Coronary Artery Anatomy and Physiology

Thanks to:
- SICP
- Dr. Ann Allworth
- Wes Todd, RCIS
- Cardiac Self Assessment
- Morton Kern, MD
## Disclosures

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<td>Speaker’s Bureau:</td>
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What is the #1 cause of death in the USA?
Why do men die before women???
Coronary Arteries

• Supplies blood supply to the heart
• Two primary arteries from the aorta
• **Left**
  – Left Main
  – Left Anterior Descending
  – Circumflex
• **Right**
  – Right
  – Posterior Descending
Heart Casts - Muscle Removed
Anterior (AP) Side view (RAO Lateral)

Right Heart, Left Heart

RCA, LAD, Cx
Coronary Arteries

- Originate at aortic cusps
- Protected by sinus of Valsava during systole
- Provide most of coronary blood flow during diastole
- On the epicardial surface
- Send intramural branches into the myocardium
Tricuspid

Mitral

RCA

Aortic

Pulmonary

LAD

CPP: AOd, LVEDP, CVP
Subendocardial Micro-anatomy

- **Normal Cor. flow** CA’s to Cardiac Veins to CS. #4-5
- **Thebesian plexus** may supply endocardium & dump directly into cardiac chambers.

1. **Arterio-luminal art.**
   Small AV fistula
2. **Thebesian veins** small V-A shunt
3. **Arterio-sinusoid cavities**
   insignificant blood supply by LV to LV endo. 4. Cor. Art. 5. cor. vein
4. **Trans-myocardial Revascularization (TMR)**
   = Laser holes burned in endocardium may provide significant flow for CHF patients.
Subendocardial Coronaries

- Endocardial vessels collapse in systole
  - Systolic Compression may reverse or slow flow (worse in LCA)
  - Open in diastole to increase diastolic coronary flow
Coronary Flow

- **LCA**
  - High flow due to larger size
  - LV flow most critical
  - Mostly diastolic flow, due to systolic endocardial compression

- **RCA**
  - Lower overall flow, smaller vessel
  - Steadier flow (due to less systolic RV endocardial compression)
Measuring Coronary Flow

- Doppler intracoronary flow wire
- Normally Diastolic flow highest
- IC Adenosine vasodilates, normally >doubles flow

Normal diastolic Increase with adenosine >2x
Regulation of Blood Flow

Normal Artery
- Normal microvascular tone
  - $\Delta P = 30$ mm Hg
  - 100 → 70

Atherosclerotic Artery
- Partial microvascular dilatation
  - $\Delta P = 60$ mm Hg
  - 100 → 40
- Complete microvascular dilatation

Epicardial arterial dilatation
- Complete microvascular dilatation

Coronary Blood Flow (Multiple of Resting Value)

Duration of Exercise
Fractional Flow Reserve (FFR)

$\text{FFR} = \frac{P_d}{P_a}$

$\text{FFR} = \text{the ratio of maximal flow in the stenotic artery to maximal flow in that same artery if the stenosis were absent.}$

“Normal” FFR = 1; Intervention with FFR < 0.80

NHJ Pijls et al. Circulation 1993
FFR Case Operation

Induce hyperemia to obtain FFR

![Graph showing FFR measurement and physiological data]
Intravascular Ultrasound

- Normal/Minimal Disease
- Abnormal
- Stent

- Catheter
- Lumen
- Stent Struts

- Intima
- Media
- Adventitia
Counterpulsation – Balloon Pump

- Because the coronary capillaries are open, IABP Inflates in Diastole
- Diastolic Inflation increases coronary flow
- Increases diastolic blood pressure
- Deflates as AO valve opens in systole
Effect of Heart Rate on Coronary Flow

- **Bradycardia** Increases diastolic filling & Coronary flow
- **Tachycardia** Reduces diastolic filling & Cor flow
Blood vessel layers:
- Intima
- Basal lamina
- Medial
- Adventitia
Coronary Artery Dominance

• Blood supply to inferior and posterior wall of left ventricle
• Determined by supply to the Posterior Descending (PDA) and Posterior Lateral (PLA) branches

• Right 85%
  – RCA gives off PDA and major PLA branches

• Left 8%
  – Circumflex gives off PDA and major PLA branches

• Balanced 7%
  – RCA gives off PDA
  – Circumflex gives off major PLA branches
Septal perforators
CO-DOMINANT CORONARY ARTERY

- Left Main Coronary Artery
- Circumflex Artery
- Left Anterior Descending
- Diagonal Branches
- Right Coronary Artery
- Marginal Branches
- Posterior Descending Artery
Left Coronary Artery

• Most of LV, LA, HIS and BB’s in IVS
• Left Main
• LAD (anterior, apical and septal LV)
  – Diagonal branches
  – Septal perforators
• Circumflex (LA, posterior and lateral LV)
  – Left atrial branch
  – Obtuse Marginal branches
  – Posterior descending artery (if left dominate)
• Intermediate Ramus
Left Main

LAD

Diagonal

Septal perforators

Circumflex

Left atrial branch

Obtuse Marginal

Diagonal
Right Coronary Artery

- RA, RV, Inferior LV, SA Node, AV Node
- Conus branch (RVOT)
- Sinus node branch (SA node, RA)
- RV Branches
- Acute Marginal branches (RV)
- AV nodal artery (AV node, IAS)
- Posterior descending artery (inferior IVS)
- Left ventricular branch-PLA’s (inferior LV)
Imaging Projections

• AP = Anterior-Posterior, the Image Intensifier (II) is completely vertical
• LAO = Left Anterior Oblique, the II is to the left of the patient
• RAO = Right Anterior Oblique, the II is to the right of the patient
• Cranial Skew, the II is angled towards the patient’s head
• Caudal Skew, the II is angled towards the patient’s feet
ANGULATED VIEWS OF THE CORONARIES

- RAO
- AP
- LAO
- LAT
- CRAN
- CUAD
- COMBINATIONS
- SINGLE PLANE
- BIPLANE
General Rules

- **RAO**
  - spine is on the left, apex point to the right
- **AP**
  - spine bisects the screen
- **LAO**
  - spine is on the right, apex points to the left
What if you cannot see the spine?

- The Aorta lies on the left side of the spine
- The Catheter will be visible in the Aorta
- The Ribs will slope down away from the spine
RCA General Rules

• In LAO the RCA will form a “C” shape
• In RAO 45 the RCA will form an “L” shape
Projection is LAO

RCA forms a “C”

Spine is on the Right
Projection is RAO

Spine is on the Left

RCA forms an “L”
Right Coronary Anatomy
LCA General Rules

- The Circumflex will be closest to the spine
- The LAD will be away from the spine
- The LAD should be the longest artery
- In LAO the LAD will be to the left
- In RAO the LAD will be to the right
Spine is on the Left

Ribs point down from Spine
Left Coronary Anatomy
Sternocostal Aspect

- Superior Vena Caval Branch (Nodal Artery)
- Anterior R. Atrial Branch of R. Coronary Artery
- Right Coronary Artery
- Anterior Cardiac Veins
- Small Cardiac Vein
- L Coronary Artery
- Circumflex Branch of L Coronary Artery
- Great Cardiac Vein
- Anterior Interventricular (Anterior Descending) Branch of L. Coronary Artery

4th Annual Interventional Cardiology Self-Assessment Course at TCT2001

Basic Coronary Artery Anatomy: Frederick Feit, M.D.
LCA IN THE LAO PROJECTION
LCA IN THE RAO PROJECTION
RCA IN THE LAO PROJECTION
RCA IN THE RAO PROJECTION
CORONARY ANGIOGRAPHIC ANATOMY: REPRESENT IN STANDARD PROJECTIONS
Left Ventriculography

LV wall function and motion (global and regional)

LV Chamber size

Ejection fraction (EDV, ESV, SV)

MR, LVH, VSD,

Angiographic Cardiac Output
LV Regional Identification

- Coronary perfusion by region
  - LAD
  - CIRC
  - RCA
LV Wall Motion Abnormalities

- Wall motion reflects perfusion,* not temporal
  - Stunned, hibernation theory
- Regional vs. Global WMA
  - CAD vs. Cardiomyopathy
Thank You
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