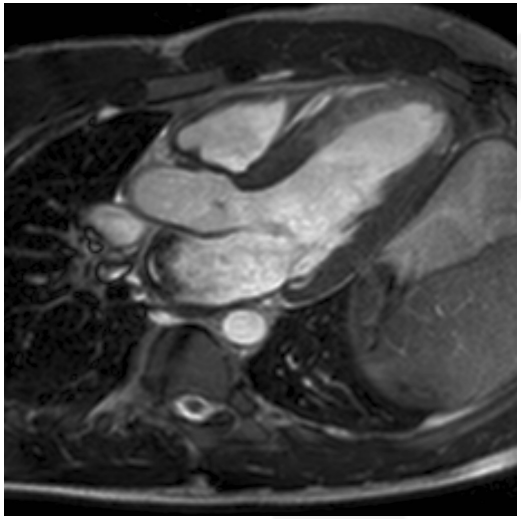
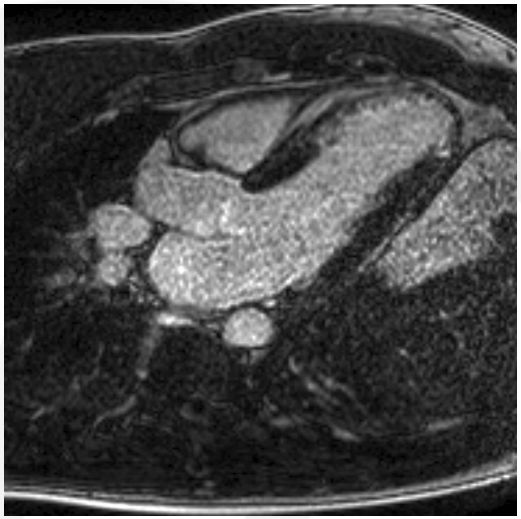
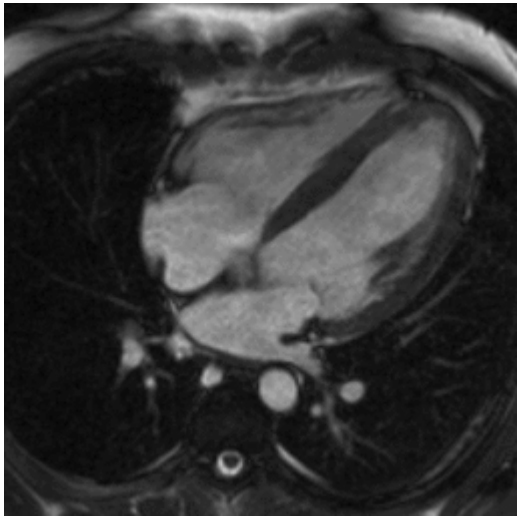
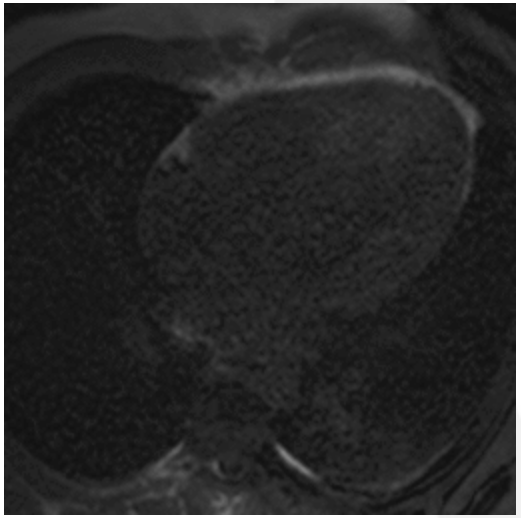
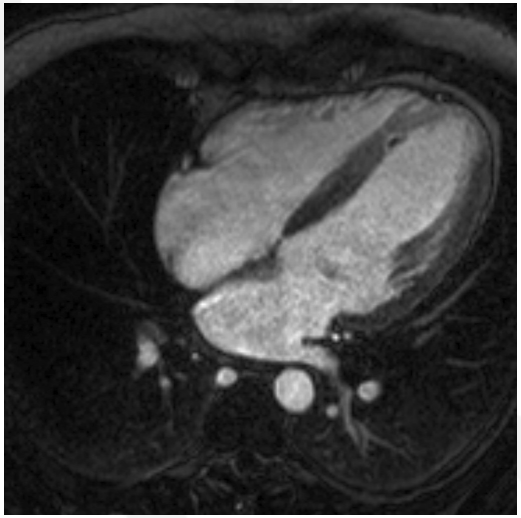
SA_VIA-3D SA(1)
11,1 SA_VIA-3D SA(1)
12,1 LA_LE_IR LA(1)
13,1 LA_LE_IR LA
14,1 SA_LE_IR SA
15,1 IRTFE_3D_NA... SA
16,1 BTFE_FB_50 4CH
17,1 3D_BTFE_WH WH
18,1 BTFE_FB_50 LA
3D_BTFE_BH CORON
3D_BTFE_BH CORON
SAR: <45 %
SameScan ScanAlign Cancel Proceed
initial geometry contrast motion dyn/ang postproc offc/ang conflicts
Coil selection SENSE-Cardiac
element selection 12345
connection d
Dual coil no
CLEAR yes
FOV FH (mm) 250
AP (mm) 200
RL (mm) 25
Voxel size FH (mm) 1.1
AP (mm) 1.1
RL (mm) 1.1
Recon voxel size (mm) 0.5
Fold-over suppression yes
Slice oversampling default
Reconstruction matrix 512
SENSE no
k-t BLAST no
Overcontiguous slices no
Stacks 1
slices 23
slice orientation sagittal (coronal)
fold-over direction AP (RL)
Total scan duration 02:45.7
Rel. signal level (%) 100
Act. TR/TE (ms) 4.9 / 2.4
ACQ matrix M x P 228 x 182
ACQ voxel MPS (mm) 1.10 / 1.11 / 1.10
REC voxel MPS (mm) 0.49 / 0.49 / 1.10
Scan percentage (%) 98.9
TFE shots 172
TFE dur. shot / acq (ms) 270.9 / 112.5
TFE shot interval (beats) 1
Entered heartrate 63
Trigger delay max. / act... 904.8 / 630.0
Max. heart phases 1
Act. WFS (pix) / BW (Hz) 0.223 / 974.7
Min. WFS (pix) / Max. B... 0.222 / 980.4
SAR / whole body < 32 % / 1.3 W/kg
Whole body / level < 1.3 W/kg / normal
B1 rms [uT] 2.6
PNS / level 59 % / normal
Sound Pressure Level (... 14.5
Tips Info
3D_BTFE_BH
3D Balanced TFE coronary scan
Navigator Display
3D_BTFE_BH
Leading navigator, beam 1
+40
0
-40
Save Hide
19:11 Gating efficiency is 57% over the last 60s.

Complains on excercise: LAD bridge

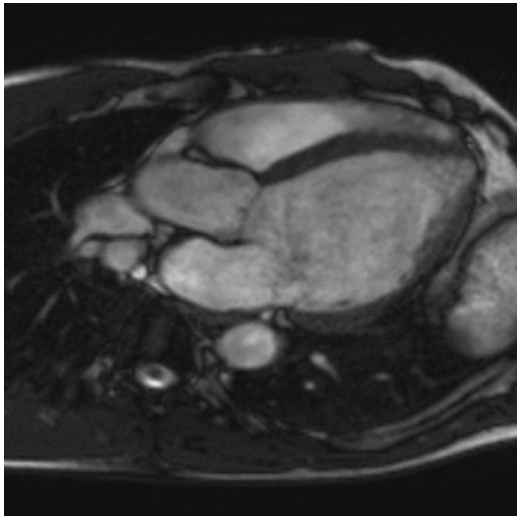
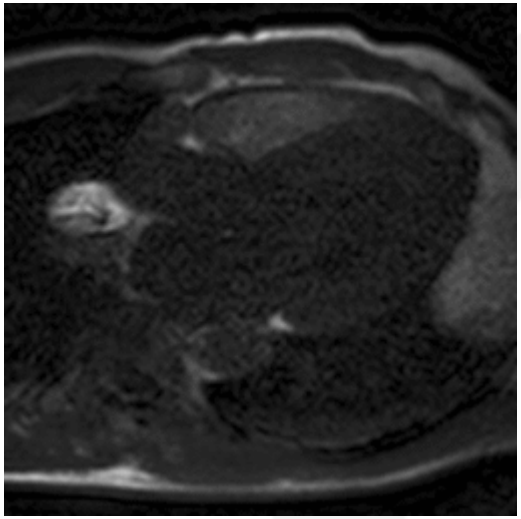
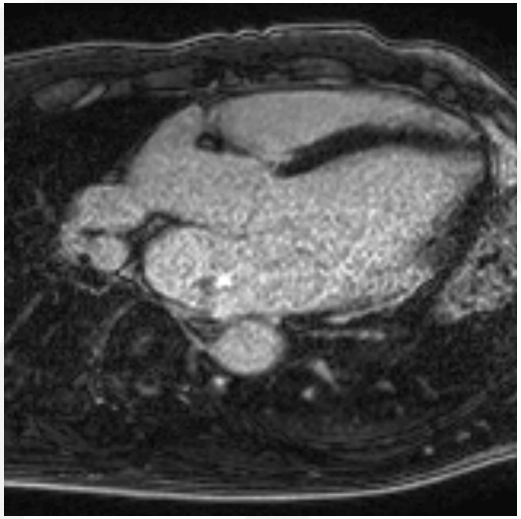
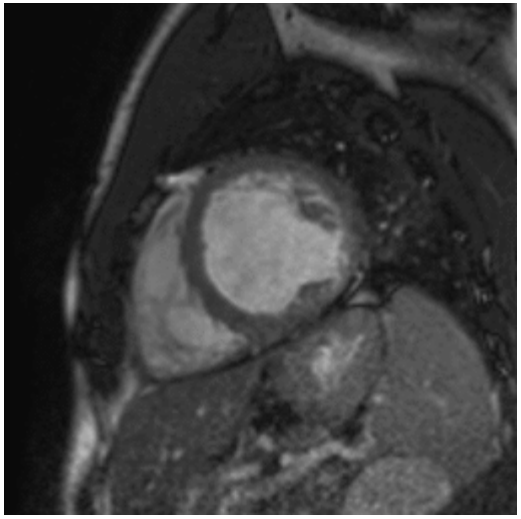
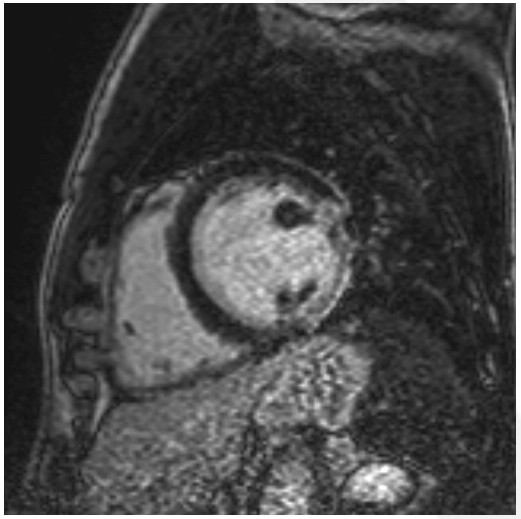
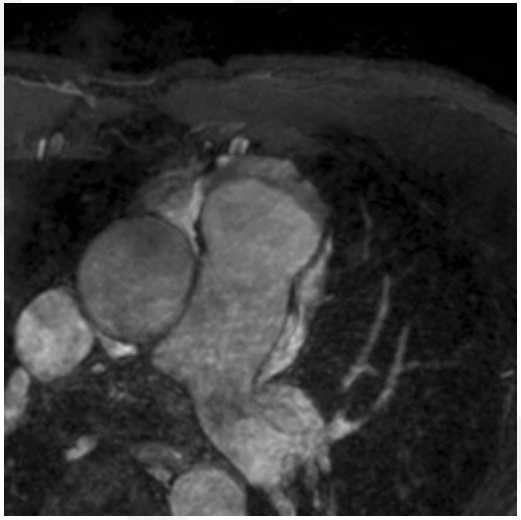







Acute MI: 21% non-viable

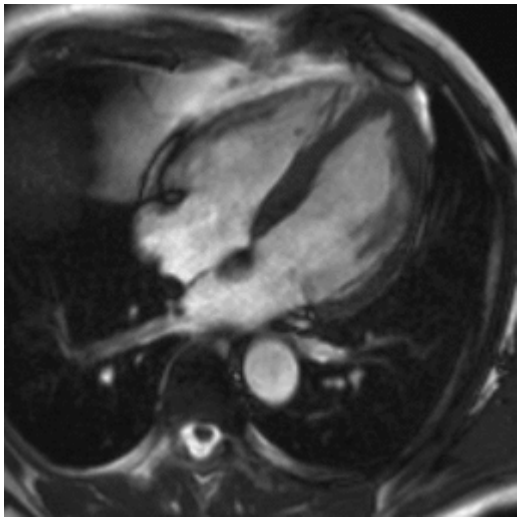
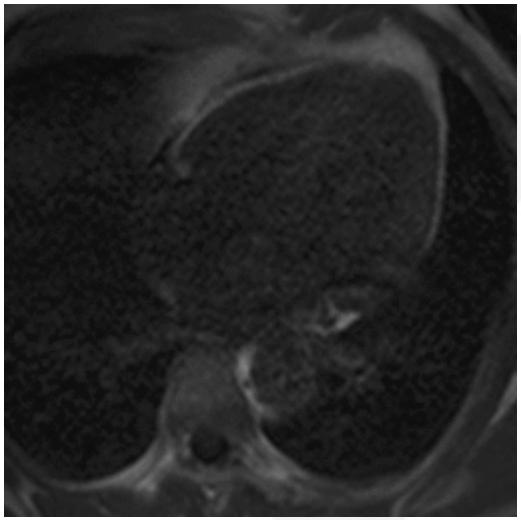
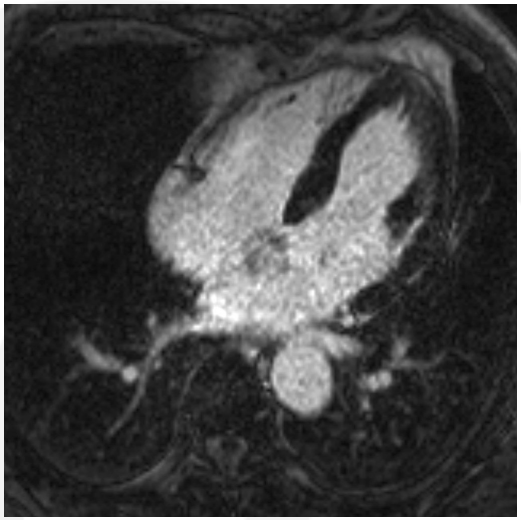
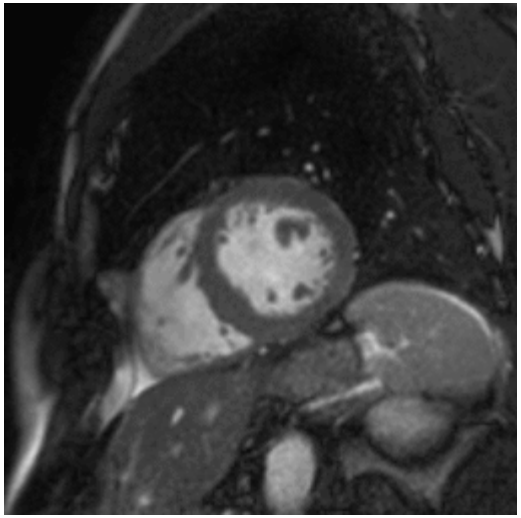
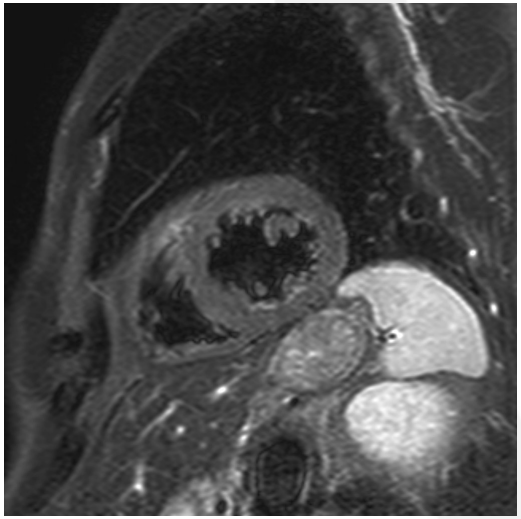
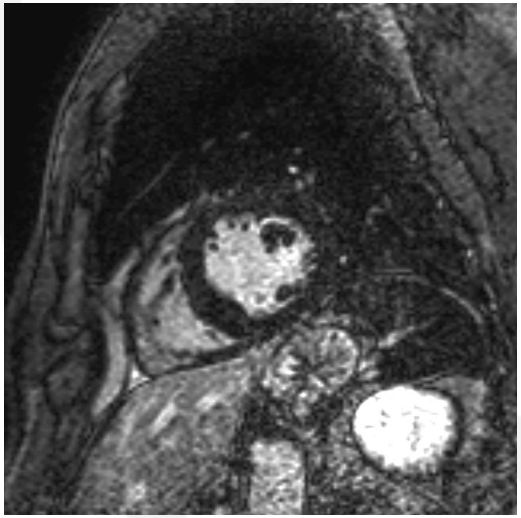
LV: EF 62, ESVi 44, EDVi 114, SVi 71, Mi 108 sport index: 0.14
RV: EF 60, ESVi 48, EDVi 122, SVi 73, Mi 31 max diast wt: 16mm

Duathlon, ultra-marathon

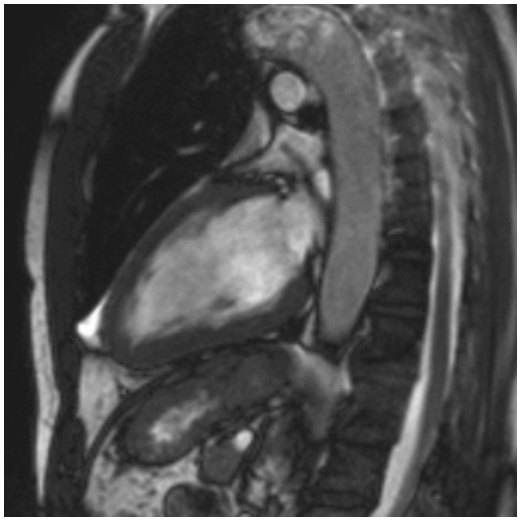
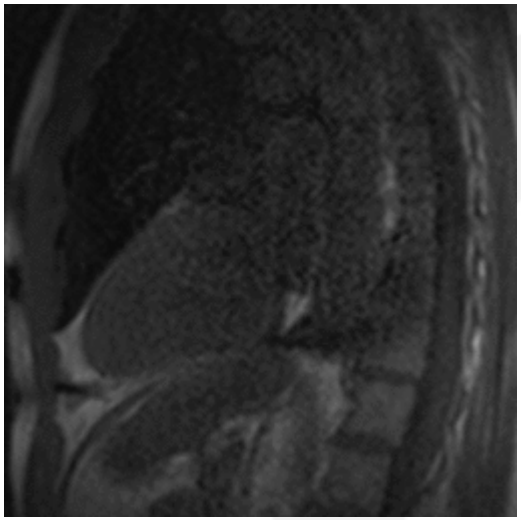
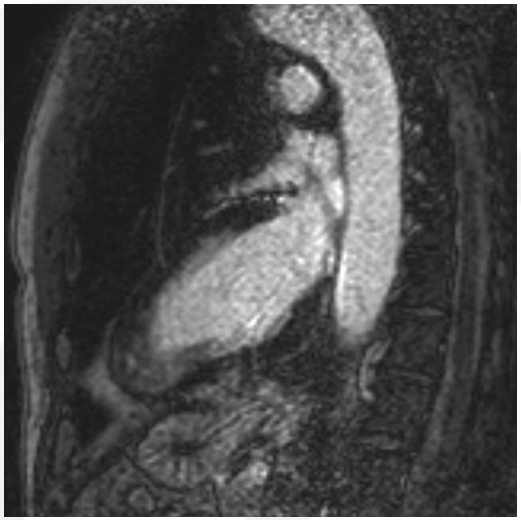
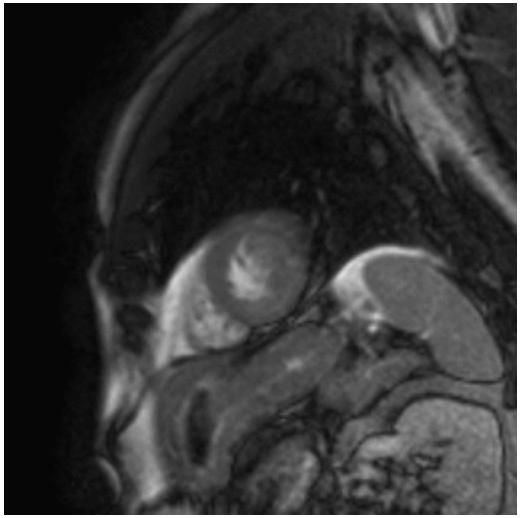
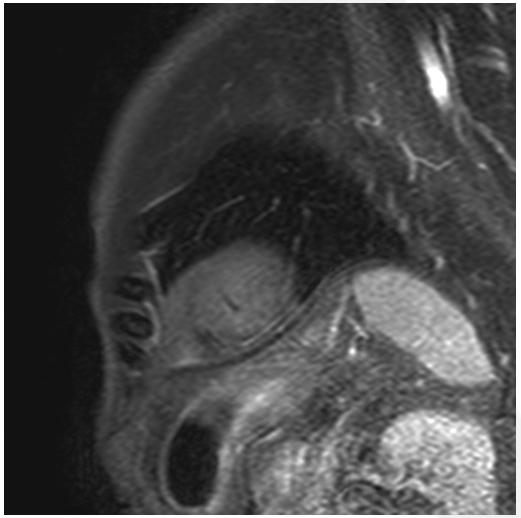
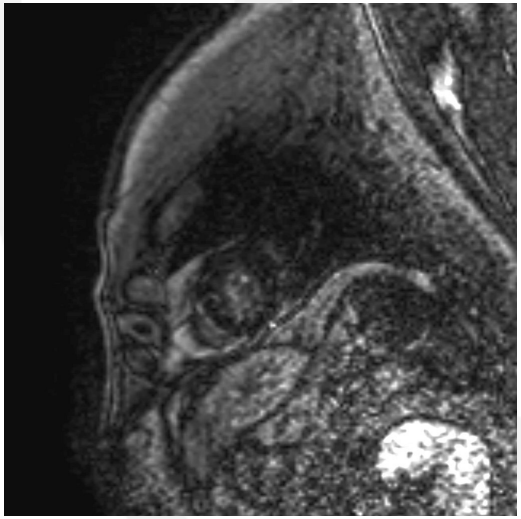
LV: EF 37, ESVi 112, EDVi 177, SVi 65, Mi 102
RV: EF 47, ESVi 95, EDVi 178, SVi 83, Mi 39

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

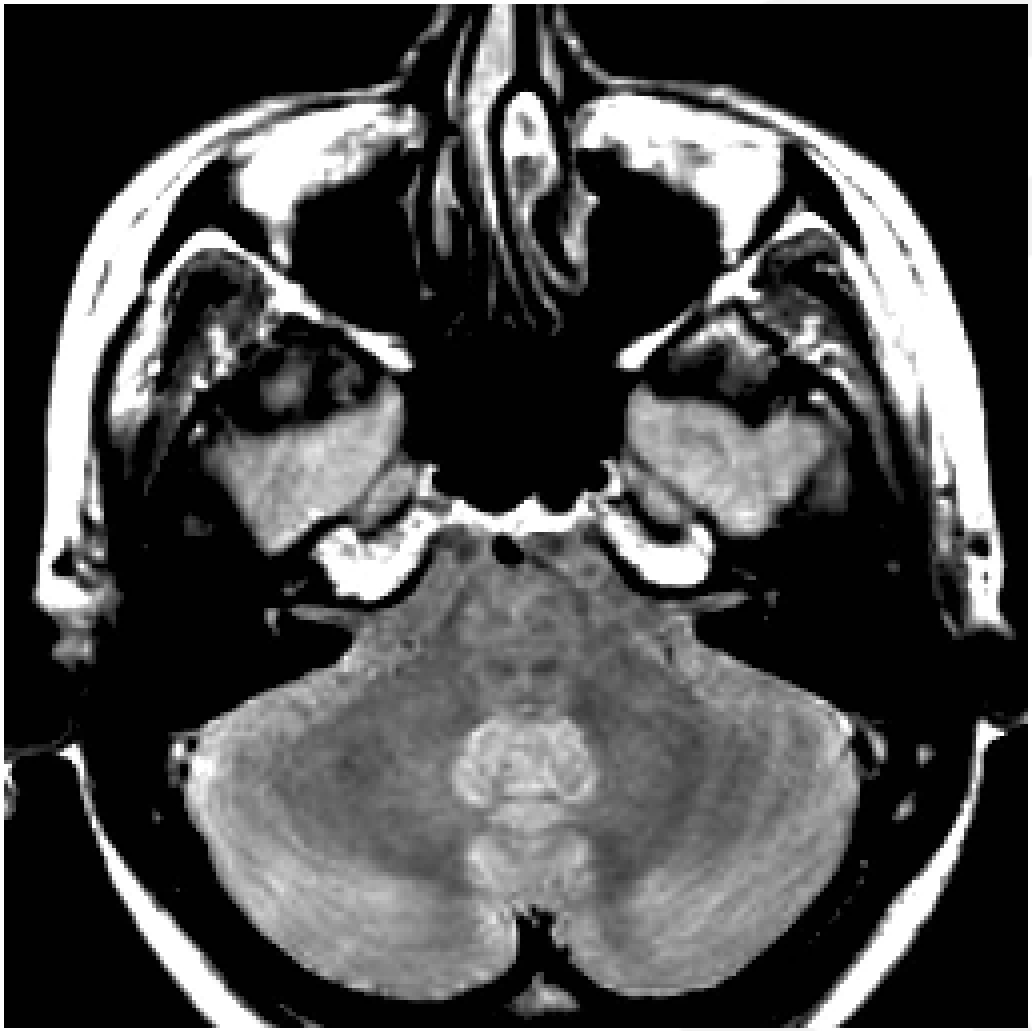
LV: EF 65, ESVi 31, EDVi 88, SVi 58, Mi 85, Max diast wt: 17mm
RV: EF 59, ESVi 38, EDVi 93, SVi 55, Mi 30, Sport index: 0.19

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

LV: EF 65, ESVi 31, EDVi 88, SVi 58, Mi 85, diast index: 3.4
RV: EF 59, ESVi 38, EDVi 93, SVi 55, Mi 30

Thank you for your attention



Sponsored by: TÁMOP 4.2.2. - 08/1/KMR-2008-004.

BY NC ND