

# Introduction to Cardiac Catheterization

Focus on Left Heart Catheterization

David Stultz, MD

Cardiology Fellow, PGY-6

July 18, 2005

# Cardiac Catheterization

- Level 1
  - 100 diagnostic cases
  - 4 months of training
- Level 2
  - 300 diagnostic cases
  - 8 months of training
- Level 3 (Interventional)
  - 250 more cases
  - Total 20 months of training

# The Wright State Fellowship Cardiac Catheterization

- VA
  - 2 months each year
  - Approximately 30 cases/month
- GSH
  - Various opportunity in 1<sup>st</sup> year
  - 2 months dedicated in 2<sup>nd</sup> year
  - 2-4 months in 3<sup>rd</sup> year

# Indications for Cardiac Catheterization

Known CAD with Stable Angina or Asymptomatic

- **Class I**

1. **CCS class III and IV angina on medical treatment. (*Level of Evidence: B*)**
2. **High-risk criteria on noninvasive testing regardless of anginal severity (Table 5). (*Level of Evidence: A*)**
3. **Patients who have been successfully resuscitated from sudden cardiac death or have sustained (>30 s) monomorphic ventricular tachycardia or nonsustained (<30 s) polymorphic VT**

# Indications for Cardiac Catheterization

## Known CAD with Stable Angina or Asymptomatic

- **Class IIa**

1. **CCS class III or IV angina, which improves to class I or II with medical therapy. (*Level of Evidence: C*)**
2. **Serial noninvasive testing using identical testing protocols, at the same level of medical therapy, showing progressively worsening abnormalities. (*Level of Evidence: C*)**
3. **Patients with angina and suspected coronary disease who, due to disability, illness, or physical challenge, cannot be adequately risk stratified by other means. (*Level of Evidence: C*)**
4. **CCS class I or II angina with intolerance to adequate medical therapy or with failure to respond, or patients who have recurrence of symptoms during adequate medical therapy as defined above. (*Level of Evidence: C*)**
5. **Individuals whose occupation involves the safety of others (e.g., pilots, bus drivers, etc.) who have abnormal but not high-risk stress test results, or multiple clinical features that suggest high risk. (*Level of Evidence: C*)**

# Indications for Cardiac Catheterization

## Class IIb Known CAD with Stable Angina or Asymptomatic

1. CCS class I or II angina with demonstrable ischemia but no high-risk criteria on noninvasive testing. (*Level of Evidence: C*)
2. Asymptomatic man or postmenopausal woman with >2 major clinical risk factors and abnormal but not high-risk criteria on noninvasive testing (performed for indications stated in the ACC/AHA noninvasive testing guidelines) without known coronary heart disease. (*Level of Evidence: C*)
3. Asymptomatic patients with prior MI with normal resting left ventricular function and ischemia on noninvasive testing, but without high-risk criteria. (*Level of Evidence: C*)
4. Periodic evaluation after cardiac transplantation. (*Level of Evidence: C*)
5. Candidate for liver, lung or renal transplant >40 years old as part of evaluation for transplantation. (*Level of Evidence: C*)

# Indications for Cardiac Catheterization

## Class II Known CAD with Stable Angina or Asymptomatic

1. Angina in patients who prefer to avoid revascularization even though it might be appropriate. (*Level of Evidence: C*)
2. Angina in patients who are not candidates for coronary revascularization or in whom revascularization is not likely to improve quality or duration of life. (*Level of Evidence: C*)
3. As a screening test for CAD in asymptomatic patients. (*Level of Evidence: C*)
4. After CABG or angioplasty when there is no evidence of ischemia on noninvasive testing, unless there is informed consent for research purposes. (*Level of Evidence: C*)
5. Coronary calcification on fluoroscopy, electron beam CT, or other screening tests without criteria listed above. (*Level of Evidence: C*)

# Indications for Cardiac Catheterization

- **Class I Nonspecific Chest Pain**
  1. **High-risk findings on noninvasive testing. (*Level of Evidence: B*)**
- **Class IIa**
  1. **None.**
- **Class IIb**
  1. **Patients with recurrent hospitalizations for chest pain who have abnormal (but not high-risk) or equivocal findings on noninvasive testing. (*Level of Evidence: B*)**
- **Class III**
  1. **All other patients with nonspecific chest pain. (*Level of Evidence: C*)**



# Unstable Angina

- Symptoms of angina at rest (usually prolonged >20 min);
- New-onset (<2 months) exertional angina of at least CCS class III in severity;
- Recent (<2 months) acceleration of angina as reflected by an increase in severity of at least one CCS class to at least CCS class III.

# Indications for Cardiac Catheterization

- **Class I Unstable Angina**
  1. High or intermediate risk for adverse outcome in patients with unstable angina refractory to initial adequate medical therapy, or recurrent symptoms after initial stabilization. Emergent catheterization is recommended. (*Level of Evidence: B*)
  2. High risk for adverse outcome in patients with unstable angina. Urgent catheterization is recommended. (*Level of Evidence: B*)
  3. High- or intermediate-risk unstable angina that stabilizes after initial treatment. (*Level of Evidence: A*)
  4. Initially low short-term-risk unstable angina that is subsequently high risk on noninvasive testing (Table 5). (*Level of Evidence: B*)
  5. Suspected Prinzmetal variant angina. (*Level of Evidence: C*)

# Indications for Cardiac Catheterization

- **Class IIa**      **Unstable Angina**
  1. None.
- **Class IIb**
  1. Low short-term–risk unstable angina, without high-risk criteria on noninvasive testing. (*Level of Evidence: C*)
- 1. **Class III**
  1. Recurrent chest discomfort suggestive of unstable angina, but without objective signs of ischemia and with a normal coronary angiogram during the past five years. (*Level of Evidence: C*)
  2. Unstable angina in patients who are not candidates for coronary revascularization or in patients for whom coronary revascularization will not improve the quality or duration of life. (*Level of Evidence: C*)

# Indications for Cardiac Catheterization

- **Patients With Post-revascularization Ischemia**
- **During the Initial Management of Acute MI (MI Suspected and ST-Segment Elevation or Bundle-Branch Block Present)**
- **Patient With Suspected MI (ST-Segment Elevation or Bundle-Branch Block Present) Who Has Not Undergone Primary PTCA**
- **Early Coronary Angiography in Acute MI (MI Suspected but No ST-Segment Elevation)**
- **Coronary Angiography During the Hospital-Management Phase (Patients With Q-wave and Non-Q-Wave Infarction)**
- **During the Risk-Stratification Phase (Patients With All Types of MI)**
- **Perioperative Evaluation Before (or After) Noncardiac Surgery**
- **Patients With Valvular Heart Disease**
- **Patients With Congenital Heart Disease**
- **Patients With Congestive Heart Failure**
- **Other Conditions**

# High Risk Predictors on Noninvasive Assessment

- Severe resting left ventricular dysfunction (LVEF <35%)
- High-risk treadmill score (score  $\leq -11$ )
  - Minutes – 5x ST deviation – 4x Angina score (0-2)
- Severe exercise left ventricular dysfunction (exercise LVEF <35%)
- Stress-induced large perfusion defect (particularly if anterior)
- Stress-induced multiple moderate perfusion defects
- Large, fixed perfusion defect with LV dilatation or increased lung uptake (thallium 201)
- Stress-induced moderate perfusion defect with LV dilatation or increased lung uptake (thallium 201)
- Echocardiographic wall motion abnormality (involving >2 segments) developing at low dose of dobutamine ( $\leq 10$  mg/kg per minute) or low heart rate (<120 beats/min)
- Stress echocardiographic evidence of extensive ischemia

# Relative Contraindications

- Acute **renal failure**
- Chronic renal failure secondary to diabetes
- Active gastrointestinal bleeding
- Unexplained **fever**, which may be due to infection
- Untreated **active infection**
- Acute stroke
- Severe anemia
- Severe **uncontrolled hypertension**
- Severe symptomatic electrolyte imbalance
- Severe lack of cooperation by patient due to psychological or severe systemic illness
- Severe concomitant illness that drastically shortens life expectancy or increases risk of therapeutic interventions
- **Refusal** of patient to consider definitive therapy such as PTCA, CABG, or valve replacement
- Digitalis intoxication
- Documented anaphylactoid reaction to angiographic contrast media
- Severe **peripheral vascular disease limiting vascular access**
- **Decompensated congestive heart failure or acute pulmonary edema**
- Severe coagulopathy
- Aortic valve endocarditis

# Left Heart Catheterization

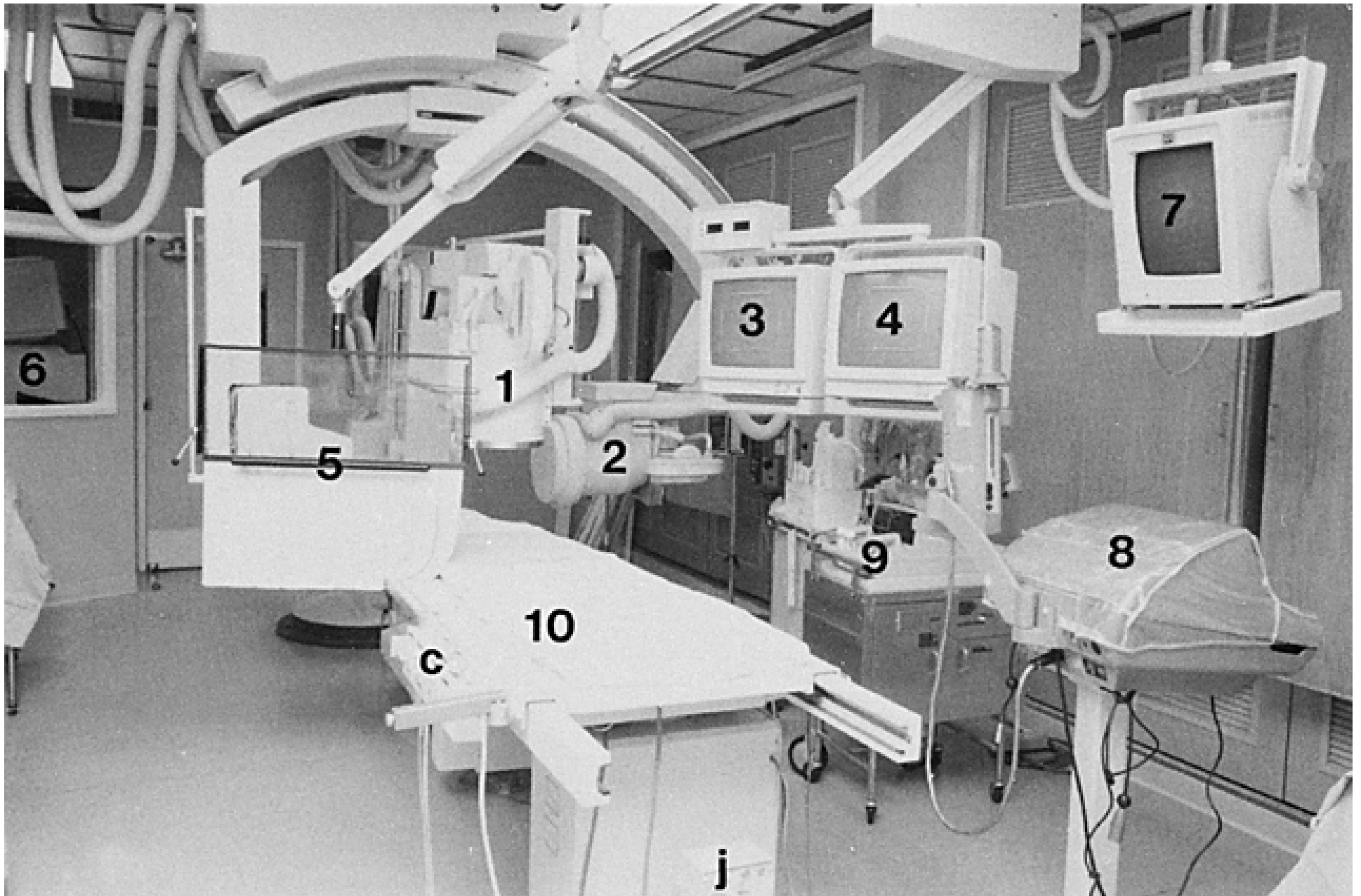
- Setup
- Vascular Access
- Anatomy and Imaging

# Setup

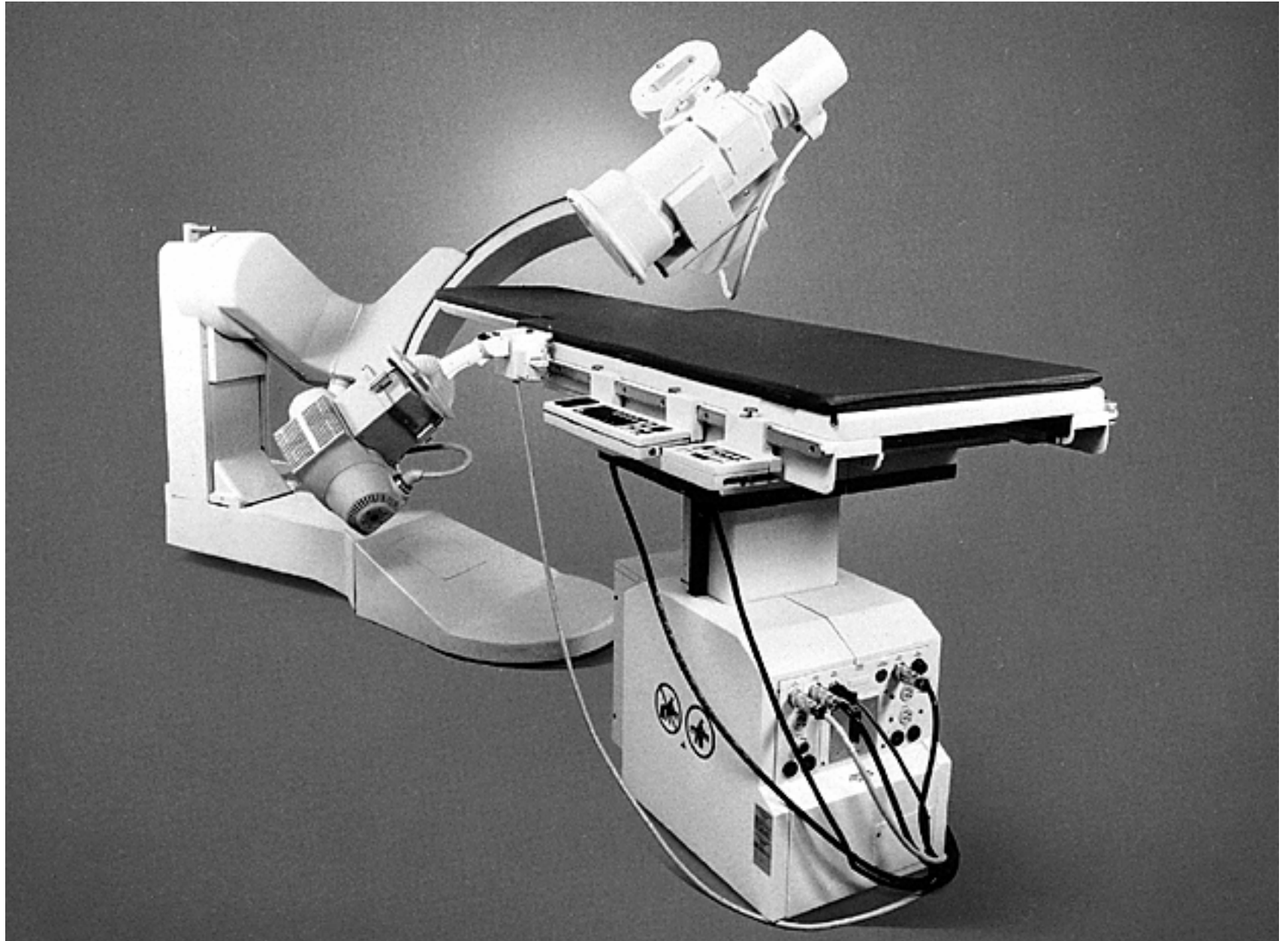
- Patient Consent
- Prep and Drape patient and access site in sterile fashion
- Manifold connected and lines primed
- EKG/BP/Pulse ox monitoring



# The Cath Lab



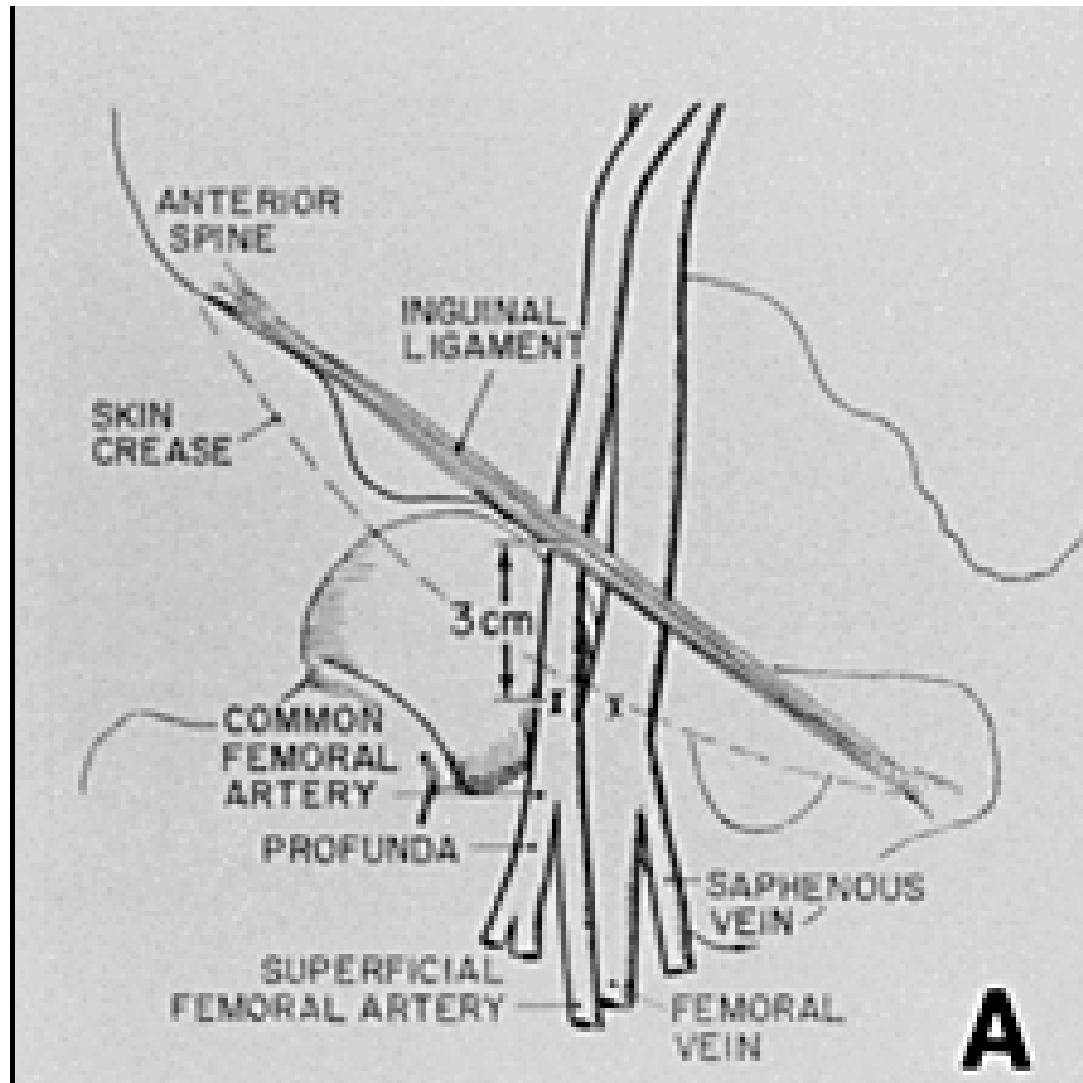
# The Cath Table



# Vascular Access

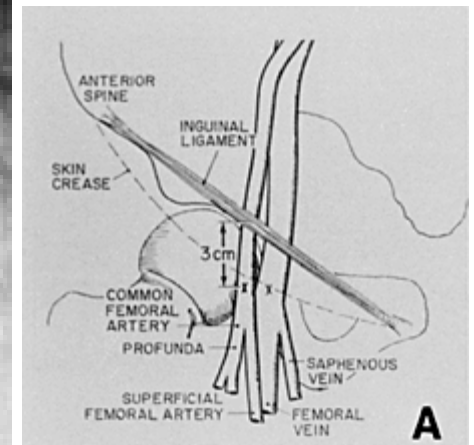
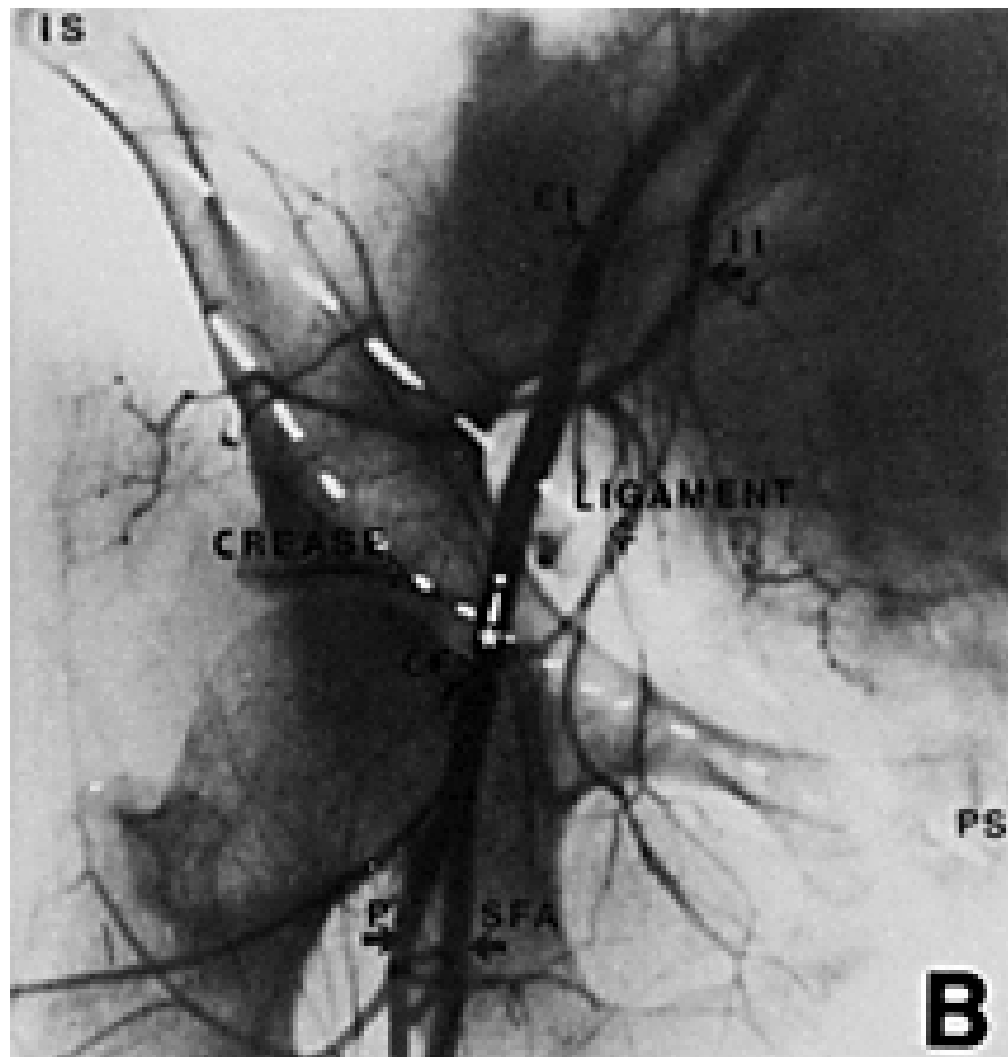
- Femoral
- Radial
- Brachial
- Axillary
  
- NEVER use carotid or subclavian

# Femoral Approach Anatomy

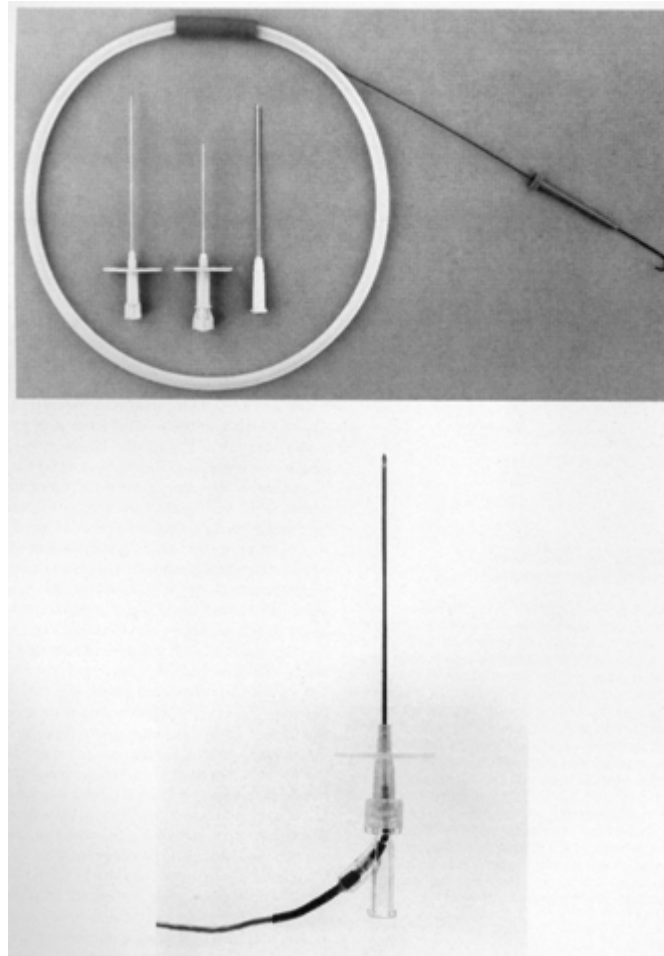


X = Skin  
insertion Site

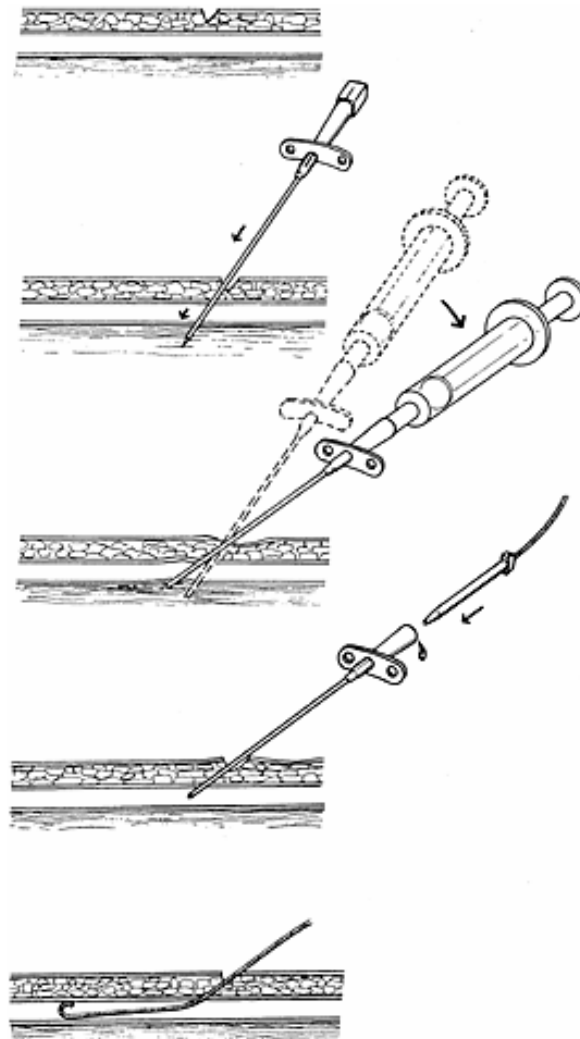
# Femoral Approach Fluoroscopy



# Femoral Artery Approach Equipment

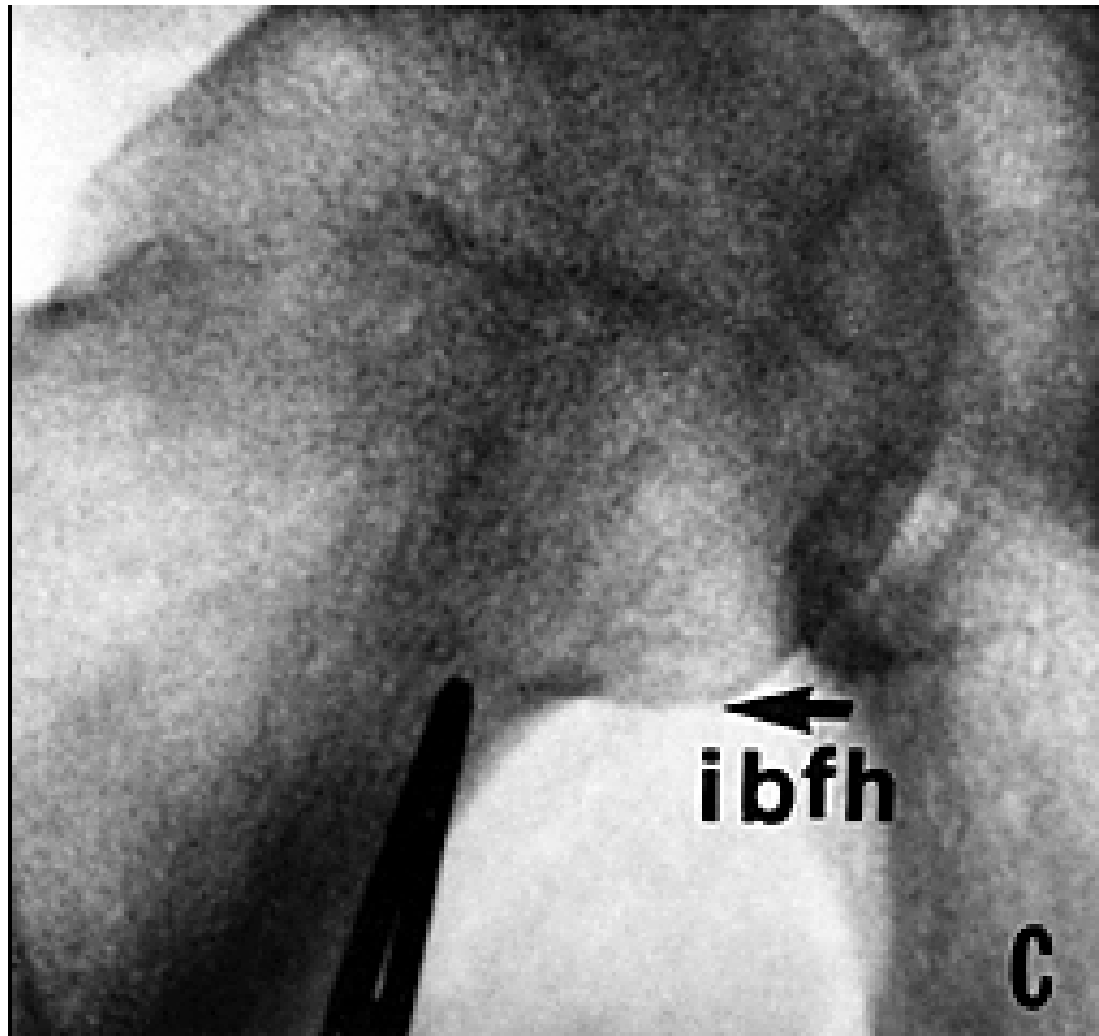


# Femoral Artery Approach Modified Seldinger Technique



# Femoral Approach

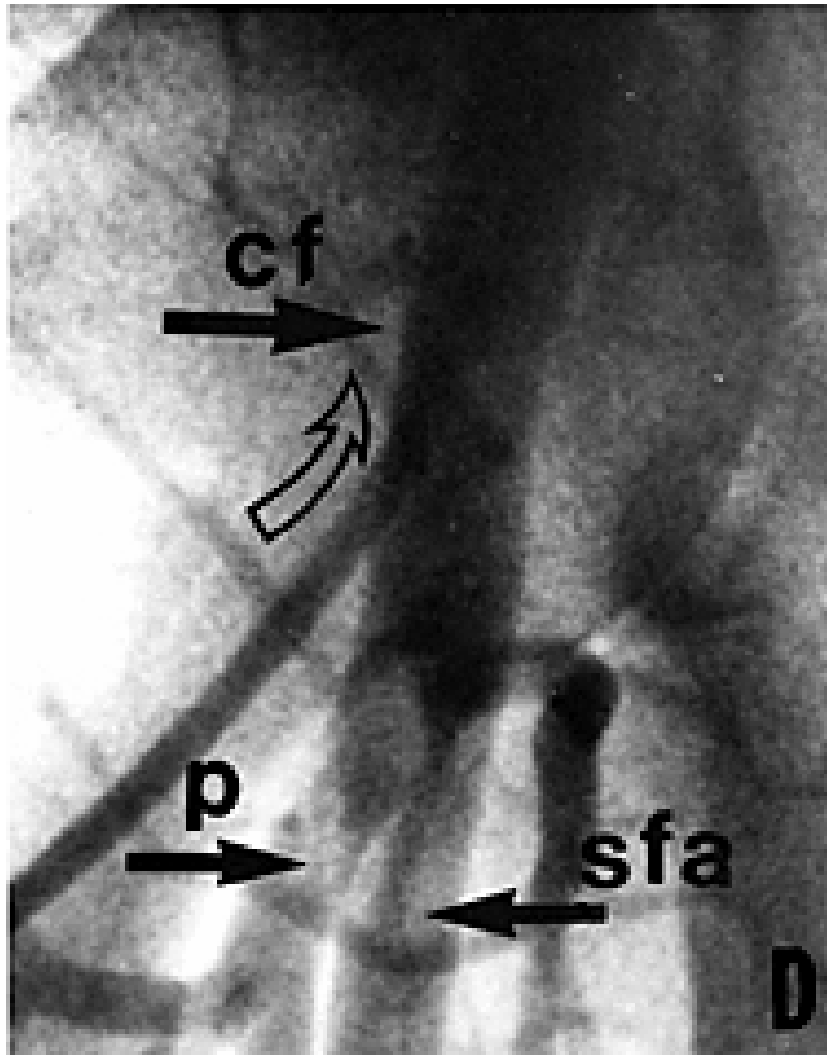
## Finding a site



Skin entry site  
at inferior  
border of the  
femoral head



# Femoral Approach Ideal Cannulation

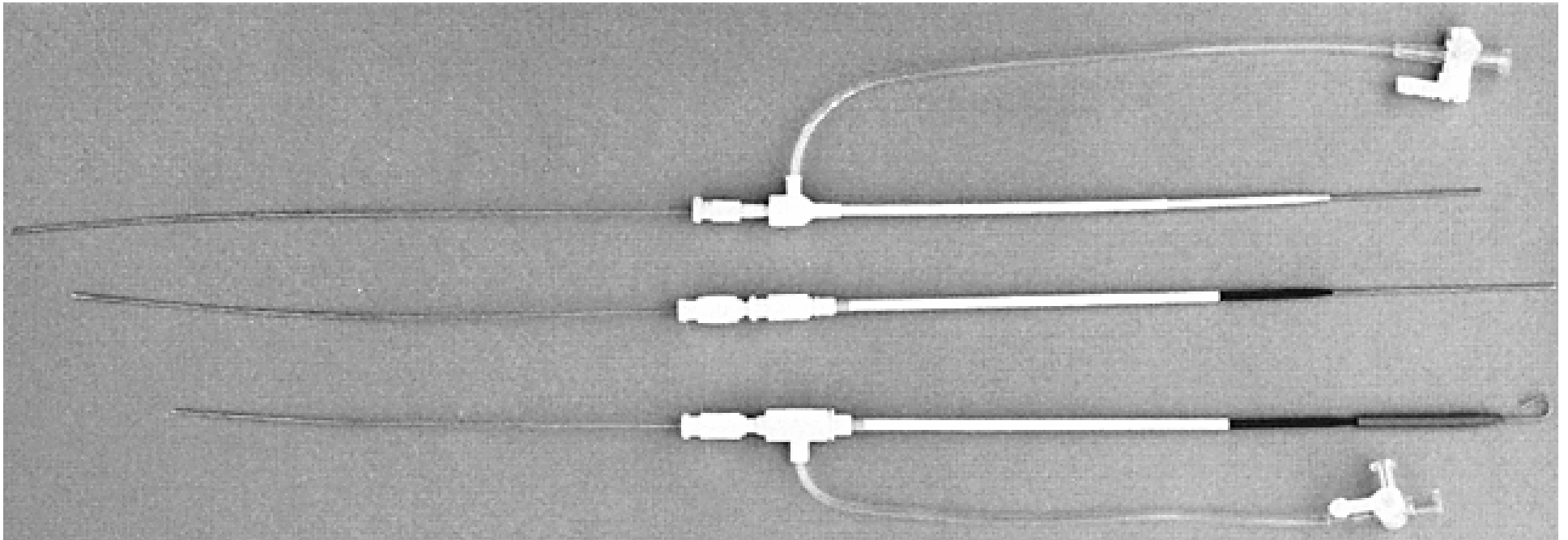


Arterial access in common femoral artery.

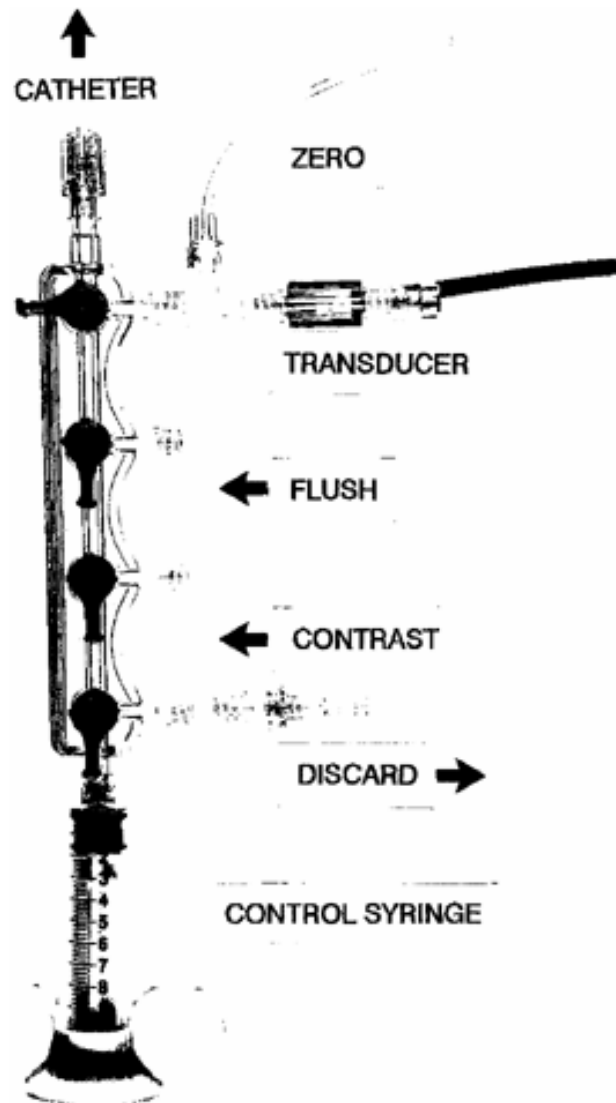
Low stick in the profunda or superficial femoral artery has higher risk of pseudoaneurysm formation and AV fistulae

High stick above inguinal ligament allows retroperitoneal bleeding

# Sheaths



# A Manifold

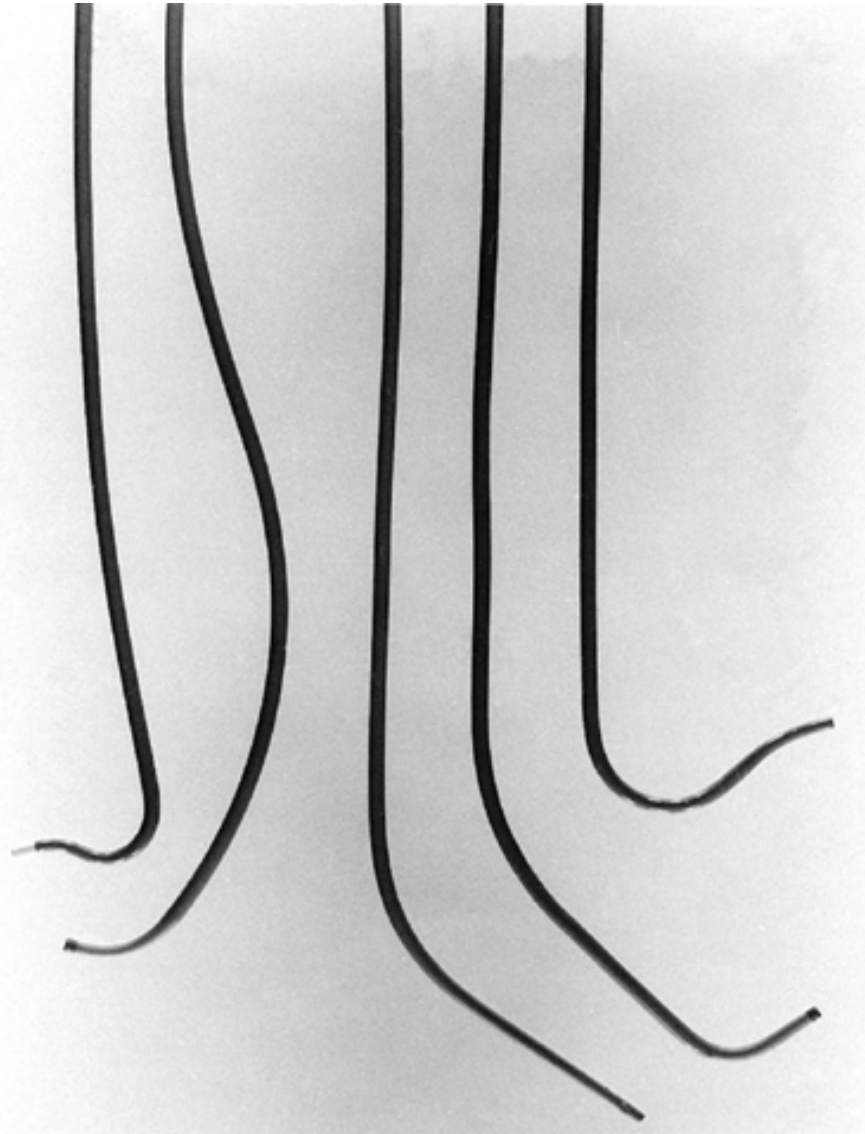


Typically 3 or 4 valve system that has

- Pressure transducer
- IV Contrast
- Saline Flush/Waste
- (Open port for intracoronary administration)

**The knob of the Valve points to the direction that is SHUT OFF**

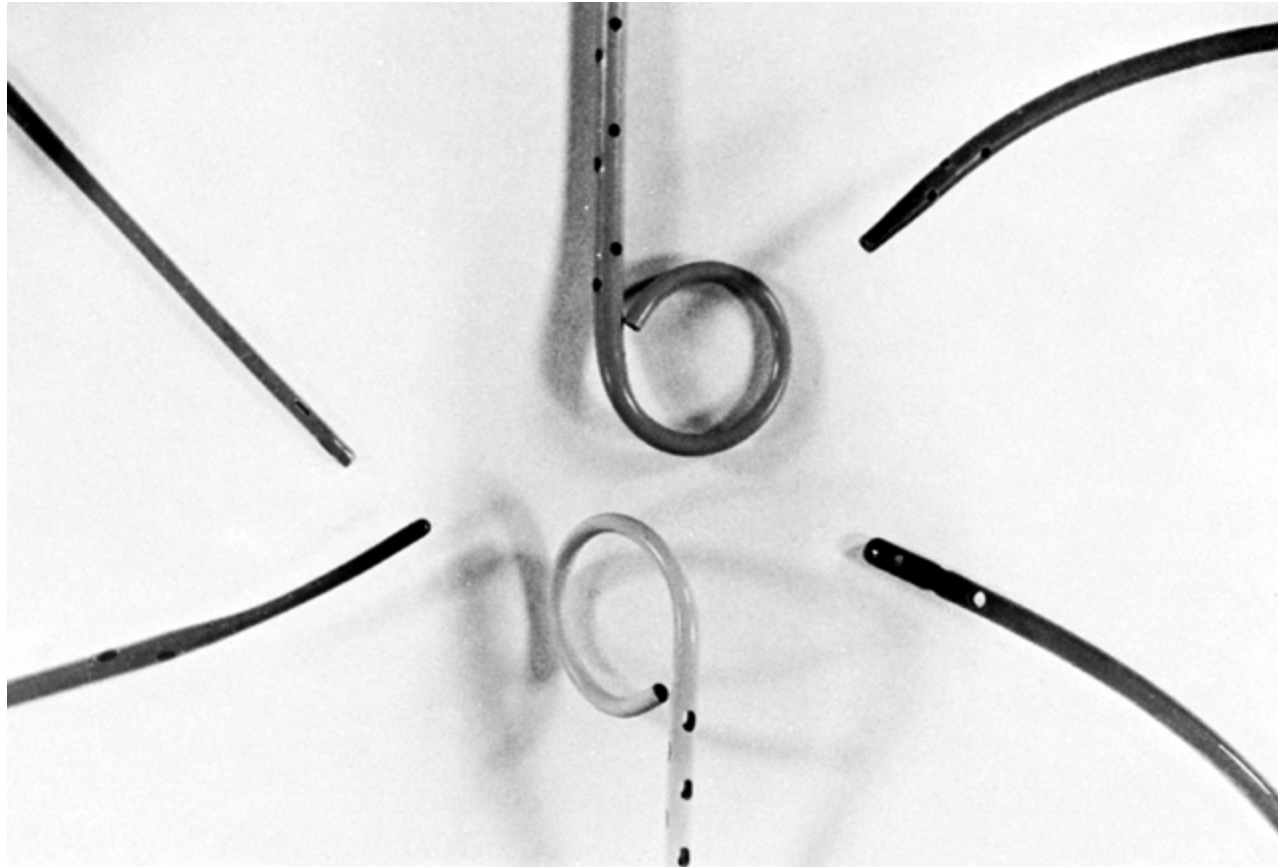
# Diagnostic Catheters



Left to Right:

- Amplatz Right
- Judkins Right
- Sones
- Judkins Left
- Amplatz Left

# Ventricular Catheters



Pigtail

Gensini

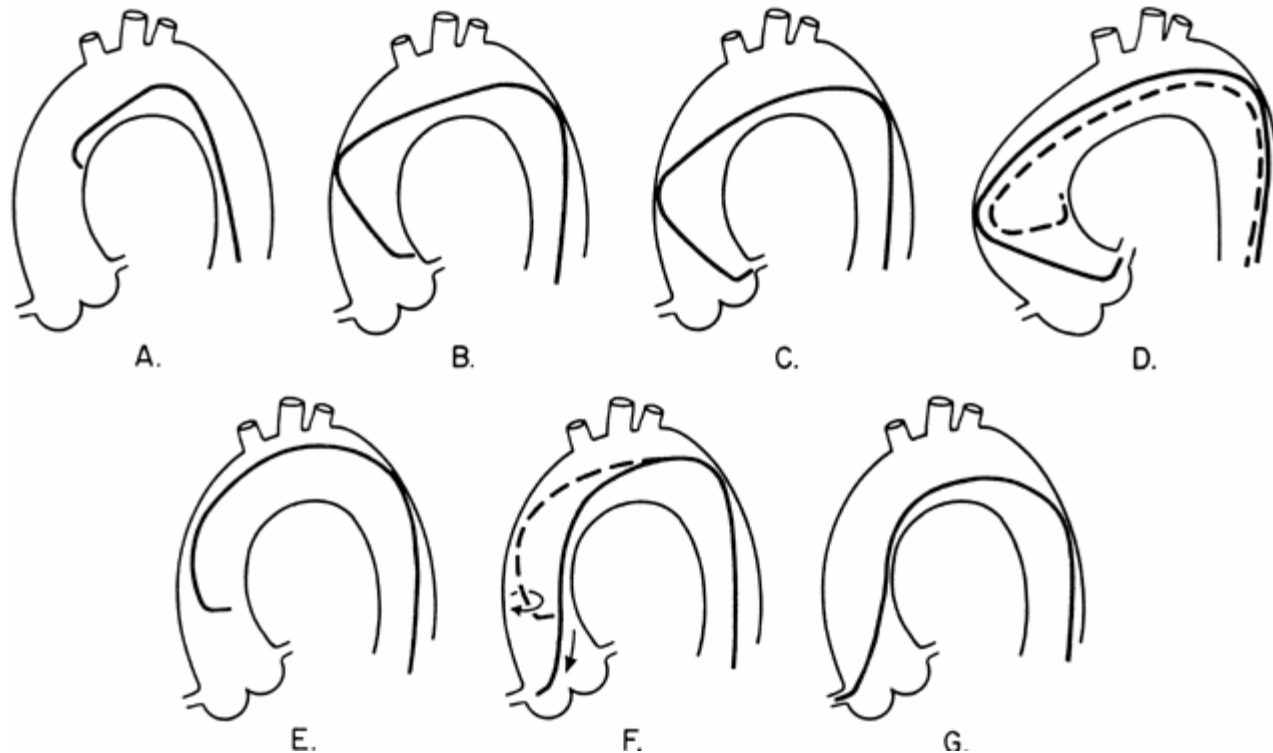
NIH

Pigtail

Lehman

Sones

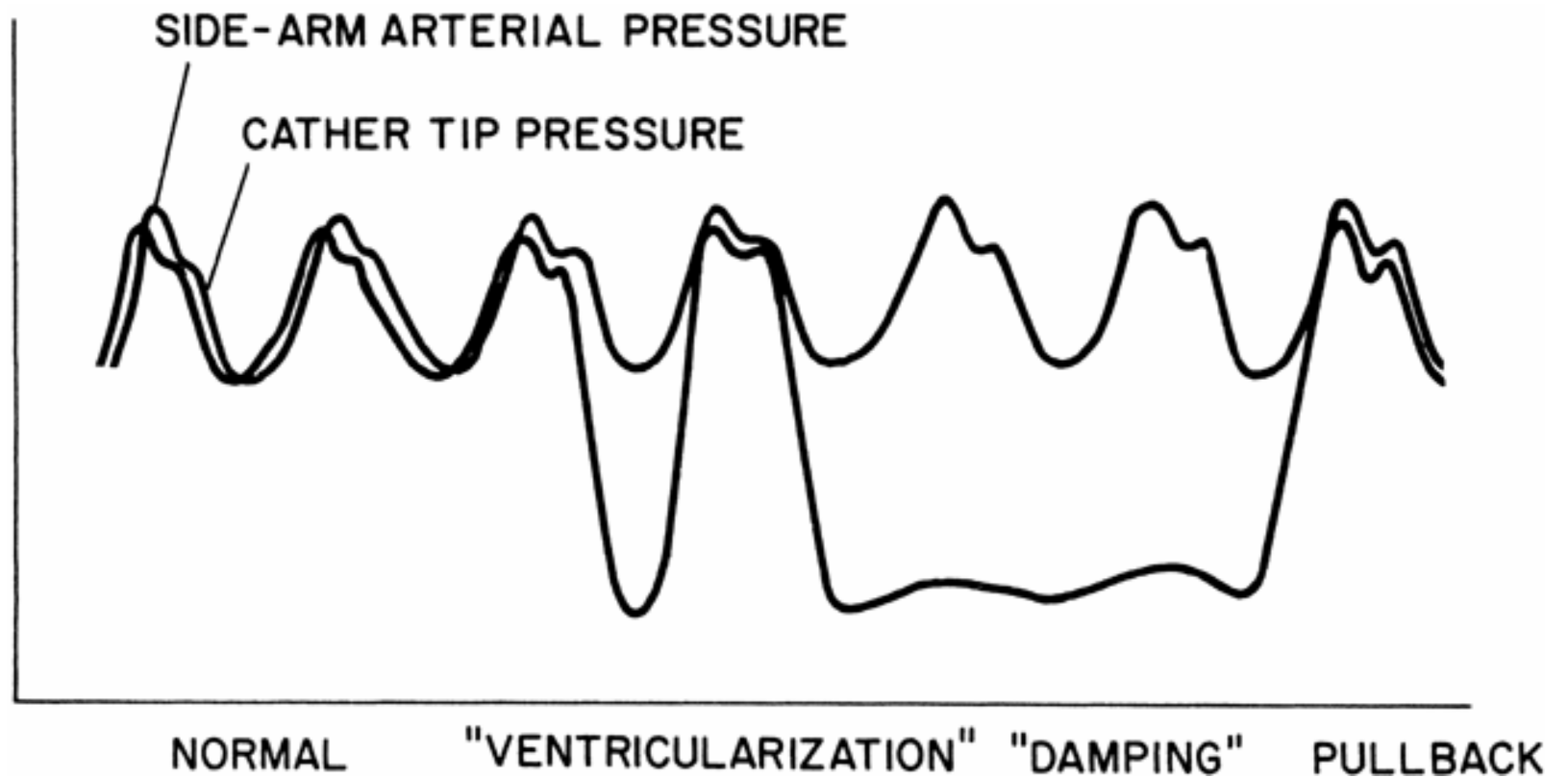
# Advancing and Engaging Catheters



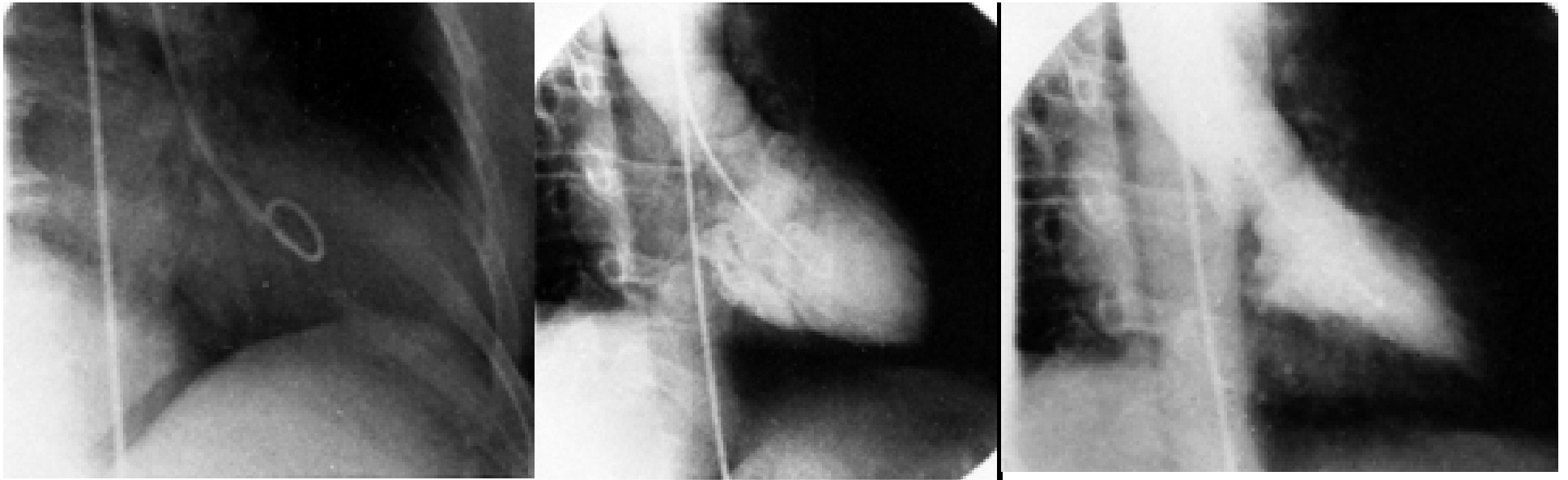
Top = LCA  
with Judkins  
Left

Bottom =  
RCA with  
Judkins Right

# Damping



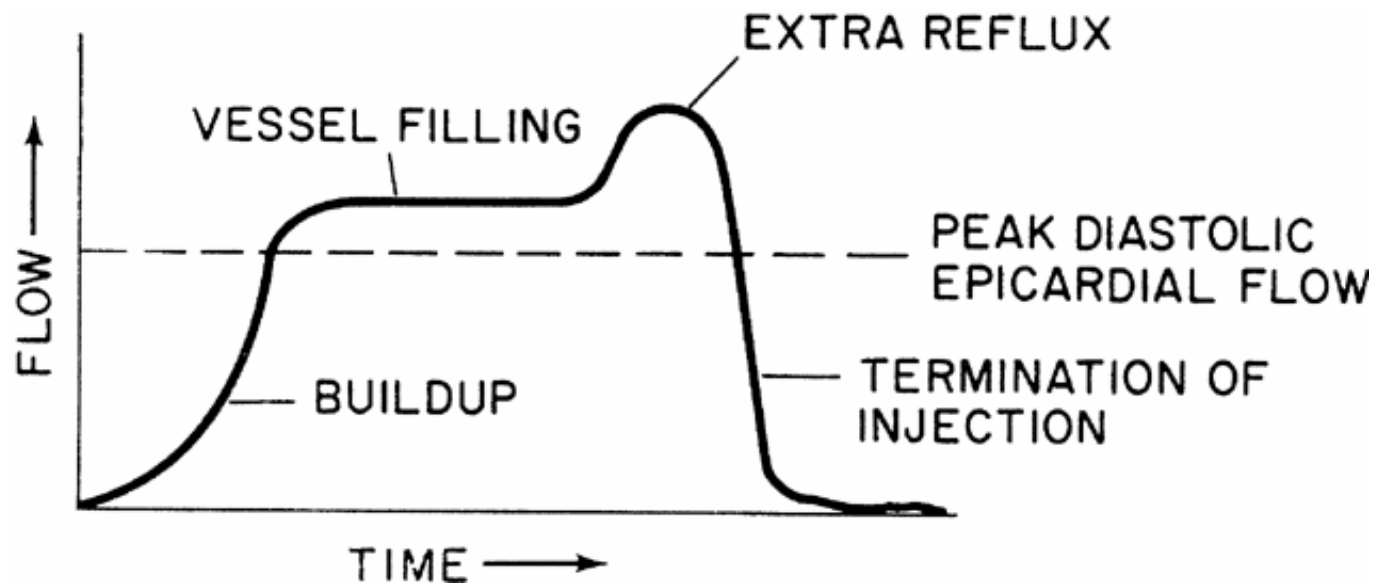
# Ventriculography position



Midcavitary positioning in 30 degrees RAO

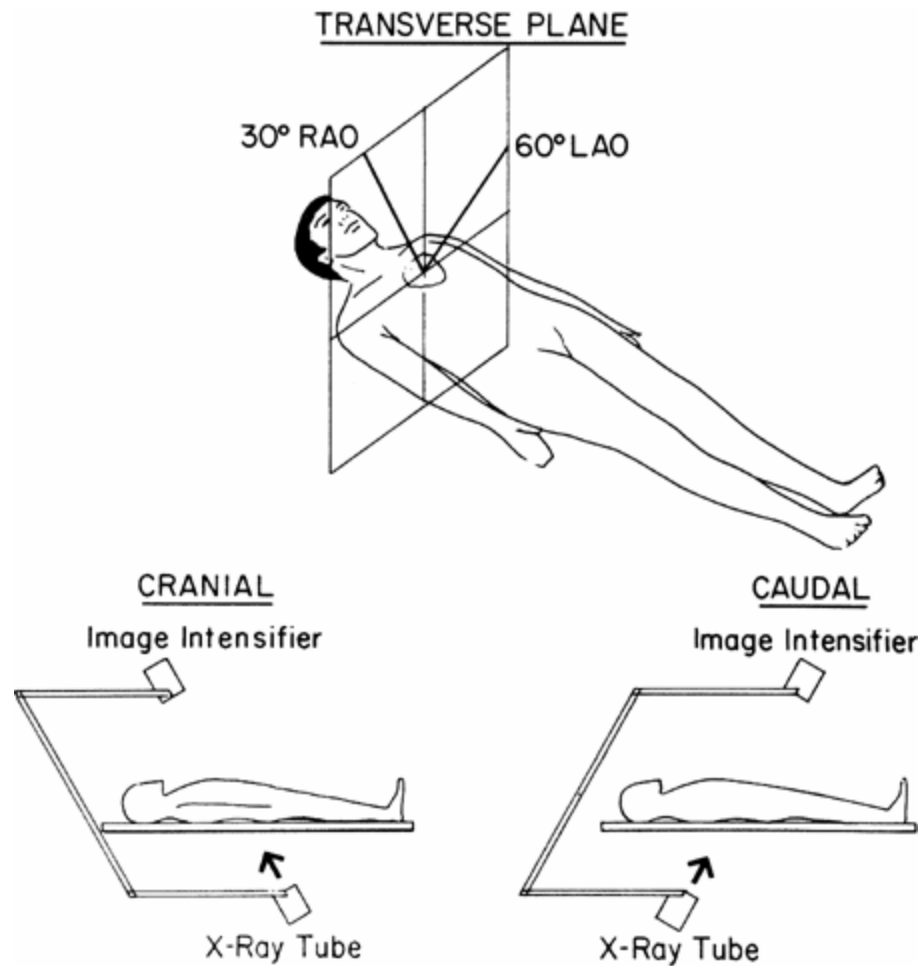


# Injection technique



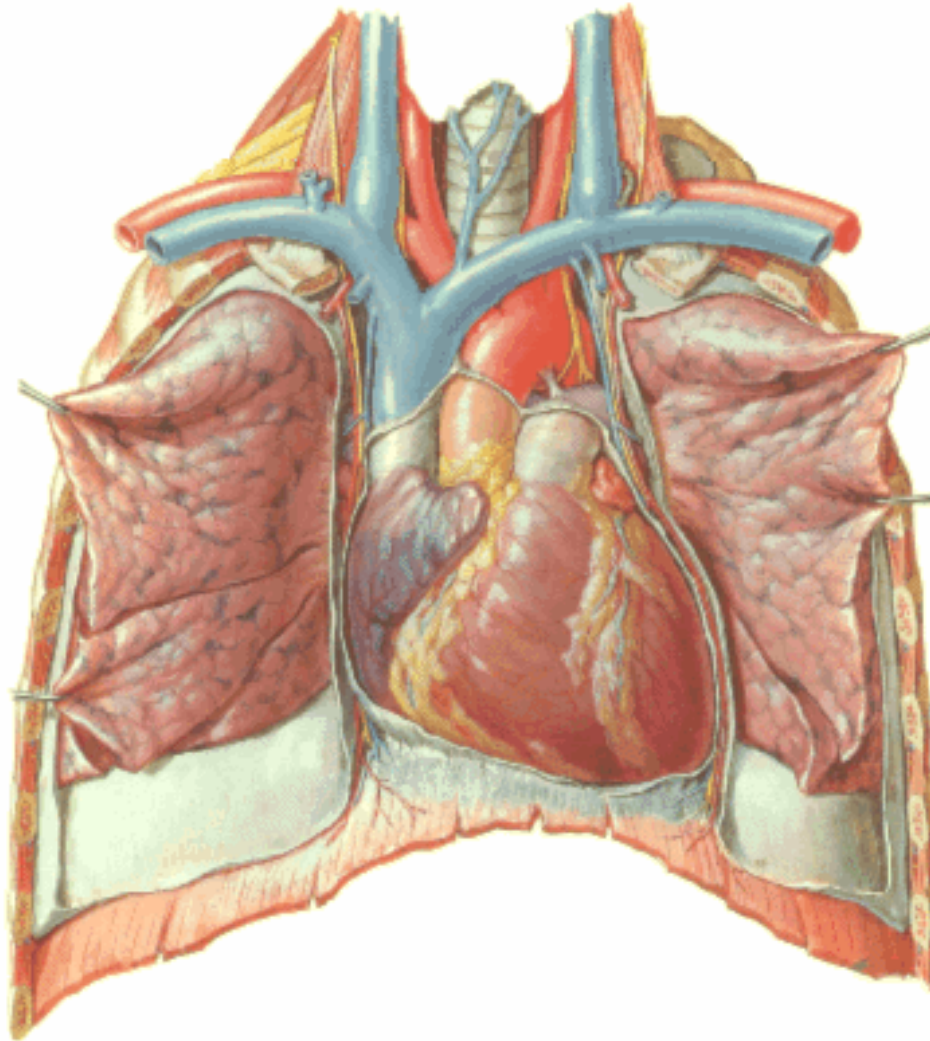
Steady but rapid buildup with peak pressure at end to see reflux of contrast into the aorta.

# Camera Position



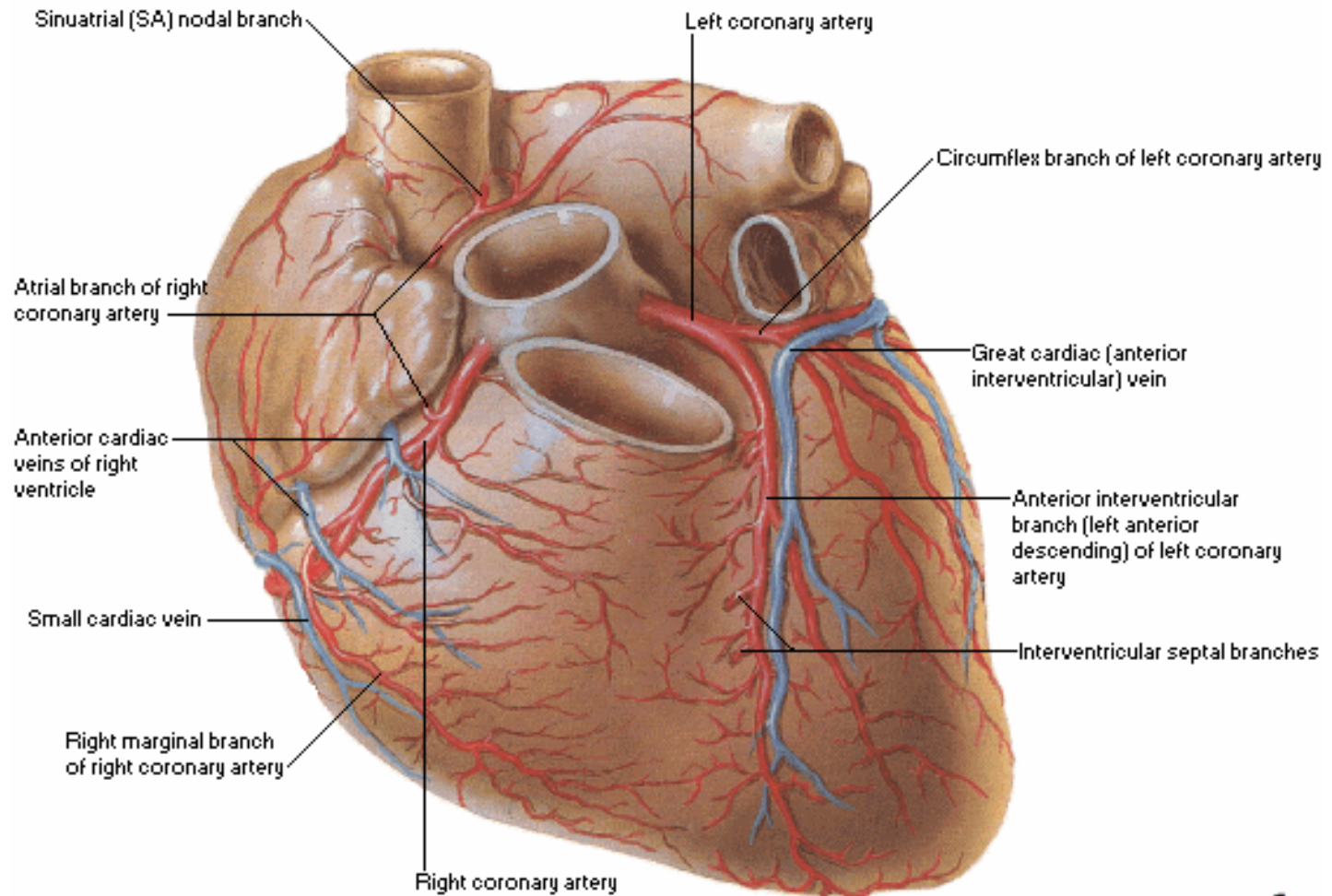
Camera positions  
referenced to  
location of Image  
Intensifier

# Basic Anatomy



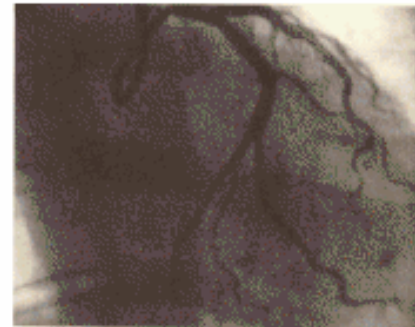
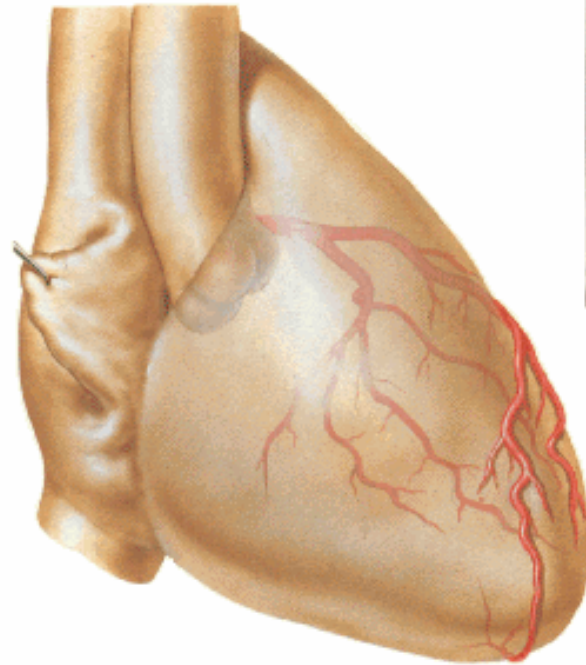
# Basic Anatomy

## Coronary Arteries and Cardiac Veins Sternocostal Surface



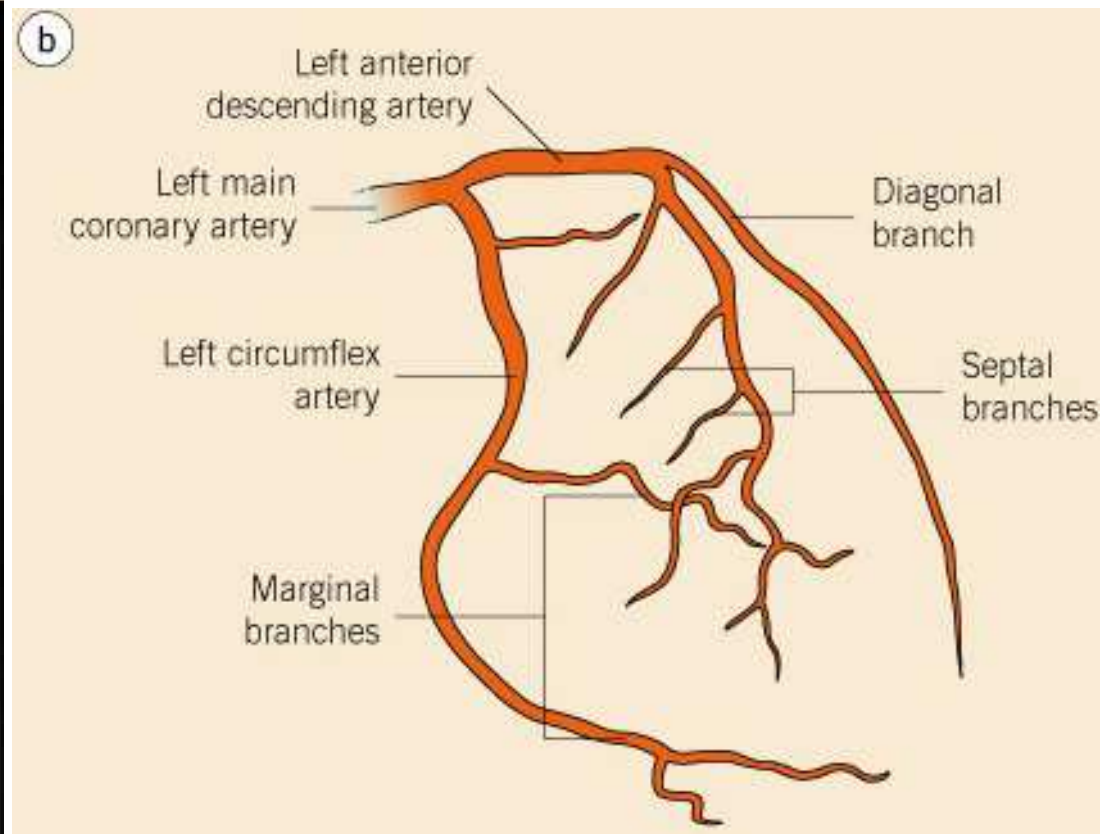
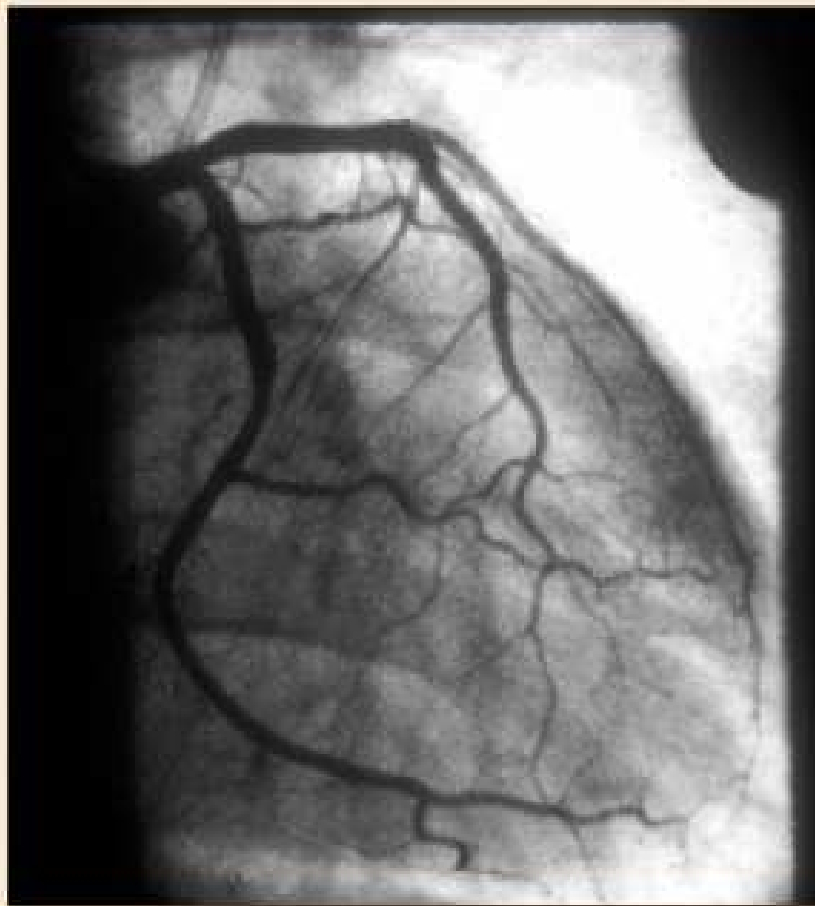
# Left Coronary Artery – RAO

## Left Coronary Artery Arteriographic View 2

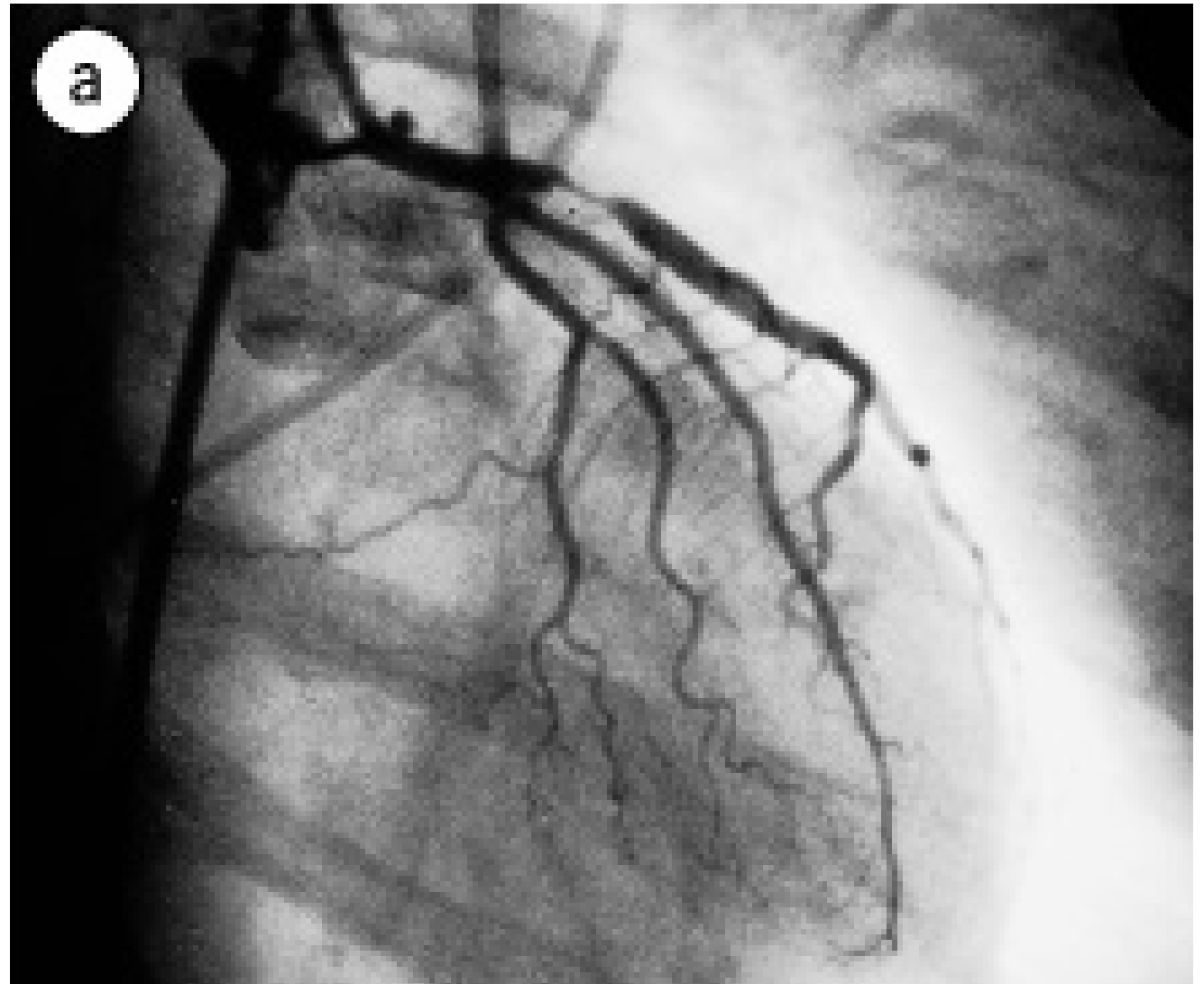


# Basic Anatomy

## Left Coronary Artery - RAO



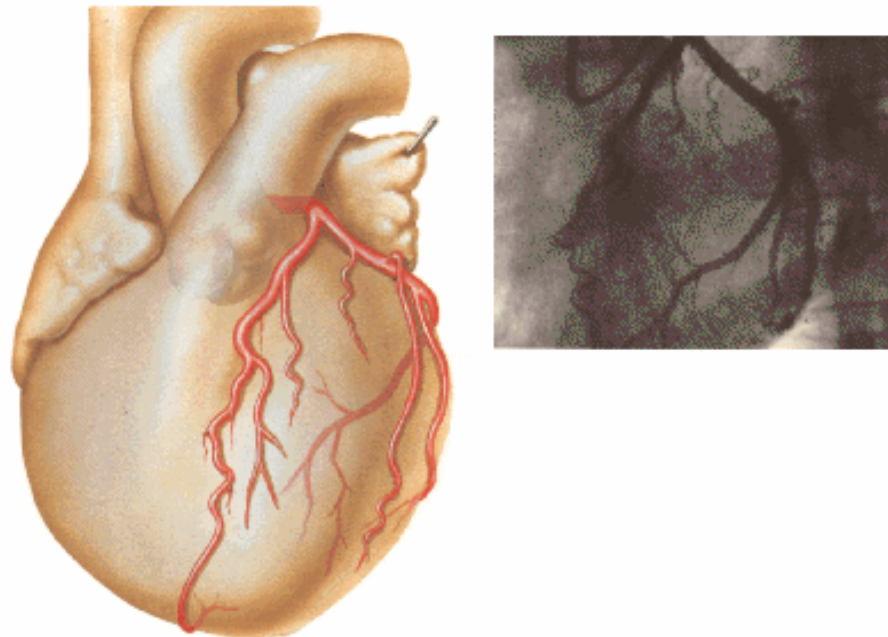
# LAD Stenosis - RAO





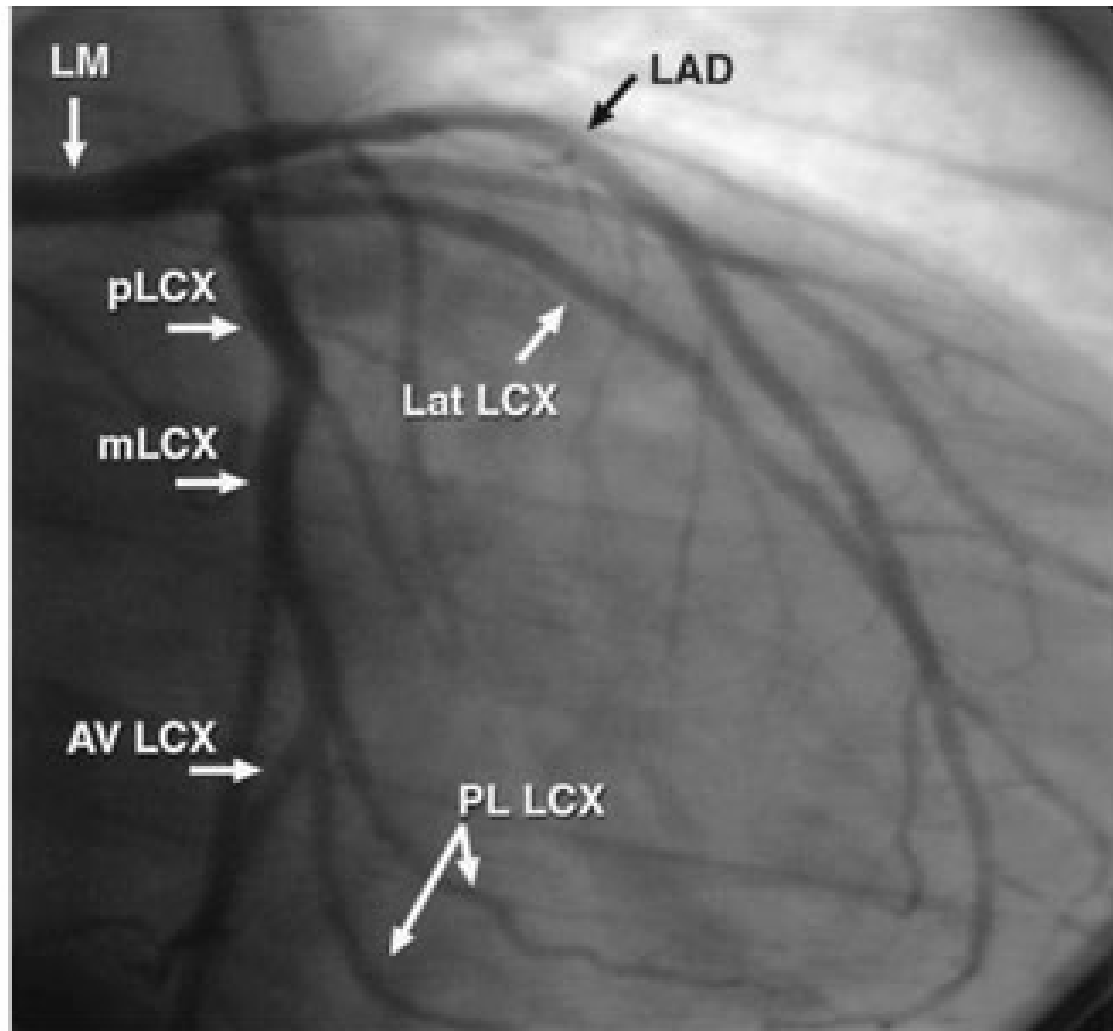
# Left Coronary Artery - LAO

## Left Coronary Artery Arteriographic View 1

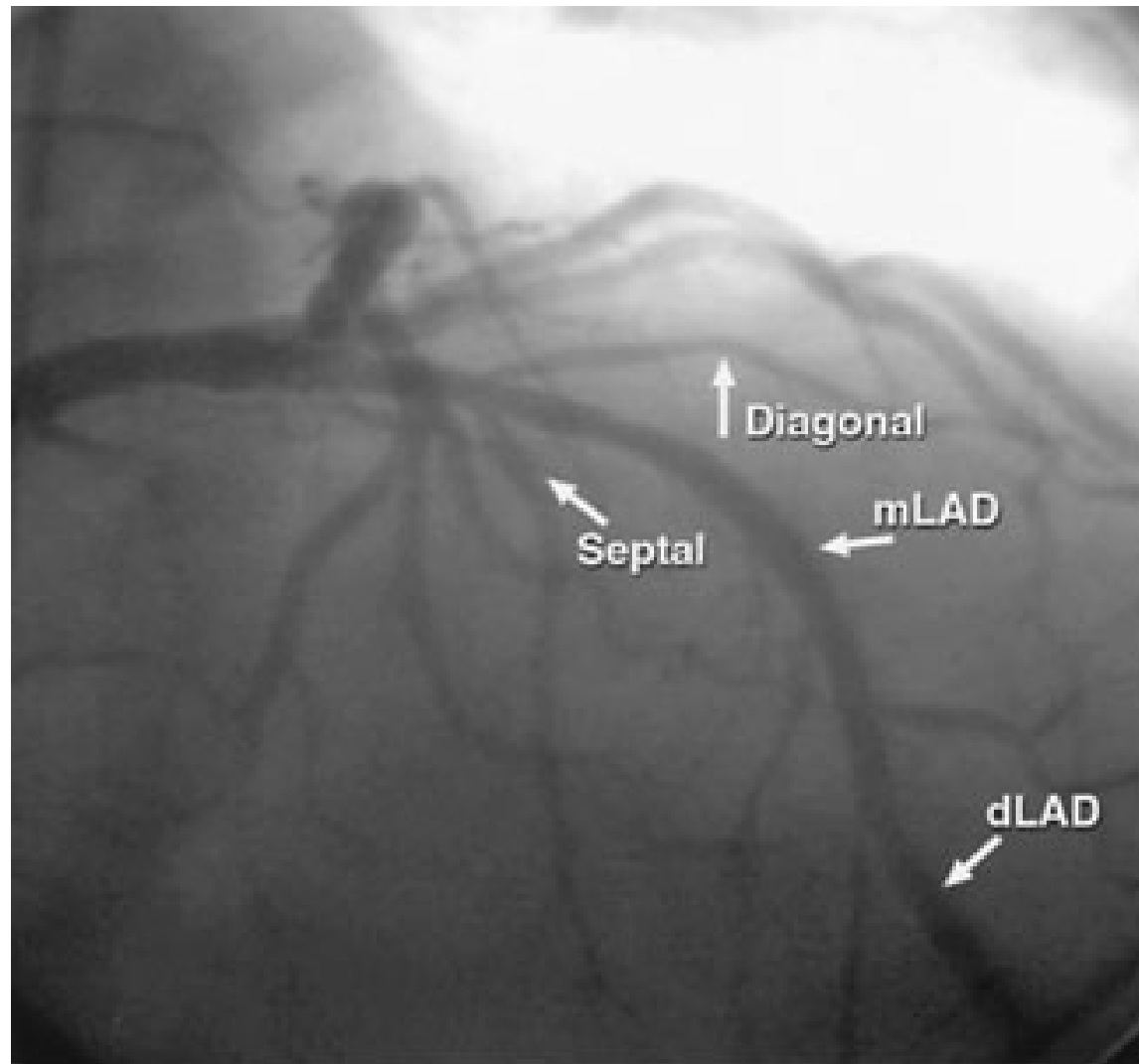




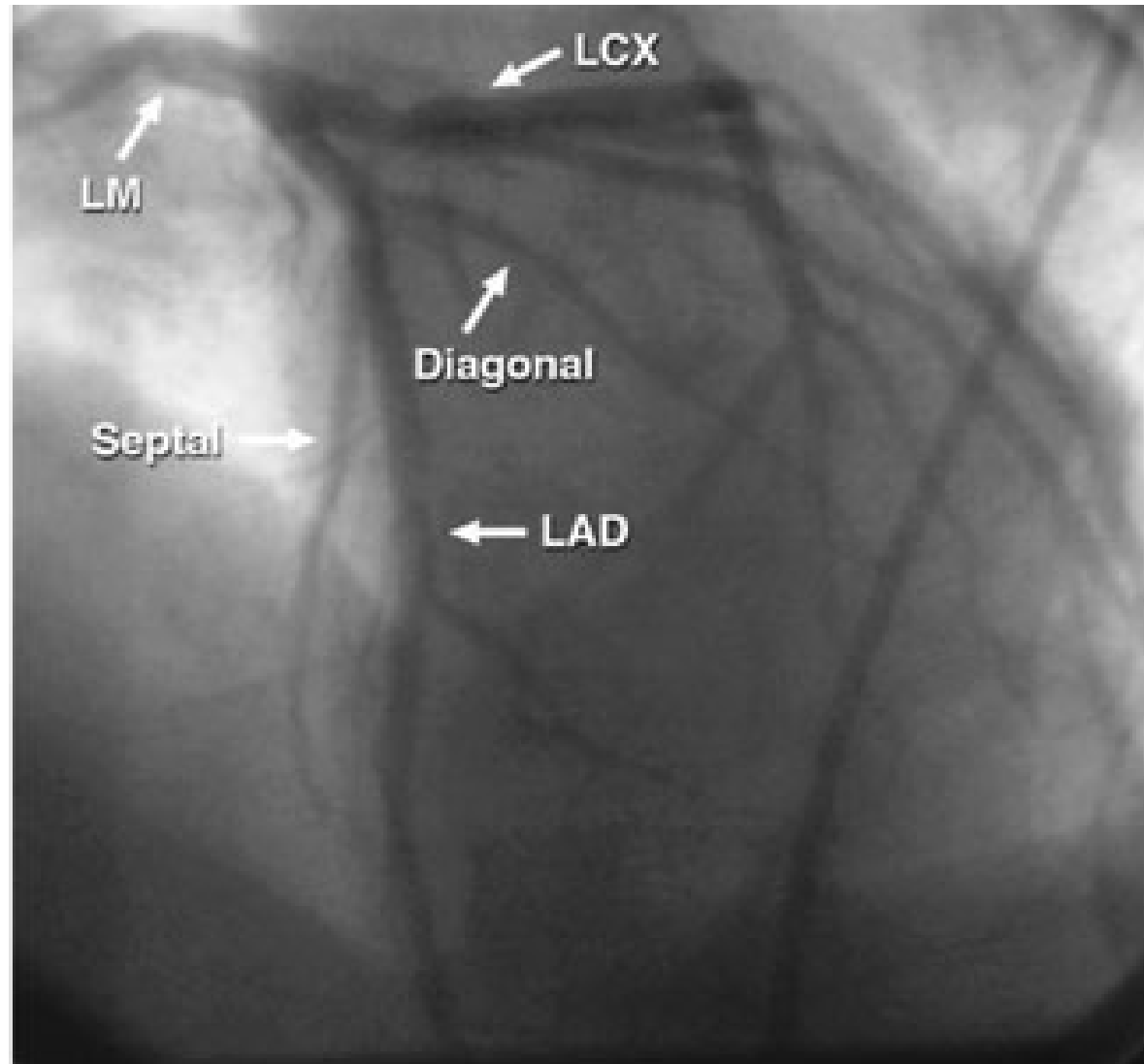
# LCA – RAO Caudal



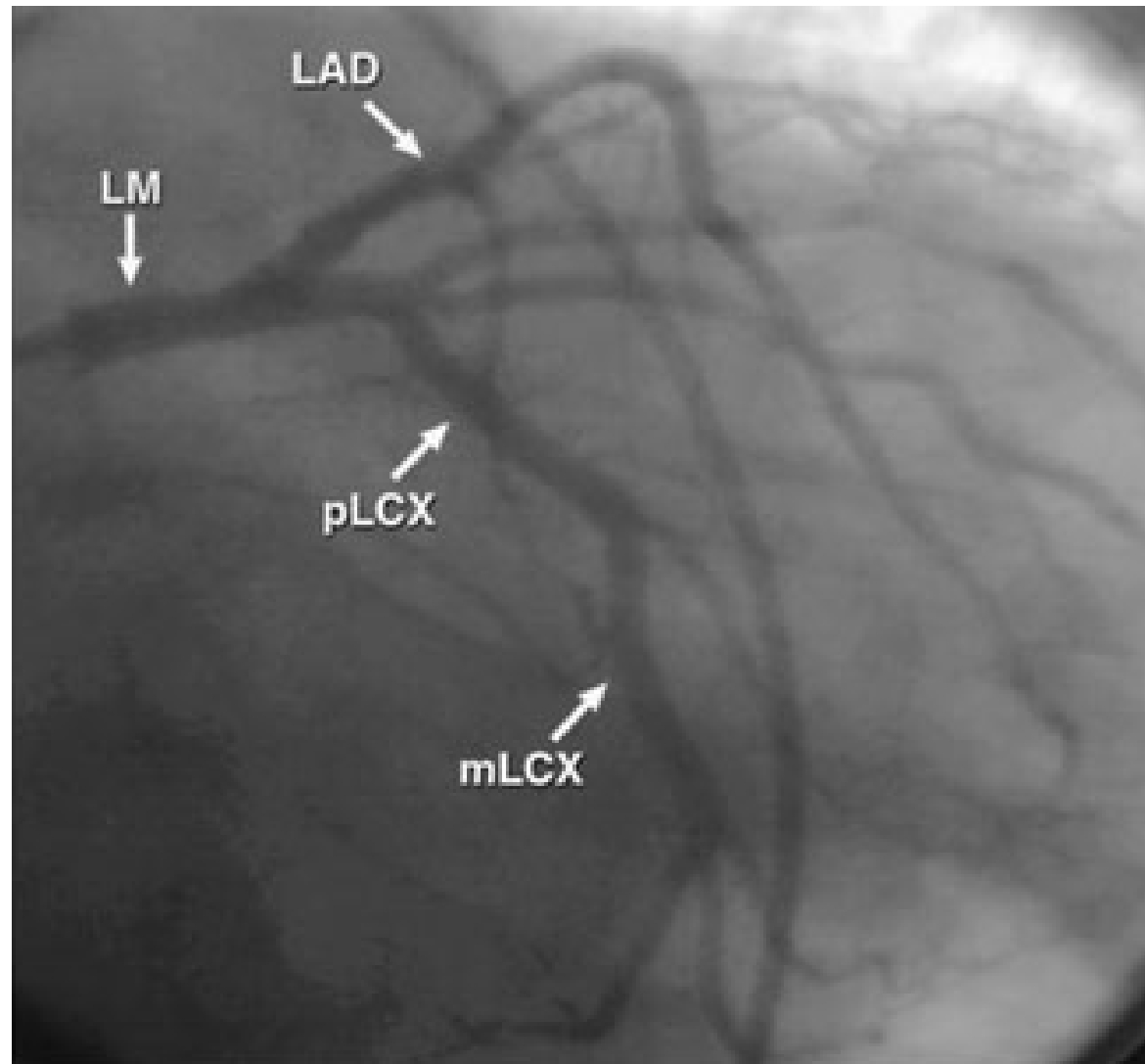
# LCA – RAO Cranial



# LCA – LAO Cranial

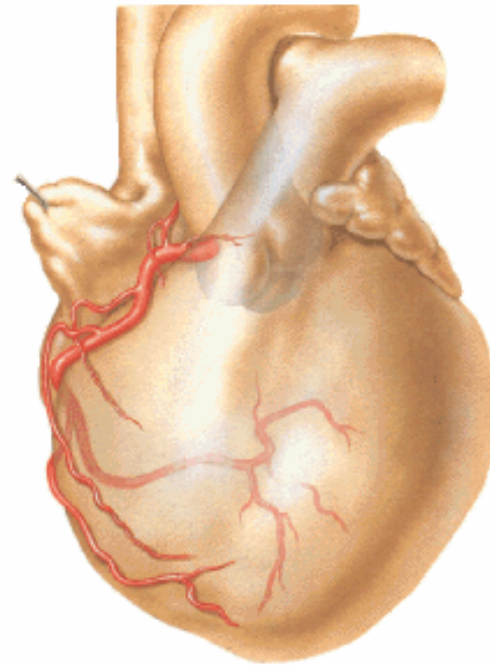
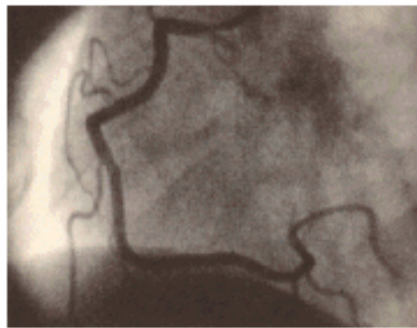


# LCA – LAO Caudal (Spider)



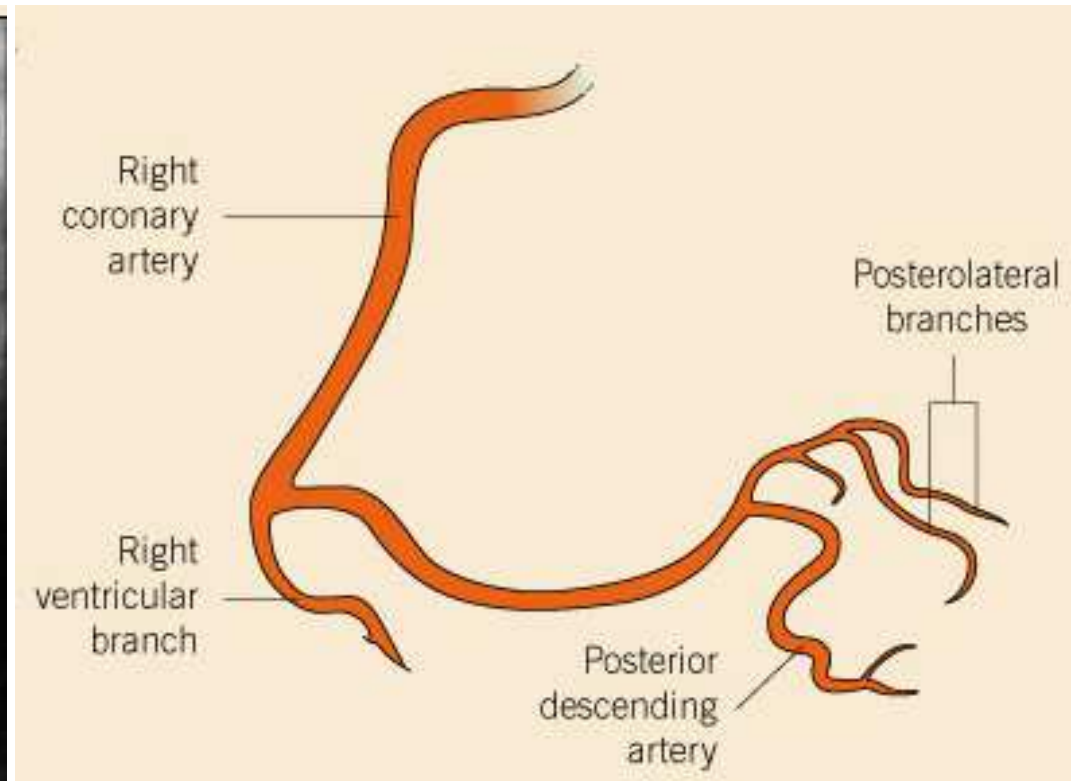
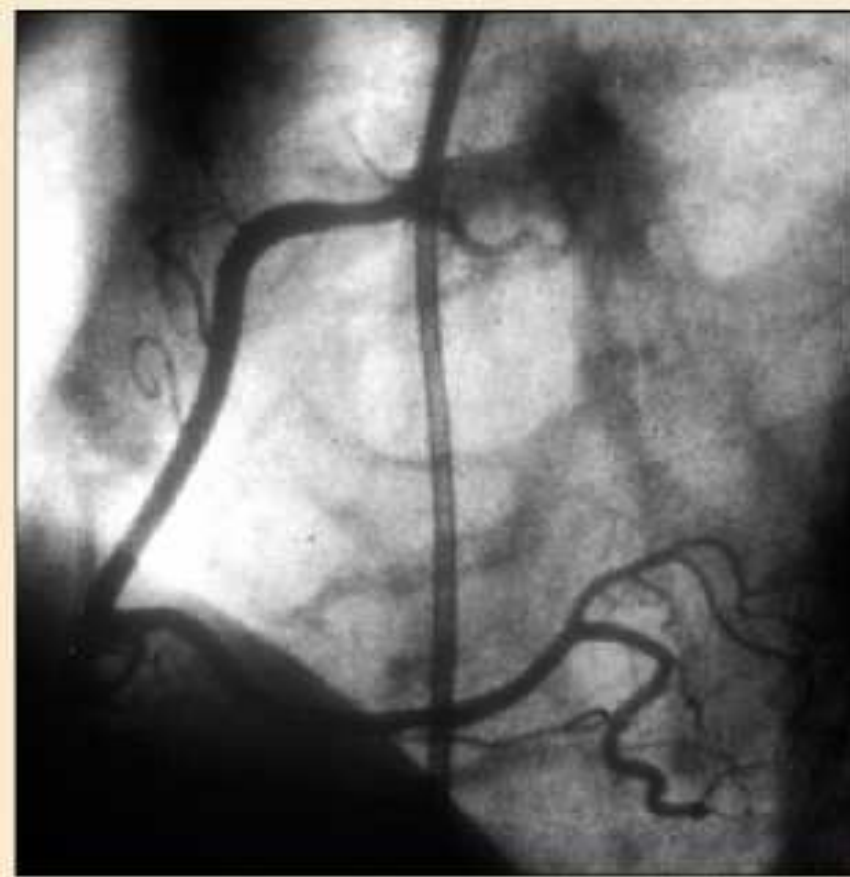
# RCA - LAO

## Right Coronary Artery Arteriographic View 1

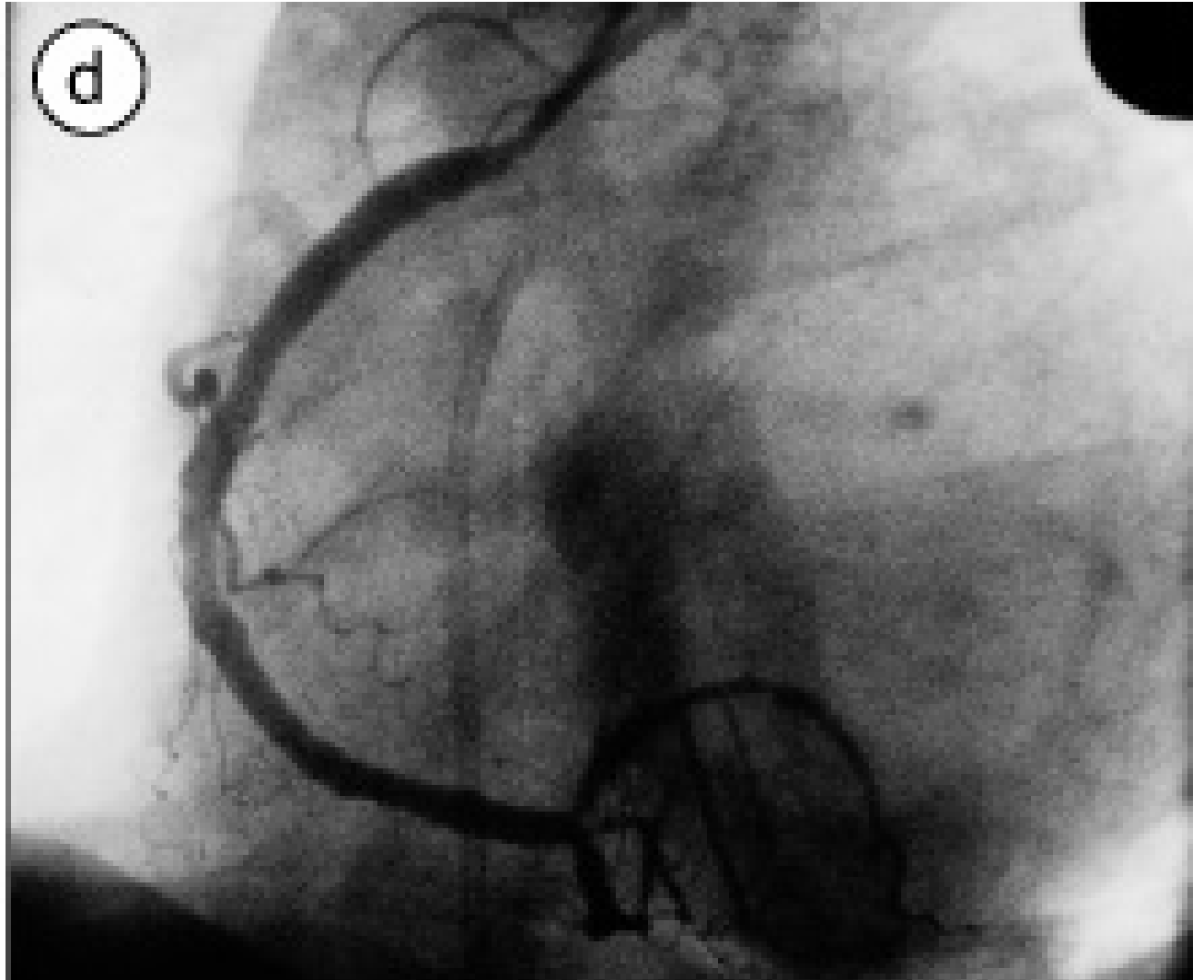


# Basic Anatomy

## Right Coronary Artery - LAO

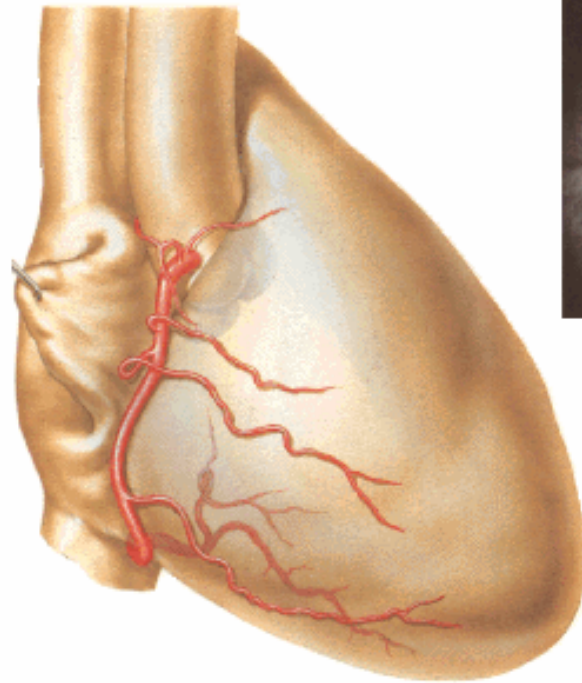


# Right Coronary Thrombus



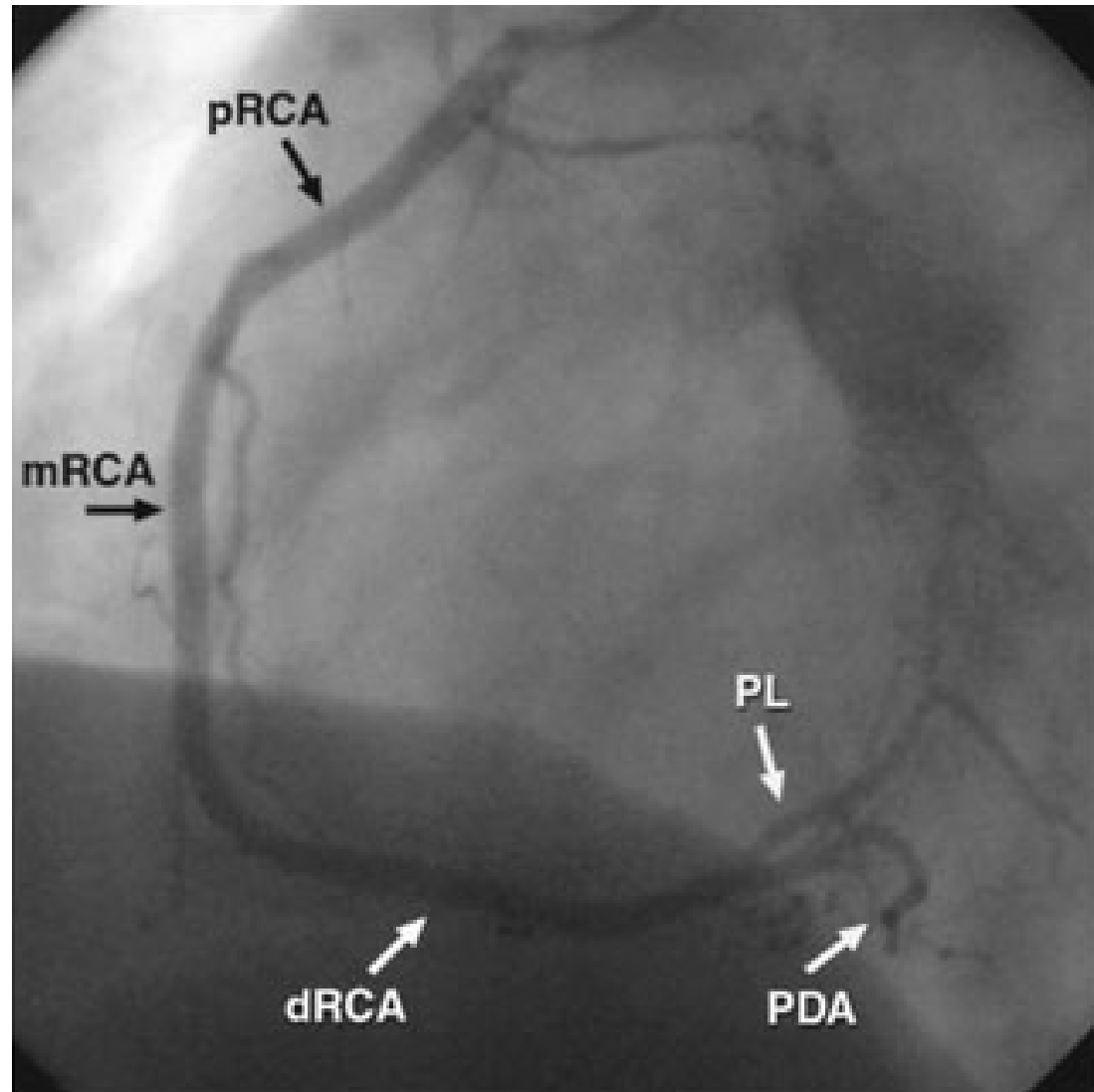
# RCA - RAO

## Right Coronary Artery Arteriographic View 2

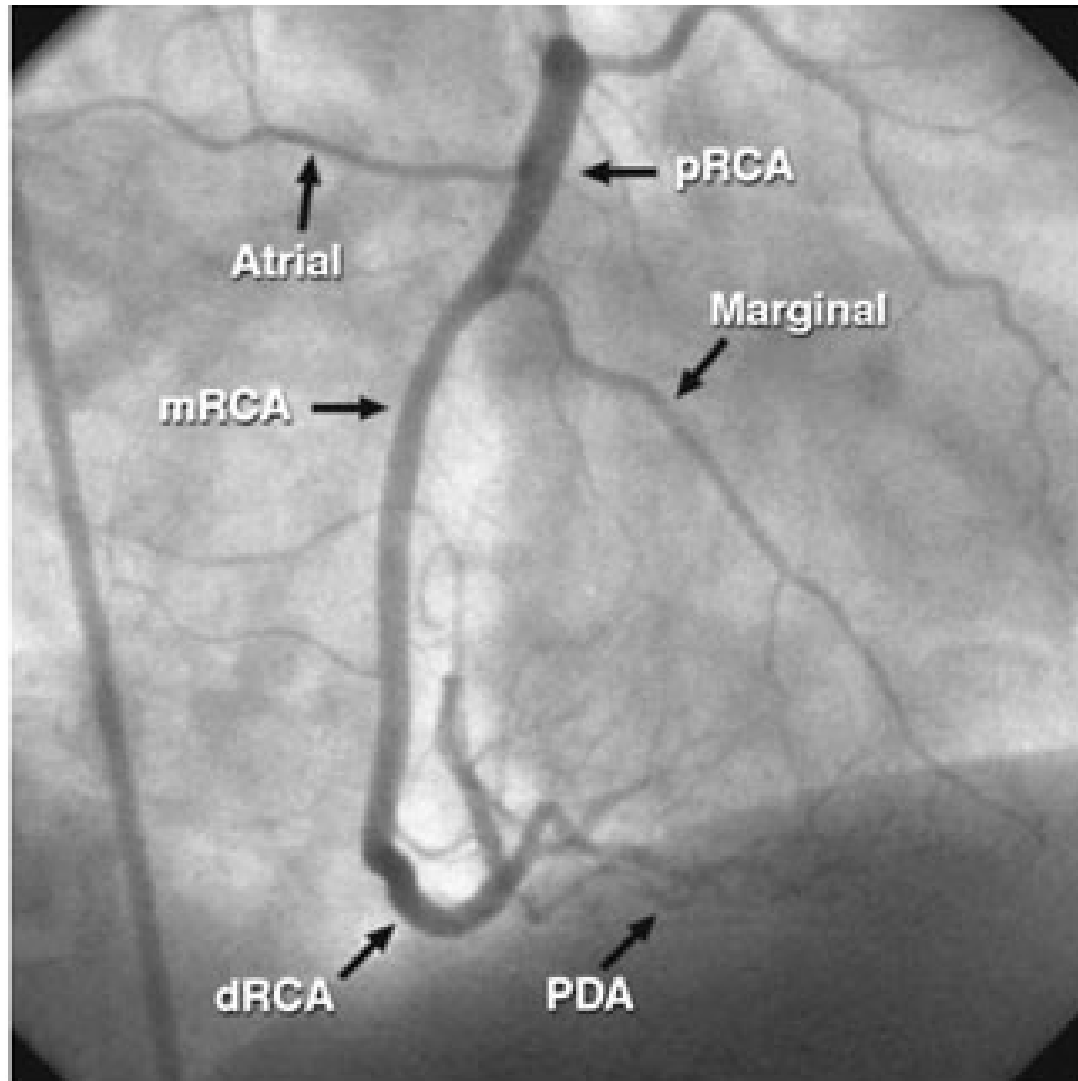




# RCA - LAO

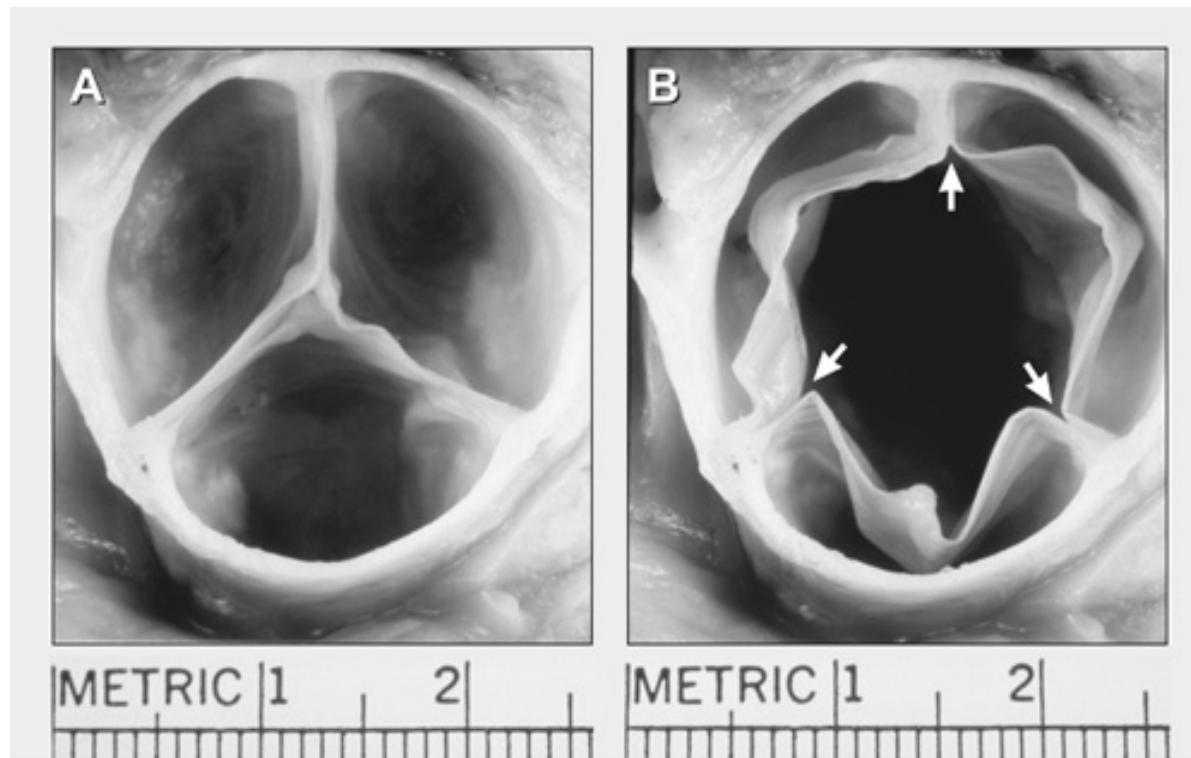


# RCA - RAO



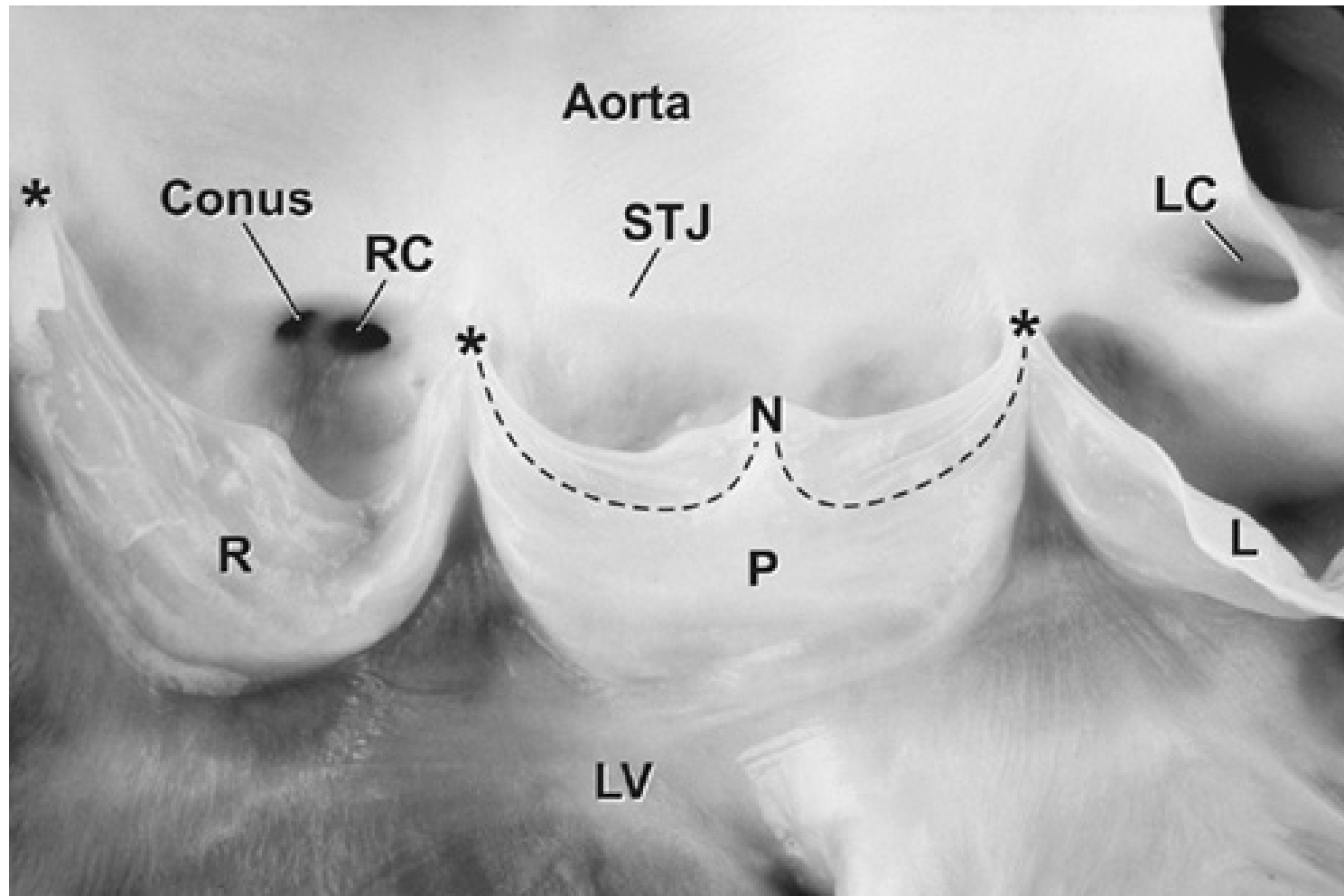
# Basic Anatomy

## Aortic Valve Cusps

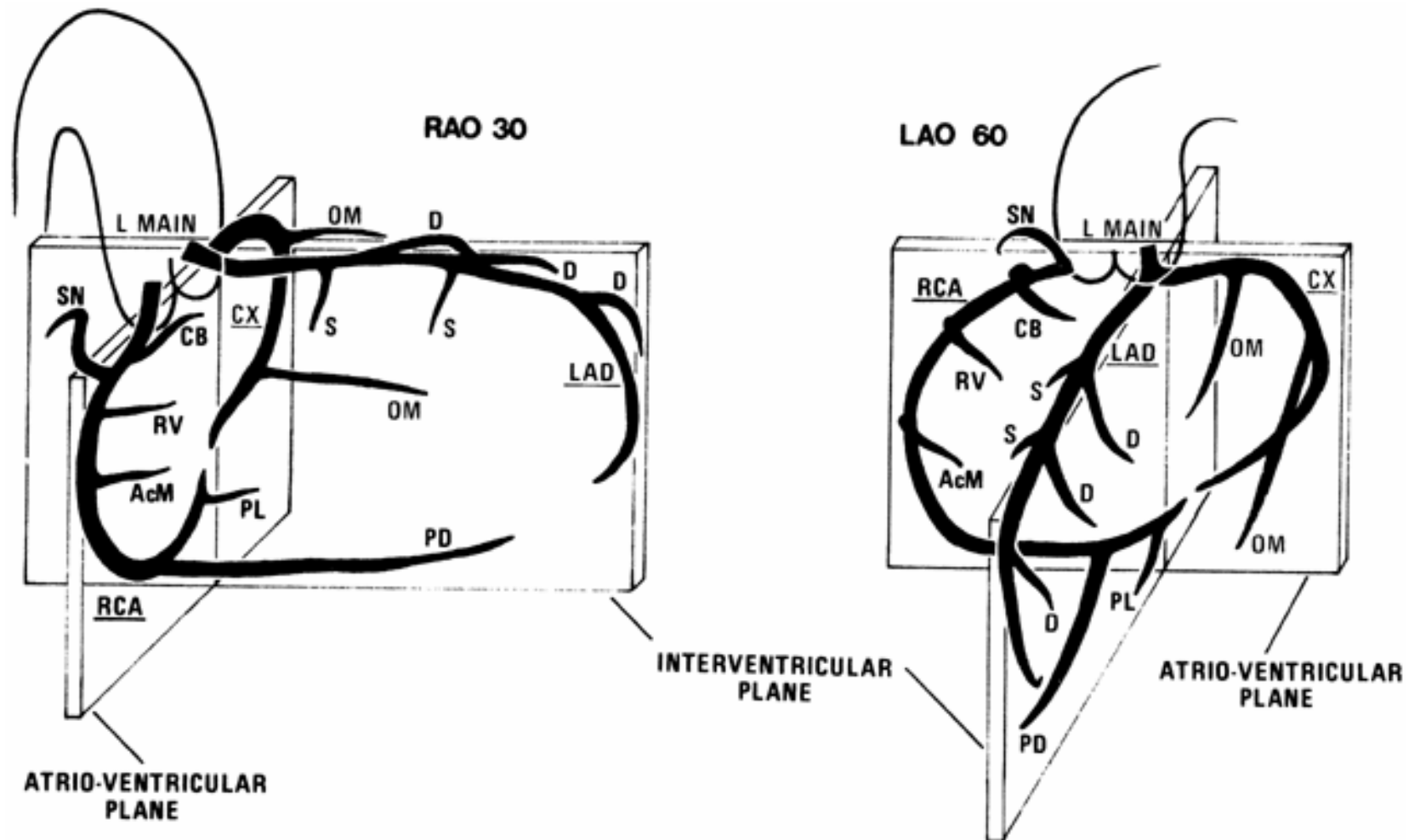


# Basic Anatomy

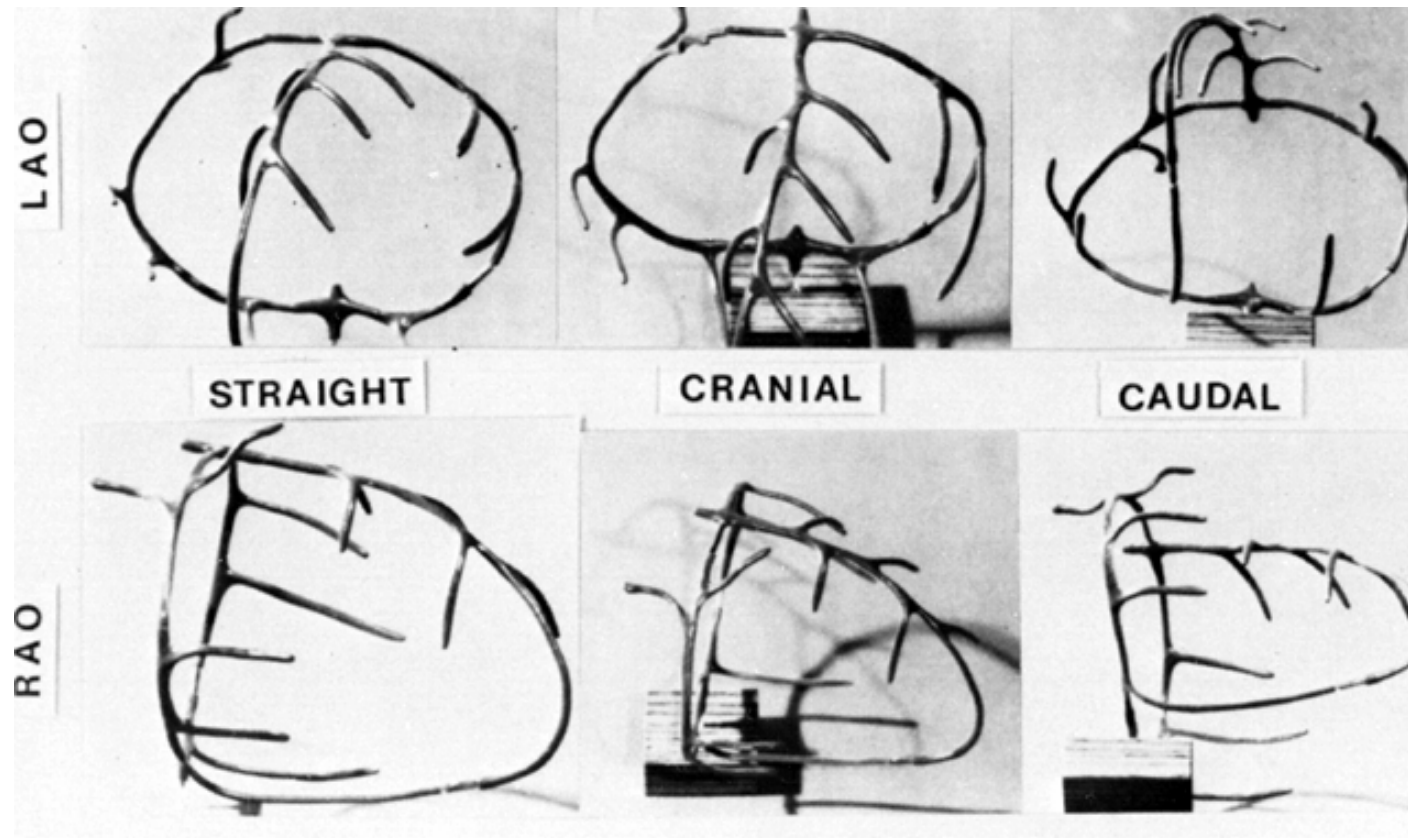
## Aortic Valve opened



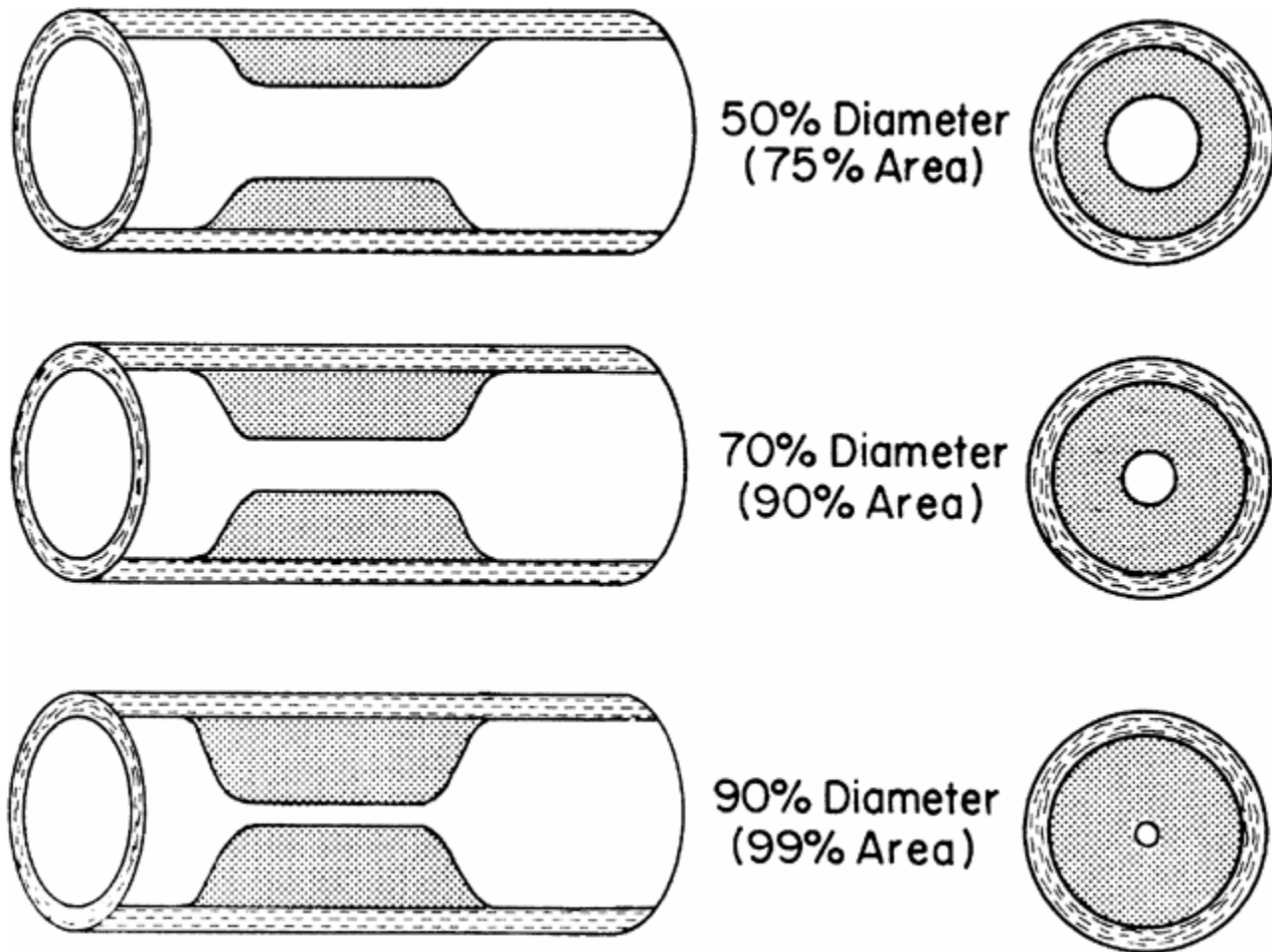
# Coronary Anatomy Planes



# Coronary Anatomy Planes



# Estimation of Stenosis



# References

- Baim DS, Grossman W. Grossman's Cardiac Catheterization, Angiography, and Intervention, 6<sup>th</sup> ed. Philadelphia: Lippincott Williams & Wilkins, 2000.
- Beller GA, Bonow RO, Fuster V; Core Cardiology Training Symposium (COCATS). ACC revised recommendations for training in adult cardiovascular medicine. Core Cardiology Training II (COCATS 2). (Revision of the 1995 COCATS training statement). *J Am Coll Cardiol*. 2002 Apr 3;39(7):1242-6.
- Crawford MH, DiMarco JP, Paulus WJ et. al. *Cardiology*, 2<sup>nd</sup> ed. New York: Mosby, 2004.
- Fuster V, Alexander RW, O'Rourke RA et. al. *Hurst's The Heart*, 10<sup>th</sup> ed. New York: McGraw-Hill, 2001.
- Scanlon PJ, Faxon DP, Audet AM, et al. ACC/AHA guidelines for coronary angiography. A report of the American College of Cardiology/American Heart Association Task Force on practice guidelines (Committee on Coronary Angiography). Developed in collaboration with the Society for Cardiac Angiography and Interventions. *J Am Coll Cardiol* 1999;33:1756–1824.