COMPLEX CORONARY SESSION
Left Main PCI: Ostial

Y. Louvard, ICPS, Massy, France

ARCH 2015, Saint Louis, MO, USA
Ostial unprotected left main stenosis

- Ostial de novo left main stenosis (ostial and body)
- Ostial stenosis of the left main after previous PCI
- Isolated left main coronary artery stenosis after thoracic radiation
- Left main coronary artery stenosis after aortic valve replacement.
- Left main coronary ostial stenosis after a Bentall procedure
- Stenosis in a Gore-Tex graft connected to the left main (Cabrol procedure)
- Ostial left main stenosis secondary to Takayashu arteritis (or syphilitic aortitis …)
- Anomalous origin of the left coronary artery with an intramural segment.
Ostial LM stenosis after bifurcation stenting
2 important factors against the success of PCI in LM lesions

1. up to 80% of LM disease involves the bifurcation, which is known to be at higher risk of restenosis

2. up to 80% of LM patients also have multivessel SCAD, where CABG offers a survival advantage independent of the presence of LM disease.
Diagnostic of ostial stenosis

Dg of LM ostial and mid-LAD bifurcation stenosis with CT Scan (angina)

Coronary angiography (5F)  
PCI(6F)
Structure-function scaling laws of vascular trees

**Murray’s law**
\[ D_1^3 = D_2^3 + D_3^3 \]

**Finet’s law**
\[ D_1 = 0.67(D_2 + D_3) \]
LM diffuse stenosis
IVUS-Derived MLA Criteria for Functionally Significant LMCA Stenosis

Cutoff Values and Corresponding Diagnostic Accuracies of the IVUS-Derived MLA Adjusted for Various Anthropometric Measurements

<table>
<thead>
<tr>
<th></th>
<th>Cut-off value</th>
<th>AUC (95% CI)</th>
<th>P value vs. MLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLA</td>
<td>≤4.5</td>
<td>0.85 (0.76-0.91)</td>
<td>-</td>
</tr>
<tr>
<td>MLA/BMI</td>
<td>≤0.17</td>
<td>0.86 (0.77-0.92)</td>
<td>0.46</td>
</tr>
<tr>
<td>MLA/BSA</td>
<td>≤2.36</td>
<td>0.86 (0.77-0.92)</td>
<td>0.54</td>
</tr>
<tr>
<td>MLA/LV mass</td>
<td>≤0.03</td>
<td>0.83 (0.74-0.91)</td>
<td>0.64</td>
</tr>
</tbody>
</table>
Ostial/MidShaft vs distal LM
Long-Term Clinical Outcomes After PCI for Ostial/Mid-Shaft Lesions Versus Distal Bifurcation Lesions in UPLM

DELTA Registry (N = 2775)

Patients treated with PCI (N = 1874)

Ostial/midshaft lesion (N = 744)

Distal bifurcation lesion (N = 1130)

Patients treated with CABG were excluded (N = 901)

Patients treated with bifurcation stenting were excluded (N = 262)

Ostial/midshaft ULMCA PCI group (N = 482)

Distal ULMCA PCI group (N = 1130)

Study population (N = 1612)

Naganuma, J Am Coll Cardiol Intv 2013;6:1242–9)
Long-Term Clinical Outcomes After PCI for Ostial/Mid-Shaft Lesions Versus Distal Bifurcation Lesions in UPLM

Predictors of the MACE at Cox Multivariate Analysis

<table>
<thead>
<tr>
<th>Predictor</th>
<th>HR</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs</td>
<td>1.01</td>
<td>0.99–1.02</td>
<td>0.180</td>
</tr>
<tr>
<td>LVEF</td>
<td>0.99</td>
<td>0.98–0.99</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>EuroSCORE</td>
<td>1.02</td>
<td>0.99–1.05</td>
<td>0.273</td>
</tr>
<tr>
<td>Distal ULMCA</td>
<td>1.40</td>
<td>1.08–1.80</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Elective</td>
<td>0.87</td>
<td>0.68–1.11</td>
<td>0.256</td>
</tr>
<tr>
<td>IABP</td>
<td>2.28</td>
<td>1.65–3.14</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stent diameter</td>
<td>0.57</td>
<td>0.42–0.77</td>
<td></td>
</tr>
</tbody>
</table>
Long-Term Clinical Outcomes After PCI for Ostial/Mid-Shaft Lesions Versus Distal Bifurcation Lesions in UPLM

Freedom From MACE in Ostial/Mid-Shaft ULMCA PCI Group Versus Distal ULMCA PCI Group in the Propensity-Score Matched Groups

![Graphs showing outcomes](image-url)
Long-Term Clinical Outcomes After PCI Vs CABG for Ostial/Midshaft Lesions in UPLM From the DELTA Registry

Study Population Flowchart

DELTA Registry (N = 2775)

Patients with distal bifurcation lesion were excluded (N = 1657)

Patients with ostial/midshaft lesion (N = 1118)

Treated with PCI (N = 744)

Treated with CABG (N = 374)

Patients treated with bifurcation stenting were excluded (N = 262)

PCI group (N = 482)

CABG group (N = 374)

Study population (N = 856)

Naganuma, J Am Coll Cardiol Intv 2014;7:354–61)
## Lesion and Procedural Characteristics

<table>
<thead>
<tr>
<th>Lesion and procedural characteristic</th>
<th>PCI (n = 482)</th>
<th>CABG (n = 374)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multivessel disease</td>
<td>338 (70.1)</td>
<td>338 (90.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>RCA disease</td>
<td>164 (34.0)</td>
<td>221 (59.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SYNTAX score*</td>
<td>26.1 ± 12.3</td>
<td>35.5 ± 13.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>IABP</td>
<td>15 (3.1)</td>
<td>15 (4.0)</td>
<td>0.478</td>
</tr>
<tr>
<td>IVUS</td>
<td>161 (33.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessels treated</td>
<td>1.17 ± 0.78</td>
<td>2.29 ± 0.98</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PCI for LAD or LCx</td>
<td>243 (50.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCI for RCA</td>
<td>67 (13.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DES type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>281 (58.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PES</td>
<td>199 (41.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZES/EES</td>
<td>2 (0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean stent diameter, mm</td>
<td>3.51 ± 0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean stent length, mm</td>
<td>15.9 ± 13.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximal balloon diameter, mm</td>
<td>3.88 ± 0.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximal pressure, atm</td>
<td>16.7 ± 3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean arterial graft</td>
<td>1.9 ± 1.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean venous graft</td>
<td>1.6 ± 1.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Long-Term Clinical Outcomes After PCI Vs CABG for Ostial/Midshaft Lesions in UPLM From the DELTA Registry

Predictors of the Primary Endpoint at Cox Multivariable Analysis

<table>
<thead>
<tr>
<th>Predictor</th>
<th>HR</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI vs. CABG</td>
<td>0.99</td>
<td>0.64–1.52</td>
<td>0.948</td>
</tr>
<tr>
<td>Age</td>
<td>1.03</td>
<td>1.01–1.06</td>
<td>0.014</td>
</tr>
<tr>
<td>EuroSCORE</td>
<td>1.09</td>
<td>1.01–1.17</td>
<td>0.039</td>
</tr>
<tr>
<td>Female</td>
<td>0.81</td>
<td>0.51–1.30</td>
<td>0.389</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.21</td>
<td>0.77–1.88</td>
<td>0.411</td>
</tr>
<tr>
<td>LVEF</td>
<td>0.99</td>
<td>0.97–1.01</td>
<td>0.204</td>
</tr>
<tr>
<td>Multivessel disease</td>
<td>1.00</td>
<td>0.55–1.84</td>
<td>0.991</td>
</tr>
<tr>
<td>AMI</td>
<td>0.91</td>
<td>0.51–1.62</td>
<td>0.739</td>
</tr>
</tbody>
</table>

Naganuma, J Am Coll Cardiol Intv 2014;7:354–61)
Long-Term Clinical Outcomes After PCI Vs CABG for Ostial/Midshaft Lesions in UPLM From the DELTA Registry

Freedom From Cardiac and Cerebrovascular Events in the PCI Group Versus the CABG Group for Ostial/Midshaft UPLMCA in the Propensity Score-Matched Groups

Naganuma, J Am Coll Cardiol Intv 2014;7:354–61)
Freedom from cardiac events in first generation DES group versus new generation DES group for ostial/midshaft UPLMCA lesions

## Predictors of MACE at Cox Multivariable Analysis

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Univariate</th>
<th>Cox regression adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR</td>
<td>95% CI</td>
</tr>
<tr>
<td>New vs. first generation DES</td>
<td>1.16</td>
<td>0.62–2.17</td>
</tr>
<tr>
<td>SYNTAX score</td>
<td>1.07</td>
<td>1.03–1.11</td>
</tr>
<tr>
<td>EuroSCORE</td>
<td>1.14</td>
<td>1.02–1.27</td>
</tr>
<tr>
<td>IVUS</td>
<td>0.58</td>
<td>0.30–1.12</td>
</tr>
<tr>
<td>Age</td>
<td>1.01</td>
<td>0.98–1.04</td>
</tr>
<tr>
<td>Male</td>
<td>0.74</td>
<td>0.39–1.41</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.23</td>
<td>0.65–2.31</td>
</tr>
<tr>
<td>LVEF &lt;35%</td>
<td>1.21</td>
<td>0.43–3.41</td>
</tr>
<tr>
<td>Postdilation</td>
<td>0.76</td>
<td>0.38–1.52</td>
</tr>
<tr>
<td>Stent diameter (mm)</td>
<td>1.38</td>
<td>0.46–4.17</td>
</tr>
<tr>
<td>Maximum balloon diameter (mm)</td>
<td>1.31</td>
<td>0.69–2.49</td>
</tr>
<tr>
<td>Maximum balloon pressure (atm)</td>
<td>1.02</td>
<td>0.95–1.08</td>
</tr>
</tbody>
</table>
MultivesSEL disease
## Guide to calculate the SYNTAX score

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable assessed</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Dominance</td>
<td>The weight of individual coronary segments varies according to coronary artery dominance (right or left). Co-dominance does not exist as an option in the SYNTAX score.</td>
</tr>
<tr>
<td>Step 2</td>
<td>Coronary segment</td>
<td>The diseased coronary segment directly affects the score as each coronary segment is assigned a weight, depending on its location, ranging from 0.5 (i.e., posterior branch) to 6 (i.e., left main in case of left dominance).</td>
</tr>
</tbody>
</table>

### Diagram

**Right dominance**

- Weighting factor
  - +6
  - +5
  - +3.5
  - +2.5
  - +1.5
  - +1
  - +0.5

**Left dominance**

- Weighting factor
  - +6
  - +5
  - +3.5
  - +2.5
  - +1.5
  - +1
  - +0.5

### Step 3: Diameter stenosis

The score of each diseased coronary segment is multiplied by 2 in case of a stenosis 50-99% and by 3 in case of total occlusion. In case of total occlusion, additional points will be added as follows:

- age > 3 months or unknown: +1
- Bulbous stump: +1
- Distal stump: +1
- Bridging: +1
- First segment viable distally: +1 per non-viable segment
- Side branch at the stenosis: +1 if <1.5 mm diameter
- +1 if both <1.5 and <1.5 mm diameter
- +0 if >1.5 mm diameter (e.g., infarction lesion)

### Step 4: Trifurcation lesion

The presence of a trifurcation lesion adds additional points based on the number of diseased segments:

- 1 segment: +2
- 2 segments: +4
- 3 segments: +5
- 4 segments: +6

### Step 5: Bifurcation lesion

The presence of a bifurcation lesion adds additional points based on the type of bifurcation according to the Medina classification:

- Medina 1,0,0 or 0,1,0 or 1,1,0 add 1 additional point
- Medina 1,1,1 or 0,1,1 or 0,0,1 add 2 additional points

Additionally, the presence of a bifurcation angle <70° adds 1 additional point.

### Step 6: Ascending aorta lesion

The presence of ascending aorta lesion segments adds 1 additional point.

### Step 7: Severe tortuosity

The presence of severe tortuosity proximal of the diseased segment adds 2 additional points.

### Step 8: Lesion length

Lesion length >30 mm adds 1 additional point.

### Step 9: Calcification

The presence of heavy calcification adds 2 additional points.

### Step 10: Thrombus

The presence of thrombus adds 1 additional point.

### Step 11: Diffuse disease/small vessels

The presence of diffuse disease and/or small vessels distal to the lesion (A) when at least 75% of the lesion length is a vessel diameter of <2mm adds 1 point per segment length.
Risk models to assess medium- to long-term (≥1 year) outcomes

<table>
<thead>
<tr>
<th>Score</th>
<th>Development cohort</th>
<th>Patient inclusion</th>
<th>Coronary procedures</th>
<th>Number of variables</th>
<th>Outcome</th>
<th>Recommendation</th>
<th>Validation studies</th>
<th>Calculation</th>
<th>Ref*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYNTAX</td>
<td>none, expert opinion</td>
<td>none</td>
<td>-</td>
<td>0</td>
<td>11</td>
<td>MACCE</td>
<td>I B</td>
<td>&gt;50</td>
<td><a href="http://www.syntaxscore.com">www.syntaxscore.com</a></td>
</tr>
<tr>
<td>SYNTAX II</td>
<td>1 800 Multicentre</td>
<td>03/2005 – 04/2007</td>
<td>50% CABG, 50% PCI</td>
<td>6</td>
<td>12</td>
<td>4-year mortality</td>
<td>IIa B</td>
<td>&lt;5</td>
<td>-</td>
</tr>
<tr>
<td>ASCERT CABG</td>
<td>174 506 Multicentre</td>
<td>01/2002 – 12/2007</td>
<td>100% (i)CABG</td>
<td>23</td>
<td>2</td>
<td>Mortality &gt;2 years</td>
<td>IIa B</td>
<td>&lt;5</td>
<td>-</td>
</tr>
<tr>
<td>ASCERT PCI</td>
<td>206 081 Multicentre</td>
<td>2004 – 2007</td>
<td>100% PCI</td>
<td>17</td>
<td>2</td>
<td>Mortality &gt;1 year</td>
<td>IIa B</td>
<td>&lt;5</td>
<td>-</td>
</tr>
<tr>
<td>Logistic Clinical SYNTAX</td>
<td>6 508 Multicentre</td>
<td>03/2005 – 04/2007</td>
<td>100% PCI</td>
<td>3</td>
<td>11</td>
<td>1-year MACE and mortality</td>
<td>IIa B</td>
<td>&lt;5</td>
<td>-</td>
</tr>
</tbody>
</table>
Syntax Score 2 (4 years)
Functional SYNTAX Score for Risk Assessment in Multivessel Coronary Artery Disease

Chang-Wook Nam, MD, PhD,*† Fabio Mangiacapra, MD,‡ Robert Entjes, MD,§ In-Sung Chung, MD, PhD,† Jan-Willem Sels, MD, PhD, A. L. Torino, MD, PhD,§ Bernard De Bruyne, MD, PhD,§ Nico H. J. Fijls, MD, PhD,§ William F. Fearon, MD,* on behalf of the FAME Study Investigators

Figure 1  Proportions of Study Population

Proportions of the study population according to the tertiles of the classic SYNTAX score (SS) (A) and those of the functional SYNTAX score (FSS) (B). After incorporating FFR into the SS to calculate FSS, 32% of patients moved from a higher-risk group to a lower-risk group as follows: 38% of the highest SS tertile moved to the medium- or lowest-risk FSS group, whereas 59% of the medium-risk SS tertile moved to the lowest-risk FSS group.
FAME study: Event-free Survival

absolute difference in MACE-free survival

Survival Free of MACE

Days since Randomization

30 days
2.9%

90 days
3.8%

180 days
4.9%

360 days
5.3%

FFR-guided

Angio-guided
2013 ESC Guidelines For Stable CAD

Left main coronary artery with relevant stenosis\(^a\)

±1 vessel disease

Ostium/mid shaft

Distal bifurcation

+2 or 3 vessel disease

Syntax score ≤32

Syntax score ≥33

Heart Team Discussion\(^b\)

High surgical risk\(^b\)

Low surgical risk\(^b\)

PCI

CABG

\(^a\)50% stenosis and proof of ischaemia, >70% stenosis in two angiographic views, or FFR <0.80. \(^b\)Preferred option in general.
Recommendation for the type of revascularization (CABG or PCI) in patients with SCAD with suitable coronary anatomy for both procedures and low predicted surgical mortality

<table>
<thead>
<tr>
<th>Recommendations according to extent of CAD</th>
<th>CABG</th>
<th>PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One or two-vessel disease without proximal LAD stenosis.</strong></td>
<td>IIb</td>
<td>C</td>
</tr>
<tr>
<td>One-vessel disease with proximal LAD stenosis.</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Two-vessel disease with proximal LAD stenosis.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Left main disease with a SYNTAX score ≤ 22.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Left main disease with a SYNTAX score 23–32.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Left main disease with a SYNTAX score &gt;32.</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Three-vessel disease with a SYNTAX score ≤ 22.</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Three-vessel disease with a SYNTAX score 23–32.</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Three-vessel disease with a SYNTAX score &gt;32.</td>
<td>I</td>
<td>A</td>
</tr>
</tbody>
</table>

Windecker, European Society of Cardiology 2014
Ostial LM PCI: technical aspects

- Hemodynamic support
- Guiding
- Preparation (after thoracic radiations +)
- Stent positioning
- Sizing
Ostial / diffuse left main
Predilation
Stent positioning (1)
Stent positioning (2)
Stent deployment
Result
Final result (FFR prox and distal LAD > 0.8)
- 48 yo
- Male
- Smoking, family history
- Ressuscitated sudden death
- Sinus rythm
- 105 / 58 mmHg
- Some Adrenaline
- Right TRA 5F
- At night …
Right radial angio 5F
Right radial angio 4F (friction)
1 wire only
Stenting

Xience 3.5X8
Post stenting
Post dilatation

Balloon 4.5
Final result
Very short LM: Bifurcation stenting
Conclusions

• Ostial LM stenosis are less frequent than distal

• Ostial stenting is easier and has a better outcome than distal bifurcation stenting

• Respective places of CABG and PCI are depending of surgical risk (Euroscore …) and number/complexity of non LM lesions (SYNTAX and other scores)

• Stent sizing and positioning are the difficult technical aspects