Cardiac Anatomy Assessed by Examining the Important Components of a Cardiac CT Exam
An Understanding for Ideal Image Acquisition and Interpretation

Amgad N. Makaryus, MD FACC
Director of Cardiac CT and MRI
North Shore University Hospital
New York
Cardiac Anatomy
SYSTEMATIC APPROACH

• Structure and Function Based approach
• Relating imaging planes for ideal structure visualization: axial $\rightarrow$ oblique $\rightarrow$ 3D-reconstruction
• Appreciation for structure function
• Pericardium $\rightarrow$ Right Heart $\rightarrow$ Left Heart $\rightarrow$ Heart Valves $\rightarrow$ Coronary Arteries $\rightarrow$ Great Vessels

Makaryus 2009
Three Important Views

Can be obtained from one important short axis view

VLA (2C)

4C

HLA (3C)

Makaryus 2009
PERICARDIUM

• The heart is contained within the pericardial sac.
• **Visceral pericardium** is adherent to the ventricular myocardium, and cannot be visually separated from the epicardial fat.
• **Parietal pericardium** may be identified as a paper-thin high signal intensity surface surrounding the heart and great arteries
• **FUNCTION:** restricts excessive movements and provides a lubricated sac containing pericardial fluid
• Visualization of the parietal pericardium depends upon the presence and extent of low-density fatty deposition in the pericardial fat pad and middle mediastinum.

Makaryus 2009
Pericardium, Axial Section
**RIGHT HEART**

- Deoxygenated blood drains back to the right heart from the body through the SVC and IVC as well as the cardiac veins (coronary sinus into the right atrium).

- **Right Atrium:** round in shape, and forms the right lower border of the heart.

- **Right atrial appendage** is a broad-based, triangular structure, contained within the pericardium, which extends from about the middle of the heart obliquely around the ascending aorta.
The tricuspid valve is contained within the anterior atrioventricular ring between the RA and RV.

Right Ventricle: resides immediately posterior to the sternum. The right ventricular surface of the interventricular septum is irregular. The septomarginal trabeculation has papillary muscles extending from it to the tricuspid valve leaflets. The inferior-most of the septomarginal trabeculation is the moderator band, which carries the conducting system right bundle fibers.

Pulmonary valve lies slightly out of the axial plane, so may appear elongated in conventional axial acquisition. The caliber of the main pulmonary artery should be about the caliber of the ascending aorta at this anatomic level.
Right Heart, SVC, Axial Section
Right Heart, RV, Axial Section
LEFT HEART

- **Pulmonary Veins**: return oxygenated blood from the lungs to the left atrium. Generally 2 upper and 2 lower veins.

- **Left Atrium**: The left atrium lies posterior, superior, and toward the left with respect to the right atrium. The left atrial appendage is long and finger-like. The LAA runs around the left aspect of the heart, below the level of the pulmonary valve.

- The **mitral valve** lies within the posterior atroventricular ring, immediately subjacent to the circumflex coronary artery. Fibrous continuity between the anterior mitral leaflet and the aortic annulus is characteristically found in morphologic left ventricles.
LEFT HEART

• **Left Ventricle:** the shape of a prolate-ellipse. The left ventricle lies posterior and to the left with respect to the RV. The LV is characterized by its smooth walls and two large papillary muscles.

• The **aortic valve** has three sinuses of Valsalva, the right (anterior), the left (posterior), and the non-coronary (right posterior).

• The **aortic arch** lies almost entirely behind the manubrium of the sternum. It is not contained within the pericardium. The origins of the three major aortic branches, the innominate, left common carotid, and left subclavian arteries, are slightly ventral to the vertex of the arch.

Makaryus 2009
Left Heart, Pulmonary Veins and Left Atrium, Axial Section

Makaryus 2009
Left Heart, LV, Oblique Axial Section
# LV Volumes and Ejection Fraction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-Diastolic Volume (EDV)</td>
<td></td>
</tr>
<tr>
<td>End-Systolic Volume (ESV)</td>
<td></td>
</tr>
<tr>
<td>Stroke Volume (SV)</td>
<td>(SV = EDV - ESV)</td>
</tr>
<tr>
<td>Ejection Fraction (EF)</td>
<td>(EF = SV / EDV)</td>
</tr>
<tr>
<td>Cardiac Output (CO)</td>
<td>(CO = SV \times \text{Heart Rate})</td>
</tr>
</tbody>
</table>

LV Mass = (Spec. Grav.) \(\times\) (Epicardal Volume – Endocardial Volume)

Makaryus 2009
Coronary Arteries

- Supply oxygenated blood to the heart.
- The RCA originates from the right aortic sinus of Valsalva. It runs in the anterior AV ring. The RCA originates more caudally from the aorta than the LMCA.

- The PDA originates from the RCA and perfuses the inferior interventricular septum. In 85% of individuals, the PDA arises from the distal RCA; this is called a right dominant circulation. The PDA may also derive from the LCX forming a left dominant circulation or there may be "co-dominance" with derivation of the PDA from the RCA and LCX.

- The highest marginal branch from the RCA is the conus artery which supplies the RVOT.
Coronary Arteries

- The **LMCA** arises from the left aortic sinus of Valsalva. It continues posteriorly, and passes beneath the left atrial appendage, to enter the posterior AV ring. It continues within the ring as the **circumflex artery**.

- Before the **LMCA** passes beneath the LAA, the **anterior descending artery** arises along the top of the interventricular septum. Within the epicardial fat, it passes along the top of the septum in the interventricular groove.
RCA, RAO Projection

Coronary Angiography

Invasive and CT

Makaryus 2009
LCA, LAO Projection

Coronary Angiography

Invasive and CT

Makaryus 2009
RCA, Coronal Section
LCA, Axial Section

Makaryus 2009
LAD, Oblique 4 Chamber View
LCA,
Coronal Section
LCA, Short Axis Section
Curved Multiplanar Reformats
Summary

- Knowledge of normal anatomy will allow for ideal imaging planes and sections.

- Knowledge of normal anatomy will allow for the identification of pathology and proper CT scan interpretation.

Makaryus 2009