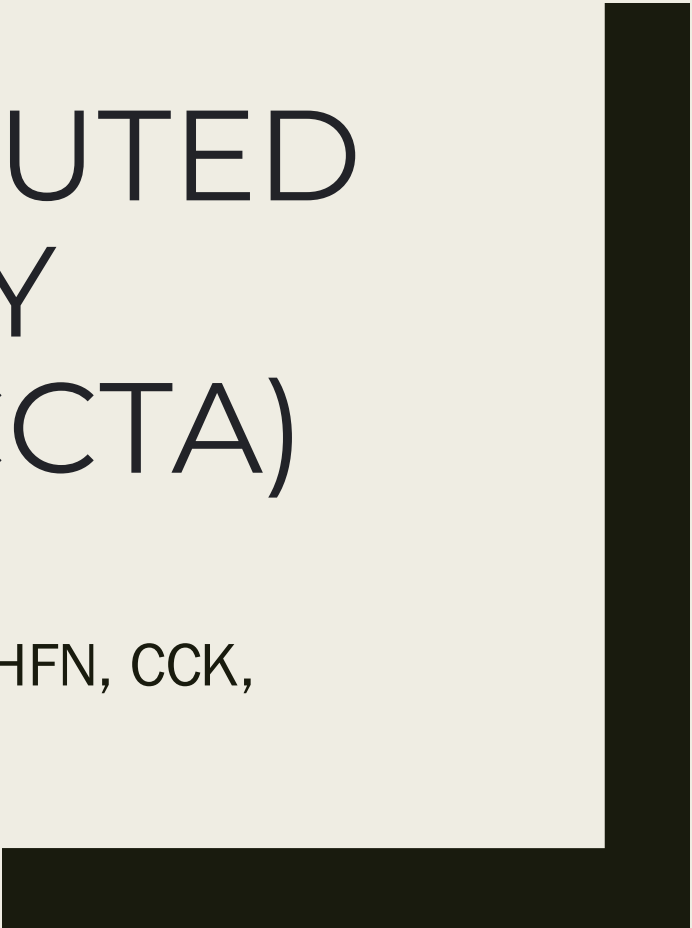# CORONARY COMPUTED TOMOGRAPHY ANGIOGRAPHY (CCTA)

By: Sydney Anderson, DNP, ARNP, FNP-C, CHFN, CCK, AACC
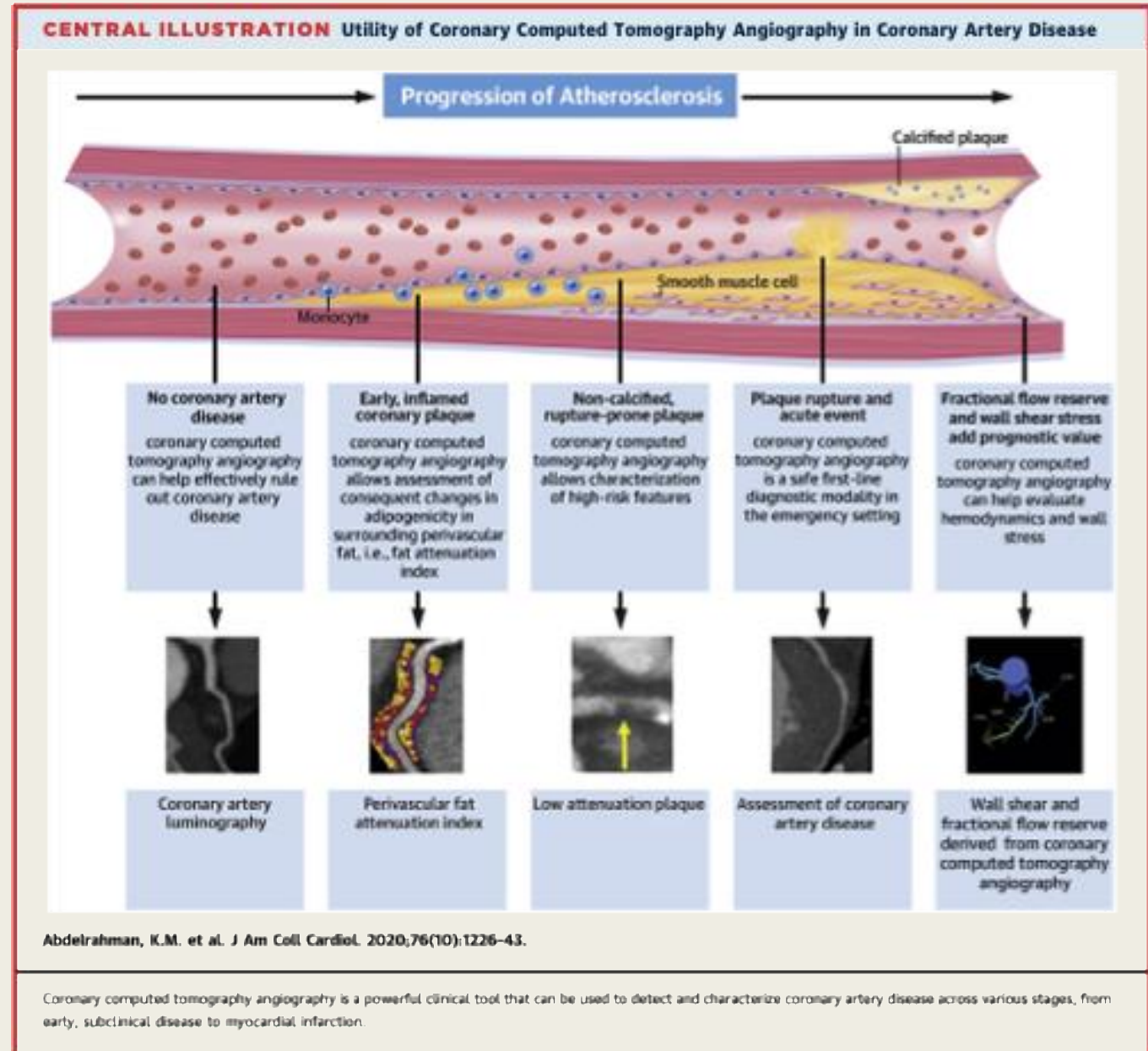
Disclosures

- I do not have any relevant financial relationships with any companies or products discussed within this presentation.

Objectives

- Understand basic principles of CCTA exam

- Identify clinical indications and contraindications of CCTA

- Understand when to choose CCTA versus coronary calcium score

- Familiarize yourself with patient preparation instructions

- Become more comfortable with management of CCTA results

Progression of Atherosclerosis

- Multifactorial, systemic disease

- Can range from early non-atherosclerotic intimal lesions and progress into vulnerable rupture-prone lesions and eventually to calcified plaque

- Coronary plaque progression is a major determinant of future myocardial infarction even when compared with coronary stenosis severity

CENTRAL ILLUSTRATION Utility of Coronary Computed Tomography Angiography in Coronary Artery Disease

Progression of Atherosclerosis

Calcified plaque

Smooth muscle cell

Monocyte

No coronary artery disease
coronary computed tomography angiography can help effectively rule out coronary artery disease

Early, inflamed coronary plaque
coronary computed tomography angiography allows assessment of consequent changes in adipogenicity in surrounding perivascular fat, i.e., fat attenuation index

Non-calcified, rupture-prone plaque
coronary computed tomography angiography allows characterization of high-risk features

Plaque rupture and acute event
coronary computed tomography angiography is a safe first-line diagnostic modality in the emergency setting

Fractional flow reserve and wall shear stress add prognostic value
coronary computed tomography angiography can help evaluate hemodynamics and wall stress

Coronary artery luminography

Perivascular fat attenuation index

Low attenuation plaque

Assessment of coronary artery disease

Wall shear and fractional flow reserve derived from coronary computed tomography angiography

Abdelrahman, K.M. et al. J Am Coll Cardiol. 2020;76(10):1226–43.

Coronary computed tomography angiography is a powerful clinical tool that can be used to detect and characterize coronary artery disease across various stages, from early, subclinical disease to myocardial infarction.
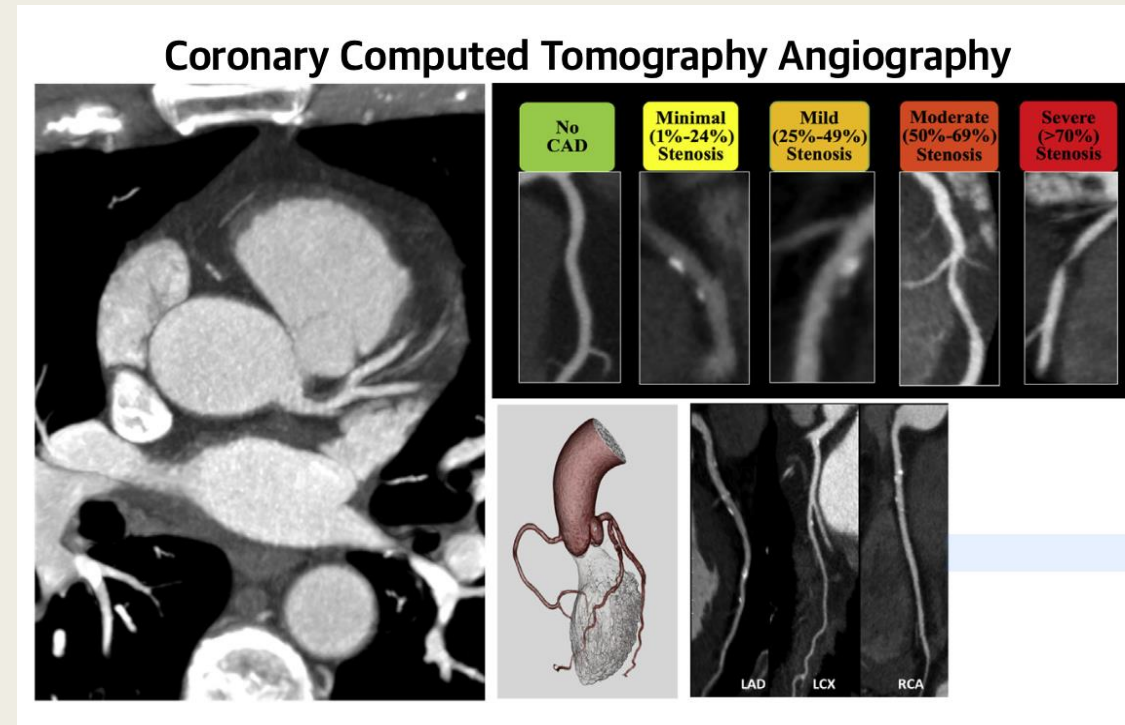
(Abdelrahman, et al., 2020)

What is a Coronary Calcium Score (CCS)?

- Non-contrast CT scan to detect presence of calcified atherosclerosis
- Tool for developing prevention recommendations
    - *Possibly upgrade statin therapy if elevated score*
    - *Possibly de-escalate statin therapy for advanced age and negative calcium score.*
- Approximate age to begin CCS
    - *Males 45 <u>or</u> 35 with risk factors*
    - *Females 55 <u>or</u> 45 with risk factors*
- Usually an out-of-pocket cost to the patient (Approximately $100)
- Not recommended to repeat CCS once a positive result has been found as it does not change prevention recommendations
- <u>*Should not be done in patients with suspected anginal symptoms as it cannot detect soft/non-calcified plaque*</u>

Coronary Calcium

(Abdelrahman, et al., 2020)

What is a CCTA?

- CCTA is a 3-D, contrast CT exam

- In contrast to CCS, CCTA can detect severity of coronary artery stenosis, plaque composition and morphology including calcified and non-calcified/soft plaque

- Characteristics of plaque determined by CCTA can help predict evolution of plaque, rupture, and prediction of ischemia to help aid in patient management

- Coming in February 2026: Iowa Heart Center will have plaque analysis capabilities

Coronary Computed Tomography Angiography

No CAD | Minimal (1%-24%) Stenosis | Mild (25%-49%) Stenosis | Moderate (50%-69%) Stenosis | Severe (>70%) Stenosis

LAD | LCX | RCA

(Abdelrahman, et al., 2020)

When to Consider CCTA

- Evaluation of possible ischemic symptoms in patients with low-moderate risk of coronary artery disease
  - *Coronary artery risk can be done with risk score calculators*
    - Ex: ASCVD Risk Score (For primary prevention in individuals 40-79 years old)

- Inconclusive or previously normal ischemic testing with high-clinical suspicion
  - *Coronary CTA can identify non-obstructive plaque that can be missed with ischemia-based imaging (ex: SPECT), which can help prompt preventative therapies (Serruys, et al., 2021).*

- Specific chest pain guidelines for acute vs. chronic chest pain available through the American College of Cardiology/American Heart Association

Why choose CCTA?

- Able to accurately and noninvasively quantify and characterize coronary atherosclerosis

- Accuracy
  - *Sensitivity 85%-99% and specificity 64%-92% in patients with suspected but unconfirmed CAD (Serruys, et al., 2021).*
  - *EVINCI (Evaluation of Integrated Cardiac Imaging in Ischemic Heart Disease) study showed CCTA was the most accurate non-invasive imaging modality to detect significant CAD when compared to single photon emission CT (SPECT), position emission tomography (PET), echocardiography, and cardiac magnetic resonance (Abdelrahman, et al., 2020).*

(Abdelrahman, et al., 2020)

Factors That May Impact CCTA Results

- Uncontrolled heart rhythm or rate
  - *Goal is for heart rate < 60 and regular*
  - *Atrial fibrillation and premature ventricular contractions make for difficult images but are not a complete contraindication*

- Obesity with BMI > 50 **or** weight > 400 pounds
  - *Images may have poor quality and scan may be non-diagnostic*
  - *It makes a difference as to where the patient carries most of their weight*

- Contraindicated with anaphylactic reactions to contrast
  - *Premedication can be utilized for non-severe allergy*
  - *Coronary CTA through Iowa Heart Center should be done at Mercy One downtown hospital for contrast allergies*

Factors That May Impact CCTA Results *(cont.)*

- Alternative testing should be considered for significant renal impairment
  - *Low-contrast load can be utilized*
  - *Pre-hydration may be beneficial*
- Presence of ICD/PPM is not a contraindication but may cause some artifact
  - *Iterative Metal Artifact Reduction (IMAR) can be used*
- Inability to tolerate nitrates is not a complete contraindication as the test can be done without it
  - *Nitroglycerin is utilized for vasodilation during test*

CCTA Preparation: Provider Responsibility

- Determine beta blocker adjustments as needed

- Order BUN/Creatinine for 1-week prior to CCTA

- Order iodine contrast allergy pre-treatment as needed

- Occasionally ivabradine is utilized if contraindication to beta blocker

Pre-CCTA Beta Blocker Recommendations:	
If HR < 60:	No changes needed to medications
If HR $\geq$ 60 and patient is on BB	Double 2 doses of BB prior to scan
If HR 60-69 bpm and patient is not on BB	Consider metoprolol tartrate 50mg the night before and 1.5 hours prior to CCTA
If HR > 70 bpm and patient is not on BB	Consider metoprolol tartrate 100mg the night before and 1.5 hours prior to CCTA

Iodine Contrast Allergy Pre-Treatment Options

1) Prednisone 50 mg tablet to be taken 13 hours, 7 hours, and 1 hour prior to procedure
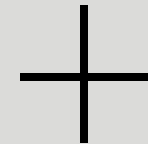
2) Benadryl (diphenhydramine) 50 mg 1 hours prior to procedure

Always check with your organization for specific protocols

CCTA Preparation: Patient Responsibility

- Nothing to eat or drink (except water) for 4 hours prior to test

- Drink 20 ounces of water prior to test

- <u>NO</u> caffeine, nicotine, or alcohol the day of the test

- <u>DO NOT TAKE</u> any phosphodiesterase 5 inhibitors 72 hours prior and 24 hours post CCTA

- Remove continuous glucose monitor or insulin pump prior to CCTA

- Contrast allergy pre-medication as applicable

- Medication adjustments as instructed

UNDERSTANDING CCTA RESULTS

CAD-RADS 2.0 (Coronary Artery Disease Reporting and DATA System)

- Three goals with CAD-RADS 2.0 scoring system:

- Present degree of stenosis
  - *Ranges from CAD-RADS 0 → CAD-RADS 5*

- Add interpretation of the study
  - *Modifiers present to account for additional findings*

- Review patient management
  - *Different CAD-RADS 2.0 scoring and recommendations for stable chest pain versus acute chest pain*

(Cury et al., 2022)

CAD-RADS 2.0 For Stable Chest Pain

Category	Degree of maximal stenosis	Interpretation	Further cardiac investigation	Management considerations
CAD-RADS 0	0% No plaque or stenosis	Absence of CAD	None	Reassurance. Consider non-atherosclerotic causes of symptoms
CAD-RADS 1	1-24% Minimal stenosis or plaque without stenosis	Minimal non-obstructive CAD	None	Consider non-atherosclerotic causes of symptoms - P1: Consider risk factor modification and preventive pharmacotherapy - P2: Risk factor modification and preventive pharmacotherapy - P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy
CAD-RADS 2	25-49% Mild stenosis	Mild non-obstructive CAD	None	Consider non-atherosclerotic causes of symptoms - P1 or P2: Risk factor modification and preventive pharmacotherapy - P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy

(Cury et al., 2022)

CAD-RADS 2.0 For Stable Chest Pain *(cont.)*

CAD-RADS 3	50-69% Moderate stenosis	Moderate stenosis	Consider functional assessment	P1, P2, P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy - Other treatments (including anti-anginal therapy) should be considered per guideline directed cared - When modifier I+, consider ICA, especially if frequent symptoms persist after guideline-directed medical therapy
CAD-RADS 4	**A:** 70-99% **B:** Left main ≥ 50% or 3 vessel obstructive (≥70%) disease	Severe stenosis	**A:** Consider invasive coronary angiogram **B:** Coronary angiogram recommended	P1, P2, P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy. - Other treatments (including anti-anginal therapy and options of revascularization (should be considered per guideline directed care
CAD-RADS 5	100% Total occlusion	Total coronary occlusion or sub-total occlusion	Consider invasive coronary angiogram and/or viability assessment	P1, P2, P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy. - Other treatments (including anti-anginal therapy and options of revascularization) should be considered per guideline directed care
CAD-RADS N	Non-diagnostic study	Obstructive CAD can't be excluded	Additional/alternative evaluation may be needed	

(Cury et al., 2022)

CAD-RADS 2.0 For Acute Chest Pain

Category	Degree of maximal stenosis	Interpretation	Further cardiac investigation	Management considerations
CAD-RADS 0	0%	ACS highly unlikely	No further evaluation of ACS is required - If Tn + consider other sources of increased troponin	Reassurance.
CAD-RADS 1	1-24%	ACS unlikely	No further evaluation of ACS is required - If Tn + consider other sources of increased troponin	-P1 or P2: Referral for outpatient follow-up for risk factor modification and preventive pharmacotherapy. -P3 or P4: Referral for outpatient follow-up for aggressive risk factor modification and preventive pharmacotherapy
CAD-RADS 2	25-49%	ACS less likely	-No further evaluation of ACS is required -If clinical suspicion of ACS is high, Tn + or HRP features, consider hospital admission with cardiology consultation.	-P1 or P2: Referral for outpatient follow-up for risk factor modification and preventive pharmacotherapy. -P3 or P4: Referral for outpatient follow-up for aggressive risk factor modification and preventive pharmacotherapy

(Cury et al., 2022)

CAD-RADS 2.0 For Acute Chest Pain *(cont.)*

CAD-RADS 3	50-69%	ACS possible	-Consider hospital admission with cardiology consultation. -Consider functional assessment	-P1, P2, P3 or P4: Preventive management, including aggressive preventive pharmacotherapy. Other treatments, including anti-anginal therapies, should be considered per guideline directed care. - When modifier I+, consider ICA.
CAD-RADS 4	**A**: 70-99% **B**: Left main ≥ 50% or 3 vessel obstructive (≥70%) disease	ACS likely	-Hospital admission with cardiology consultation. -**A**: Consider ICA or functional assessment -**B**: ICA is recommended	-P1, P2, P3 or P4: Preventive management, including aggressive preventive pharmacotherapy. -Other treatments, including anti-anginal therapies and options of revascularization, should be considered per guideline directed care
CAD-RADS 5	100% Total occlusion	ACS very likely	-Hospital admission with cardiology consultation. -Expedited ICA and revascularization if suspected acute occlusion	P1, P2, P3 or P4: Preventive management, including aggressive preventive pharmacotherapy. -Other treatments (including anti-anginal therapies and options of revascularization) should be considered per guideline directed care
CAD-RADS N	Non-diagnostic study	ACS cannot be excluded	-Additional or alternative evaluation for ACS is needed	

CAD-RADS 2.0 Modifiers

- **N:** Nondiagnostic segments

- **S:** Presence of a coronary stent

- **G:** Bypass Graft

- **HRP:** High-risk or vulnerable plaque.

  - *Examples:*

    - Low attenuation plaque

    - Positive remodeling

    - Spotty calcification

    - "Napkin ring sign": Ring of calcium with a necrotic core

- **P:** Overall amount of plaque

  - *Range from P1-P4*

CAD-RADS 2.0 Modifiers *(cont.)*

- **I:** Ischemia: Derived from Coronary CTA ischemia identified by FFR-CT or stress CT perfusion
  - *I+: Reversible defect*
  - *I-: Prior infarction or no ischemia*
  - *I+: Borderline or inconclusive*
- **E:** Exceptions from non-atherosclerotic causes of CAD
  - *Coronary dissection*
  - *Aneurysm*
  - *Anomaly*

(Choi, 2023)

Fractional Flow Reserve (FFR)

- Non-invasive evaluation to estimate lesion-specific ischemia

- FFR > 0.80: Normal/May be non-significant

- FFR 0.76-0.80: Grey zone/Borderline

- FFR < 0.80: Abnormal/May be functionally significant

(Cury et al., 2022)
(Heartflow, 2025)
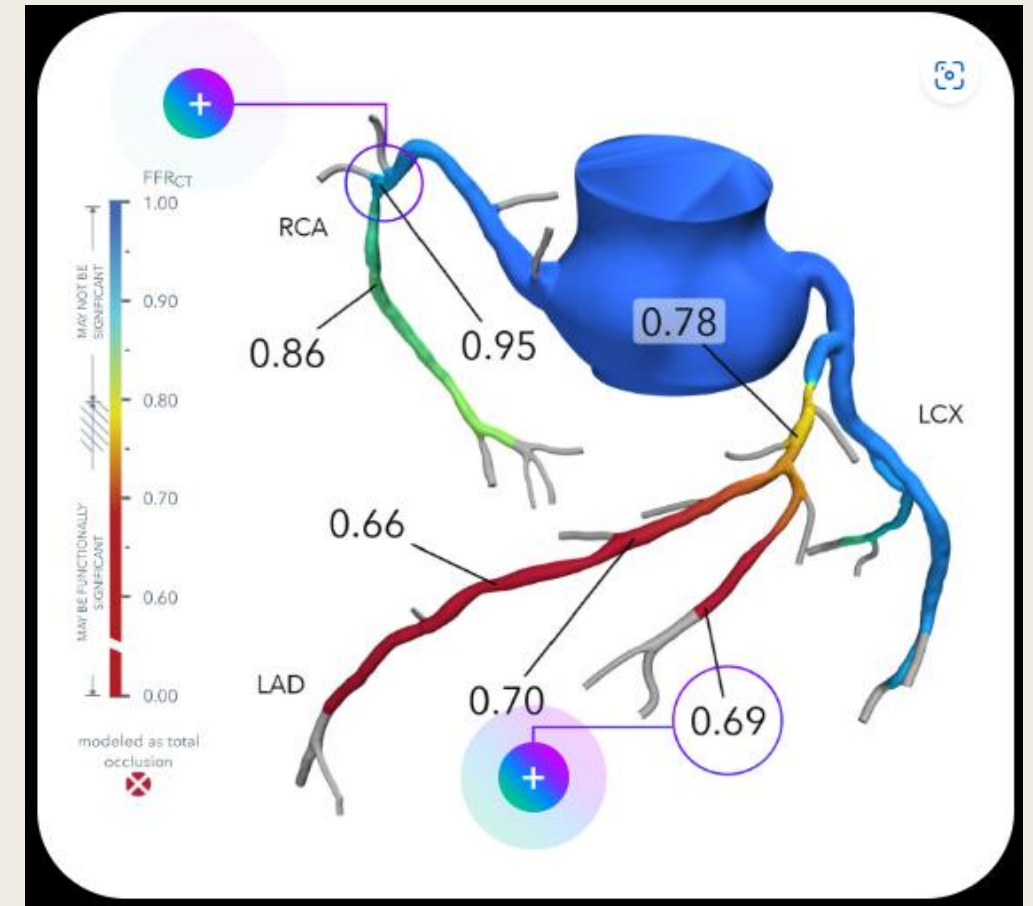
CASE STUDY:

Case Study #1

- <u>**56-year-old Male initially presented to cardiology for evaluation of palpitations**</u>

- <u>**PMHx:**</u> Remote history of anxiety. Otherwise, no medical problems. No current medications. No family history of CAD. No tobacco use. Occasional alcohol use.

- <u>**S/S:**</u> Random episodes of palpitations associated with dizziness

- <u>**Work-up:**</u>
  - *7-Day holter monitor: Sinus rhythm, avg. HR 85 bpm, 1 asymptomatic non-sustained atrial tachycardia episode (4 beats).*
  - *Transthoracic echocardiogram: LVEF 65%, Borderline LVH, No significant valvular abnormalities*
  - *EKG showed non-specific ST/T wave changes with slight ST depression in lead V6*

- <u>**Follow-up appointment:**</u>
  - *Patient confirmed he had chest discomfort not associated with palpitations while wearing the 7-day monitor which did not show any significant arrhythmia*

- <u>**Next Step:**</u>
  - *Coronary CTA was ordered*

Case Study #1 *(cont.)*

- **<u>Coronary CTA Results:</u>**
  - *"Calcium score: 15.3 which is 43rd percentile for age and gender matched controls.*
  - *CAD-RADS 1/P1: Minimal, non-obstructive coronary artery disease. Minimal stenosis (1-24%) with mild amount of plaque*
  - *"Non-obstructive disease of the RCA"*

- **<u>Recommendations:</u>**
  - *"Consider non-atherosclerotic causes of symptoms. Consider risk factor modification and preventative pharmacotherapy"*
    - Lipid panel ordered which showed LDL of 95.
    - Rosuvastatin 5mg daily ordered for goal LDL < 70, ideally <55
    - Recheck lipid panel/ALT in 3 months and adjust rosuvastatin as needed
    - F/U with PCP regarding non-cardiac etiologies of his symptoms

References

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