SIEMENS

SCMR Recommended Cardiac MRI Protocols

User's Guide MAGNETOM Aera / MAGNETOM Skyra

For software version *syngo* MR D11D

www.siemens.com/magnetom-world

Introduction

This user's guide describes the SCMR recommended cardiac MRI protocols that have been clinically optimized for the Siemens MAGNETOM family of MRI scanners, including 3T MAGNETOM Skyra and 1.5T MAGNETOM Aera, with software version *syngo* MR D11D. The protocols described here do not use Dot. For the user's guide of the Dot protocols, please visit www.siemens.com/magnetom-world.

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: Breath-hold & 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.

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.

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.

You 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:
Any Siemens MAGNETOM MRI system with Tim technology:

- MAGNETOM Aera 1.5T
- MAGNETOM Skyra 3.0T

Software:
syngo MR D11D software level with cardiac and flow licenses:

- Advanced Cardiac – sequence package
- Advanced Angio – sequence package
- Flow Quantification – sequence package
- *syngo* TWIST – sequence package
- Dedicated post processing software is needed to evaluate flow dynamics and volumetric parameters (e.g *syngo*.MR 4D Ventricular Function)

Installation Procedure

- Obtain the appropriate protocol file for your system configuration
- Burn the protocol file onto a CD-ROM disk or thumb-drive memory stick, and insert it into your *syngo* host computer
- Use the Object > Import function on the *syngo* Exam Explorer to install the protocol file into your User Protocols list
- If your system is missing some of the software options listed above, the corresponding protocols will not import completely – verify you have all the required software licenses listed above

SCMR Recommended Cardiac MRI Protocols

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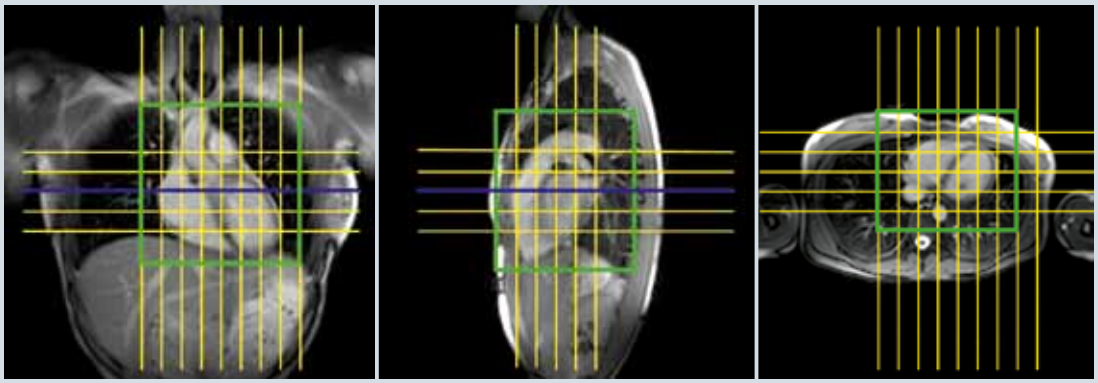
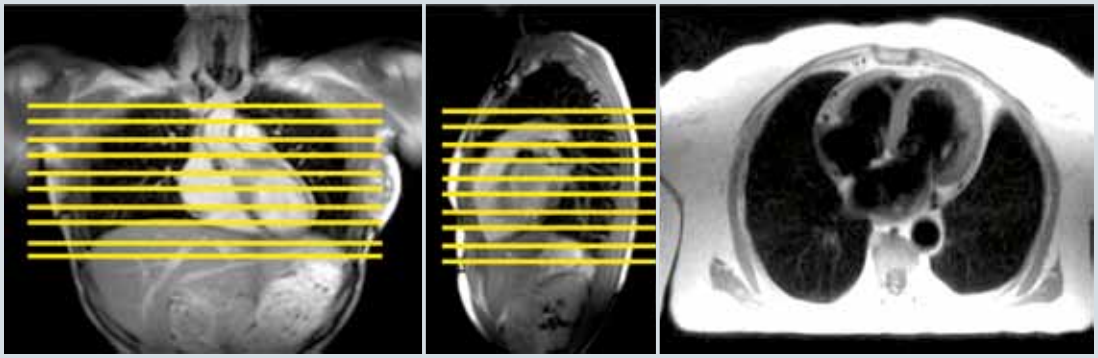
Localizers Module

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

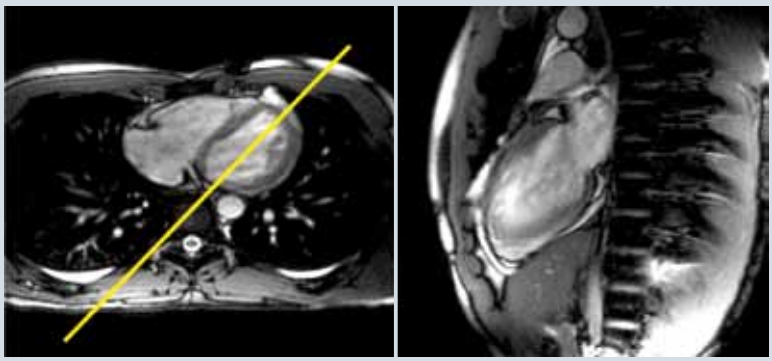
2. Multi Plane Isocenter Localizer: adjusts heart to isocenter of bore (ISO table mode), prescribe 3 axial, 3 coronal, 3 sagittal slices, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.



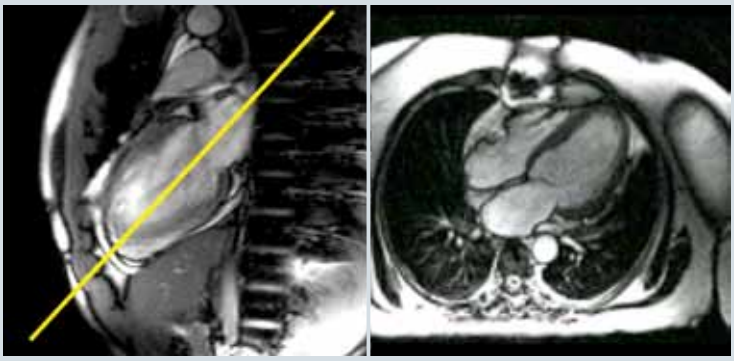
3. Axial Dark Blook Haste Localizer: prescribe 20 slices from sagittal and coronal views, cover from above aortic arch to below apex, multiple breath-holds, trigger on every second heartbeat, capture cycle for diastolic gating.



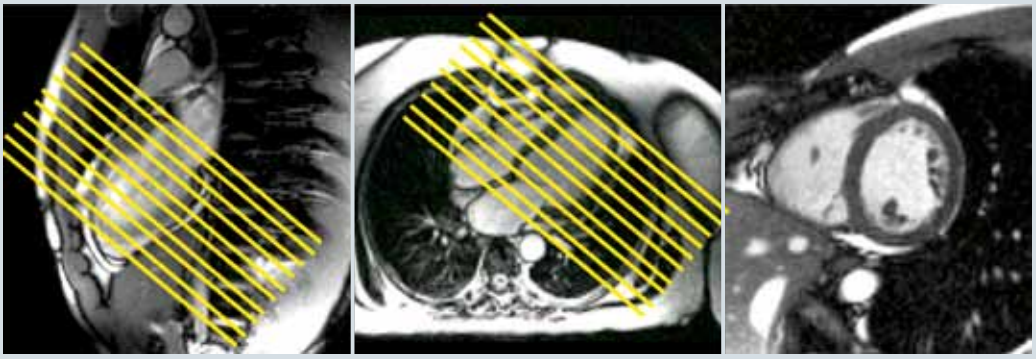
4. Two Chamber Localizer: prescribe 1 slice from axial view parallel to ventricular septum, bisect left ventricle through mitral valve and apex, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.



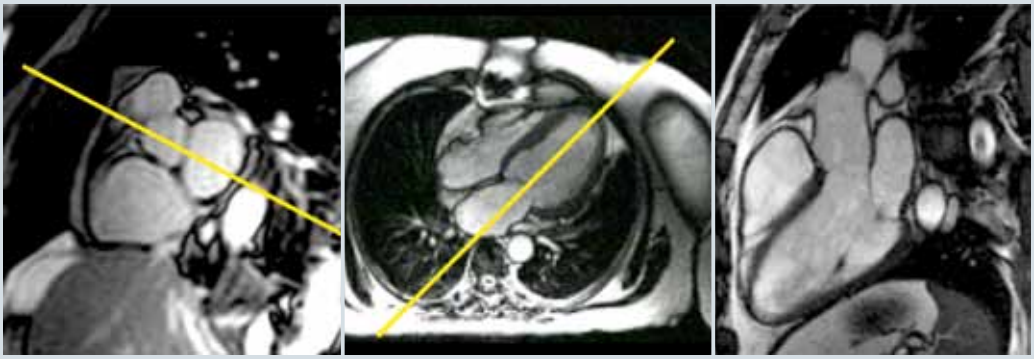
5. Four Chamber Localizer: prescribe 1 slice from two chamber view, bisect left ventricle through mitral valve and apex, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.



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

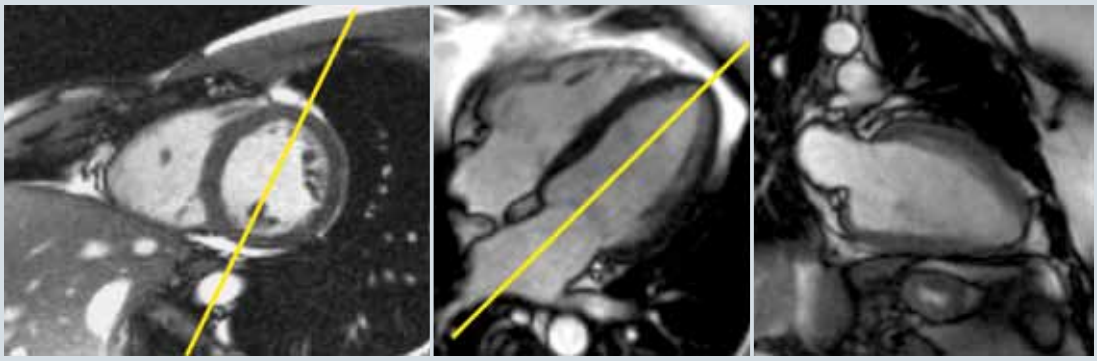


7. Three Chamber Localizer: prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four chamber view, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.



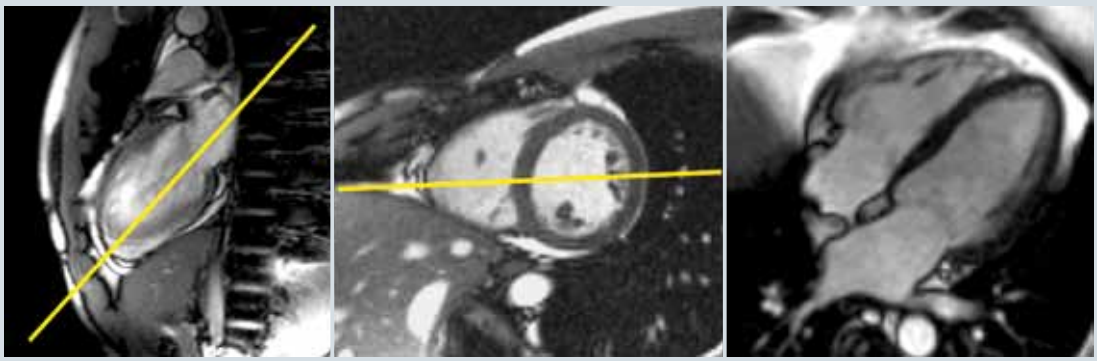
LV Function Module

1. 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 breath-hold, retrospective gating.

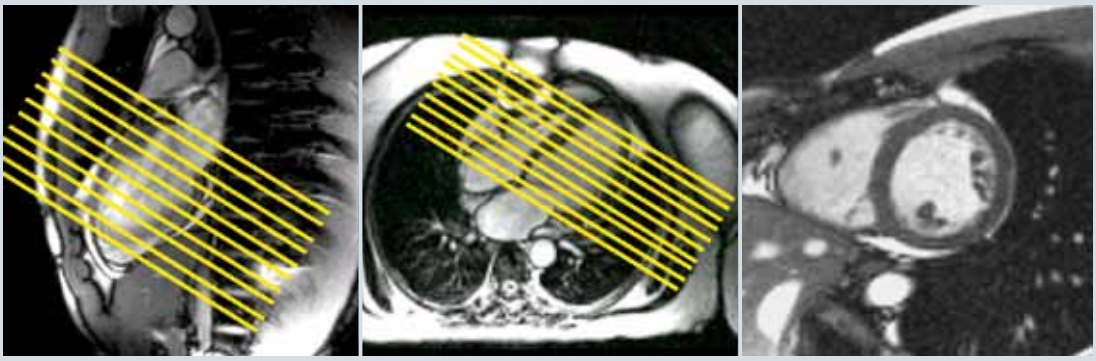


2. Three Chamber Cine: prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four chamber view, rotate FOV to avoid wrap, single breath-hold, retrospective gating.

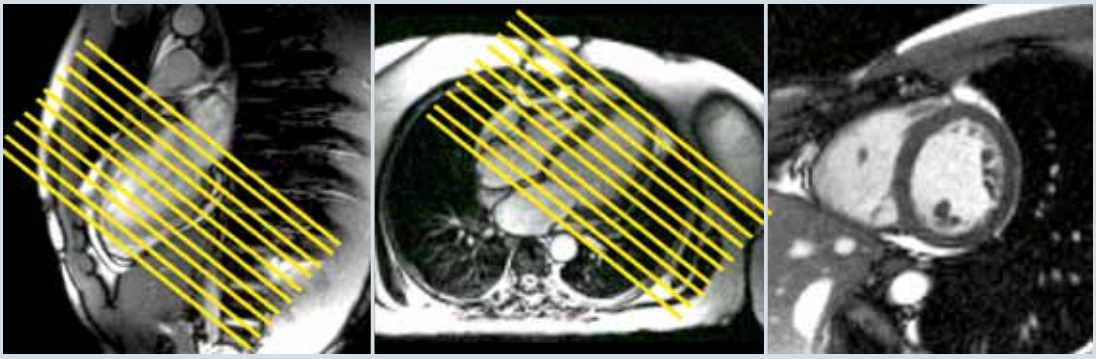
3. Four Chamber Cine: prescribe 1 slice, bisect left ventricle through mitral valve and apex on a two chamber view, bisect left and right ventricles on a short axis view, rotate FOV to avoid wrap, single breath-hold, retrospective gating.



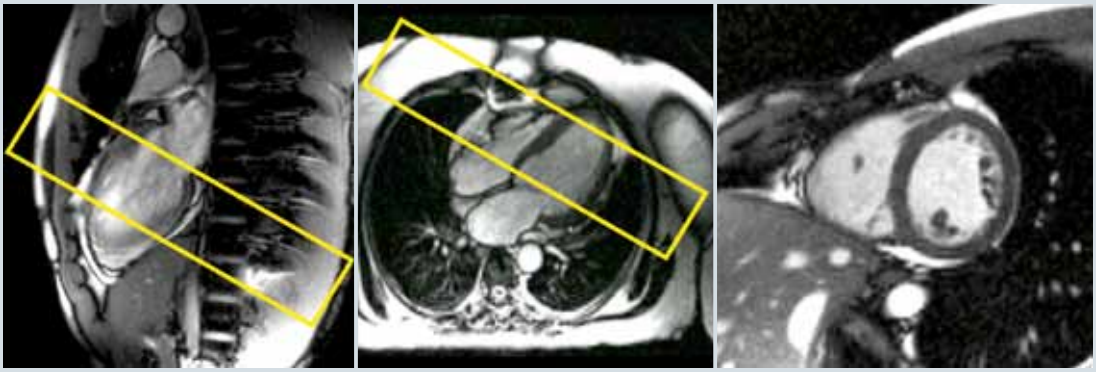
4. Short Axis Cine: prescribe 10 slices from two chamber and four chamber views, perpendicular to long axis of left ventricle, adjust gap to cover from mitral valve to apex, rotate FOV to avoid wrap, multiple breath-holds, retrospective gating.



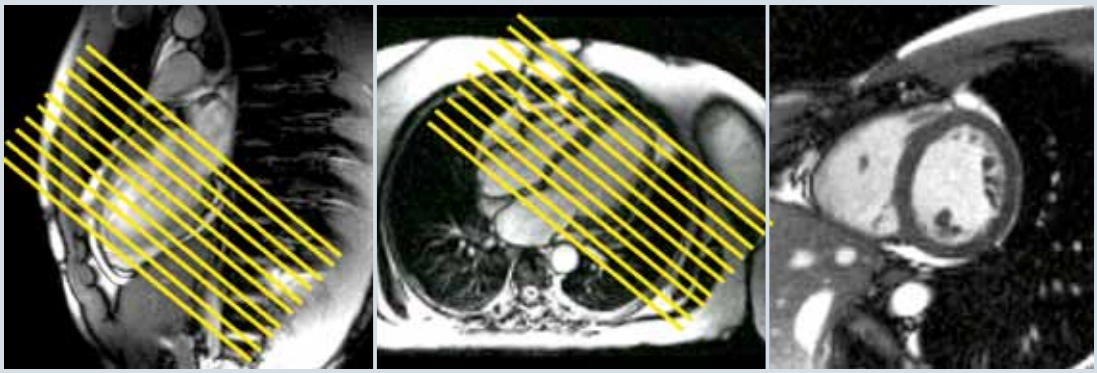
5. Optional Short Axis Cine Radial: high resolution radial *k*-space TrueFISP cine, multi slices, multi breath-hold, retrospective gating.



6. Optional Short Axis Cine 3D Slab: 3D slab TrueFISP cine, multi slices, single breath-hold, prospective gating, rotate FOV to avoid wrap.

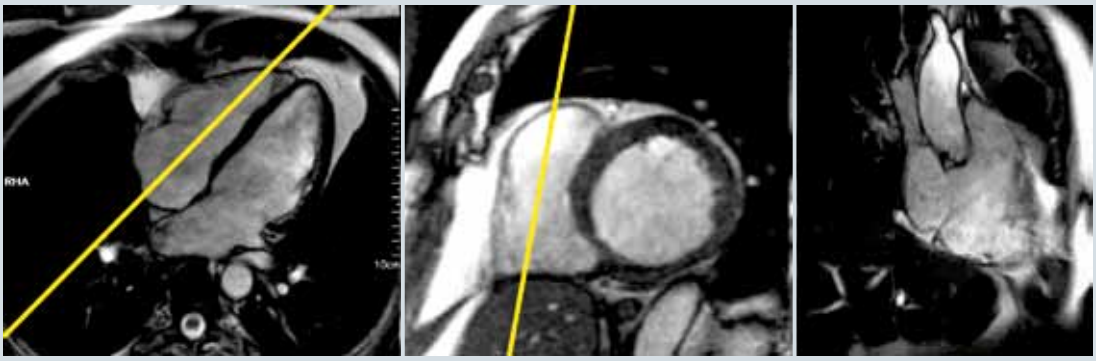


7. Optional Short Axis Cine Realtime: realtime TrueFISP cine, multi slices, single breath-hold, prospective gating, rotate FOV to avoid wrap.

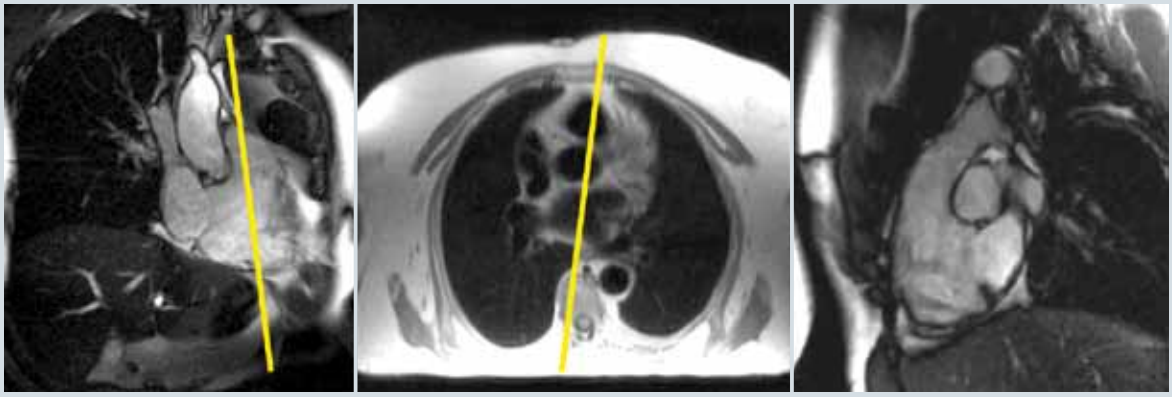


RV Function Module

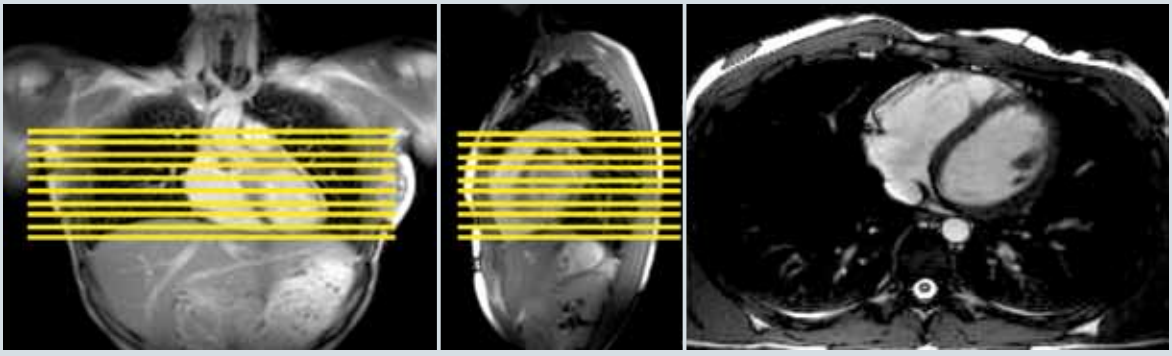
1. Right Ventricular Vertical Long Axis Cine: prescribe 1 slice from four chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, single breath-hold, retrospective gating.



2. Right Ventricular Outflow Tract Cine: prescribe 1 slice from right ventricular vertical long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, single breath-hold, retrospective gating.



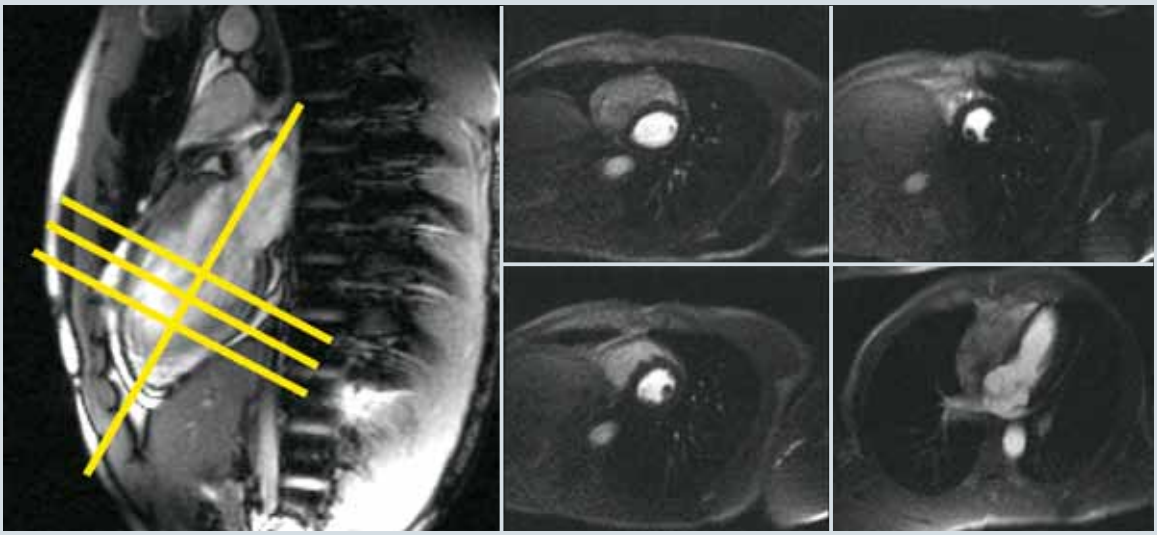
3. Axial Cine: prescribe from coronal and sagittal views, adjust gap to cover entire right ventricle and outflow tract, multiple slices, multiple breath-holds, retrospective gating.



Dynamic Module

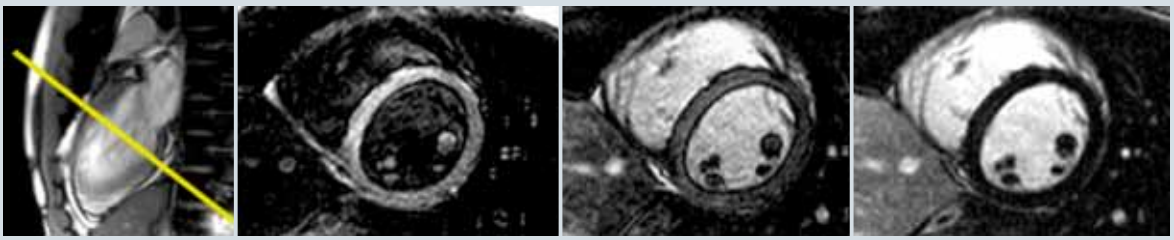
1. Dynamic Test: saturation recovery segmented turboflash, requires 3 short axis slices at base, mid, and apex levels, optional 1 long axis slice if R-R interval is long enough, rotate FOV to avoid wrap, trigger on every heartbeat, start breath-hold during early phase of scan, only 5 measurements for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

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

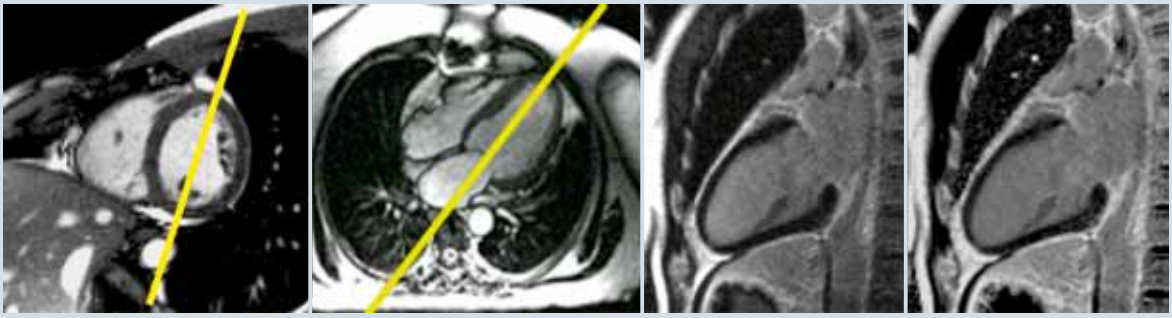


Delayed Module

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 breath-hold, trigger on every second heartbeat, capture cycle for optimal acquisition window.

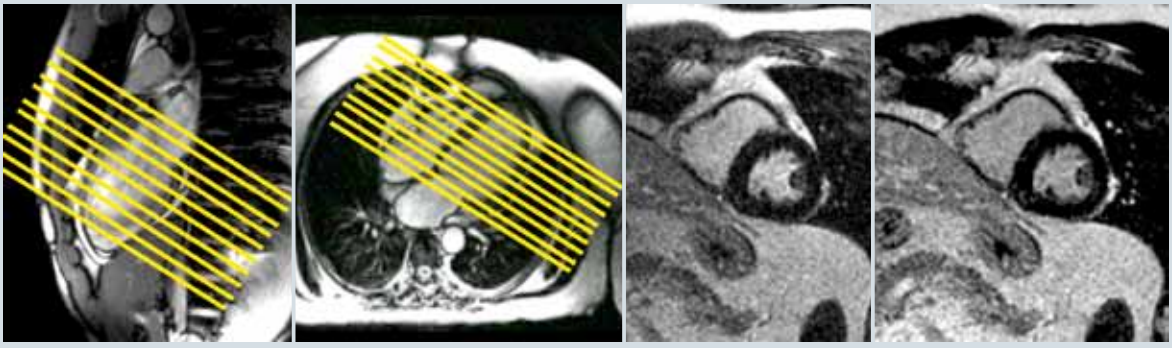


2. Two Chamber Delayed: prescribe 1 slice, phase sensitive inversion recovery turboflash technique, provides both magnitude and real images, adjust TI for nulling of normal myocardium, rotate FOV to avoid wrap, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.

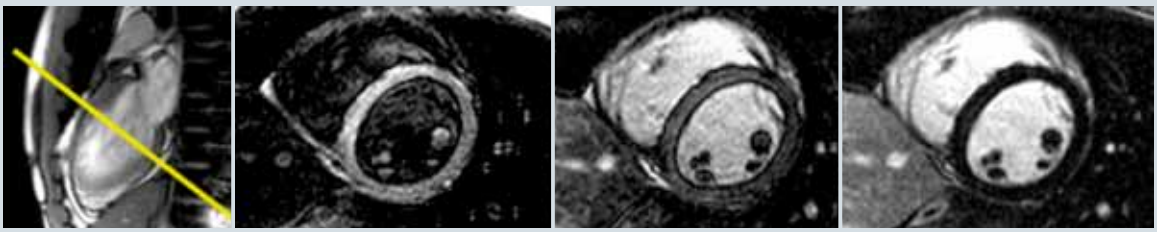


3. Four Chamber Delayed: prescribe 1 slice, phase sensitive inversion recovery turboflash technique, provides both magnitude and real images, adjust TI for nulling of normal myocardium, rotate FOV to avoid wrap, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.

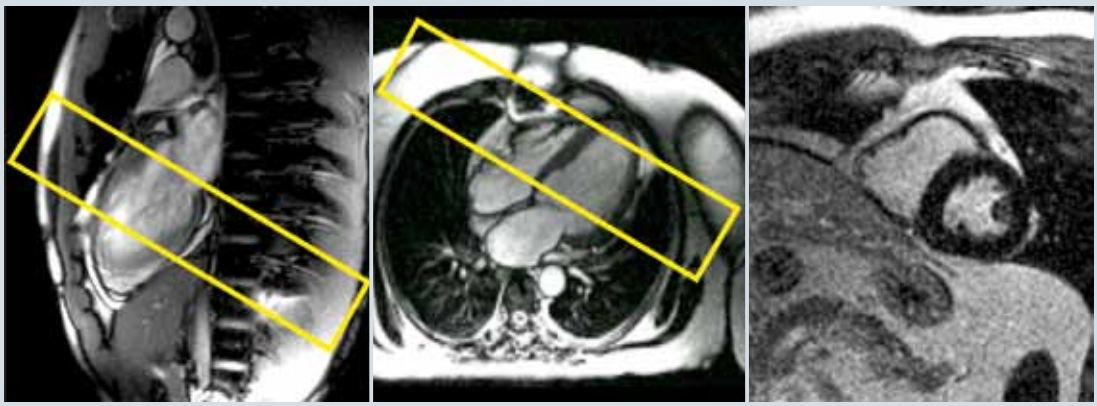
4. Short Axis Delayed: prescribe 12 slices, phase sensitive inversion recovery turboflash technique, provides both magnitude and real images, adjust TI for nulling of normal myocardium, rotate FOV to avoid wrap, multiple breath-holds, trigger on every second heartbeat, capture cycle for diastolic gating.



5. OPTIONAL 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.

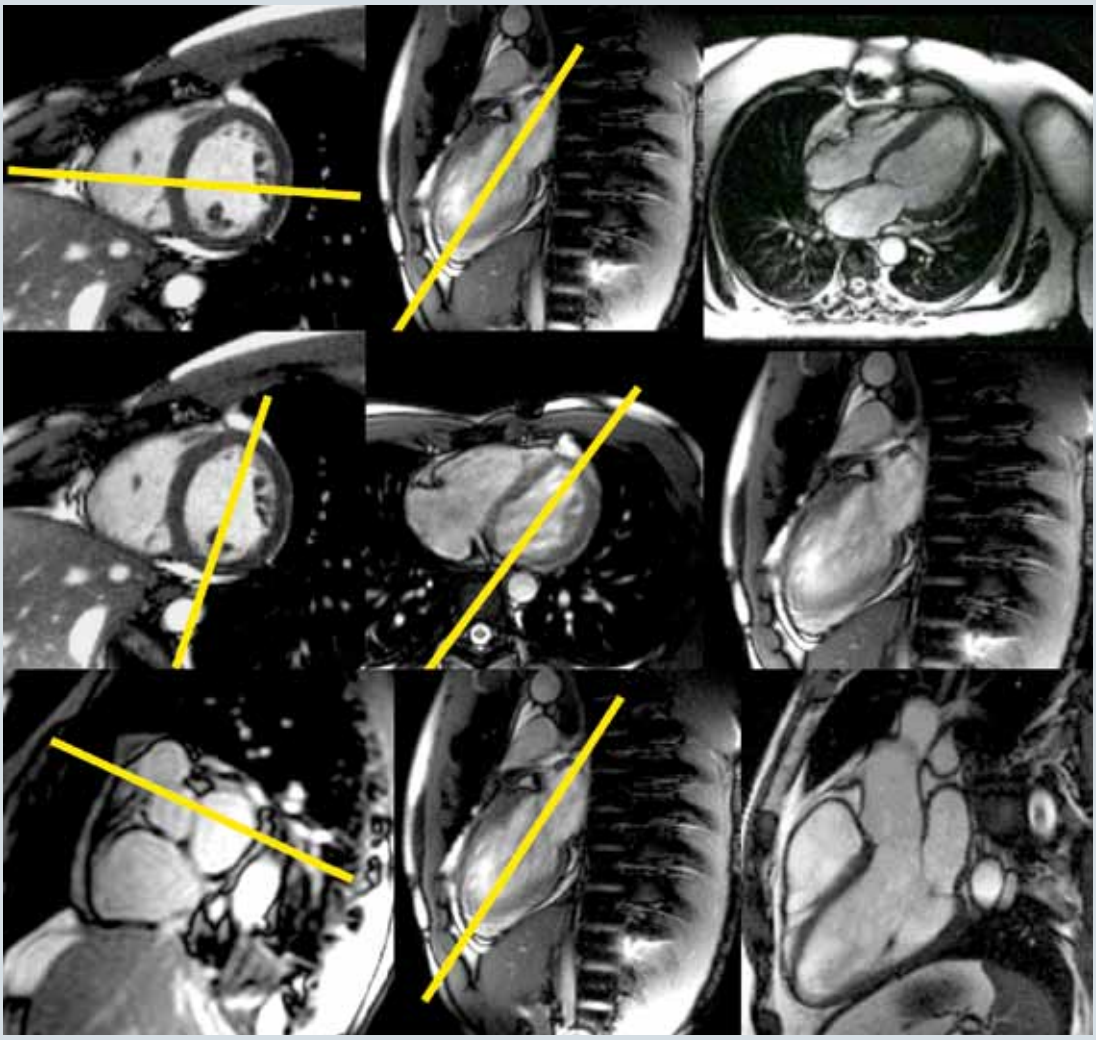


6. OPTIONAL Short Axis Delayed 3D: inversion recovery turboflash 3D technique, adjust TI for nulling of normal myocardium, rotate FOV to avoid wrap, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.

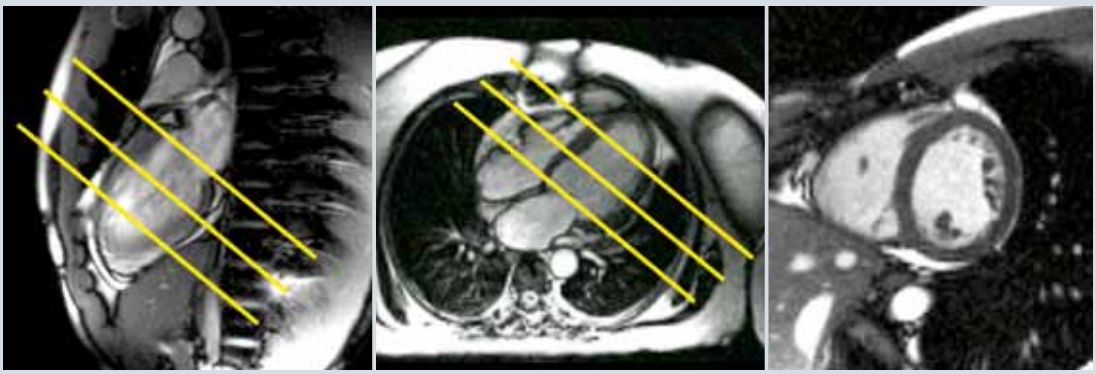


Dobutamine Stress Module

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 breath-hold, retrospective gating. Reduce temporal resolution as heart rate increases.



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 breath-hold, retrospective gating. Reduce temporal resolution as heart rate increases.

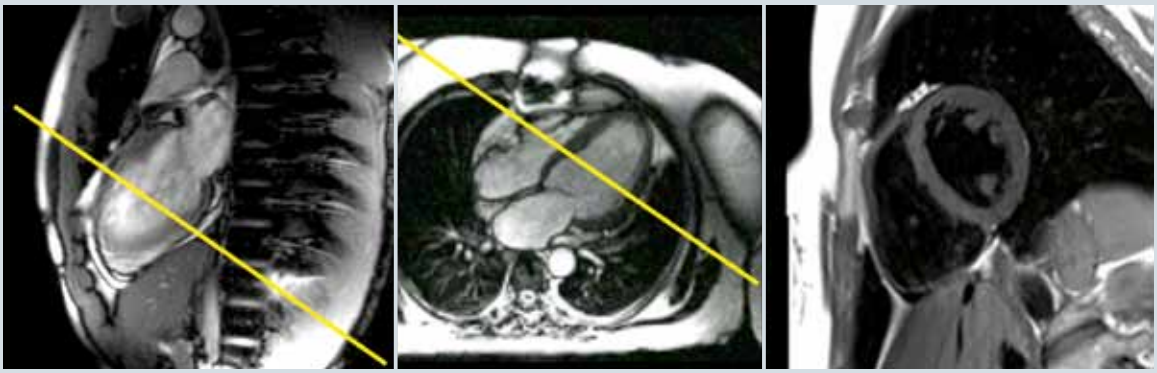


Acute Myocardial Infarct

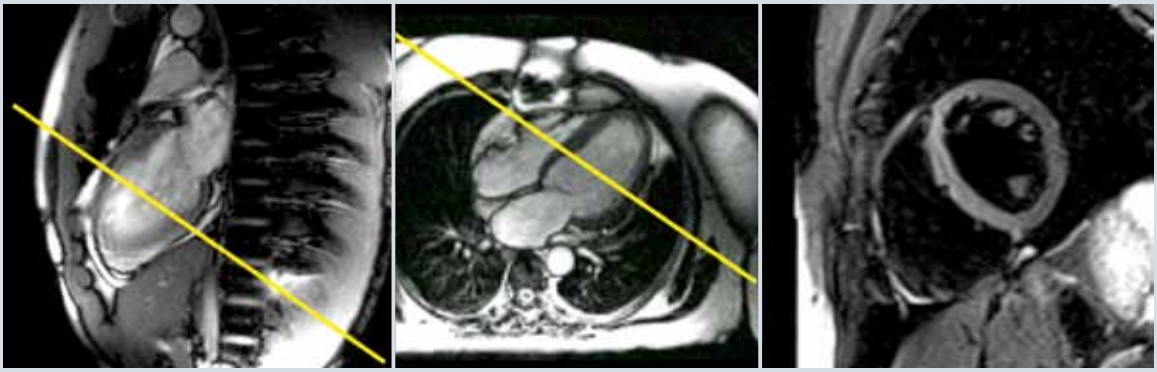
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

3. Optional TSE Dark Blood T2: prescribe 1 slice, segmented TSE dark blood T2, rotate FOV to avoid wrap, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.



4. Optional TSE Dark Blood T2 Fatsat: prescribe 1 slice, segmented TSE dark blood T2 with fatsat, rotate FOV to avoid wrap, single breathhold, trigger on every second heartbeat, capture cycle for diastolic gating.



5. Dynamic Module without Adenosine to assess myocardial ischemia.

6. Optional Delayed Module early after injection to assess microvascular obstruction.

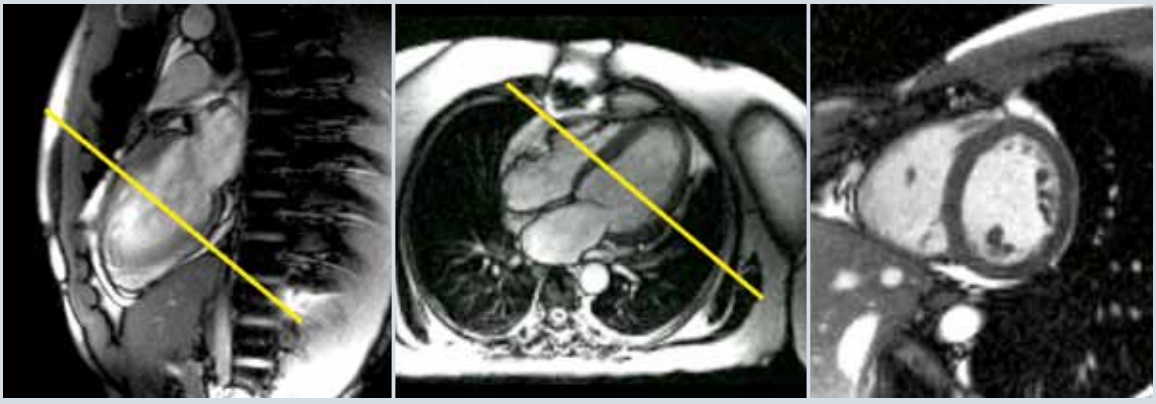
7. Delayed Module late after injection to assess myocardial infarct.

Chronic Ischemic Disease

1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

3. Optional Low Dose Dobutamine Cine: to assess contractile reserve as improvements in wall thickening, prescribe 1 slice through area of interest, adjust gap to cover base, mid, apex levels of left ventricle, single breath-hold, retrospective gating.



4. Optional Stress/Rest Dynamic Module with/without Adenosine to assess myocardial ischemia.

5. Delayed Module late after injection to assess myocardial infarct.

Adenosine Stress

1. **Localizer Module** for localization.

2. **Stress Dynamic Module** with Adenosine to assess myocardial ischemia.

3. **LV Function Module** to assess ventricular function.

4. **Rest Dynamic Module** without Adenosine to assess myocardial ischemia.

5. **Delayed Module** late after injection to assess myocardial infarct.

Peripheral Arteries

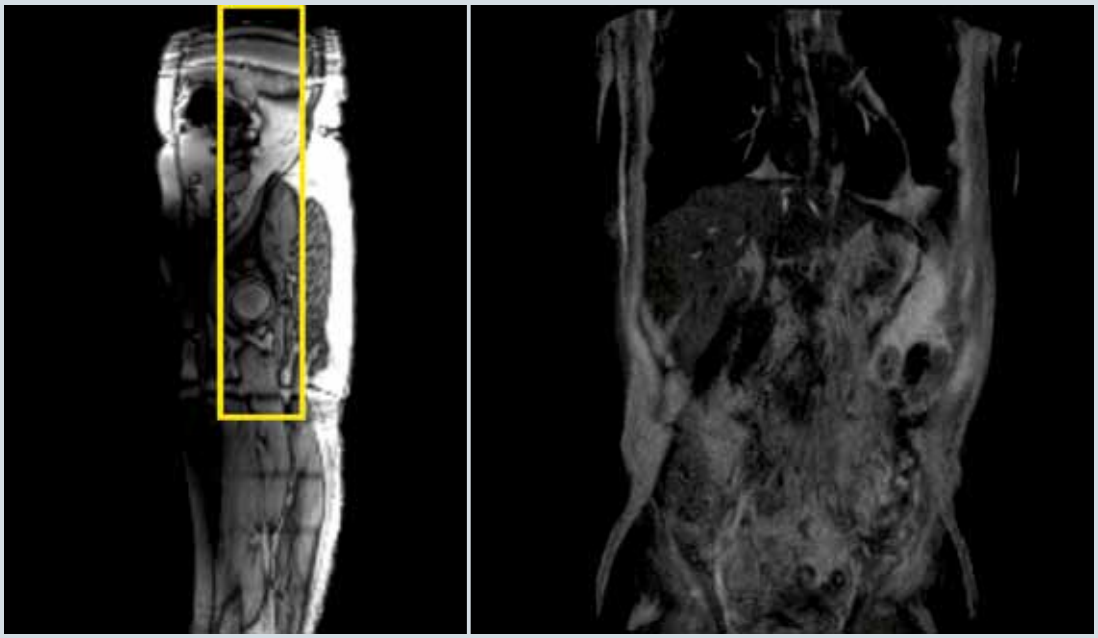
1. Localize: feet-first 230mm above feet.

2. Leg Multiple Localizers: runs automatically with Body Coil, fixed table position zero, automatic composing.

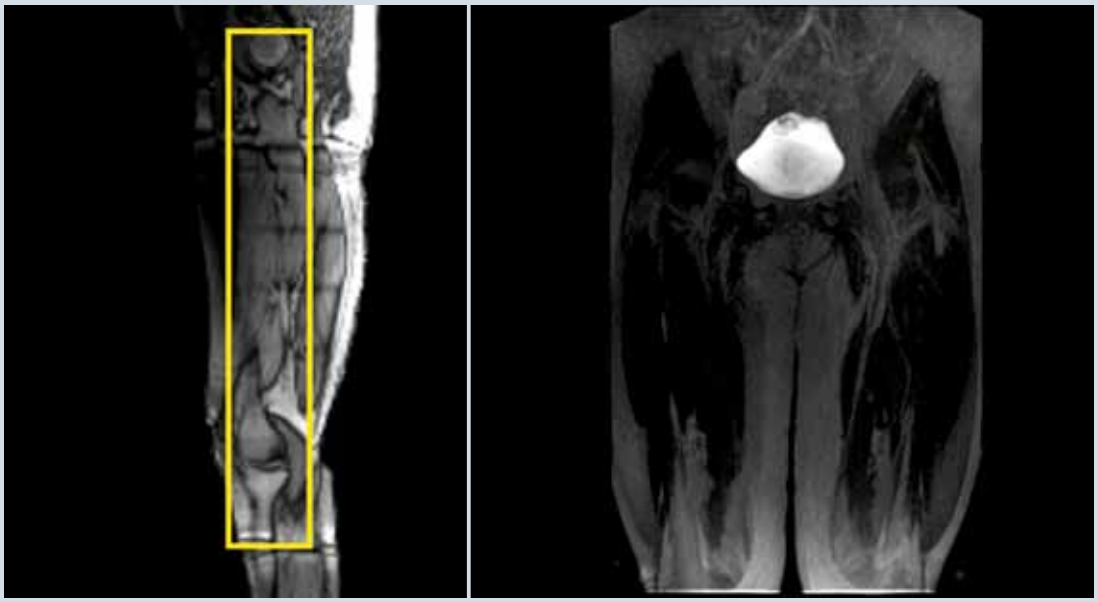
3. Thigh Multiple Localizers: runs automatically with Body Coil, fixed table position Head 450 mm, automatic composing.

4. Abdomen Multiple Localizers: runs automatically with Body Coil, fixed table position Head 900 mm, automatic composing.

5. Abdomen Coronal Mask: adjusts abdomen to isocenter of bore (ISO table mode), prescribe coronal slab from abdomen localizer images, subtraction mask for angio scans, automatic subtraction and mip and composing.

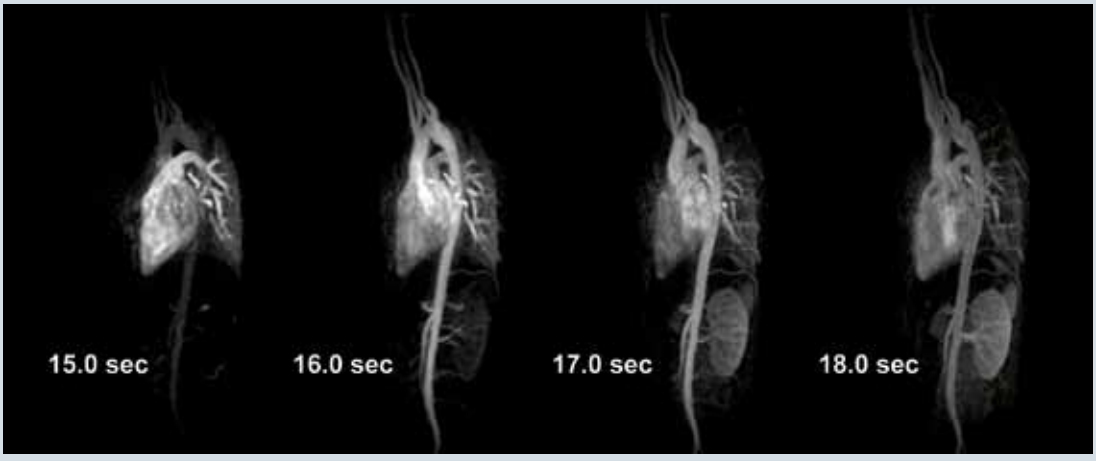


6. Thigh Coronal Mask: adjusts thighs to isocenter of bore (ISO table mode), prescribe coronal slab from thigh localizer images, subtraction mask for angio scans, automatic subtraction and mip and composing.



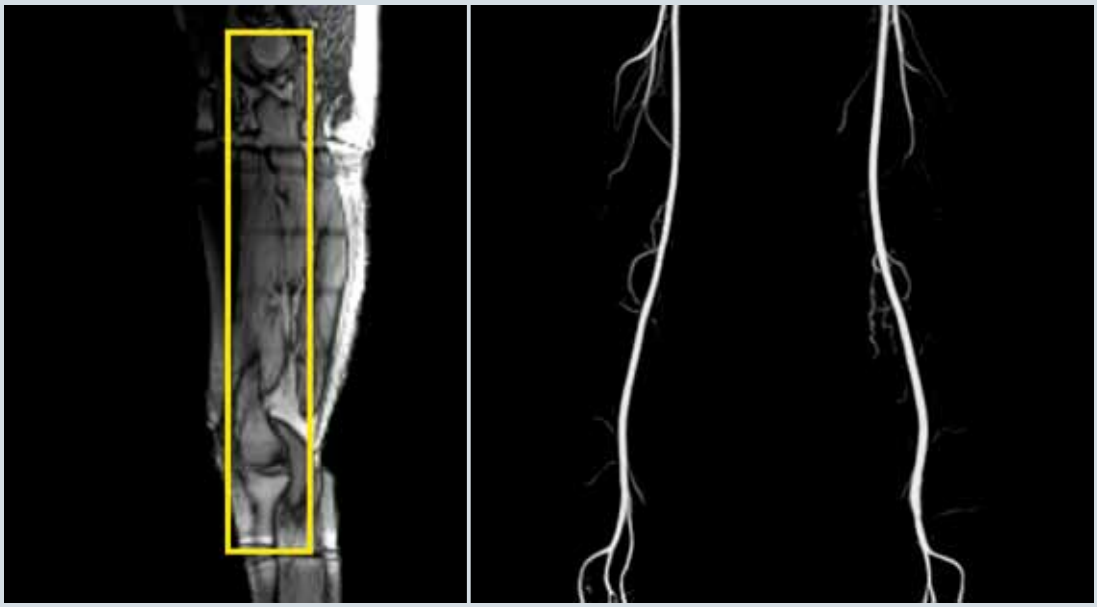
7. Leg Coronal Mask: adjusts lower legs to isocenter of bore (ISO table mode), prescribe coronal slab from leg localizer images, subtraction mask for angio scans, automatic subtraction and mip and composing.

8. Aorta Sagittal Care-Bolus: uses the care-bolus technique for dynamic imaging of the aorta, adjusts abdomen to isocenter of bore (ISO table mode), prescribe sagittal oblique candy cane slice from abdomen scout images, acquires 1 image per second.



9. Abdomen Coronal Angio: adjusts abdomen to isocenter of bore (ISO table mode), automatically repeats mask scan parameters and position, automatic subtraction and mip and composing, 1 measurement with linear reordering.

10. Thigh Coronal Angio: adjusts thighs to isocenter of bore (ISO table mode), automatically repeats mask scan parameters and position, automatic subtraction and mip and composing, 1 measurement with linear reordering.

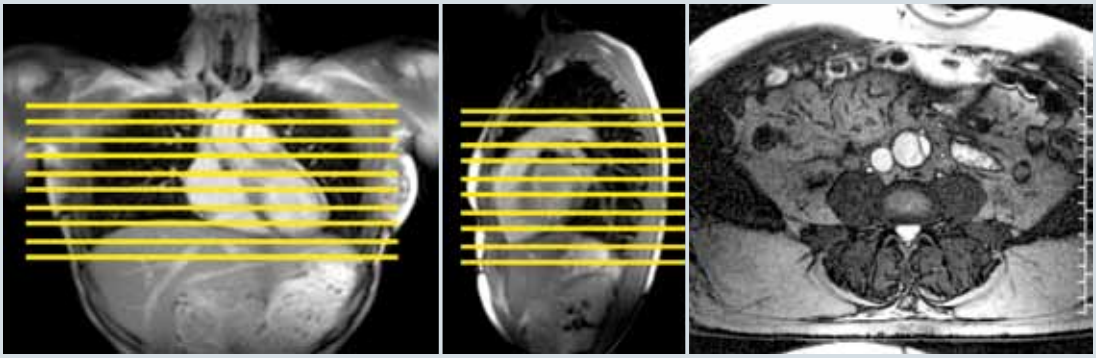


11. Leg Coronal Angio: adjusts lower legs to isocenter of bore (ISO table mode), automatically repeats mask scan parameters and position, automatic subtraction and mip and composing, 2 measurements with centric reordering.

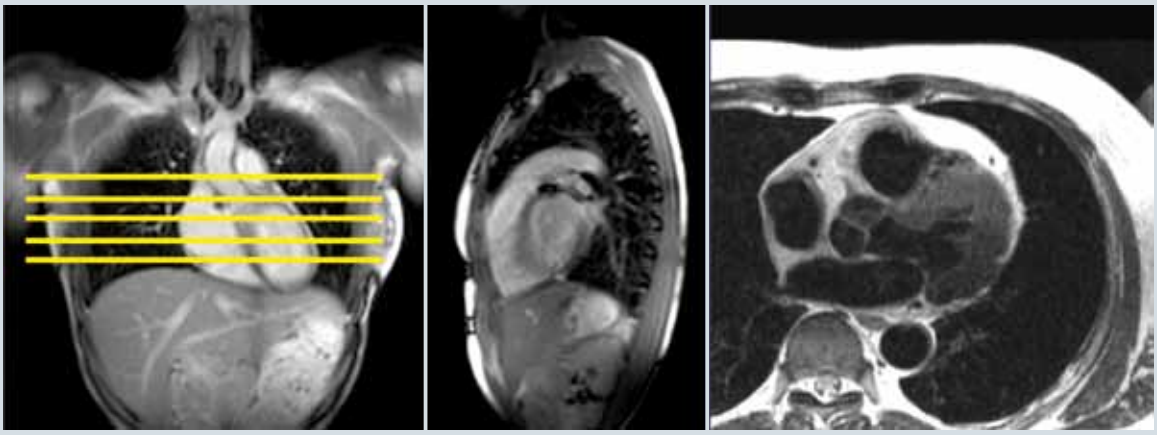
Thoracic Aorta

1. Localizer Module for localization.

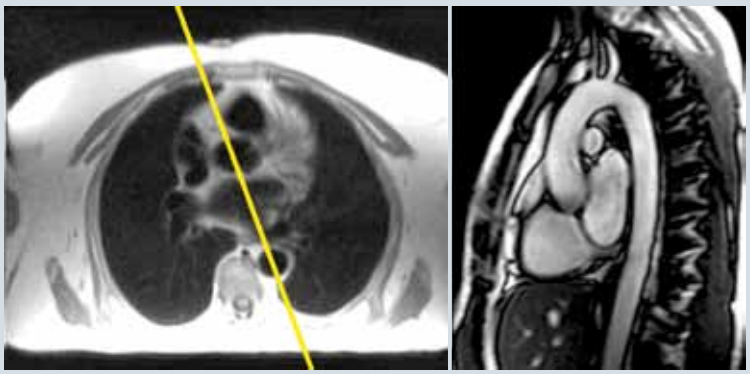
2. Axial Bright Blood: prescribe 30 axial slices to cover entire chest, multiple breath-holds, trigger on every heartbeat, capture cycle for diastolic gating.



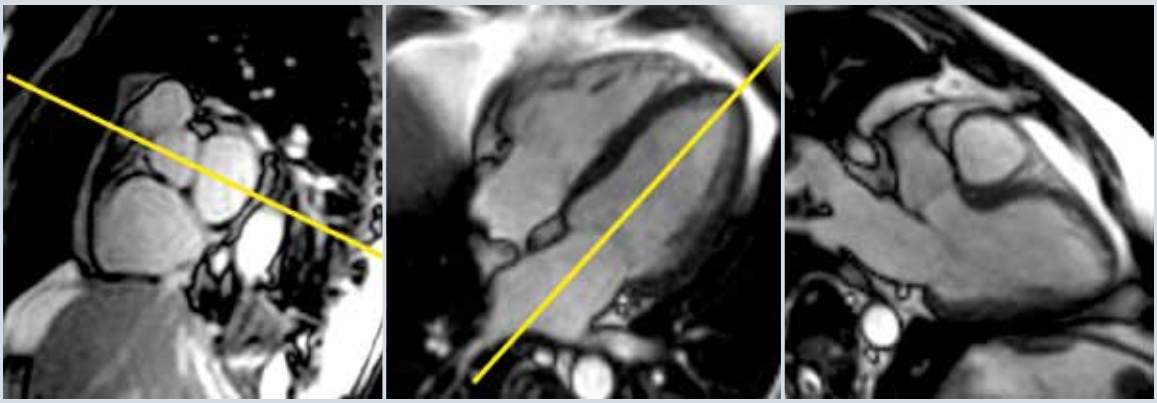
3. Axial TSE Dark Blood T1: for selected slice levels through aortic dissection or intramural hematoma, segmented dark blood TSE T1, single slice, single breath-hold, repeat as needed, trigger on every heartbeat, capture cycle for diastolic gating.



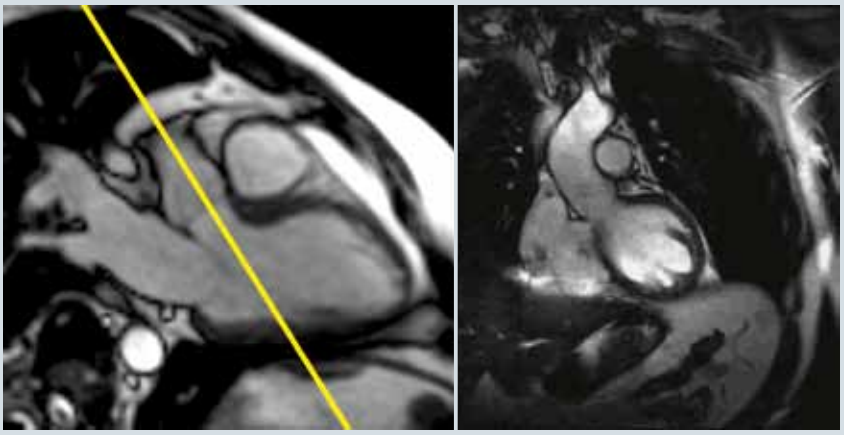
4. Sagittal Aorta Cine: prescribe 1 slice in sagittal oblique (candy cane) view, rotate FOV to avoid wrap, single breath-hold, retrospective gating.



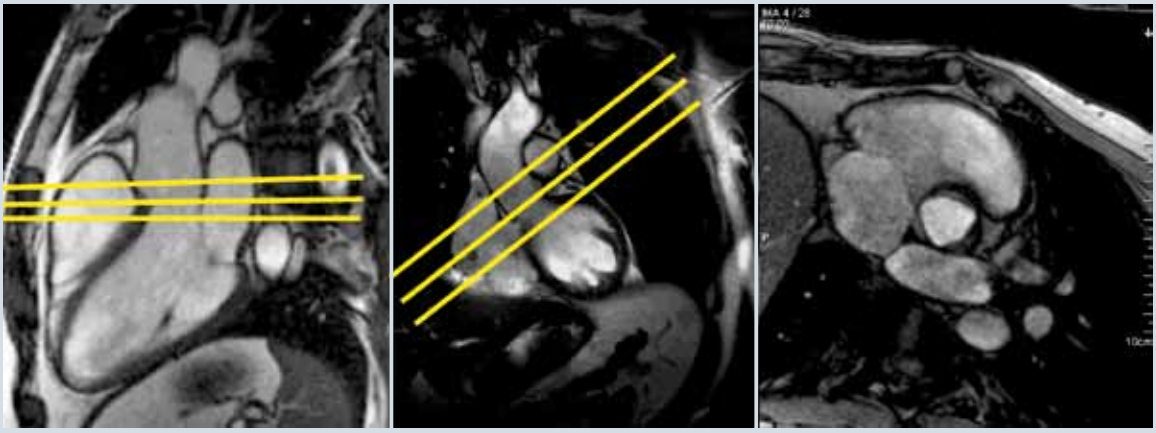
5. Three Chamber Cine: prescribe 1 slice, bisect the LVOT and posterolateral LV wall on the most basal short axis view, and bisect the LV through the mitral valve and apex on a four chamber view, rotate FOV to avoid wrap, single breath-hold, retrospective gating.



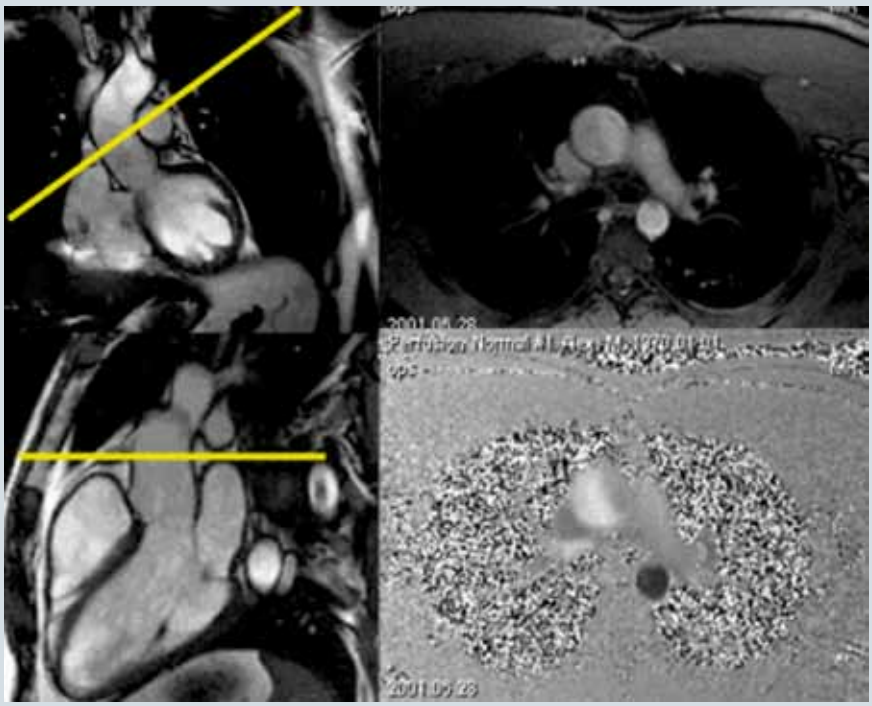
6. Coronal Aortic Outflow Cine: prescribe 1 slice from three chamber view, bisect the LVOT, aortic valve, and ascending aorta, rotate FOV to avoid wrap, single breath-hold, retrospective gating.



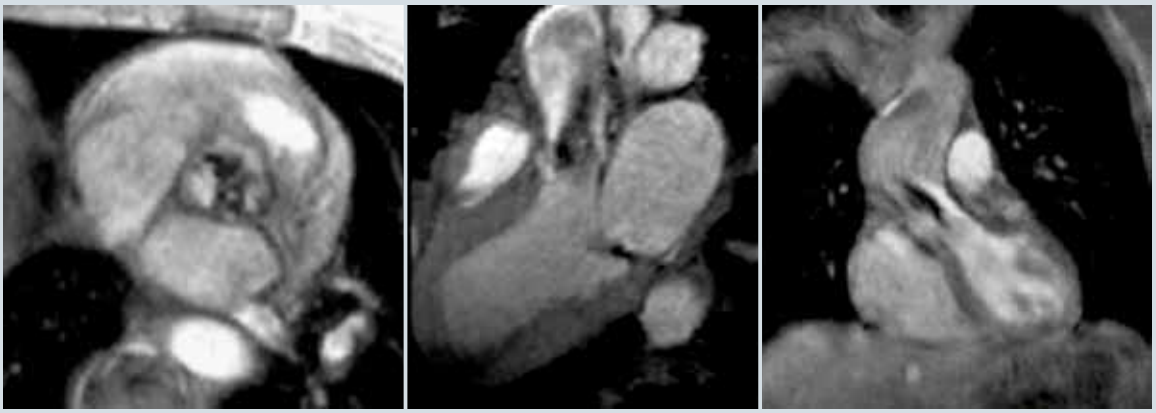
7. Cross-Sectional Aortic Valve Cine: 3 contiguous cross-sectional slices across aortic valve plane, high resolution TrueFISP radial eliminates wrap with small FOV, multiple breath-holds, retrospective gating.



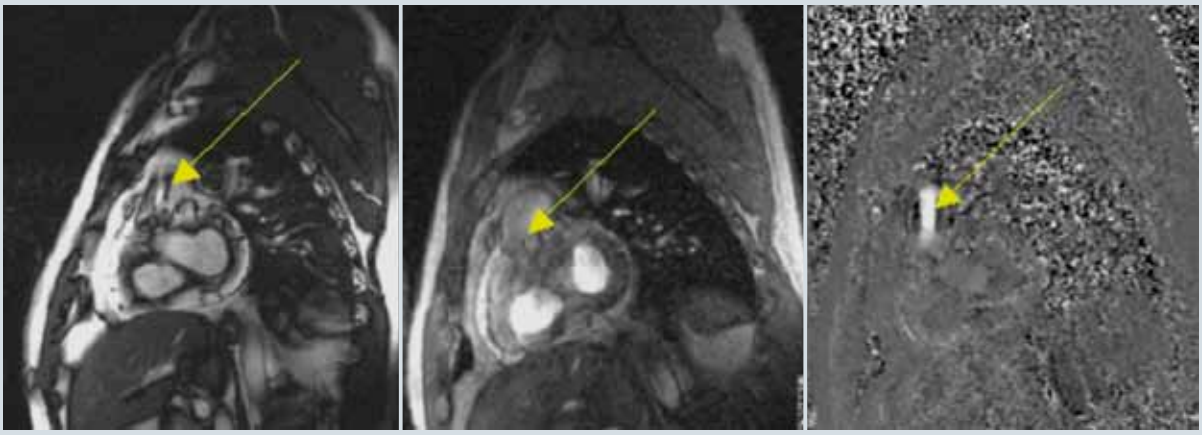
8. Optional Aorta Through-Plane Flow Qs: prescribe from three chamber view and coronal aorta view, 1 cross-sectional slice perpendicular to ascending aorta distal to valve leaflet tips, through-plane VENC 150 cm/sec for normal flow (or greater for stenosis), single breath-hold, retrospective gating, short TE for optimal flow sensitivity.



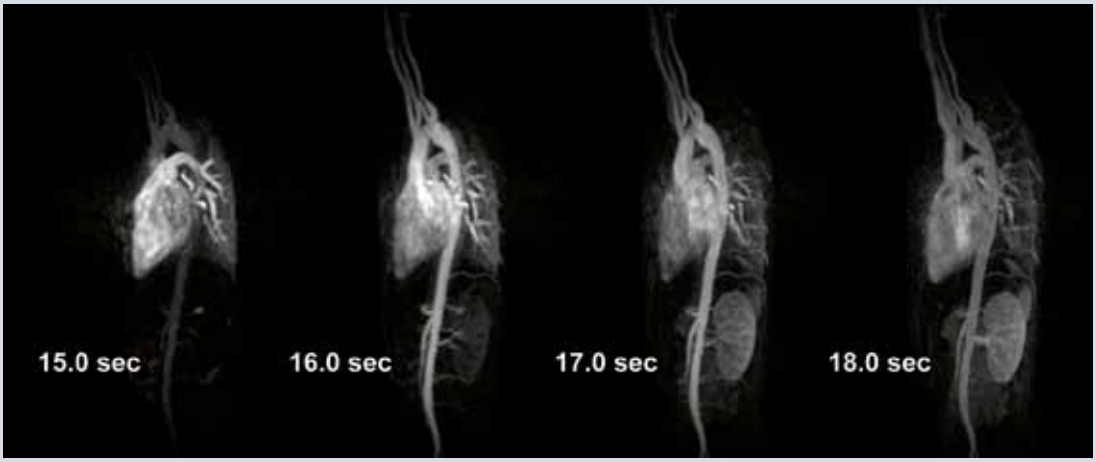
9. Optional GRE Stenotic Jet Cine: 1 slice in the best long-axis view to see the stenotic flow jet, single breath-hold, long TE for dark turbulent flow void, retrospective gating.



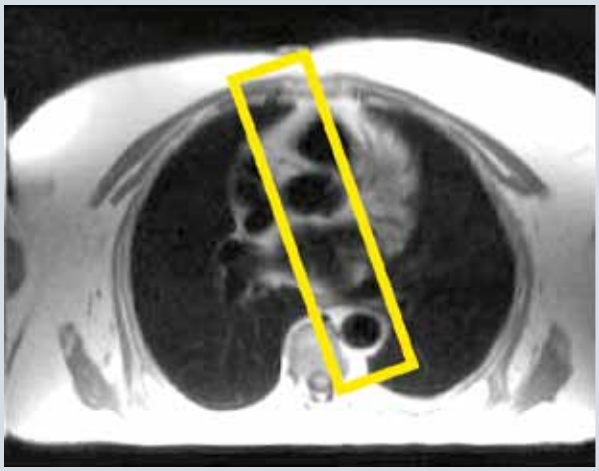
10. Optional Stenotic Jet In-Plane Flow: 1 slice in the best long-axis view to see the stenotic flow jet, single breath-hold, in-plane VENC 250 cm/sec or greater, retrospective gating, short TE for optimal flow sensitivity.

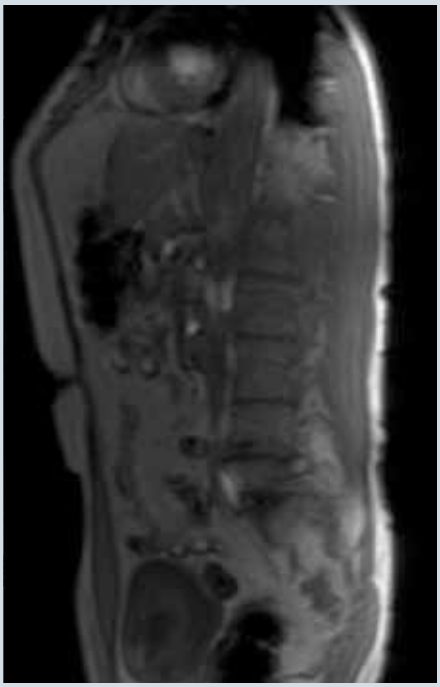


11. Aorta Test-Bolus: uses the test-bolus technique for dynamic imaging of the aorta, prescribe sagittal oblique (candy cane) slice from axial localizer, acquires 1 image per second.

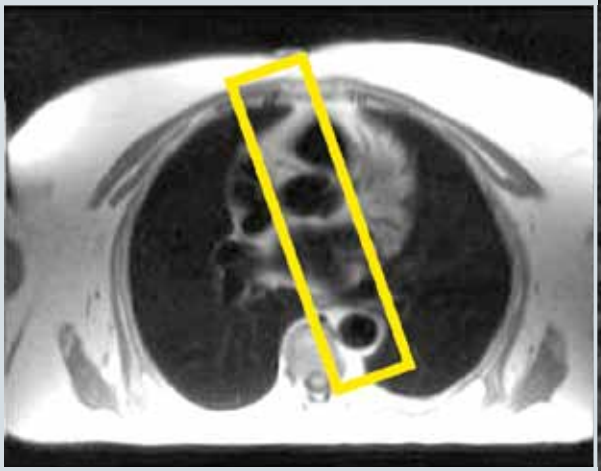


12. Sagittal Aorta Mask: used as the subtraction mask for post scan, prescribe 1 slab in sagittal oblique (candy cane) view, 1 measurement in 1 breath-hold, untriggered, automatic subtraction and mip.

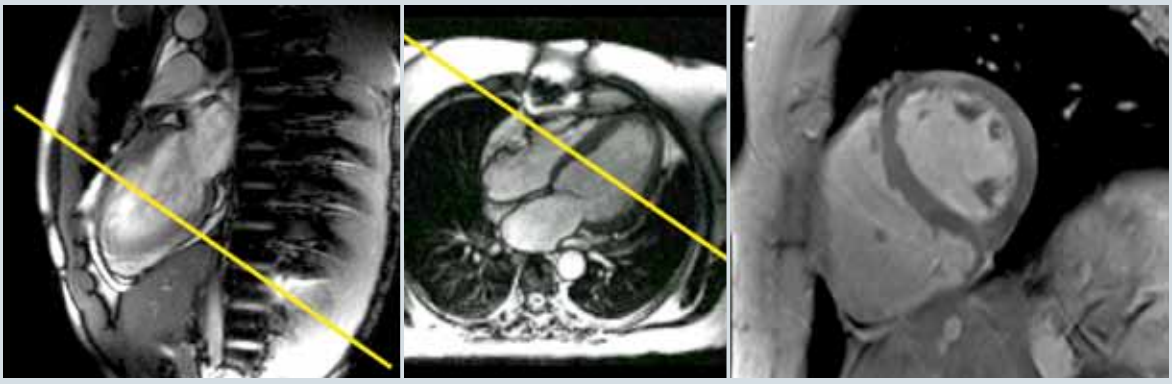




13. Sagittal Aorta Angio 2 Measurements: use appropriate scan delay as determined from test-bolus scan, automatically repeats scan parameters and position from mask scan, 2 measurements in 2 breath-holds with 10 second pause in between, untriggered, automatic subtraction and mip.



14. Optional Axial GRE T1: for selected slice levels through aorta to visualize aortitis post bolus injection, segmented GRE sequence without dark blood pulse, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating

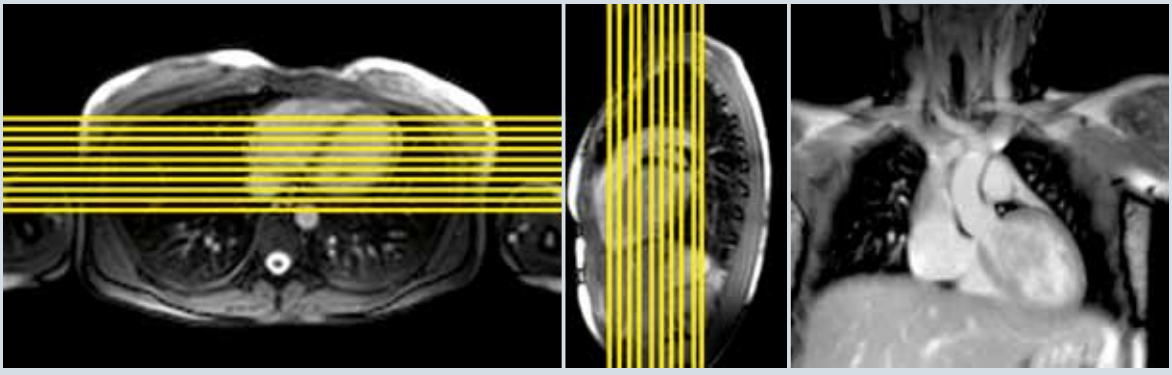


Anomalous Coronary Artery

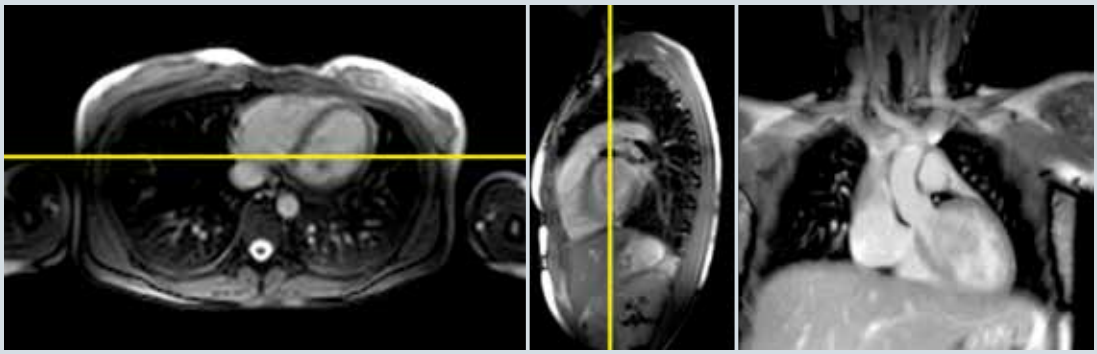
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

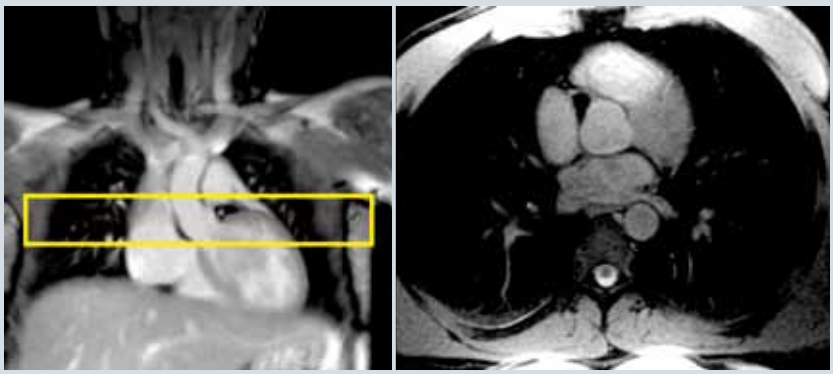
3. Coronal Coronary Scout: prescribe 10 slices from axial and sagittal views, cover entire ascending aorta, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



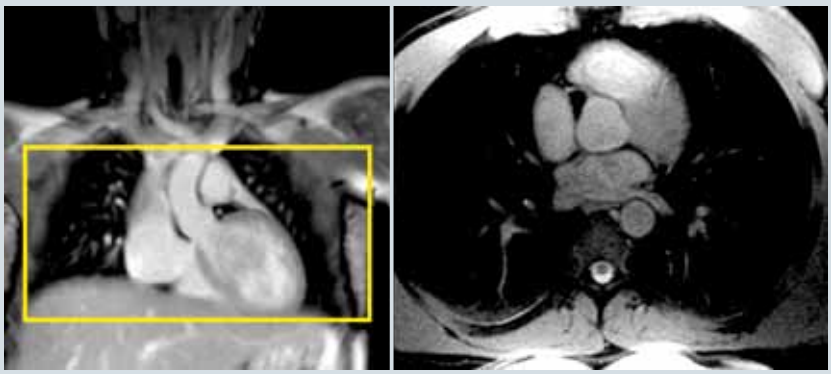
4. Dynamic Coronary Scout: single coronal slice acquired dynamically during free-breathing to determine end-inspiratory and end-expiratory diaphragm positions, copy slice position from previous coronal coronary scout to see coronary origins.



5. Axial 3D Coronary Origins: prescribe 1 axial slab from coronal aortic scout, cover just the coronary origins in a single breath-hold, adjust trigger delay to acquire data in mid-diastolic stationary phase as determined from viewing a four chamber cine, no respiratory navigator required.



6. Optional Axial Whole Heart: 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.

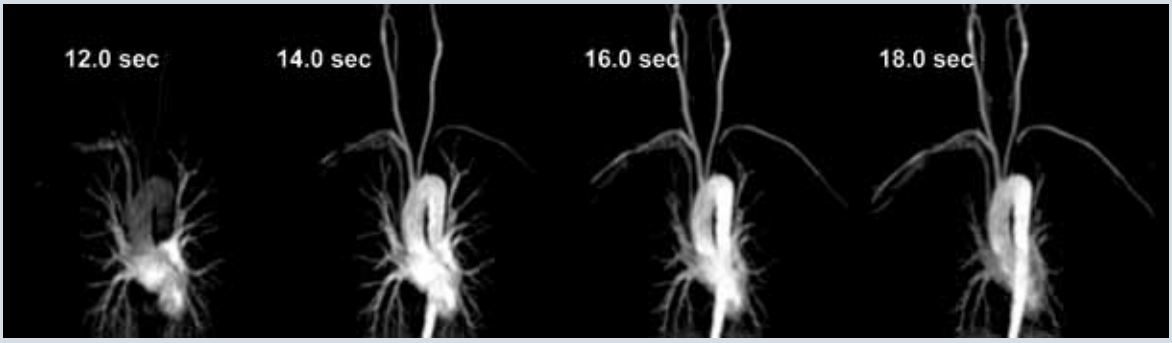


Pulmonary Vein

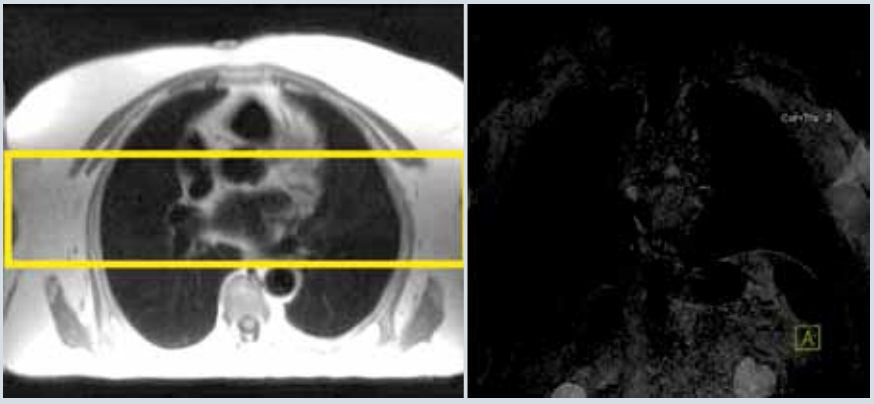
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

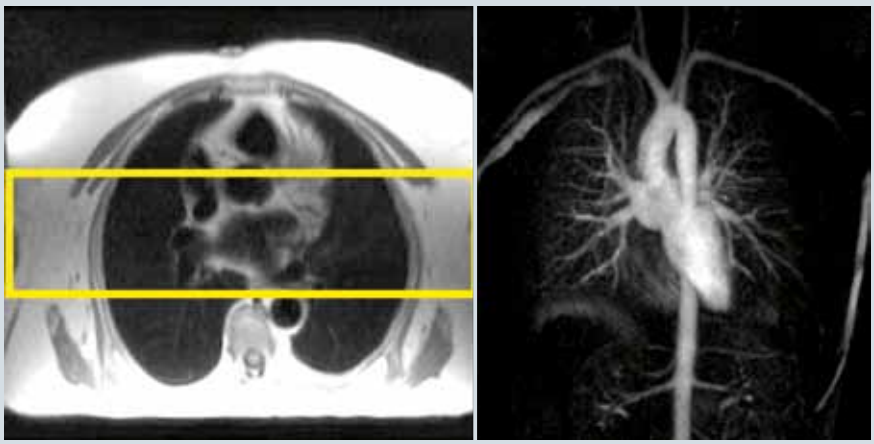
3. Coronal Pulmonary Test-Bolus: uses the test-bolus technique for dynamic imaging of the pulmonary veins, prescribe coronal slice through pulmonary veins and left atrium.



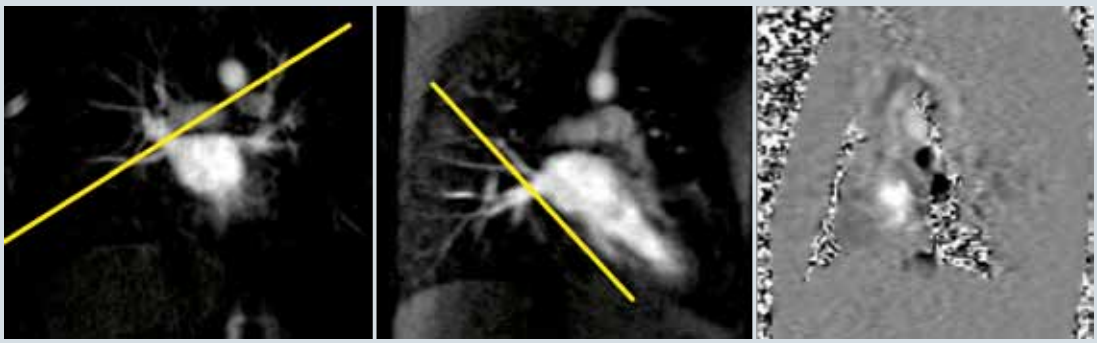
4. Coronal Pulmonary Mask: used as the subtraction mask for angio scan, prescribe coronal slab through pulmonary veins and left atrium, 1 measurement in 1 breath-hold, untriggered, automatic subtraction and mip.



5. Coronal Pulmonary Angio 2 Measurements: use appropriate scan delay as determined from test-bolus scan, automatically repeats scan parameters and position from pre bolus mask, 2 measurements in 2 breathholds with 10 second pause between, untriggered, automatic subtraction and mip.



6. Optional Pulmonary Vein Flow: 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 breath-hold, retrospective gating.

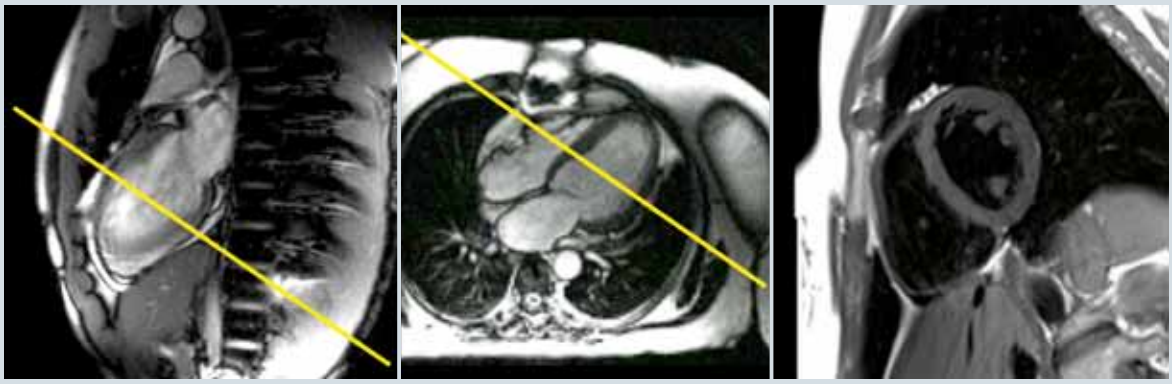


Nonischemic Cardiomyopathy

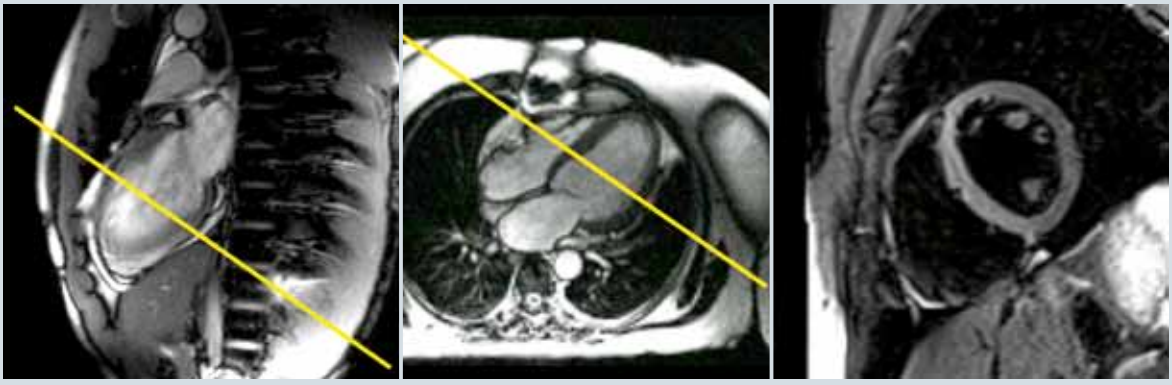
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

3. Optional TSE Dark Blood T2: segmented TSE dark blood T2, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.



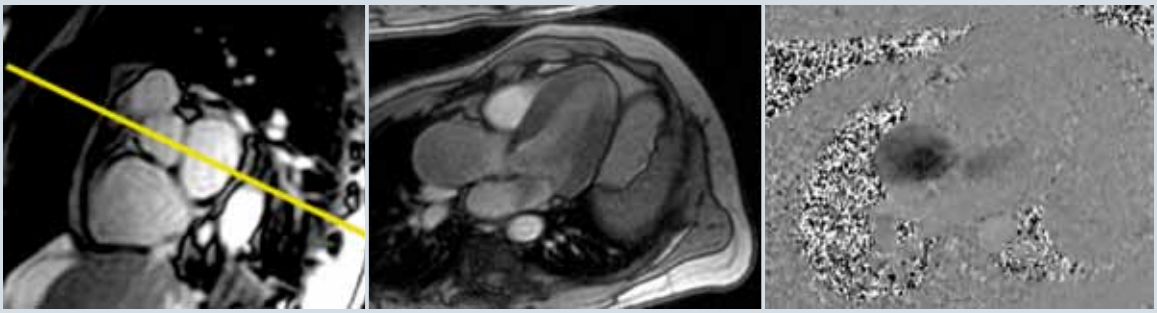
4. Optional TSE Dark Blood T2 Fatsat: segmented TSE dark blood T2 fatsat, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.



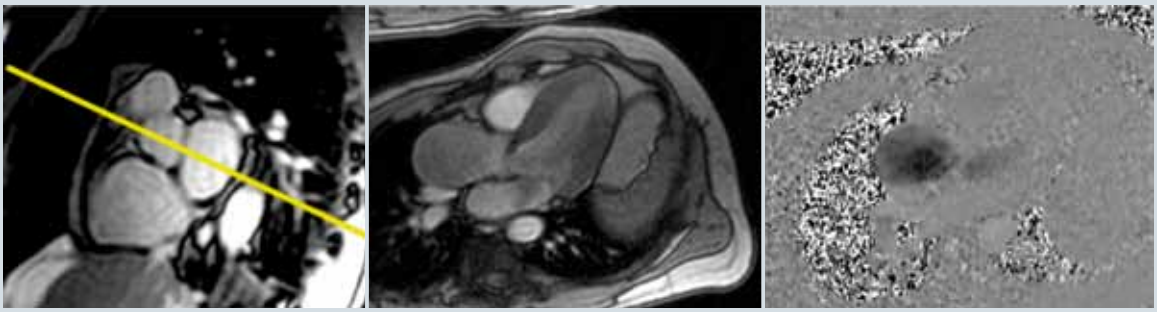
5. Optional Stress/Rest Dynamic Module with/without Adenosine to assess myocardial ischemia.

6. Delayed Module late after injection to assess myocardial infarct.

7. Optional In-Plane Flow: three chamber view for hypertrophic cardiomyopathy, adjust in-plane VENC to best visualize flow disturbances in LV outflow tract, single breath-hold, retrospective gating.



8. Optional Through-Plane Flow: cross-sectional view of LV outflow tract for hypertrophic cardiomyopathy, adjust thru-plane VENC to best visualize flow disturbances in LV outflow tract, single breath-hold, retrospective gating.

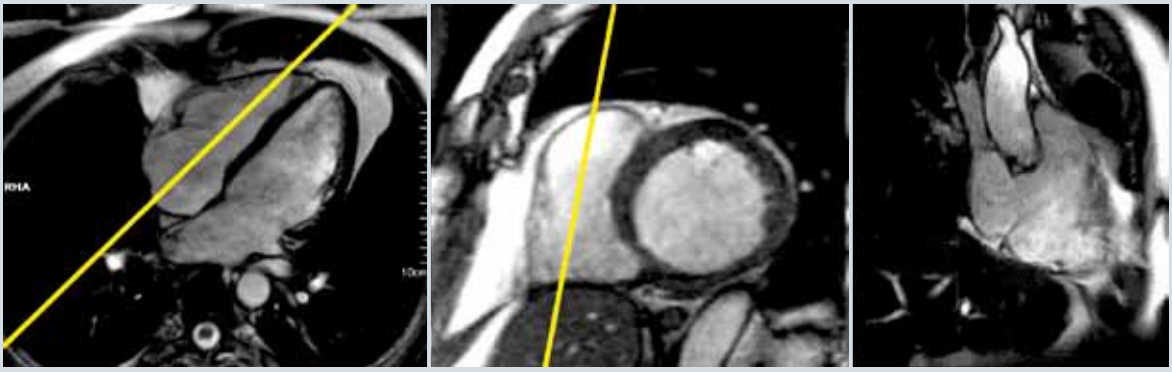


Arrhythmogenic Right Ventricular Cardiomyopathy

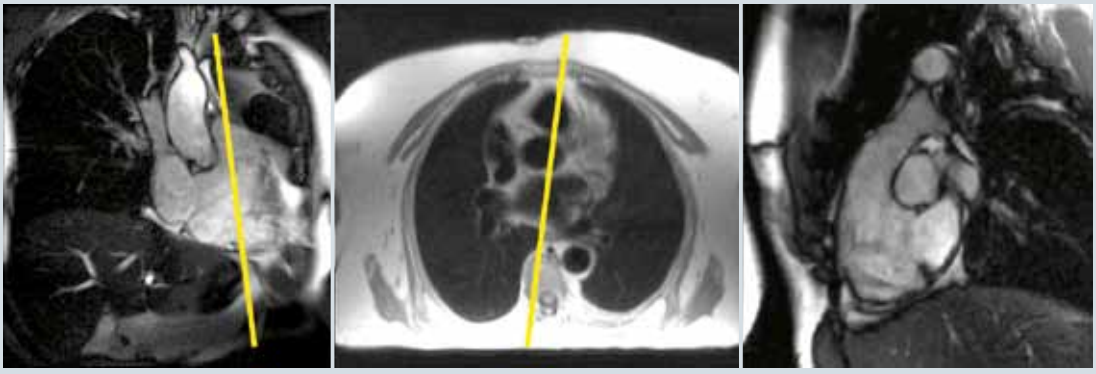
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

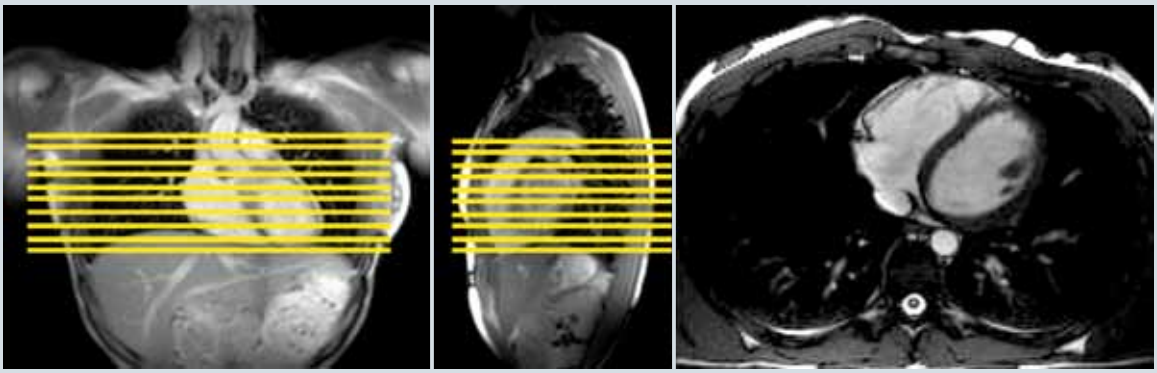
3. Right Ventricular Vertical Long Axis Cine: prescribe 1 right ventricular long axis slice from four chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, single breath-hold, retrospective gating.



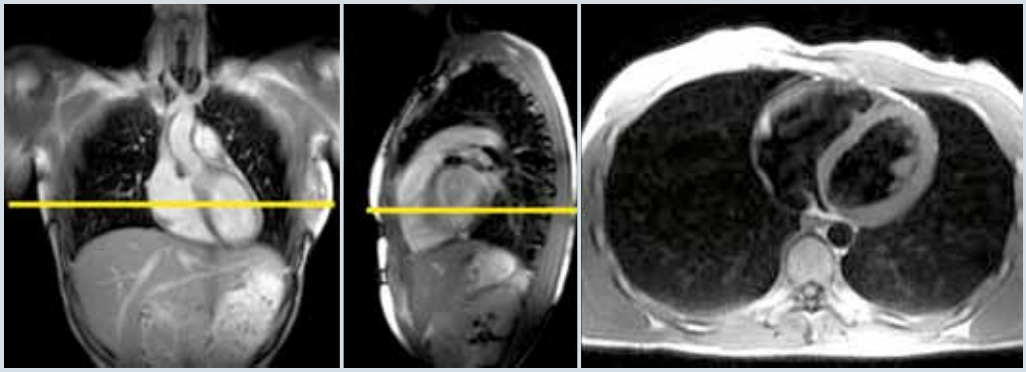
4. Right Ventricular Outflow Tract Cine: prescribe 1 slice from right ventricular vertical long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, single breath-hold, retrospective gating.



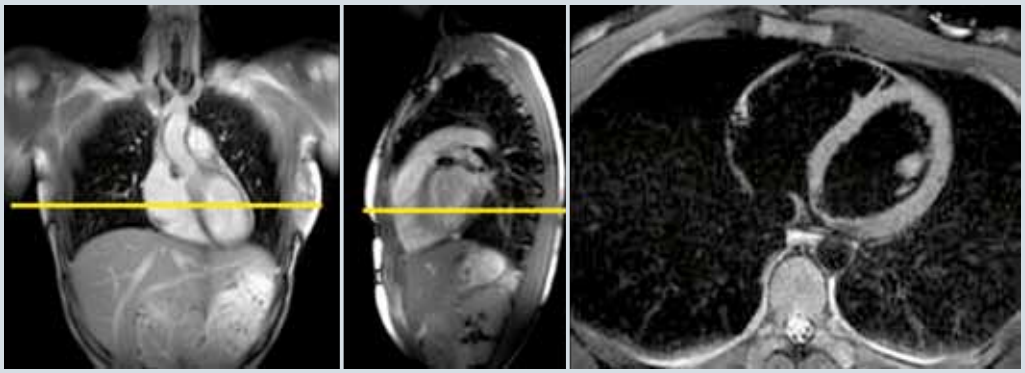
5. Axial Cine: prescribe 12 slices, adjust gap to cover entire right ventricle from base to apex, multiple breath-holds, retrospective gating.



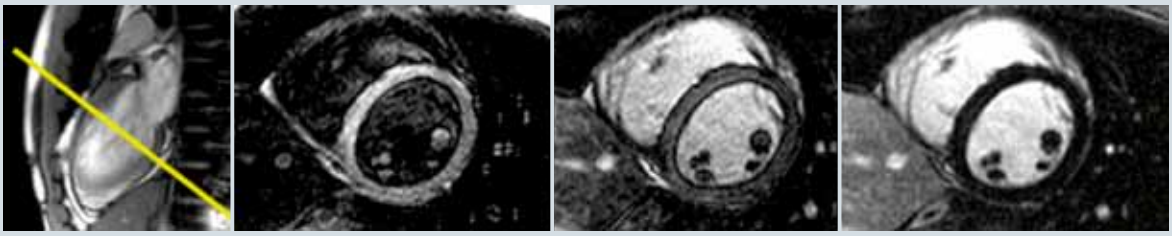
6. Optional Axial TSE Dark Blood T1: for selected slice levels of right ventricle, segmented dark blood tse, single breathhold, trigger on every heartbeat, capture cycle for diastolic gating.



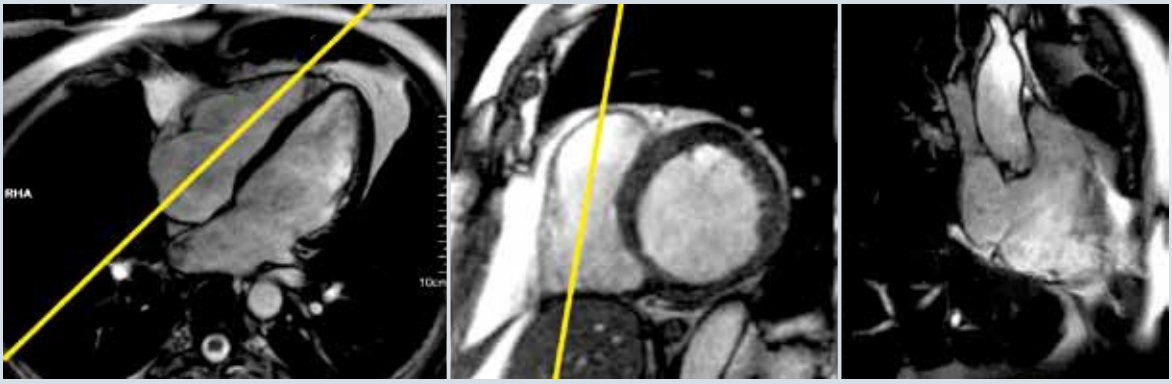
7. Optional Axial TSE Dark Blood T1 Fatsat: for selected slice levels of right ventricle, segmented dark blood TSE with fatsat, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.



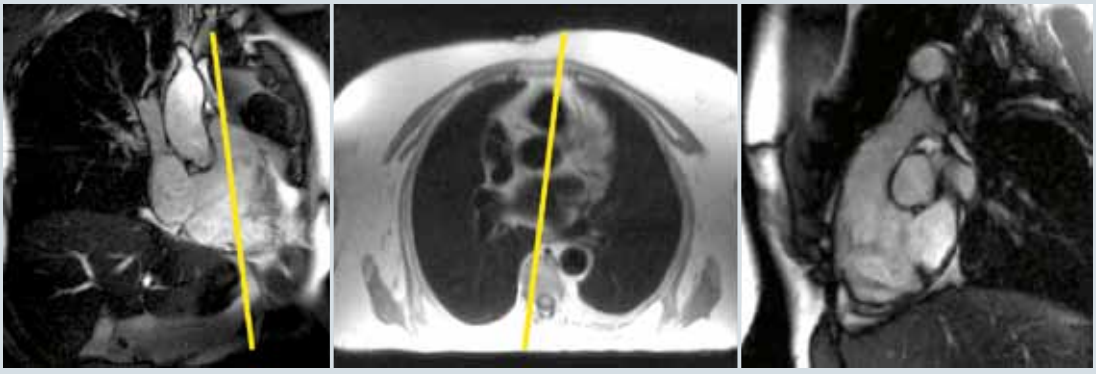
8. Optional TI Scout: determine optimal TI for nulling of normal RV myocardium, prescribe as a mid ventricular short axis slice, rotate FOV to avoid wrap, single breath-hold, trigger on every second heartbeat, capture cycle for optimal acquisition window.



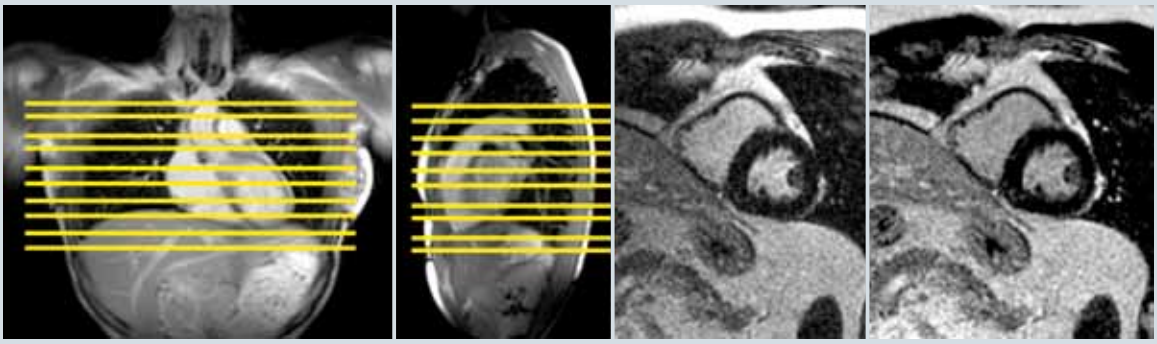
9. Optional Right Ventricular Vertical Long Axis Delayed: 1 slice in 1 breath-hold, phase sensitive inversion recovery turboflash technique, provides both magnitude and real images, adjust TI for nulling of normal RV myocardium, trigger on every second heartbeat, capture cycle for diastolic gating.



10. Optional Right Ventricular Outflow Tract Delayed: 1 slice in 1 breath-hold, phase sensitive inversion recovery turboflash technique, provides both magnitude and real images, adjust TI for nulling of normal RV myocardium, trigger on every second heartbeat, capture cycle for diastolic gating.



11. Optional Axial Delayed: 12 slices in 12 breath-holds, phase sensitive inversion recovery turboflash technique, provides both magnitude and real images, adjust TI for nulling of normal RV myocardium, trigger on every second heartbeat, capture cycle for diastolic gating.

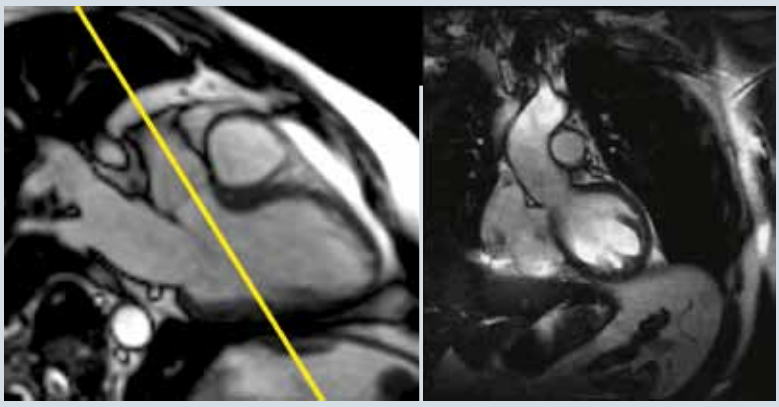


Pediatrics* (Teen, Child, Infant)

1. Localizer Module for localization.

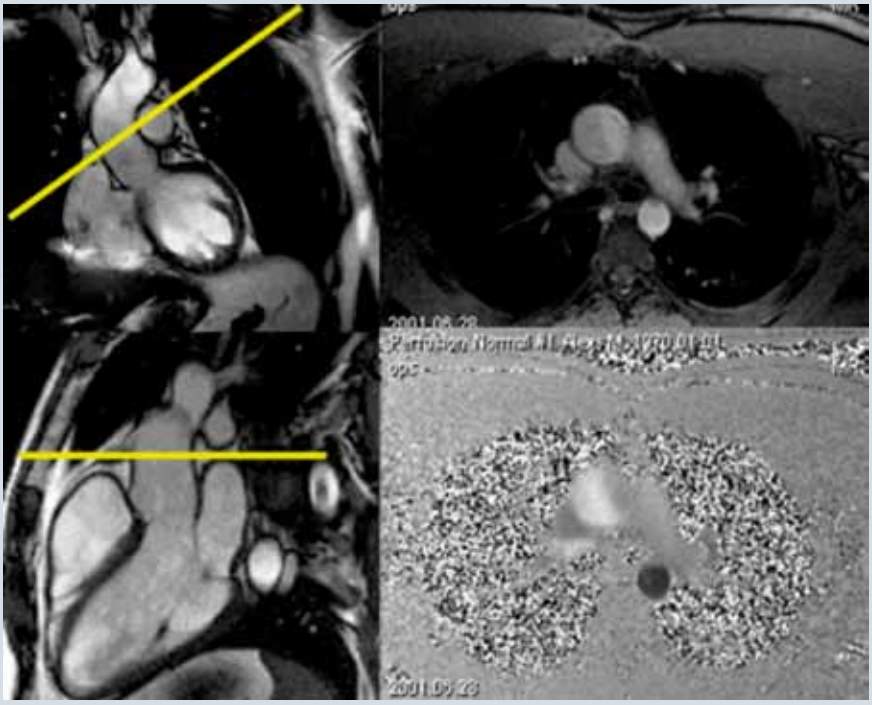
2. LV Function Module to assess ventricular function.

3. Coronal Aortic Outflow Cine: prescribe 1 coronal oblique aortic outflow slice from three chamber view, bisect LV outflow tract, aortic valve, and ascending aorta, single breath-hold, retrospective gating.

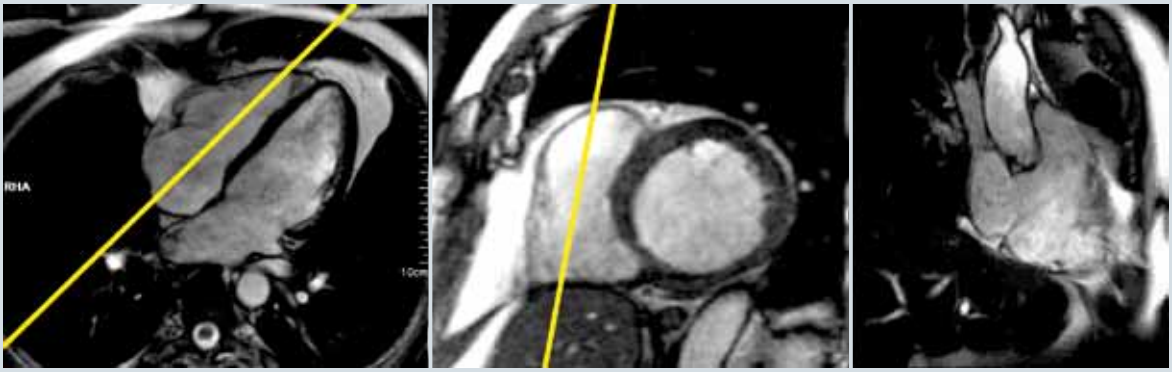


*MR scanning has not been established as safe for imaging fetuses and infants under two years of age. The responsible physician must evaluate the benefit of the MRI examination in comparison to other imaging procedures.

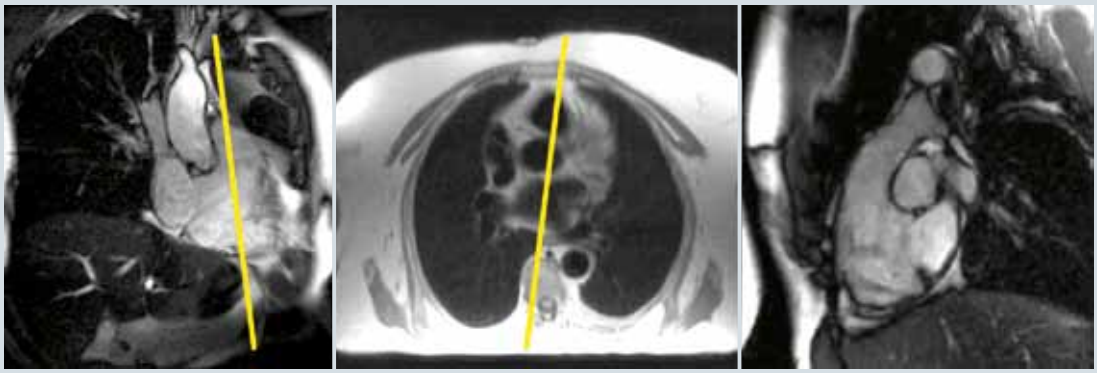
4. Aorta Through-Plane Flow Qs: prescribe from three chamber view and coronal aorta view, 1 cross-sectional slice perpendicular to ascending aorta distal to valve leaflet tips, repeat 1 cross-sectional slice across aortic valve orifice, through-plane VENC 150 cm/sec for normal flow (or greater for stenosis), single breath-hold, retrospective gating, short TE for optimal flow sensitivity.



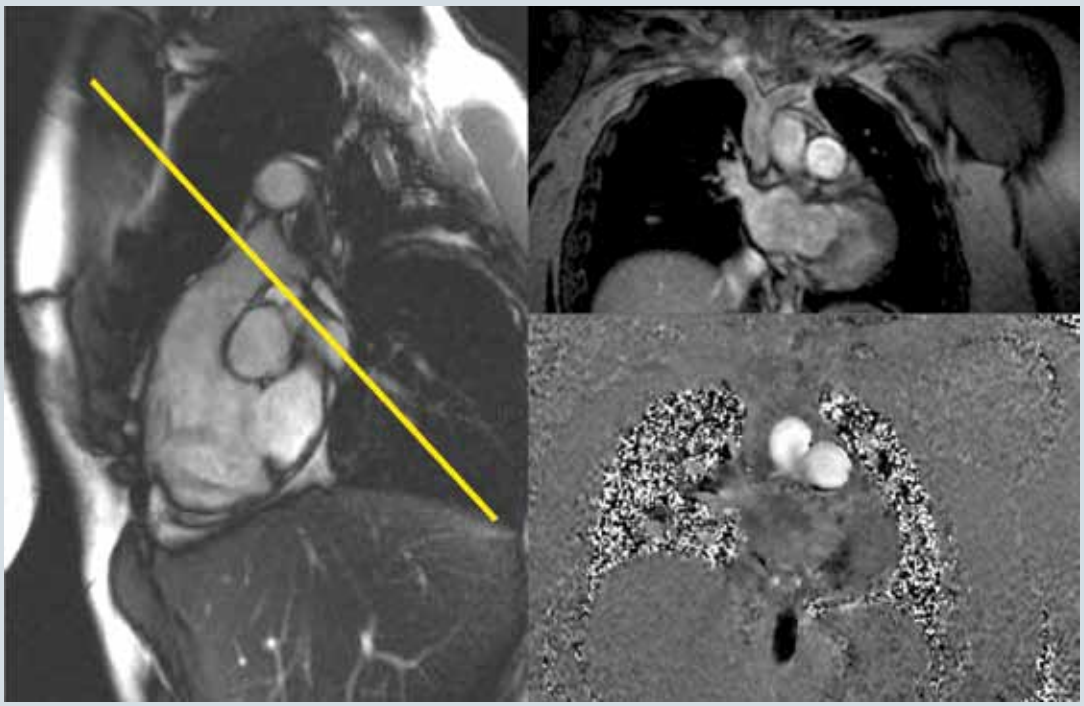
5. Right Ventricular Vertical Long Axis Cine: prescribe 1 right ventricular long axis slice from four chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, single breath-hold, retrospective gating.



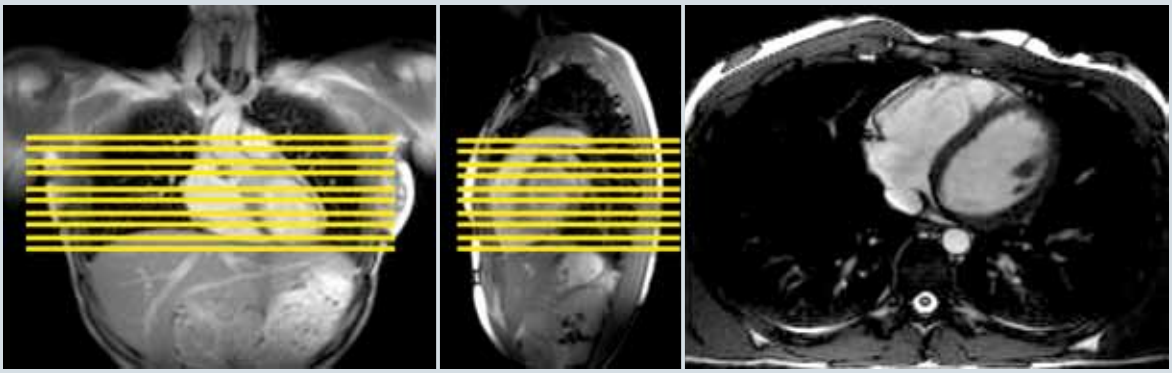
6. Right Ventricular Outflow Tract Cine: prescribe 1 slice from right ventricular vertical long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, single breath-hold, retrospective gating.



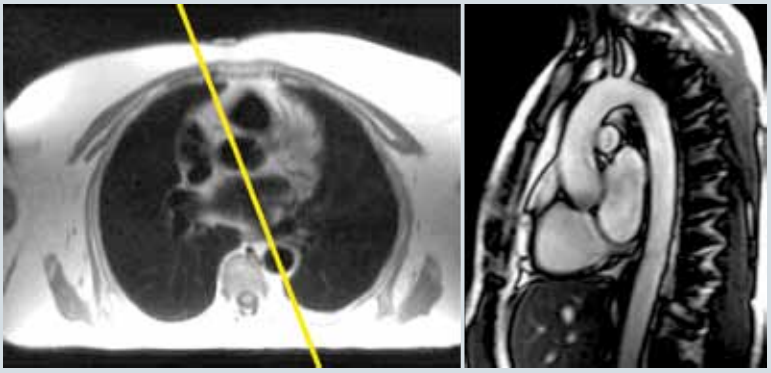
7. Pulmonary Through-Plane Flow Qp: prescribe from right ventricular outflow tract view, 1 cross-sectional slice perpendicular to main pulmonary artery distal to valve leaflet tips, repeat 1 cross-sectional slice across pulmonic valve orifice, through-plane VENC 90 cm/sec for normal flow (or greater for stenosis), single breath-hold, retrospective gating, short TE.



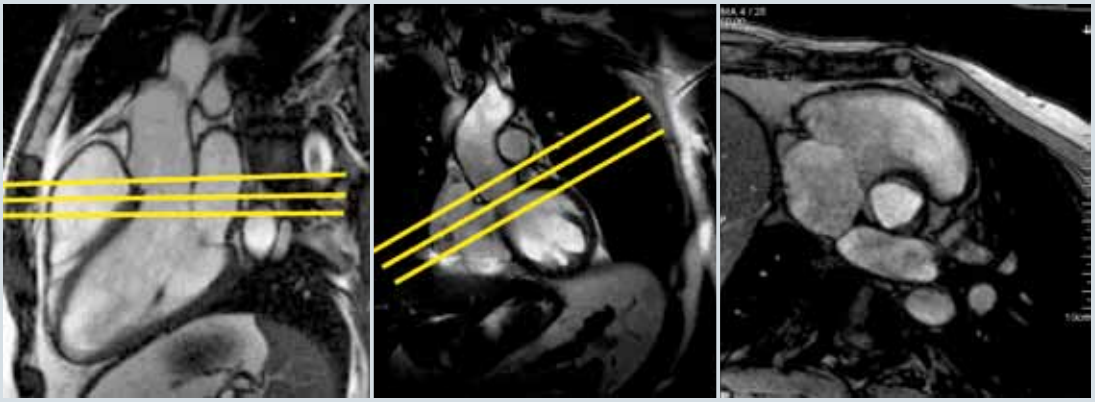
8. Optional Axial Cine: 15 slices, from coronal and sagittal views, adjust gap to cover entire heart from aortic arch to apex, multiple breath-holds, retrospective gating.



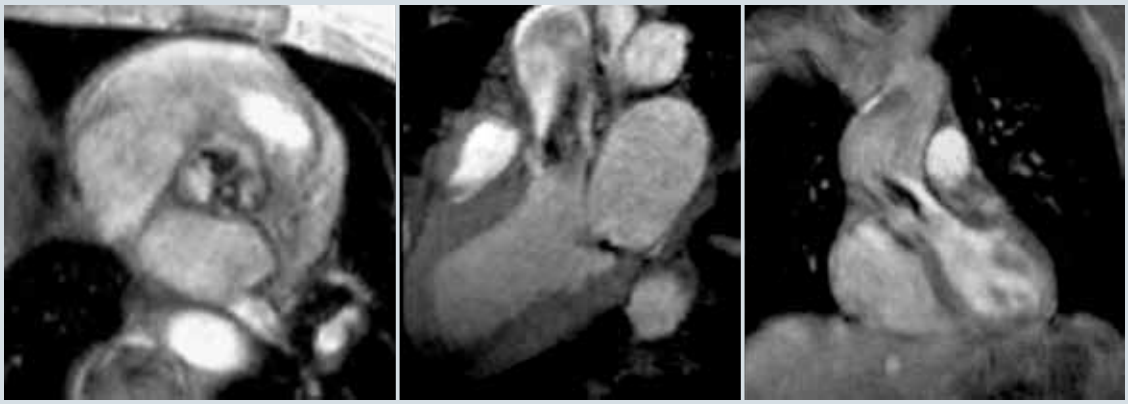
9. Optional Sagittal Aorta Cine: prescribe 1 sagittal oblique candy cane slice from axial view, single breath-hold, retrospective gating.



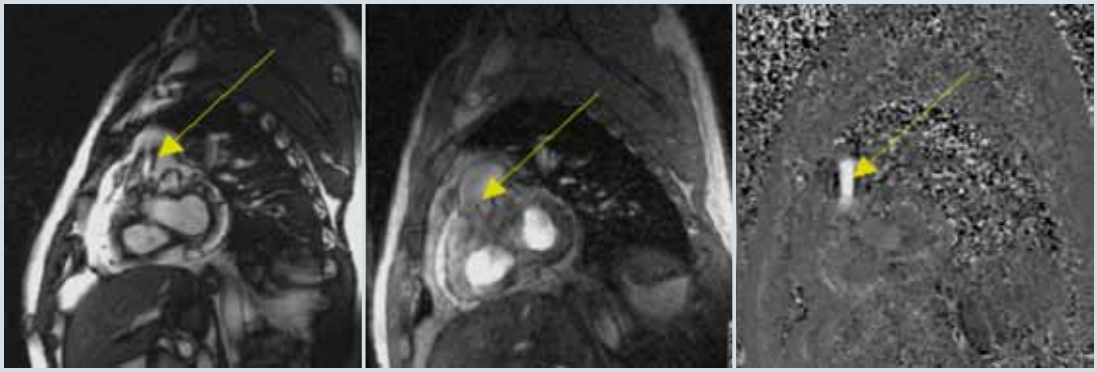
10. Optional GRE Cross-Sectional Valve Cine: 3 contiguous cross-sectional slices across valve plane, 3 breath-holds, short TE for bright flow through orifice, retrospective gating.



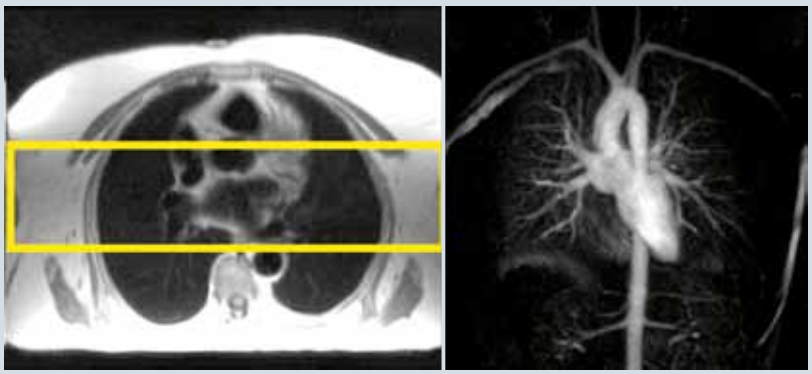
11. Optional GRE Stenotic Jet Cine: 1 slice in the best long axis view to see the stenotic flow jet, single breath-hold, long TE for dark turbulent flow void, retrospective gating.



12. Optional Stenotic Jet In-Plane Flow: 1 slice in the best long axis view to see the stenotic flow jet, single breath-hold, retrospective gating, in-plane VENC 250 cm/sec or greater, short TE for optimal flow sensitivity.



13. 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 and must contain no bolus, untriggered breath-hold, automatic subtraction and mip.

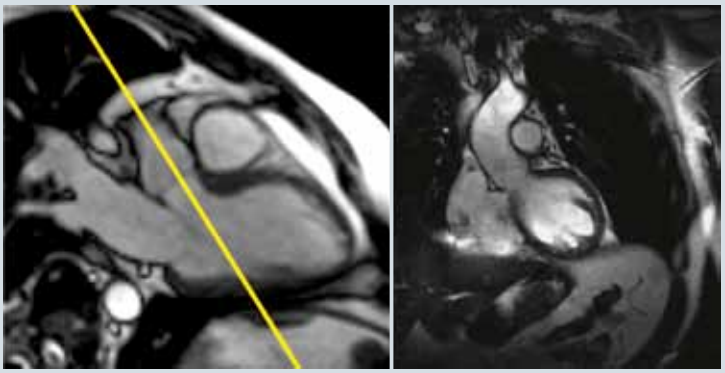


Valvular Disease

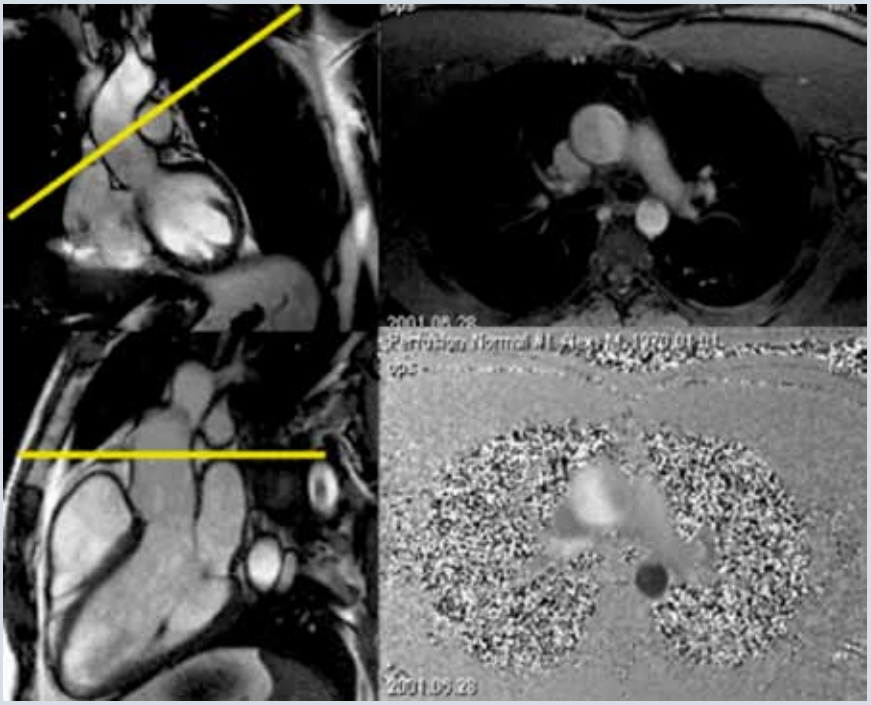
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

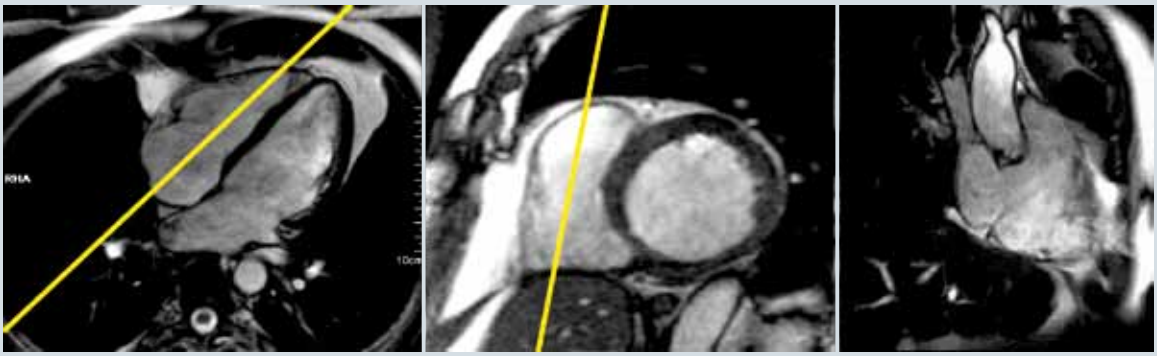
3. Coronal Aortic Outflow Cine: prescribe 1 coronal oblique aortic outflow slice from three chamber view, bisect LV outflow tract, aortic valve, and ascending aorta, single breath-hold, retrospective gating.



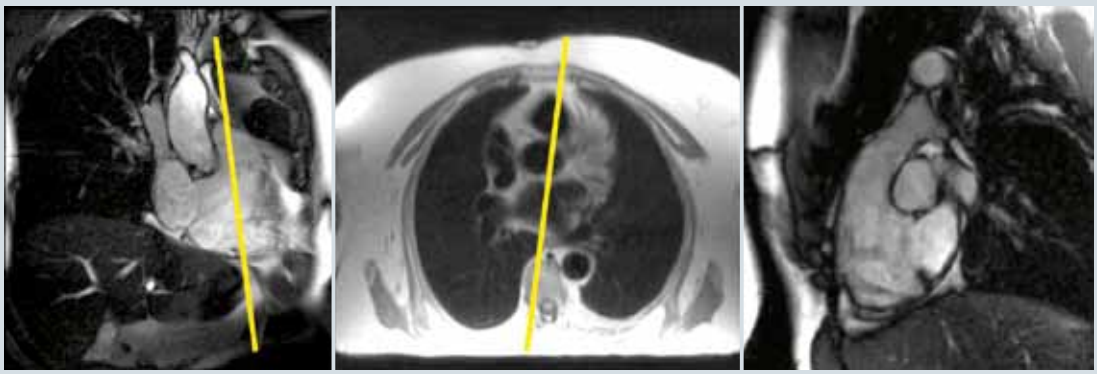
4. Aorta Through-Plane Flow Qs: prescribe from three chamber view and coronal aorta view, 1 cross-sectional slice perpendicular to ascending aorta distal to valve leaflet tips, repeat 1 cross-sectional slice across aortic valve orifice, through-plane VENC 150 cm/sec for normal flow (or greater for stenosis), single breathhold, retrospective gating, short TE for optimal flow sensitivity.



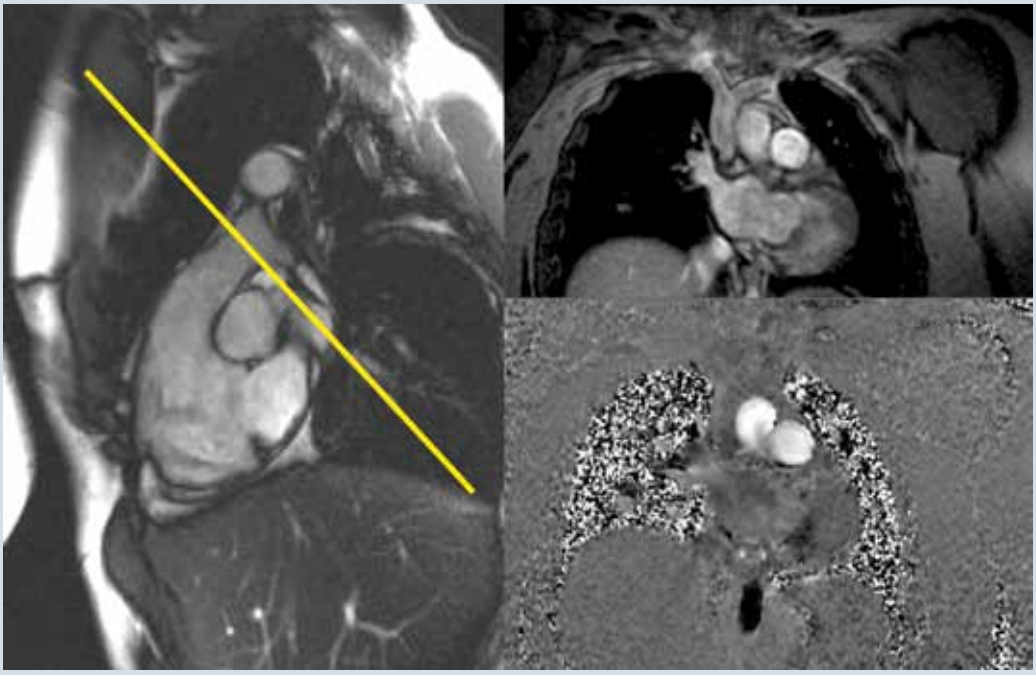
5. Right Ventricular Vertical Long Axis Cine: prescribe 1 right ventricular long axis slice from four chamber and basal short axis views, parallel to ventricular septum bisecting tricuspid valve, right atrium, and right ventricle, single breath-hold, retrospective gating.



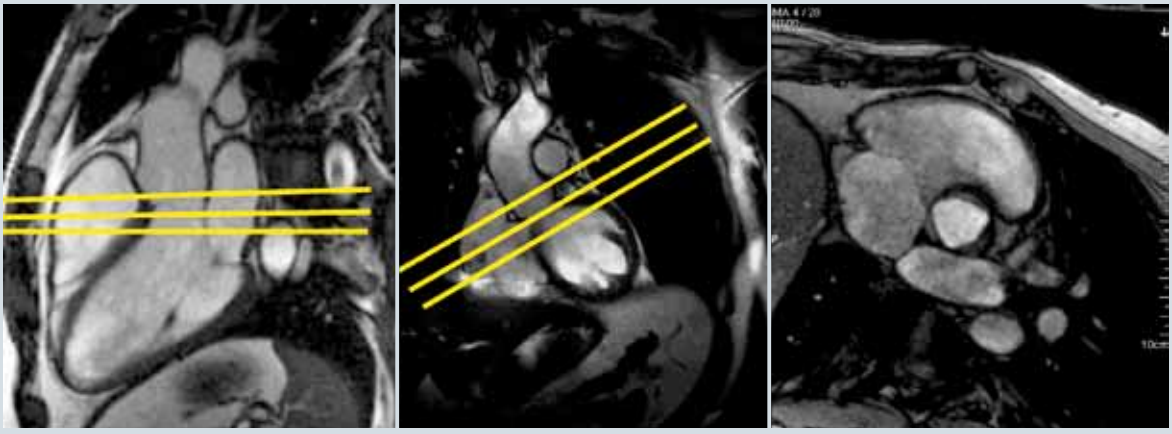
6. Right Ventricular Outflow Tract Cine: prescribe 1 slice from right ventricular vertical long axis and axial views, bisect pulmonary outflow tract, pulmonic valve, and main pulmonary artery, single breath-hold, retrospective gating.



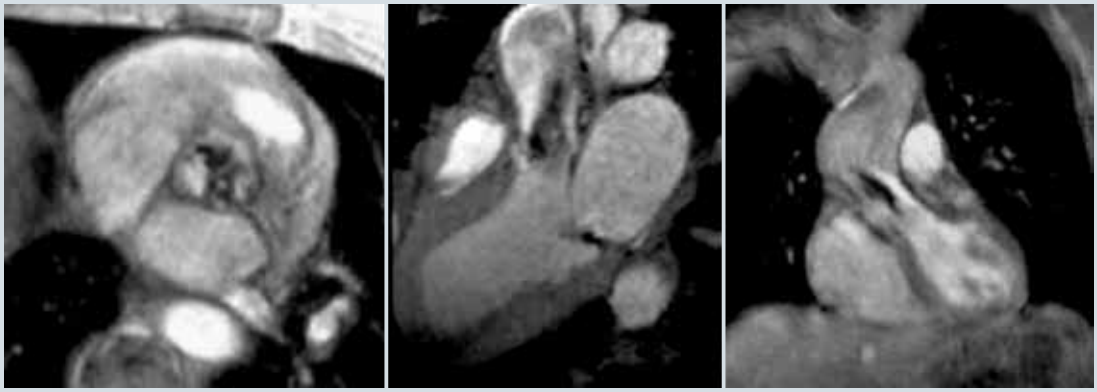
7. Pulmonary Through-Plane Flow Qp: prescribe from right ventricular outflow tract view, 1 cross-sectional slice perpendicular to main pulmonary artery distal to valve leaflet tips, repeat 1 cross-sectional slice across pulmonic valve orifice, through-plane VENC 90 cm/sec for normal flow (or greater for stenosis), single breath-hold, retrospective gating, short TE.



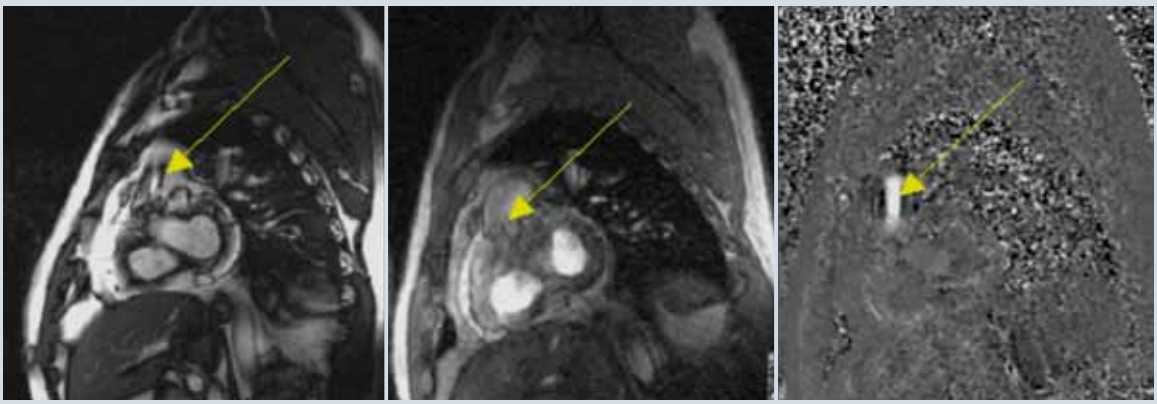
8. GRE Cross-Sectional Valve Cine: 3 contiguous cross-sectional slices across valve plane, 3 breath-holds, short TE for bright flow through orifice, retrospective gating.



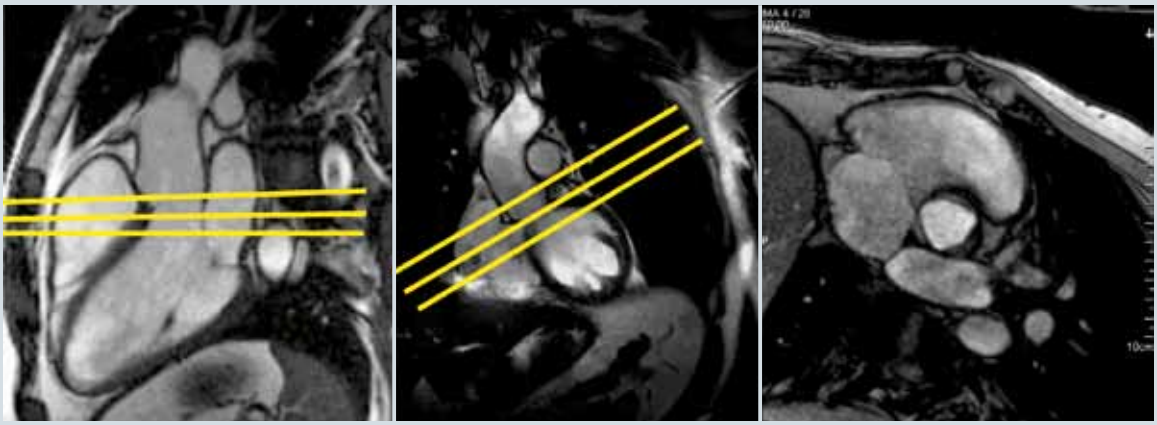
9. Optional GRE Stenotic Jet Cine: 1 slice in the best long axis view to see the stenotic flow jet, long TE for dark turbulent flow void, retrospective gating.



10. Optional Stenotic Jet In-Plane Flow: 1 slice in the best long axis view to see the stenotic flow jet, single breathhold, retrospective gating, in-plane VENC 250 cm/sec or greater, short TE for optimal flow sensitivity.



11. Optional Radial Valve Cine: 3 contiguous cross-sectional slices across valve plane, high resolution trufisp radial eliminates wrap with small FOV, multiple breath-holds, retrospective gating.

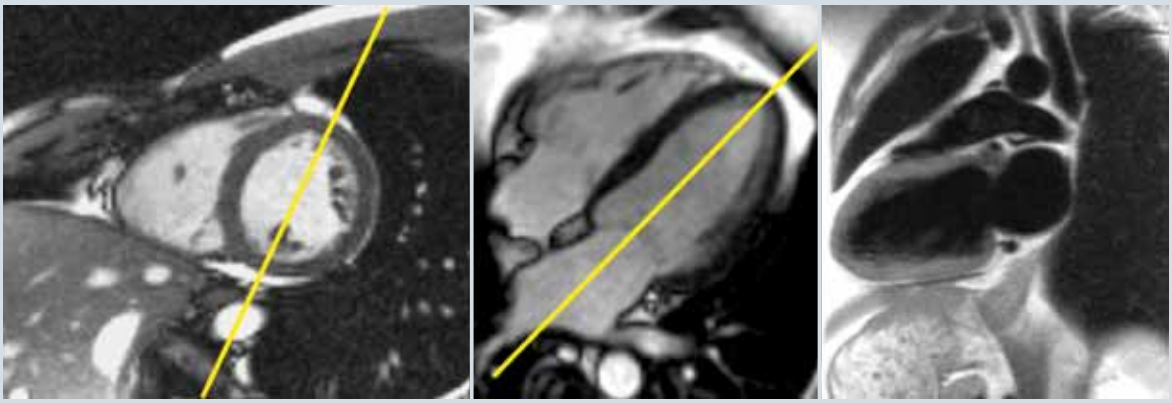


Pericardial Disease

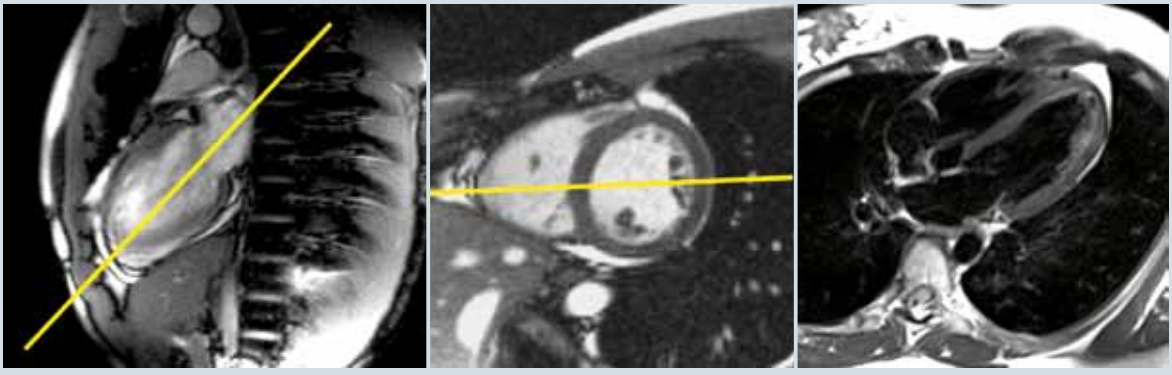
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

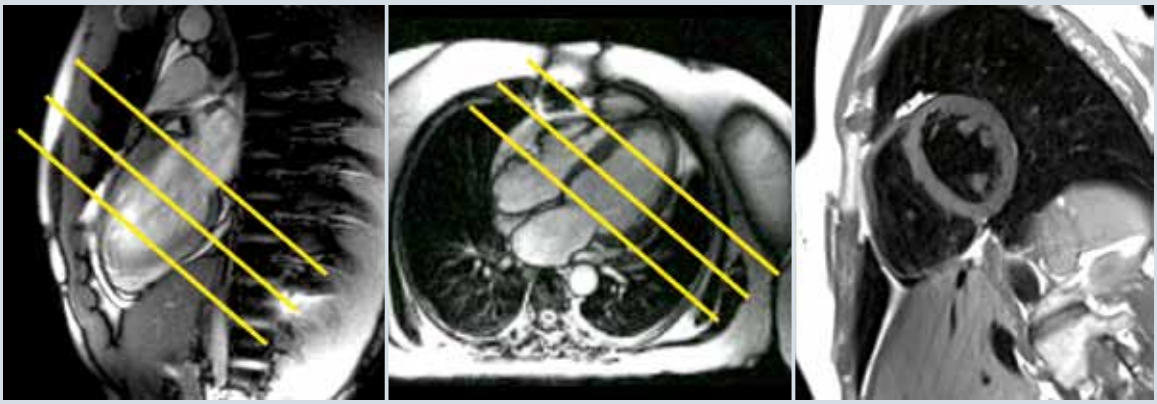
3. Two Chamber TSE Dark Blood T2: segmented TSE dark blood T2 to evaluate pericardial thickening, 1 slice in a single breath-hold, rotate FOV to avoid wrap, trigger on every second heartbeat, capture cycle for diastolic gating.



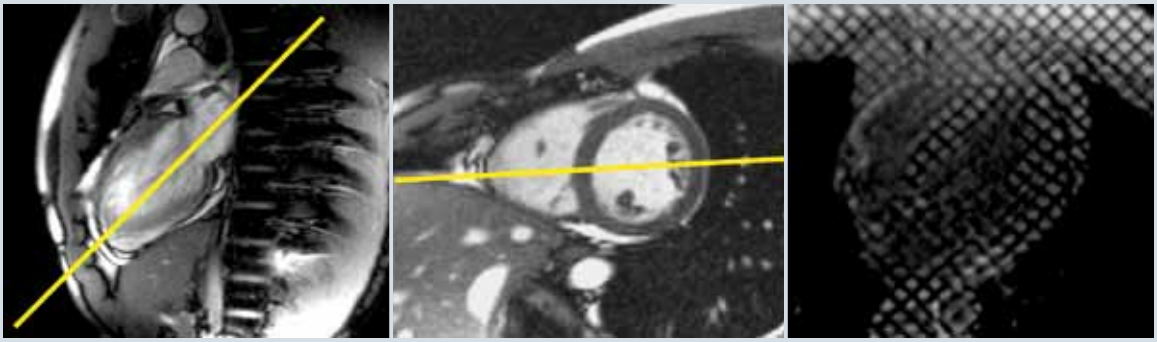
4. Four Chamber TSE Dark Blood T2: segmented TSE dark blood T2 to evaluate pericardial thickening, 1 slice in a single breath-hold, rotate FOV to avoid wrap, trigger on every second heartbeat, capture cycle for diastolic gating.



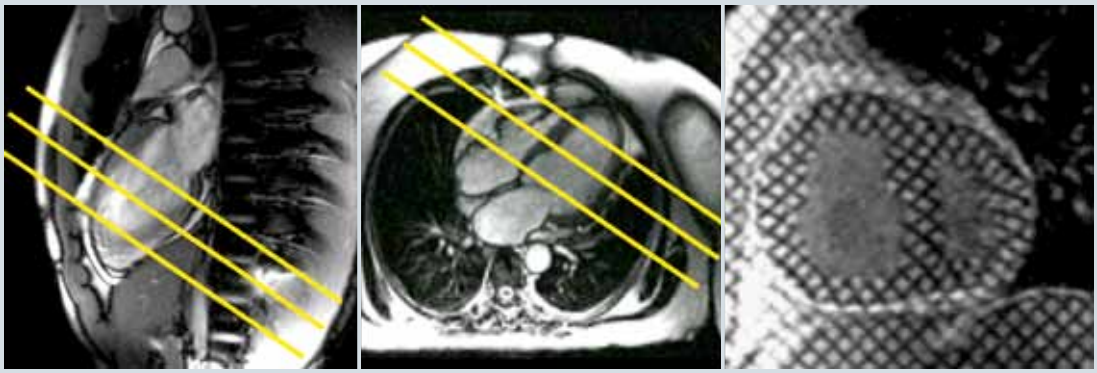
5. Short Axis TSE Dark Blood T2: segmented TSE dark blood T2 to evaluate pericardial thickening, 3 slices at base, mid, and apex in 3 breath-holds, rotate FOV to avoid wrap, trigger on every second heartbeat, capture cycle for diastolic gating.



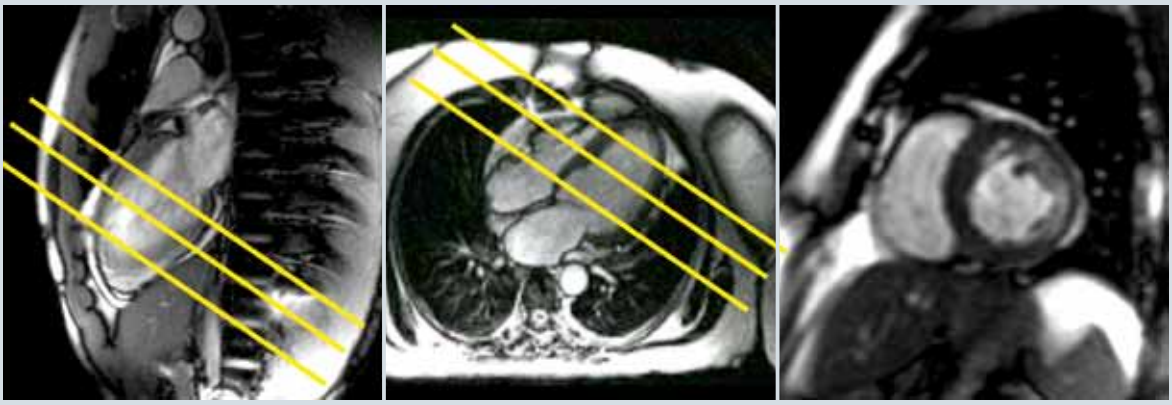
6. Optional Four Chamber Grid Tag: 1 slice in 1 breath-hold to evaluate pericardial adhesion, rotate FOV to avoid wrap, retrospective gating.



7. Optional Short Axis Grid Tag: 3 slices in 1 breath-holds at base, mid, and apex to evaluate pericardial adhesion, rotate FOV to avoid wrap, retrospective gating.



8. Optional Real-Time Free-Breathing Cine: 3 slices in free-breathing at base, mid, and apex, rotate FOV to avoid wrap, scans for 3 seconds per slice to evaluate ventricular interdependence.



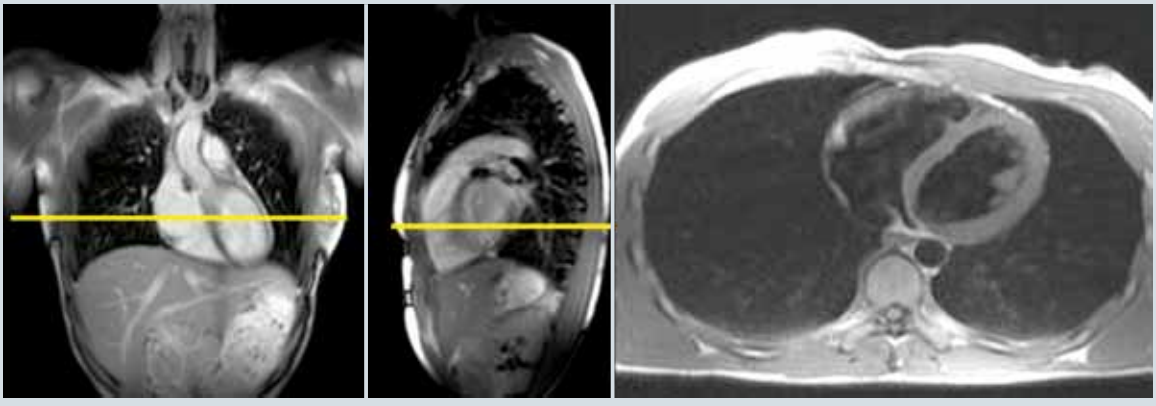
9. Delayed Module late after injection to assess pericardial disease.

Cardiac Mass or Thrombus

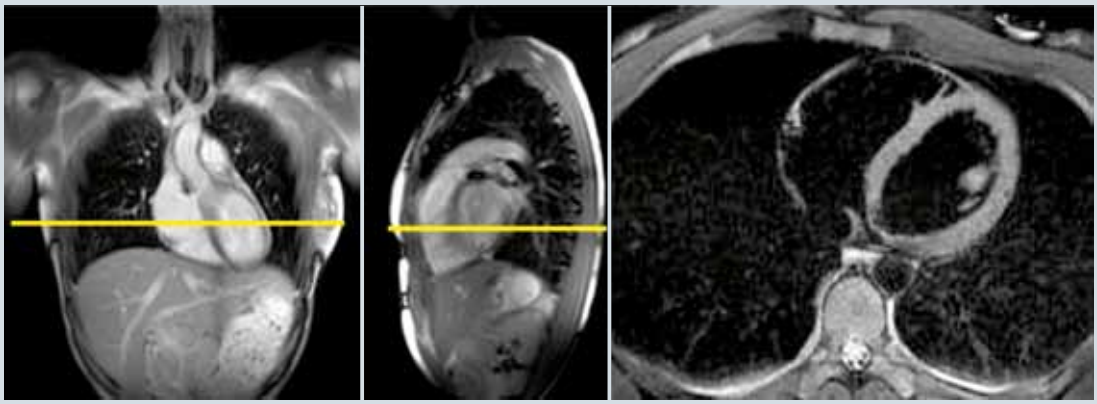
1. Localizer Module for localization.

2. LV Function Module to assess ventricular function.

3. TSE Dark Blood T1: for selected slice levels through mass or thrombus, segmented dark blood TSE T1, single slice, single breath-hold, trigger on every heartbeat, capture cycle for diastolic gating.

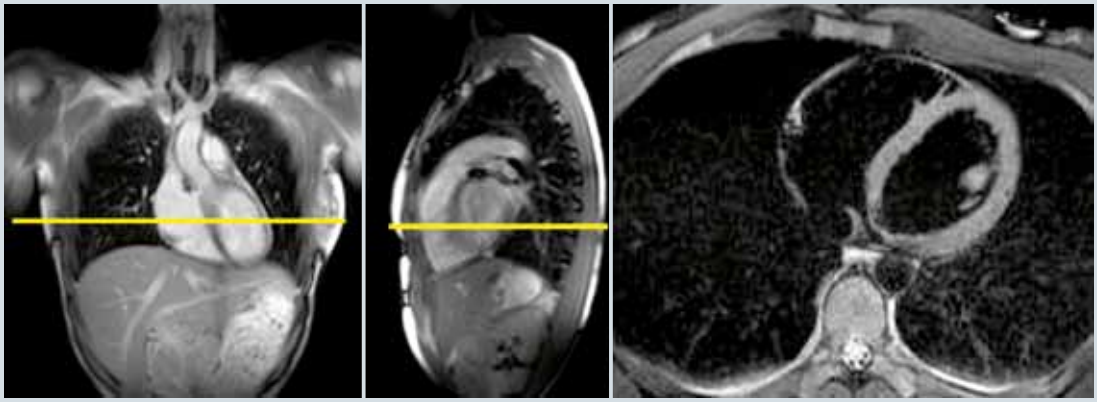


4. TSE Dark Blood T2 Fatsat: for selected slice levels through mass or thrombus, segmented dark blood TSE T2 with fatsat, single slice, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.

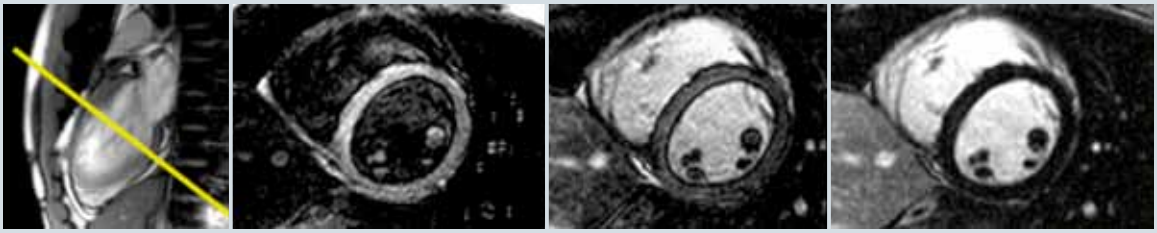


5. Dynamic Module without Adenosine to assess mass or thrombus.

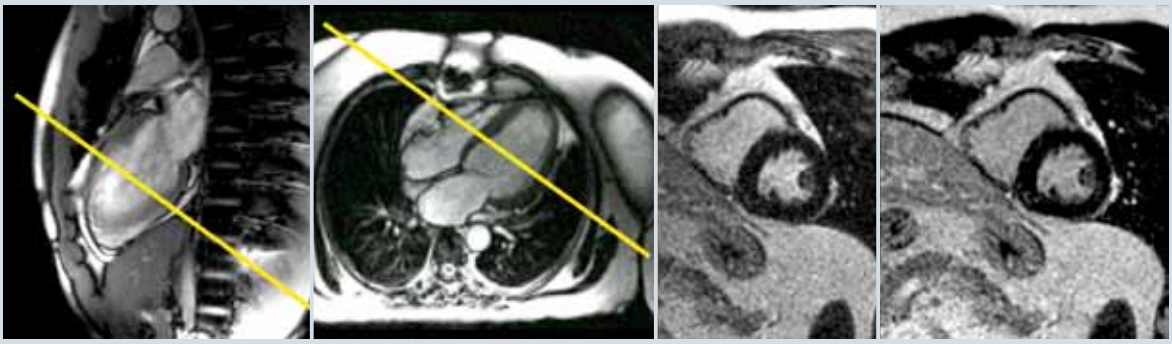
6. TSE Dark Blood T1 Fatsat: for selected slice levels through mass or thrombus, segmented dark blood TSE T2-weighted with fatsat, single breath-hold, trigger on every second heartbeat, capture cycle for diastolic gating.



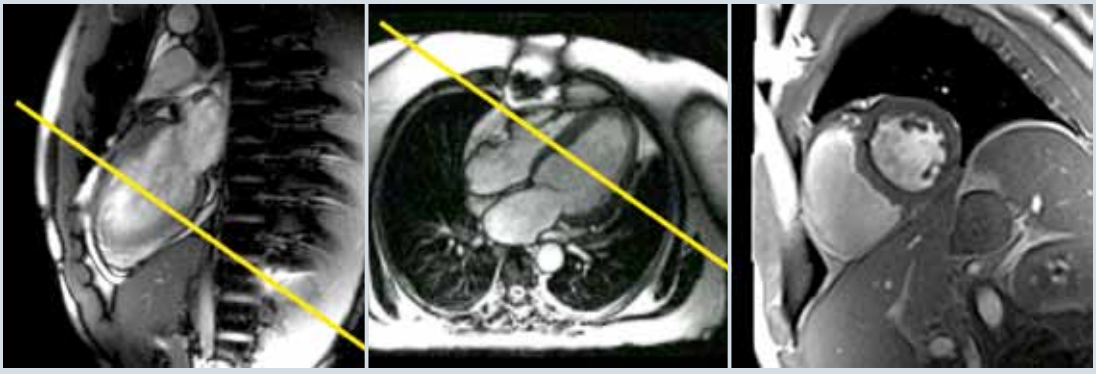
7. Optional TI Scout: determine optimal TI for nulling of normal myocardium, prescribe as a mid ventricular short axis slice, rotate FOV to avoid wrap, single breath-hold, trigger on every second heartbeat, capture cycle for optimal acquisition window.



8. Optional Early Enhance: 1 slice in 1 breath-hold, acquire early after injection to assess mass or thrombus, segmented phase sensitive inversion recovery turboflash technique, adjust TI for nulling of mass or thrombus, trigger on every second heartbeat, capture cycle for diastolic gating.



9. Optional GRE Cine: prescribe slice through mass or thrombus, 1 slice in 1 breath-hold, retrospective gating.



10. Delayed Module late after injection to assess mass or thrombus.

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