Coronary Anatomy and Normal Variants
Isabel B. Oliva, MD

Objectives
- Review the current available imaging modalities and their strengths when evaluating coronary artery anatomy.
- Understand coronary artery dominance.
- Understand and recognize the normal anatomy of the coronary arteries.
- Review coronary artery segmentation.
- Recognize the normal anatomic variants.

Imaging Modalities
- Coronary CTA
- Cardiac MRI
- Cardiac catheterization

Coronary CTA
- Modality of choice when evaluating the coronary arteries for anatomy and disease.
- High spatial resolution allows for better assessment of luminal stenosis.
- More sensitive than conventional angiography for detecting anomalous coronary arteries.
- Allows assessment of the other organs including mediastinum, great vessels and lung parenchyma.

Cardiac MRI
- Does not expose the patient to ionizing radiation.
- Should be consider in children and young adults when assessing for anomalous origin of the coronary arteries.
- Lower spatial resolution precludes accurate assessment of luminal stenosis and plaques.

No conflict of interest.
Cardiac Catheterization

- Exposure to ionizing radiation and large IV contrast load.
- Less sensitive for detection of anomalous coronary arteries.
- Invasive.
- Allows therapeutic intervention.

Aortic Valve

- Valve leaflets.
- Sinus of Valsalva.
- Coronary artery ostia.

Coronary Arteries

- Named based on the structure it supplies rather than their origin.
- Nomenclature is also based on the appearance on angiograms rather than axial images.
- Origin at the Aortic sinuses.
- Normally course in the epicardial fat.

Coronary Artery Dominance

- Based on the supply of the inferior wall and Atrioventricular node.
- Artery supplying the AV node typically supplies the inferior wall through the PDA.
- Coronary dominance is defined based on the origins of the PDA and PL branch.

Coronary Artery Dominance

- Right dominant
  - Most common (~ 80%)
  - PDA and PL branches arise from RCA

- Left dominant
  - ~ 10%
  - PDA and PL branches arise from LCx

Coronary Artery Dominance

- Co-dominant System
  - ~ 20%
  - PDA and PL branches arise from separate arteries:
    - If PDA arises from RCA then PL branches will arise from LCx.
    - If PDA arises from LCx then PL branches will arise from RCA.
  - Two PDAs, one arising from the RCA and one from the LCx.
Right Coronary Artery
- Originates in the right sinus of Valsalva.
- Courses through the right AV groove.
- Supplies the morphologic right ventricle.
- Branches:
  - Conus – 1st branch in 50-60%, supplies RVOT.
  - Acute marginal – supply the RV free wall.
  - AV node (90%)
  - SA node (60%)
  - Posterior Descending Artery (PDA) and Posterolateral (PL) – if right dominant.

Left Main Coronary Artery
- Originates in the left sinus of Valsalva and typically bifurcates into LAD and LCx.
- Courses between main PA and LA
- Branches:
  - LAD
  - LCx

Left Anterior Descending Coronary Artery
- Originates from the bifurcation of the left main coronary artery.
- Courses along the anterior interventricular groove.
- Supplies the anterior wall, anterior 2/3 of the interventricular septum, and entire septum at the mid and apical halves.
- Branches:
  - Diagonal
  - Septal perforators

Circumflex Coronary Artery
- Originates from the bifurcation of the left main coronary artery.
- Courses along the left AV groove.
- Supplies the lateral wall and variable portions of the inferior wall (PLB).
- Branches:
  - Obtuse Marginal
  - Posterior Descending Artery (PDA) and Posterolateral (PL) – if left dominant.

Posterior Descending Artery
- May originate from the RCA or LCx.
- Courses in the posterior interventricular groove.
- Supplies the inferior wall and inferior 1/3 of the interventricular septum.

Coronary Artery Segmentation
- Coronary arteries are divided into segments based on arising branches and specific anatomic structures.
- Understanding segmentation is important when describing findings and allow for more clear communication with other clinicians.
Coronary Artery Segmentation

- American Heart Association.
- SCCT guidelines.

**Coronary Artery Segmentation**

- RCA is divided into proximal, middle, and distal segments.
  - Proximal segment is from the origin halfway to the acute margin.
  - Middle segment is from this halfway point to the acute margin itself.
  - Distal segment is from the acute margin to the base of the heart at the junction of the atrial and ventricular septa.

- Like the RCA, the LAD artery is divided into three segments.
  - Proximal segment runs from the LAD origin to the origin of the first septal perforator.
  - Middle segment runs from the first septal perforator origin halfway to the left ventricular apex.
  - Distal segment runs from this halfway point to the apex itself.

- Unlike the RCA and LAD artery, the LCX artery has only two segments.
  - Proximal segment runs from the LCX origin to the origin of the first obtuse marginal branch.
  - Distal segment includes everything distal to this origin.
  - In some patients, a posterolateral branch arises from the LCX artery or an obtuse marginal branch to supply a portion of the inferior wall.
  - The LCX artery may also supply branches to the atrioventricular node.

Anatomic Variants

- Anatomic variants are coronary artery anomalies that are not hemodynamically significant.
- There are no associated independent clinical significance.
- Important to recognize and differentiate these from potentially dangerous anomalies that are typically associated with potential clinical implications.
Anatomic Variants

- High origin
  - The left main or right coronary arteries may arise from the proximal ascending thoracic aorta, 1 cm or more above the sinotubular junction.
  - MC RCA, specially in pts with bicuspid aortic valve.
  - Not hemodynamically significant but associated with bicuspid valve.
  - Important for planning catheterization and aortic surgeries.

- Absent Left main coronary artery
  - ~ 2% prevalence.
  - LAD and LCx arise directly from the left coronary sinus.
  - Needs separate catheterization of the LAD and LCx.

- Duplicated Coronary Artery
  - MC LAD: two LADs arising off the left main coronary artery.
  - Variable courses.
  - Not hemodynamically significant.

- Ramus Intermedius
  - ~ 25% of patients.
  - This is the third branch of the left main coronary artery, which arises between the LAD and LCx.

- Sinoatrial Nodal supply
  - 60% arise from the proximal RCA.
  - May also arise from the proximal LCx or even distal portions of the RCA or LCx.

- Conus branch
  - ~ 35% incidence.
  - Arises separately, directly from the aortic sinus.
Anatomic Variants

- Shepard’s crook RCA
  - ~5% prevalence.
  - Tortuous and high course of the RCA.
  - Normal origin from the right coronary sinus.
  - Important to describe acuity of the angle and distance from the RCA origin.
  - Difficult catheterization and stent placement.

Summary

- Understanding the available imaging modalities for evaluation of coronary arteries is important for better studies and patient care.
- Coronary artery dominance is important in the planning of intervention as it maps myocardium supply.
- Knowledge of coronary artery anatomy and its segmentation are important for accurate localization of pathology and planning potential intervention.
- Understanding normal variants is important as these are not associated with clinical significant events.

References