Why Cardiac MRI?
Common indications for MR imaging of the heart include the following:

- Diagnosis of arterial and ventricular septal defects.
- Assess congenital abnormalities.
- Visualization of the papillary muscles and valves.
- Cardiac Perfusion
ECG Prep and Triggering

MRI Electrocardiogram (ECG) helps to trigger (or time) the MRI pulse sequence to reduce motion artifact.

Cardiac Gating

Normal Cardiac Cycle:
P wave to P wave.

R to R Interval:
R wave to R wave.

Cardiac Gating

Trigger window starts at the p wave (orange)
Delay window starts at the R wave (yellow)
Available imaging time is between the T wave and P wave (green)

Cardiac Gating

Image slice acquisition
MRI Positioning

A. Two-Chamber view positioning
B. Four-Chamber view positioning
C. Four-Chamber view positioning

Two-Chamber View

- Center parallel to long axis of left ventricle
- Always center from breath-hold (BH) transverse
- The resultant image will demonstrate the left ventricle, left atrium, left atrial appendage (LAA) and mitral valve (MV)
- Also called vertical long axis view

Two-Chamber View

Notice the left atrial appendage? Mitral valve regurgitation?

Aliased Two-Chamber View

- The field of view (FOV) that was selected was too small for body habitus; therefore fold over or wrap has degraded this image
Four-Chamber View

- Center parallel to the two-chamber view
- Center in between the papillary muscles on short axis (SA) image
- The resultant image will demonstrate the right and left atrium, the right and left ventricle, and MV and tricuspid valve
- Also known as horizontal long axis

Malpositioned Four-Chamber View

- This image was positioned too superior on the two-chamber view
- The resultant image has the aortic valve (AV) in the view making it a five-chamber image

MRI Cine (Movie):
**Short Axis**

- Center perpendicular to the septum on the four-chamber view
- The resultant image demonstrates the left and right ventricle in a nice round shape (donuts)
- Left ventricle (LV) has a thicker myocardial wall.

**Short Axis with Motion Artifact**

- Impaired image quality because patient had difficulty holding their breath

**Left Ventricular Outflow Tract of Aorta**

- Center perpendicular to the aorta
- The resultant image demonstrates the left ventricle, AV and outflow tract
- Also known as coronal view
**Left Ventricular Outflow Tract of Aorta**

MRI Cine (Movie):
The black line in the left ventricle represents regurgitation of the aortic valve.

**Flow Artifact**

- Turbulent flow in the aorta causing a flow artifact on left ventricular outflow tract (LVOT) image

**Para-Axial Aorta**

- Center parallel to the aortic valve (AV) using the LVOT image
- The resultant image demonstrates the cusps of the aortic valve (AV)
**Aortic Valve**

- Center parallel to the long axis of the left ventricle and aorta
- This image demonstrates the AV, MV, and right and left ventricle

**Three-Chamber View**

- Center parallel to the long axis of the left ventricle and aorta
- This image demonstrates the AV, MV, and right and left ventricle

**Parasagittal Aorta**

- Center parallel to the ascending and descending aorta
- The resultant image shows the aorta in a candy cane view

**Parasagittal Aorta**
Hypertrophic Cardiomyopathy

Right Ventricle Perforation: 85 YO Un

Life threatening rupture on CMR

MRI

Perfusion

Myocardial Perfusion

- Normal – Myocardium enhances homogeneously in both rest and stress scans
Myocardial Perfusion

- **Myocardial Perfusion Defect**
  - Ischemia – myocardial defect presents at stress, disappears at rest.
  - Necrosis – myocardial defect presents at stress and at rest.

- **Intramural** – perfusion defect is placed in the inner layers of myocardium
- **Transmural** – perfusion defect is located in the entire myocardial wall
- **Subendocardial** – perfusion defect is placed in the subendocardial myocardium.
  - Usually this is not well identified by Single Photon Emission Computed Tomography (SPECT) studies.

Heart Wall

- **Why MRI Perfusion?**
  - Better resolution than other modalities CT and Nuclear Medicine (Resolution < 2mm)
  - No radionuclide
  - Visualize subendocardial defects. This helps the cardiologist determine if coronary stenosis should be treated by angioplasty or coronary bypass surgery. Cardiac viability or damage.
  - Morphology and of the heart is included.
Comparisons

<table>
<thead>
<tr>
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<th>Nuclear Imaging</th>
<th>MRI</th>
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<tbody>
<tr>
<td>Spatial Resolution</td>
<td>1.0 – 1.3 cm</td>
<td>1.0 – 1.5 mm</td>
</tr>
<tr>
<td>Voxel resolution</td>
<td>3 – 5 cm</td>
<td>8 – 10 mm</td>
</tr>
<tr>
<td>SNR</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>CNR</td>
<td>8</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Difference in resolution</td>
<td>1</td>
<td>60 – 80</td>
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PET, position–emission tomography
CNR, contrast-to-noise ratio
SNR, signal-to-noise ratio

41 YO M with 1-mm ST Elevation Myocardial Infarction 1 Week Ago and Negative Nuclear Scan Yesterday

A very thin lateral wall subendocardial infarction below the limit for detection by standard nuclear imaging well visualized by the high spatial resolution afforded by cardiovascular magnetic resonance (CMR). Note, the high CMR resolution to demonstrate the dual supply of the posterior lateral papillary muscle suggested by variable scar (middle arrow).

MRI Challenges

- Claustrophobia
- Motion
- Cardiac Triggering (arrhythmias)
- Coil selection
- Pacemakers
- Gradient strength (faster imaging)
- Coronary Arteries/Stents

The End
References: