How Imaging Leads to Coronary Intervention

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Medical School, University of Ioannina
Summary

- Introduction
- Non-invasive imaging modalities
- Invasive imaging modalities
- Advanced imaging techniques
- Conclusions
How We Proceed

- Anatomy

- Functional assessment
  - Diagnosis of ischaemia
  - Identification of myocardial viability
Echocardiography

- Acute MI
  - identification of certain pathologies, which may need individualized management
    - Acute mitral regurgitation
    - Myocardial rupture
    - VSD
    - RV failure
    - Aneurysm of the ascending aorta
Echocardiography

- Stable angina
  - stress echocardiography can be used to identify areas of:
    - reversible ischemia
    - viable myocardial segments
Identification of Reversible Ischaemia
Identification of Reversible Ischaemia
**Myocardial Perfusion Scan**

- Allows non-invasive detection of myocardial ischemia and myocardial viability

- **Myocardial ischaemia protocol**
  - At rest
  - During stress

- **Myocardial viability protocol**
  - After administration of nitrates (viability)
  - At rest

**Stress**

**Exercise Stress test**

- The ideal choice even when the ECG in non-diagnostic (digoxin, LVH, LBBB)
- Patient’s exercise tolerance

**We stop:**
- BP↓ >10mmHg, angina, ST↑ >1mm, patient decision, achievement of the goal, ST↓ >2mm, arrythmia, hypertention, tiredness – SOB

**Pharmaceutical stress test**

- Adenosine, dypiridamole, dobutamine
Myocardial perfusion scan
Computed Tomography

- Appears to have a high negative predictive value in detecting the presence of CAD therefore it is the only anatomical test that has indication for symptomatic patients with intermediate likelihood of obstructive CAD (only these patients need diagnostic tests)

<table>
<thead>
<tr>
<th>Anatomical test</th>
<th>Asymptomatic (screening)</th>
<th>Symptomatic</th>
<th>Prognostic value of positive result</th>
<th>Prognostic value of negative result</th>
<th>References</th>
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<tr>
<td>Invasive angiography</td>
<td>III A</td>
<td>III A</td>
<td>IIb A</td>
<td>I A</td>
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<tr>
<td>MDCT angiography</td>
<td>III B&lt;sup&gt;c&lt;/sup&gt;</td>
<td>IIb B</td>
<td>IIa B</td>
<td>III B</td>
<td>IIb B</td>
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<tr>
<td>MRI angiography</td>
<td>III B</td>
<td>III B</td>
<td>III B</td>
<td>III C</td>
<td>III C</td>
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<thead>
<tr>
<th>Functional test</th>
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<tr>
<td>Stress echo</td>
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<td>III A</td>
<td>I A</td>
<td>III A&lt;sup&gt;d&lt;/sup&gt;</td>
<td>IA</td>
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<tr>
<td>Nuclear imaging</td>
<td>III A</td>
<td>III A</td>
<td>I A</td>
<td>III A&lt;sup&gt;d&lt;/sup&gt;</td>
<td>IA</td>
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<tr>
<td>Stress MRI</td>
<td>III B</td>
<td>III C</td>
<td>IIa B</td>
<td>III B&lt;sup&gt;d&lt;/sup&gt;</td>
<td>IIa B</td>
</tr>
<tr>
<td>PET perfusion</td>
<td>III B</td>
<td>III C</td>
<td>IIa B</td>
<td>III B&lt;sup&gt;d&lt;/sup&gt;</td>
<td>IIa B</td>
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</tbody>
</table>
Computed Tomography

- The problems of low PPV

- Limited positive predictive value especially in stented segments and in calcified arteries

- In a recent study that compared FFR with CT the specificity of CT in detecting hemodynamic significant CAD was only 64%
Computed Tomography

- Useful in the study of the patency of the grafts
- Can be useful in complex procedures
Computed Tomography

- **CTA: Why useful in complex procedures?**
  - Assessing the course of the vessel in CTO
  - Detecting the presence of Ca (independent predictor of procedural failure)
  - Evaluate angulation in bifurcation lesions
    - (important for the prediction of carina shift and so for the planning of the procedure)
Magnetic Resonance Imaging

• The gold standard for detecting the presence of scar
  • Very useful in discriminating ischaemic cardiomyopathy from other cardiomyopathies
    • Where the scar lies
  • Useful in defining the underlying syndrome in patients with myocardial necrosis and normal angiograms
    • Acute coronary syndromes vs myocarditis

• Diagnosing myocardial viability
  • A cut-off of 50% scar has been initially used to identify viable myocardium but recent reports cast doubts about the reliability of this metric
  • Low-dobutamine stress test can be used to detect myocardial viability

• Diagnosing myocardial ischaemia
  • Pharmacological stress test can be used to detect areas of reversible ischemia

Baer et al. JACC 1998
Kaandorp et al. Am J Cardiol 2005
Invasive Imaging Modalities
The acquired cross-sectional images allow:

- Identification of the lumen, stent and vessel wall
- Quantification of their dimensions and plaque volume
- Classification of the plaque type

Relatively low resolution - limited capability in:

- Detecting plaque erosion, rupture and the presence of thrombus
- Unable to see microstructures related to increased vulnerability

Mintz et al. J Am Coll Cardiol. 2011
Intravascular Ultrasound
Clinical Indications

**Estimate the severity of a lesion**
- “Hazy” or intermediate lesions difficult to accurately assess by coronary angiography
- Lesions located in diffusely diseased segments
- Lesions located at the origin of side branches
- Lesions located in the LMCA
- Detection of restenosis or in-stent restenosis

**Clinical decision making**
- Help in the identification of a pseudoaneurysm
- Accurate assessment of the extent, morphology and constitution of the plaque

**Guide treatment**
- Help to identify the optimal entry/true lumen in CTO
- **POBA:** Selection of balloon’s dimensions and inflation pressures
- **BMS, DES:** Selection of optimal stent dimensions
  - In the treatment of complex disease e.g. small vessels, long lesions, bifurcations, LMCA
  - In the treatment of high risk patients e.g. renal failure, heart failure diabetes mellitus, those who cannot take long-term dual anti-platelet therapy
  - To identify the cause of restenosis and guide further treatment

**Examine final results and identify suboptimal stent expansion or dissections after percutaneous intervention**

Bourantas CV, Naka KK, ... , Michalis LK. Echocardiography 2010
Intravascular Ultrasound

Assessment of lesion severity
Where we stand
**IVUS: Is this lesion significant?**

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<tr>
<td>N</td>
<td>112</td>
<td>70</td>
<td>51</td>
<td>53</td>
<td>14</td>
<td>94</td>
<td>236</td>
<td>170</td>
<td>92</td>
<td>110</td>
<td>267</td>
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<tr>
<td>% abnormal</td>
<td>40%</td>
<td>65%</td>
<td>49%</td>
<td>23%</td>
<td>50%</td>
<td>40%</td>
<td>21%</td>
<td>26%</td>
<td>26%</td>
<td>41%</td>
<td>33%</td>
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<td>IVUS</td>
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<tr>
<td>Ref lumen (mm²)</td>
<td>8.3</td>
<td>11.9</td>
<td>9.3</td>
<td>7.8</td>
<td>10.3</td>
<td>5.5</td>
<td>5.9</td>
<td>7.6</td>
<td>7.8</td>
<td>6.7</td>
<td></td>
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<tr>
<td>MLA (mm²)</td>
<td>4.4</td>
<td>4.3</td>
<td>3.9</td>
<td>3.9</td>
<td>3.5</td>
<td>2.3</td>
<td>2.6</td>
<td>2.1</td>
<td>3.0</td>
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<td><strong>MLA Cut-off (mm²)</strong></td>
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<td><strong>4.0</strong></td>
<td><strong>3.0</strong></td>
<td><strong>4.0</strong></td>
<td><strong>n/a</strong></td>
<td><strong>2.0</strong></td>
<td><strong>2.4</strong></td>
<td><strong>2.1</strong></td>
<td><strong>3.2</strong></td>
<td><strong>3.2</strong></td>
<td><strong>2.75</strong></td>
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<td>Other determinants of ischemia</td>
<td>•LL</td>
<td>•MLA/LL</td>
<td>•LL</td>
<td>•Plaque burden</td>
<td>•Plaque burden</td>
<td>•Vessel size</td>
<td>•Prox-Mid</td>
<td>•LL</td>
<td>•Prox-Mid</td>
<td>•LAD</td>
<td>•Vessel size</td>
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<td>QCA</td>
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<tr>
<td>Length (mm)</td>
<td>14</td>
<td>8.5</td>
<td>17.9</td>
<td>15.1</td>
<td>21.2</td>
<td>16.5</td>
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<tr>
<td>QCA Ref (mm)</td>
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<td>2.7</td>
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<td>3.1</td>
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<td>DS (%)</td>
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<td>50</td>
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Mintz G. TCT 2011
**Intravascular Ultrasound**

**Diagnosis of Functionally Significant Lesions**

**FIRST:** Fractional Flow Reserve and Intravascular Ultrasound Relationship Study

**FIRST:** a multinational, multicenter, prospective registry of a large patient cohort with intermediate coronary stenosis (350 patients; 367 intermediate lesions)

<table>
<thead>
<tr>
<th>Lesion Type</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>All Lesion</td>
<td>64%</td>
<td>42%</td>
</tr>
<tr>
<td>RVD &lt; 3.0</td>
<td>63%</td>
<td>45%</td>
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<td>RVD 3.0-3.5</td>
<td>58%</td>
<td>45%</td>
</tr>
<tr>
<td>RVD &gt; 3.5</td>
<td>57%</td>
<td>36%</td>
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Diagnostic Accuracy of IVUS MLA in the Prediction of Functionally Significant Stenosis Overall and by RVD

*Waksman R, et al. JACC 2013*
Intravascular Ultrasound

Guidance of Treatment
Where we stand
Impact of Intravascular Ultrasound Guidance on Long-Term Mortality in Stenting for Unprotected Left Main Coronary Artery Stenosis

Seung-Jung Park, MD, PhD*; Young-Hak Kim, MD, PhD*; Duk-Woo Park, MD, PhD; Seung-Whan Lee, MD, PhD; Won-Jang Kim, MD, PhD; Jon Suh, MD; Sung-Cheol Yun, PhD; Cheol Whan Lee, MD, PhD; Myeong-Ki Hong, MD, PhD; Jae-Hwan Lee, MD, PhD; Seong-Wook Park, MD, PhD; for the MAIN-COMPARE Investigators

Background—Although intravascular ultrasound (IVUS) guidance has been useful in stenting for unprotected left main coronary artery stenosis, its impact on long-term mortality is still unclear.

Methods and Results—In the MAIN-COMPARE registry, patients with unprotected left main coronary artery stenosis in a hemodynamically stable condition underwent elective stenting under the guidance of IVUS (756 patients) or conventional angiography (219 patients). Patients with acute myocardial infarction were excluded. The 3-year outcomes between the 2 groups were primarily compared using propensity-score matching in the entire and separate populations according to stent type. In 201 matched pairs of the overall population, there was a tendency of lower risk of 3-year morality with IVUS guidance compared with angiography guidance (6.0% versus 13.6%, log-rank P=0.063; hazard ratio, 0.54; 95% CI, 0.28 to 1.03; Cox-model P=0.061). In particular, in 145 matched pairs of patients receiving drug-eluting stent, the 3-year incidence of mortality was lower with IVUS guidance as compared with angiography guidance (4.7% versus 16.0%, log-rank P=0.048; hazard ratio, 0.39; 95% CI, 0.15 to 1.02; Cox model P=0.055). In contrast, the use of IVUS guidance did not reduce the risk of mortality in 47 matched pairs of patients receiving bare-metal stent (8.6% versus 10.8%, log-rank P=0.35; hazard ratio, 0.59; 95% CI, 0.18 to 1.91; Cox model P=0.38). The risk of myocardial infarction or target vessel revascularization was not associated with the use of IVUS guidance.

Conclusions—Elective stenting with IVUS guidance, especially in the placement of drug-eluting stent, may reduce the long-term mortality rate for unprotected left main coronary artery stenosis when compared with conventional angiography guidance. (Circ Cardiovasc Intervent. 2009;2:167-177.)
Interventional Cardiology

A prospective, randomized trial of intravascular-ultrasound guided compared to angiography guided stent implantation in complex coronary lesions: The AVIO trial

Alaide Chieffo, MD, a,5 Azeem Latib, MD, a,5 Christophe Caussin, MD, b,5 Patrizia Presbitero, MD, c,5 Stefano Galli, MD, d,5 Alberto Menozzi, MD, e,5 Ferdinando Varbella, MD, f,5 Fina Mauri, MD, g,5 Marco Valgimigli, MD, h,5 Chourmouzakis Arampatzis, MD, i,5 Manuel Sabate, MD, j,5 Andrejs Erglis, MD, k,5 Bernhard Reimers, MD, l,5 Flavio Airoldi, MD, m,5 Mika Laine, MD, n,5 Ramon Lopez Palop, MD, o,5 Ghada Mikhail, MD, p,5 Philip McCarthy, MD, q,5 Francesco Romeo, MD, r,5 and Antonio Colombo, MD, s,5 Milan, Parma, Rovigo, Ferrara, Mirano, and Rome, Italy; Le Plessis Robinson, France; Badalona, Barcelona, and Alicante, Spain; Thessaloniki, Greece; Riga, Latvia; Helsinki, Finland; and London, United Kingdom

Background  No randomized studies have thus far evaluated intravascular ultrasound (IVUS) guidance in the drug-eluting stent (DES) era. The aim was to evaluate if IVUS optimized DES implantation was superior to angiographic guidance alone in complex lesions.

Methods  Randomized, multicentre, international, open label, investigator-driven study evaluating IVUS vs angiographically guided DES implantation in patients with complex lesions (defined as bifurcations, long lesions, chronic total occlusions or small vessels). Primary study endpoint was post-procedure in lesion minimal lumen diameter. Secondary end points were combined major adverse cardiac events (MACE), target lesion revascularization, target vessel revascularization, myocardial infarction (MI), and stent thrombosis at 1, 6, 9, 12, and 24 months.

Results  The study included 284 patients. No significant differences were observed in baseline characteristics. The primary study end point showed a statistically significant difference in favor of the IVUS group (2.70 mm ± 0.46 mm vs. 2.51 ± 0.46 mm; *P* = .0002). During hospitalization, no patient died, had repeated revascularization, or a Q-wave MI. No difference was observed in the occurrence of non-Q wave MI (6.3% in IVUS vs. 7.0% in angiography-guided group). At 24-months clinical follow-up, no differences were still observed in cumulative MACE (16.9% vs. 23.2%), cardiac death (0% vs. 1.4%), MI (7.0% vs. 8.5%), target lesion revascularization (9.2% vs. 11.9%) or target vessel revascularization (9.8% vs. 15.5%), respectively in the IVUS vs. angiography-guided groups. In total, only one definite subacute stent thrombosis occurred in the IVUS group.

Conclusions  A benefit of IVUS optimized DES implantation was observed in complex lesions in the post-procedure minimal lumen diameter. No statistically significant difference was found in MACE up to 24 months. (Am Heart J 2013;165:65-72.)
Although meta-analysis and some clinical studies have demonstrated that an IVUS guided PCI is likely to be associated with better clinical outcomes there are no clear indications about the set of patients and the type of lesions in which IVUS imaging should be used.
Intravascular Ultrasound Research Utility

Application of Intravascular Ultrasound to Characterize Coronary Artery Disease and Assess the Progression or Regression of Atherosclerosis

Nissen SE. Am J Cardiol 2002

And to Assess the Effect of Treatment

PLAQUE REGRESSION UNDER STATIN THERAPY

BASELINE

FOLLOW-UP

Nissen SE, et al. JAMA 2006
The acquired cross-sectional images allow:

- Imaging of micro-features related to plaque vulnerability
- Evaluation of stent endotheliazation
- Classification of the plaque type
- Identification of plaque rupture/thrombus

Limitations of this modality are:

- Poor penetration which often does not allow imaging of the entire vessel wall
- Cannot “see” behind lipid tissue
- Unable to discriminate deeply embedded lipid-rich from calcific tissue

Optical Coherence Tomography

Diagnosis & Guidance of Treatment
Where we stand
Diagnosis of Spontaneous Coronary Artery Dissection by Optical Coherence Tomography

Fernando Alfonso, MD, PhD, Manuel Paulo, MD, Nieves Gonzalo, MD, PhD, Jaime Dutary, MD, Pilar Jimenez-Quevedo, MD, PhD, Vera Lennie, MD, Javier Escaned, MD, PhD, Camino Bañuelos, MD, Rosana Hernandez, MD, PhD, Carlos Macaya, MD, PhD

OCT allows identification of dissections (N=17)
Anatomy of the LMS, circumflex, LAD, diagonal and septal branches

**New Insights Into the Coronary Artery Bifurcation**

Hypothesis-Generating Concepts Utilizing 3-Dimensional Optical Frequency Domain Imaging

Vasim Farooq, MBCHB, Patrick W. Serruys, MD, PhD, Jung Ho Heo, MD, Bill D. Gogas, MD, Takayuki Okamura, MD, PhD, Josep Gomez-Lara, MD, Salvatore Brugaletta, MD, Hector M. García-García, MD, MSc, PhD, Robert Jan van Geuns MD, PhD

Is the evaluation of coronary anatomy better? Is it useful?
View from the LMS

LCx

CARINA

SEPTAL

LAD

D1
Three-dimensional Optical Coherence Tomography Assessment of Coronary Wire Re-crossing Position during Bifurcation Stenting

Takayuki Okamura, MD*, Jutaro Yamada, MD, Tomoko Nao, MD, Takeshi Suetomi, MD, Takao Maeda, MD, Kohzoh Shiraishi, MD, Toshiro Miura, MD, Masunori Matsuzaki, MD

Division of Cardiology, Department of Medicine and Clinical Science, Yamaguchi University Graduate School of Medicine, Ube, Japan
A novel automatic Strut Detection software (from Yamaguchi University) enabled a rapid 3-D stent image reconstruction during bifurcation stenting procedure.

Napkin-ring Narrowing at the ostium of LCx (0,0,1)
PRE

POST

DIAGONAL

LAD

PRE

POST

PROTRUDING STRUTS

OVERLAPPING SEGMENT
STENT UNDEREXPANSION*

PRE

POST

OVERHANGING STRUT
Angiography alone versus angiography plus optical coherence tomography to guide decision-making during percutaneous coronary intervention: the Centro per la Lotta contro l’Infarto-Optimisation of Percutaneous Coronary Intervention (CLI-OPCI) study

Francesco Prati¹²*, MD; Luca Di Vito³, MD, PhD; Giuseppe Biondi-Zoccai²³, MD; Michele Occhipinti²⁴, MD; Alessio La Manna⁴, MD; Corrado Tamburino⁴, MD; Francesco Burzotta⁵, MD, PhD; Carlo Tran⁵, MD; Italo Porto⁵, MD; Vito Ramazzotti¹, MD; Fabrizio Imola¹, MD; Alessandro Manzoli¹, MD; Laura Materia², PharmD; Alberto Cremonesi⁶, MD; Mario Albertucci², MD

1. Department of Interventional Cardiology, San Giovanni-Addolorata Hospital, Rome, Italy; 2. Centro per la Lotta contro l’Infarto - Fondazione Onlus, Rome, Italy; 3. Department of Medico-Surgical Sciences and Biotechnologies, Sapienza University of Rome, Latina, Italy; 4. Division of Cardiology, University of Catania, Catania, Italy; 5. Institute of Cardiology, Catholic University, Rome, Italy; 6. GVM Care and Research, E.S. Health Science Foundation, Cotignola, Italy

If we needed 20,000 pts to prove that IVUS-guided PCI is associated with a better prognosis how many pts do we need in an OCT study?
The prognosis of the pts who had OCT guided PCI was compared with the prognosis of 335 pts with similar demographics that underwent angiography guided PCI.

- Stent in case of edge dissection
- PCI if MLA <4mm²
- Post-dilation in case of stent underexpansion (MLA <90%)
- Malapposition when the detachment distance was 200μm

Pts having OCT guided PCI had a better prognosis.

We need a randomized control trial.
Optical Coherence Tomography

Assessment of lesion severity
Where we stand
Optical Coherence Tomography
Diagnosis of Functionally Significant Lesions

Comparison with FFR

Gonzalo N, et al. JACC 2012
OCT vs IVUS
Diagnosis of Functionally Significant Lesions

Gonzalo N, et al. JACC 2012
Advanced Imaging Techniques

Hybrid Imaging
Advanced Imaging Techniques

Assessment of Lesion Severity
Fusion of SPECT-PET with CT

- The fusion of SPECT with Computed tomography appears provide comprehensive imaging and it is likely to be useful in clinical setting:
  - To estimate the severity of a lesion
  - To detect the lesion causing symptoms in patients with 2 or 3 vessel disease

CFD in Models derived by 3D QCA

FFR assessment

(A) Coronary angiogram showing a lesion.
(B) FFR measurement with values:
- FFR: 0.86
- Pa:iPa: 118:158
- Pd:iPd: 102:137
- Pd/Pa: 0.86
- Pa-Pd(p): 15

(C) Pressure vs. flow relationship:
- ΔP = 3.4Q + 1.5Q^2
- Q: 1 ml/s, ΔP: 4.9 mm Hg
- Q: 3 ml/s, ΔP: 23.4 mm Hg

(D) Pd/Pa ratio vs. flow [Q] (ml/s):
- vFAI = 0.854

(E) Receiver Operating Characteristic (ROC) curve:
- vFAI: AUC = 93.6%
- %Area Stenosis: AUC = 82.2%
CFD in Models derived by Intravascular Ultrasound FFR assessment

Virtual FFR: 0.92

Advanced Imaging Techniques

Predicting Events and 
? Implementing pre-emptive treatment
Independent predictors of lesion level events by logistic regression analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR [95% CI]</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB_{MLA} ≥70%</td>
<td>4.99 [2.54, 9.79]</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>VH-TCFA</td>
<td>3.00 [1.68, 5.37]</td>
<td>0.0002</td>
</tr>
<tr>
<td>MLA ≤4.0 mm²</td>
<td>2.77 [1.32, 5.81]</td>
<td>0.007</td>
</tr>
<tr>
<td>Lesion length ≥11.6 mm</td>
<td>1.97 [0.94, 4.16]</td>
<td>0.07</td>
</tr>
<tr>
<td>EEM_{MLA} &lt;14.3 mm²</td>
<td>1.30 [0.62, 2.75]</td>
<td>0.49</td>
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</table>
A Prospective Natural-History Study of Coronary Atherosclerosis

Gregg W. Stone for the PROSPECT Investigators


<table>
<thead>
<tr>
<th>Lesion Type</th>
<th>Rate of Major Adverse Cardiovascular Events (%)</th>
<th>Lesion Hazard Ratio (95% CI)</th>
<th>P value</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCFA (all)</td>
<td>4.9</td>
<td>3.90 (2.25–6.76)</td>
<td>&lt;0.001</td>
<td>46.7</td>
</tr>
<tr>
<td>TCFA + MLA ≤4 mm²</td>
<td>10.2</td>
<td>6.55 (3.43–12.51)</td>
<td>&lt;0.001</td>
<td>15.9</td>
</tr>
<tr>
<td>TCFA + PB ≥70%</td>
<td>16.4</td>
<td>10.83 (5.55–21.10)</td>
<td>&lt;0.001</td>
<td>10.1</td>
</tr>
<tr>
<td>TCFA + PB ≥70% + MLA ≤4 mm²</td>
<td>18.2</td>
<td>11.05 (4.39–27.82)</td>
<td>&lt;0.001</td>
<td>4.2</td>
</tr>
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</table>
Low ESS was associated with plaque progression.

Large plaque burden and low ESS appeared as independent predictors of plaque progression.

Large plaque burden and low ESS predicted with 41% accuracy disease progression requiring PCI.

Non-invasive imaging modalities have a role in assessing myocardial viability and detecting reversible ischemia.

Although intravascular imaging modalities seem to be useful in PCI there are no robust data to support their use in everyday clinical practice.

Novel hybrid and computational expensive imaging based techniques have emerged over the last years that appear capable to detect hemodynamic significant lesions and areas at high-risk for future events, and are expected to have a role in the future in the clinical setting.
Myocardial perfusion scan

- Spect with Th 14mSv
- Spect with Tc 7mSv + 7mSv
- Angiogram 14mSv
- CTA 3mSv

Increasing to 160 ml/min

80% diameter stenosis

Increasing to 320 ml/min

Radiation dose

80 ml/min per 100g

80 ml/min per 100g
Guidelines on myocardial revascularization

The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Developed with the special contribution of the European Association for Percutaneous Cardiovascular Interventions (EAPCI)

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Stress SA

Stress VLA

Stress HLA
The aim of this study was to assess the short- and mid-term clinical impact of intravascular ultrasound guidance in 58 patients referred for elective percutaneous treatment of unprotected left main coronary artery disease with drug-eluting stents. The use of intravascular ultrasound, used in 41% of the procedures, was not associated with additional clinical benefit with respect to angiographic-assisted stent deployment. ©2005 by Excerpta Medica Inc. (Am J Cardiol 2005;95:644-647)
Functional Angioplasty
Proposed Role of FFR and IVUS

Fusion of OCT and Angiography: Enhanced *In Vivo* Investigations on ESS and High-risk Plaque Features

- **Large calcified plaque**
- **Thin-cap atheroma**
- **MΦ accumulation**
- **Neovessels**

Papafaklis MI, ... , Stone PH, Jang IK, Michalis LK. *JACC Intv* 2013;6:S34
OCT + Angiography:
Augmented **Lipid Content** & Thinner **Fibrous Cap** in Areas With Low Endothelial Shear Stress

*Non-culprit Lesions* in Patients With Acute Coronary Syndromes

Vergallo R, Papafaklis MI, ... , Michalis LK, Stone PH, Jang IK. *AHA Sessions* 2013
OCT + Angiography:
Hemodynamic Micro-environment in Endovascular Devices in Humans

Thick struts (156 μm)
Flow Disruption
Inter-strut Areas with Low Shear Stress
Neointima Thickening

Papafaklis MI, Bourantas CV, ... , Michalis LK, Serruys PW. EuroIntervention 2013
Advanced Imaging
Prediction of Natural History and Clinical Events

• Prediction of future culprit lesions

• Prediction of coronary regions with rapid worsening

• Prediction of clinical events
A Prospective Natural-History Study of Coronary Atherosclerosis

Gregg W. Stone for the PROSPECT Investigators


697 pts with ACS

MSCT Substudy
N=50-100

3-vessel imaging post PCI

Angiography (QCA of entire coronary tree), IVUS, Virtual histology, Palpography

Biomarkers
- Hs CRP
- IL-6
- sCD40L
- MPO
- TNFα
- MMP9
- Lp-PLA2
- others

At 3y follow-up 107 new symptomatic lesions appeared in 74 pts
Fusion of Angiography & IVUS: Local Hemodynamics and Disease Progression

Prediction of Progression of Coronary Artery Disease and Clinical Outcomes Using Vascular Profiling of Endothelial Shear Stress and Arterial Plaque Characteristics: The PREDICTION Study


_Circulation._ 2012;126:172-181; originally published online June 21, 2012; doi: 10.1161/CIRCULATIONAHA.112.096438

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