A randomized trial evaluating On-line three-dimensional OFDI guided PCI vs. angiography guided PCI in bifurcation lesions
OPTIMUM study
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On behalf of the OPTIMUM investigators
• In bifurcation PCI, re-crossing the distal cell with a wire after main vessel stenting is important to avoid creating a de novo metal carina\textsuperscript{1}. Those protruded/malapposed struts result in lower tissue strut coverage of the side branch ostium and more overhanging metal into the main branch after implantation of the stent\textsuperscript{2}.

• Angiography guided PCI is limited in recognizing the recrossing position, while intracoronary imaging during PCI has a potential to visualize the recrossing point and to optimize the acute results.

• The feasibility of \textbf{off-line} 3-dimensional optical frequency domain imaging (OFDI) in bifurcation and its potential benefits were demonstrated in retrospective studies\textsuperscript{3,4}.

• However, the feasibility and efficacy of \textbf{on-line 3D OFDI guided} PCI in bifurcation lesion has not yet been fully investigated.

To determine whether bifurcation PCI guided by on-line 3D-OFDI is superior to bifurcation PCI with angiographic guidance in terms of **incomplete stent apposition (ISA)** in bifurcation segment.
**How was the study executed?**

**Design**
- A multi-centre, open-label, prospective **randomized** investigator-driven trial

**Primary endpoints**
- Post-procedural **percentage of malapposed struts** assessed by OFDI in bifurcation segment.

**Major eligibility criteria**
- Patients who undergoes bifurcation PCI with evidence of ischemia, excluding patients presented with STEMI
- Angiographically significant stenosis (>50%) in de novo, native, previously unstented **bifurcation lesion(s)** with a **sidebranch of >2.0mm** in diameter, which is appropriate to be treated by **PCI with a single stent strategy**
How was the study executed?

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Imaging OFDI Corelab: Cardialysis, Rotterdam, NL
Grant Giver: TERUMO
NCT02972489

4 Japanese Centres

CARDIALYSIS
Clinical Trial Management - Core Laboratories

TERUMO
How was the study executed?

Sample size calculation

Assumptions for sample size determination are based on previous registries \(^1,^2\).

**Assumption:**
- Malapposition rate in bifurcation by angio-guidance is 26%.
- 3D-OFDI guidance reduces malapposition by 50%.
- Common standard deviation: 20%

**Sample size:**
- Alpha = 0.05 (2-sided)
- Power 90%
- 5% of insufficient quality OFDI
- N = 53 x 2

106 subjects are to be randomized.

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Bifurcation PCI with provisional single stent strategy
n = 110

3D OFDI guidance arm
56 pts with 57 lesions

Implantation of Ultimaster stent

POT

3D OFDI guidance wire recross

Angio guidance arm
54 pts with 54 lesions

Implantation of Ultimaster stent

POT

Wire recross
Bifurcation PCI with provisional single stent strategy  
\( n = 110 \)

**3D OFDI guidance arm**  
56 pts with 57 lesions

**Angio guidance arm**  
54 pts with 54 lesions

- **Implantation of Ultimaster stent**
- **POT**
- **3D OFDI guidance wire recross**

Study Flow Chart

Bifurcation PCI with provisional single stent strategy
n = 110

3D OFDI guidance arm
56 pts with 57 lesions

Implantation of Ultimaster stent

POT

3D OFDI guidance wire recross

Final KBD

OFDI
L = 57

Angio guidance arm
54 pts with 54 lesions

Implantation of Ultimaster stent

POT

Wire recross

Final KBD

OFDI
L = 52

1: OFDI was not able to be performed due to wire stuck
1: OFDI was not able to cross the lesion
Bifurcation PCI with provisional single stent strategy
n = 110

3D OFDI guidance arm
56 pts with 57 lesions

Implantation of Ultimaster stent

POT

3D OFDI guidance wire recross

Final KBD

OFDI
L = 57

ISA was analyzable
L = 55

Primary endpoint
Acute ISA at bifurcation

Angio guidance arm
54 pts with 54 lesions

Implantation of Ultimaster stent

POT

Wire recross

Final KBD

OFDI
L = 52

1: OFDI was not able to be performed due to wire stuck

1: OFDI was not able to cross the lesion

2: insufficient quality of OFDI

ISA was analyzable
L = 50

2: insufficient quality of OFDI
## Baseline characteristics

<table>
<thead>
<tr>
<th></th>
<th>OFDI-guided PCI</th>
<th>Angio-guided PCI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>68.9 ± 10.2</td>
<td>69.4 ± 11.6</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>79%</td>
<td>74%</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Medical history</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>52%</td>
<td>46%</td>
<td>0.56</td>
</tr>
<tr>
<td>Hypertension</td>
<td>77%</td>
<td>74%</td>
<td>0.74</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>86%</td>
<td>85%</td>
<td>0.94</td>
</tr>
<tr>
<td>Current smoker</td>
<td>55%</td>
<td>59%</td>
<td>0.68</td>
</tr>
<tr>
<td>Previous MI</td>
<td>16%</td>
<td>15%</td>
<td>0.86</td>
</tr>
<tr>
<td>Previous PCI</td>
<td>4%</td>
<td>0%</td>
<td>0.26</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>21%</td>
<td>35%</td>
<td>0.06</td>
</tr>
<tr>
<td>Serum creatinine, mg/dL</td>
<td>0.79 (0.70-0.95)</td>
<td>0.81 (0.70-0.99)</td>
<td>0.78</td>
</tr>
<tr>
<td>Ejection fraction, %</td>
<td>60.8 ± 14.3</td>
<td>59.7 ± 11.8</td>
<td>0.67</td>
</tr>
<tr>
<td><strong>Clinical presentation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-STEMI</td>
<td>2%</td>
<td>2%</td>
<td>0.74</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>7%</td>
<td>4%</td>
<td>0.36</td>
</tr>
<tr>
<td>Stable angina/Silent ischemia</td>
<td>91%</td>
<td>94%</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Data are mean ± SD, median (IQ1,3) or percentage.
## Procedural characteristics

<table>
<thead>
<tr>
<th></th>
<th>OFDI L=57</th>
<th>Angio L=54</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target bifurcation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LMT or LAD-Dx</td>
<td>75%</td>
<td>67%</td>
<td>0.31</td>
</tr>
<tr>
<td>LCx-OM or PL</td>
<td>16%</td>
<td>15%</td>
<td>0.89</td>
</tr>
<tr>
<td>RCA PD-PL</td>
<td>9%</td>
<td>19%</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Medina classification</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1, 1, 1) or (0, 1, 1)</td>
<td>14%</td>
<td>6%</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Ultimaster stent implantation</strong></td>
<td>100%</td>
<td>100%</td>
<td>NA</td>
</tr>
<tr>
<td>Size, mm</td>
<td>2.76 ± 0.38</td>
<td>2.72 ± 0.33</td>
<td>0.51</td>
</tr>
<tr>
<td>Length, mm</td>
<td>30.0 ± 7.3</td>
<td>28.8 ± 7.3</td>
<td>0.36</td>
</tr>
<tr>
<td>POT was performed</td>
<td>98%</td>
<td>98%</td>
<td>0.74</td>
</tr>
<tr>
<td>Balloon size, mm</td>
<td>3.29 ± 0.47</td>
<td>3.30 ± 0.54</td>
<td>0.94</td>
</tr>
<tr>
<td>Pressure, atm</td>
<td>13.6 ± 3.2</td>
<td>13.9 ± 3.8</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Data are mean ± SD or percentage.
A Case of Angio-guided PCI

LM bifurcation with Medina 010

Wire re-cross after POT

post FKBD

3D OFDI after final KBT

Wire crossed through A2-L segment

Ultimaster 3.0x15 mm
POT 4.0 mm
A Case of Angio-guided PCI

LM bifurcation with Medina 010

SB

MB

Ultimaster 3.0x15 mm
POT 4.0 mm

Wire crossed through A2-L segment

%ISA: 33.9%
A Case of OFDI-guided PCI

LAD bifurcation with Medina 111

pre PCI

post PCI

Ultimaster 3.0x28 mm

3D OFDI after final KBT

Achieved optimal result!

3D OFDI guided Wire-recross

Distal

Proximal
A Case of OFDI-guided PCI

LAD bifurcation with Medina 111

post PCI

Ultimaster 3.0x28 mm
Primary endpoint:
Incomplete Stent Apposition at bifurcation

Incidence of ISA (%)

P=0.008
19.5%
27.5%

3D-OFDI guidance was superior to angio-guidance in acute incomplete strut apposition (creation of metal carina) of bifurcation segment
Summary of 3-D OFDI guided wire recrossing

- Feasibility of on-line 3D-OFDI: 56/57 (98%)
- Re-crossing position after POT was suboptimal in 45%, requiring 2\textsuperscript{nd} attempt
- With 3D-OFDI guidance, optimal wire re-crossing was achieved in 100%.
- Distribution of configurations of overhanging struts

<table>
<thead>
<tr>
<th>No ring at carina</th>
<th>Ring at carina with multiple 2\textsuperscript{nd} distal compartments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Distal</td>
<td>Proximal</td>
</tr>
<tr>
<td>11 (19%)</td>
<td>22 (39%)</td>
</tr>
</tbody>
</table>

- Use of total contrast volume was not different between two arms.

<table>
<thead>
<tr>
<th></th>
<th>OFDI, N=56</th>
<th>Angio, N=54</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast volume, ml (Median)</td>
<td>175.0 (146.3-210.0)</td>
<td>175.0 (125.0-230.0)</td>
<td>0.87</td>
</tr>
</tbody>
</table>
Quantitative OFDI measurement of stented segments

<table>
<thead>
<tr>
<th>Stent segment</th>
<th>OFDI guidance L=55</th>
<th>Angio guidance L=50</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ISA area, mm²</td>
<td>0.23 ± 0.20</td>
<td>0.27 ± 0.27</td>
<td>0.39</td>
</tr>
<tr>
<td>Mean stent area, mm²</td>
<td>6.48 ± 1.61</td>
<td>6.20 ± 1.65</td>
<td>0.38</td>
</tr>
<tr>
<td>Mean intrastent defect attached to/free from the vessel wall, mm²</td>
<td>0.11 ± 0.09</td>
<td>0.09 ± 0.06</td>
<td>0.15</td>
</tr>
<tr>
<td>Minimum flow area, mm²</td>
<td>4.72 ± 1.36</td>
<td>4.63 ± 1.24</td>
<td>0.70</td>
</tr>
<tr>
<td>Mean flow area, mm²</td>
<td>6.85 ± 1.63</td>
<td>6.67 ± 1.78</td>
<td>0.60</td>
</tr>
</tbody>
</table>
In the randomized trial of bifurcation PCI, 3D-OFDI guidance was superior to angio-guidance in acute incomplete strut apposition (creation of metal carina) of bifurcation segment (3D-OFDI 19.5±15.8% vs. angio: 27.5%±14.2%, p=0.008).

Excellent feasibility of online 3D-OFDI was demonstrated (98%).

After mandatory POT, the first wiring position was not optimal in 45% of cases, requiring 2nd attempt to redirect the wire into the optimal cell when 3D-OFDI guidance was used.

On-line 3D OFDI images help operator to undergo rewiring to the optimal cell, resulting in a lower rate of malapposition compared with angiography guided PCI.