Coronary CTA is becoming an established means to evaluate patients with low and medium risk for coronary artery atherosclerotic disease and it is increasingly utilized.

It is a problem solver of confusing findings and dilemma discovered at echocardiography & conventional angiography (con ang).

Having a useful pattern-based approach to abnormal findings of coronary arteries on CTA will guide the radiologist to diagnosis.

Coronary CTA Disease Patterns

Main Categorization:
- Focal or segmental narrowing
- Focal widening or aneurysm
- Diffuse narrowing
- Diffuse widening or ectasia
  - with tortuosity
  - without tortuosity

Atherosclerotic Plaque with Negative Remodeling

- Plaque involved with fibrosis, wall contraction, and luminal narrowing. Usually calcified.

Two different patients with left anterior descending (LAD) lesions. Arrows point to stenoses due to negative remodeling. Images on the right are CTA & correlative conventional angiography (ConAng) revealing 2 LAD lesions. The distal lesion has an obvious loss of caliber (red arrows).

Myocardial Bridge

- Most common in mid LAD & mid RCA
- Usually of no clinical significance

Oblique sagittal CTA reformatted image (right) and correlative ConAng in same plane (left) show abnormal intramyocardial course of the mid LAD with mild smooth luminal narrowing (arrows).
Myocardial Bridge

- Vessel surrounded by muscle, not fat
- Resurfaces after a short distance

Same patient as previous slide – Thin maximum intensity projection (MIP) along the course of LAD (left) and perpendicular to that plane creating a short-axis view (right) demonstrate that the mid LAD is surrounded by myocardium (arrows).

Pseudo-stenosis due to Artifact

- Caused by arrhythmias, misgating of R-wave, beam hardening artifact, or chest wall motion.
- Other reformatted image either reveals stair-step artifact or conversely, resolution of stenosis.

Image on the right shows two areas of narrowing in mid LAD caused by cardiac motion. The curved multiplanar reformat image of same patient (left) shows no LAD stenosis.

Pseudo-stenosis Due to Artifact

- Pseudolesions can be identified by finding arrhythmias on the CTA electrocardiography (ECG) strip.
- ECG editing may resolve the pseudo-stenosis.

Paroxysmal ventricular contraction (PVC) on correlated ECG strip (blue arrow) is the cause of pseudoleison (red arrows).

Resolution of Pseudo-stenosis by ECG Editing

- Usual resolution of pseudo-stenosis by ECG editing.

Coronary Artery Dissection

- Usually iatrogenic during catheterization
- Spontaneous in Marfan and Loews Dietz

Arrows point to a linear filling defect in distal RCA of woman with coronary dissection proven by angiography.

Beam hardening artifact by pacemaker lead in right atrial appendage, creates a pseudo-stenosis of the proximal right coronary artery (RCA).
Anomalous Coronary Artery

- Caused by:
  - abnormal angle of origin or at bifurcation → altered flow causes premature atherosclerotic lesion
  - inter-arterial course → external compression by aorta and main pulmonary artery (PA) can cause ischemia

External Compression or Surrounding Fibrosis

- Causes: mediastinal fibrosis, inflammatory changes of arteritis involving the aorta, or compression by aneurysm of ascending aorta or PA

Focal Widening or Aneurysm

- Congenital
- Positive remodeling of atherosclerotic plaque
- Atherosclerotic aneurysm
- Kawasaki
- Traumatic & iatrogenic pseudoaneurysm
- Mycotic or infectious pseudoaneurysm
- Vasculitides causing aneurysm: e.g., Behcet
- Coronary artery bypass graft aneurysm

Congenital Aneurysm

- Rare
- No associated atherosclerosis or calcification.
**Positive Remodeling of Atherosclerotic Plaque**

- Due to focal expansion of outer wall of vessel in reaction to intra-luminal atherosclerotic plaque
- The expansion prevents luminal narrowing despite considerable plaque burden
- Lesion and plaque burden are not appreciated by Con Ang CTA & endovascular ultrasound better diagnose positive remodeling → earlier initiation of lipid-reducing medications
- Associated with increased risk of acute coronary event due to inflammation of plaque margins, which can undergo ulceration, thrombosis, & complete occlusion.

**Atherosclerotic Aneurysm**

- Most common cause of coronary aneurysm in USA
- Calcification and thrombosis common, usually atherosclerotic plaques prevalent throughout

**Kawasaki Disease**

- 80% affected patients are younger than age of 5
- Initial clinical presentation: Fever, mucocutaneous rash, enlarged lymph nodes
- Treatment: aspirin & intravenous immunoglobulin
- Complications: myocarditis, pericarditis, or coronary artery aneurysm
  - aneurysm may rupture
  - aneurysm may embolize → cause myocardial infarction
  - patient presents with elevated troponin
Kawasaki Disease
- Worldwide, most common cause of coronary aneurysm
- Can be calcified or non-calcified
- Sometimes causes ectasia
- Appropriate history needed for diagnosis

Transaxial thin MIP of CTA of 56-year-old man with incidental diagnosis of focal ectasia of left main coronary artery, extending to proximal LAD. It is either a congenital aneurysm or more likely, due to undiagnosed Kawasaki disease, since the former is more rare. (below)

18-year-old female with fever, rash, & chest pain
- Troponin I: elevated (6.7 ng/mL)
- Non-gated contrast-enhanced CT of chest shows noncalcified aneurysms of LAD and RCA (arrows)

Traumatic Pseudo-Aneurysm (PSA)
- Usually iatrogenic: catheterization, coronary artery reinsertion in aortic root repair, & valve replacement

Transaxial non-gated CT of chest at the level of aortic root (Ao) in patient who had ascending aorta surgery with coronary artery insertion, demonstrates pseudoaneurysms, both anterior and posterior to the aortic root (arrows), and a large hemopericardium (H), as well as thrombosed blood in the mediastinum.

Infectious or “Mycotic” Aneurysm
- Not a true aneurysm
- Findings: ill-defined margins & extraluminal blood common.
- Clinical symptoms differentiates it from iatrogenic PSA.

31-year-old man with non-ST elevated myocardial infarction and sepsis from dialysis line infection, and normal adenosine-stress Thallium study, has a coronary CTA to further evaluate the cause of pain. Thin MIP axial (left) and oblique coronal (center) images show a large aneurysm arising from the left main coronary artery. The surrounding fat is obliterated by high-density material, thought to be a thrombus. This pseudoaneurysm is due to infection, given the history. Selective Con Ang of LM (right) under-represents the size of this post-infectious aneurysmal dilation.

Coronary Artery Bypass Graft Aneurysm
- Anastomosis site ➔ pseudoaneurysm
  - Contained leakage of blood ➔ similar to iatrogenic PSA, but at anastomosis site
- Saphenous vein and arterial grafts ➔ true aneurysm
  - Atherosclerotic process of the venous graft >>> arterial graft
  - Can thrombose or occlude

Coronary CTA and correlative con ang shows a long segmental narrowing of proximal LAD due to diffuse mostly calcified atherosclerotic plaque. The extent of stenosis is falsely over-estimated by CTA when the lesions are densely calcified.
Diffuse Widening or Ectasia

Two groups:

- Without tortuosity
  - Sometimes Kawasaki
  - Marfan disease and Ehlers-Danlos

- With tortuosity
  - Anomalous origin from pulmonary artery
  - Anomalous distal insertion (fistula)

Note: tortuosity without ectasia seen with connective tissue disease such as Marfan, collateral vasculature in diffuse atherosclerosis, & in hypertension.

Ectasia Without Tortuosity

Kawasaki less commonly causes ectasia.

Focal Narrowing
Diffuse Narrowing
Focal Widening
Diffuse Widening

Ectasia With Tortuosity

Anomalous coronary artery originating from pulmonary artery (ACAPA)

- If anomalous origin of RCA Æ ARCAPA
- If anomalous origin of LAD or LM Æ ALCAPA

Causes pulmonary artery steal phenomenon (left-to-right shunting).

Flow: high pressure aorta Æ normal coronary artery Æ large tortuous collateral arterioles Æ coronary artery with anomalous origin from PA Æ low pressure pulmonary artery

Anomalous coronary artery origin from pulmonary artery (ACAPA)

- If severe Æ present as congestive heart failure in infants 2-3 months old (Bland-White-Garland syndrome)
- If good collateralization Æ presents in adulthood

Ectasia With Tortuosity

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Diffuse Widening (Ectasia) With Tortuosity

Coronary artery fistula

- Anomalous drainage of coronary artery into:
  - coronary vein or sinus
  - superior or inferior vena cava
  - cardiac chamber (atria, ventricles)

- Congenital or acquired (usually iatrogenic)

CT Features of ACAPA and Coronary Fistula

Similarities:

- The coronary arteries are larger than normal
- Many tortuous collateral arterioles seen

Differences:

- Fistula: normal origins of coronary arteries found, abnormal termination
- ACAPA: no coronary artery originating from the coronary sinus related to the ACAPA artery.
Practice Case: ACAPA or Coronary Fistula to PA?

- 37 year old man with chest pain

Coronary CTA – transaxial images show numerous tortuous and ectatic vessels along the left lateral cardiac border (yellow arrow). The LM has a normal origin (red arrow). One of the tortuous vessels approaches the left cusp of the PA(blue arrow).

LAD to PA Fistula

Abnormal drainage to main PA

Same patient as previous slide – Volume rendered 3D reformations with different coloring show the enlarged and slightly tortuous LAD (blue arrows). The enlargement is because of shunting. The yellow arrows depict the course of the ectatic distal LAD branch as it drains into the PA.

Different Patient

LAD to Main Pulmonary Artery Fistula

Double-oblique thin MIP image of coronary CTA along the vertical long-axis of the left ventricle (left) and Con Ang image (right) demonstrate an ectatic tortuous vessel in a patient with dyspnea and angina on exertion.

Summary

- Radiologist are increasingly involved in diagnosis of cardiac and coronary artery disease
- Important to be familiar with imaging findings and to utilize a useful approach, based on causes of focal and diffuse luminal narrowing & widening.
- The same pattern-based approach can be used when confronting coronary artery abnormalities on routine non-gated thoracic CTA.
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