Pitfalls in Coronary Angiogram Interpretation

By
Eman El safty, MD & Gamal F. Gomaa, MD
Cardiology Department
Faculty of Medicine
Mansoura University
Introduction

• Coronary angiogram is currently the gold standard in diagnostic and therapeutic management of CAD

• However, several pitfalls and limitations exist

• The non recognition of those limitations may result in sub-optimal patients care (i.e. over or under treatment)
Agenda

1. Diameter stenosis severity
2. Calcification
3. Thrombus
4. Bifurcation
5. Left main
6. SYNTAX score
Agenda

1. Diameter stenosis severity
2. Calcification
3. Thrombus
4. Ectasia
5. Left main
6. SYNTAX score
Lesion Severity?
Schematic representation of an important limitation of projection imaging.
Concealment of severe coronary disease by diffuse concentric involvement.
QCA vs. Visual assessment?
Comparison of Clinical Interpretation with Visual Assessment and Quantitative Coronary Angiography in Patients Undergoing Percutaneous Coronary Intervention in Contemporary Practice: The Assessing Angiography (A2) Project

175 patients; PCI of 228 lesions at 7 US sites
CathPCI Registry of the NCDR®
Comparison of QCA and visual assessment

Nallamothu et al. Circulation on line March 2013
The mean difference in %DS between the clinical interpretation and QCA was $+8.2\% \pm 8.4\%$, ($P<0.001$)

Of all the lesions considered 70% or greater by clinical assessment 26.3% were measured at less than 70%

A weighted kappa of 0.27 (95% CI, 0.18 to 0.36) was found between QCA and visual assessment

Conclusions
Physicians tended to overestimated lesion severity compared to QCA. Almost all treated lesions were >70% by clinical interpretation, while approximately a quarter were <70% by QCA.
Discrepancies Between Cineangiographic and Postmortem Findings in Patients with Coronary Artery Disease and Recent Myocardial Revascularization
CLAUDR M. GRONDIN, THOR DÝRDA, ANDRE PASTERNAC, LUCIEN CAMPEAU, MARTIAL G. BOURASSA and JACQUES LESPÉRANCE

23 patients died inside 30 days post CABG
Autopsies were performed to compared pathological findings to pre CABG lesion severity performed by QCA analysis

Diagrammatic portrayal of coronary arterial lesions for which a discrepancy existed between findings at autopsy and at cineangiography. The roman numbers in the squares indicate the degree of narrowing as seen at angiography (A) and at pathological (P) examination. Narrowings are graded from 0 to IV (0% to 100%). Vein grafts to various arteries can be recognized by the hash marks. Order of patients is same as in table 1 and in arabic numbers in lower right hand corner. In cases 2, 5, 6 and 7, angiographic underestimation of the severity of coronary arterial lesions led to incomplete revascularization and contributed to the surgical failure. PDB = posterior descending branch; LAD = left anterior descending artery; Cx = circumflex

"...it is recommended that additional projections in the sagittal plane be included to eliminate angiographic superimposition of multiple branches, which often cannot be properly separated in the standard transverse plane..."
Not identifying/treating a significant lesion may have similar (or even worse...) detrimental consequence than over-treating non significant lesion...
Angio vs. Physiology?
Angiography versus FFR in the FAME study

Proportions of functionally diseased coronary arteries in patients with angiographic 3-vessel disease

Angiographic 3-VD (n=115)

Angiography versus FFR in the FAME study

Proportions of functionally diseased coronary arteries in patients with angiographic 3-vessel disease

Angiographic 3-VD (n=115)

Angio vs. IVUS?
IVUS vs. QCA at Baseline
Total plaque volume (mm³)
n=525 pts

<table>
<thead>
<tr>
<th>Measure</th>
<th>Correlation (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary artery score, mm</td>
<td>0.22 (0.14 to 0.30)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cumulative coronary stenosis score</td>
<td>0.25 (0.16 to 0.32)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean lesion diameter, mm</td>
<td>0.22 (0.12 to 0.32)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Mean plaque area, mm²</td>
<td>0.14 (0.06 to 0.23)</td>
<td>0.0013</td>
</tr>
</tbody>
</table>

Myocardial Bridge

- Segment of a major coronary epicardial coronary artery that dives intramurally through the myocardium beneath the muscle bridge.\(^1\)
- Generally involving LAD and its diagonal branches
- Frequency
  - Coronary angiographic series: 0.5-16%\(^2\)
  - Pathological series up to 85%.\(^1,2\)
- Superficial and deep variants

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\(^1\) Alegria et al Eur Heart Joul 2005; 26:1159-1168
\(^2\) Ge et al Eur Heart Joul 1999; 20:1707-1716
Angiographic and intravascular ultrasound images before (A, D) and after (B, E) stent implantation; stent collapse after seven weeks (C, F) and unsuccessful re-PTCA with high pressure insufflation (G).

Haager et al Heart 2000; 84:403-408
Why is it so important to appropriately assess %DS and lesion severity?

- Avoid unnecessary stenting
- Avoid under revascularization
- Offer the most appropriate revascularization strategy for every given patients

For intermediate lesions…use FFR
Agenda

1. Diameter stenosis severity
2. Calcification
3. Thrombus
4. Bifurcation
5. Left main
6. SYNTAX score
Calcifications

Moderate

Severe

Readily apparent densities noted within the apparent vascular wall at the stenosis

**Moderate:** Densities noted only during the cardiac cycle prior to contrast injection

**Severe:** Radioopacities noted without cardiac motion prior to contrast injection generally involving *both sides of the arterial wall*
Thrombus vs. Calcium?
Because IVUS does not penetrate into calcium...

1) it cannot measure thickness or mass, only arc and length
2) we assume that superficial calcium is thicker than deep calcium

Lee et al. Am J Cardiol 2011;108:1547-51
Calcified Nodules in PROSPECT

Angio interpretation/appearance of Calcified Nodule n=314

1) Severe calcification in 1%
2) Moderate calcification in 11%
3) Hazy/thrombus in 6%
4) Normal in 82%

Xu et al. Circulation 2012;126:537-45
Why is it so important to assess appropriately calcification severity?
1-Year Ischemic Outcomes: ACS Population-6,855 pts

- **Death**: None/Mild - 2.8, Moderate - 1.8, Severe - 1.7; p = 0.0001
- **Cardiac death**: None/Mild - 4.2, Moderate - 2.8, Severe - 3.4; p = 0.0017
- **MI**: None/Mild - 6.3, Moderate - 7.6, Severe - 8.7; p = 0.22
- **TLR**: None/Mild - 7.3, Moderate - 9.4, Severe - 8.2; p = 0.002
- **ARC Definite ST**: None/Mild - 6.0, Moderate - 8.2, Severe - 12.9; p = 0.013
- **MACE**: None/Mild - 19.9, Moderate - 15.3, Severe - 12.9; p = 0.003

Source: Généreux, P. et al. J Am Coll Cardiol 2014
**IVUS stent expansion is the strongest predictor of early ST or restenosis after BMS or DES**

<table>
<thead>
<tr>
<th>Early Stent Thrombosis</th>
<th>Restenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMS</strong></td>
<td></td>
</tr>
<tr>
<td>• Castagna et al. AHJ 2001;142:970-4</td>
<td>• Castagna et al. AHJ 2001;142:970-4</td>
</tr>
<tr>
<td><strong>DES</strong></td>
<td></td>
</tr>
<tr>
<td>• Okabe et al., Am J Cardiol. 2007;100:615-20</td>
<td>• Hong et al. Eur Heart J 2006;27:1305-10</td>
</tr>
<tr>
<td>• Song et al. Catheter Cardiovasc Interv, in press</td>
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</table>
Agenda

1. Diameter stenosis severity
2. Calcification
3. Thrombus
4. Bifurcation
5. Left main
6. SYNTAX score
Thrombus Containing Lesions

Large thrombus: filling defect with contrast staining
Thrombus Diagnostic Considerations

- **Angiography:**
  - Low sensitivity, high specificity
- Thrombus can form/embolize during procedure (IPST, IPTE)...be vigilant
- **Angioscopy** is best diagnostic tool
- Be careful: can looks like *calcium or dissection*
Type of Thrombus
Agenda

1. Diameter stenosis severity
2. Calcification
3. Thrombus
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5. Left main
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The MEDINA Classification

1. Prox PV > 50%: 0 or 1
2. Distal PV > 50%: 0 or 1
3. SB > 50%: 0 or 1

Medina A. Rev Esp Cardiol. 2006 Feb;59(2):183
Ostial SB Lesion Severity at Baseline

**Measurements On Current Frame**

<table>
<thead>
<tr>
<th>Area [mm$^2$]</th>
<th>Diameter [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumen</td>
<td>3.83</td>
</tr>
<tr>
<td>Vessel</td>
<td>6.31</td>
</tr>
<tr>
<td>Start</td>
<td></td>
</tr>
<tr>
<td>Plaque</td>
<td>2.48 (39.2% of Vessel)</td>
</tr>
</tbody>
</table>

**NIH**
Relationship Between Fractional Flow Reserve and Angiographic and Intravascular Ultrasound Parameters in Ostial Lesions

Major Epicardial Vessel Versus Side Branch Ostial Lesions

Jin-Sin Koh, MD,† Bon-Kwon Koo, MD, PhD,* Ji-Hyun Kim, MD,* Han-Mo Yang, MD, PhD,* Kyung-Woo Park, MD, PhD,* Hyun-Jae Kang, MD, PhD,* Hyo Soo Kim, MD, PhD,* Byung-Hee Oh, MD, PhD,* Young Bae Park, MD, PhD*

Seoul and Jinju, Korea

Angiographic and IVUS parameters had poor diagnostic accuracy in predicting the functional significance of SB ostial lesions.

Koh et al. J Am Coll Cardiol Intv 2012;5:409-15
Diagnostic Considerations
Ostial SB Lesion Severity after SB Jailing

Angiography vs FFR: N=94

Physiologic Assessment of Jailed Side Branch Lesions Using Fractional Flow Reserve (FFR)

The optimal cutoff value for percent stenosis to predict functionally significant stenosis was %DS of 85% (Sensitivity: 0.80, Specificity: 0.76)

Conclusions: QCA is unreliable in the “functional” assessment of stenosis severity in jailed SBs. Conversely, FFR measurements demonstrate that most of stenotic SBs do not have functional significance

Why appropriate bifurcation assessment important?

- Avoiding unnecessary stenting/treatment of SB lesions when not physiologically significant
- Stent failure is high in this sub-set of lesion

In doubt...use FFR
Agenda

1. Diameter stenosis severity
2. Calcification
3. Thrombus
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6. SYNTAX score
Pitfalls of QCA LM assessment

- Diffuse atherosclerotic involvement affects the %DS calculation because of the lack of a normal reference segment
- Short LMCA also makes identification of a normal reference segment difficult
- Ostial lesion can be miss
  - Guiding engagement; damping of pressure
- Positive remodeling

Figure 2. This case example illustrates the discrepancy between angiographic and IVUS evaluation of LMCA disease. This patient underwent bypass surgery for ostial LMCA disease (black arrow). After the bypass grafts closed, he was referred for IVUS study. By QCA, the ostial LMCA stenosis MLD measured 1.32 mm. By IVUS, there was mild diffuse atherosclerosis (white arrows), no significant plaque burden and an MLD of 3.5 mm. LMCA = left main coronary artery. Other abbreviations as in Figure 1.
One-Year Follow-up After Intravascular Ultrasound Assessment of Moderate Left Main Coronary Artery Disease in Patients With Ambiguous Angiograms

Andrea S. Abizaid, MD, Gary S. Mintz, MD, FACC, Alexandre Abizaid, MD, Roxana Mehran, MD, FACC, Alexandra J. Lansky, MD, Augusto D. Pichard, MD, FACC, Lowell F. Satler, MD, FACC, Hongsheng Wu, PhD, Kenneth M. Kent, MD, FACC, Martin B. Leon, MD, FACC

Washington, DC

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**QCA MLD (mm)**

![Graph showing QCA MLD vs IVUS MLD](image1)

- Correlation: $r = 0.364, p = 0.0005$

**QCA Reference (mm)**

![Graph showing QCA Reference vs IVUS Reference](image2)

- Correlation: $r = 0.492, p = 0.0001$

**IVUS MLD (mm)**

- Values range from 1 to 6 mm

**IVUS Reference (mm)**

- Values range from 2 to 8 mm

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Angiographically unrecognized left main coronary artery disease.
Agenda

1. Diameter stenosis severity
2. Calcification
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4. Bifurcation
5. Left main
6. SYNTAX score
The SYNTAX score

- SYNTAX score is a powerful tool to risk stratify and discriminate outcomes of patients with complex CAD undergoing PCI compared to coronary artery bypass graft surgery.
- SYNTAX score has been validated in different cohorts of patients undergoing PCI and for different subsets of lesions.
Nothing is perfect...

- Assessment of the SYNTAX score relies on *visual interpretation*
- Time consuming...
- Reproducibility and variability issues
Syntax Score
How Much Training Is Necessary?
Is the current “recommended training” enough?

- Online tutorial www.syntaxscore.org
- Variable definitions
- 13 schematic case examples
- Self-evaluation, including 7 real cases with online angiograms
SYNTAX Score Reproducibility and Variability Between Interventional Cardiologists, Core Laboratory Technicians, and Quantitative Coronary Measurements

Philippe Généreux, Tullio Palmerini, Adriano Caixeta, Ecaterina Cristea, Roxana Mehran, Raquel Sanchez, Dana Lazar, Ivana Jankovic, Maria D. Corral, Ovidiu Dressler, Martin P. Faby, Helen Parise, Alexandra J. Lansky and Gregg W. Stone

Circ Cardiovasc Interv 2011;4;553-561; originally published online October 25, 2011; DOI: 10.1161/CIRCINTERVENTIONS.111.961862

Circulation: Cardiovascular Interventions is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2011 American Heart Association. All rights reserved. Print ISSN: 1941-7640; Online ISSN: 1941-7632
SYNTAX score assessment: 80 angiograms

3 Interventional Cardiologists (experience 7.5 years)
- 30 angiograms
  - www.syntaxscore.org
- 50 angiograms
  - 6 hours cases reviews
- Same 50 angiograms 12 weeks apart

4 Core lab technicians (experience 10 years)
- 30 angiograms
  - www.syntaxscore.org
- 50 angiograms
  - 6 hours cases review
- Same 50 angiograms 12 weeks apart

“QCA” derived SYNTAX
- 30 angiograms
- 50 angiograms

Table 2. SYNTAX Score Inter-observer Variability Before and After an Advanced Training Session

<table>
<thead>
<tr>
<th>Angiographic Core Laboratory Technicians</th>
<th>30 cases after basic training*</th>
<th>50 cases after advanced training†</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNTAX score (tertile)</td>
<td>0.82 [0.72, 1.00]</td>
<td>0.84 [0.76, 1.00]</td>
</tr>
<tr>
<td>Number of lesions</td>
<td>0.70 [0.64, 1.00]</td>
<td>0.78 [0.73, 1.00]</td>
</tr>
<tr>
<td>Severe calcification</td>
<td>0.86 [0.72, 1.00]</td>
<td>0.84 [0.73, 1.00]</td>
</tr>
<tr>
<td>Length &gt;20 cm</td>
<td>0.61 [0.46, 0.99]</td>
<td>0.84 [0.72, 1.00]</td>
</tr>
<tr>
<td>Bifurcation/trifurcation</td>
<td>0.47 [0.41, 0.84]</td>
<td>0.56 [0.51, 1.00]</td>
</tr>
<tr>
<td>Sum of lesions</td>
<td>0.77 [0.67, 1.00]</td>
<td>0.82 [0.73, 1.00]</td>
</tr>
<tr>
<td>Small vessel disease</td>
<td>0.56 [0.49, 1.00]</td>
<td>0.60 [0.54, 1.00]</td>
</tr>
<tr>
<td>Total occlusion present</td>
<td>0.96 [0.84, 1.00]</td>
<td>1.00 [0.89, 1.00]</td>
</tr>
</tbody>
</table>

* Basic training consisted of completion of the tutorial available on the SYNTAX score website (www.syntaxscore.com).
† Advanced training consisted of a 6 hour extensive review of the initial 30 reads with a highly experienced angiographic core laboratory team.

Table 2. SYNTAX Score Inter-observer Variability Before and After an Advanced Training Session (Cont.)

<table>
<thead>
<tr>
<th>Interventional Cardiologist Group</th>
<th>30 cases after basic training*</th>
<th>50 cases after advanced training†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SYNTAX score (tertile)</strong></td>
<td>Kappa [95% CI]</td>
<td>Kappa [95% CI]</td>
</tr>
<tr>
<td></td>
<td>0.33 [0.18, 0.44]</td>
<td>0.76 [0.64, 1.00]</td>
</tr>
<tr>
<td>Number of lesions</td>
<td>0.26 [0.17, 0.38]</td>
<td>0.65 [0.55, 1.00]</td>
</tr>
<tr>
<td>Severe calcification</td>
<td>0.23 [0.02, 0.34]</td>
<td>0.57 [0.41, 0.89]</td>
</tr>
<tr>
<td>Length &gt;20 cm</td>
<td>0.48 [0.27, 0.64]</td>
<td>0.65 [0.49, 1.00]</td>
</tr>
<tr>
<td>Bifurcation/trifurcation</td>
<td>0.13 [0.04, 0.22]</td>
<td>0.49 [0.39, 0.81]</td>
</tr>
<tr>
<td>Sum of lesions</td>
<td>0.38 [0.23, 0.53]</td>
<td>0.70 [0.58, 1.00]</td>
</tr>
<tr>
<td>Small vessel disease</td>
<td>0.20 [0.09, 0.24]</td>
<td>0.30 [0.20, 0.45]</td>
</tr>
<tr>
<td>Total occlusion present</td>
<td>0.81 [0.60, 1.00]</td>
<td>0.96 [0.80, 1.00]</td>
</tr>
</tbody>
</table>

* Basic training consisted of completion of the tutorial available on the SYNTAX score website (www.syntaxscore.com).
† Advanced training consisted of a 6 hour extensive review of the initial 30 reads with a highly experienced angiographic core laboratory team.

Bifurcation and small vessel...
Table 4. Difference in Quantitative Components of the SYNTAX Score Between Interventional Cardiologists, Core Laboratory Technicians and Quantitative Coronary Analysis

<table>
<thead>
<tr>
<th></th>
<th>Core lab technicians vs. QCA analysis</th>
<th>Interventional cardiologists vs. QCA analysis</th>
<th>Core lab technicians vs. Interventional cardiologists</th>
<th>p-value (3-way)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNTAX Score</td>
<td>Mean difference [95% CI]</td>
<td>Mean difference [95% CI]</td>
<td>Mean difference [95% CI]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1 [0.4, 1.8]</td>
<td>-6.4 [-8.5, -4.3]</td>
<td>7.5 [5.5, 9.5]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of lesions</td>
<td>0.2 [0.1, 0.3]</td>
<td>-0.8 [-1.1, -0.5]</td>
<td>0.99 [0.7, 1.3]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bifurcation/trifurcation</td>
<td>0.18 [-0.2, 0.5]</td>
<td>-1.9 [-2.5, -1.2]</td>
<td>2.04 [1.5, 2.6]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Small vessels disease</td>
<td>0.3 [0.1, 0.4]</td>
<td>-1.1 [-1.5, -0.7]</td>
<td>1.37 [0.9, 1.8]</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

There were no statistically significant differences between QCA analysis and Core lab technicians analysis.
2 interventional cardiologists: <50%
1 Interventional cardiologist: >50%

QCA=52%

<table>
<thead>
<tr>
<th>SYNTAX tertile</th>
<th>Core lab technicians</th>
<th>Interventional Cardiologists</th>
<th>Difference [95% CI]</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=120</td>
<td>n=90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low score ≤22; %</td>
<td>46.7% (56/120)</td>
<td>63.3% (57/90)</td>
<td>16.7% [2.3, 31.1]</td>
<td></td>
</tr>
<tr>
<td>[95% CI]</td>
<td>[37.5%, 56.0%]</td>
<td>[52.5%, 73.3%]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate score 23-32; %</td>
<td>26.7% (32/120)</td>
<td>27.8% (25/90)</td>
<td>1.1% [-12.1, 14.3]</td>
<td>p=0.004</td>
</tr>
<tr>
<td>[95% CI]</td>
<td>[19.0%, 35.5%]</td>
<td>[18.9%, 38.2%]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Score &gt;32; %</td>
<td>26.7% (32/120)</td>
<td>8.9% (8/90)</td>
<td>-17.8% [-28.7, -6.9]</td>
<td></td>
</tr>
<tr>
<td>[95% CI]</td>
<td>[19.0%, 35.5%]</td>
<td>[3.9%, 16.8%]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

50 cases after advanced training

<table>
<thead>
<tr>
<th>SYNTAX tertile</th>
<th>Core lab technicians</th>
<th>Interventional Cardiologists</th>
<th>Difference [95% CI]</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=200</td>
<td>n=150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low score ≤22; %</td>
<td>67.5% (135/200)</td>
<td>92.7% (139/150)</td>
<td>25.2% [16.8, 33.5]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>[95% CI]</td>
<td>[60.5%, 73.9%]</td>
<td>[87.3%, 96.3%]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate score 23-32; %</td>
<td>19.5% (39/200)</td>
<td>4.7% (7/150)</td>
<td>-14.8% [-21.9, -7.8]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>[95% CI]</td>
<td>[14.3%, 25.7%]</td>
<td>[1.9%, 9.4%]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Score &gt;32; %</td>
<td>13.0% (26/200)</td>
<td>2.7% (4/150)</td>
<td>-10.3% [-16.3, -4.4]</td>
<td></td>
</tr>
<tr>
<td>[95% CI]</td>
<td>[8.7%, 18.5%]</td>
<td>[0.7%, 6.7%]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p value derived from the generalized estimated equations method

Conclusion

- Training beyond the standard on-line tutorial is warranted if the full clinical potential of the SYNTAX score is to be realized.
FFR-guided SYNTAX Score (FSS) versus Conventional SYNTAX Score (SS) and Clinical Outcome

497 patients of the FFR-arm of FAME I
Syntax scored re-calculated by 3 independent reviewers
3 tertiles based on SS

<table>
<thead>
<tr>
<th>SS</th>
<th>LOW risk 33%</th>
<th>MEDIUM risk 33%</th>
<th>HIGH risk 33%</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSS</td>
<td>LOW risk 59%</td>
<td>MEDIUM risk 21%</td>
<td>HIGH risk 21%</td>
</tr>
</tbody>
</table>

32% of patients moved to a lower-risk group

Nam, C.W. et al. JACC 2011
Conclusions

• Coronary angiogram remains the gold standard in CAD assessment
• Acknowledgement and understanding of its limitations will ensure its appropriate use/interpretation
• **IVUS guidance** is important for assessing ambiguous lesions and procedure optimization (ca+, thrombus, LM)
• **FFR** is an important tool to help in assessment of angiographic intermediate lesion
• **SYNTAX score** is a complex score for which training beyond the proposed online tutorial is needed to achieve its full potential
References

Pitfalls in Coronary Angiogram Interpretation:

*Philippe Généreux, MD*

Director, Angiographic Core Laboratory
Columbia University Medical Center and the Cardiovascular Research Foundation, New York, NY
Assistant Professor of Medicine, Interventional Cardiologist,
Director, Transcatheter Aortic Valve Implantation program
Hôpital du Sacré-Coeur de Montréal, Québec, Canada
Thank You