Topics

Heart:
- LV function
- Viability
- Perfusion
- Cardiac Mass / Pericardium
- ARVD

Vascular:
- Coronary
- Chest / Abdomen
- Peripheral vascular

Cardiac Protocols

✓ LV function
Viability
Perfusion
Cardiac Mass / Pericardium
ARVD

LV function
1. HLA chamber cine
2. Short axis cine
   8 mm thick, 2 mm spacing
3. VLA cine
4. LV outflow tract

10 minutes (use parallel imaging n=2)

Steady state free precession (SSFP) cine

balanced FFE – Philips
TruFISP – Siemens
Fiesta – GE

ALL THE SAME

Fast GRE (16 sec)  SSFP (6 sec)  Real time SSFP

T. Foo, GEMS

Disclosures

- Off-label: gadolinium MRI of the heart and vessels, adenosine MRI
- Research support: Epix Medical
- Consultant: GE Healthcare, Berlex
**LV Function**

**4D SSFP: use parallel imaging**
Full 3d recon + cine; 1 breath-hold

**LV Function - Segmentation**

**LV volume analysis**
- Body Surface Area: 1.89 m²
- ED volume: 357.65 ml
- ED volume/BSA: 189.04 ml/m²
- ES volume: 241.32 ml
- ES volume/BSA: 127.55 ml/m²
- Stroke volume: 116.33 ml
- Stroke volume/BSA: 61.49 ml/m²
- Ejection fraction: 32.53%

**Cardiac Protocols**
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Viability Protocol

- Purpose: evaluate delayed washout of gadolinium in infarction, inflammation, infiltrative disease

1. Long axis cine images 5 min
2. Administer 0.15 mmol/kg gadolinium
15 min
3. Short axis cines, then TI scout
4. Delayed gad images, short and long axis, begin ≥10 min after gad was given

Delayed Gad: adjust TI for each patient

- Optimal TI time depends on clearance of gadolinium from the normal myocardium
- Typical range: 175-250 msec
- Lower TI time when more gad is present:
  - decreased renal function
  - CHF

“TI Scout” “Look-Locker”

- Single breath-hold, 50 phases, 20 msec temporal resolution

Technologist dependent image optimization

Images every 20 msec

Phase Sensitive Inversion Recovery

Magnitude Reconstruction

Phase Sensitive Reconstruction
Viability Protocol: Increasing Dyspnea

Viability Protocol: also for Nonischemic Cardiomyopathy
- Hypertrophic cardiomyopathy
- Myocarditis – inflammation
- Amyloid
- Sarcoid
- Drug toxicity
- Chagas disease (fibrosis)

Hibernating Myocardium

HOCM: Myocardial Fibrosis
- Cine
- Delayed contrast

Hypertrophic Cardiomyopathy: Septum
Myocarditis with scar

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MRI perfusion

- 0.05 mmol gad, 4-5 ml/sec
- EPI-GRE or SSFP acquisition
- 4-8 images / 2 R-R
- 96 x 128 matrix
- 8 mm thick, 6-8 mm gap
- 30-40 phases

Protocol – Stress Perfusion

- Short axis:
  - 3 min adenosine @140 ug/kg/min OR,
  - 2 min dipyridamole @0.56 mg/kg over 4 min
- 0.05 mmol/kg gadolinium bolus, 5 ml/sec
- Short axis perfusion for 1 min
- Repeat at rest + viability

Cardiac mass protocol

1. Axial T1 images (find the mass!)
2. Axial T2 images
3. +/- fat suppressed T1 images
4. Axial cine images
5. Pre/post gadolinium T1 images
   • fat sat double IR FSE (1x gadolinium) or “viability” T1 images with 1.5-2x dose gadolinium
Emergency transfer for cardiac mass on echo

Axial T1  Axial T1

Axial STIR images (fat is dark, edema is bright)  Axial T1 images with fat suppression

Metastatic chondrosarcoma

T1 pre  T1 post

T2  perfusion

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Arrhythmogenic RV Dysplasia

- Fibrofatty infiltration of RV resulting in ventricular tachycardia
- Palpitations, syncope, sudden death
- Age $33 \pm 14$ yrs
- 30-50% cases are familial. MR screening of family members
**RV dysplasia - Protocol**

1. *Axial / short axis* “T1” images, blood suppression (double IR FSE)
   - 5 mm slice thickness, ETL 24-32
   - Anterior coil, FOV 24-28
2. same as (1), with fat suppression
3. *axial / short axis* cine images
4. *axial / short axis* delayed gadolinium images

**Black blood images**

- Axial “T1” images, blood/ ±fat suppression
  - TE min, ETL 24-32, 256x256, ZIP
  - 5x3 mm
  - Anterior coil, FOV 24-28

**“Double IR” single shot (HASTE) FSE**

2 sec per image – *do not use for heart MRI*

**Right ventricle fat**

**RV and Pulmonary outflow tract enlarged, poor function**

**Right ventricular aneurysm**

Typical ARVD
RV delayed enhancement

*ICD, investigational

Delayed enhancement present in about 2/3 of ARVD patients

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  - Chest
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Coronary MRA Protocols

1. Targeted MRA of each artery
   - breath-hold or navigator 3d SSFP technique
   - double oblique images, oriented along the course of each coronary artery

2. Whole heart coronary MRA

Targeted Breath-hold 3D SSFP MRA

- Advantages: quick, 20 sec, repeatable
- Disadvantages: breath-hold time limits resolution, difficult at high heart rates, complex for technologist

Multicenter Coronary MRA Study 1.5T: targeted MRA with navigator (non-breath-hold)

Aarhus Berlin Boston Leiden Köln Texas Leeds Zürich

**Whole Heart 3d axial MRA:**
Navigator echoes are used to track the diaphragm and reduce motion artifacts

**Whole Heart 3d MRA**
2mm thick slices, 5-15 min

**Vascular Protocols**

- Coronary
- Chest
- Abdomen
  - Peripheral vascular

**Abdomen, Chest Protocols**

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<th>Chest</th>
<th>Abdomen</th>
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<td>3D MRA</td>
<td>≤ 3mm</td>
<td>≤ 2mm (fat suppression)</td>
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<tr>
<td>Pre</td>
<td>Ax, Sag obl. T1 (gated)</td>
<td>Ax SSFSE or SSFP (cysts, fluid)</td>
</tr>
<tr>
<td>Post</td>
<td>Ax post T1 (fat sat, gated)</td>
<td>Cor 3d T1 GRE (liver, kidney, etc)</td>
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**Thrombosed Aortic Dissection**

"double IR" black blood FSE
Aortic Dissection - intraluminal view

Takayasu arteritis

Takayasu arteritis

Fluoroscopic MRA trigger

MRA: Venous phase

MRA - Aorta
**Vascular Protocols**

- Coronary
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- Peripheral vascular

### Bolus Chase: Stepping Table MRA

1. 9 - 12 sec
2. 9 - 11 sec
3. 11-13 sec x 2 runs

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### Peripheral MRA:
**3 stations, 2 injections**

- Calf and foot station
  - 20 ml Gad, and 2 - 3 acquisitions
- Pelvis & thigh stations with step table
  - 25 – 35 ml Gad bolus chase style
- Avoids venous contamination in the feet and calves.

### Time Resolved MRA, 20 cc gad (TREAT, TRICKS)

- 33 sec
- 38 sec
- 43 sec
Time Resolved MRA (TREAT, TRICKS)

Summary

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Thank you!

www.rad.jhmi.edu/mri/MRI_Info_RSNA.htm

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