In collaboration with

SCMR
Society for Cardiovascular Magnetic Resonance

The information presented on this supplement to MAGNETOM Flash is for illustration only and is not intended to be relied upon by the reader for instruction as to the practice of medicine. Any health care practitioner reading this information is reminded that they must use their own learning, training and expertise in dealing with their individual patients.
This material does not substitute for that duty and is not intended by Siemens Medical Solutions to be used for any purpose in that regard. The drugs and doses mentioned on this CD supplement to MAGNETOM Flash are consistent with the approval labeling for uses and/or indications of the drug.
The treating physician bears the sole responsibility for the diagnosis and treatment of patients, including drugs and doses prescribed in connection with such use. The Operating Instructions must always be strictly followed when operating the MR System. The source for the technical data is the corresponding data sheets.

Not for distribution in the US.

SCMR Recommended Cardiac MRI Protocols

1.5T MAGNETOM Systems with Tim

www.siemens.com/medical

SIEMENS
medical

Introduction

This users guide describes the SCMR Recommended Cardiac MRI Protocols that have been clinically optimized for the Siemens MAGNETOM family of MRI scanners operating at 1.5 Tesla with Tim Technology and *syngo* MR B13 software.

For ease of use, the protocols are organized by common cardiac diseases and sub-organized by the patient's cooperative abilities.

For example:
Acute Myocardial Infarct
- Recommended – Breathhold & Triggered
- Free Breathing & Triggered
- Extreme Arrhythmia – Free Breathing & Non Triggered

If the patient has a **good quality ECG signal with only a few minor arrhythmias (or none) and is able to hold the breath,** then use the **Recommended protocols.** Most of these are segmented k-space techniques with a single signal average. Retro-gated cine techniques allow Arrhythmia Detection for minor variations in the cardiac cycle, but this should be done with the "slice and shift" method for best results.

If the patient has a **good quality ECG signal with only a few minor arrhythmias (or none) but is not able to hold the breath,** then use the **Free Breathing protocols.** Most of these are either segmented k-space techniques with multiple signal averages or single-shot k-space techniques. Retro-gated cine techniques allow Arrhythmia Detection for minor variations in the cardiac cycle, but this should be done with the "slice and shift" method for best results.

If the patient has a **poor quality ECG signal (or none),** or if the patient has **such extreme arrhythmias that gating is impossible,** then use the **Extreme Arrhythmia protocols.** Such extreme conditions require exclusively single shot k-space techniques which are also compatible with free breathing. Real-time cine techniques can be used without triggering in very extreme cases (default), or with triggering in less extreme cases.

The user may easily switch from one sub-group to another as the conditions of the patient change even during an exam because all three sub-groups contain essentially the same protocols in the same sequence, simply optimized to a different set of conditions (breathing and triggering).

System Requirements

Hardware:
The following 1.5T Siemens MAGNETOM MRI systems with Tim technology:
- MAGNETOM Avanto
- MAGNETOM Espree
- MAGNETOM Symphony Tim

Software:
syngo MR B13 software level with cardiac options:
- Advanced Cardiac – sequence package
- Advanced Angio – sequence package
- Flow Quantification – sequence package
- *syngo* TWIST – sequence package
- Argus Viewer – analysis package
- Argus Function – analysis package
- Argus Flow – analysis package

Installation Procedure

The appropriate installation file that corresponds to your MAGNETOM equipment configuration can be found on this CD. You can also obtain it from a Siemens Application Specialist or from the Siemens MAGNETOM World website:

www.siemens.com/magnetom-world

- Download the appropriate protocol file for your system configuration:
  - MAGNETOM Avanto 32SQ
  - MAGNETOM Avanto 18SQ
  - MAGNETOM Avanto 18Q
  - MAGNETOM Avanto 8Q
  - MAGNETOM Espree 18DZ
  - MAGNETOM Espree 18Z
  - MAGNETOM Espree 8Z
  - MAGNETOM Symphony Tim
- Burn the protocol file onto a CD-ROM and insert into your *syngo* computer
- Use the Object > Import function on the *syngo* Exam Explorer to install the protocol file into the User Protocols list
- If your system is missing some of the software options listed above in System Requirements, the corresponding protocols will not import

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Localizers Module

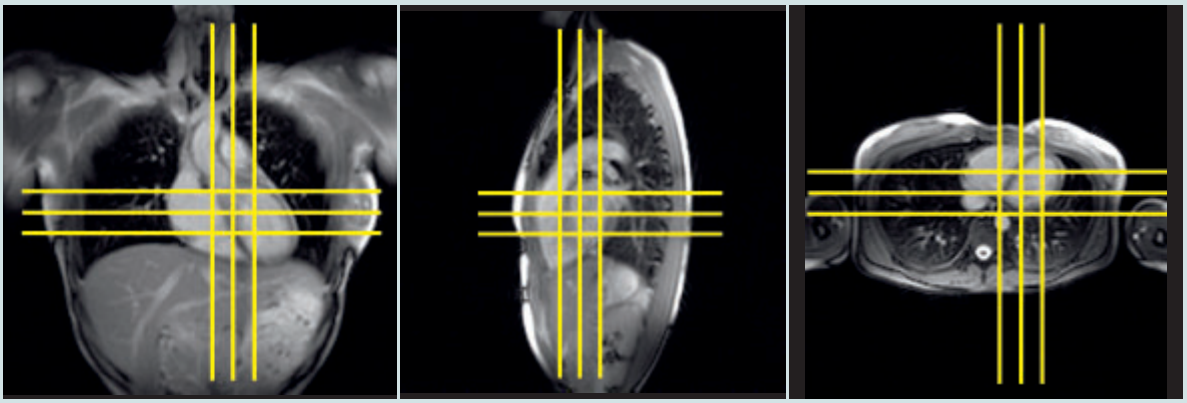
Recommended – Breath Hold & Triggered

1. **Turn On Coupled Graphics:** all slices move together.

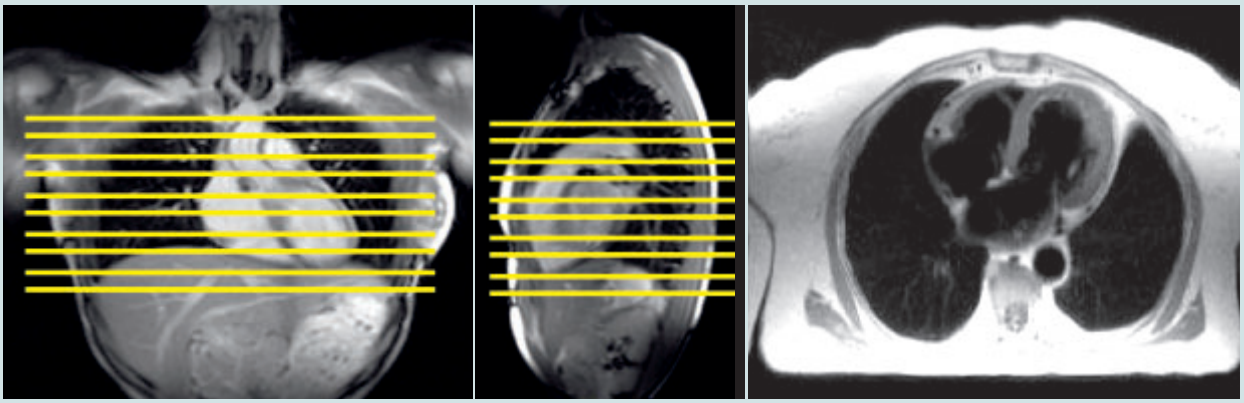
2. **Turn Off Auto Coil Select:** for all cardiac imaging protocols.

3. **Auto Detect Table Position:** runs automatically, untriggered free breathing.

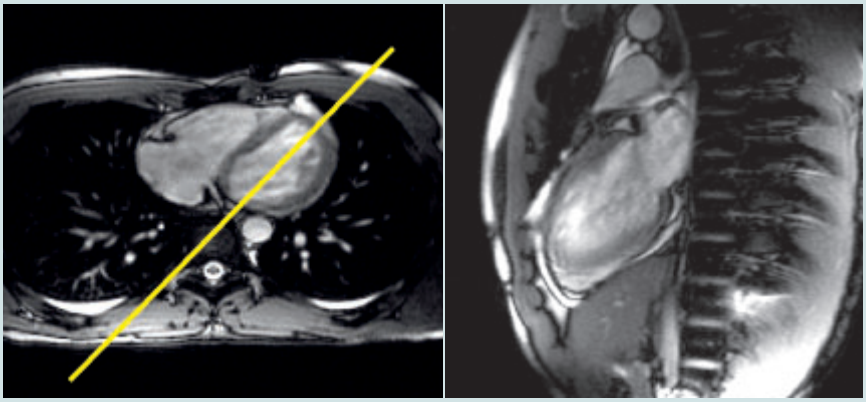
4. **Multi Plane Loc:** adjusts heart to isocenter of bore (ISO table mode), prescribe 3 axial, 3 coronal, 3 sagittal slices, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



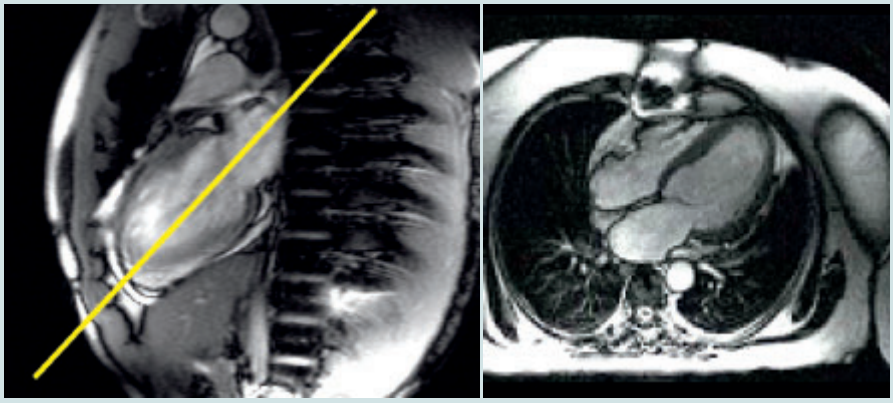
5. **Axial DB HASTE Loc:** prescribe 20 slices from sagittal and coronal views, cover from above aortic arch to below apex, multiple breathholds, trigger on every second heartbeat, capture cycle for diastolic gating



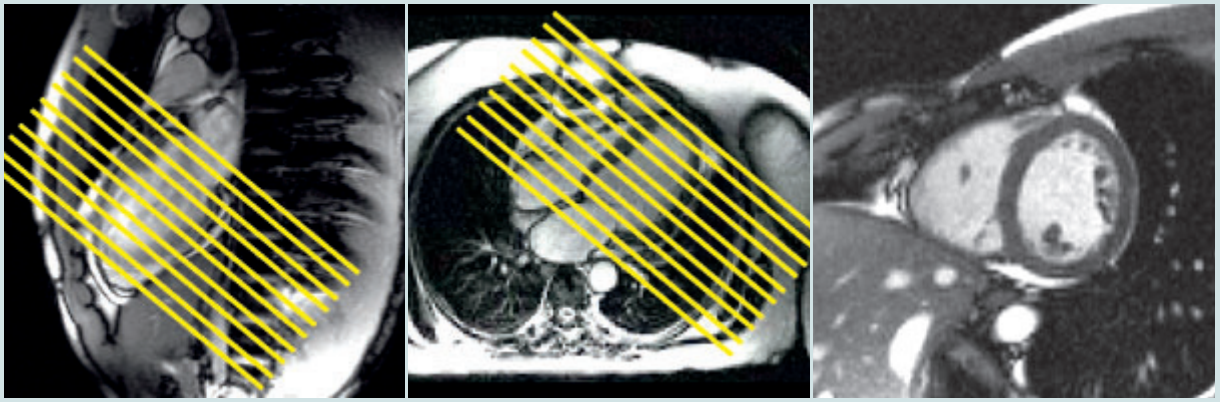
6. Two-Chamber Loc: prescribe 1 slice from axial view parallel to ventricular septum, bisect left ventricle through mitral valve and apex, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.



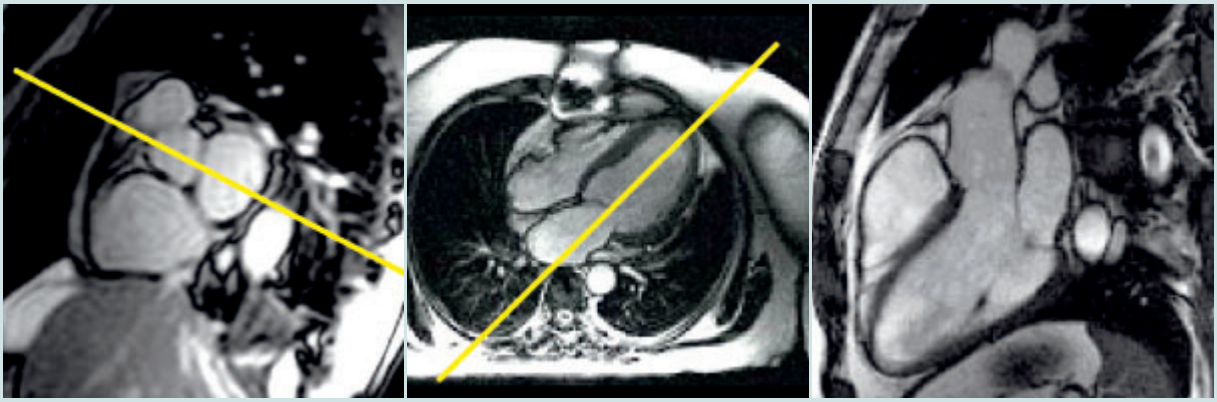
7. Four-Chamber Loc: prescribe 1 slice from two-chamber view, bisect left ventricle through mitral valve and apex, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



8. Short Axis Loc: prescribe 10 slices from two-chamber and four-chamber views, perpendicular to long axis of left ventricle, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



9. **Three-Chamber Loc:** prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



Localizers Module

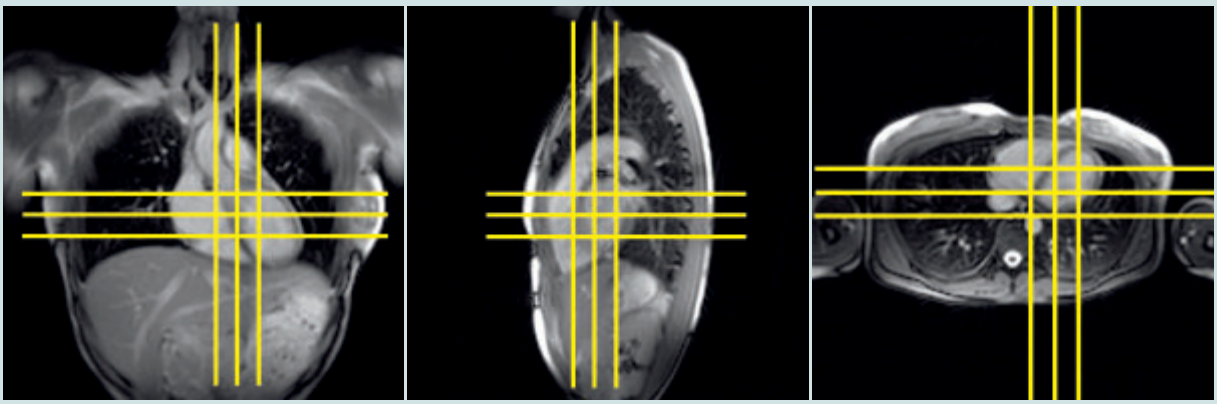
Free Breathing & Triggered

1. **Turn On Coupled Graphics:** all slices move together.

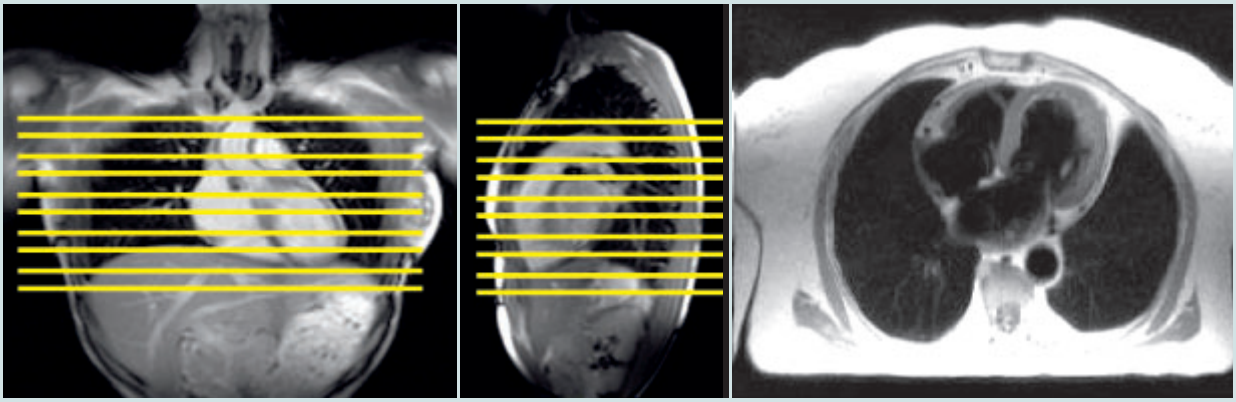
2. **Turn Off Auto Coil Select:** for all cardiac imaging protocols.

3. **Auto Detect Table Position:** runs automatically, untriggered free breathing.

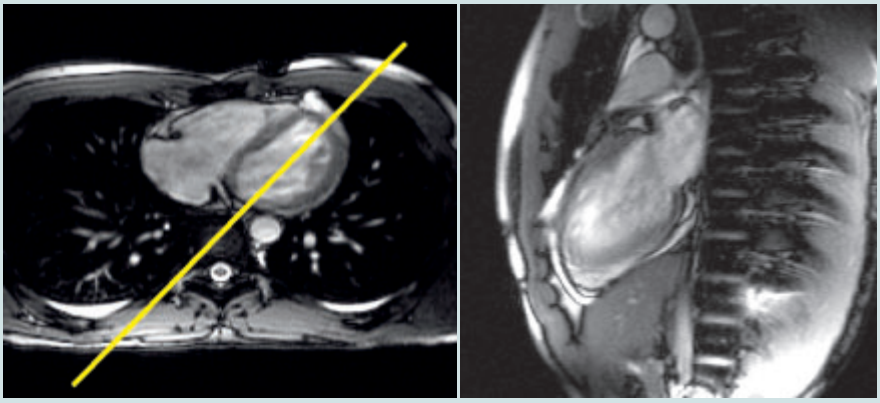
4. **Multi Plane Loc:** adjusts heart to isocenter of bore (ISO table mode), prescribe 3 axial, 3 coronal, and 3 sagittal slices, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



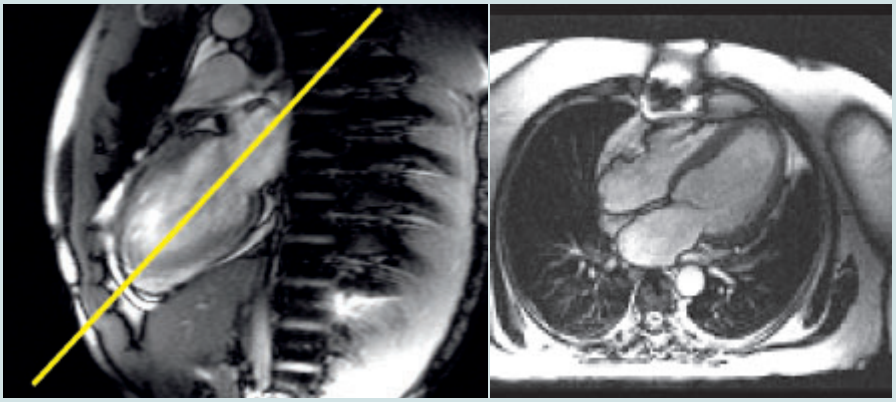
5. Axial DB HASTE Loc: prescribe 20 slices from sagittal and coronal views, cover from above aortic arch to below apex, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



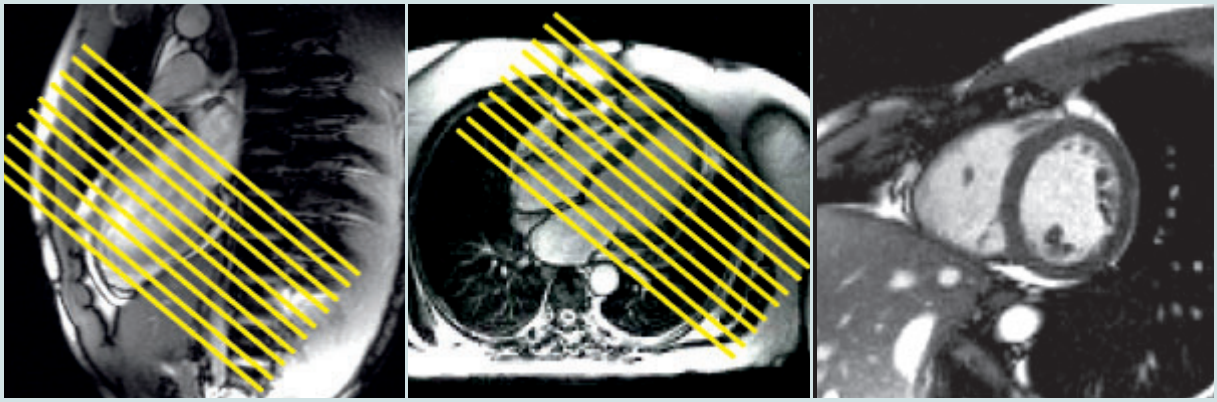
6. Two-Chamber Loc: prescribe 1 slice from axial view parallel to ventricular septum, bisect left ventricle through mitral valve and apex, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



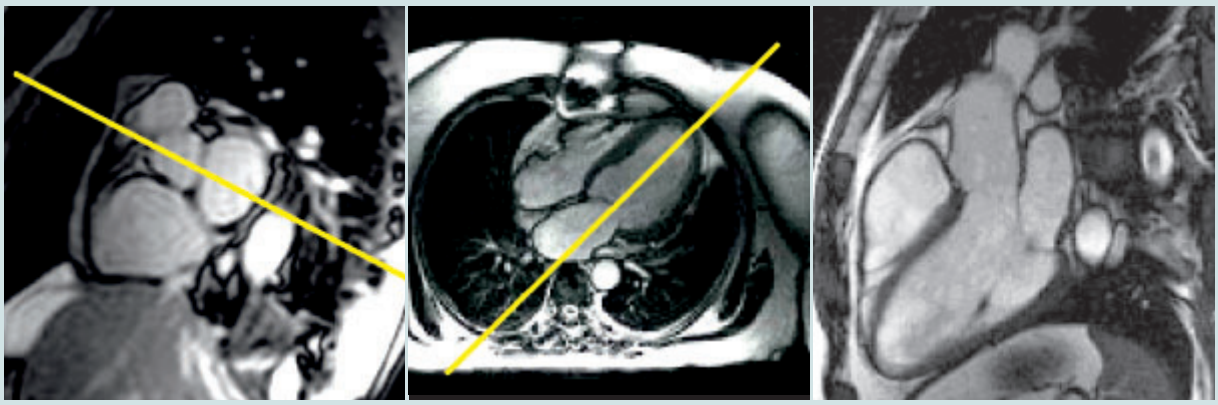
7. Four-Chamber Loc: prescribe 1 slice from two-chamber view, bisect left ventricle through mitral valve and apex, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



8. **Short Axis Loc:** prescribe 10 slices from two-chamber and four-chamber views, perpendicular to long axis of left ventricle, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



9. **Three-Chamber Loc:** prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



Localizers Module

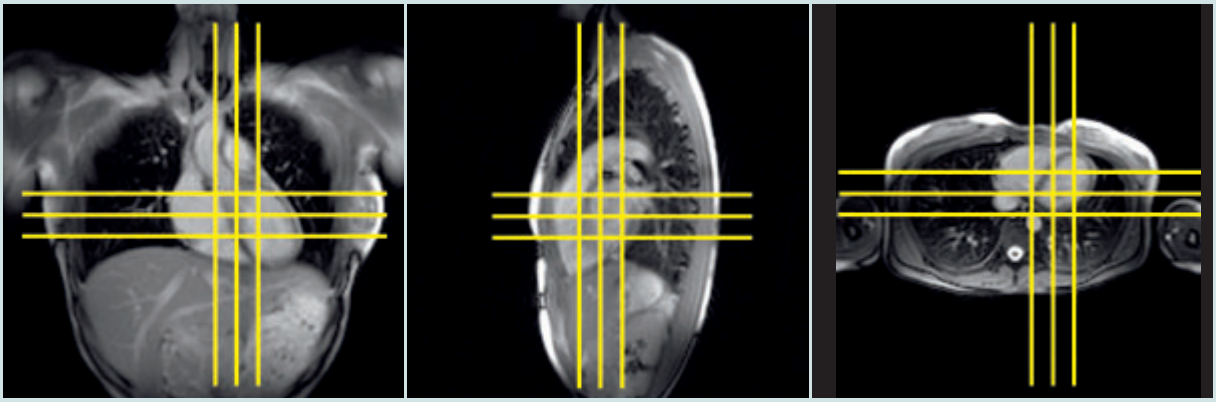
Extreme Arrhythmia – Free Breathing & Non Triggered

1. **Turn On Coupled Graphics:** all slices move together.

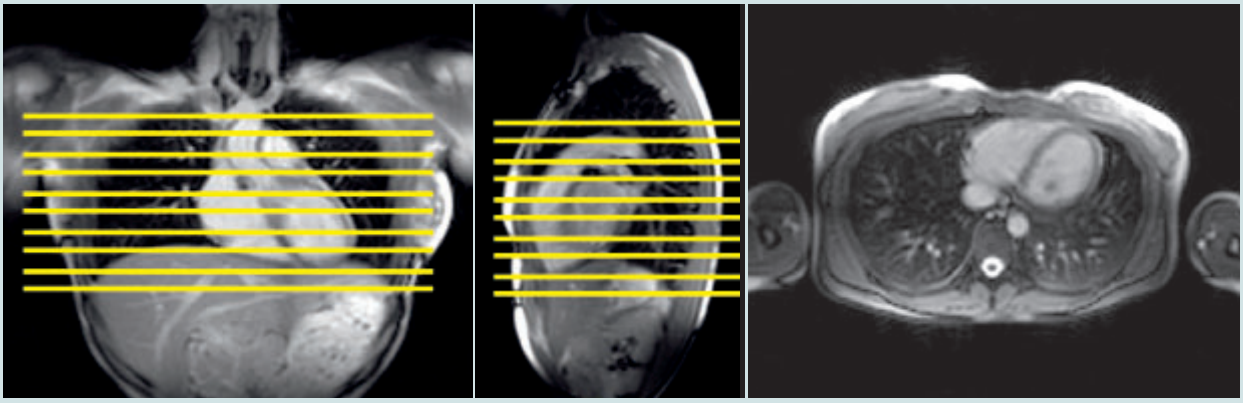
2. **Turn Off Auto Coil Select:** for all cardiac imaging protocols.

3. **Auto Detect Table Position:** runs automatically, untriggered free breathing.

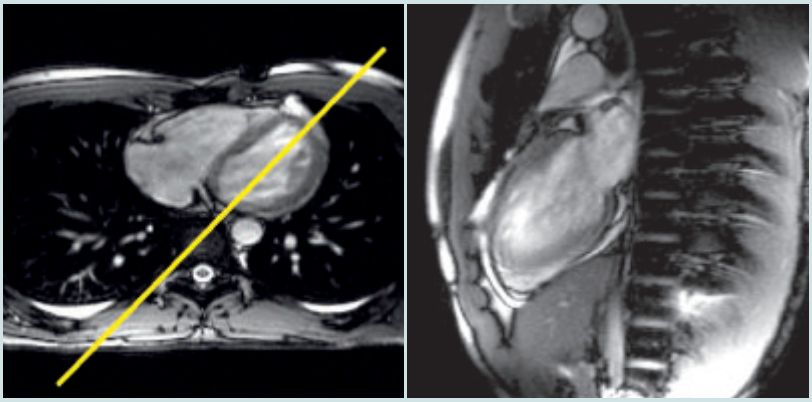
4. Multi Plane Loc: adjusts heart to isocenter of bore (ISO table mode), prescribe 3 axial, 3 coronal, 3 sagittal slices, untriggered free breathing.



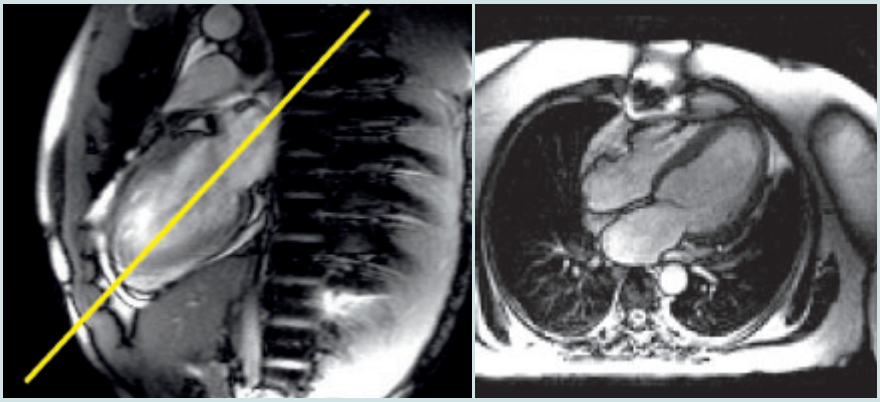
5. Axial Loc: prescribe 20 axial slices, untriggered free breathing.



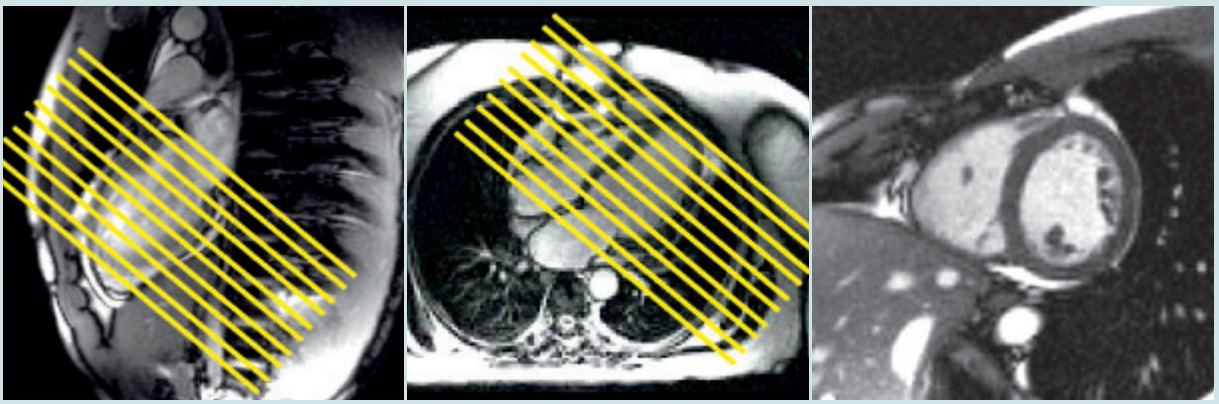
6. Two-Chamber Loc: prescribe 1 slice from axial view parallel to ventricular septum, bisect left ventricle through mitral valve and apex, untriggered free breathing.



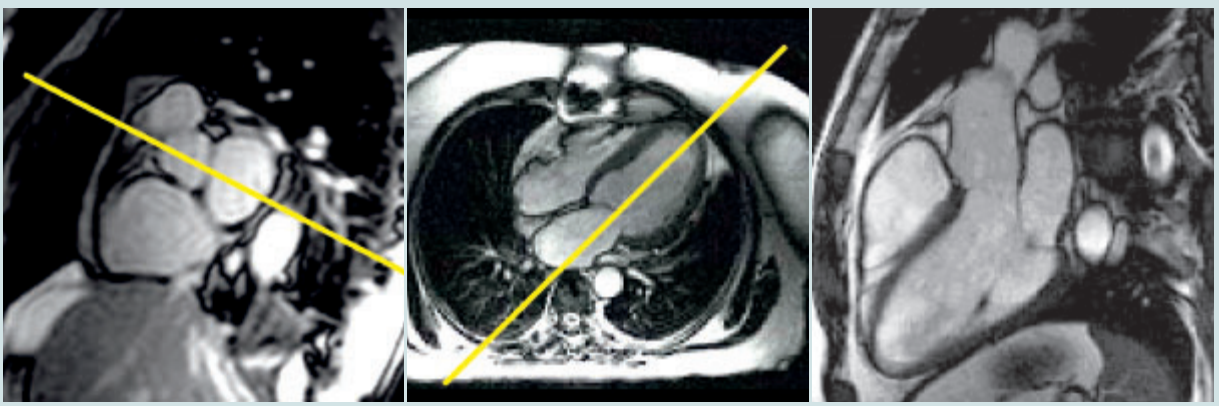
7. Four-Chamber Loc: prescribe 1 slice from two-chamber view, bisect left ventricle through mitral valve and apex, untriggered free breathing.



8. Short Axis Loc: prescribe 10 slices from two-chamber and four-chamber views, perpendicular to long axis of left ventricle, untriggered free breathing.



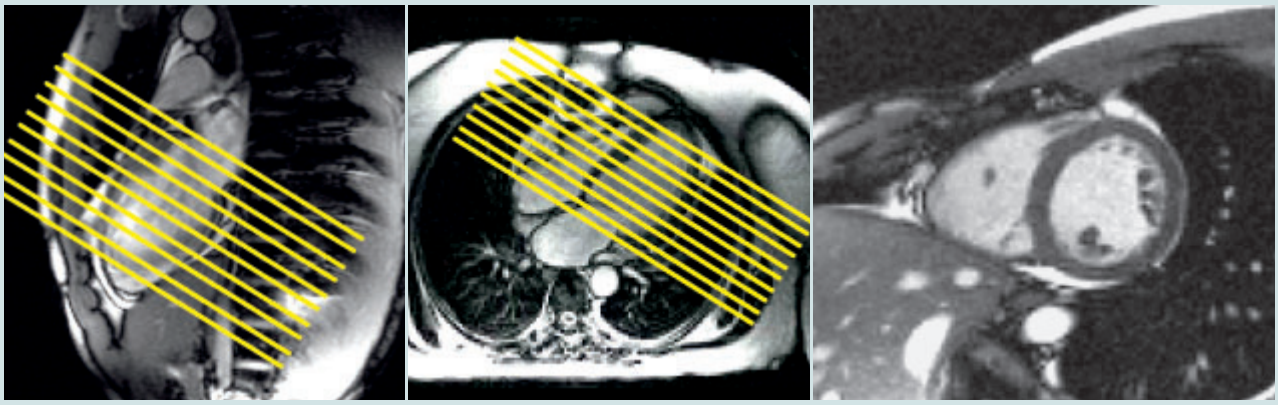
9. Three-Chamber Loc: prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, untriggered free breathing.



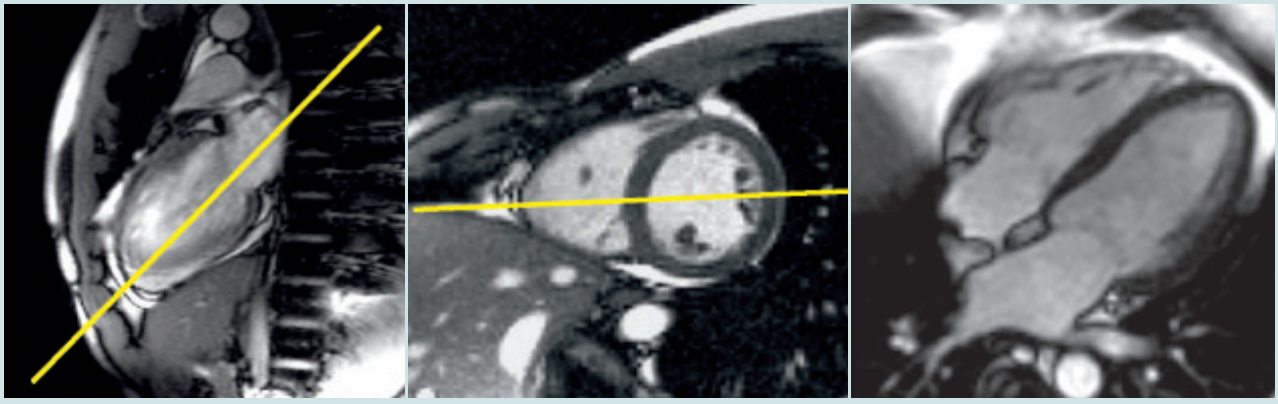
LV Function Module

Recommended – Breath Hold & Triggered

1. **Short Axis Cine:** prescribe 10 slices from two-chamber and four-chamber views, perpendicular to long axis of left ventricle, adjust gap to cover from mitral valve to apex, rotate FoV to avoid wrap, multiple breathholds, retrospective gating.

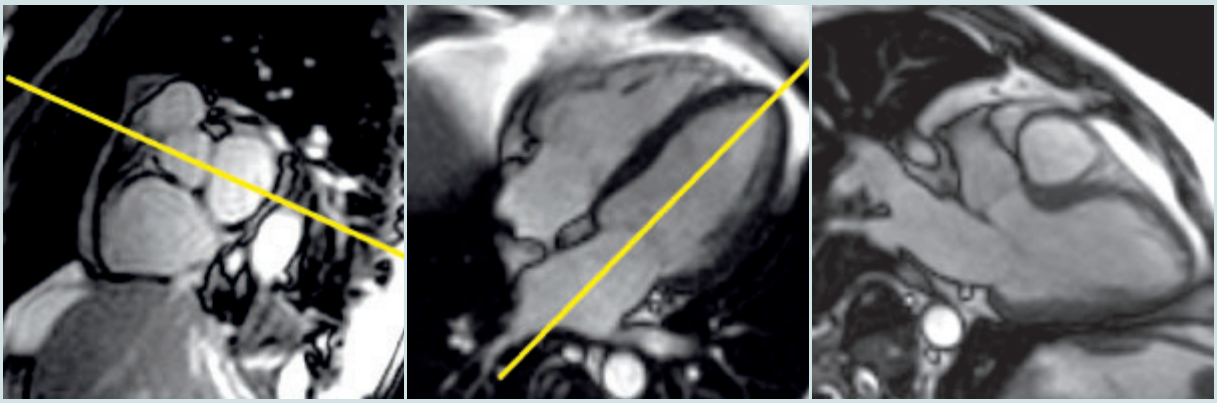


2. **Four-Chamber Cine:** prescribe 1 slice, bisect left ventricle through mitral valve and apex on a two-chamber view, bisect left and right ventricles on a short axis view, rotate FoV to avoid wrap, single breathhold, retrospective gating.



3. Two-Chamber Cine: prescribe 1 slice, parallel to ventricular septum on a short axis view, bisect left ventricle through mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, single breathhold, retrospective gating.

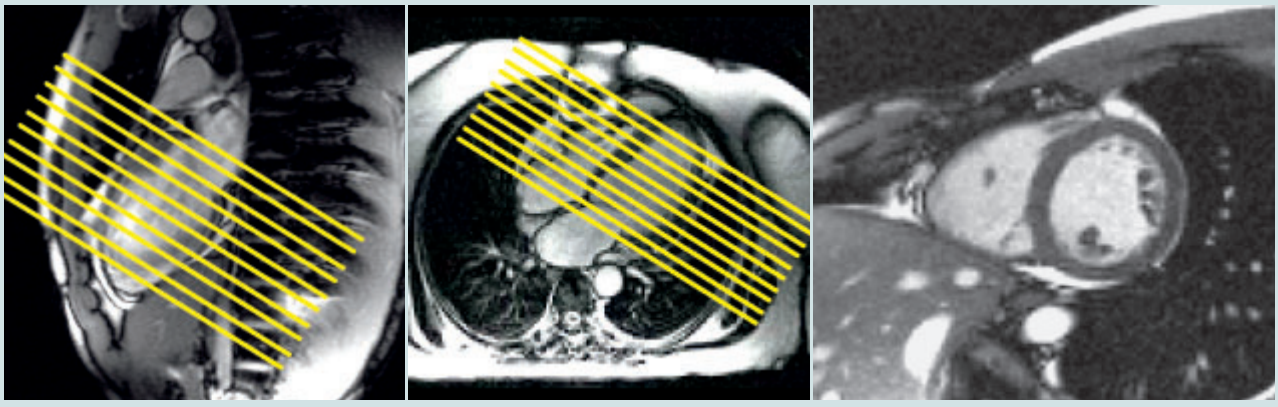
4. Three-Chamber Cine: prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, single breathhold, retrospective gating.



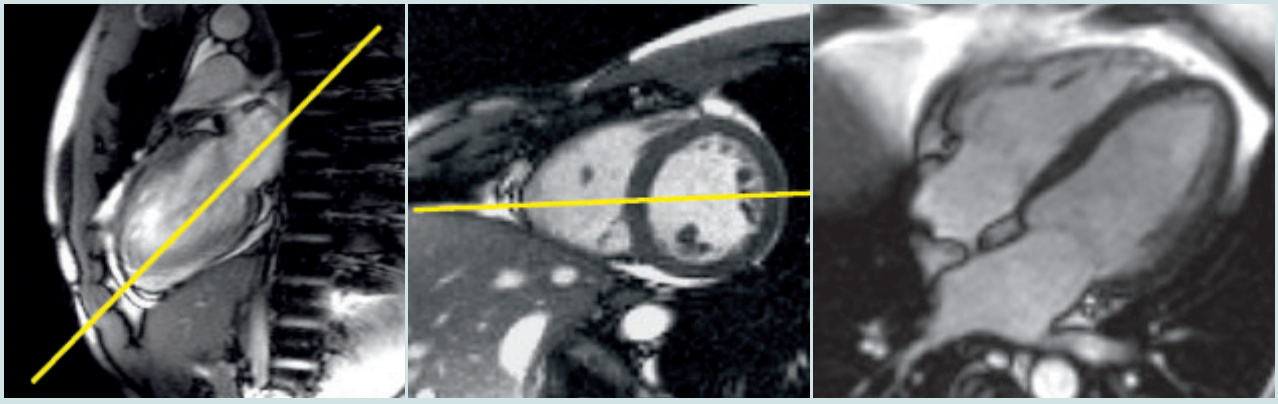
LV Function Module

Free Breathing & Triggered

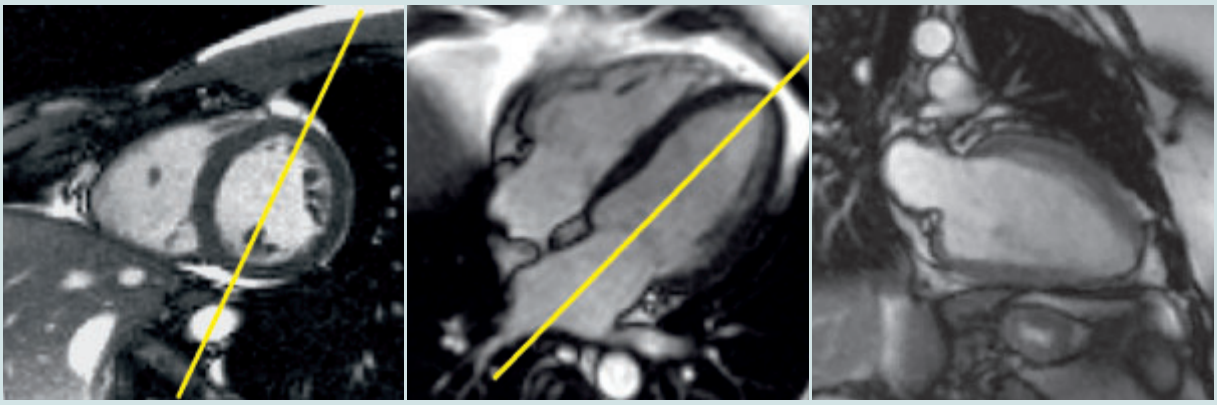
1. **Short Axis Cine:** prescribe 10 slices from two-chamber and four-chamber views, perpendicular to long axis of left ventricle, adjust gap to cover from mitral valve to apex, rotate FoV to avoid wrap, free breathing, retrospective gating.



2. **Four-Chamber Cine:** prescribe 1 slice, bisect left ventricle through mitral valve and apex on a two-chamber view, bisect left and right ventricles on a short axis view, rotate FoV to avoid wrap, free breathing, retrospective gating.



3. Two-Chamber Cine: prescribe 1 slice, parallel to ventricular septum on a short axis view, bisect left ventricle through mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, free breathing, retrospective gating.

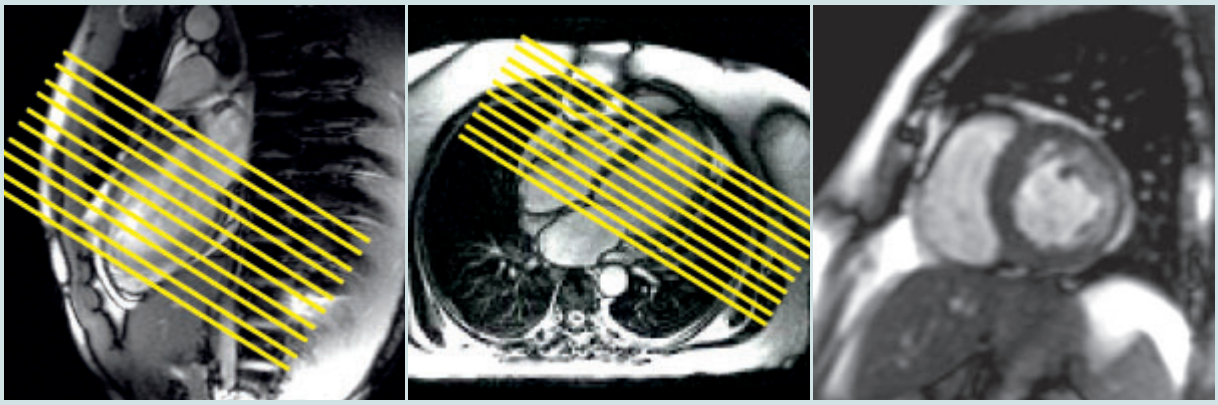


4. Three-Chamber Cine: prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, free breathing, retrospective gating.

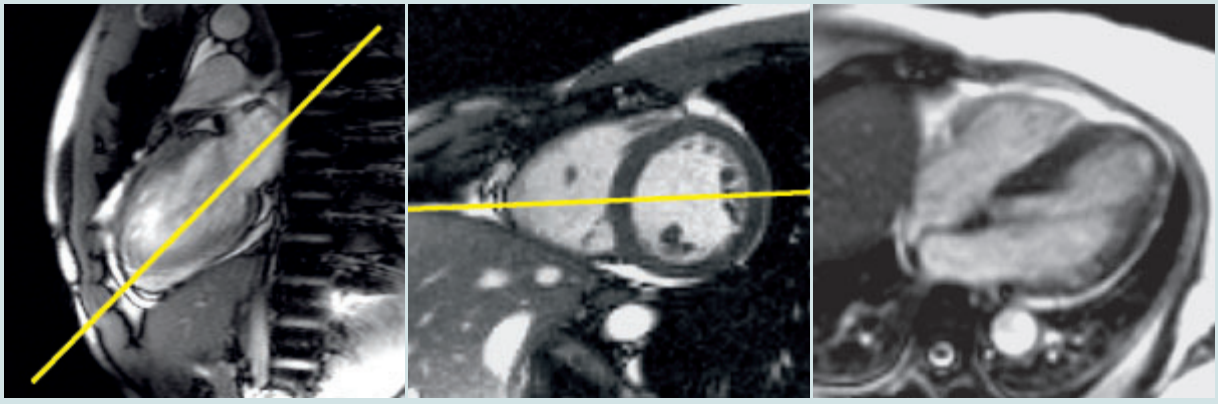
LV Function Module

Extreme Arrhythmia – Free Breathing & Non Triggered

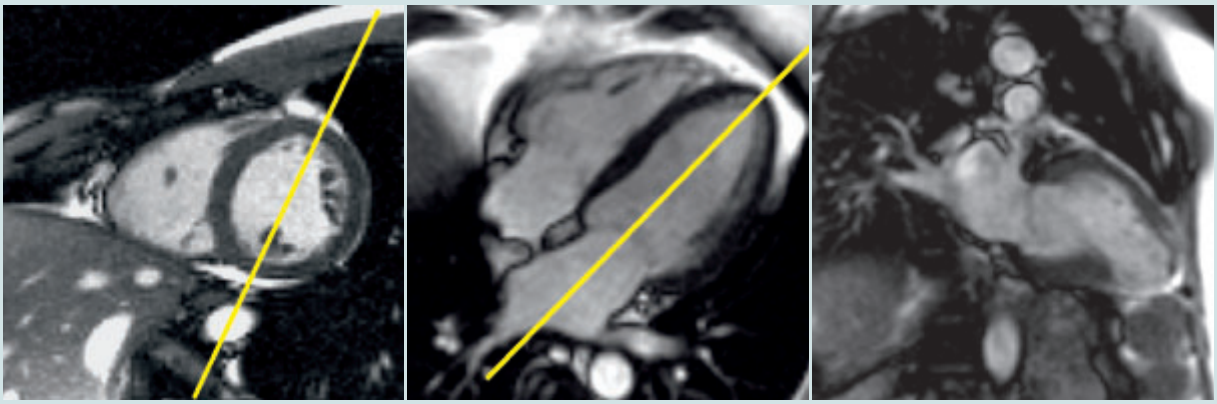
1. **Short Axis Cine Realtime:** prescribe 10 slices from two-chamber and four-chamber views, perpendicular to long axis of left ventricle, adjust gap to cover from mitral valve to apex, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



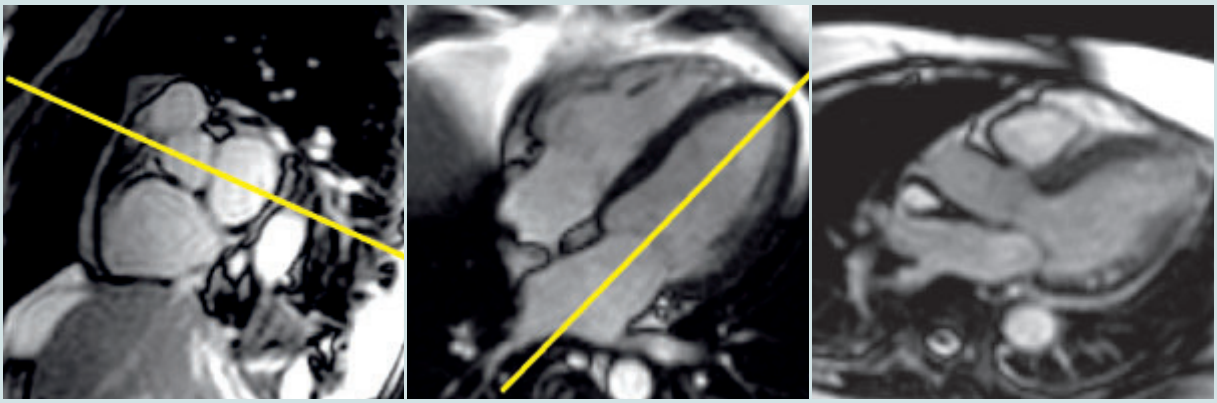
2. **Four-Chamber Cine Realtime:** prescribe 1 slice, bisect left ventricle through mitral valve and apex on a two-chamber view, bisect left and right ventricles on a short axis view, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



3. **Two-Chamber Cine Realtime:** prescribe 1 slice, parallel to ventricular septum on a short axis view, bisect left ventricle through mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



4. **Three-Chamber Cine Realtime:** prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.

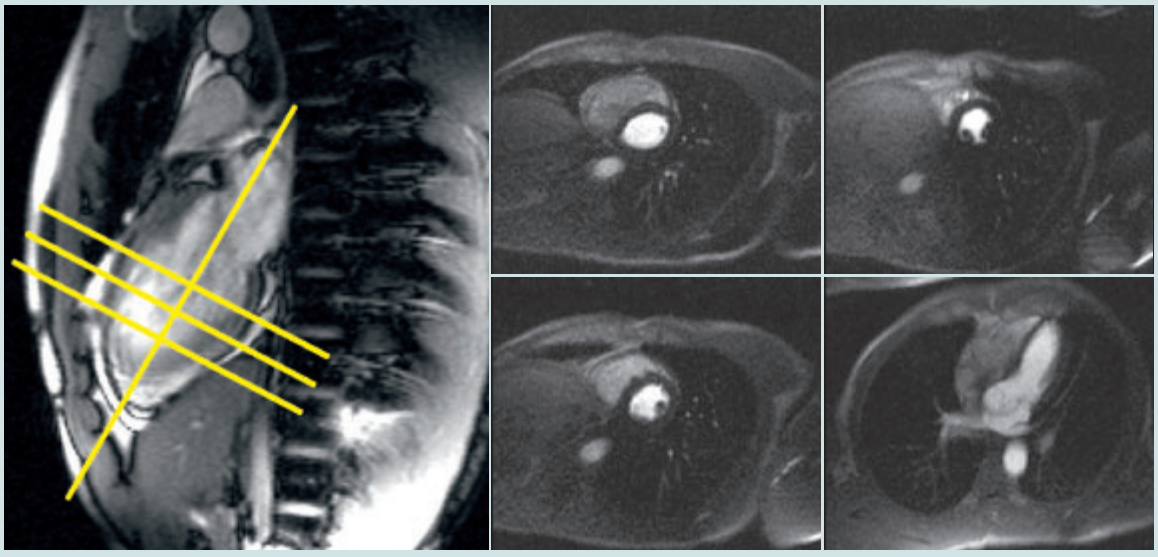


Dynamic Module

Recommended – Breath Hold & Triggered

1. **Dynamic Test:** saturation recovery segmented TurboFLASH, requires 3 short axis slices at base, mid, and apex levels, optional 1 long axis slice if R-R interval is long enough, rotate FoV to avoid wrap, trigger on every heartbeat, start breathhold during early phase of scan, only 5 measurements for test.

2. **Dynamic:** same as above except with 50 measurements.

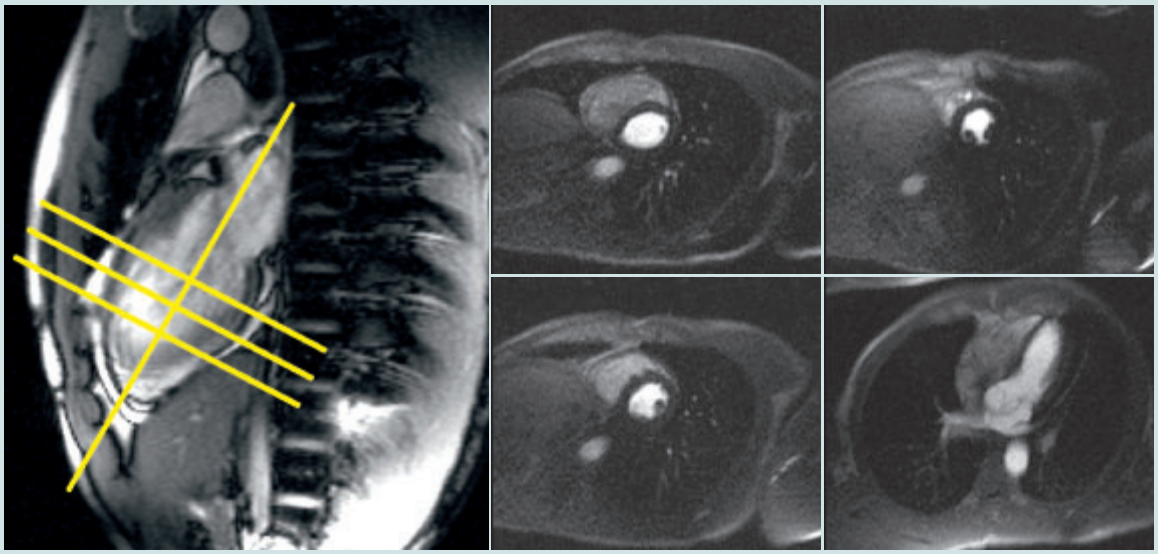


Dynamic Module

Free Breathing & Triggered

1. **Dynamic Test:** saturation recovery segmented TurboFLASH, requires 3 short axis slices at base, mid, and apex levels, optional 1 long axis slice if R-R interval is long enough, rotate FoV to avoid wrap, trigger on every heartbeat, free breathing, only 5 measurements for test.

2. **Dynamic:** same as above except with 50 measurements.

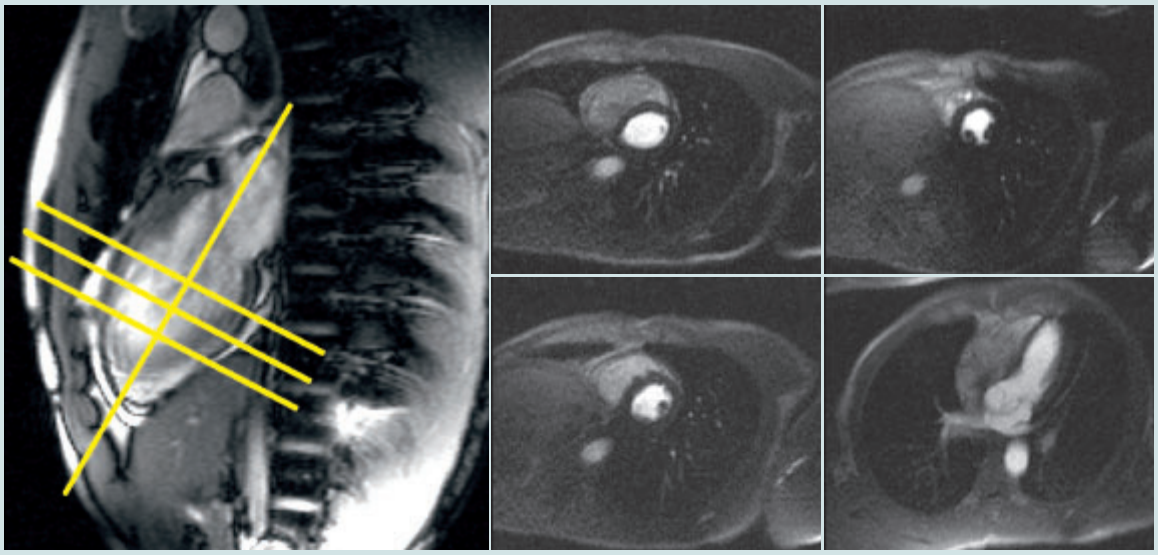


Dynamic Module

Extreme Arrhythmia – Free Breathing & Non Triggered

1. **Dynamic Test:** saturation recovery segmented TurboFLASH, requires 3 short axis slices at base, mid, and apex levels, optional 1 long axis slice, rotate FoV to avoid wrap, untriggered free breathing, only 5 measurements for test.

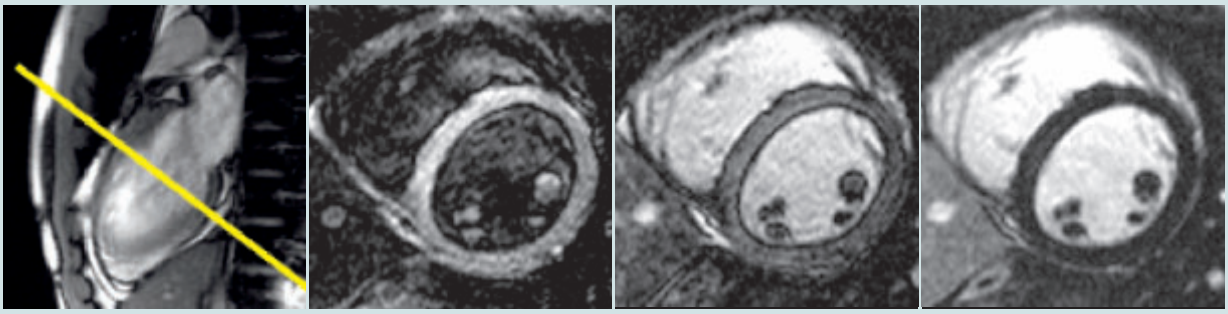
2. **Dynamic:** same as above except with 50 measurements.



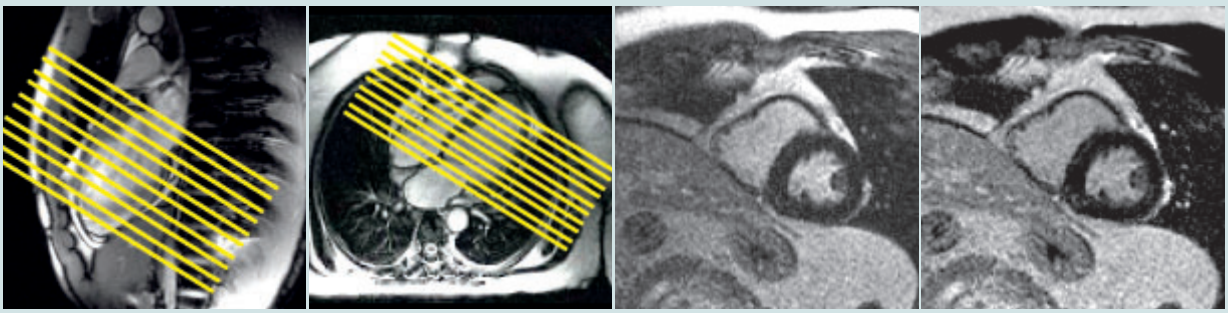
Delayed Module

Recommended – Breath Hold & Triggered

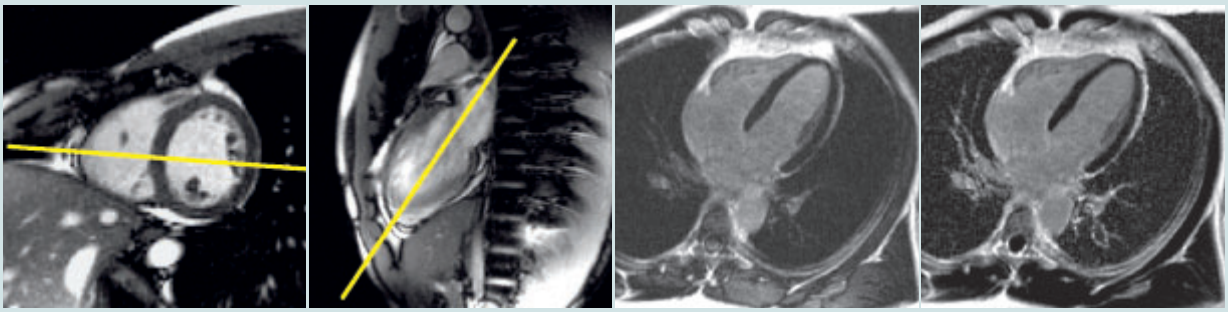
1. **TI Scout*:** determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for optimal acquisition window.



2. **Short Axis Delayed:** prescribe 10 slices, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, adjust TI for nulling of normal myocardium, rotate FoV to avoid wrap, multiple breath-holds, trigger on every second heartbeat, capture cycle for diastolic gating.

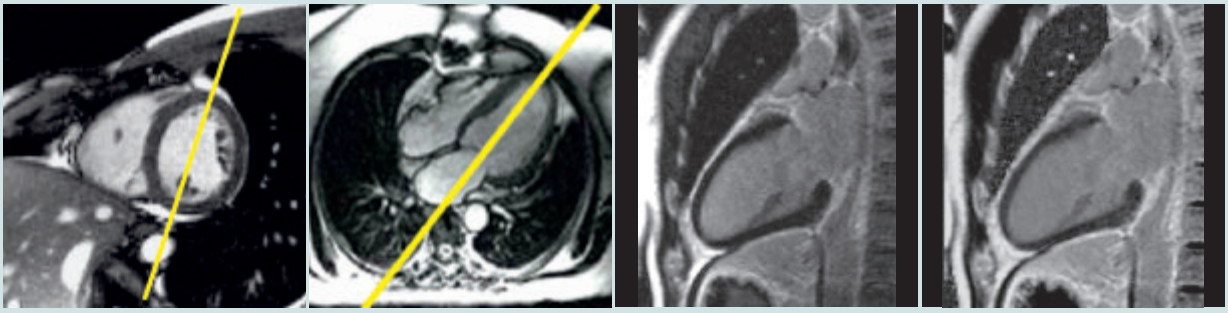


3. **Four-Chamber Delayed:** prescribe 1 slice, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, adjust TI for nulling of normal myocardium, rotate FoV to avoid wrap, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.



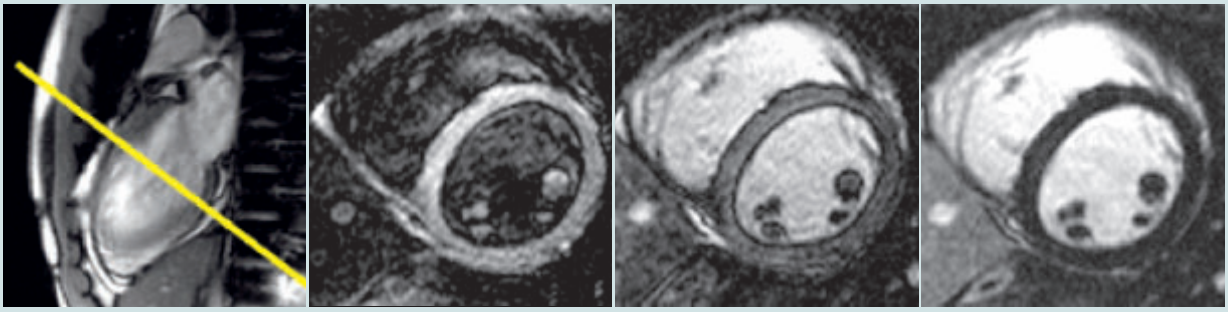
* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

4. Two-Chamber Delayed: prescribe 1 slice, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, adjust TI for nulling of normal myocardium*, rotate FoV to avoid wrap, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.

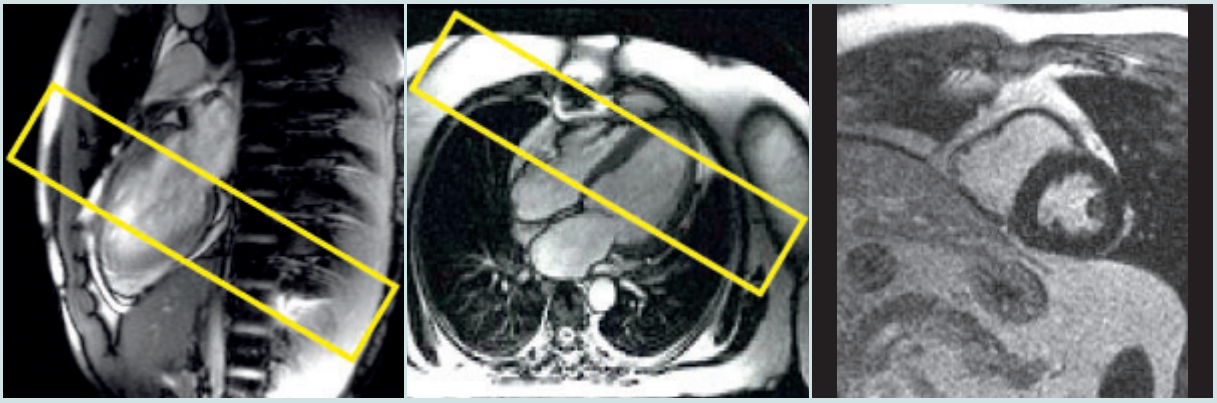


5. ----------Optional_3D

6. TI Scout: determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, single breath-hold, trigger on every heartbeat, capture cycle for optimal acquisition window.



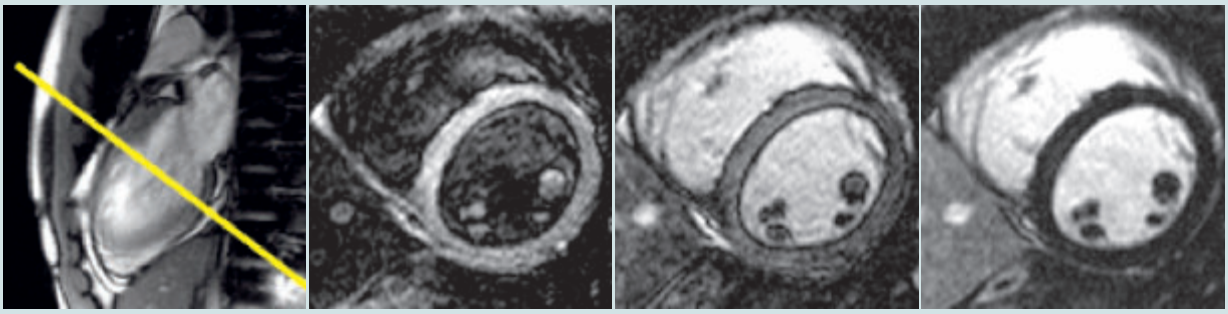
7. Short Axis Delayed 3D: inversion recovery TurboFLASH 3D technique, adjust TI for nulling of normal myocardium, rotate FoV to avoid wrap, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



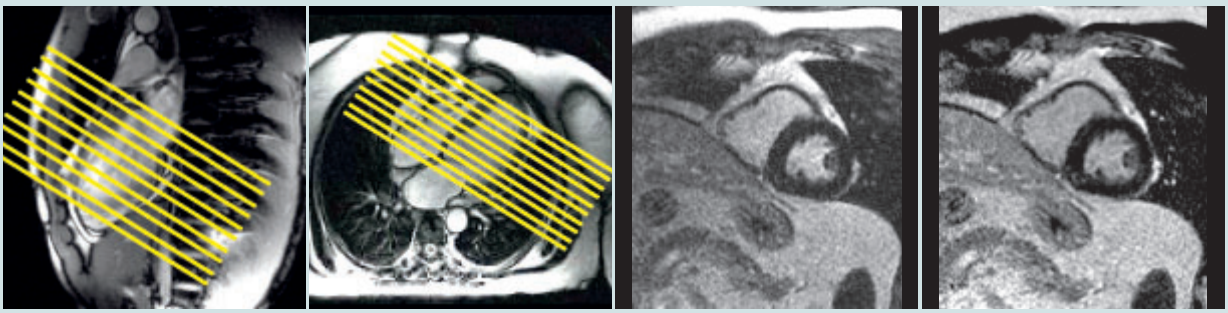
Delayed Module

Free Breathing & Triggered

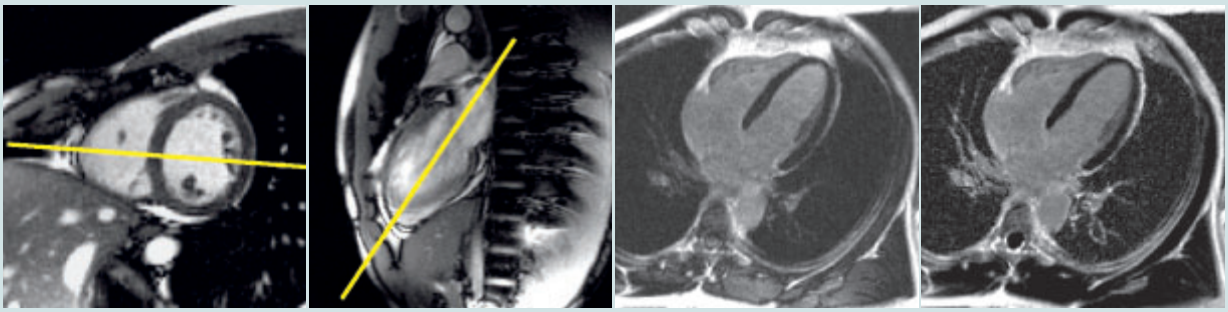
1. **TI Scout*:** determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for optimal acquisition window.



2. **Short Axis Delayed:** prescribe 10 slices, single shot phase sensitive inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.

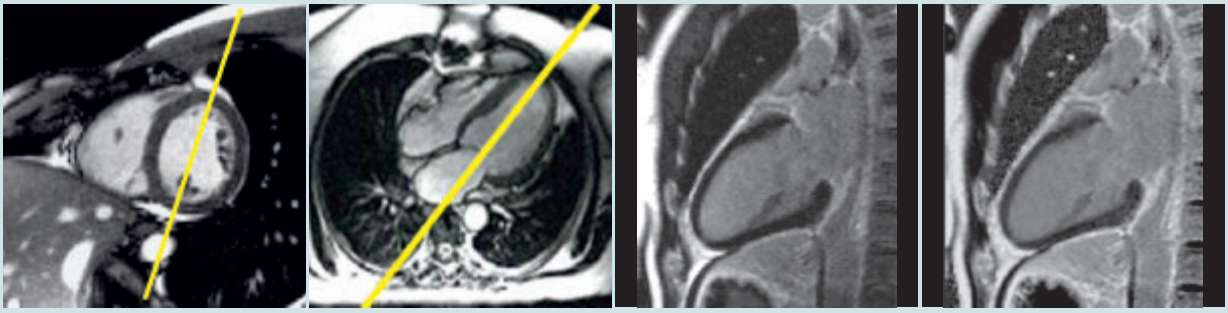


3. **Four-Chamber Delayed:** prescribe 1 slice, single shot phase sensitive inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



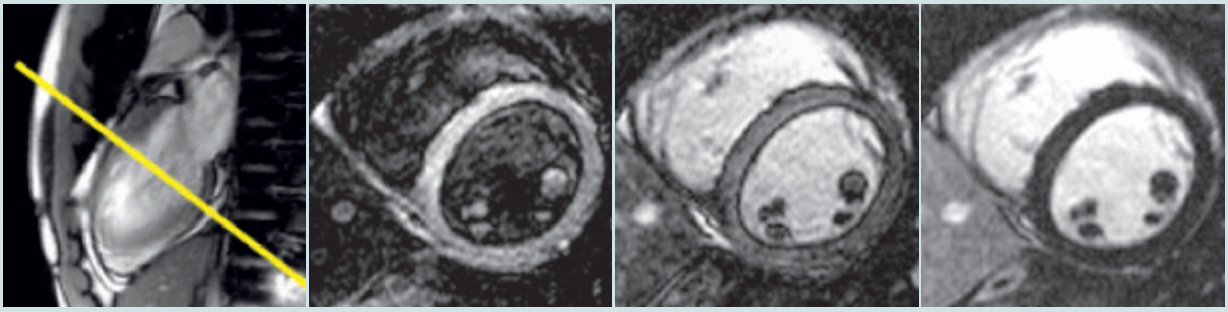
* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

4. Two-Chamber Delayed: prescribe 1 slice, single shot phase sensitive inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.

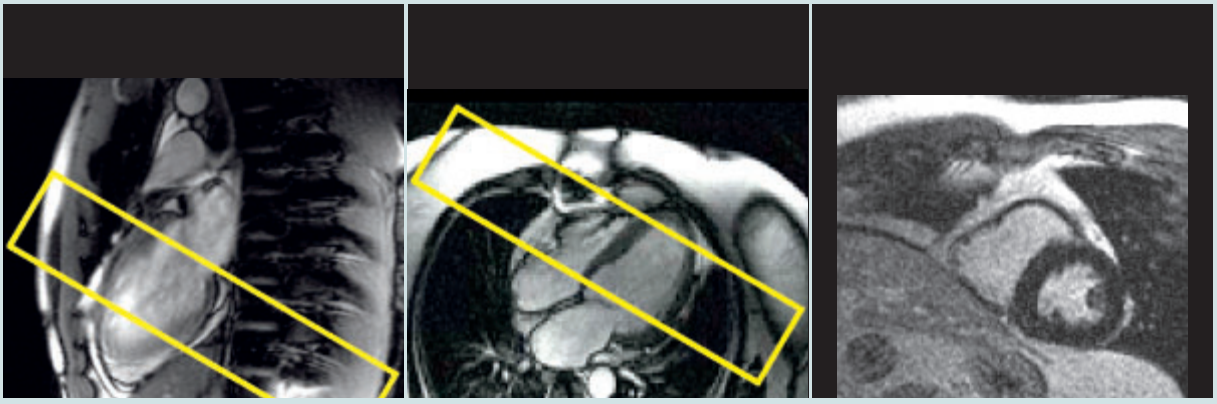


5. ----------Optional_3D

6. TI Scout: determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, free breathing, trigger on every heartbeat, capture cycle for optimal acquisition window.



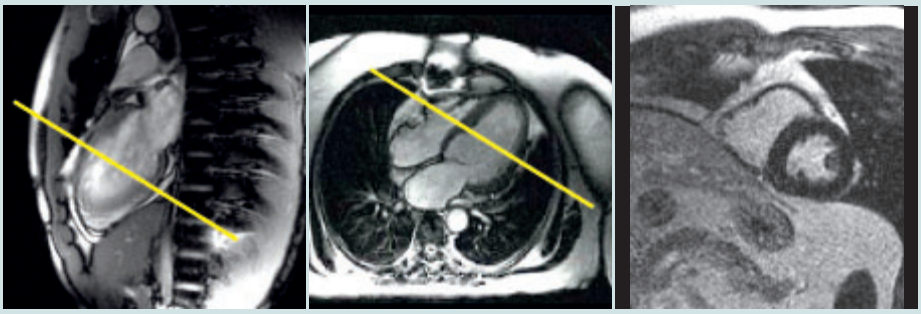
7. Short Axis Delayed 3D: inversion recovery TurboFLASH 3D technique, adjust TI for nulling of normal myocardium, rotate FoV to avoid wrap, free breathing with navigator, trigger on every heartbeat, capture cycle for diastolic gating, test with respiratory scout mode ON to adjust acceptance position, repeat with respiratory scout mode OFF to acquire images.



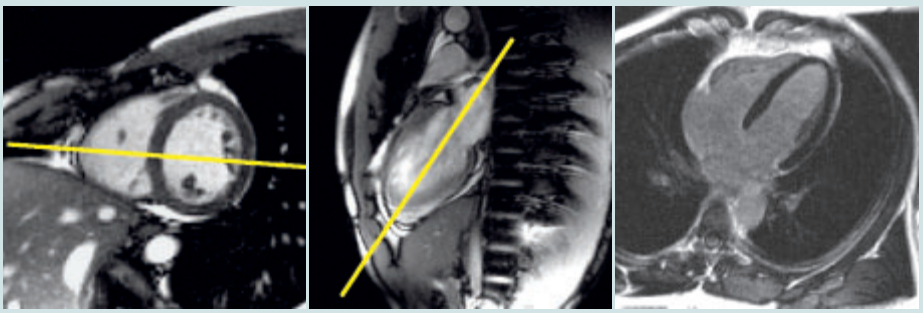
Delayed Module

Extreme Arrhythmia – Free Breathing & Non Triggered

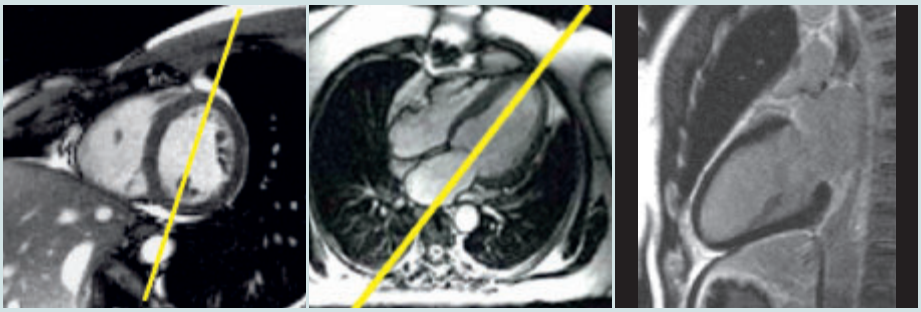
1. **Short Axis Delayed:** prescribe 1 slice, single shot inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium*, rotate FoV to avoid wrap, untriggered free breathing, repeat as needed for coverage.



2. **Four-Chamber Delayed:** prescribe 1 slice, single shot inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium*, rotate FoV to avoid wrap, untriggered free breathing.



3. **Two-Chamber Delayed:** prescribe 1 slice, single shot inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium*, rotate FoV to avoid wrap, untriggered free breathing

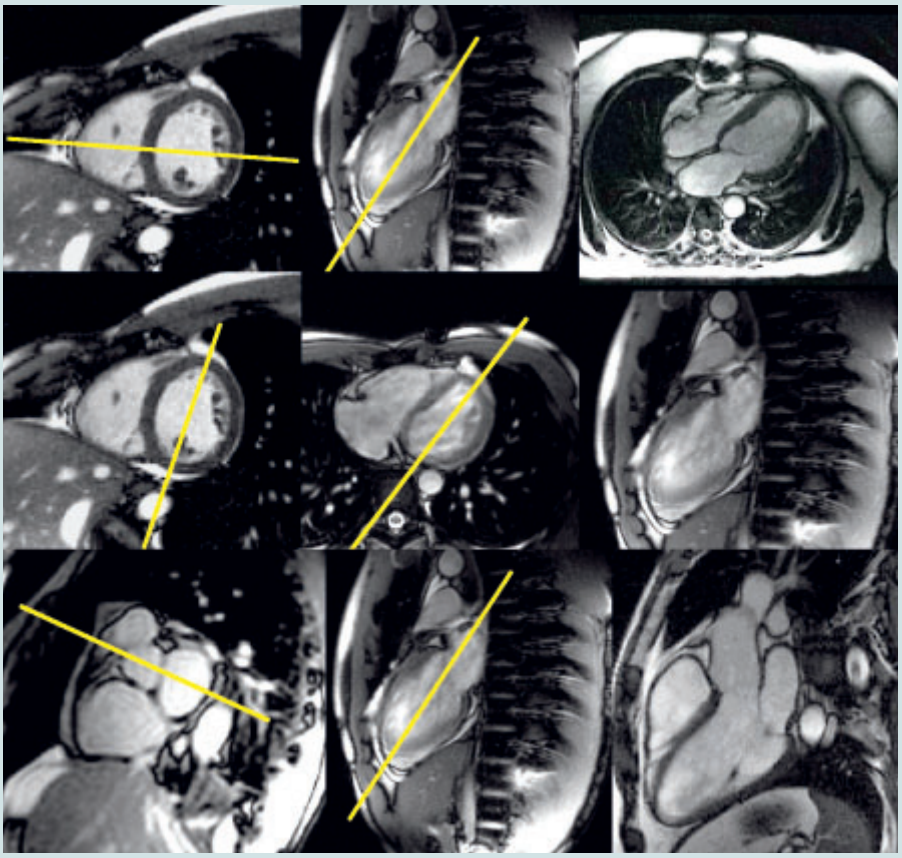


* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

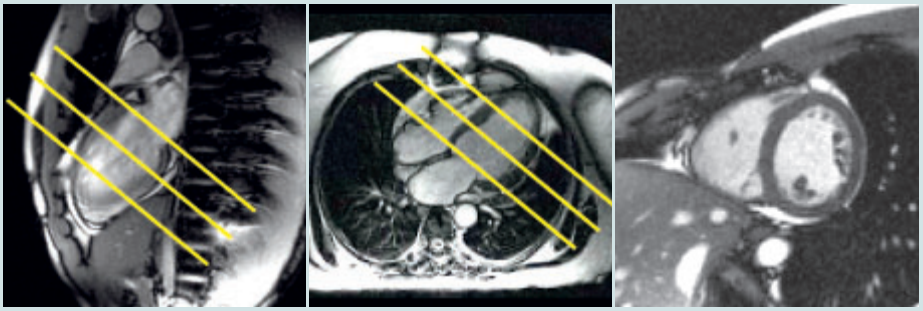
Dobutamine Stress Module

Recommended – Breath Hold & Triggered

1. **Long Axis Rest/Stress:** prescribe 2-, 3-, and 4-chamber long axis slices as 3 separate slice groups, rotate FoV to avoid wrap, single breathhold, retrospective gating



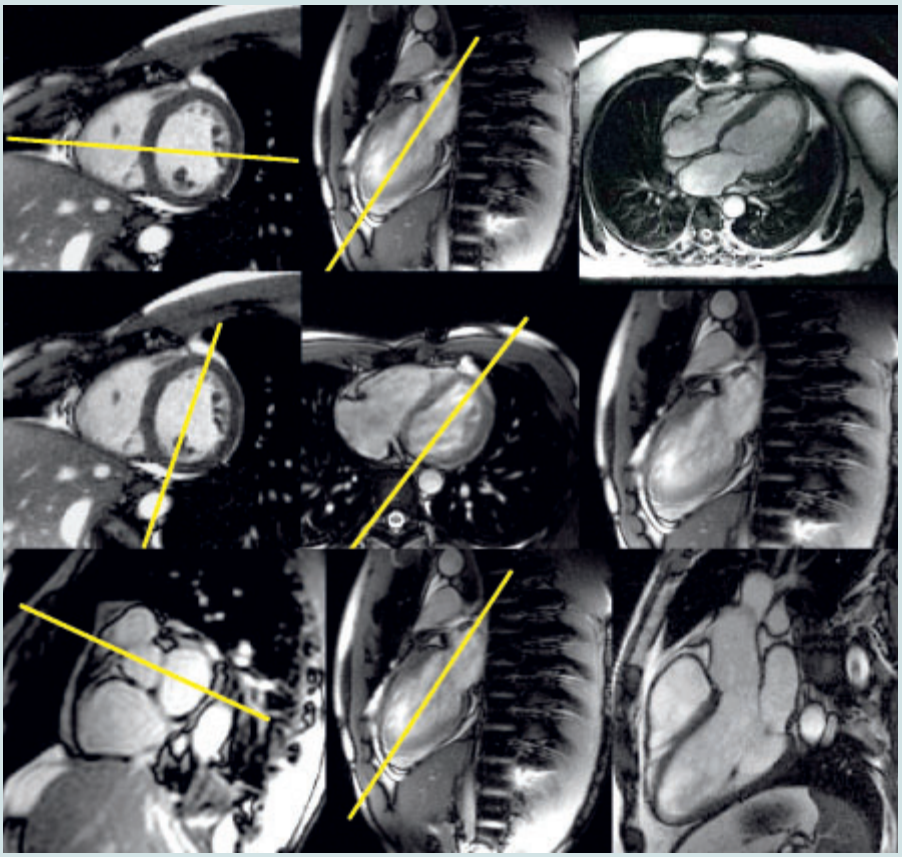
2. **Short Axis Rest/Stress:** prescribe 3 short axis slices in a single slice group, adjust gap to cover base, mid, apex levels of left ventricle, rotate FoV to avoid wrap, single breathhold, retrospective gating.



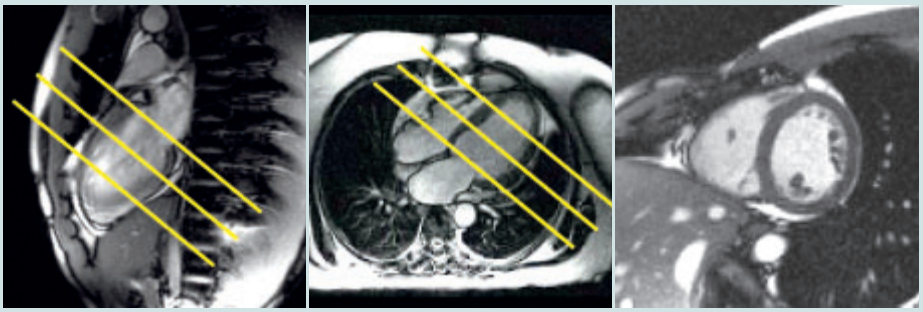
Dobutamine Stress Module

Free Breathing & Triggered

1. **Long Axis Rest/Stress:** prescribe 2-, 3-, and 4-chamber long axis slices as 3 separate slice groups, rotate FoV to avoid wrap, free breathing, retrospective gating.



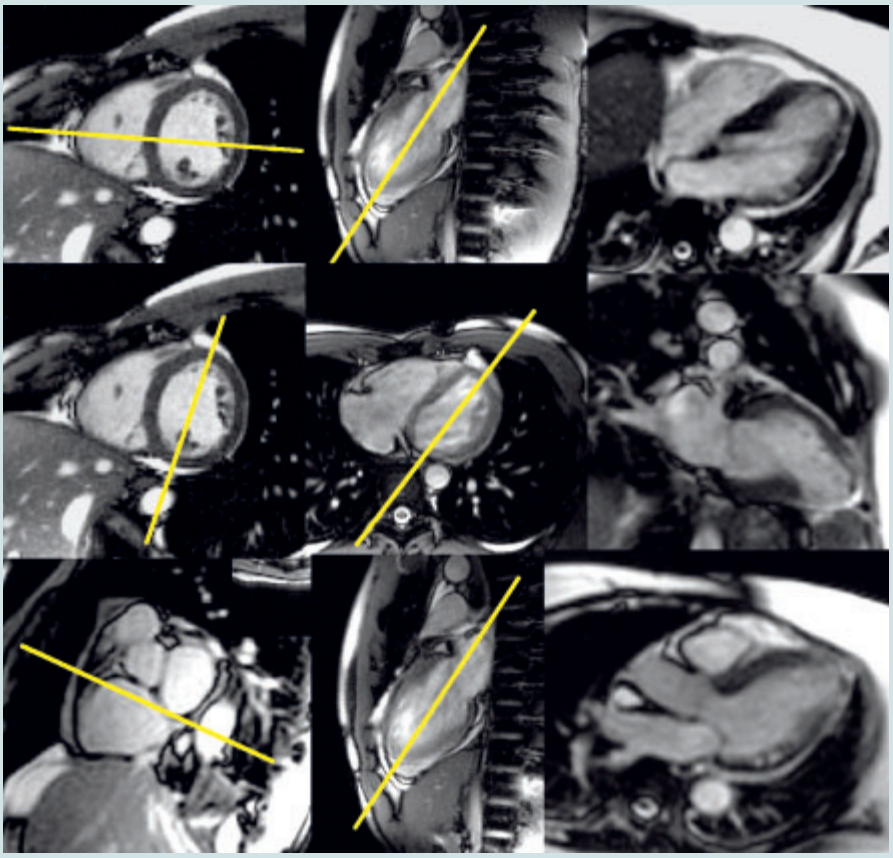
2. **Short Axis Rest/Stress:** prescribe 3 short axis slices in a single slice group, adjust gap to cover base, mid, apex levels of left ventricle, rotate FoV to avoid wrap, free breathing, retrospective gating.



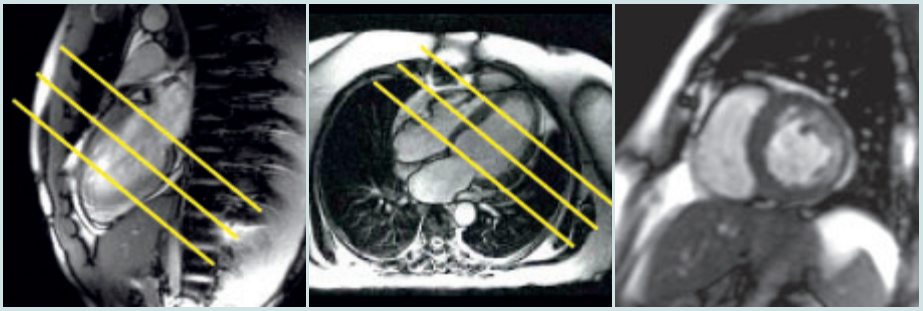
Dobutamine Stress Module

Extreme Arrhythmia – Free Breathing & Non Triggered

1. **Long Axis Rest/Stress:** prescribe 2-, 3-, and 4-chamber long axis slices as 3 separate slice groups, rotate FoV to avoid wrap, untriggered free breathing, realtime cine scans for 3 seconds per slice.



2. **Short Axis Rest/Stress:** prescribe 3 short axis slices in a single slice group, adjust gap to cover base, mid, apex levels of left ventricle, rotate FoV to avoid wrap, untriggered free breathing, realtime cine scans for 3 seconds per slice.



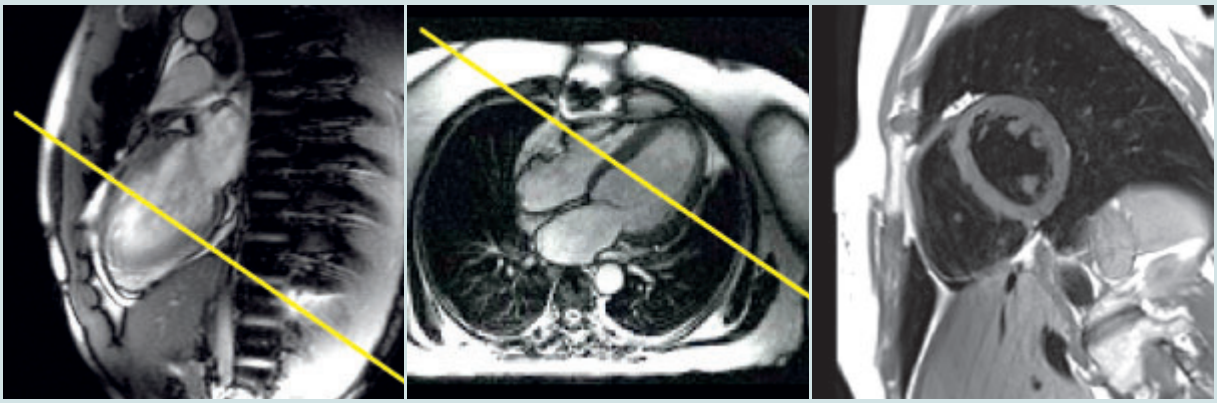
Acute Myocardial Infarct

Recommended – Breath Hold & Triggered

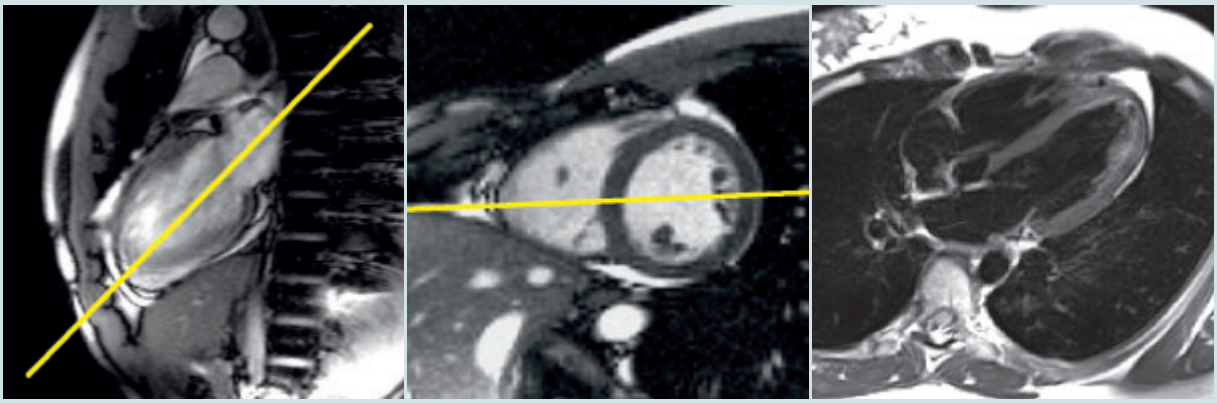
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

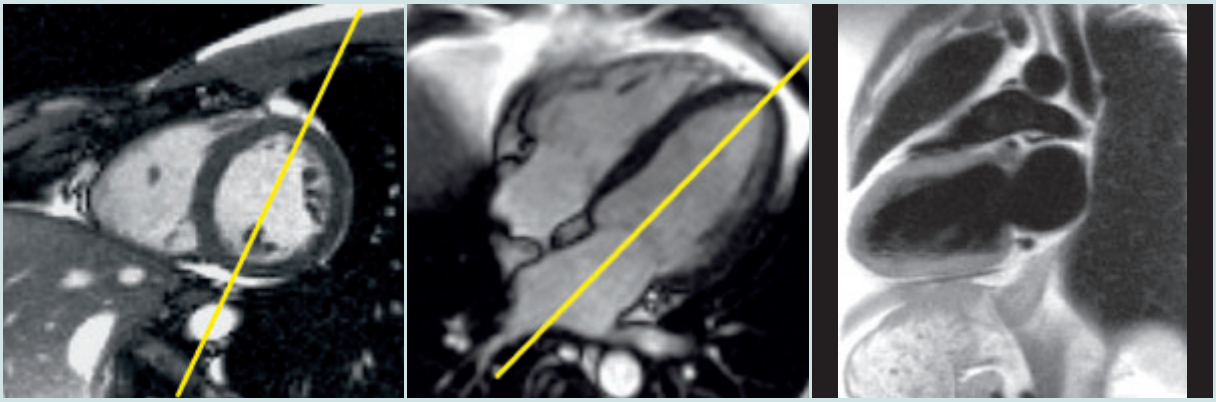
3. OPT Short Axis DB T2: optional, prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



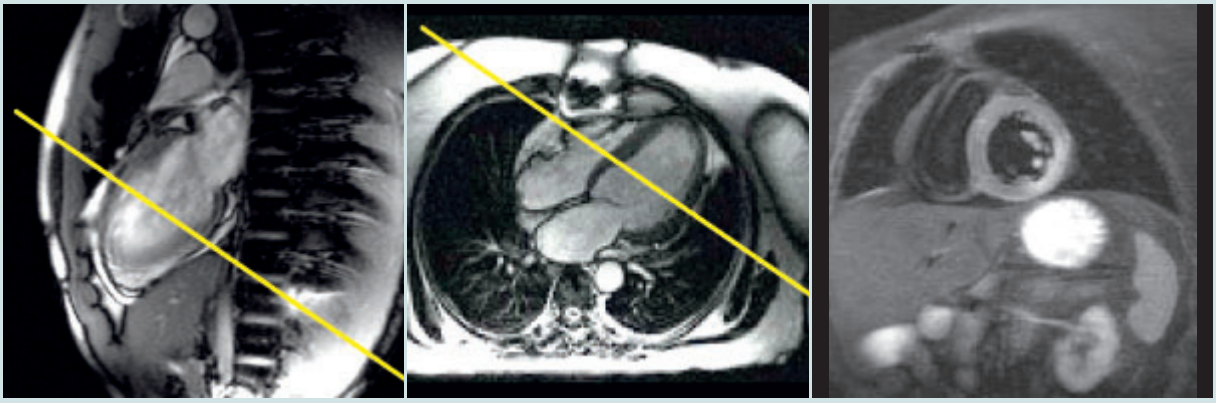
4. OPT Four-Chamber DB T2: optional, prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



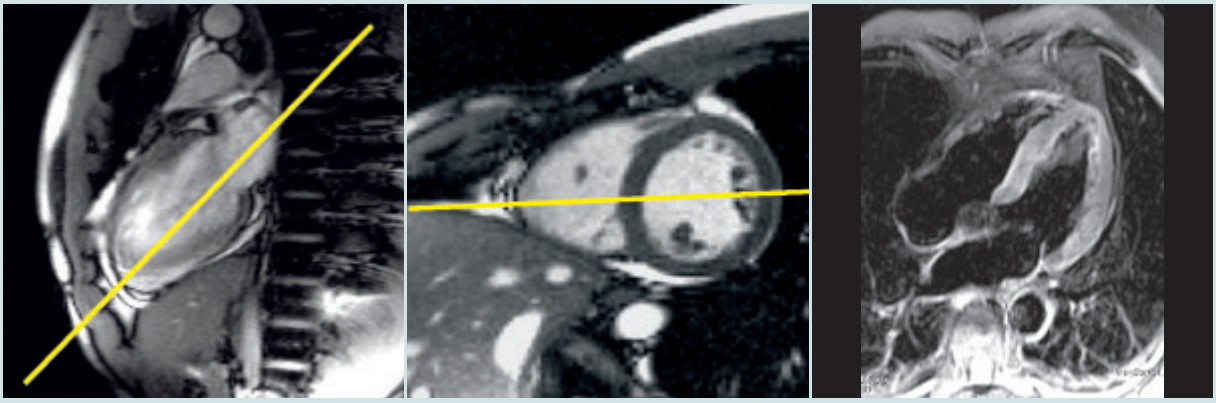
5. OPT Two-Chamber DB T2: optional, prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



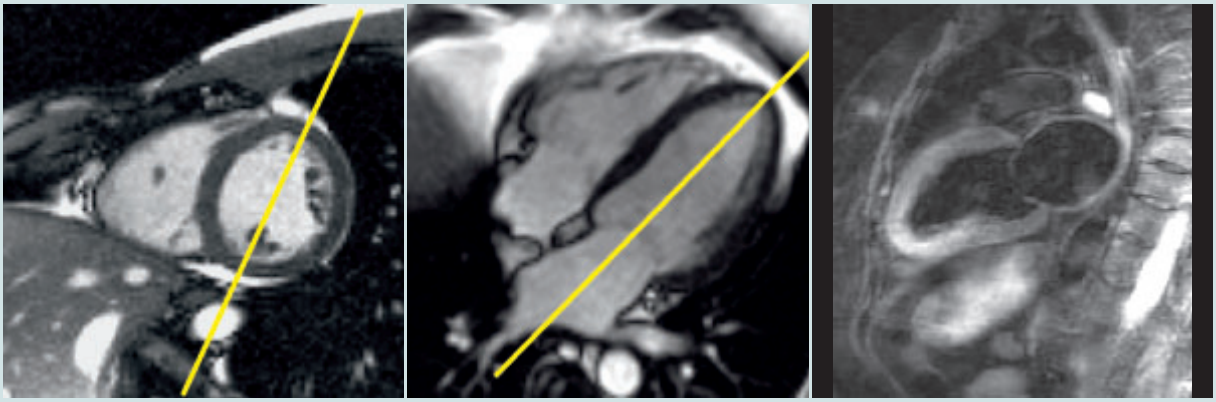
6. OPT Short Axis DB STIR: optional prescribe 1 slice, segmented DarkBlood STIR, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



7. OPT Four-Chamber DB STIR: optional, prescribe 1 slice, segmented DarkBlood STIR, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.

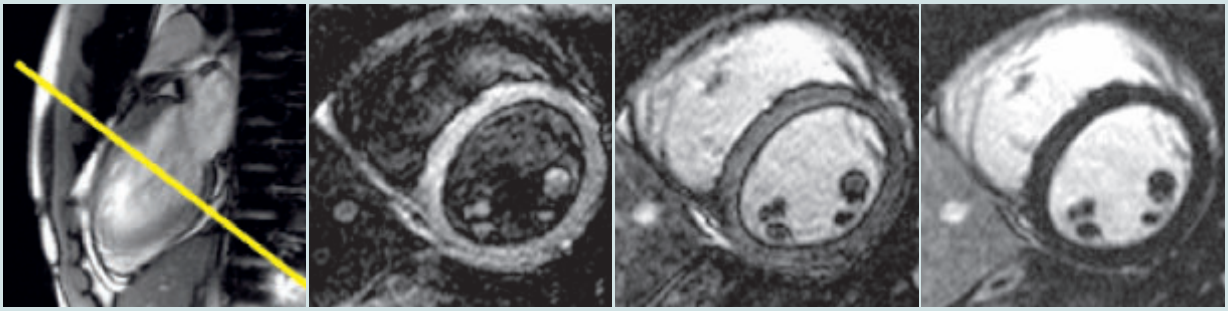


8. OPT Two-Chamber DB STIR: optional, prescribe 1 slice, segmented DarkBlood STIR, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.

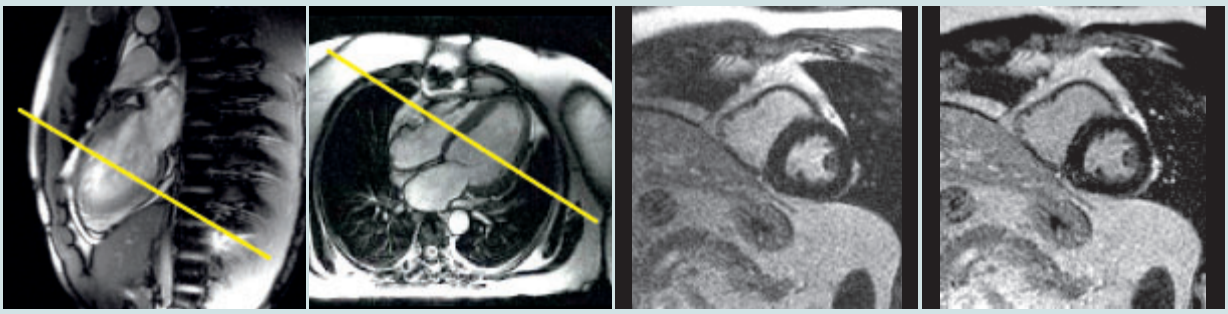


9. Dynamic Module (p. 19)

10. OPT TI Scout*: optional, determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for optimal acquisition window.

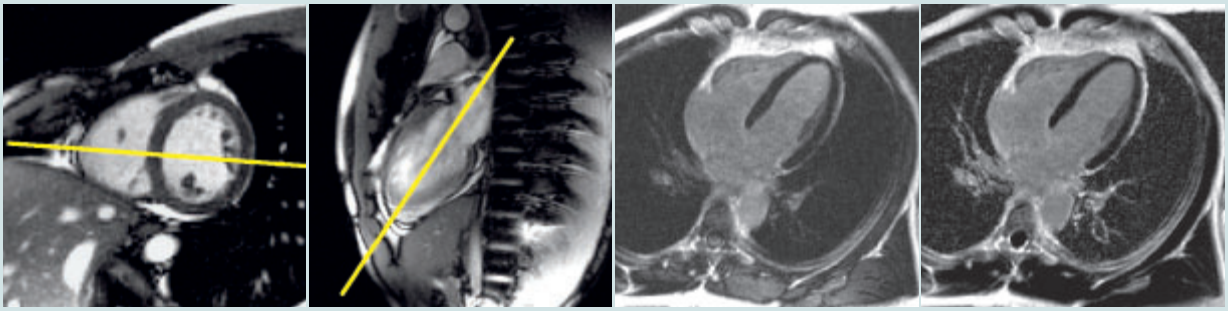


11. OPT Short Axis Early: optional, prescribe 1 slice, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.

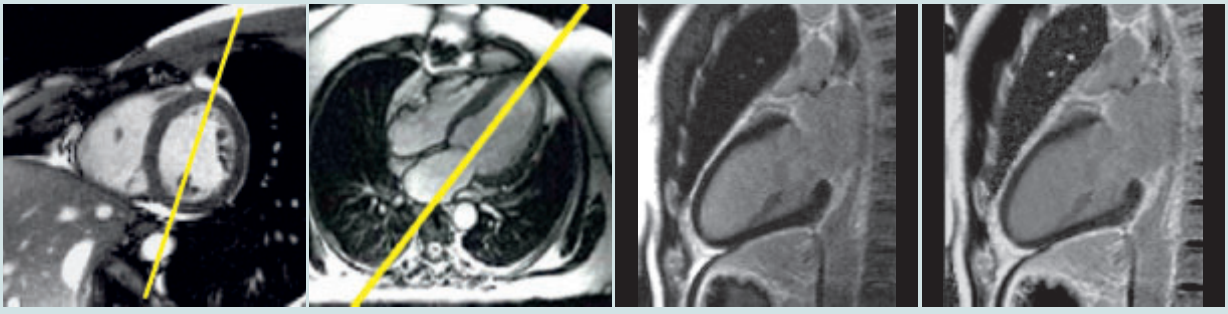


* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

12. OPT Four-Chamber Early: optional, prescribe 1 slice, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



13. OPT Two-Chamber Early: optional, prescribe 1 slice, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



14. Delayed Module (p. 22)

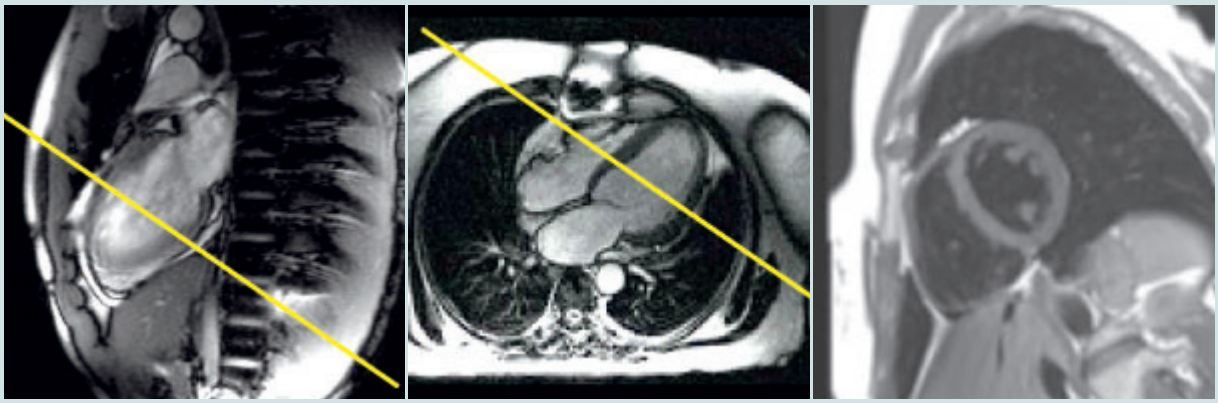
Acute Myocardial Infarct

Free Breathing & Triggered

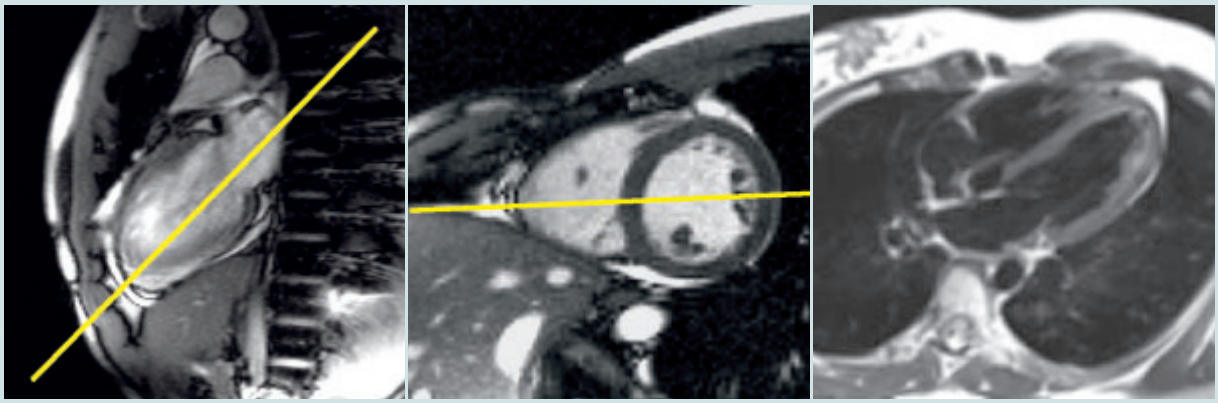
1. Localizers Module (p. 8)

2. LV Function Module (p. 15)

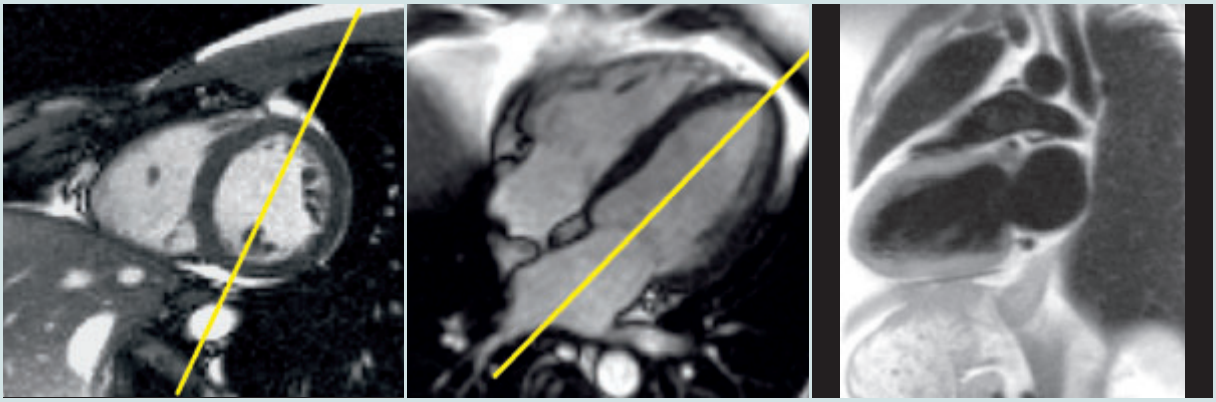
3. OPT Short Axis DB HASTE T2: optional, prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



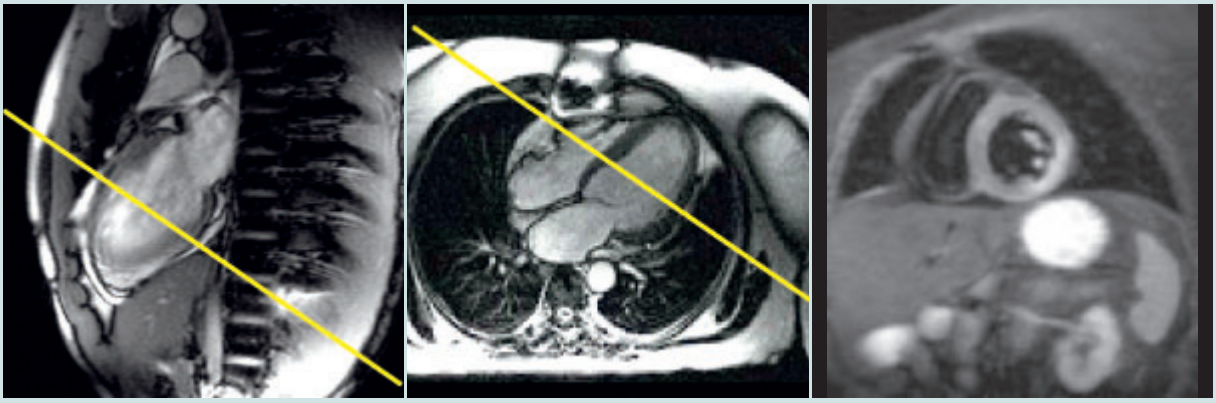
4. OPT Four-Chamber DB HASTE T2: optional, prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



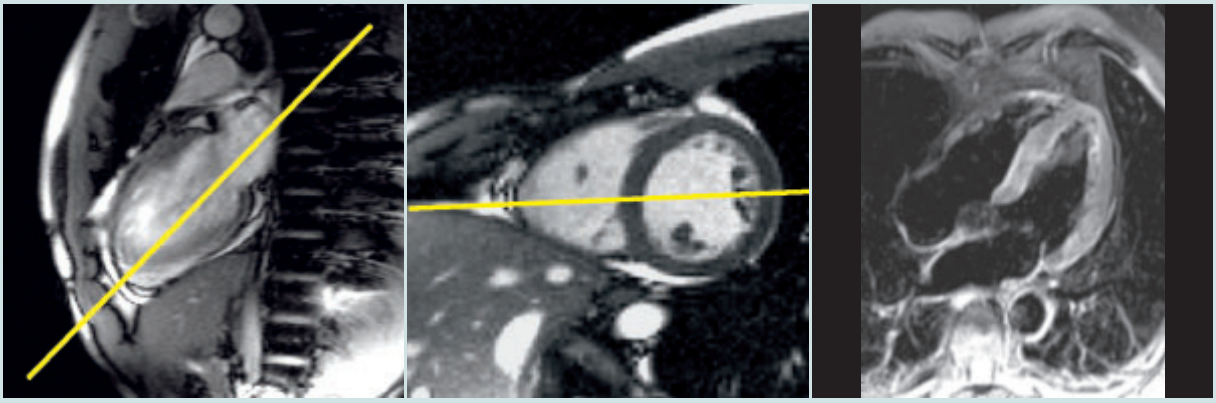
5. OPT Two-Chamber DB HASTE T2: optional, prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



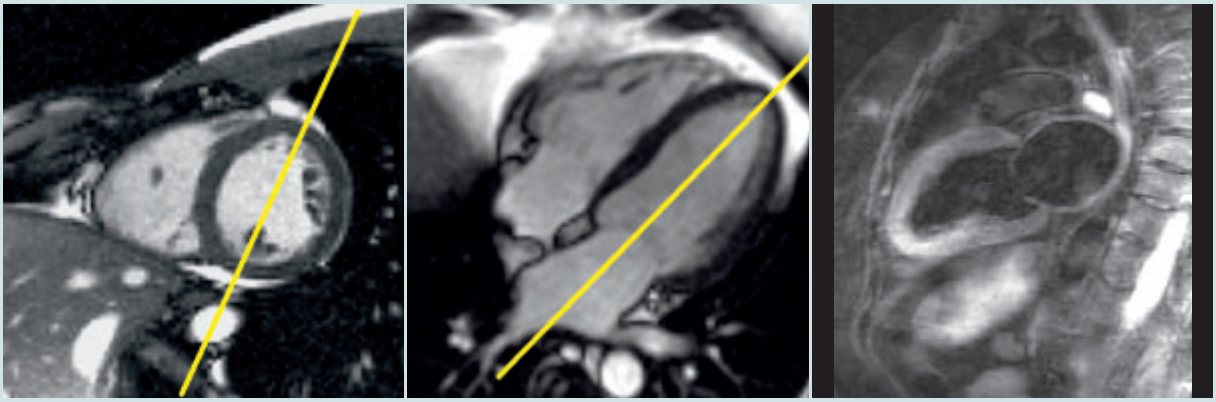
6. OPT Short Axis DB HASTE STIR: optional, prescribe 1 slice, DarkBlood HASTE STIR, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



7. OPT Four-Chamber DB HASTE STIR: optional, prescribe 1 slice, DarkBlood HASTE STIR, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.

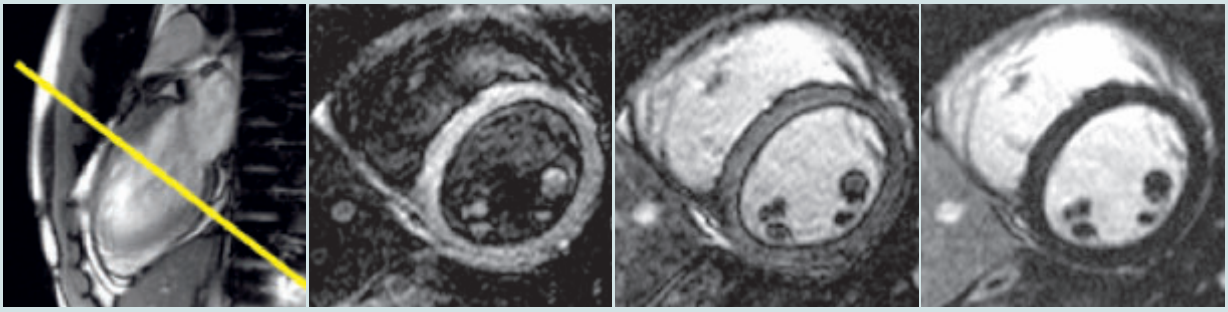


8. OPT Two-Chamber DB HASTE STIR: optional, prescribe 1 slice, DarkBlood HASTE STIR, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.

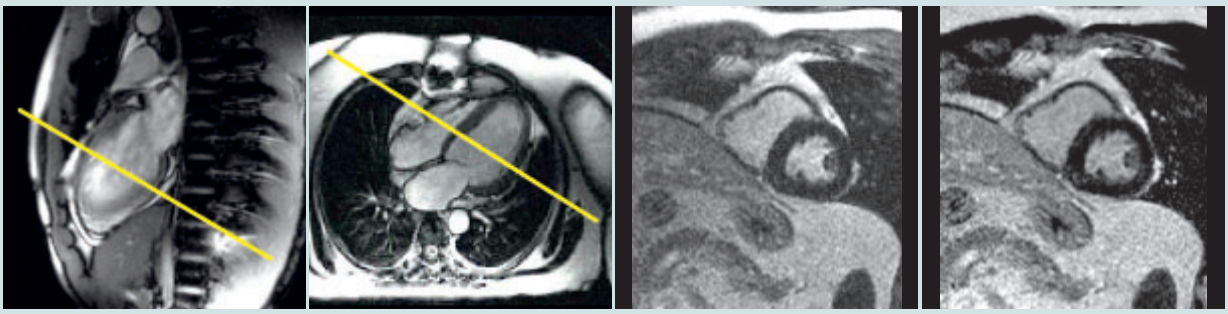


9. Dynamic Module (p. 20)

10. OPT TI Scout*: optional, determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for optimal acquisition window.

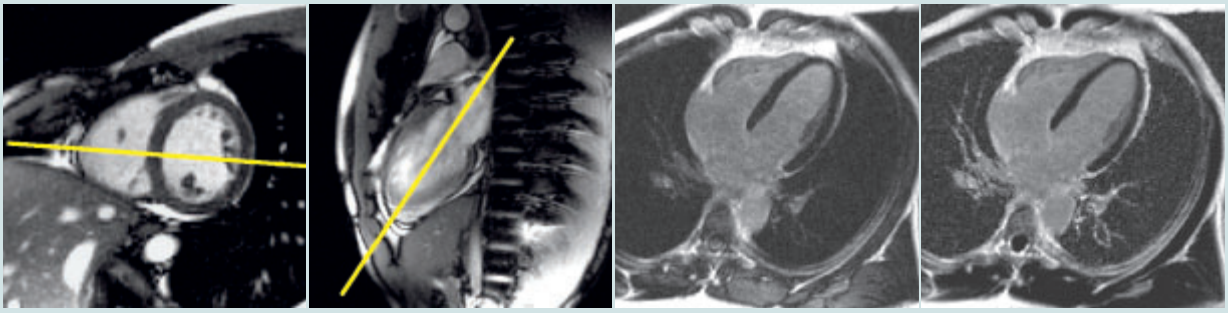


11. OPT Short Axis Early: optional, prescribe 1 slice, single shot phase sensitive inversion recovery TrueFISP technique, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.

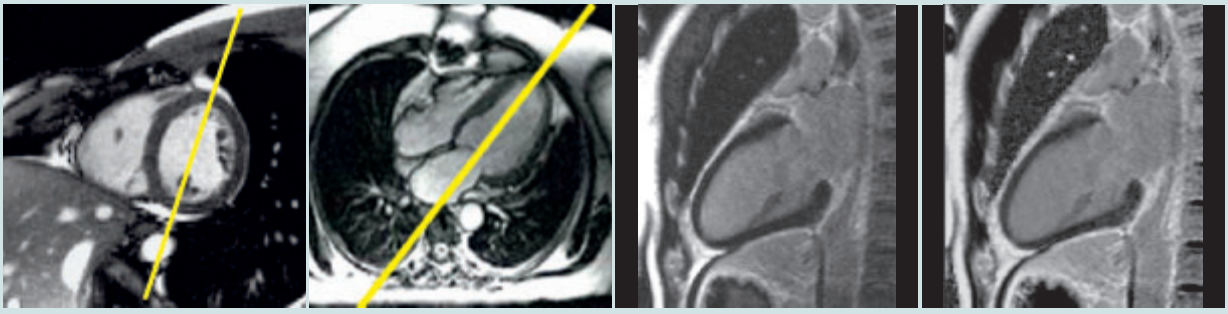


* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

12. **OPT Four-Chamber Early:** optional, prescribe 1 slice, single shot phase sensitive inversion recovery TrueFISP technique, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



13. **OPT Two-Chamber Early:** optional, prescribe 1 slice, single shot phase sensitive inversion recovery TrueFISP technique, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



14. **Delayed Module (p. 24)**

Acute Myocardial Infarct

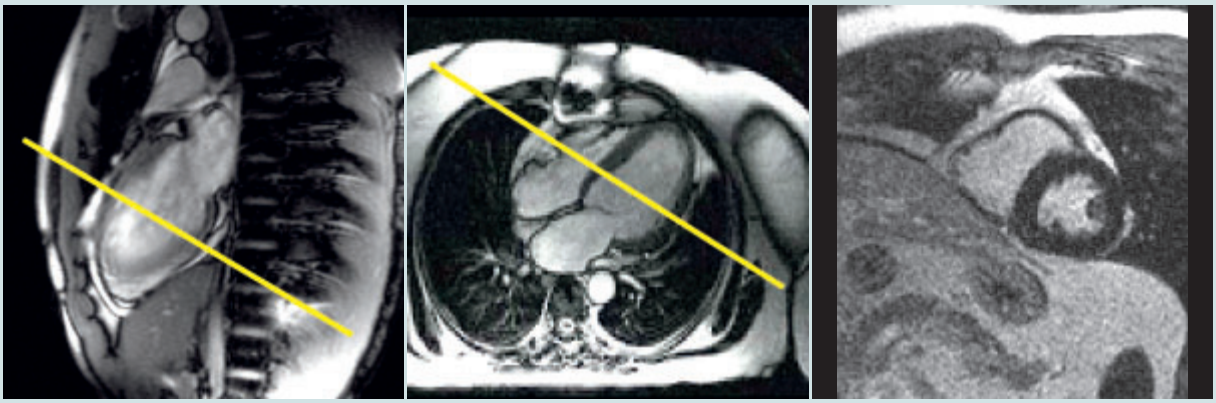
Extreme Arrhythmia – Free Breathing & Non Triggered

1. Localizers Module (p. 10)

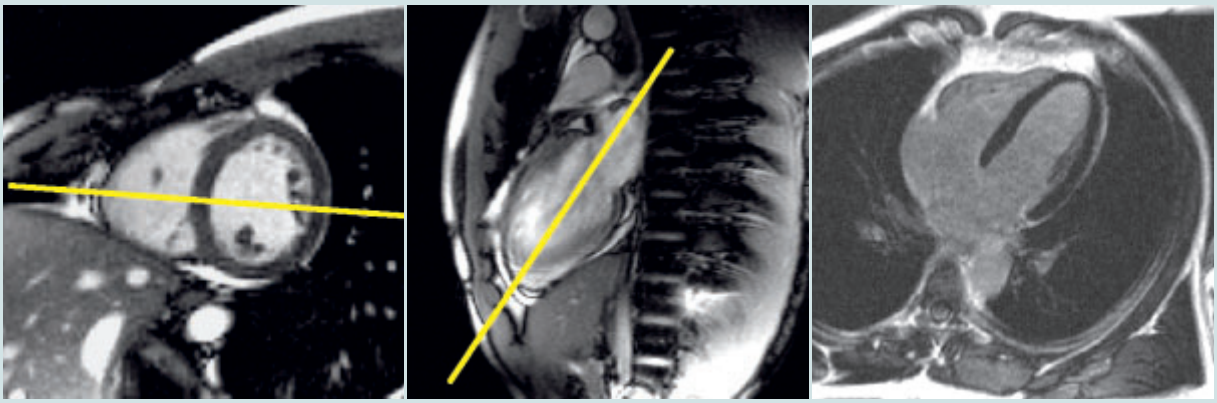
2. LV Function Module (p. 17)

3. Dynamic Module (p. 21)

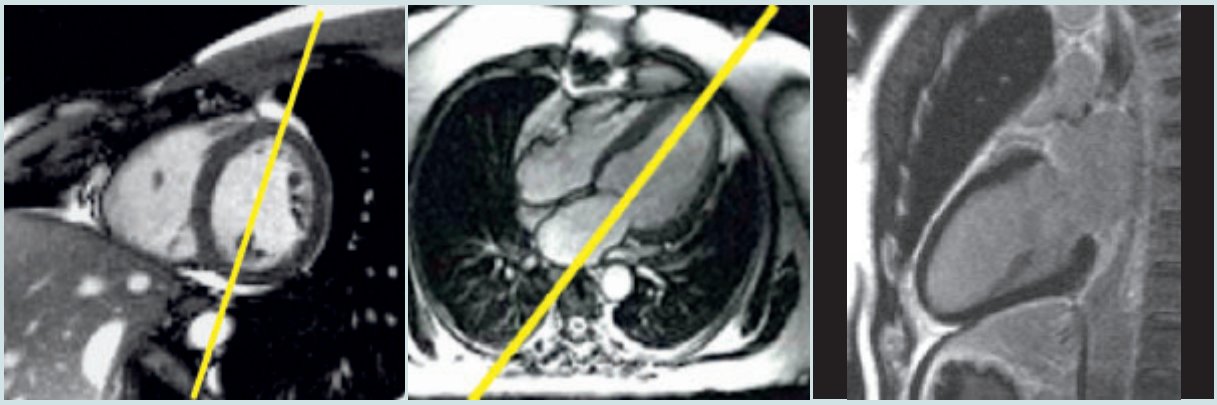
4. **OPT Short Axis Early:** optional, prescribe 1 slice, single shot inversion recovery TrueFISP technique, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, untriggered free breathing.



5. **OPT Four-Chamber Early:** optional, prescribe 1 slice, single shot inversion recovery TrueFISP technique, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, untriggered free breathing.



6. OPT Two-Chamber Early: optional, prescribe 1 slice, single shot inversion recovery TrueFISP technique, used to optimally identify microvascular obstruction, run early after dynamic exam, rotate FoV to avoid wrap, untriggered free breathing.



7. Delayed Module (p. 26)

Chronic Ischemic Heart Disease

Recommended – Breath Hold & Triggered

1. Localizers Module (p. 6)
2. LV Function Module (p. 13)
3. OPT Dobutamine Stress Module (p. 27)
4. OPT Dynamic Stress Module (p. 19)
5. OPT Dynamic Rest Module (p. 19)
6. Delayed Module (p. 22)

Free Breathing & Triggered

1. Localizers Module (p. 8)
2. LV Function Module (p. 15)
3. OPT Dobutamine Stress Module (p. 28)
4. OPT Dynamic Stress Module (p. 20)
5. OPT Dynamic Rest Module (p. 20)
6. Delayed Module (p. 24)

Extreme Arrhythmia – Free Breathing & Non Triggered

1. Localizers Module (p. 10)
2. LV Function Module (p. 17)
3. OPT Dobutamine Stress Module (p. 29)
4. OPT Dynamic Stress Module (p. 21)
5. OPT Dynamic Rest Module (p. 21)
6. Delayed Module (p. 26)

Adenosine Stress

Recommended – Breath Hold & Triggered

1. Localizers Module (p. 6)
2. Dynamic Stress Module (p. 19)
3. LV Function Module (p. 13)
4. Dynamic Rest Module (p. 19)
5. Delayed Module (p. 22)

Free Breathing & Triggered

1. Localizers Module (p. 8)
2. Dynamic Stress Module (p. 20)
3. LV Function Module (p. 15)
4. Dynamic Rest Module (p. 20)
5. Delayed Module (p. 24)

Extreme Arrhythmia – Free Breathing & Non Triggered

1. Localizers Module (p. 10)
2. Dynamic Stress Module (p. 21)
3. LV Function Module (p. 17)
4. Dynamic Rest Module (p. 21)
5. Delayed Module (p. 26)

Peripheral Arteries

Recommended – Free Breathing & Non Triggered

1. Position Patient Feet First

2. Localize 230 mm Above Feet

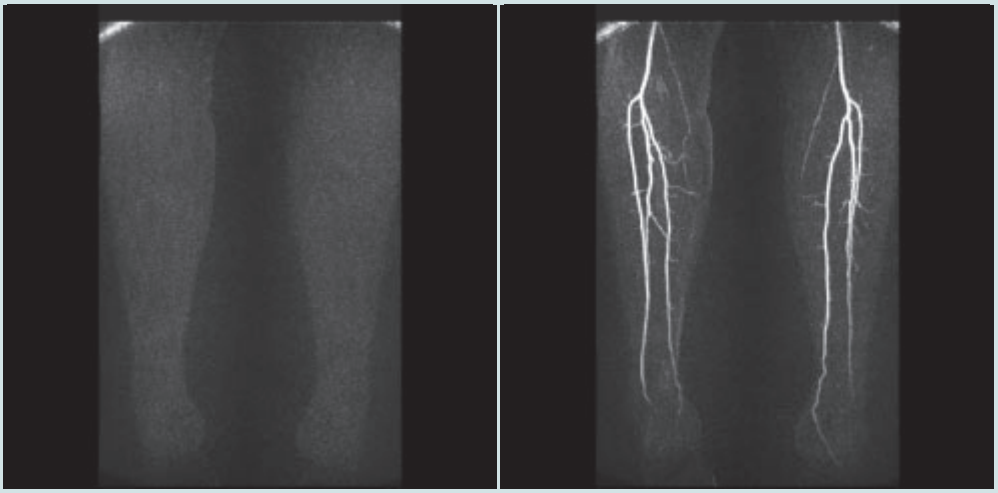
3. Turn On Coupled Graphics

4. Leg Scout: runs automatically with Body Coil, fixed table position zero, automatic composing.

5. Thigh Scout: runs automatically with Body Coil, fixed table position Head 450 mm, automatic composing.

6. Abdomen Scout: runs automatically with Body Coil, fixed table position Head 900 mm, automatic composing.

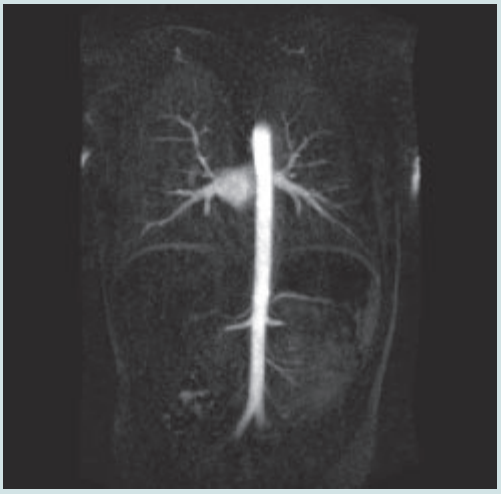
7. Leg Pre & Post: adjusts lower legs to isocenter of bore (ISO table mode), prescribe coronal slab from leg scout images, 1 pre measurement and 3 post measurements, 20 second pause after first measurement, automatic subtraction, MIP and composing.



8. Thigh Pre: adjusts thighs to isocenter of bore (ISO table mode), prescribe coronal slab from thigh scout images, subtraction mask for post measurements, automatic subtraction, MIP and composing.

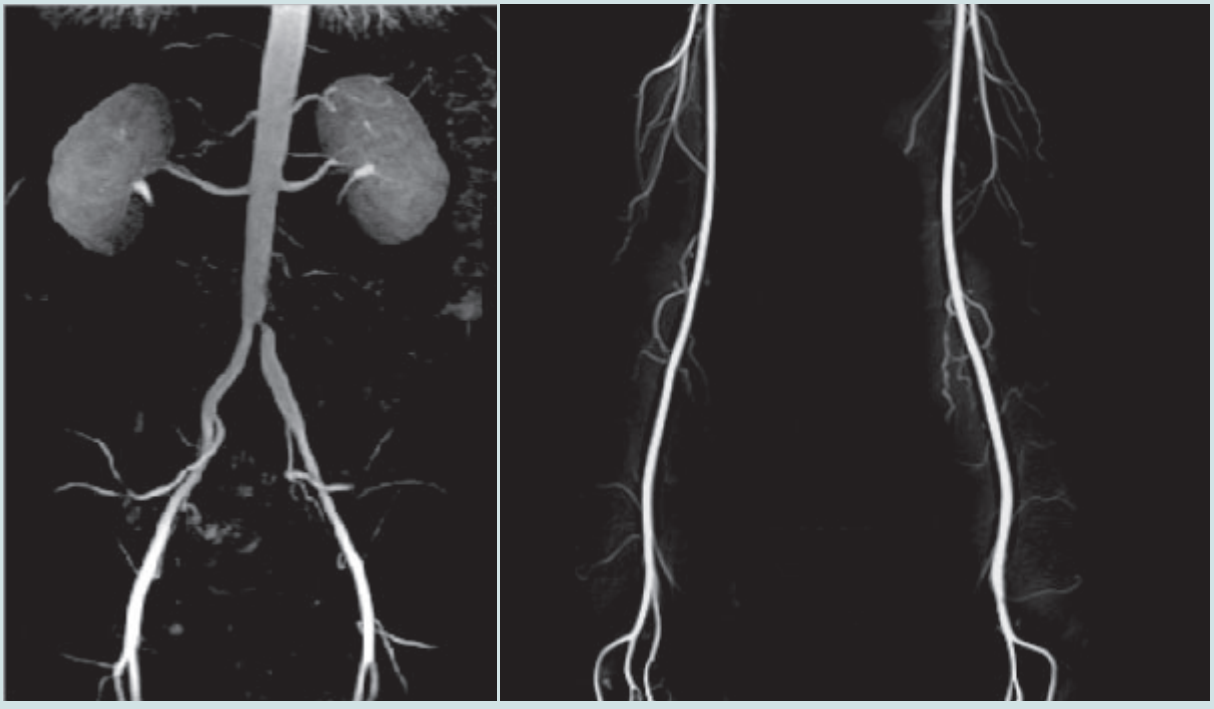
9. Abdomen Pre: adjusts abdomen to isocenter of bore (ISO table mode), prescribe coronal slab from abdomen scout images, subtraction mask for post measurements, automatic subtraction, MIP and composing.

10. **Aorta Care-Bolus:** uses the care-bolus technique for dynamic imaging of the aorta, adjusts abdomen to isocenter of bore (ISO table mode), prescribe coronal slice from abdomen scout images.



11. **Abdomen Post:** adjusts abdomen to isocenter of bore (ISO table mode), automatically repeats pre scan parameters and position, automatic subtraction, MIP and composing.

12. **Thigh Post:** adjusts thighs to isocenter of bore (ISO table mode), automatically repeats pre scan parameters and position, automatic subtraction, MIP and composing.

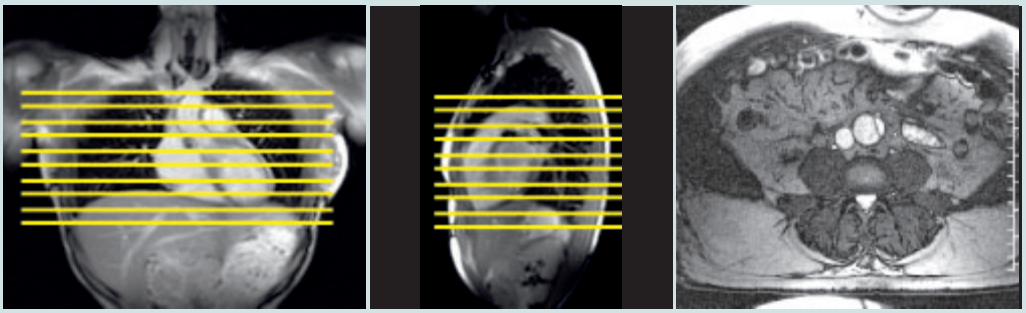


Thoracic Aorta

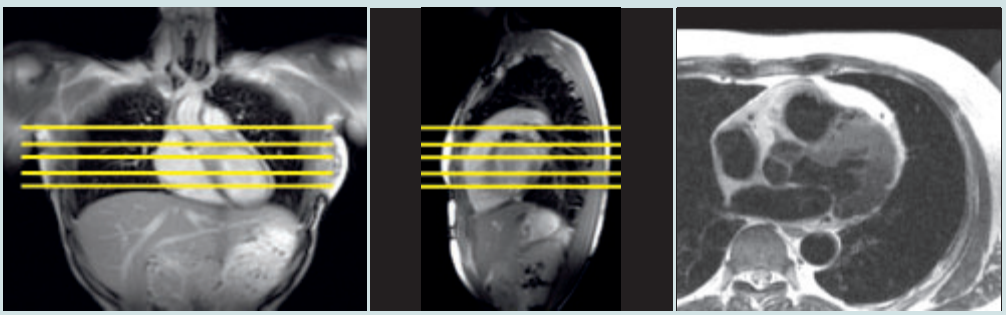
Recommended – Breath Hold & Triggered

1. Localizers Module (p. 6)

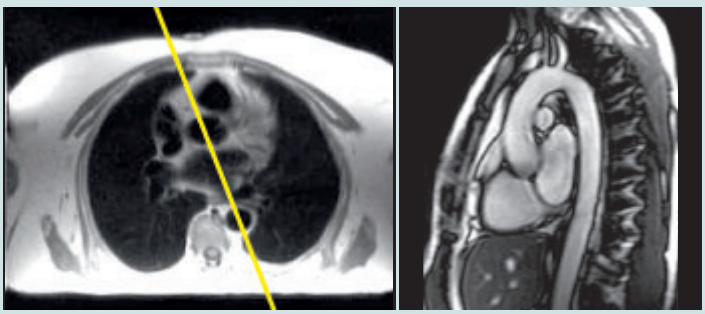
2. Axial Aorta Bright Blood: prescribe 30 axial slices to cover entire thorax, single shot TrueFISP, multiple breathholds, trigger on every heartbeat, capture cycle for diastolic gating.



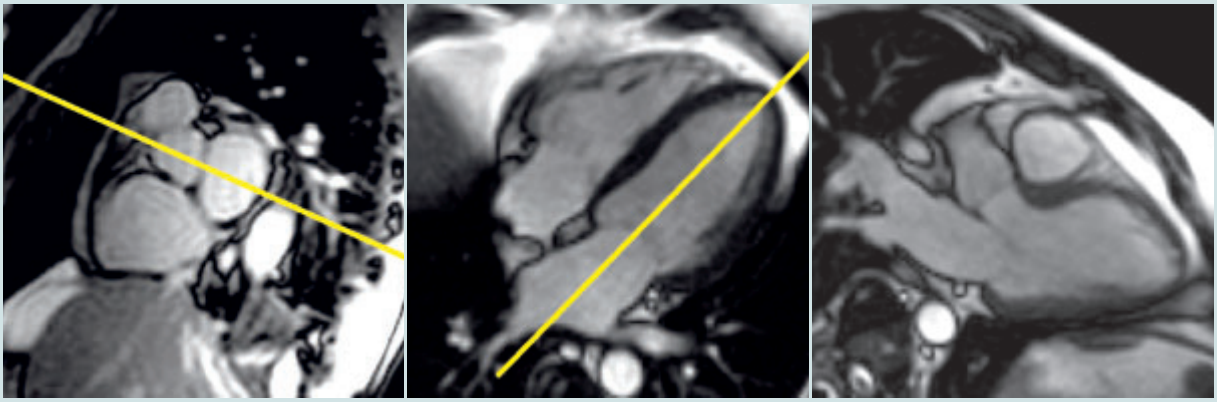
3. Axial Aorta DarkBlood: prescribe 5 axial slices through region of interest, DarkBlood segmented TSE t1-weighted, multiple breathholds, trigger on every heartbeat, capture cycle for diastolic gating.



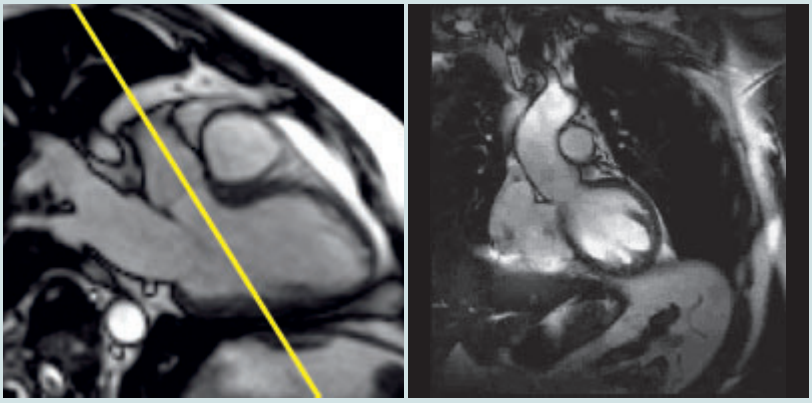
4. Sagittal Cine: prescribe 1 slice in sagittal oblique (candy cane) view from axial localizer, rotate FoV to avoid wrap, single breathhold, retrospective gating.



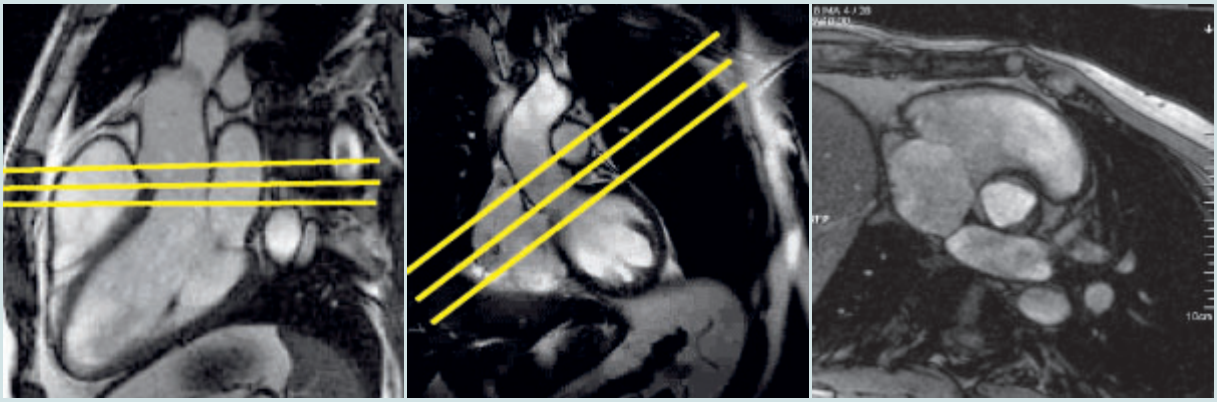
5. Three-Chamber Cine: prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, single breathhold, retrospective gating.



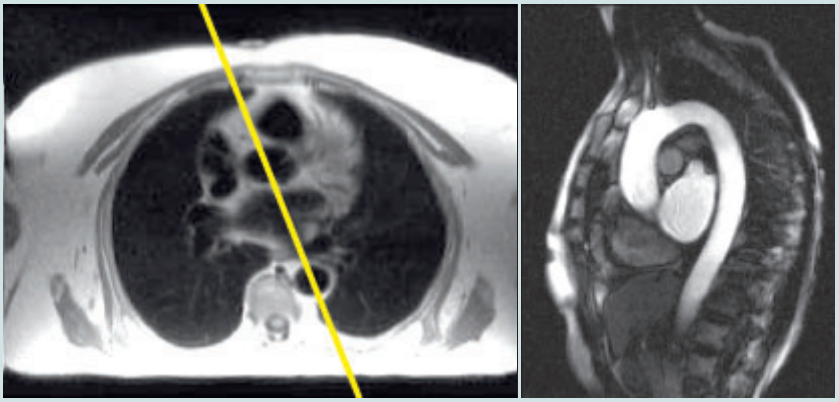
6. Coronal Aorta Cine: prescribe 1 slice from three-chamber view, bisect the LVOT, aortic valve, and ascending aorta, rotate FoV to avoid wrap, single breathhold, retrospective gating.



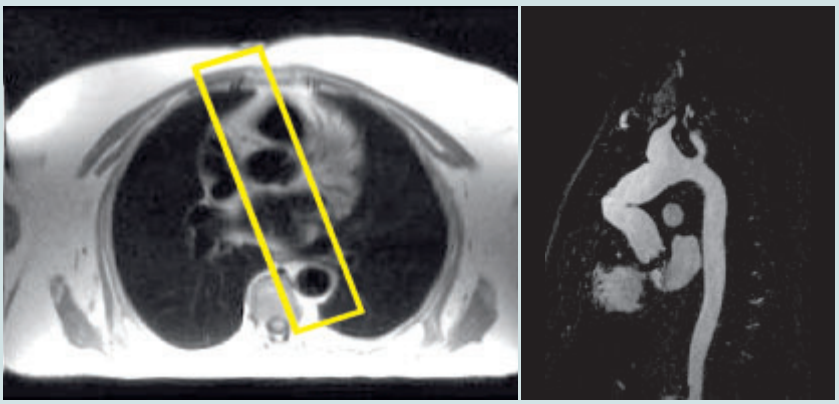
7. Aortic Valve Cine: prescribe from three-chamber view and coronal aorta view, 3 cross-sectional slices across aortic valve, rotate FoV to avoid wrap, multiple breathholds, retrospective gating.



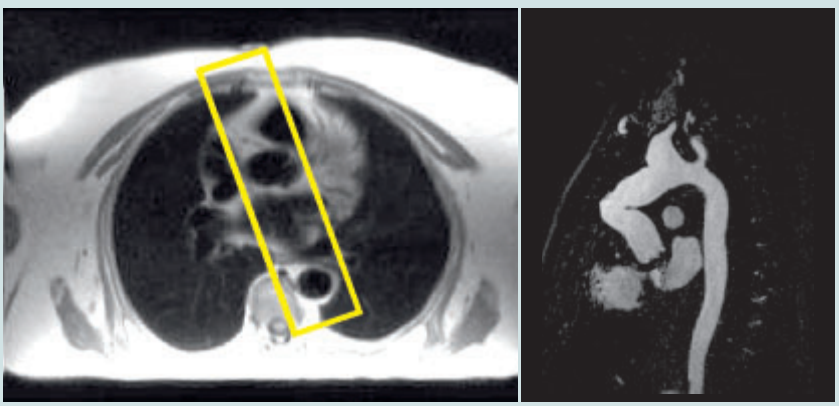
8. Aorta Test-Bolus: uses the test-bolus technique for dynamic imaging of the aorta, prescribe sagittal oblique ("candy cane") slice from axial localizer.



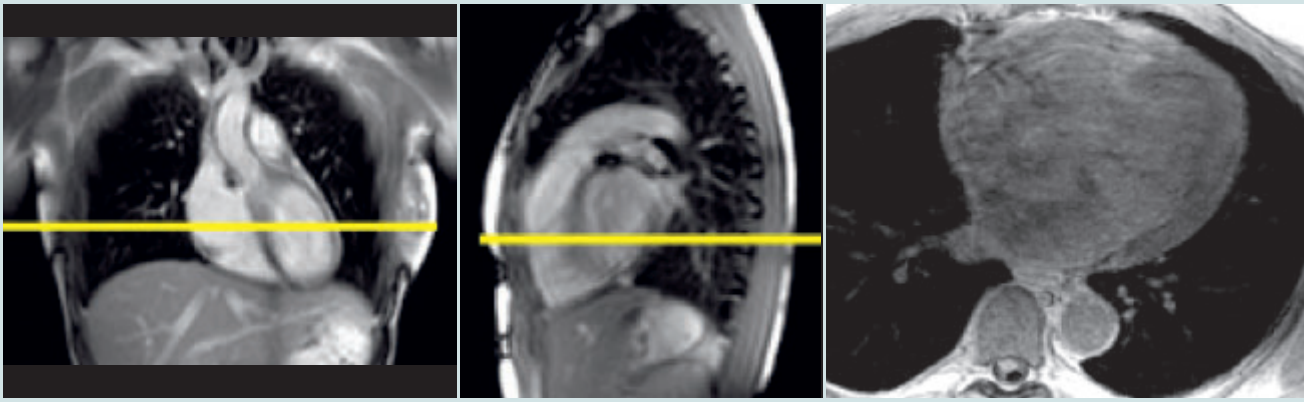
9. Sagittal Aorta Pre: used as the subtraction mask for post scan, prescribe 1 slab in sagittal oblique ("candy cane") view from axial localizer, 1 measurement in 1 breathhold (single flagman), adjust trigger delay to push data acquisition into mid-diastole, automatic subtraction and MIP.



10. Sagittal Aorta Post: use appropriate scan delay as determined from test-bolus scan, automatically repeats scan parameters and position from pre scan, 2 measurements in 2 breathholds (repeat flagman), adjust trigger delay to push data acquisition into mid-diastole, automatic subtraction and MIP.



11. OPT Axial T1 Aorta: optional, for selected slice levels through aorta to detect aortitis, segmented GRE sequence without DarkBlood pulse, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.

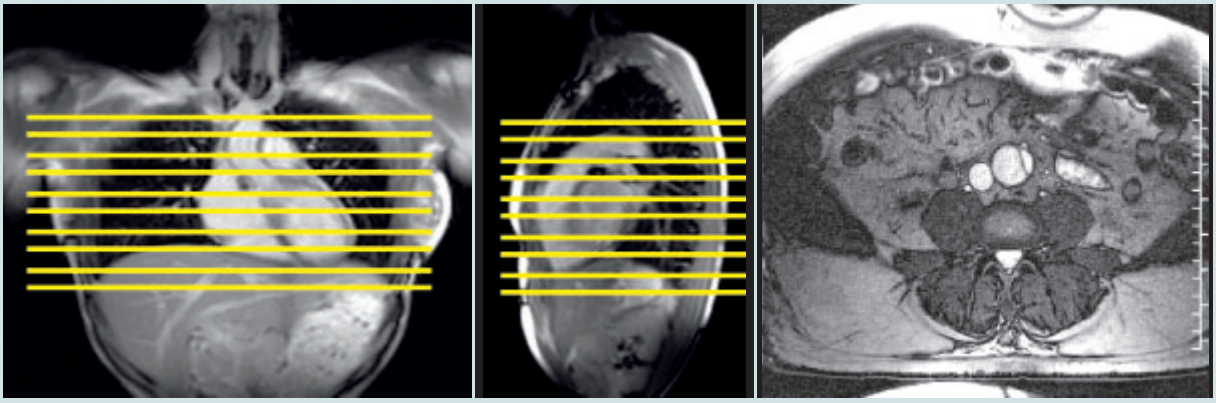


Thoracic Aorta

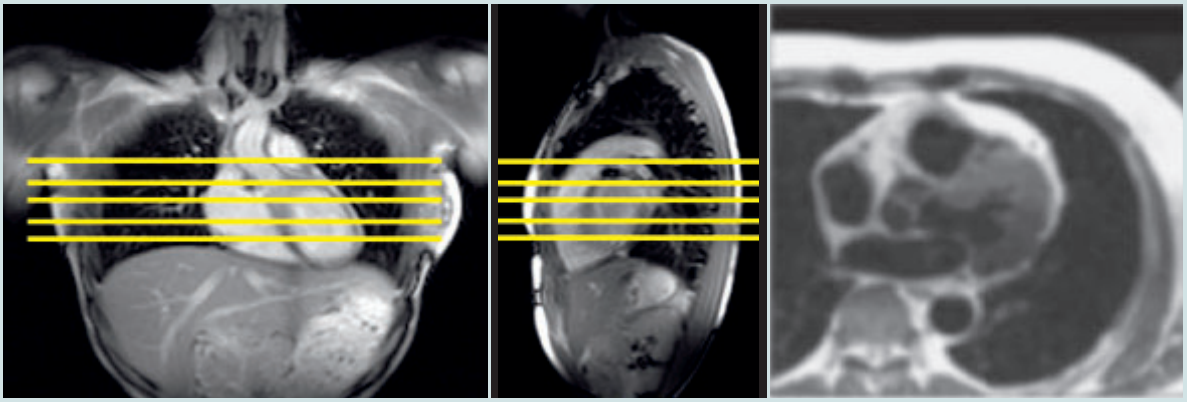
Free Breathing & Triggered

1. Localizers Module (p. 8)

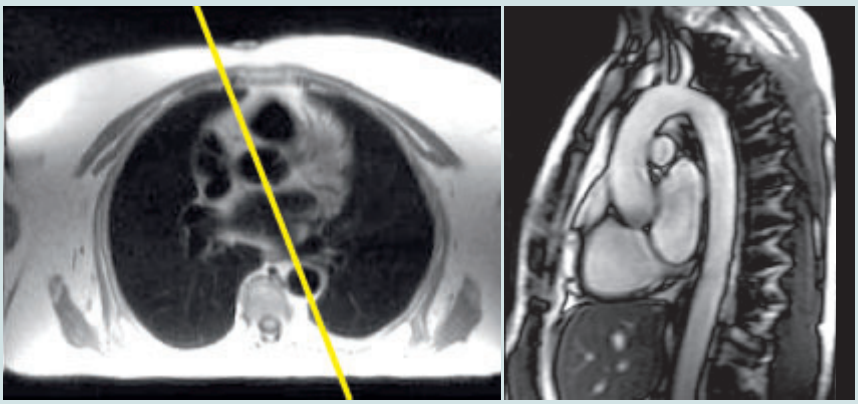
2. Axial Aorta Bright Blood: prescribe 30 axial slices to cover entire thorax, single shot TrueFISP, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



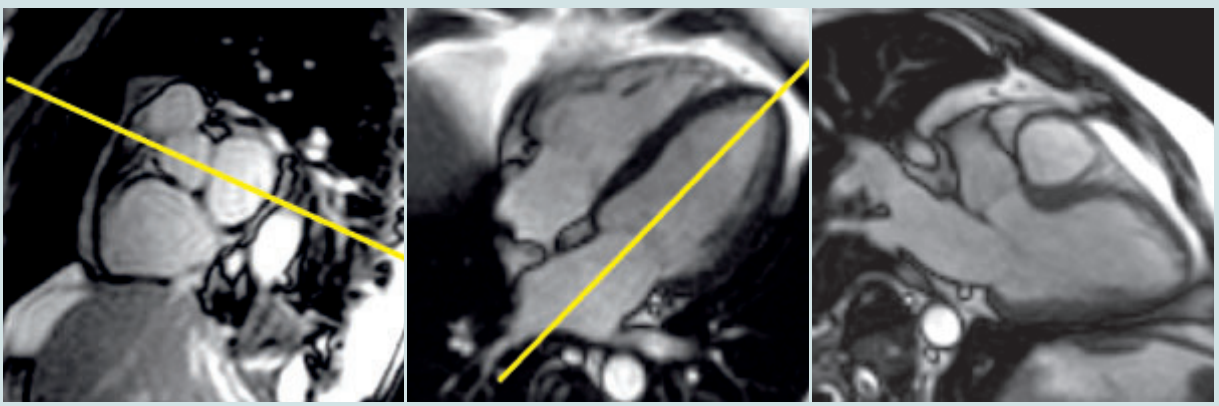
3. **Axial Aorta DarkBlood:** prescribe 5 axial slices through region of interest, DarkBlood HASTE, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



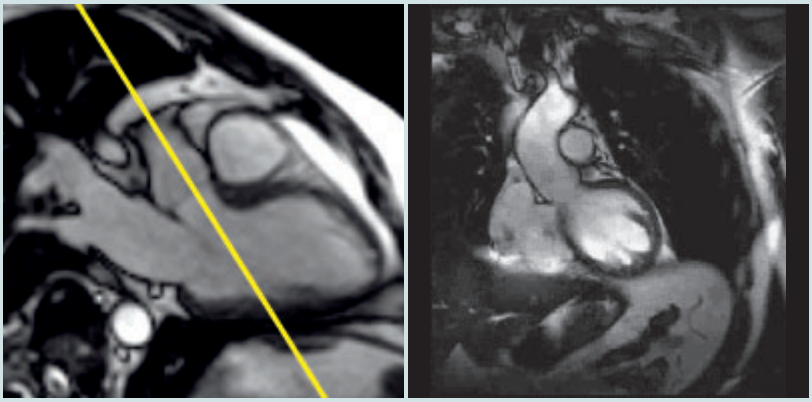
4. **Sagittal Cine:** prescribe 1 slice in sagittal oblique ("candy cane") view from axial localizer, rotate FoV to avoid wrap, free breathing, retrospective gating.



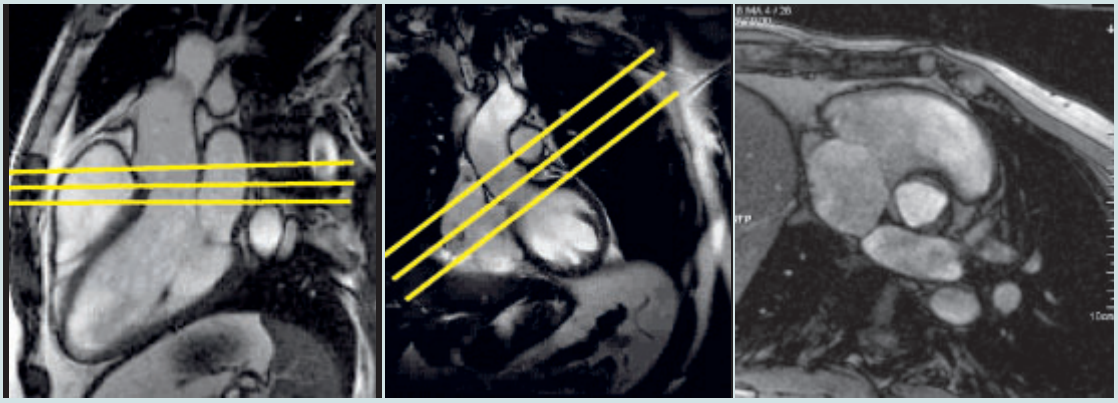
5. **Three-Chamber Cine:** prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four-chamber view, rotate FoV to avoid wrap, free breathing, retrospective gating.



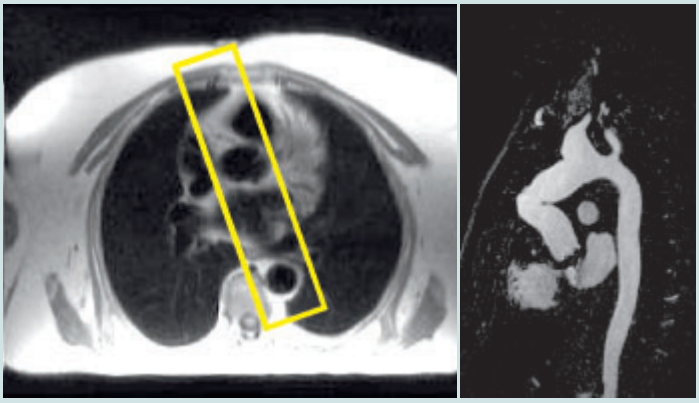
6. Coronal Aorta Cine: prescribe 1 slice from three-chamber view, bisect the LVOT, aortic valve, and ascending aorta, rotate FoV to avoid wrap, free breathing, retrospective gating.



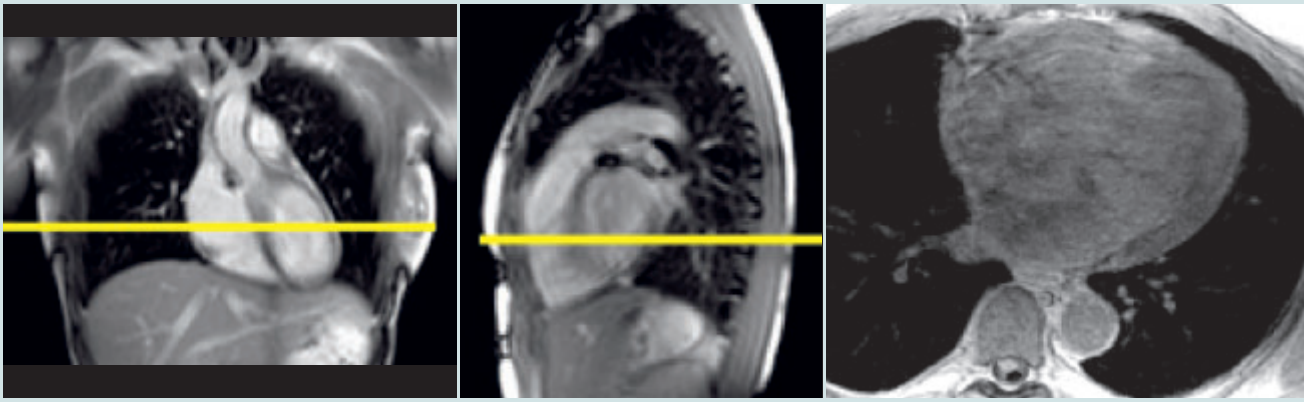
7. Aortic Valve Cine: prescribe from three-chamber view and coronal aorta view, 3 cross-sectional slices across aortic valve, rotate FoV to avoid wrap, free breathing, retrospective gating.



8. Sagittal Aorta Dynamic: prescribe 1 slab in sagittal oblique ("candy cane") view from axial localizer, 5 measurements of 5 seconds each, first one is subtraction mask, untriggered free breathing, automatic subtraction and MIP.



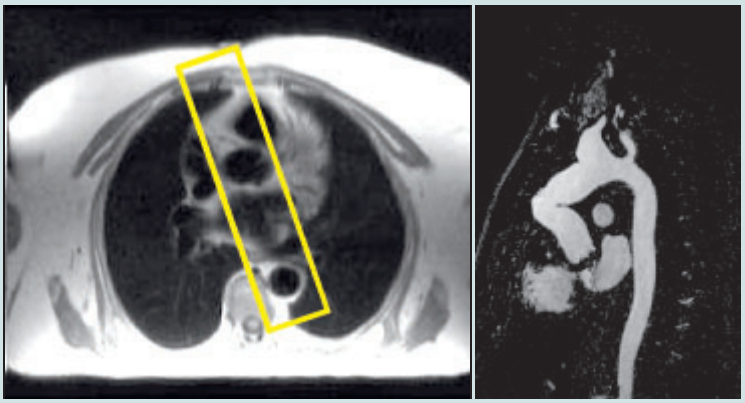
9. **OPT Axial T1 Aorta:** optional, for selected slice levels through aorta to detect aortitis, segmented gre sequence without DarkBlood pulse, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



Thoracic Aorta

syngo TWIST Option – Free Breathing & Non Triggered

1. **Sagittal Aorta Dynamic Twist:** prescribe 1 slab in sagittal oblique ("candy cane") view from axial localizer, *syngo* TWIST technique with temporal resolution 1.9 seconds, 12 measurements, untriggered free breathing, automatic subtraction and MIP.



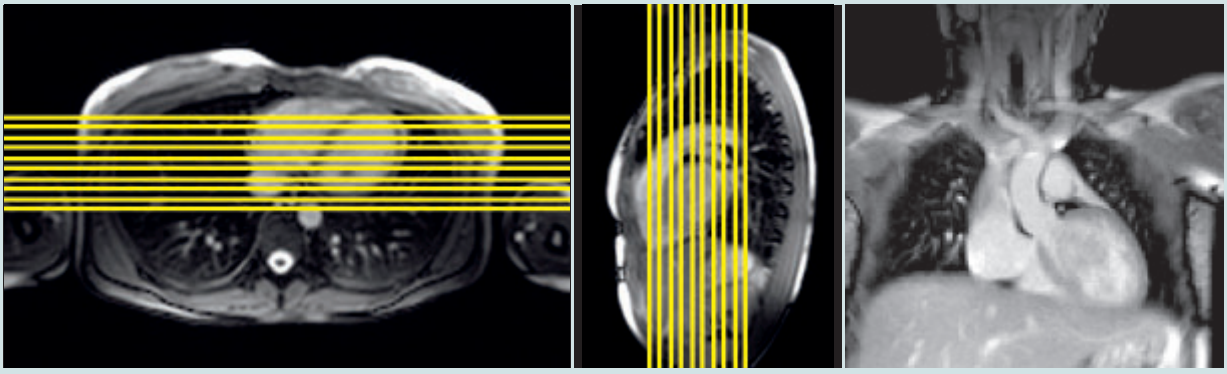
Anomalous Coronary Artery

Recommended – Breath Hold & Triggered

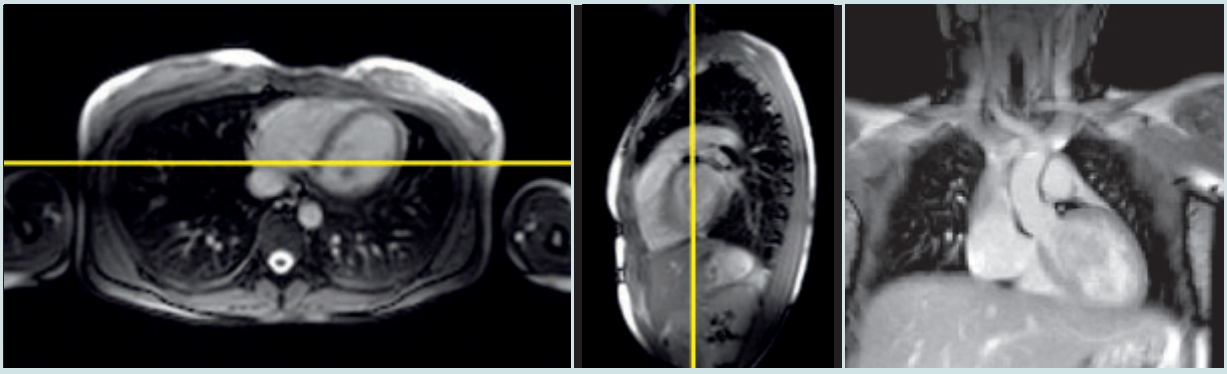
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

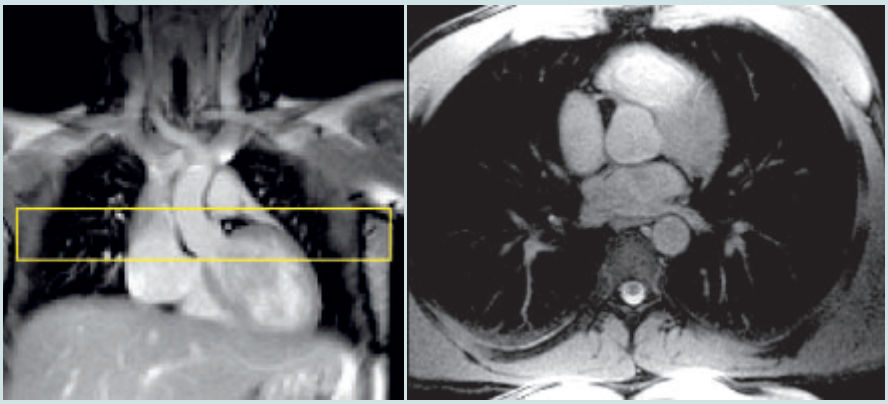
3. **Coronal Coronary Scout:** prescribe 10 slices from axial and sagittal views, cover entire ascending aorta, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



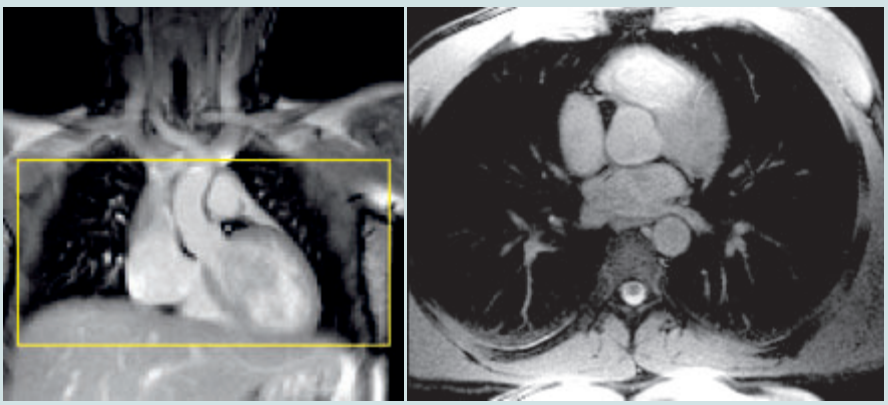
4. **Dynamic Coronary Scout:** single coronal slice acquired dynamically during free-breathing to determine end-inspiratory and end-expiratory diaphragm positions, copy slice position from previous coronal coronary scout to see coronary origins.



5. Axial Coronary Origins: prescribe 1 axial slab from coronal aortic scout, cover just the coronary origins in a single breathhold, adjust trigger delay to acquire data in mid-diastolic stationary phase as determined from viewing a four-chamber cine, no respiratory navigator required.



6. OPT Axial Whole Heart: optional, prescribe 1 axial slab at end-expiratory diaphragm position from dynamic coronary scout, cover entire heart including great vessels, free breathing navigator technique, adjust trigger delay to acquire data in mid-diastolic stationary phase as determined from viewing a four-chamber cine, test with respiratory scout mode ON to adjust acceptance position, repeat with respiratory scout mode OFF to acquire images.



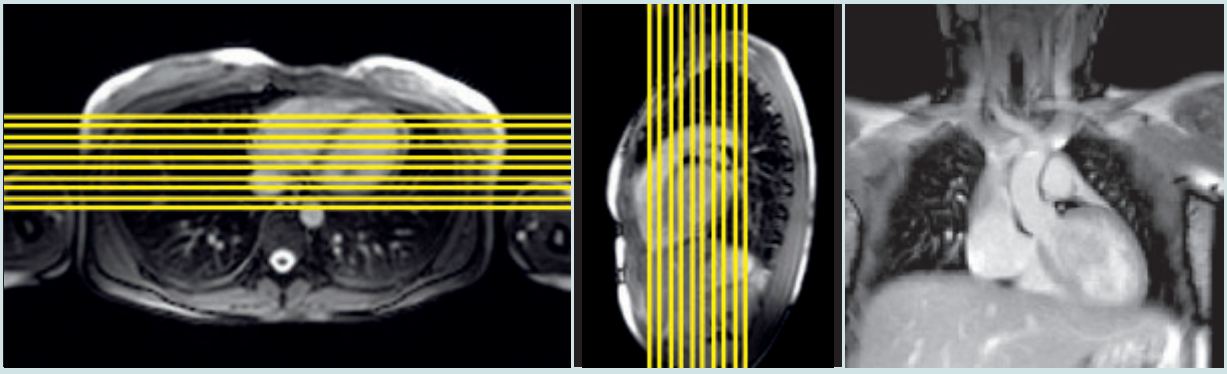
Anomalous Coronary Artery

Free Breathing & Triggered

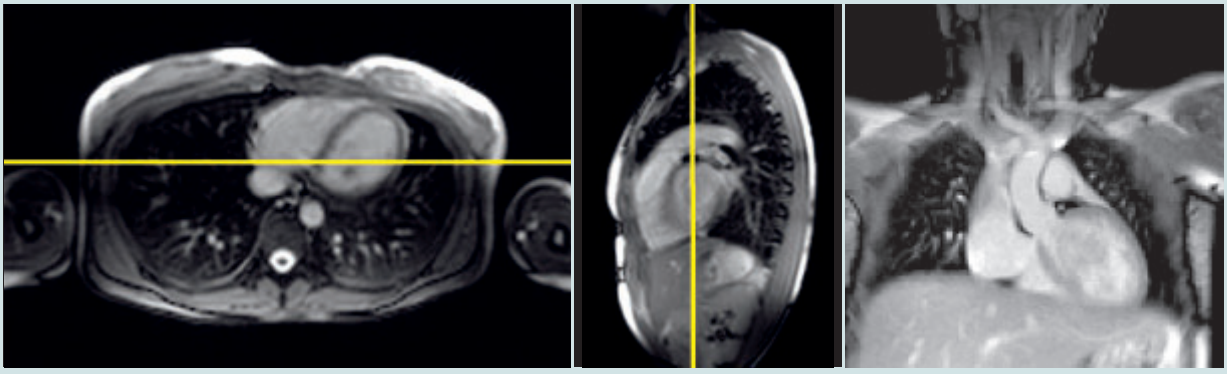
1. Localizers Module (p. 8)

2. LV Function Module (p. 15)

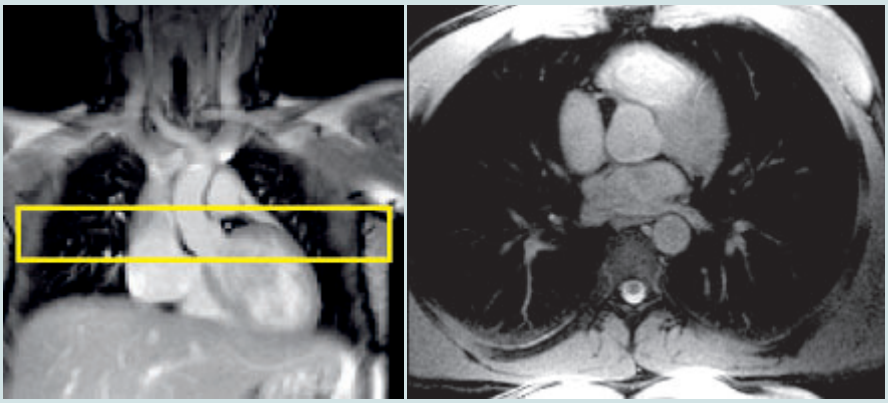
3. Coronal Coronary Scout: prescribe 10 slices from axial and sagittal views, cover entire ascending aorta, free breathing, trigger on every heartbeat, capture cycle for diastolic gating.



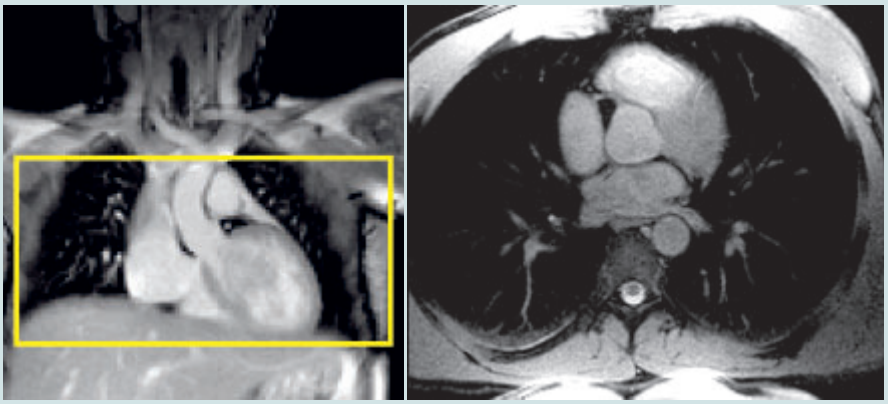
4. Dynamic Coronary Scout: single coronal slice acquired dynamically during free-breathing to determine end-inspiratory and end-expiratory diaphragm positions, copy slice position from previous coronal coronary scout to see coronary origins.



5. **Axial Coronary Origins:** prescribe 1 axial slab at end-expiratory diaphragm position from dynamic coronary scout, cover just the coronary origins, free breathing navigator technique, adjust trigger delay to acquire data in mid-diastolic stationary phase as determined from viewing a four-chamber cine, test with respiratory scout mode ON to adjust acceptance position, repeat with respiratory scout mode OFF to acquire images.



6. **OPT Axial Whole Heart:** optional, prescribe 1 axial slab at end-expiratory diaphragm position from dynamic coronary scout, cover entire heart including great vessels, free breathing navigator technique, adjust trigger delay to acquire data in mid-diastolic stationary phase as determined from viewing a four-chamber cine, test with respiratory scout mode ON to adjust acceptance position, repeat with respiratory scout mode OFF to acquire images.



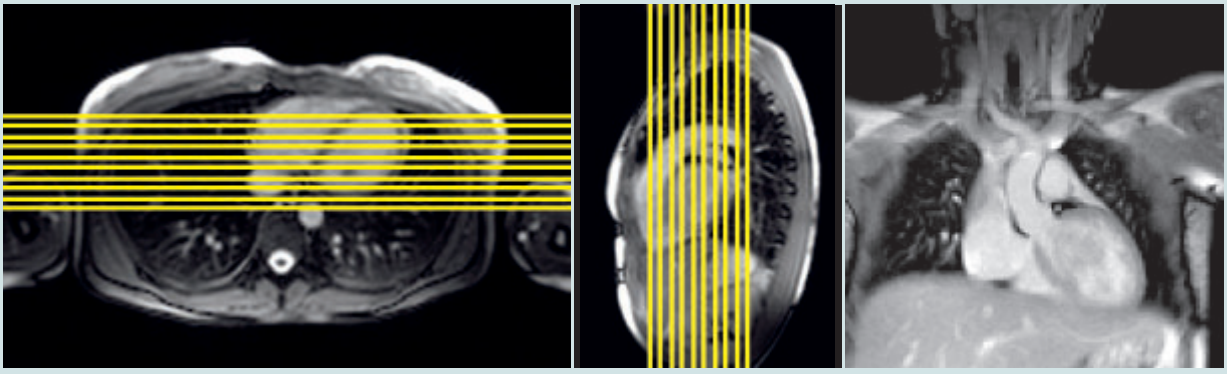
Anomalous Coronary Artery

Extreme Arrhythmia – Free Breathing & Non Triggered

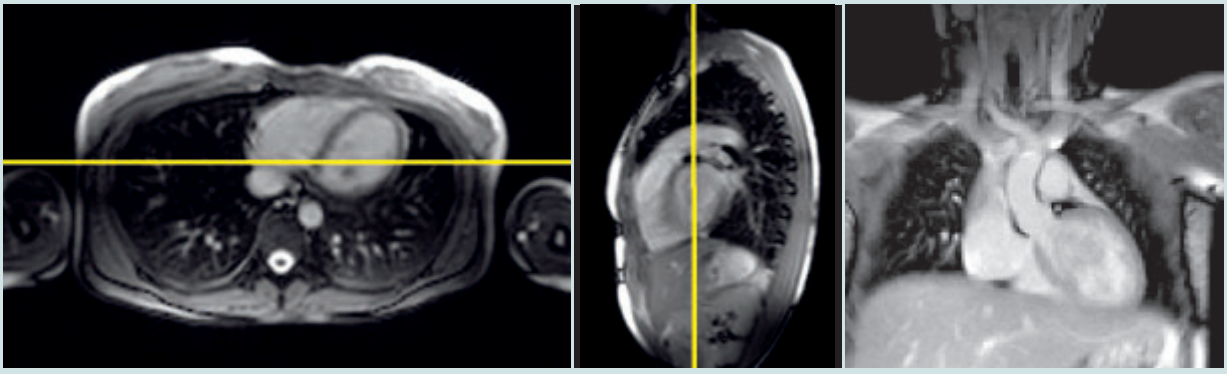
1. Localizers Module (p. 10)

2. LV Function Module (p. 17)

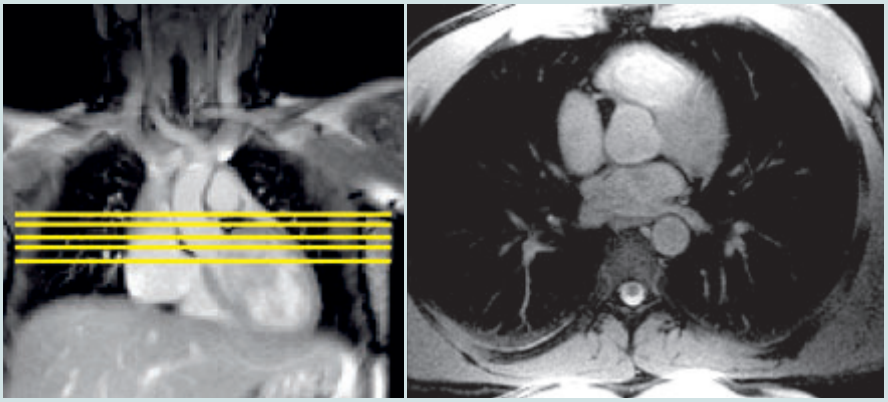
3. **Coronal Coronary Scout:** prescribe 10 slices from axial and sagittal views, cover entire ascending aorta, untriggered free breathing.



4. **Dynamic Coronary Scout:** single coronal slice acquired dynamically during free-breathing to determine end-inspiratory and end-expiratory diaphragm positions, copy slice position from previous coronal coronary scout to see coronary origins.



5. Axial Coronary Origins: prescribe 20 thin axial slices from coronal aortic scout, cover just the coronary origins, untriggered free breathing.



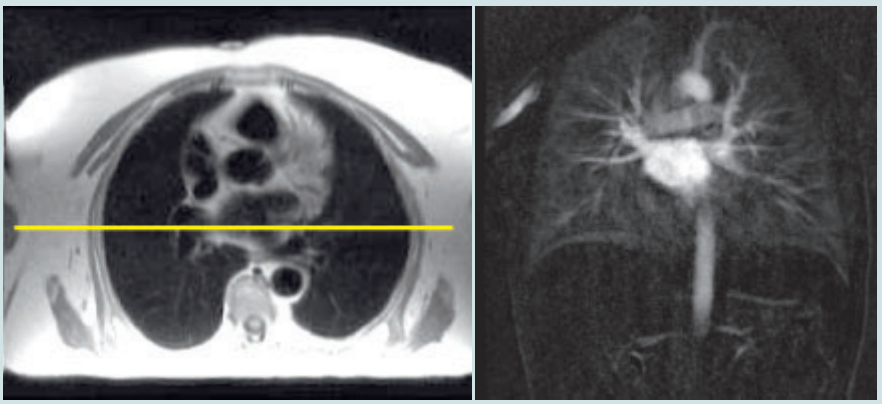
Pulmonary Veins

Recommended – Breath Hold & Triggered

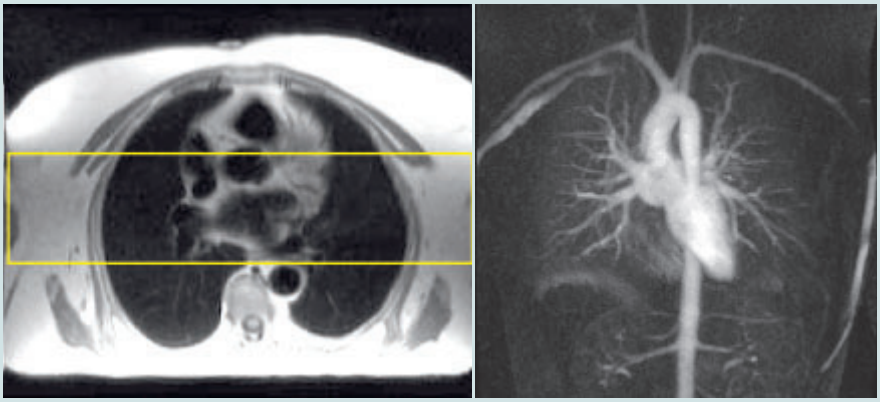
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

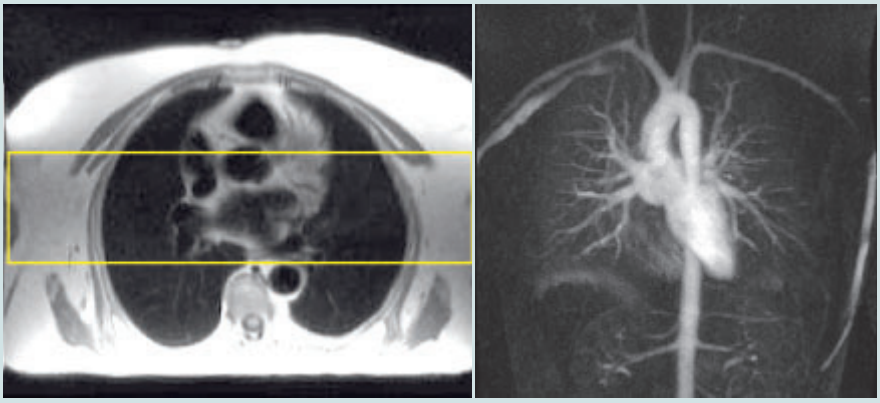
3. Coronal Pulmonary Test-Bolus: uses the test-bolus technique for dynamic imaging of the pulmonary veins, prescribe coronal slice through pulmonary veins and left atrium.



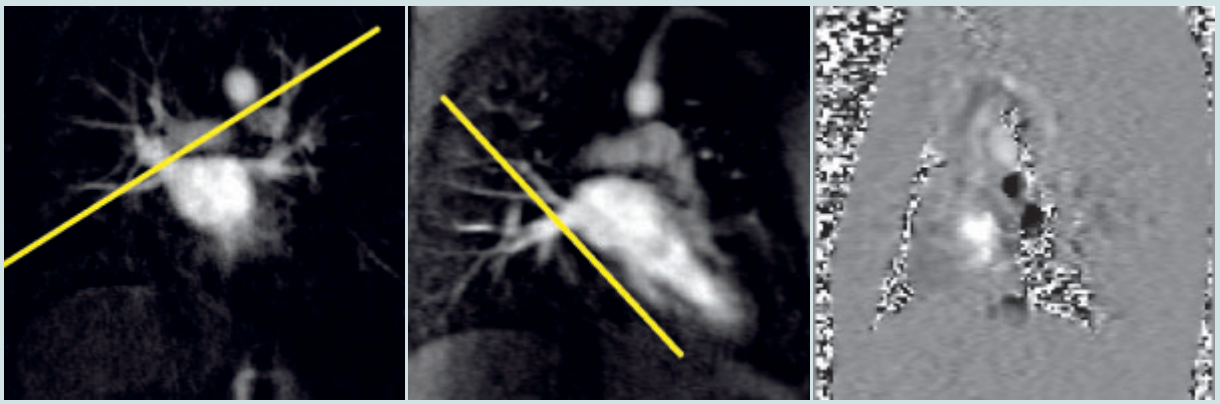
4. Coronal Pulmonary Pre: used as the subtraction mask for post scan, prescribe coronal slab through pulmonary veins and left atrium, 1 measurement in 1 breathhold (single flagman), untriggered, automatic subtraction and MIP.



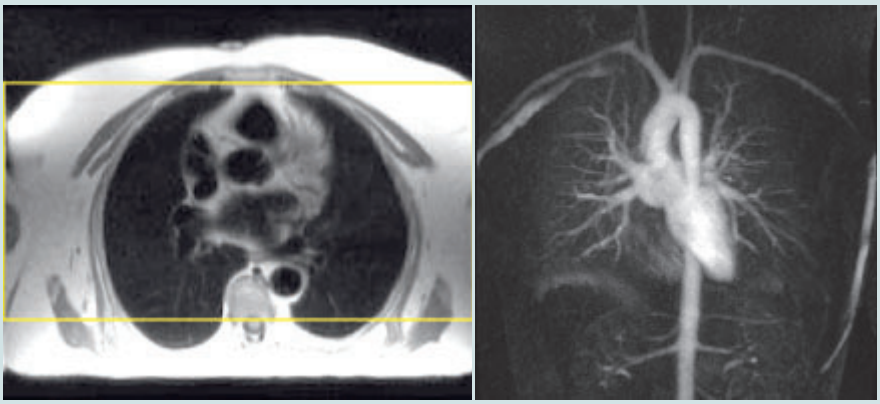
5. Coronal Pulmonary Post: use appropriate scan delay as determined from test-bolus scan, automatically repeats scan parameters and position from pre scan, 2 measurements in 2 breathholds (repeat flagman), untriggered, automatic subtraction and MIP.



6. OPT Pulmonary Vein Flow: optional, prescribe 1 slice from coronal and sagittal views, cross-sectional to the origins of either left or right pulmonary veins, through-plane VENC 30 cm/sec for normal flow or 60 cm/sec for mild stenosis, single breathhold, retrospective gating.



7. **OPT Coronal Whole Chest:** optional, prescribe coronal slab from axial scout, cover entire chest including heart and great vessels, free breathing navigator technique, adjust trigger delay to acquire data in mid-diastolic stationary phase as determined from viewing a four-chamber cine, test with respiratory scout mode ON to adjust acceptance position, repeat with respiratory scout mode OFF to acquire images.



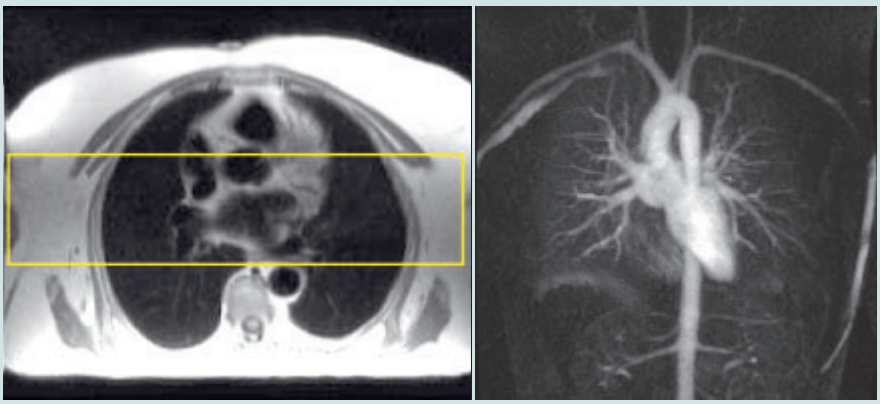
Pulmonary Veins

Free Breathing & Triggered

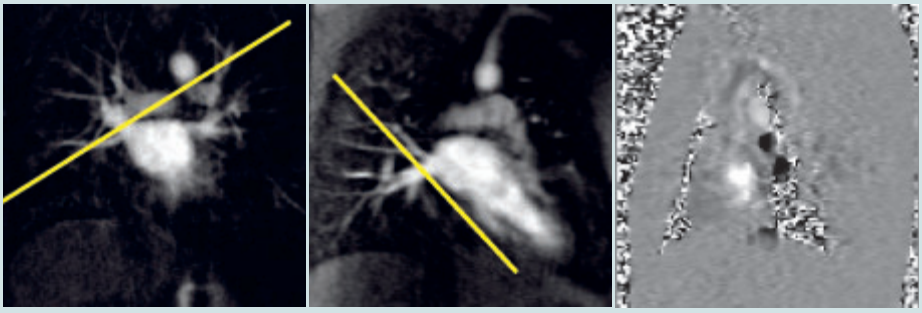
1. **Localizers Module (p. 8)**

2. **LV Function Module (p. 15)**

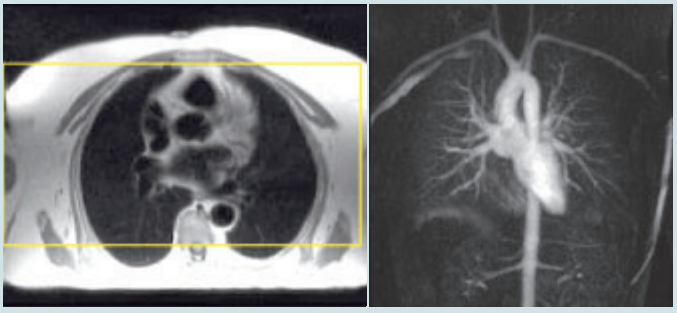
3. **Coronal Pulmonary Dynamic:** prescribe 1 slab in coronal view from axial localizer, 5 measurements of 7 seconds each, first one is subtraction mask, untriggered free breathing, automatic subtraction and MIP.



4. **OPT Pulmonary Vein Flow:** optional, prescribe 1 slice from coronal and sagittal views, cross-sectional to the origins of either left or right pulmonary veins, through-plane VENC 30 cm/sec for normal flow or 60 cm/sec for mild stenosis, free breathing retrospective gating.



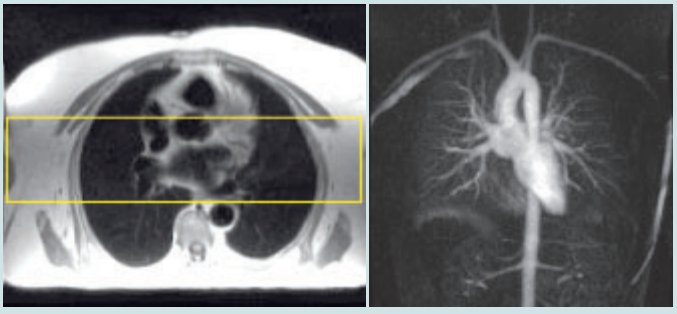
5. **OPT Coronal Whole Chest:** optional, prescribe coronal slab from axial scout, cover entire chest including heart and great vessels, free breathing navigator technique, adjust trigger delay to acquire data in mid-diastolic stationary phase as determined from viewing a four-chamber cine, test with respiratory scout mode ON to adjust acceptance position, repeat with respiratory scout mode OFF to acquire images.



Pulmonary Veins

syngo TWIST Option – Free Breathing & Non Triggered

1. **Coronal Pulmonary Dynamic TWIST:** prescribe coronal slab through pulmonary veins and left atrium, *syngo* TWIST technique with temporal resolution 3.0 seconds, 12 measurements, untriggered free breathing, automatic subtraction and MIP.



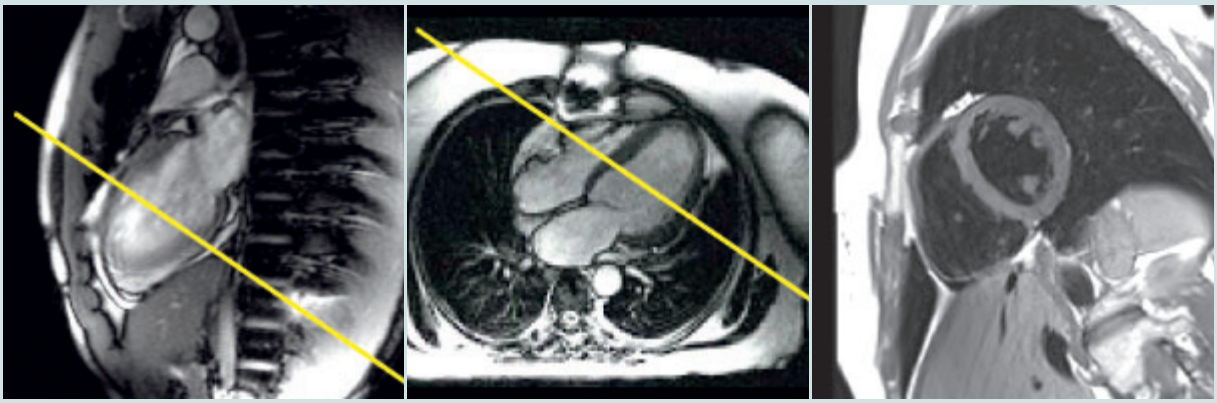
Nonischemic Cardiomyopathy

Recommended – Breath Hold & Triggered

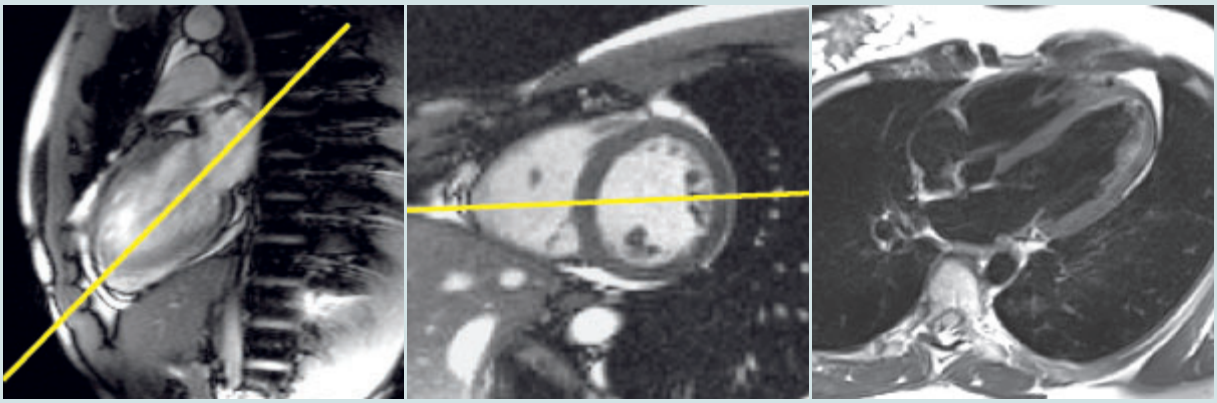
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

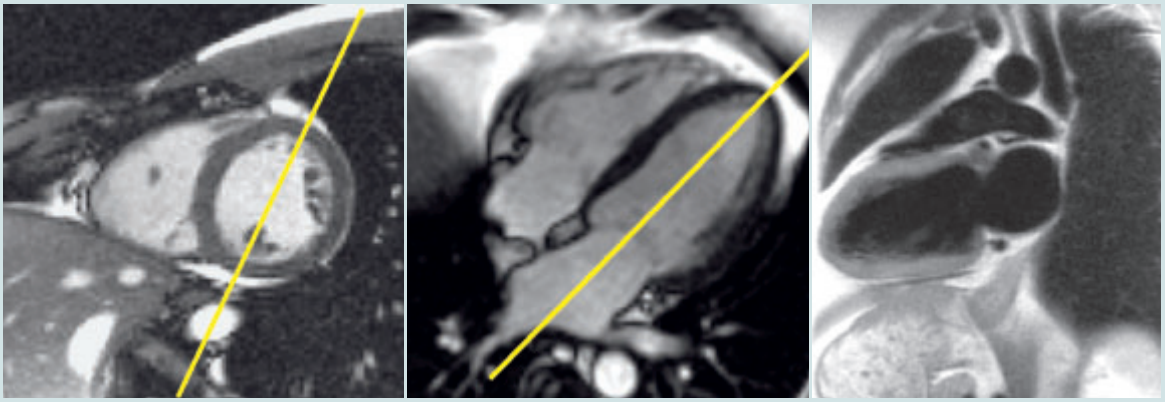
3. **Short Axis DarkBlood T2:** prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



4. **Four-Chamber DarkBlood T2:** prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



5. **Two-Chamber DarkBlood T2:** prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



6. **OPT Dynamic Stress Module (p. 19)**

7. **OPT Dynamic Rest Module (p. 19)**

8. **Delayed Module (p. 22)**

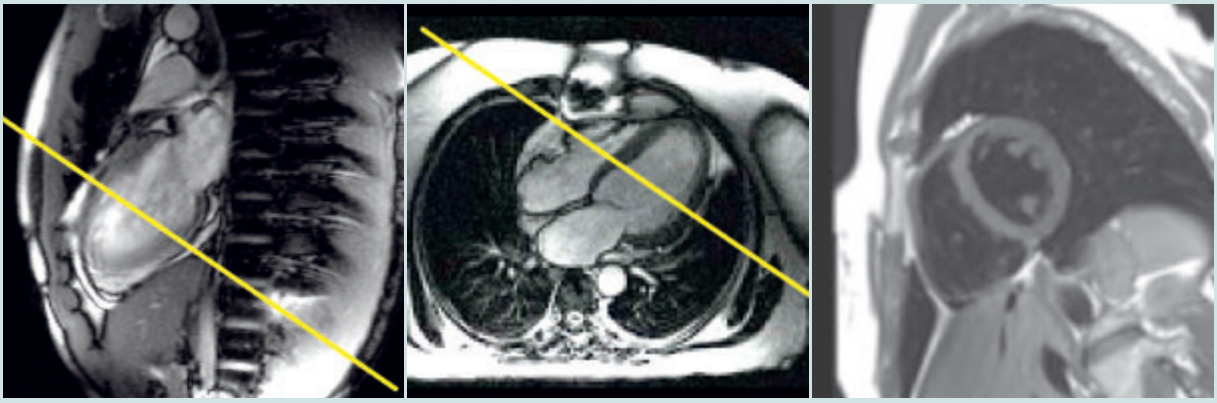
Nonischemic Cardiomyopathy

Free Breathing & Triggered

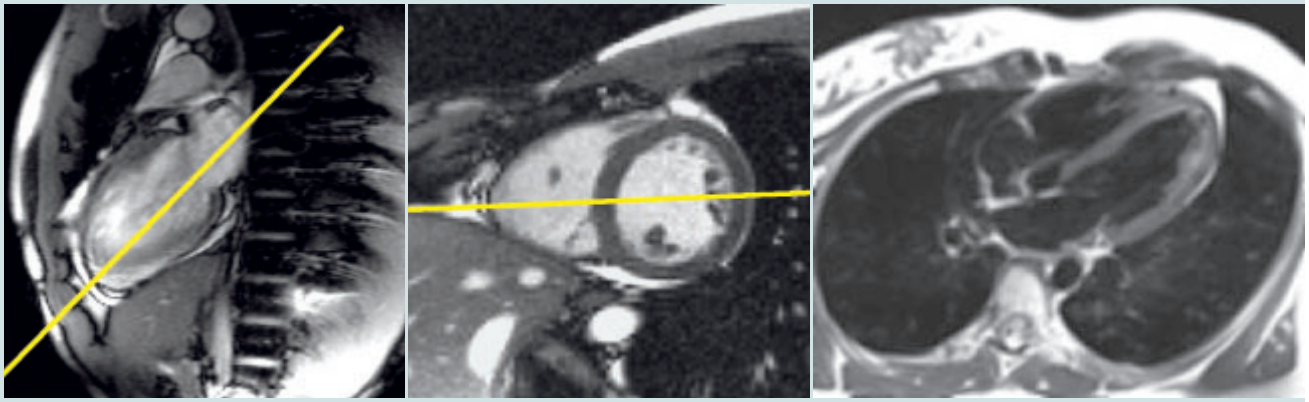
1. **Localizers Module (p. 8)**

2. **LV Function Module (p. 15)**

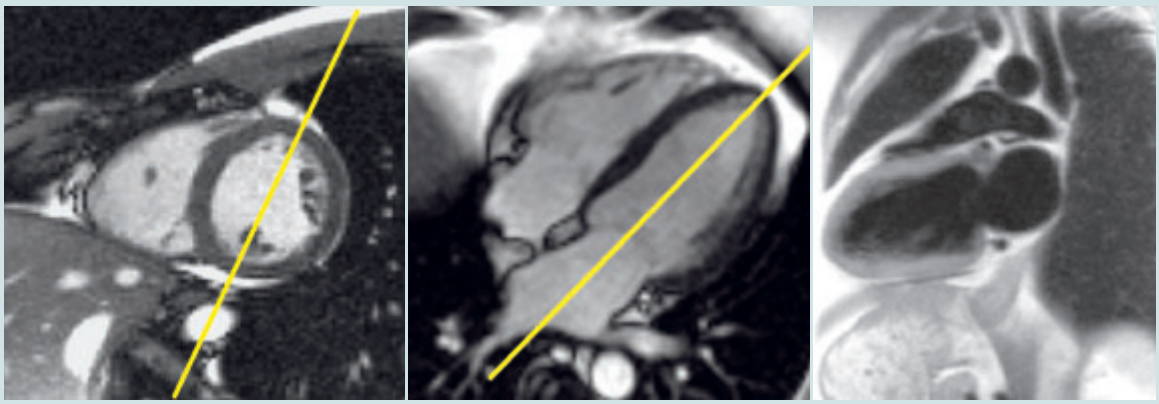
3. **Short Axis DarkBlood HASTE T2:** prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



4. **Four-Chamber DarkBlood HASTE T2:** prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



5. **Two-Chamber DarkBlood HASTE T2:** prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



6. OPT Dynamic Stress Module (p. 20)

7. OPT Dynamic Rest Module (p. 20)

8. Delayed Module (p. 24)

Nonischemic Cardiomyopathy

Extreme Arrhythmia – Free Breathing & Non Triggered

1. Localizers Module (p. 10)

2. LV Function Module (p. 17)

3. OPT Dynamic Stress Module (p. 21)

4. OPT Dynamic Rest Module (p. 21)

5. Delayed Module (p. 26)

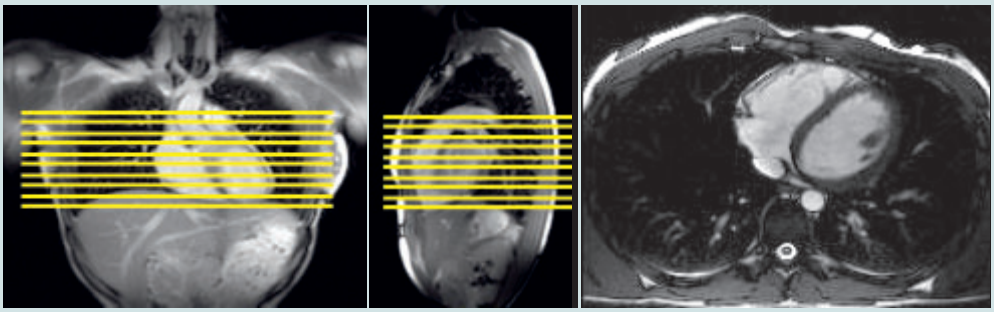
ARVC

Recommended – Breath Hold & Triggered

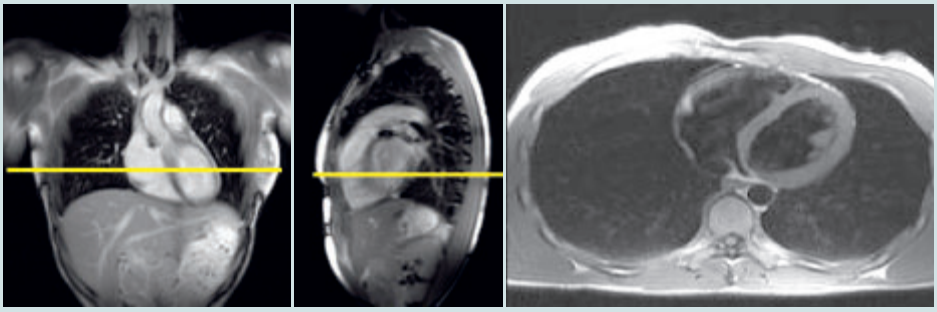
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

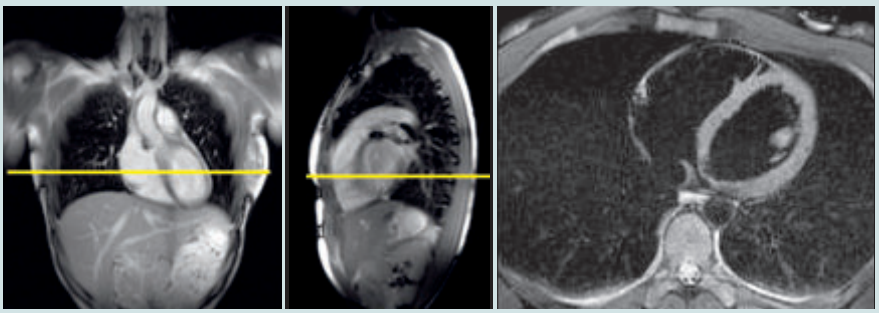
3. Axial Cine: prescribe 10 slices from coronal and sagittal views, adjust gap to cover entire right ventricle and outflow tract, multiple breathholds, retrospective gating.



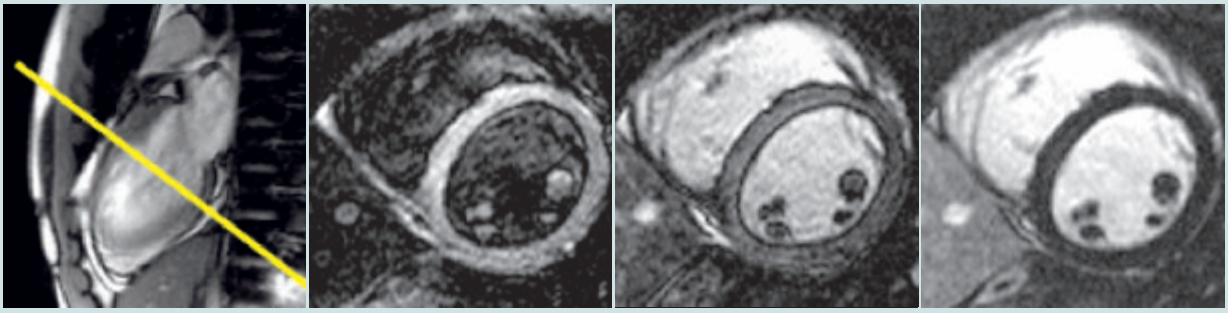
4. OPT Axial DarkBlood T1: optional, for selected slice levels of right ventricle, segmented DarkBlood TSE, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



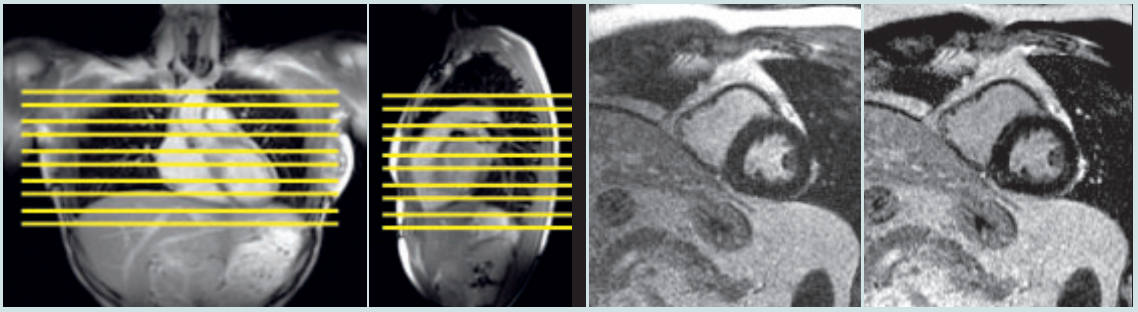
5. OPT Axial DarkBlood T2 Fatsat: optional, for selected slice levels of right ventricle, segmented DarkBlood TSE with strong fatsat pulse and tune up shim mode, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



6. TI Scout*: determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for optimal acquisition window.



7. Axial Delayed: prescribe 10 slices, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, adjust TI for nulling of normal myocardium, adjust gap to cover entire right ventricle and outflow tract, multiple breathholds, trigger on every second heartbeat, capture cycle for diastolic gating.



* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

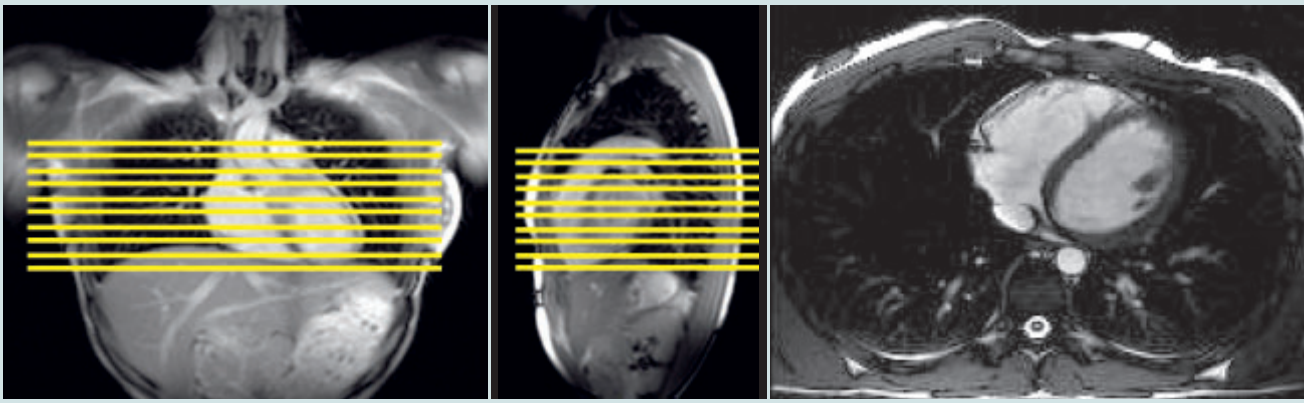
ARVC

Free Breathing & Triggered

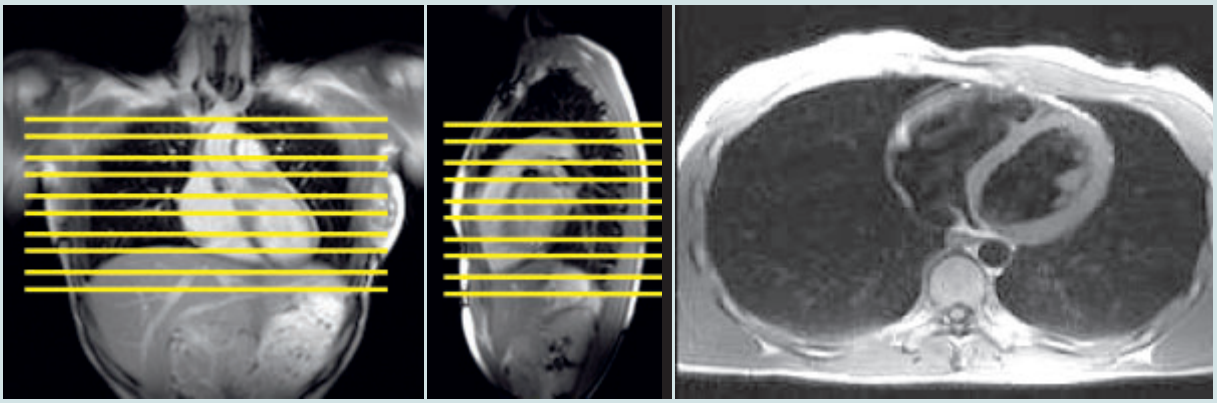
1. Localizers Module (p. 8)

2. LV Function Module (p. 15)

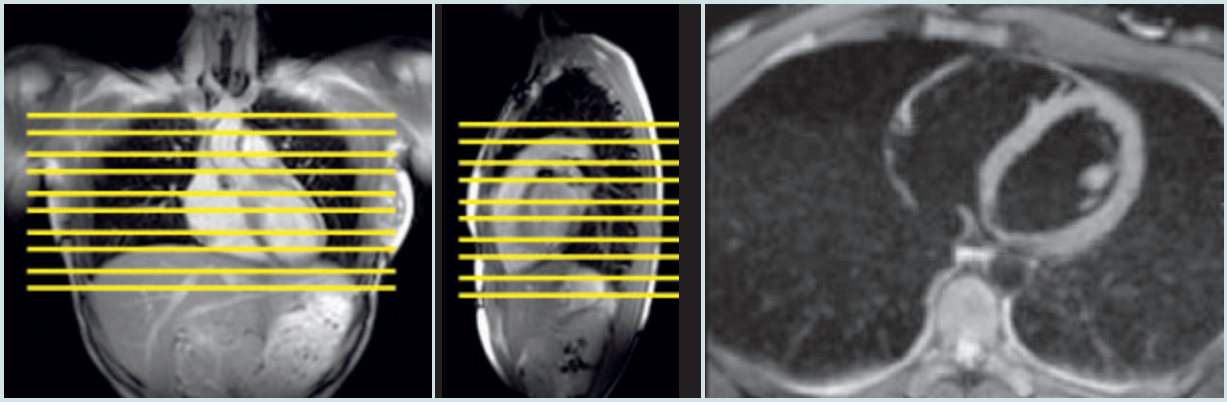
3. Axial Cine: prescribe 10 slices from coronal and sagittal views, adjust gap to cover entire right ventricle and outflow tract, free breathing, retrospective gating.



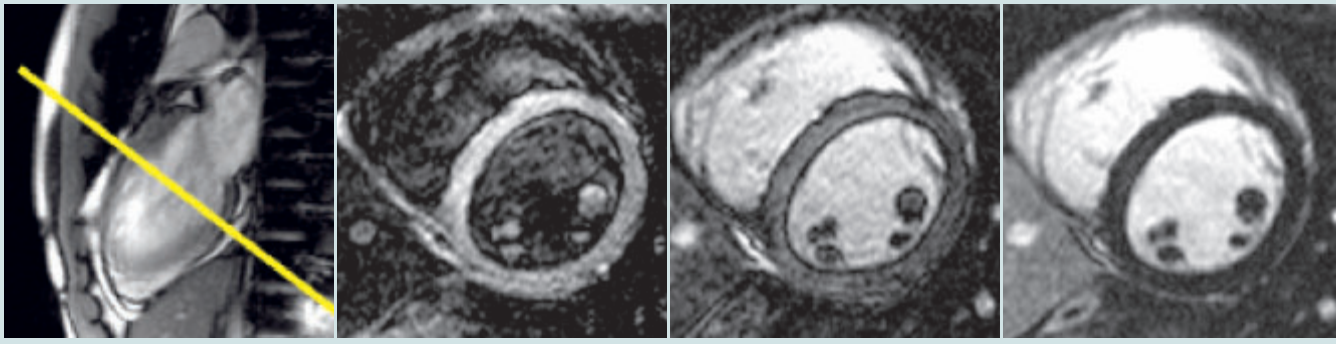
4. OPT Axial DarkBlood HASTE: optional, prescribe 10 slices, for selected slice levels of right ventricle, DarkBlood HASTE, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



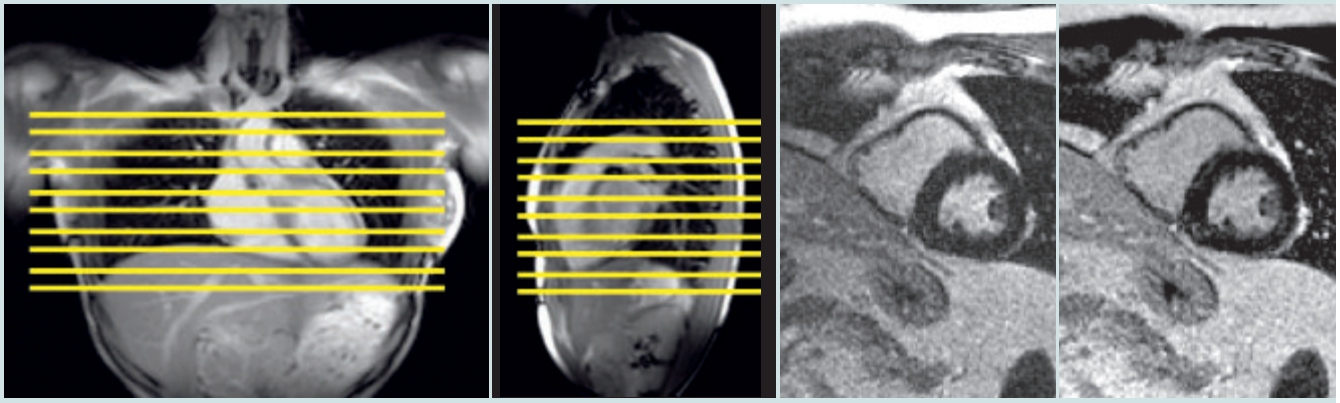
5. OPT Axial DarkBlood HASTE Fatsat: optional, prescribe 10 slices, for selected slice levels of right ventricle, DarkBlood HASTE with fatsat, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



6. TI Scout*: determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for optimal acquisition window.



7. Axial Delayed: prescribe 10 slices, single shot phase sensitive inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium, adjust gap to cover entire right ventricle and outflow tract, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

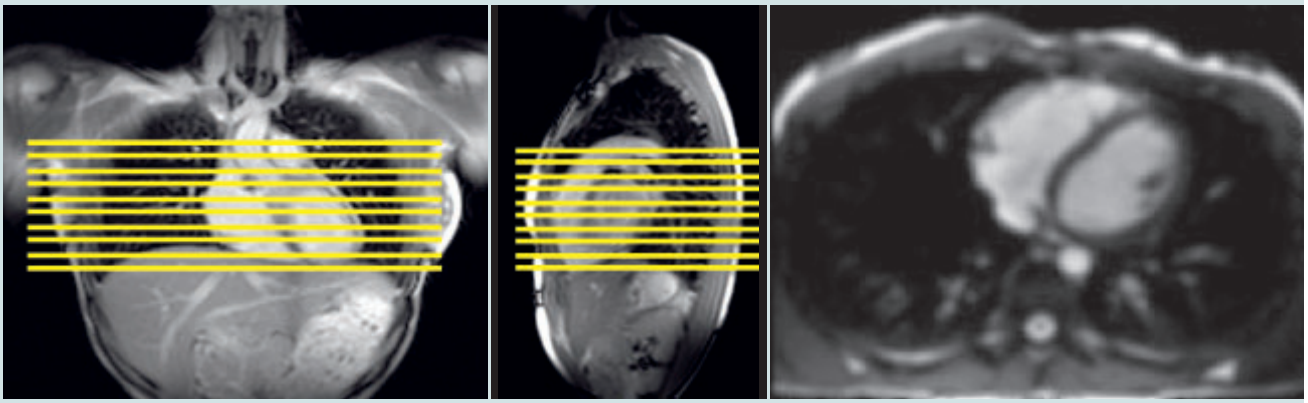
ARVC

Extreme Arrhythmia –Free Breathing & Non Triggered

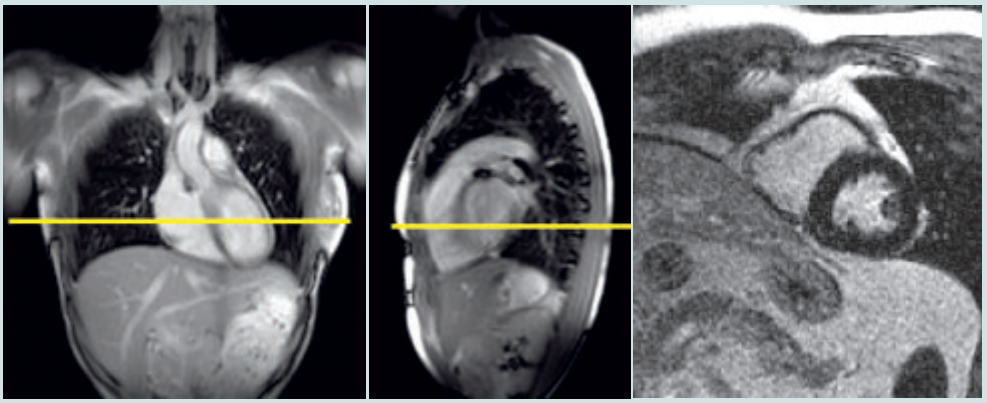
1. Localizers Module (p. 10)

2. LV Function Module (p. 17)

3. Axial Cine Realtime: prescribe 10 slices from coronal and sagittal views, adjust gap to cover entire right ventricle and outflow tract, untriggered free breathing, scans for 3 seconds per slice.



4. Axial Delayed: prescribe 1 slice, single shot inversion recovery TrueFISP technique, adjust TI for nulling of normal myocardium*, untriggered free breathing.



* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

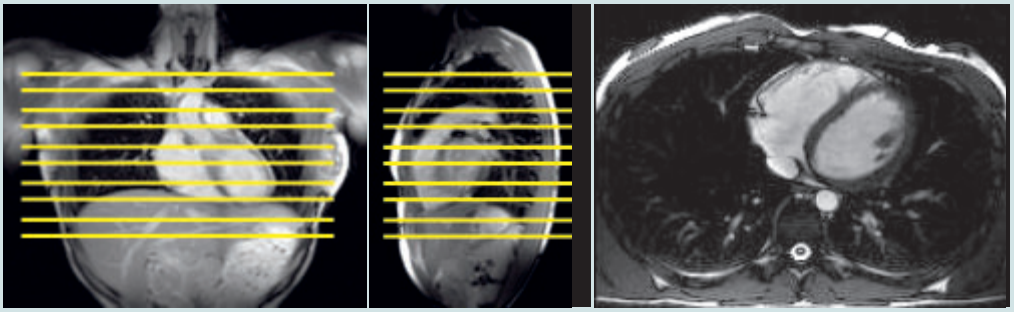
Congenital Heart Disease

Adults – Breath Hold & Triggered

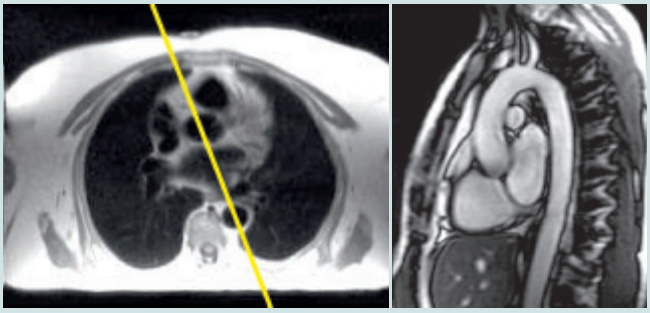
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

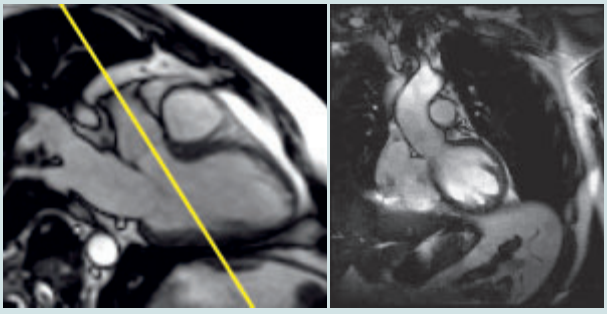
3. Axial Aorta Cine: prescribe 10 axial slices from coronal and sagittal views, adjust gap to cover from above aortic arch to below apex, multiple breath-holds, retrospective gating.



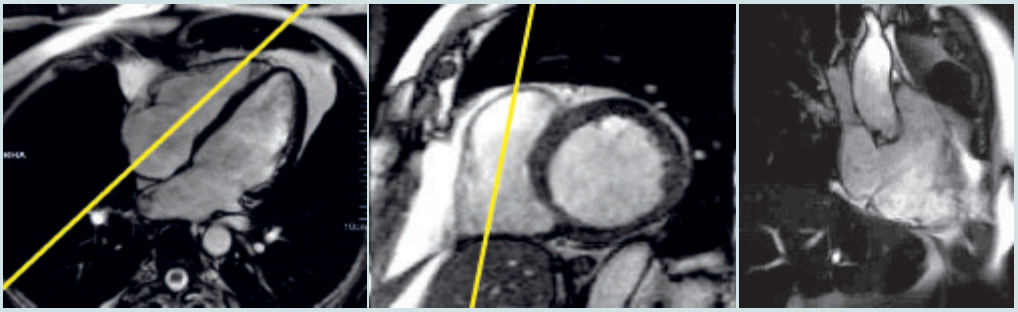
4. Sagittal Aorta Cine: prescribe 1 sagittal oblique "candy cane" slice from axial view, single breathhold, retrospective gating.



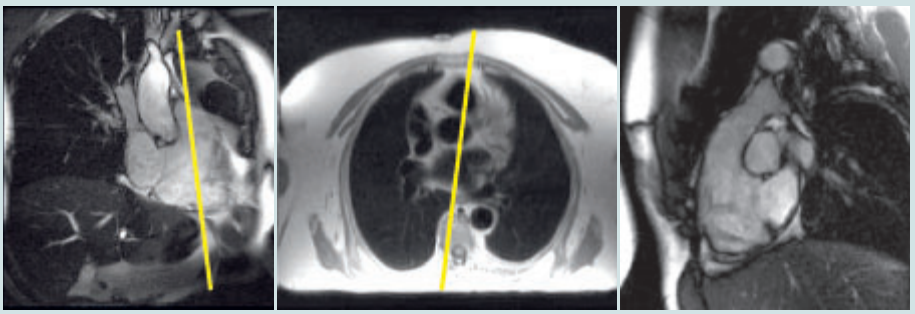
5. Coronal Aorta Cine: prescribe 1 coronal oblique aortic outflow slice from three-chamber view, bisect LV outflow tract, aortic valve, and ascending aorta, single breathhold, retrospective gating.



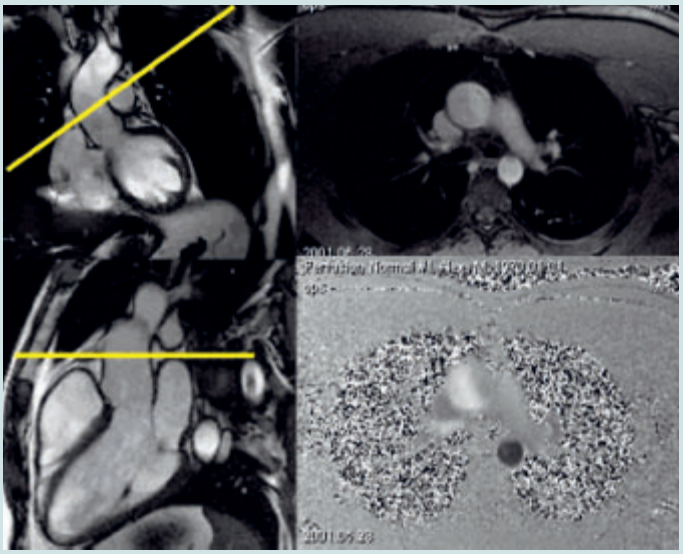
6. **Right Ventricular Long Axis Cine:** prescribe 1 right ventricular long axis slice from four-chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, single breathhold, retrospective gating.



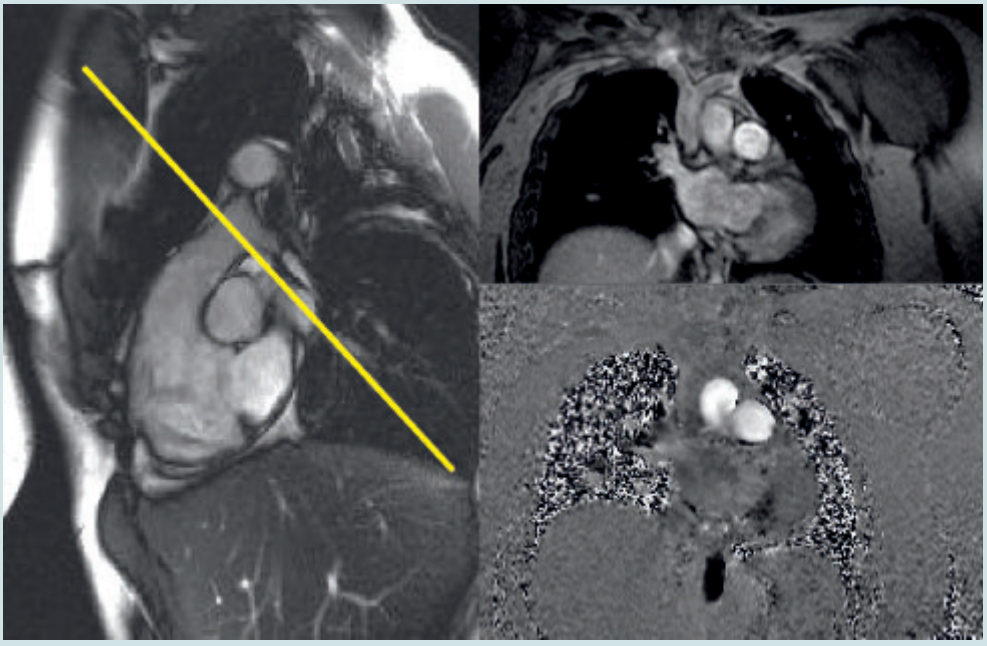
7. **Pulmonary Outflow Cine:** prescribe 1 slice from right ventricular long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, single breathhold, retrospective gating.



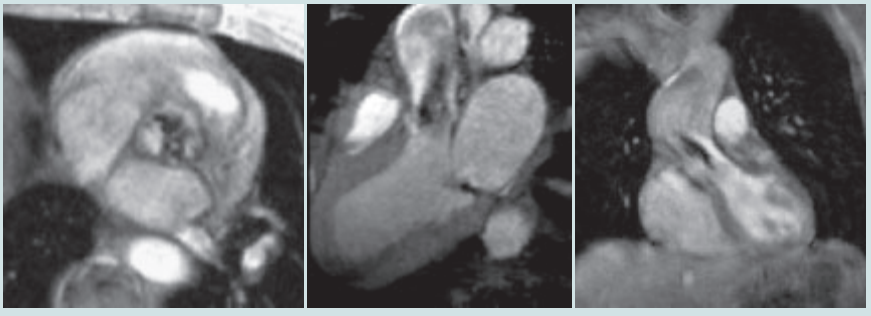
8. **Aorta Through-Plane Flow:** prescribe from three-chamber view and coronal aorta view, 1 cross-sectional slice perpendicular to ascending aorta distal to valve leaflet tips, repeat 1 cross-sectional slice across aortic valve orifice, through-plane VENC 150 cm/sec for normal flow or 250 cm/sec for mild stenosis, single breathhold, retrospective gating.



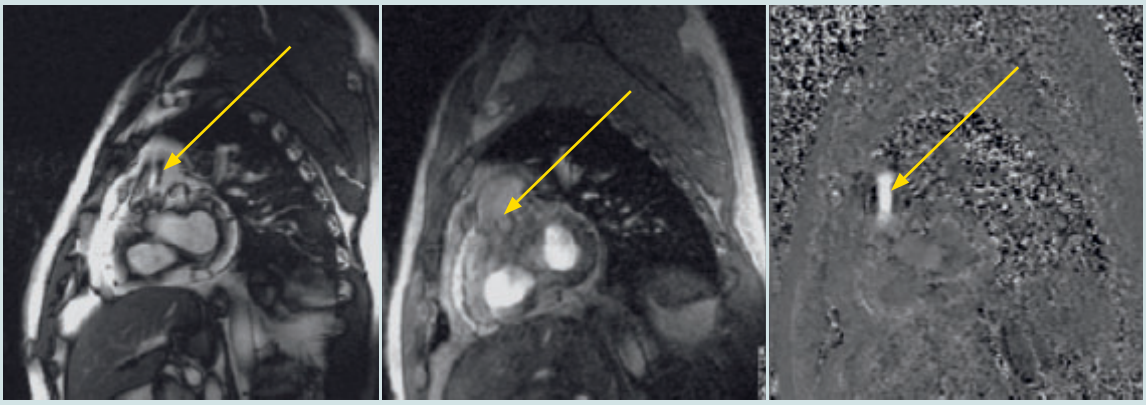
9. Pulmonary Through-Plane Flow: prescribe from pulmonary outflow view, 1 cross-sectional slice perpendicular to main pulmonary artery distal to valve leaflet tips, repeat 1 cross-sectional slice across pulmonic valve orifice, through-plane VENC 90 cm/sec for normal flow or 150 cm/sec for mild stenosis, single breathhold, retrospective gating.



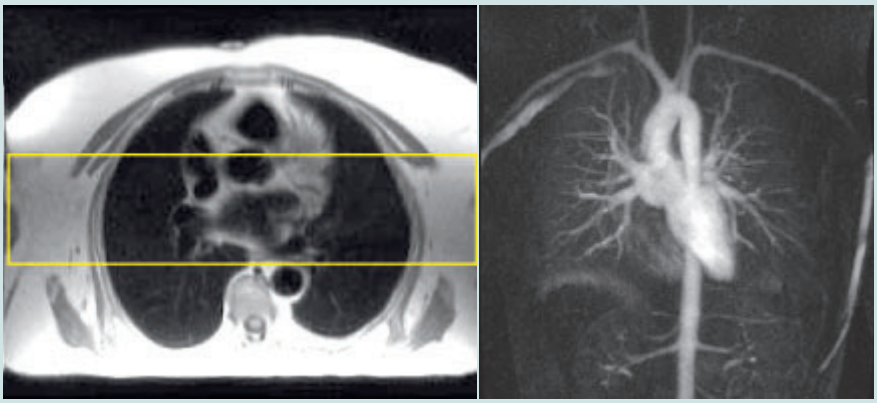
10. OPT Stenotic Jet GRE Cine: optional, selectively prescribe 1 sice in the best view to see the flow jet, GRE sequence with long TE, single breathhold, retrospective gating.



11. **OPT Shunt In-Plane Flow:** optional, selectively prescribe 1 sice in the best view to see the shunt, select appropriate in-plane VENC for direction and velocity of shunt flow, used for visualization only, single breathhold, retrospective gating.



12. **Coronal Dynamic:** prescribe 1 slab in coronal view through lungs and aorta from axial view, 5 measurements of 7 seconds each, first one is subtraction mask, untriggered breath hold, automatic subtraction and MIP.



Congenital Heart Disease

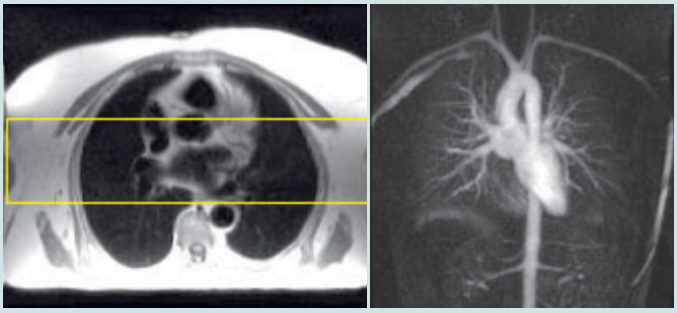
Children & Infants – Free Breathing & Triggered

1. Same protocols as for **Adults (p. 69),** but with higher spatial resolution as well as temporal resolution and with free-breathing techniques.

Congenital Heart Disease

syngo TWIST Option – Free Breathing & Non Triggered

1. **Coronal Dynamic TWIST:** prescribe 1 slab in coronal view through lungs and aorta from axial view, _syngo_ TWIST technique with temporal resolution of 3.0 seconds, 12 measurements, untriggered free breathing, automatic subtraction and MIP.



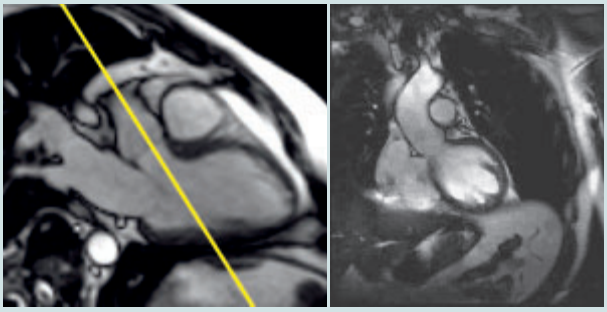
Valvular Heart Disease

Recommended – Breath Hold & Triggered

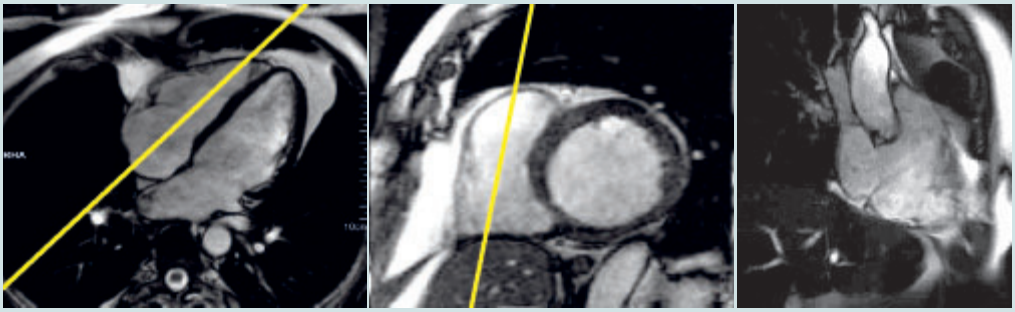
1. **Localizers Module (p. 6)**

2. **LV Function Module (p. 13)**

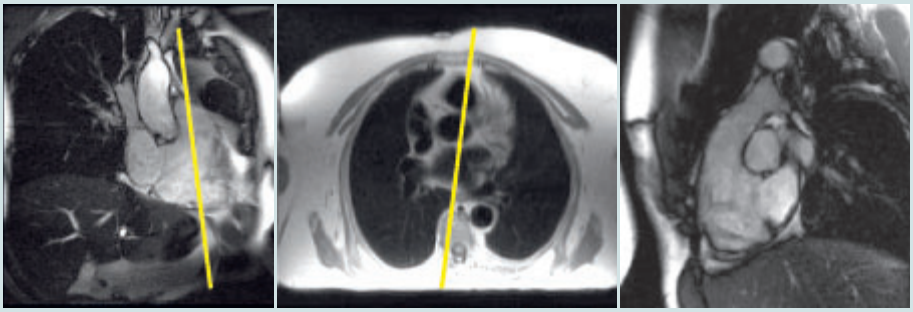
3. **Coronal Aorta Cine:** prescribe 1 coronal oblique aortic outflow slice from three-chamber view, bisect LV outflow tract, aortic valve, and ascending aorta, rotate FoV to avoid wrap, single breathhold, retrospective gating.



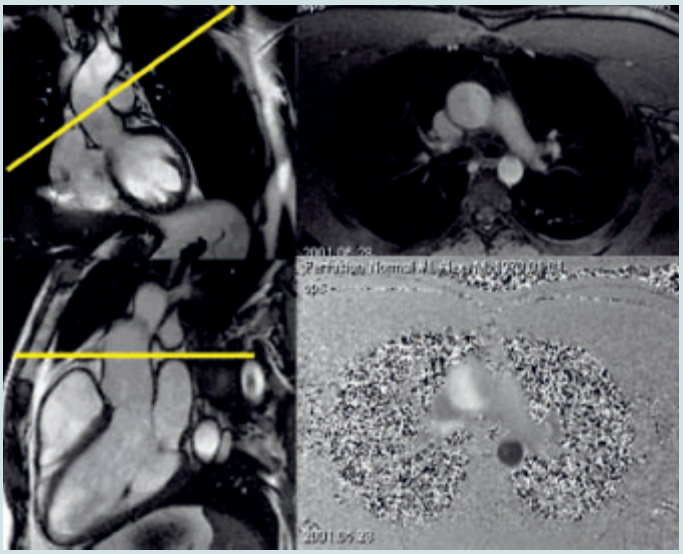
4. **RV Long Axis Cine:** prescribe 1 right ventricular long axis slice from four-chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, rotate FoV to avoid wrap, single breathhold, retrospective gating.



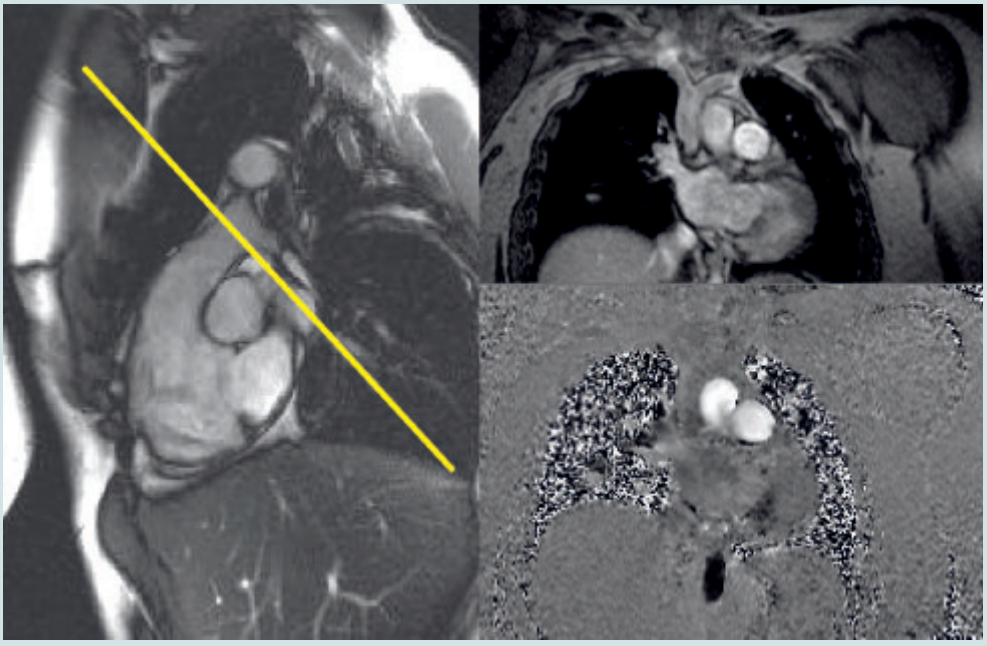
5. **Pulmonary Outflow Cine:** prescribe 1 slice from right ventricular long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, rotate FoV to avoid wrap, single breathhold, retrospective gating.



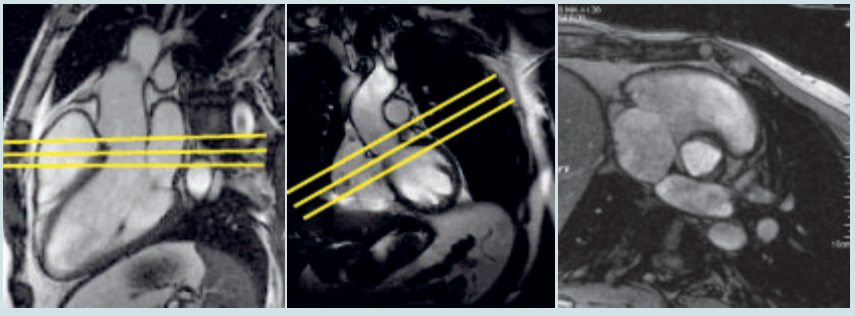
6. **Aorta Through Plane Flow:** prescribe from three-chamber view and coronal aorta view, 1 cross-sectional slice perpendicular to ascending aorta distal to valve leaflet tips, repeat 1 cross-sectional slice across aortic valve orifice, through-plane VENC 150 cm/sec for normal flow or 250 cm/sec for mild stenosis, single breathhold, retrospective gating.



7. Pulmonary Through-Plane Flow: prescribe from pulmonary outflow view, 1 cross-sectional slice perpendicular to main pulmonary artery distal to valve leaflet tips, repeat 1 cross-sectional slice across pulmonic valve orifice, through-plane VENC 90 cm/sec for normal flow or 150 cm/sec for mild stenosis, single breathhold, retrospective gating.

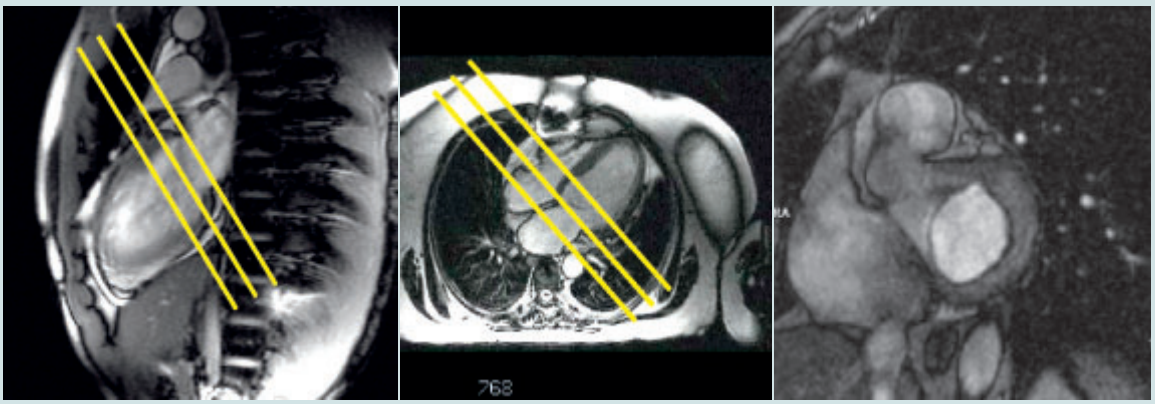


8. OPT Aortic Valve Cine: optional, prescribe from three-chamber and coronal aorta views, 3 cross-sectional slices across aortic valve, rotate FoV to avoid wrap, multiple breathholds, retrospective gating.

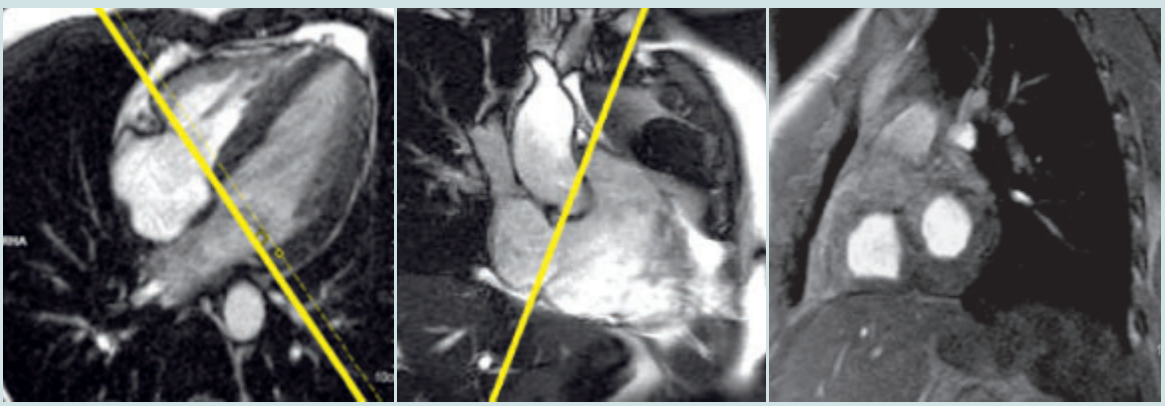


9. OPT Pulmonic Valve Cine: optional, prescribe from pulmonary outflow view, 3 cross-sectional slices across pulmonic valve, rotate FoV to avoid wrap, multiple breathholds, retrospective gating.

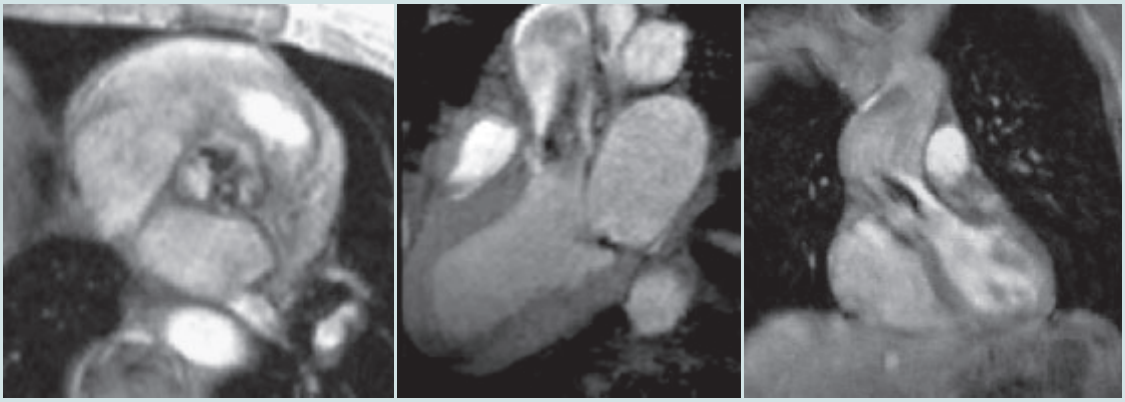
10. OPT Mitral Valve Cine: optional, prescribe from two-chamber and four-chamber views, 3 cross-sectional slices across mitral valve, rotate FoV to avoid wrap, multiple breathholds, retrospective gating.



11. OPT Tricuspid Valve Cine: optional, prescribe from four-chamber and right ventricular long axis views, 3 cross-sectional slices across tricuspid valve, rotate FoV to avoid wrap, multiple breathholds, retrospective gating.



12. **OPT Stenotic Jet GRE Cine:** optional, selectively prescribe 1 slice in the best view to see the flow jet, GRE sequence with long TE, single breath-hold, retrospective gating.



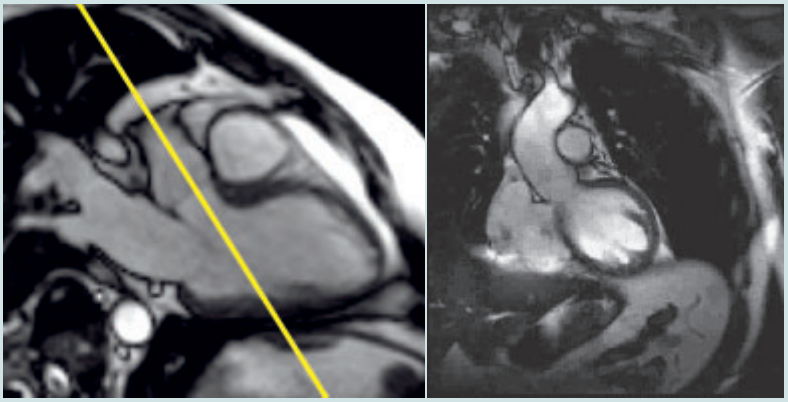
Valvular Heart Disease

Free Breathing & Triggered

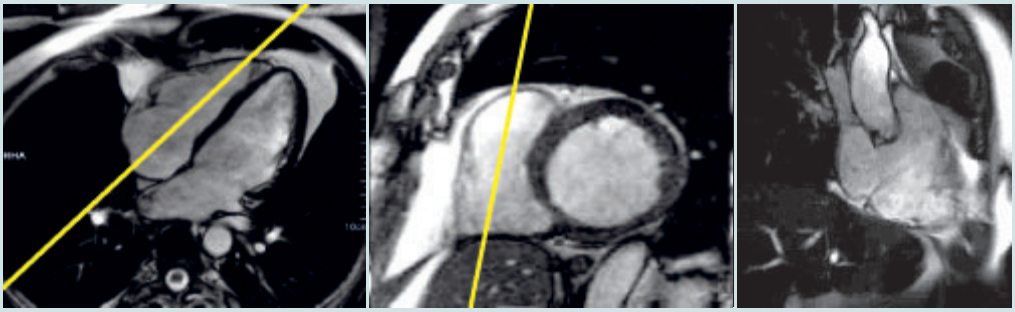
1. **Localizers Module** **(p. 8)**

2. **LV Function Module** **(p. 15)**

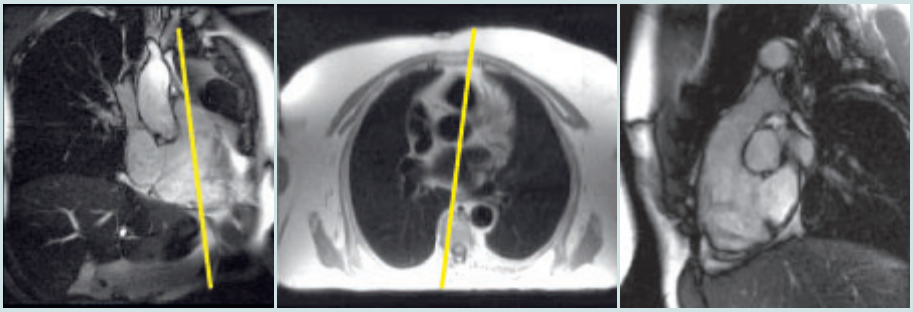
3. **Coronal Aorta Cine:** prescribe 1 coronal oblique aortic outflow slice from three-chamber view, bisect LV outflow tract, aortic valve, and ascending aorta, rotate FoV to avoid wrap, free breathing, retrospective gating.



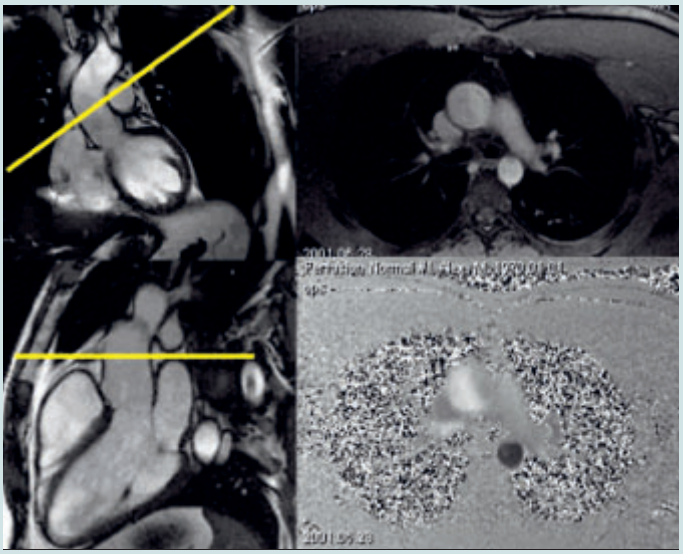
4. **RV Long Axis Cine:** prescribe 1 right ventricular long axis slice from four-chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, rotate FoV to avoid wrap, free breathing, retrospective gating.



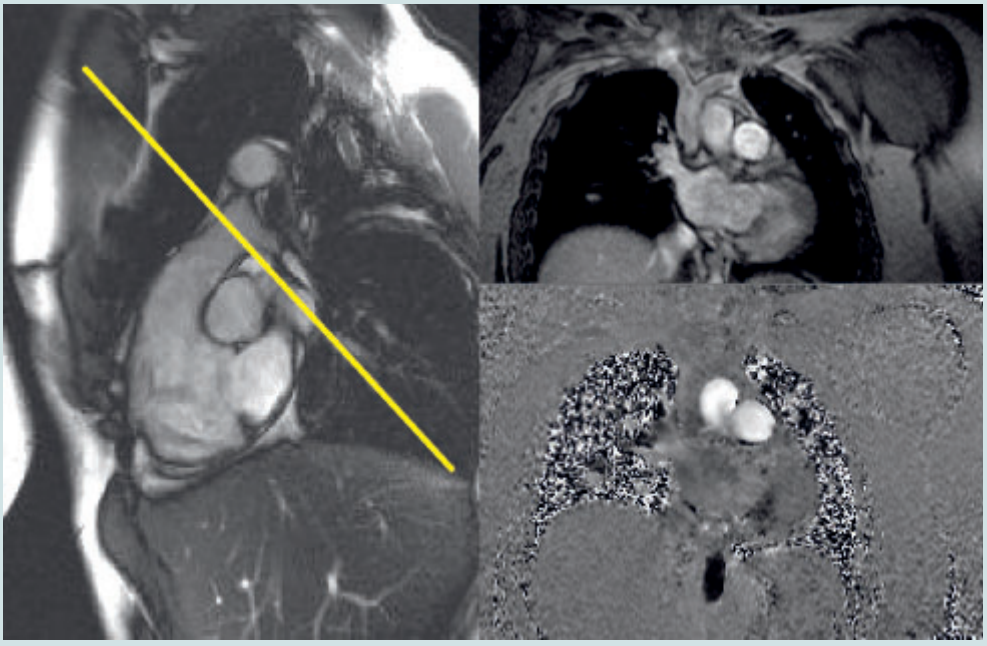
5. **Pulmonary Outflow Cine:** prescribe 1 slice from right ventricular long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, rotate FoV to avoid wrap, free breathing, retrospective gating.



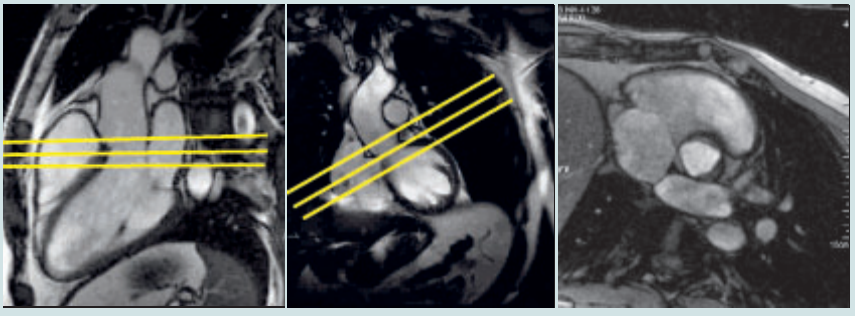
6. **Aorta Through-Plane Flow:** prescribe from three-chamber view and coronal aorta view, 1 cross-sectional slice perpendicular to ascending aorta distal to valve leaflet tips, repeat 1 cross-sectional slice across aortic valve orifice, through-plane VENC 150 cm/sec for normal flow or 250 cm/sec for mild stenosis, free breathing, retrospective gating.



7. Pulmonary Through-Plane Flow: prescribe from pulmonary outflow view, 1 cross-sectional slice perpendicular to main pulmonary artery distal to valve leaflet tips, repeat 1 cross-sectional slice across pulmonic valve orifice, through-plane VENC 90 cm/sec for normal flow or 150 cm/sec for mild stenosis, free breathing, retrospective gating.

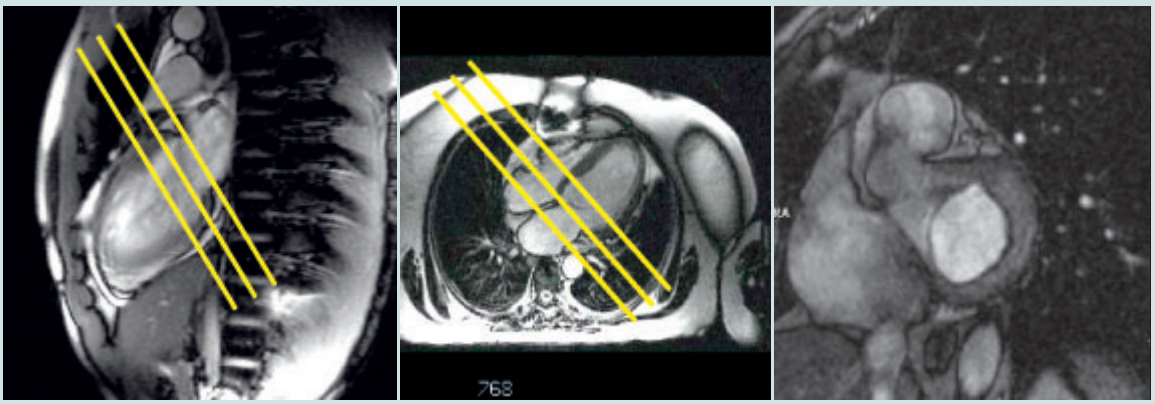


8. OPT Aortic Valve Cine: optional, prescribe from three-chamber and coronal aorta views, 3 cross-sectional slices across aortic valve, rotate FoV to avoid wrap, free breathing, retrospective gating.

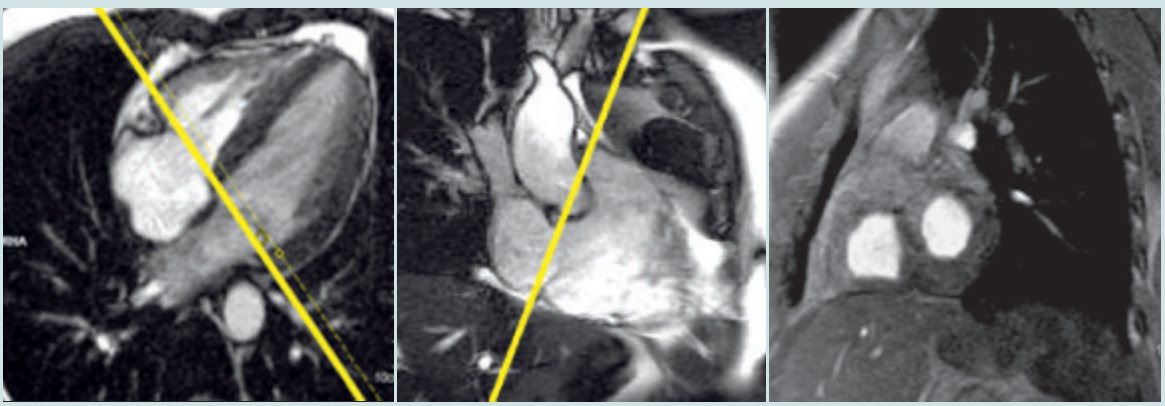


9. OPT Pulmonic Valve Cine: optional, prescribe from pulmonary outflow view, 3 cross-sectional slices across pulmonic valve, rotate FoV to avoid wrap, free breathing, retrospective gating.

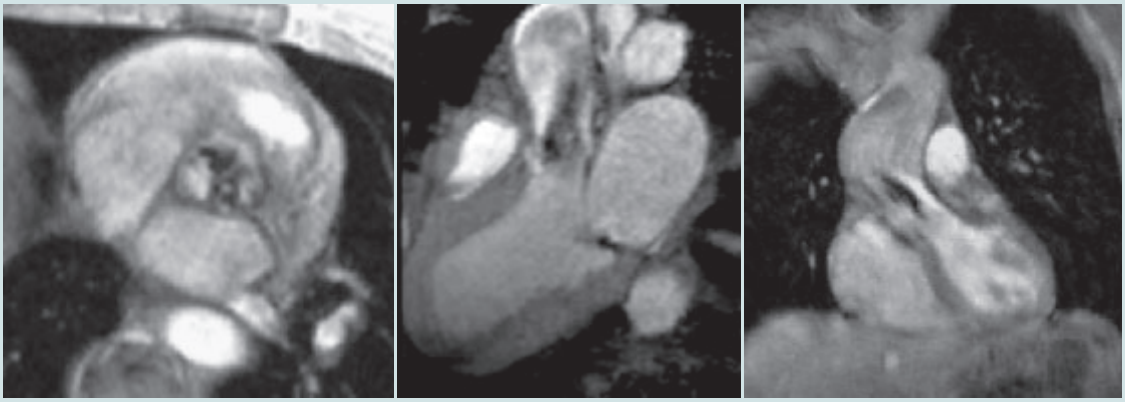
10. OPT Mitral Valve Cine: optional, prescribe from two-chamber and four-chamber views, 3 cross-sectional slices across mitral valve, rotate FoV to avoid wrap, free breathing, retrospective gating.



11. OPT Tricuspid Valve Cine: optional, prescribe from four-chamber and right ventricular long axis views, 3 cross-sectional slices across tricuspid valve, rotate FoV to avoid wrap, free breathing, retrospective gating.



12. **OPT Stenotic Jet GRE Cine:** optional, selectively prescribe 1 slice in the best view to see the flow jet, GRE sequence with long TE, free breathing, retrospective gating.



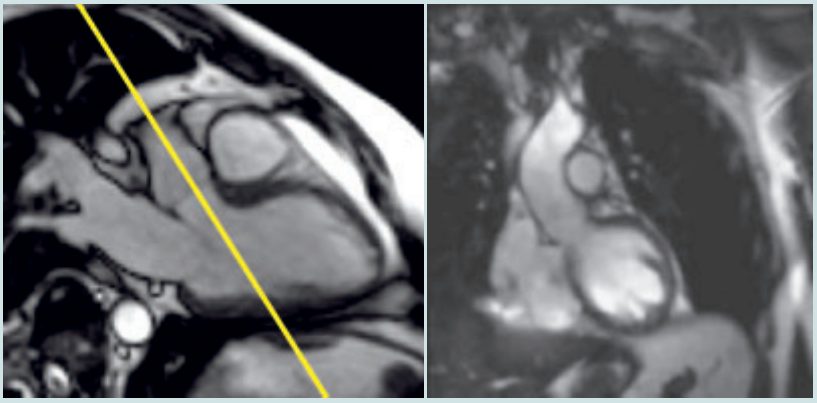
Valvular Heart Disease

Extreme Arrhythmia – Free Breathing & Non Triggered

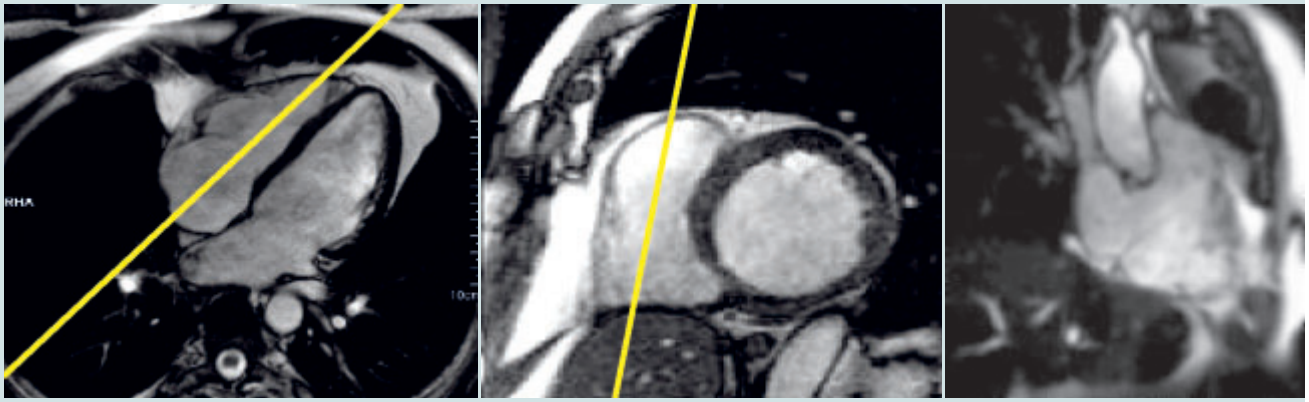
1. Localizers Module (p. 10)

2. LV Function Module (p. 17)

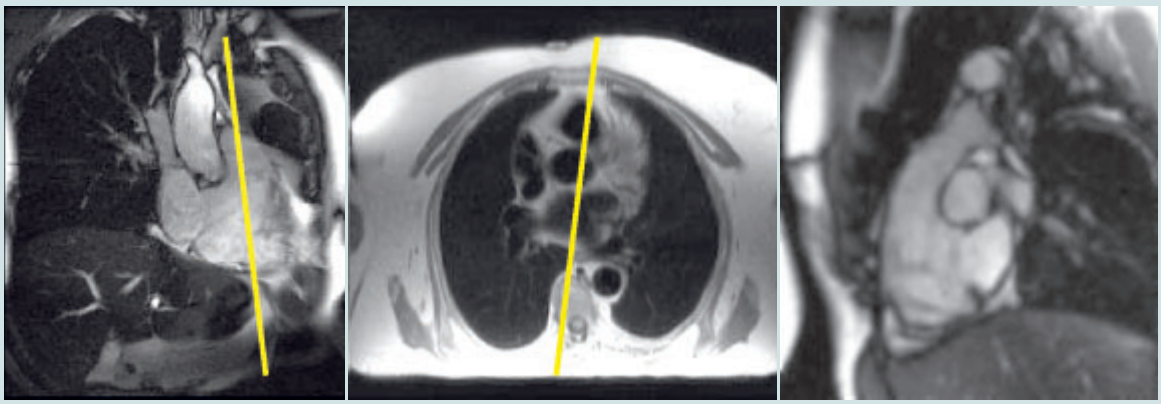
3. **Coronal Aorta Cine Realtime:** prescribe 1 coronal oblique aortic outflow slice from three-chamber view, bisect LV outflow tract, aortic valve, and ascending aorta, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



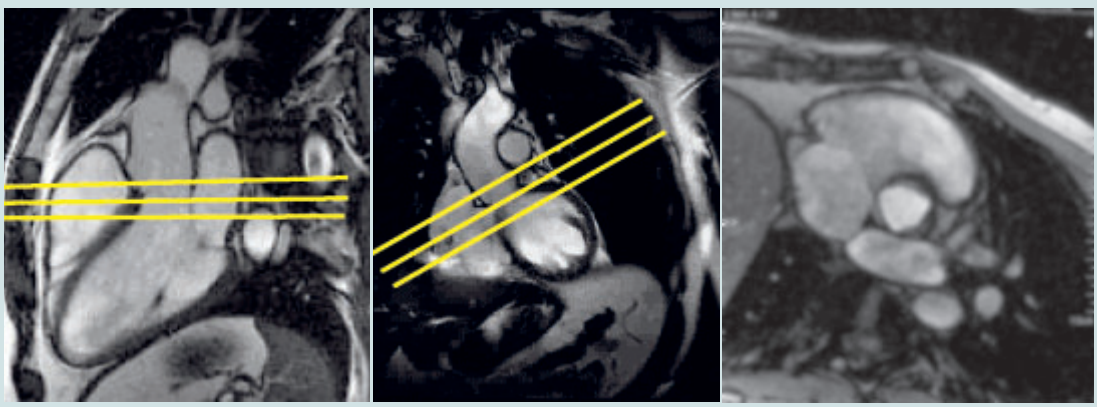
4. RV Long Axis Cine Realtime: prescribe 1 right ventricular long axis slice from four-chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



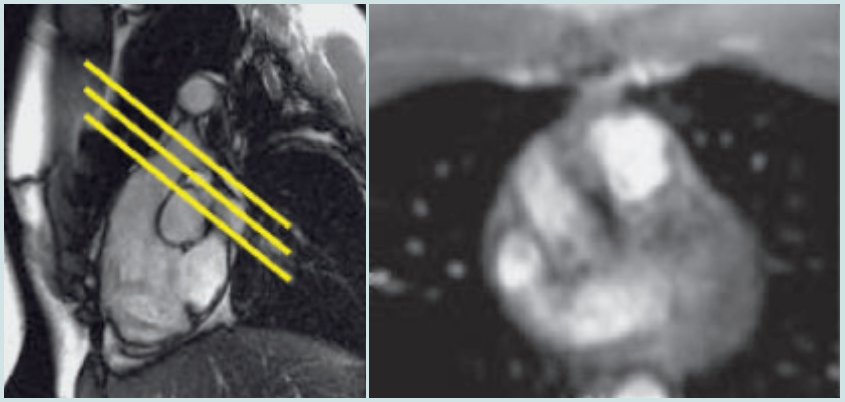
5. Pulmonary Outflow Cine Realtime: prescribe 1 slice from right ventricular long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



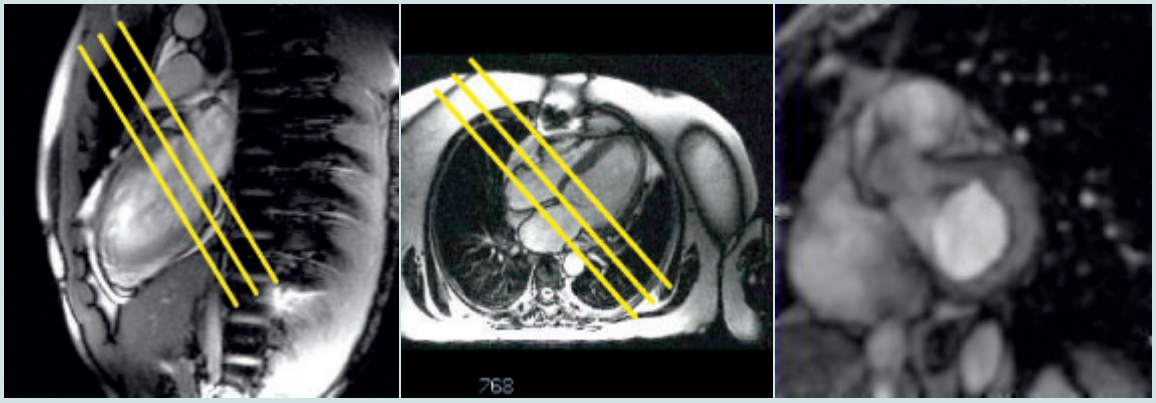
6. OPT Aortic Valve Cine Realtime: optional, prescribe from three-chamber and coronal aorta views, 3 cross-sectional slices across aortic valve, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



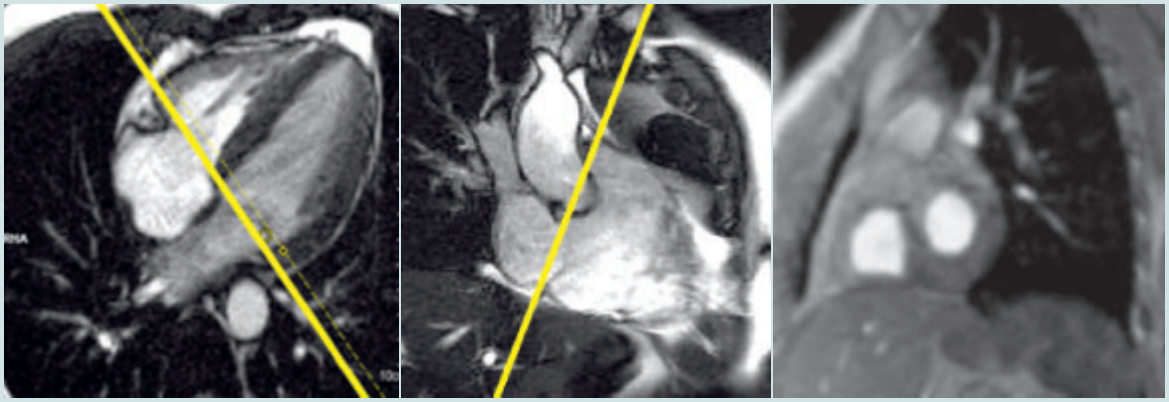
7. OPT Pulmonic Valve Cine Realtime: optional, prescribe from pulmonary outflow view, 3 cross-sectional slices across pulmonic valve, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



8. OPT Mitral Valve Cine Realtime: optional, prescribe from two-chamber and four-chamber views, 3 cross-sectional slices across mitral valve, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



9. OPT Tricuspid Valve Cine Realtime: optional, prescribe from four-chamber and right ventricular long axis views, 3 cross-sectional slices across tricuspid valve, rotate FoV to avoid wrap, untriggered free breathing, scans for 3 seconds per slice.



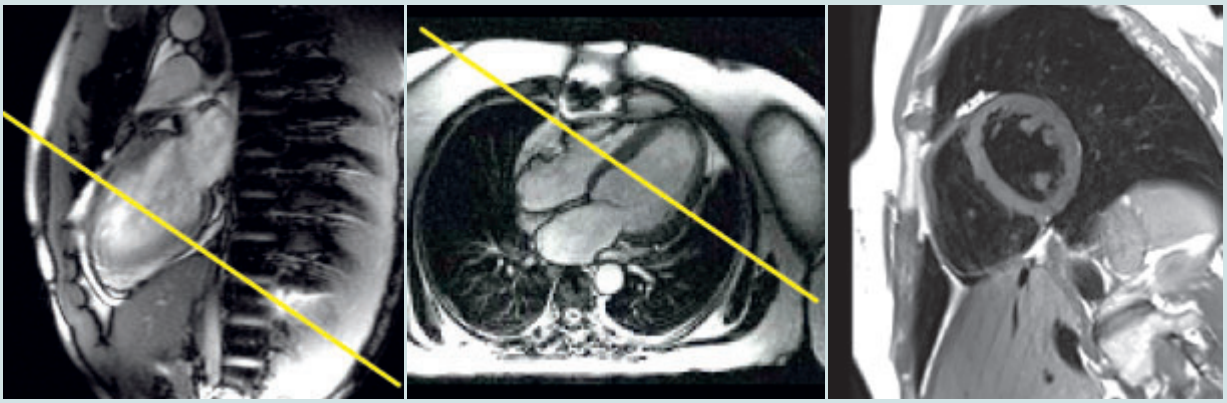
Pericardial Disease

Recommended – Breath Hold & Triggered

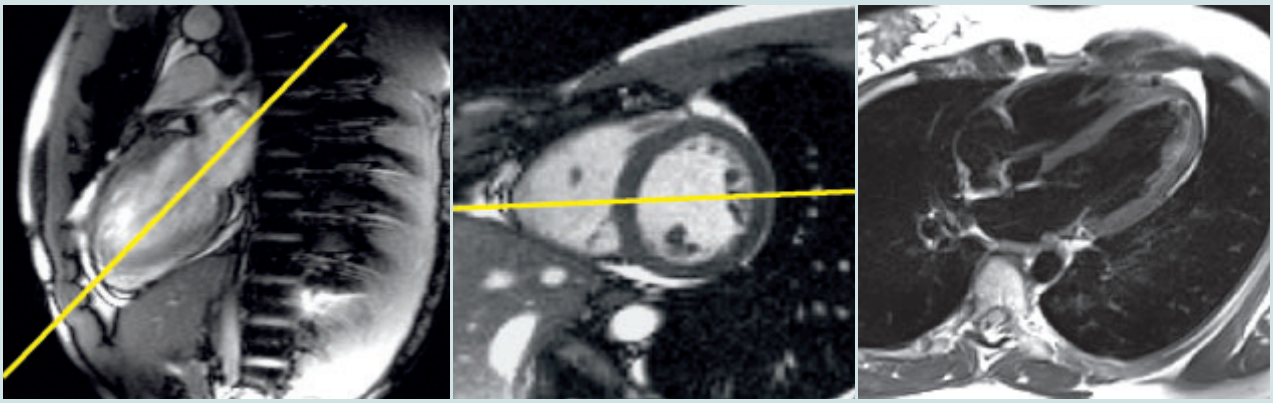
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

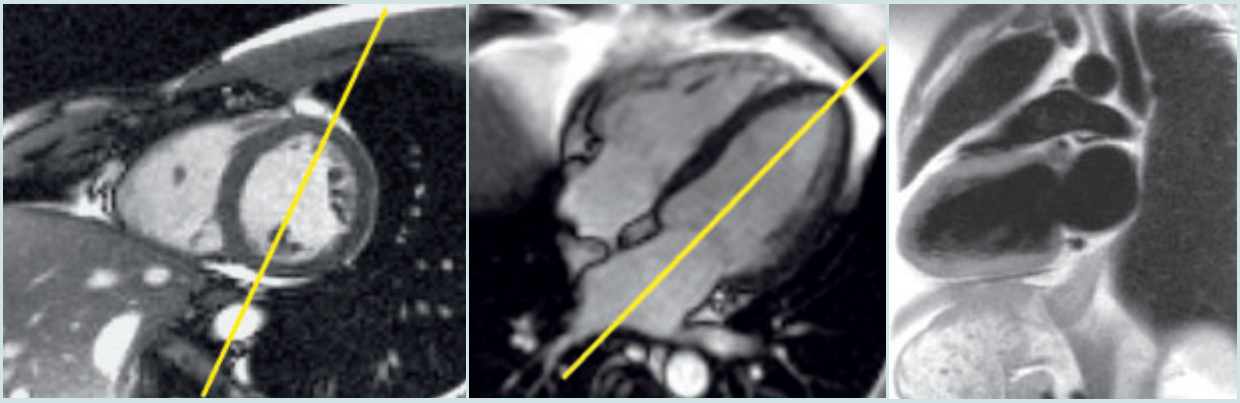
3. **Short Axis DarkBlood T2:** prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



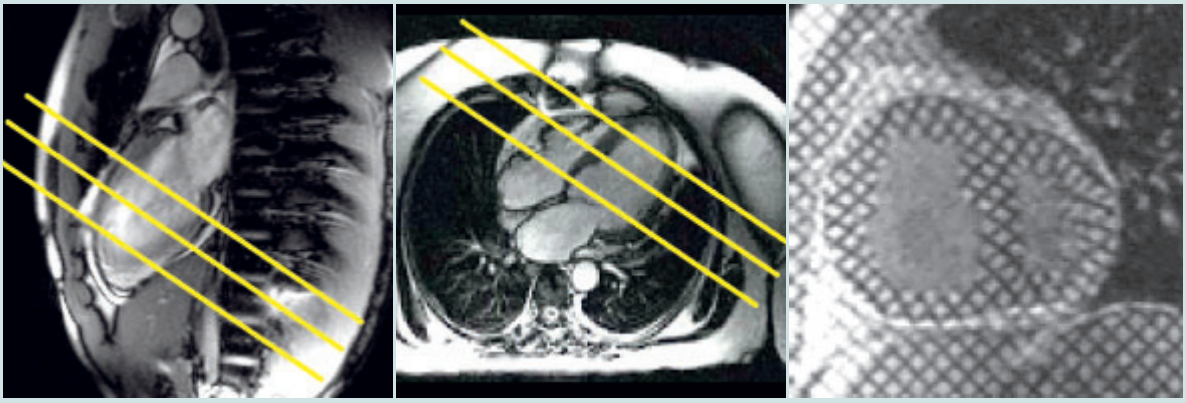
4. **Four-Chamber DarkBlood T2:** prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



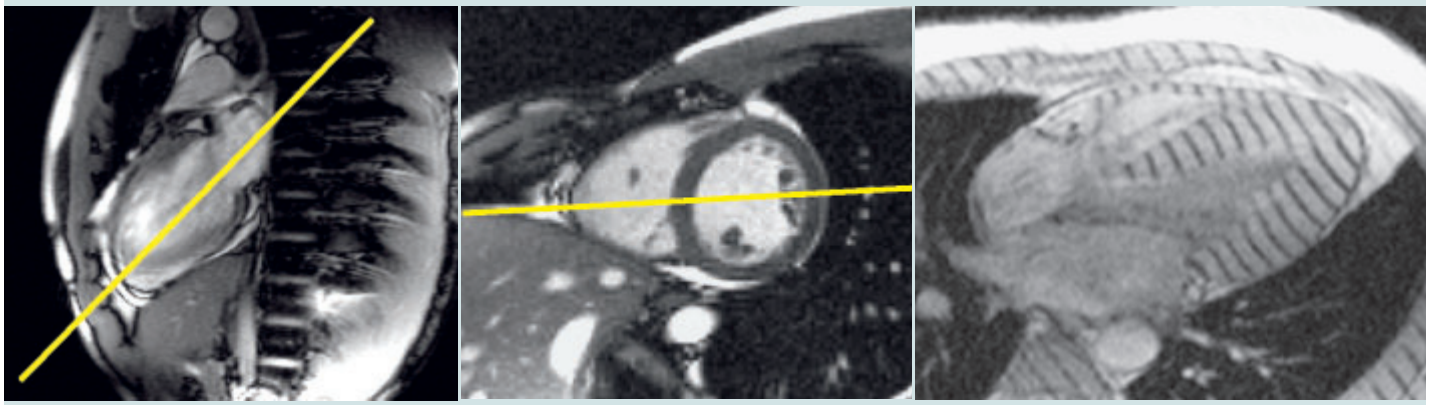
5. Two-Chamber DarkBlood T2: prescribe 1 slice, segmented DarkBlood TSE, rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



6. OPT Short Axis Grid Tag: optional, prescribe 3 slices and adjust gap to cover the base, mid, and apex levels, rotate FoV to avoid wrap, multiple breathholds, retrospective gating.



7. OPT Four-Chamber Line Tag: optional, prescribe 1 slice, rotate FoV to avoid wrap, single breathhold, prospective gating, capture cycle, rotate line tags to be perpendicular to ventricular septum.



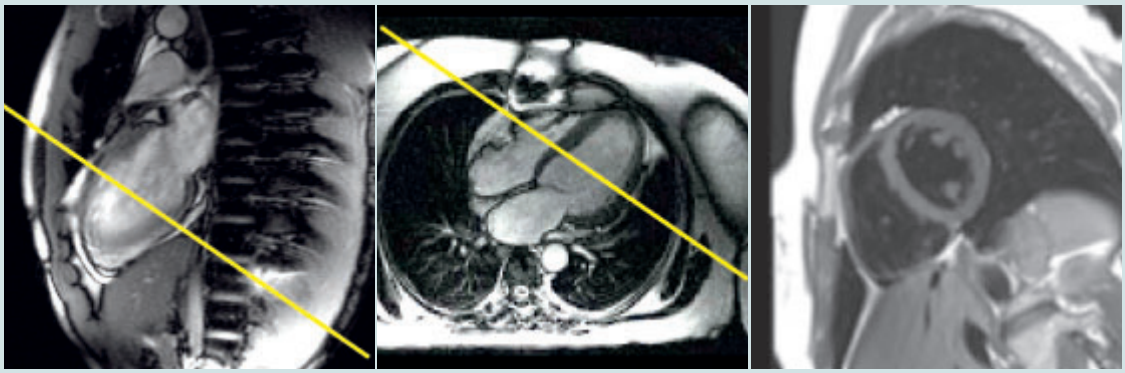
Pericardial Disease

Free Breathing & Triggered

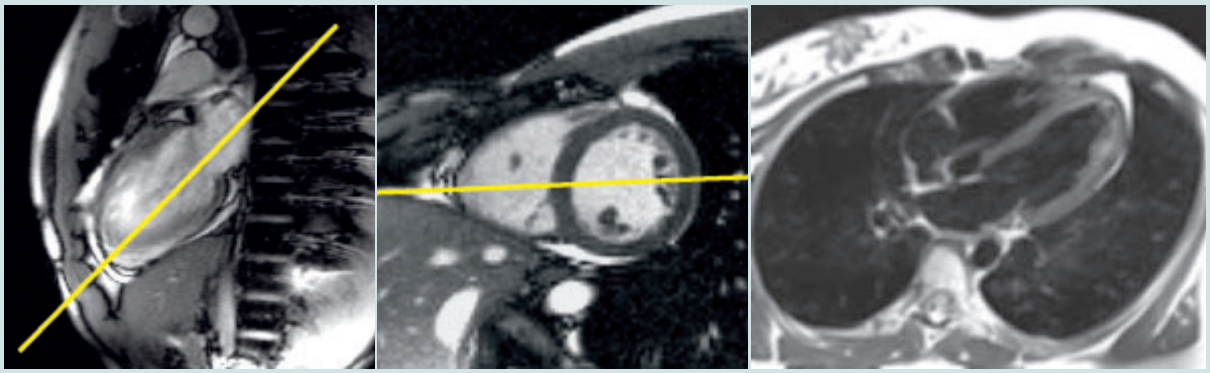
1. Localizers Module (p. 8)

2. LV Function Module (p. 15)

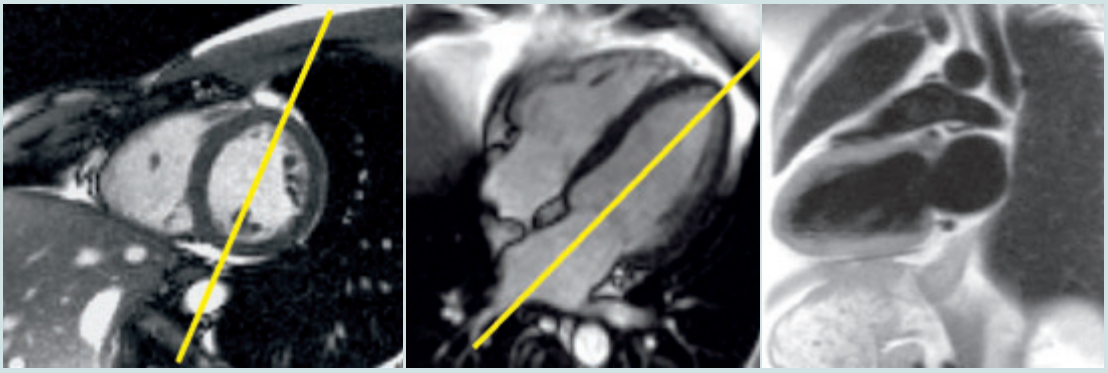
3. **Short Axis DarkBlood HASTE T2:** prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



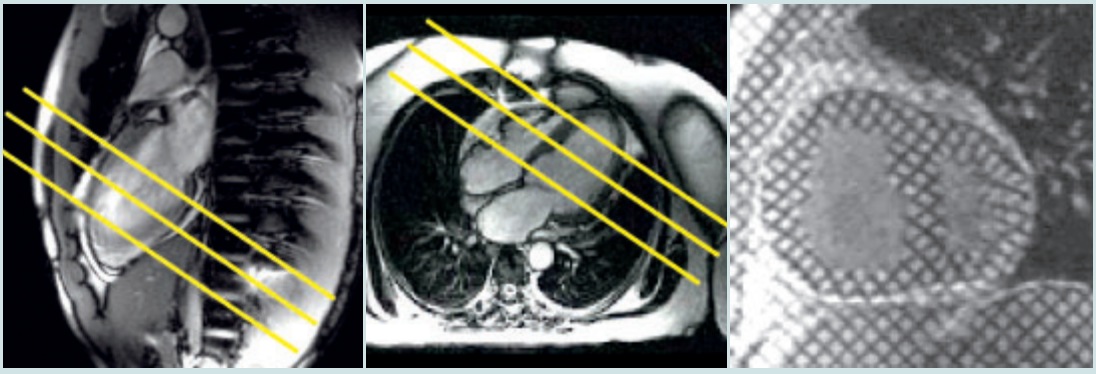
4. **Four-Chamber DarkBlood HASTE T2:** prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



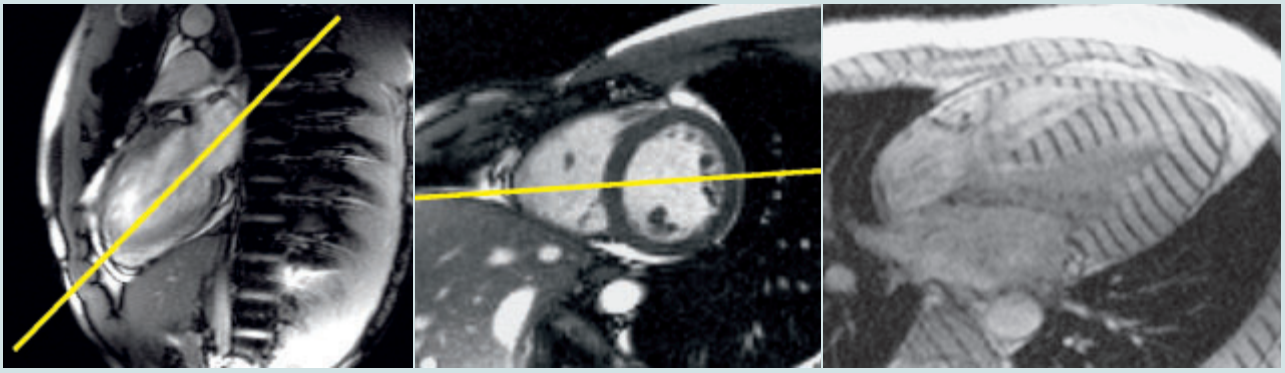
5. Two-Chamber DarkBlood HASTE T2: prescribe 1 slice, DarkBlood HASTE, rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



6. OPT Short Axis Grid Tag: optional, prescribe 3 slices and adjust gap to cover the base, mid, and apex levels, rotate FoV to avoid wrap, free breathing, retrospective gating.



7. OPT Four-Chamber Line Tag: optional, prescribe 1 slice, rotate FoV to avoid wrap, free breathing, prospective gating, capture cycle, rotate line tags to be perpendicular to ventricular septum.



8. Delayed Module (p. 24)

Pericardial Disease

Extreme Arrhythmia – Free Breathing & Non Triggered

1. Localizers Module (p. 10)

2. LV Function Module (p. 17)

3. Delayed Module (p. 26)

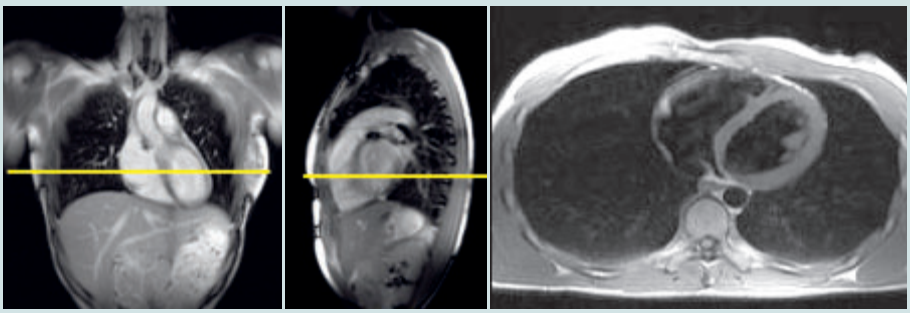
Cardiac Mass or Thrombus

Recommended – Breath Hold & Triggered

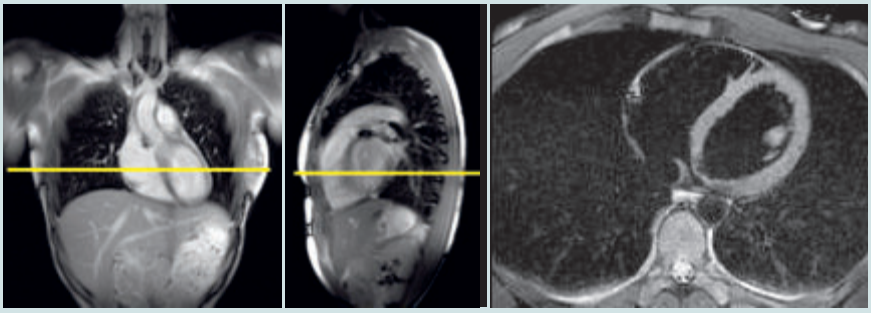
1. Localizers Module (p. 6)

2. LV Function Module (p. 13)

3. **DarkBlood T1:** for selected slice levels through mass or thrombus, segmented DarkBlood TSE T1-weighted, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.

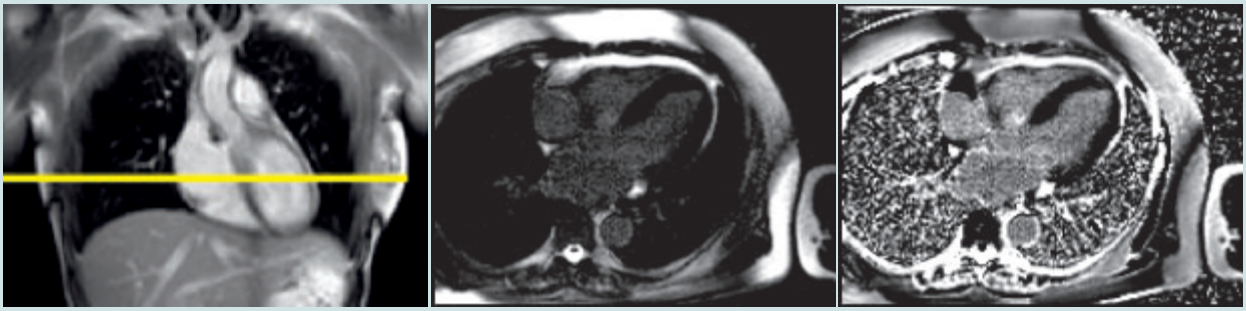


4. DarkBlood T2 Fatsat: for selected slice levels through mass or thrombus, segmented DarkBlood TSE T2-weighted with fatsat, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.

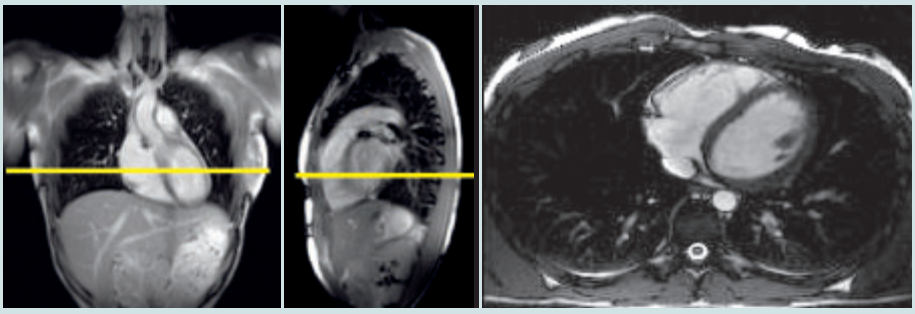


5. Dynamic Module (p. 19)

6. OPT T1: optional, for selected slice levels through mass or thrombus, acquire early after dynamic module, phase sensitive inversion recovery TurboFLASH technique, provides both magnitude and real images, adjust TI for nulling* of normal myocardium (be aware: thrombus nulling requires different TI than myocardial nulling), rotate FoV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



7. OPT Cine: optional, for selected slice levels through mass or thrombus, segmented TrueFISP cine, single breathhold, retrospective gating.



8. Delayed Module (p. 22)

* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

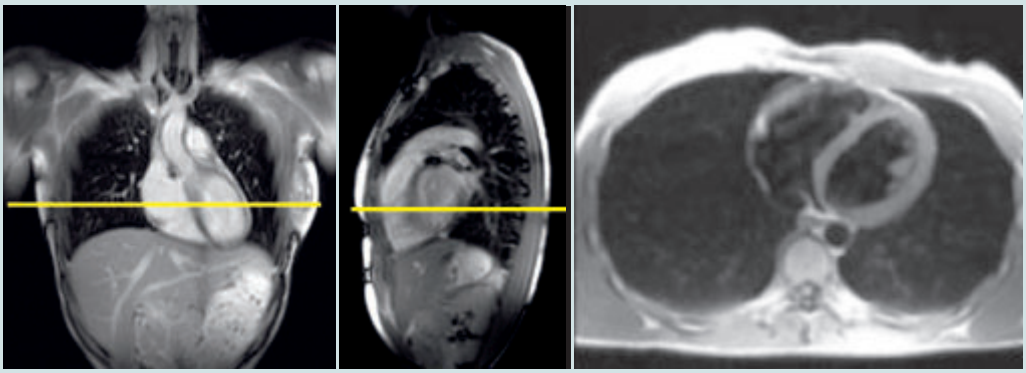
Cardiac Mass or Thrombus

Free Breathing & Triggered

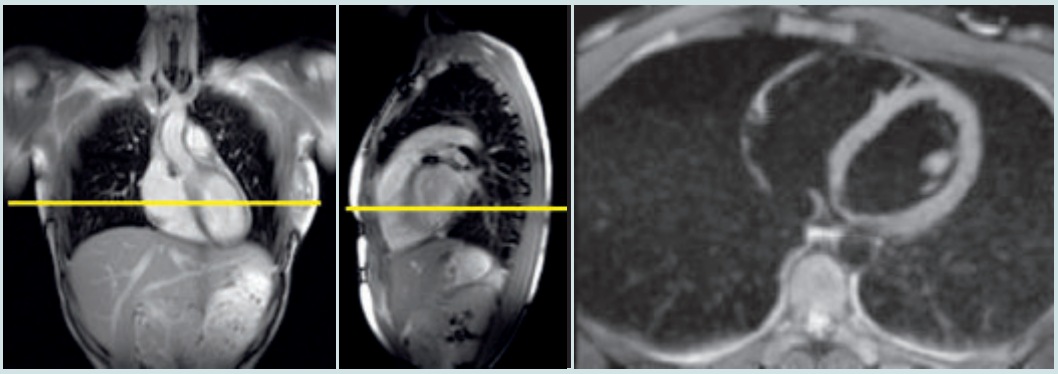
1. Localizers Module (p. 8)

2. LV Function Module (p. 15)

3. **DarkBlood HASTE:** for selected slice levels through mass or thrombus, DarkBlood HASTE, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.

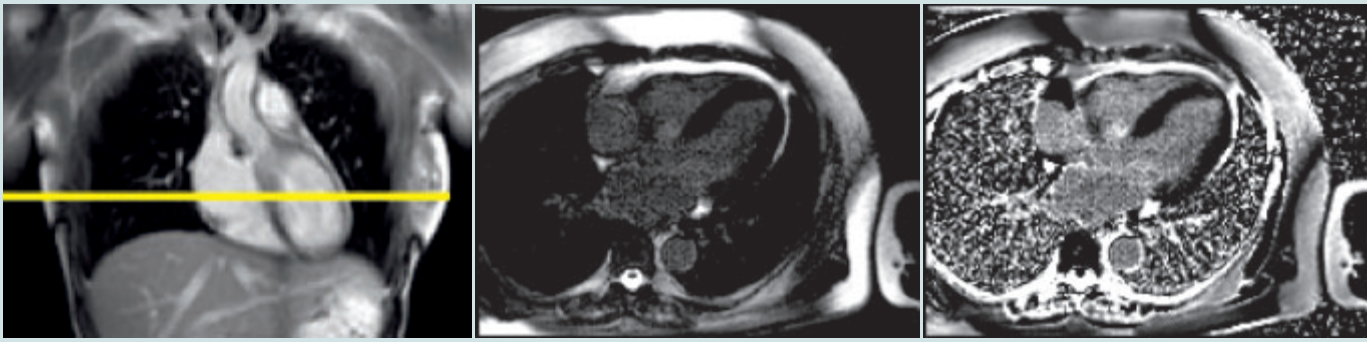


4. **DarkBlood HASTE Fatsat:** for selected slice levels through mass or thrombus, DarkBlood HASTE with fatsat, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.

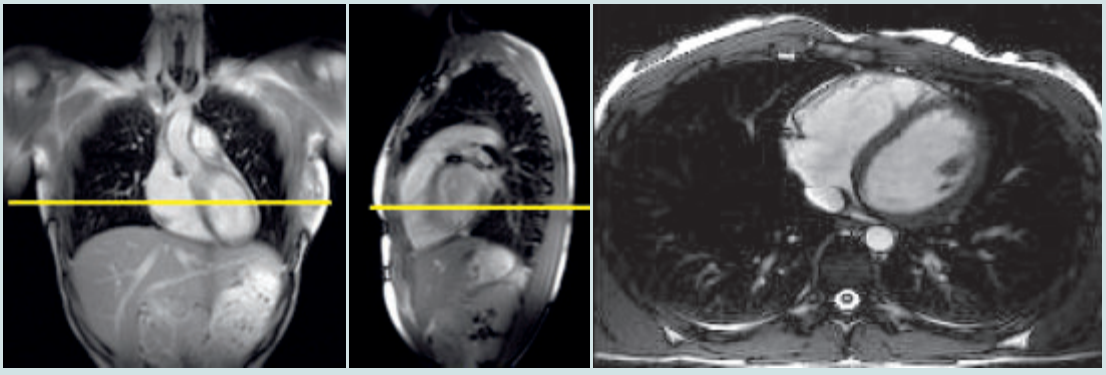


5. Dynamic Module (p. 20)

6. OPT T1: optional, for selected slice levels through mass or thrombus, acquire early after dynamic module, single shot phase sensitive inversion recovery TrueFISP technique, provides both magnitude and real images, adjust TI for nulling* of normal myocardium (be aware: thrombus nulling requires different TI than myocardial nulling), rotate FoV to avoid wrap, free breathing, trigger on every second heartbeat, capture cycle for diastolic gating.



7. OPT Cine: optional, for selected slice levels through mass or thrombus, segmented TrueFISP cine, free breathing, retrospective gating.



8. Delayed Module (p. 24)

* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

Cardiac Mass or Thrombus

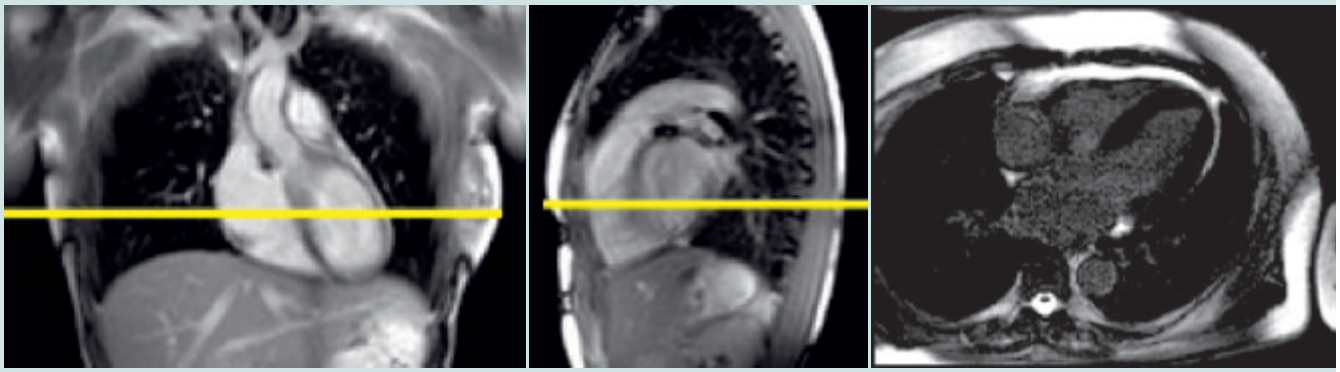
Extreme Arrhythmia – Free Breathing & Non Triggered

1. Localizers Module (p. 10)

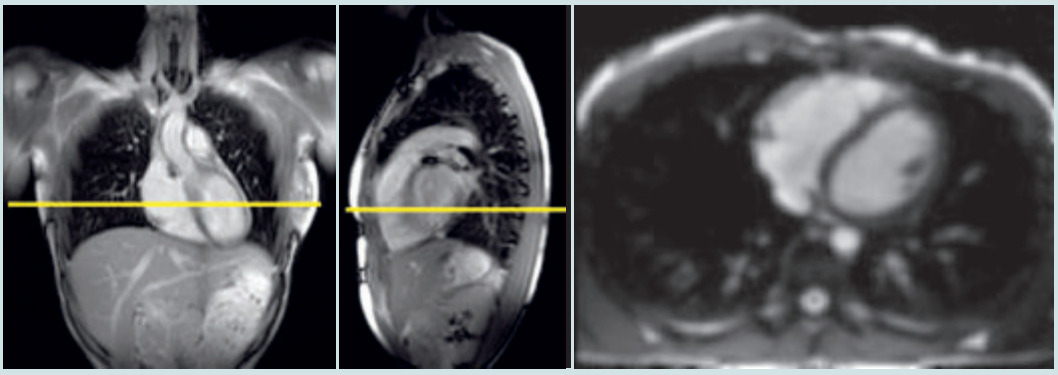
2. LV Function Module (p. 17)

3. Dynamic Module (p. 21)

4. OPT T1: optional, for selected slice levels through mass or thrombus, acquire early after dynamic module, single shot inversion recovery TrueFISP technique, adjust TI for nulling* of normal myocardium (be aware: thrombus nulling requires different TI than myocardial nulling), rotate FoV to avoid wrap, untriggered free breathing.



5. OPT Cine Realtime: optional, for selected slice levels through mass or thrombus, untriggered free breathing, scans for 3 seconds per slice.



6. Delayed Module (p. 26)

* When performing PSIR imaging, both PSIR and magnitude images are provided by the protocol. The TI scout helps to optimize the myocardial nulling on the magnitude image, but is not needed if only the PSIR images of the protocol are used for analysis.

The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.

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