CARDIAC AND CORONARY ARTERY ANATOMY

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OBJECTIVES

- CARDIAC ANATOMY: VARIOUS IMAGING PLANES
- NORMAL, VARIANT and SOME ANOMALOUS ANATOMY OF CORONARY ARTERIES AND SUBJACENT VEINS

IMPORTANT FOR CORRECT IMAGE INTERPRETATION AND PATIENT CARE
Axial Anatomy of Heart

Axial Anatomy of Heart-MRI

Imaging Planes (Set-Up)

Cardiac Anatomy (4D MIPs) (Vertical Long Axis-RAO)

Cardiac and Coronary Artery Anatomy (3D-MIPs) (Vertical Long Axis-RAO)

Cardiac Anatomy (Cine MRI) (Vertical Long Axis-RAO)
**CARDIAC ANATOMY-(CINE MRI)**

**SHORT AXIS-LAO**

Above schematic is for RCA dominance. Note: With left dominance, LCx supplies the inferior septum and inferior distributions.

**BASE**

**MIDDLE**

**APEX**

**ADDITIONAL VIEWS-(CINE MRI)**

**LVOT** Direct coronal

**RVOT** Oblique coronal

**AORTIC ROOT** Oblique axial

**17-MYOCARDIAL SEGMENT MODEL**

**CARDIAC ANATOMY-(CINE MRI)**

**(INLET-OUTLET, 3-CHAMBER, “PARASTERNAL LONG AXIS”)**

**CORONARY DOMINANCE**

- Determined by blood supply to inferior wall
- PDA, PLB and AV-node branches help define dominance
**RIGHT DOMINANCE (80-85%)**

- RCA gives rise to PDA, PLB and AV-node branches
- PDA supplies inferior septum
- PLB supplies inferior wall

**DOMINANT RCA ANATOMY**

- RCA proximal – From ostium to one half the distance to the acute margin of the heart.
- RCA middle – RCA from above segment to the acute margin of heart.
- RCA distal – From the acute margin to the origin of the PDA.


**CONUS BRANCH VARIATIONS**

50% Conus Branch Supplies RVOT

50%

**CONUS BRANCH FROM LAD**
**SA-NODE BRANCH VARIATIONS**

55% FROM RCA

45% FROM LCx

**RV (ACUTE) MARGINAL BRANCHES**

SUPPLY ANTERIOR RV

**PDA and PLB VARIATION - RCA DOMINANCE**

- SINGLE PDA and PLB
- DUAL PDA and PLB

**AV-NODE BRANCH - RIGHT DOMINANCE**

- Usually distal to PDA

**LEFT DOMINANCE (15-20%)**

- PDA and PLB arise from LCx and supply inferior wall and inferior septum
- AV-Node branch usually distal to PDA

**LAO SCHEMATIC - DOMINANT LEFT CORONARY ANATOMY**
DOMINANT LCx ANATOMY

AVGA = AV-groove artery of LCx

DOMINANT LCx ANATOMY

Dual PDA

PDA ARISES FROM RCA
PLB ARISES FROM LCx

CO-DOMINANCE (5%)

PDA ARISES FROM RCA
PLB ARISES FROM LCx

LAO SCHEMATIC - DOMINANT LEFT CORONARY ANATOMY

LEFT MAIN BIFURCATION

LM - 5-10 mm
LAD ANATOMY

- **LAD proximal** – Proximal to and including origin of the first major septal perforator.
- **LAD middle** – Distal to origin of first major septal perforator and extending to point where the LAD forms an angle (RAO view). This is often, but not always, close to the origin of the second diagonal. If this angle or diagonal is not identifiable, this segment ends one half the distance from the first major septal perforator to the apex.
- **LAD apical** – Beginning at the end of the previous segment and extending to or beyond the apex.


SEPTAL PERFORATOR BRANCH VARIATION

NUMBERED IN SEQUENCE S1, S2, S3, ...
SUPPLY VENTRICULAR SEPTUM

LAD ANATOMY

DIAGONAL BRANCH ANATOMY

NUMBERED IN SEQUENCE D1, D2, D3, ...
SUPPLY ANTERIOR WALL
**LCX ANATOMY**

- **LCx proximal** – From its origin off LCA to and including origin of obtuse marginal.
- **LCx distal** – The LCx distal to the origin of the obtuse marginal and running along or close to left (posterior) AV groove.


**DOMINANT LCx ANATOMY**

OBTUSE MARGINAL BRANCHES
NUMBERED IN SEQUENCE: OM1, OM2, OM3....
SUPPLY LATERAL WALL

**NON-DOMINANT LCx ANATOMY**

AXIAL-ANTERIOR
LAO

**Cardiac Veins**

PDA and MIDDLE CARDIAC VEIN
SMALL CARDIAC VEIN

ANTERIOR INTERVENTRICULAR VEIN AND GREAT CARDIAC VEIN

CORONARY SINUS ANATOMY

What is an Anomaly?
- Normal – the anatomy seen in >99% of the population
- Variant – unusual anatomy seen in >1% of the population
- Anomaly – unusual and uncommon anatomy seen in <1% of the population

Coronary Artery Anomalies

Anomalies of Origin
- High takeoff
- Multiple ostia
- Single coronary artery
- Anomalous origin of the coronary artery from the pulmonary artery
- Origin of coronary artery from the opposite or noncoronary sinus with an anomalous course (either retroaortic, interarterial, septal (subpulmonic).

Anomalies of Course
- Myocardial bridging
- Duplication of arteries
- Coronary artery fistulas
- Coronary arcade
- Extracardiac termination

Anomalies of Course – Myocardial Bridging
- Myocardial bridging - When a coronary artery runs intramurally within the myocardium instead of epicardially.
- Encased segment called tunneled artery.
- Superficial bridge (75%) (no deviation into myocardium)
- Deep Bridge (25%) (Dips, ie U-shaped, into myocardium)
**Anomalies of Course – Myocardial Bridging**

- Usually asymptomatic with good prognosis. Has been associated with arrhythmia, unstable angina, myocardial infarction and sudden death.
- Incidence ranges from 0.5-2.5% in angiographic studies to 15-85% in pathologic series and thus, may be considered an anatomic variant rather than a true anomaly.

**Additional Facts – Myocardial Bridging**

- When symptoms occur they often don’t manifest until the third decade of life.
- MB predisposes artery to atherosclerosis proximal to bridge.
- Large multicenter studies needed for incidence and link between MB and chest pain.

**Anomalies of Origin**

- A coronary artery that arises from the opposite or noncoronary cusp can take any one of four common courses:
  1. interarterial (between aorta and pulmonary artery)
  2. retroaortic
  3. prepulmonic
  4. septal (subpulmonic)
- The course taken by the anomalous artery is critically important as the retroaortic, prepulmonic and septal courses are considered benign while the interarterial course can be associated with sudden cardiac death.
Axial MIP and Volume rendered images show the Left main coronary artery originating from the right coronary cusp and coursing between the aorta and pulmonary artery. The schematic diagram depicts a similar situation.

A second case demonstrating an anomalous origin of the left main coronary artery from the right coronary cusp with interarterial course. MIP images in various projections display the anomaly, however, the sagittal MIP image on the right confirms the interarterial course.

Anterior 3D Volume rendered images demonstrate the left main coronary artery arising from the right coronary cusp with interarterial course. The image on the right has had the pulmonary artery digitally removed by changing the window.

FROM RIGHT CORONARY CUSP
COURSE-BETWEEN RVOT AND AORTIC ROOT

The anomalous left main can be seen descending inferiorly. This septal or subpulmonic course has not been associated with sudden death.

LAD:
VENTRAL TO RVOT-
Prepulmonic

LCx:
POSTERIOR TO AORTIC ROOT-
Retroaortic

SINGLE CORONARY ARTERY

ANOMALOUS LM ORIGIN-
Septal (Subpulmonic) Course

Left Main Arising from Right Coronary Cusp with Interarterial Course

Left Main Arising from Right Coronary Cusp with Septal Course

Left Main Arising from Right Coronary Cusp with Interarterial Course

Left Main Arising from Right Coronary Cusp with Interarterial Course
Anomalous Left Coronary Artery Originating From the Pulmonary Artery

Left main coronary artery is seen originating from the posterior pulmonary artery. Note the large size of both the left main, LAD and the right coronary artery.

Anomalous Left Coronary Artery Originating From the Pulmonary Artery

SAME CASE AS PREVIOUS SLIDE: ALCAPA with large right coronary artery. The RCA is hypertrophied as it is providing collateral flow to the left coronary bed. Note the intramyocardial collateral vessels on the MIP image on the right.

Anomalous Pulmonary Artery Origin of Either the RCA or LCA

- Also known as ALCAPA or Bland-White-Garland syndrome.
- A rare congenital defect that represents only 0.25-0.5% of all congenital cardiac defects.
- Usually an isolated defect, but can be associated with other anomalies such as ASD, VSD and aortic coarctation in approximately 5% of cases.

Anomalous Pulmonary Artery Origin of Either the RCA or LCA

- Symptoms usually present at 1-2 months of age when LCA pressures rise and PA pressures decrease causing left to right shunting.
- Without treatment, approximately 90% of infants will die in the first year of life.
- Survival beyond infancy occurs when there are abundant intercoronary collaterals or the LCA supplies relatively less area of the myocardium.

Anomalies of Termination – Coronary Artery Fistula

- Usually congenital and accounts for 0.2-0.4% of congenital cardiac anomalies.
- Most are clinically and hemodynamically insignificant and are found incidentally.
- Approximately 60% of coronary artery fistulas originate from the right coronary artery.

Anomalies of Termination – Coronary Artery Fistula

- Coronary artery can communicate with either a chamber of the heart (coronary-cameral fistula) or a segment of the systemic or pulmonary circulation (coronary arteriovenous fistula).
- Stealing of blood to the low pressure systemic circulation leaves myocardium at risk for ischemia.
- In response, the coronary dilates and may progress to frank aneurysm which can ulcerate, thrombose or rupture.
Anomalies of Termination – Coronary Arteriovenous Fistula

A complex fistula is seen between the left main coronary artery and the pulmonary artery. Note the tortuous vessels and the contrast spill into the PA (arrows).

Anomalies of Termination – Coronary Arteriovenous Fistula

Another example of a complex coronary artery fistula, this one associated with a coronary artery aneurysm (arrows). The fistula is from the LAD and continues beyond the aneurysm as a serpiginous vessel over the main pulmonary artery.

Anomalies of Termination – Coronary Arteriovenous Fistula

SAME CASE AS PREVIOUS SLIDE: Complex coronary artery fistula from the LAD to the pulmonary artery with aneurysm (arrows).

(Coronary Anatomy–Swine Model)

SELECTIVE CTA  AORTIC ROOT CTA  XRAY ANGIO  EXVIVO

CONCLUSION

MULTIDETECTOR CTA

- High Temporal and Spatial Resolution
- 2D-MPR, 3D and 4D-MIP and VR Techniques
- Detailed Depiction of Cardiac and Coronary Anatomy

THE END
THANK YOU

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