TCTAP 2013 Fellowship Course
Left Main and Bifurcation PCI: Bifurcation PCI

Plaque Shift vs. Carina Shift
Prevalence and Implication

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Disclosure

I have nothing to disclose
Mechanisms of Angiographic SB Jailing

Stent Strut Artifact

Pre-procedural

Post-stenting

After cross-over

MLA 8.4mm²

MLA 8.3mm²

Nobori
**Carina Shift**

\[ \Delta V / \Delta L > 1 \]

\[ \Delta P < 0 \]

**Area Change**

<table>
<thead>
<tr>
<th>( \Delta L )</th>
<th>-3.4 mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta V )</td>
<td>-3.5 mm²</td>
</tr>
<tr>
<td>( \Delta P )</td>
<td>-0.1 mm²</td>
</tr>
</tbody>
</table>

- **SB MLA 7.2 mm²**
- **EEM area 9.3 mm²**
- **P+M area 2.1 mm²**

- **SB MLA 3.8 mm²**
- **EEM area 5.8 mm²**
- **P+M area 2.0 mm²**
Plaque Shift

$\Delta V / \Delta L < 1$

$\Delta P > 0$

<table>
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<tr>
<th>Area Change</th>
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<tr>
<td>$\Delta L$</td>
</tr>
<tr>
<td>$\Delta V$</td>
</tr>
<tr>
<td>$\Delta P$</td>
</tr>
</tbody>
</table>

Pre-procedure

- PB 52%
- PB 70%
- SB MLA 2.3 mm$^2$
- EEM area 5.0 mm$^2$
- P+M 2.7 mm$^2$

After MB stenting

- SB FFR 0.77
- PB 70%
- SB MLA 1.4 mm$^2$
- EEM area 4.7 mm$^2$
- P+M 3.3 mm$^2$
Plaque Shift vs. Carina Shift

- Prevalence of Carina vs. Plaque Shift
- Impact on Functional Significance
Luminal gain is not caused by plaque shift but by EEM expansion, leading to carina shift and SB compromise.

Changes in Left Main Bifurcation Geometry After a Single-Stent Crossover Technique

An Intravascular Ultrasound Study Using Direct Imaging of Both the Left Anterior Descending and the Left Circumflex Coronary Arteries Before and After Intervention (n=23 LM bifurcation lesions)

MLA within LCX ostium
5.4mm² → 4.0mm²

EEM area at MLA
11.8mm² → 9.6mm²

EEM eccentricity
1.22 → 1.47

78% showed a >10% reduction of MLA within LCX ostium after cross-over stenting

Hemodynamic Impact of Changes in Geometry of Non-LM Bifurcation

Non-LM bifurcation lesions with SB ostial DS<50%

<table>
<thead>
<tr>
<th>SB MLA (mm²)</th>
<th>EEM (mm²)</th>
<th>Eccentricity</th>
<th>P+M (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5±1.3→2.8±1.2</td>
<td>6.3±1.9→5.5±1.7</td>
<td>1.1±1.1→1.4±0.2</td>
<td>2.8±1.5→2.7±1.3</td>
</tr>
</tbody>
</table>

*Kang et al. Catheter Cardiovasc Interv 2013 in press*
Plaque Shift + Carina Shift

Plaque Shift vs. Carina Shift

- Prevalence of Carina vs. Plaque Shift
- Impact on Functional Significance
SB ostium with pre-procedural DS<50% 48% were angiographically jailed (DS>50%) after MB stenting, while 15% had FFR<0.80

AMC preliminary
How Often Functional SB Compromise?

Kang et al. Am J Cardiol 2011;107:1787-93
How to Treat Angiographic Jailing of SB?

**FFR >0.75** is safe for deferral of jailed SB

FFR-guided provisional SB intervention resulted in a low rate of 9-month MACE

*Koo et al. Eur Heart J 2008;29:726–32*
Mismatch Between QCA vs. FFR

Post-stenting DS 70%
SB FFR 0.83

Post-stenting DS 80%
SB FFR 0.88
Discordance Between Post-stenting QCA-DS vs. SB FFR

Koo et al. JACC 2005;46:633

Ahn et al. JACC Interv in Press
Why Mismatch?
Angiography and SB FFR

- Lesion eccentricity of SB
- Negative remodeling of ostium
- Various size of myocardium
- Strut artifacts

Is Post-stenting SB-IVUS Useful to Assess Jailed SB?

SB MLA <2.25mm²

To Predict FFR<0.80

- Sensitivity 100%
- Specificity 71%
- PPV 38%
- NPV 100%

Why Mismatch?
IVUS-MLA vs. FFR

- Small myocardial territory
- The general mechanism of SB jailing is focal carina shift rarely causing functional stenosis
Why Does the Isolated Carina Shift Rarely Reduce FFR?

- Not by plaque gain, but by vessel deformation
- The luminal change is extremely focal
Plaque shift may be a prerequisite to the hemodynamically significant SB stenosis

*Kang et al. Catheter Cardiovasc Interv 2013 in press*
Predictor for Plaque Shift

\[ \Delta P + M, \text{SB ostium} \ (\text{mm}^2) \]

- \[ r = 0.341 \]
- \[ p = 0.031 \]

<table>
<thead>
<tr>
<th>Plaque burden at MB carina (%)</th>
<th>( \Delta P + M, \text{SB ostium} )</th>
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<tbody>
<tr>
<td>-1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>-0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>0.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predictor</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumen area, MB carina</td>
<td>-0.137</td>
<td>0.399</td>
</tr>
<tr>
<td>Plaque burden, MB carina</td>
<td>0.341</td>
<td>0.031</td>
</tr>
<tr>
<td>Plaque burden, distal MB</td>
<td>0.299</td>
<td>0.061</td>
</tr>
<tr>
<td>Plaque burden, proximal MB</td>
<td>-0.039</td>
<td>0.813</td>
</tr>
<tr>
<td>Plaque burden, SB ostium</td>
<td>-0.218</td>
<td>0.176</td>
</tr>
</tbody>
</table>

A narrow distal carina angle predicted a greater reduction in MLA and EEM area at the LCX ostium.

Summary

- Carina shift is a general mechanism of SB jailing, occurs in almost all lesions
- Plaque shift is less frequent, but more aggressive mechanism of the functional SB compromise
- Considering the frequent visual–functional mismatch, treatment of the jailed SB should be based on post-stenting SB FFR