Atherosclerotic Imaging: Coronary Artery Disease
(Using Coronary CTA to Guide Clinical Management)

Vuyisile T. Nkomo, MD, MPH, FACC, FASE

18th Annual SA Heart Congress 2017
Disclosure

Relevant Financial Relationships
None

Off-Label / Investigational Uses
None
**CT-Guided Decisions: Objectives**

**Learning Goals:**

- Discuss the basic principles outlined in the recently published Coronary Artery Disease and Reporting and Data System (CAD-RADS).
- Describe how CT reports that follow these principles can be used to guide clinical decision making in cardiac patients.
CAD-RADS:

- Standardized reporting system for coronary CT angiography
- Designed to guide clinical management of pts presenting with stable or acute chest pain
- Per patient reporting of highest grade coronary artery lesion
CT-Guided Decisions: Background

CAD-RADS:

- Standardized reporting system for coronary CT angiography
- Approximate “quartile” grading scale with additional categories for normal & occluded
- “Severe” cut point at 70% - corresponds with cardiac cath

<table>
<thead>
<tr>
<th>SCCT grading scale for stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of luminal diameter stenosis</td>
</tr>
<tr>
<td>0% -</td>
</tr>
<tr>
<td>1-24% -</td>
</tr>
<tr>
<td>25-49% -</td>
</tr>
<tr>
<td>50-69% -</td>
</tr>
<tr>
<td>70-99% -</td>
</tr>
<tr>
<td>100% -</td>
</tr>
</tbody>
</table>
CAD-RADS:

- Standardized reporting system for coronary CT angiography
  - Numerical score from 0 (normal) to 5 (occluded)
  - Modifiers for non-diagnostic exam (N), stent (S), grafts (G), and vulnerable plaque (V)

<table>
<thead>
<tr>
<th>Degree of maximal coronary stenosis</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD-RADS 0 0% (No plaque or stenosis)</td>
<td>Documented absence of CAD*</td>
</tr>
<tr>
<td>CAD-RADS 1 1-24% - Minimal stenosis or plaque with no stenosis**</td>
<td>Minimal non-obstructive CAD</td>
</tr>
<tr>
<td>CAD-RADS 2 25-49% - Mild stenosis</td>
<td>Mild non-obstructive CAD</td>
</tr>
<tr>
<td>CAD-RADS 3 50-69% stenosis</td>
<td>Moderate stenosis</td>
</tr>
<tr>
<td>CAD-RADS 4 A - 70-99% stenosis or B - Left main &gt;50% or 3-vessel obstructive (≥ 70%) disease</td>
<td>Severe stenosis</td>
</tr>
<tr>
<td>CAD-RADS 5 100% (total occlusion)</td>
<td>Total coronary occlusion</td>
</tr>
<tr>
<td>CAD-RADS N Non-diagnostic study</td>
<td>Obstructive CAD cannot be excluded</td>
</tr>
</tbody>
</table>

Cury, JACC CVI 2016
CT-Guided Decisions: Background

- Spotty/punctate calcium within a plaque
- Central low attenuation plaque
  - Higher attenuation peripheral rim
- Positive remodeling
  - \( \frac{Av}{[(Ap + Ad)/2]} > 1.1 \)
- Low attenuation plaque
  - Non-calcified
  - Internal attenuation <30HU

Cury, JACC CVI 2016
## CT-Guided Decisions: Background

<table>
<thead>
<tr>
<th>Degree of maximal coronary stenosis</th>
<th>Interpretation</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD-RADS 0</td>
<td>0%</td>
<td>- No further evaluation of ACS is required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Consider other etiologies.</td>
</tr>
<tr>
<td>CAD-RADS 1</td>
<td>1-24%**</td>
<td>- Consider evaluation of non-ACS etiology, if normal troponin and no ECG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>changes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Consider referral for outpatient follow-up for preventive therapy and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>risk factor modification.</td>
</tr>
<tr>
<td>CAD-RADS 2</td>
<td>25-49%***</td>
<td>- Consider evaluation of non-ACS etiology, if normal troponin and no ECG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>changes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Consider referral for outpatient follow-up for preventive therapy and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>risk factor modification.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- If clinical suspicion of ACS is high or if high-risk plaque features are</td>
</tr>
<tr>
<td></td>
<td></td>
<td>noted, consider hospital admission with cardiology consultation.</td>
</tr>
<tr>
<td>CAD-RADS 3</td>
<td>50-69%</td>
<td>- Consider hospital admission with cardiology consultation, functional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>testing and/or ICA**** for evaluation and management.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Recommendation for anti-ischemic and preventive management should be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>considered as well as risk factor modification. Other treatments should be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>considered if presence of hemodynamically significant lesion.</td>
</tr>
<tr>
<td>CAD-RADS 4</td>
<td>A - 70-99% or B - Left main &gt;50% or 3-vessel obstructive disease</td>
<td>- Consider hospital admission with cardiology consultation. Further</td>
</tr>
<tr>
<td></td>
<td></td>
<td>evaluation with ICA and revascularization as appropriate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Recommendation for anti-ischemic and preventive management should be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>considered as well as risk factor modification.</td>
</tr>
<tr>
<td>CAD-RADS 5</td>
<td>100% (Total occlusion)</td>
<td>- Consider expedited ICA on a timely basis and revascularization if</td>
</tr>
<tr>
<td></td>
<td></td>
<td>appropriate if acute occlusion****.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Recommendation for anti-ischemic and preventive management should be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>considered as well as risk factor modifications.</td>
</tr>
<tr>
<td>CAD-RADS N</td>
<td>Non-diagnostic study</td>
<td>- Additional or alternative evaluation for ACS is needed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- ACS cannot be excluded.</td>
</tr>
</tbody>
</table>
## CTA Indications: Symptomatic Patients

<table>
<thead>
<tr>
<th>Exercise</th>
<th>ECG interpretable</th>
<th>Pretest probability</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Able</td>
<td>Unable</td>
<td>Yes</td>
</tr>
<tr>
<td>Chronic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Exercise**: Symptomatic Patients
- **ECG interpretable**: Yes, No
- **Pretest probability**: Low, Intermediate
- **Other**
  - **ECG uninterpretable**: X
  - **ECG normal and biomarkers normal**: X
  - **ECG nondiagnostic or biomarkers equivocal**: X

Taylor, JACC 2010
CAD-RADS: Eligible patients

- Normal TMET but continued symptoms
- Prior “intermediate risk” TMET
- Prior stress/exercise Imaging study
  - Discordant ECG and imaging findings
  - Equivocal imaging

CT-Guided Decisions: Chronic Chest Pain

Taylor, JACC 2010
Case 1: 66 y/o M (runs marathons)

CC: 6 mo h/o throat tightness & chest discomfort with exercise

- HTN, ↑ lipids, + family history
- Stress Echo: 93% FAC, no inducible RWMAs, EF 60% (rest) to 65% (stress), 10/10 throat tightness
- Coronary CT angiogram because of atypical presentation for CAD
Case 1: 66 y/o M

CC: 6 mo h/o throat tightness & chest discomfort with exercise

- HTN, ↑ lipids, + family history
- Stress Echo: 93% FAC, no inducible RWMAs, EF 60% (rest) to 65% (stress), 10/10 throat tightness
- Coronary CT angiogram because of atypical presentation for CAD

Left main & LAD
CT-Guided Decisions: Chronic Chest Pain

Case 1: 66 y/o M

Right coronary artery

Left main & LAD
CT-Guided Decisions: Chronic Chest Pain

Case 1: 66 y/o M

Normal
Right coronary artery
Left main & LAD
CT-Guided Decisions: Chronic Chest Pain

Case 1: 66 y/o M

Left main & LAD
Case 1: 66 y/o M

CC: 6 mo h/o throat tightness & chest discomfort with exercise

Severe stenosis

- Consider ICA or functional assessment

CT-Guided Decisions: Chronic Chest Pain

CAD-RADS = 4A
CT-Guided Decisions: Chronic Chest Pain

Case 1: 66 y/o M

- Coronary angiogram
- Right coronary artery
- Left main & LAD
CT-Guided Decisions: Chronic Chest Pain

Case 1: 66 y/o M

Coronary angiogram

Left main & LAD
Case 1: 66 y/o M

CC: 6 mo h/o throat tightness & chest discomfort with exercise

Severe stenosis
- Consider ICA or functional assessment
- Guideline-driven medical therapy and/or intervention

LAD stents (x2)

CAD-RADS = 4A
CAD-RADS: Clinical implications

- Good quality, negative coronary CTA reliably excludes CAD
- Abnormal cCTA requires further work-up
- Predictors of poor image quality
  - Known CAD
  - Fast/irregular heart rate
  - Uncooperative patient
CAD-RADS: Eligible patients

- Acute chest pain
- Negative first troponin,
- Negative or non-diagnostic electrocardiogram
- Low to intermediate risk (TIMI risk score < 4)
Case 1: 50 y/o M

CC: 2 hrs acute, exertional c/p

- Intermittent bouts of atypical chest pain – x 3 yrs
- Increasing DOE x 3 months
- Negative stress echo – 2 yrs ago
- Initial troponin & ECG = negative

CT-Guided Decisions: ED Chest Pain

CAD-RADS = 0
Case 1: 50 y/o M

CC: 2 hrs acute, exertional c/p

• ACS is highly unlikely
  • No further evaluation of ACS is required
  • Consider other etiologies

CAD-RADS = 0
Case 1: 50 y/o M

CC: 2 hrs acute, exertional c/p

Actual Outcome:

• d/c home ~5 hrs after admission to ED
• Outpatient w/u for sx of increasing DOE

CAD-RADS = 0
Case 2: 63 y/o F

CC: 3 hrs acute c/p at rest

- Sudden onset, sharp, midsternal radiating to upper back
- Worse w/ movement, expiration
Case 2: 63 y/o F

CC: 3 hrs acute c/p at rest

• h/o neuromuscular d/o – manifests as fatigue, DOE

• h/o neuroendocrine tumor – current w/u for possible surgical resection

✓ Cardiac CTA
CT-Guided Decisions: ED Chest Pain

Case 2: 63 y/o F
CT-Guided Decisions: ED Chest Pain

Case 2: 63 y/o F

25-50% stenosis
No positive remodeling
No low attenuation plaque
No speckled Ca$^{2+}$
No napkin ring

CAD-RADS = 2
CT-Guided Decisions: ED Chest Pain

Case 2: 63 y/o F

CC: 3 hrs acute c/p

• ACS is unlikely
  • Consider non-ACS etiology, if normal troponin and ECG
  • Consider outpatient f/u for preventative therapy & risk factor modification

CAD-RADS = 2
Case 2: 63 y/o F

CC: 3 hrs acute c/p

- ACS is unlikely
- If clinical suspicion of ACS is high or if high-risk plaque features are noted, consider hospital admission with cardiology consultation.

CT-Guided Decisions: ED Chest Pain

CAD-RADS = 2
Case 2: 63 y/o F

CC: 3 hrs acute c/p

Actual Outcome: ICA w/ IVUS

- 40% LM (30% LAD, RCA)
- Eccentric lesion w/ “soft” plaque, area = 10.2 mm²
- Medical management

CAD-RADS = 2
Case 3: 70 y/o M

CC: awoke with c/p

- Intermittent bouts of atypical chest pain – x 4 mo (worsening)
- “burning” radiation to L arm
- Not associated with activity, no other symptoms
Case 3: 70 y/o M

CC: awoke with c/p

- ECG – nonspecific ST- & T-wave
- Initial troponin <0.01

✓ Coronary CTA
Case 3: 70 y/o M

CT-Guided Decisions: ED Chest Pain
Case 3: 70 y/o M

- RCA
- 70-99% stenosis
- Positive remodeling
- Low attenuation plaque?

**CAD-RADS = 4 (V)**
Case 3: 70 y/o M

CC: awoke with c/p

• ACS is likely
  • Hospital admit / cards consult
  • ICA and revasc as appropriate
  • Anti-ischemic & preventive mgt as well as risk factor mod

CT-Guided Decisions: ED Chest Pain

CAD-RADS = 4
Case 3: 70 y/o M

CC: awoke with c/p

Actual Outcome: Cardiac Cath

- 90% proximal RCA - stent
- 20% distal L Main
- 50% proximal LAD

CAD-RADS = 4
CAD-RADS:

• Standardized method for communicating findings seen on coronary CT angiography

• Application of this system should guide decision making and facilitate clinical management of ED patients presenting with stable or acute chest pain
Thank you!
 Acknowledgments

• Eric Williamson, MD
• Philip Araoz, MD
• Philip Young, MD