Coronary angiography, angiographic views and interpretation of collected data
The left and right coronary cusp give rise to their respective coronary arteries. The major epicardial vessels are the left main coronary artery that divides into the Left anterior Descending artery and Left Circumflex Artery, an respective coronary arteries the Right Coronary artery.
Coronary dominance is based on the vessel that gives rise to the posterior descending artery which supplies the Atrio-ventricular node.

Recognized by the presence of septal perforating branches, arises from the RCA in 80% and from the LCX in 10% of the population.

Co-Dominance is found in 10% of the population where the posterior interventricular artery is formed by both the RCA and LCx.
Coronary Anatomy

**Left Main Coronary Artery (LMCA)**

- The Left main coronary artery originates from the left coronary cusp and bifurcates to give rise to the Left anterior descending and Left Circumflex arteries.
- Long LMCA when the length is > 15 mm.
- Short LMCA when the length is ≤ 5 mm.
- Occasionally, a third branch vessel, the Ramus Intermedius arises from the LMCA.
- In a small number of patients, the two major branch vessels arise from separate origins.
Coronary Anatomy

Left Anterior Descending Artery (LAD)

- LAD provides blood supply to the anterior wall of the left ventricle.
- It provides multiple septal branches to the interventricular septum and diagonal branches to the anterior lateral wall.
- The LAD in some patients wraps around the apex to supply a small amount of the posterior apex.

Proximal - Ostium to 1st major septal perforator
Mid - 1st perforator to D2 (90 degree angle)
Distal - D2 to end
Coronary Anatomy

**Left Circumflex Artery (LCx)**

- LCx courses around the lateral or left atrio-ventricular groove and gives rise to multiple marginal or lateral branches. The branches are termed obtuse marginal (OM) branches.
- OM branches are sequentially numbered (OM1, OM2 etc...).
- As the LCx courses the AV groove it also gives rise to several atrial branches, and occasionally the sino-atrial branch (40% of the population).

Proximal - Ostium to 1st major obtuse marginal branch
Mid - OM1 to OM2
Distal - OM2 to end
Right Coronary Artery (RCA)

- RCA arises from the right coronary cusp and follows the right AV groove.
- The most proximal branches of the RCA are the conus-branch which supplies the Right ventricular outflow tract and a branch that supplies the sino-atrial (SA) node (60% of patients).
- RCA gives off the postero lateral and posterior descending branches at the crux cordis

Proximal - Ostium to 1st main RV branch
Mid - 1st RV branch to acute marginal branch
Distal - acute margin to crux
LCA ostium ~ 4mm-----RCA ostium~ 3.2mm

**Normal calibre of major coronaries**

LMCA: 4.5 ± 0.5 mm  
LAD: 3.7 ± 0.4 mm  
LCX: 3.5 ± 0.5 mm (4.2 mm if dominant)  
RCA: 3.9 ± 0.6 mm (2.8 mm if non-dominant)
Indications:

➢ Acute MI
➢ Unstable angina
➢ Chronic stable angina (uncontrolled by medication)
➢ Abnormal stress test
➢ Ventricular arrhythmias
➢ Left ventricular dysfunction
➢ Valvular heart disease
➢ Preoperative coronary assessment for cardiovascular surgery
# Femoral vs Radial Access

<table>
<thead>
<tr>
<th>Feature</th>
<th>Femoral</th>
<th>Radial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access site bleeding</td>
<td>3%–4%</td>
<td>0%–0.6%</td>
</tr>
<tr>
<td>Artery complications</td>
<td>Pseudoaneurysm, retroperitoneal bleed</td>
<td>Rare local arteriovenous fistula, painful hematoma irritation, pulse loss 3%–9%</td>
</tr>
<tr>
<td>Patient comfort</td>
<td>Acceptable</td>
<td>Great</td>
</tr>
<tr>
<td>Ambulation</td>
<td>2–4 h</td>
<td>Immediate</td>
</tr>
<tr>
<td>Extra costs</td>
<td>Closure device</td>
<td>Band</td>
</tr>
<tr>
<td>Procedure time*</td>
<td>Perceived shorter</td>
<td>Perceived longer</td>
</tr>
<tr>
<td>Estimated radiation exposure*</td>
<td>Perceived shorter</td>
<td>Perceived longer</td>
</tr>
<tr>
<td>Access to left internal mammary artery</td>
<td>Easy</td>
<td>Difficult from right radial artery</td>
</tr>
<tr>
<td>Use of artery for CABG</td>
<td>N/A</td>
<td>Unknown</td>
</tr>
<tr>
<td>Learning curve</td>
<td>Short</td>
<td>Longer</td>
</tr>
<tr>
<td>&gt; 8-F guide catheters</td>
<td>No problem</td>
<td>Maximum 7 F (in men)</td>
</tr>
<tr>
<td>Peripheral vascular disease, obese</td>
<td>Problematic</td>
<td>No problem</td>
</tr>
</tbody>
</table>
Catheter Selection

- Selecting the right catheter is important and is dependent upon the following:
  - Access site: Choice of catheters depends to certain degree on the access site - femoral vs. radial vs. brachial
  - Aortic width: Normal aortic width - 35 to 40 mm; Narrow- <35 mm, Dilated >40 mm
  - Coronary ostial location: high vs. low; anterior vs. posterior
  - Coronary ostial orientation: Superior, inferior, horizontal or shepherd’s crook (for RCA only)
  - Standard workhorse catheters for routine coronary angiography are Judkins right size 4 (JR4) and Judkins left size 4(JL4) and the ostia are engaged in the LAO projection
  - Always ensure co-axial alignment of the catheter
  - Catheters generally have two curves: Primary (distal) curve and a secondary (proximal) curve. The distance between the two curves is the length of the catheter
  - Shorter curve more ideal for superior take-offs
  - Longer curve more ideal for inferior take-offs
Most Frequently Used Diagnostic Coronary Catheter Shapes

A

RIGHT
JR 3.5
JR 4.0
MOD JR 4.0
JR 4.0 L
NTR
3DRC

PIGTAIL
Pigtail 6SH
145° Pigtail 6SH
155° Pigtail 6SH
Tight Radius Pigtail 6SH

AMPLATZ
AR I/AR II

LEFT
JL 4.0 L
JL 4.0

SONES
Sones A
Sones B
Sones C

CHAMP
Champ 0.5/1.0
Champ 3.0/3.5

ALTERNATIVE
IMA
LCB
RCB

BRACHIAL
Brachial 3.5

MULTIPURPOSE
MP A-1
MP B-2
Flow Rate and Volume

- RCA- 2.1ml/sec for 2 to 3 seconds, i.e., 3 for 6 represents a flow rate of 3ml/sec for a total volume of 6ml
- LCA- 2.1ml/sec for 2 to 3 seconds, i.e., 4 for 8 which represents a flow rate of 4ml/sec for a total of 8ml
Angiographic Views - Nomenclature

**AP position**
Image intensifier is directly over patient with beam traveling perpendicularly back to front (i.e., from posterior to anterior) to patient lying flat on x-ray table.

**RAO position**
Image intensifier is on right side of patient. A, anterior; O, oblique.

**LAO position**
Image intensifier is on left side of patient.

**Lt Lateral position**
Image intensifier rotated 90 deg parallel to floor.

**Cranial**
Image intensifier is tilted toward head of patient.

**Caudal**
Image intensifier is tilted toward feet of patient.
Cranial views are best for the left anterior descending artery
Caudal views are best for the circumflex artery.
Angiographic Views-Nomenclature
**Standard Angiographic Views**

**LAO-Cranial view:** 30° to 60° LAO and 15° to 30° cranial

Best for visualizing mid and distal LAD, and the distal LCx in a left dominant system

*Separates out the septals from the diagonals*

**LAO-Caudal (spider) view:** 40° to 60° LAO and 10° to 30° caudal

Best for visualizing left main, proximal LAD and proximal LCx

**AP-Caudal view:** 0° lateral and 20° to 30° caudal

Best for visualizing distal left main bifurcation as well as the proximal LAD and the proximal to mid LCx and OM
Standard Angiographic Views

**AP-Cranial view:** 0° lateral and 30° cranial
Best for visualizing proximal and mid LAD

**RAO-Cranial view:** 0° to 10° RAO and 25° to 40° cranial
Best for visualizing mid and distal LAD and the distal LCx (LPDA and LPL)
*Separates out the septals from the diagonals*

**RAO-Caudal view:** 10° to 20° RAO and 15° to 20° caudal
Best for visualizing left main bifurcation, proximal LAD and the proximal to mid LCx
**Standard Angiographic Views**

**LAO 30° LAO**

Best for visualizing ostial and proximal RCA

**AP Cranial: PA and 30° cranial**

Best for visualizing distal RCA bifurcation and the PDA

**RAO 30° RAO**

Best for visualizing mid RCA and PDA
Bypass graft views

- **RCA graft**: LAO cranial, RAO, and AP cranial
- **LAD graft (or internal mammary artery)**: lateral, RAO cranial, LAO cranial, and AP (lateral view is especially useful to visualize anastomosis to LAD)
- **CFX (and obtuse marginal branches) grafts**: LAO caudal and RAO caudal
- **Diagonal graft**: LAO cranial and RAO cranial
Typically 30 deg RAO & 60 deg LAO views are obtained
Mad BGC-Interpretation

A systematic interpretation of a coronary angiogram would involve:

- Evaluation of the extent and severity of coronary calcification just prior to or soon after contrast opacification
- Lesion quantification in at least 3 orthogonal views:
  - Severity
  - Calcification
  - Presence of ulceration/thrombus
  - Degree of tortuosity
  - Lesion classification
  - Reference vessel size
## Analysis of the coronary angiogram

<table>
<thead>
<tr>
<th>Degree of stenosis</th>
<th>Diameter of stenosis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;25</td>
</tr>
<tr>
<td>low grade</td>
<td>25-49</td>
</tr>
<tr>
<td>intermediate grade</td>
<td>50-74</td>
</tr>
<tr>
<td>high grade</td>
<td>75-90</td>
</tr>
<tr>
<td>subtotal</td>
<td>91-99</td>
</tr>
<tr>
<td>total occlusion</td>
<td>100</td>
</tr>
</tbody>
</table>
Analysis of the coronary angiogram

Other methods

**QCA (Quantitative Coronary Analysis)**

QCA features single vessel and bifurcation analysis including calibration, automatic contour detection and quantification of the severity of stenosis.
Intravascular ultrasound (IVUS) & Optical coherence tomography (OCT)

The two technologies are analogous in that they send out energy waves — OCT uses light and IVUS uses sound waves — into the vessel wall and that energy is sent back to the catheter to reconstruct an image.
Analysis of the coronary angiogram

Other methods

**Fractional flow reserve (FFR)**

An FFR of 1.0 is widely accepted as normal. An FFR lower than 0.75-0.80 is generally considered to be associated with myocardial ischemia (MI).
ACC/AHA Lesion Classification

Type A Lesion:
Minimally complex, discrete (length <10 mm), concentric, readily accessible, non-angulated segment (<45°), smooth contour, little or no calcification, less than totally occlusive, not ostial in location, no major side branch involvement, and absence of thrombus

Type B Lesion:
Moderately complex, tubular (length 10 to 20 mm), eccentric, moderate tortuosity of proximal segment, moderately angulated segment (>45°, <90°), irregular contour, moderate or heavy calcification, total occlusions <3 months old, ostial in location, bifurcation lesions requiring double guidewires, and some thrombus present

Type C Lesion:
Severely complex, diffuse (length >2 cm), excessive tortuosity of proximal segment, extremely angulated segments >90°, total occlusions >3 months old and/or bridging collaterals, inability to protect major side branches, and degenerated vein grafts with friable lesions.
Medina Classification

1. Main Branch proximal lesion > 50%: 0 or 1
2. Main Branch distal lesion > 50%: 0 or 1
3. Side Branch lesion > 50%: 0 or 1
TIMI Flow Grades

**TIMI 0 flow**: absence of any antegrade flow beyond a coronary occlusion

**TIMI I flow**: (penetration without perfusion) faint antegrade coronary flow beyond the occlusion, with *incomplete* filling of the distal coronary bed

**TIMI II flow**: (partial reperfusion) delayed or sluggish antegrade flow with *complete* filling of the distal territory

**TIMI III flow**: (complete perfusion) is normal flow which fills the distal coronary bed *completely*
# Myocardial Blush Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>MBG</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Failure of dye to enter the microvasculature. Either minimal or no ground glass appearance (&quot;blush&quot;) or opacification of the myocardium in the distribution of the culprit artery indicating lack of tissue-level perfusion.</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Dye slowly enters but fails to exit the microvasculature. There is the ground glass appearance (&quot;blush&quot;) or opacification of the myocardium in the distribution of the culprit lesion that fails to clear from the microvasculature, and dye staining is present on the next injection (approximately 30 seconds between injections).</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Delayed entry and exit of dye from the microvasculature. There is the ground glass appearance (&quot;blush&quot;) or opacification of the myocardium in the distribution of the culprit lesion that is strongly persistent at the end of the washout phase (i.e., dye is strongly persistent after three cardiac cycles of the washout phase and either does not or only minimally diminishes in intensity during washout).</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Normal entry and exit of dye from the microvasculature. There is the ground glass appearance (&quot;blush&quot;) or opacification of the myocardium in the distribution of the culprit lesion that clears normally and is either gone or only mildly/moderately persistent at the end of the washout phase (i.e., dye is gone or is mildly/moderately persistent after three cardiac cycles of the washout phase and noticeably diminishes in intensity during the washout phase), similar to that in an uninvolved artery. Blush that is of only mild intensity throughout the washout phase but fades minimally is also classified as grade 3.</td>
</tr>
</tbody>
</table>
Syntax Score

Left dominance

Right dominance
Coronary Anomalies

**Left coronary artery arising from the right sinus of Valsalva** - course relative to great vessels must be defined as interarterial course portends an increased risk of sudden death.
Complications:

**Major**
- MI
- Stroke
- Renal failure
- Aortic or coronary dissection
- Cardiac rupture
- Air embolism
- Arrhythmia
- Peripheral vascular damage

**Minor**
- Haematoma *(at the puncture site)*
- Angina
- Vaso vegal reaction
- Allergies to contrast agents and drugs
Mistakes & Pitfalls

➢ Short Left Main or Double Left Coronary Orifices

➢ Ostial Lesions

➢ Myocardial Bridges

➢ Coronary Spasm

➢ Totally Occluded Arteries or Vein Grafts

➢ Anomalous Coronary Arteries
Ευχαριστώ πολύ για την προσοχή σας ..