Cardiovascular Disease

Diseases of the circulatory system, also called cardiovascular disease (CVD), are the leading cause of death and disability in the Westernized world. CVD can take several forms, including:

- high blood pressure
- coronary artery disease (CAD), also known as coronary heart disease (CHD)
- peripheral vascular disease
- stroke

Cardiovascular Disease

According to World Health Organization (WHO):

- 17 million people die in the world each year from CVD
- In 1998, 7.3 million people died in the world from CAD
- It is predicted that 11.1 million people will die of CAD in the year 2020.

Cardiovascular Disease

Other disease processes that can affect the heart includes:

- Congenital heart disease
- Diseases of the pericardium
- Cardiac masses

Overview

At the end of this session:

- MRI anatomy of the heart
- Equipments needed for cardiac imaging
- Imaging sequences (+ imaging pitfalls)
- Imaging planes
- Examples of CMR usage
- Latest updates
## CARDIAC MRI

- Excellent tissue contrast
- Functional
- Noninvasive
- No ionizing radiation
- Can be repeated serially
- Reproducible

## MR Safety Issues

### Contraindications

- Pacemaker/defibrillator/pumps
- Recent (<6 weeks) coronary stenting
- Ferromagnetic devices or objects
  - Cochlear implants
  - Metal in eye
  - Some aneurysm clips
- First trimester pregnancy

### Not Contraindications

- Prosthetic valves
  - Except early Starr Edwards
- Coronary stents (>6 weeks)
- Joints replacements
- Sternotomy wires
- IVC filters
What is needed?

- At least 1.5 Tesla MRI
- ECG gating
- Torso phased array coil
- +/- intravenous contrast

ECG GATING

Prospective gating is most commonly used

ECG GATING

Trigger delay – delay given from R wave to image acquisition. Use in black blood imaging.
Acquisition window – duration of data acquisition
Trigger window – duration between end of acquisition and next R wave
**ECG GATING**

**CONTACT**

### Troubleshooting
- Poor lead contact
  - Check electrode connections
  - Clean skin, shave if necessary
- Respiratory motion
  - Posterior lead placement
- Low R waves (high T wave)
  - Switch leads
  - Peripheral gating as last resort

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**Indication of CMR**

- Coronary heart disease
  - Coronary artery disease
  - Myocardial infarct - perfusion and viability
  - Ventricular function
- Cardiac masses
- Valvular diseases
- Pericardial disease
- Congenital heart disease

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**Imaging Sequences**

- **Morphology**: Black blood
- **Cardiac function**: Bright blood
- **Perfusion**: Gradient Echo
- **Viability**: Contrast enhancement of myocardium to look for infarcts
- Phase contrast - velocity/flow
- Gadolinium MR Angiography - Aorta/Great vessels

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**Imaging Sequences**

- **Black blood sequence**
  - Sequences designed to depress/null the signal from flowing blood
  - Anatomy of the heart e.g. for assessment of cardiac masses, the myocardium/pericardium
  - Spin echo/fast spin echo (half-Fourier single shot)
    - SS-FSE (GE, Philips) HASTE (Siemens)
  - Used with double inversion recovery to achieve optimal nulling of blood
  - ± breath-hold
**Imaging Sequences**

- **Bright blood sequence**
  - Sequences using cine gradient echo to assess function/movement of the myocardium
  - Steady-state free precession (SSFP)
    - FIESTA (GE) TrueFISP (Siemens) b-FFE (Philips)
  - breath-hold
  - Requires:
    - low TR (typically less than 4msec)
    - a high flip angle (typically 40-70°)
    - a uniform magnetic field (field inhomogeneities causes banding artifacts e.g. 3T system)

- **Viability: delayed contrast-enhanced**
  - Infarcted myocardium enhances compared to normal myocardium in delayed images
  - Delay: 8-15 minutes after contrast
  - Uses gradient echo sequence with inversion recovery
  - TI (inversion time) is selected to null signal from normal myocardium
  - Typical TIs are between 200 and 300msec
  - Typically done with breath-hold

**Black Blood: Morphology**

**AXIAL FSE**

**Bright Blood: Function**

**Viability**

- Inversion recovery GE
- 5-10 mins after contrast

**MRA**

(Contrast Enhanced)
Imaging Planes

- Cardiac MR demands imaging in the planes of the heart
  - Short axis
  - Vertical long axis - two chamber
  - Horizontal long axis - four chamber
  - Oblique - left ventricular outflow tract

Required orientation and no. of slices:

- Short axis = whole heart from base to apex, usually 10-12 slices
- Vertical long axis - two chamber = one slice, mid cavity
- Horizontal long axis - four chamber = one slice, mid cavity
- Oblique - left ventricular outflow tract = one slice
Coronary Artery

- Provides high resolution images of vessel wall and lumen
- Characterizes atherosclerotic plaque on basis of biophysical and biochemical properties of its different component

MR Coronary Plaque

Ventricular function

- GE sequence
- Short axis
- Short TR/TE
- SI thick 8mm
Ventricular function

Stress CMR

Stress images with infusion of stress agents

Rest images

Cardiac Masses

Spin Echo

Post Gadolinium

Cardiac Masses

T1 Spin Echo

Gradient ECHO

Coronal

Short axis

Two chamber

Pericardial disease
Coarctation of Aorta

What is current

Latest updates

Latest updates

THANK YOU