Bifurcation Stenting

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Disclosures

None
Bifurcation Stenting
Coronary Bifurcation Lesions are Technically Challenging

• Represent approximately 15-20% of PCI\textsuperscript{1}

• Associated with:
  – Higher rate of adverse cardiovascular outcomes\textsuperscript{2}
  – Higher rate of stent thrombosis (0.5% - 6%)\textsuperscript{3}
  – Rates of TLR are as high as 40\%\textsuperscript{4}
  – Longer fluoroscopy time
  – Higher amount of contrast

\textsuperscript{1}J Am Coll Cardiol 1992;19:1641-52
\textsuperscript{2}Am J Cardiol 2001;87:1139-44.
\textsuperscript{3}Catheter Cardiovasc Interv 2010;75:309-14
\textsuperscript{4}JAMA 2005;293:2126-30.
Challenges to PCI of Bifurcation Lesions

- Multitude of anatomic variations for bifurcation lesions:
  1. Bifurcation site
  2. Plaque location
  3. Plaque burden and morphology
  4. Bifurcation angle between the MB and SB
  5. Vessel diameter

- Bifurcation anatomy is dynamic during PCI:
  - Plaque shift
  - Carina shift
  - Change in the bifurcation angle
  - Vessel spasm
  - Coronary dissection

Circ J 2011;75:263-5
Predictors of SB occlusion

- Ostial or near-ostial SB disease\(^1\)
- Smaller SB diameters\(^2\)
- SB origin within a MB lesion\(^2\)
- Sharper bifurcation angles\(^2\)
- ‘Eyebrow sign’ on IVUS or vulnerable carina

Main Mechanism is likely secondary to carinal +/- plaque shift

\(^1\)Am J Cardiol 1997;80:994-997.
\(^2\)Eurointervention Supplement 2010; 6:J72-J80.
Current Strategy to PCI of Bifurcations Lesions

- A single stent strategy with cross-over technique is recommended
- Never compromise the main vessel
- Optimize side branch patency

How can we optimize the results...
CASE #1: Limitation of Angiogram
Patient Profile

- 77 year old male
  - Hypertension
  - Hyperlipidemia
  - Family history of CAD
- Presented with intermittent chest discomfort
  - During stress test ECG changes and abnormal blood pressure response suggestive of ischemia
Patient Profile

• Cath showed complex high grade lesion in the ostium of circumflex and moderate narrowing in distal LM

• Transferred for revascularization

• Discussion of CABG vs PCI with patient and family, patient opted for PCI

• Syntax score of 22
CATH

- Distal LM with 30-40% narrowing extending into ostium of LAD
- High grade 95% narrowing of circumflex
- Circumflex wired
- LAD wired for protection
- Circumflex ostium inflated with 2.5 x 12 mm semi-compliant balloon at 10 atm
- Angiography with immediate recoil
FFR LM into LAD
- Circumflex ~ 3.5 mm in diameter
- Significant plaquing in the ostium of circumflex extending back into LM

- IVUS from LM to LAD showed plaque extended into ostium of LAD
Stenting Strategy

Based on FFR/IVUS, decision was made to place a stent from LM into circumflex and a stent into ostium of LAD
Stent Position & Deployment

- 4 x 8 mm DES in ostium LAD
- 3.5 x 18 mm DES from LM to Circumflex
- LAD stent deployed at 12 atm
Stent Position & Deployment

- LM to Circumflex stent deployed at 20 atm

- Normal flow, No dissection and Mild narrowing ostium LAD
Proximal Optimization (POT)

4.5 x 8 mm NC balloon @ 12 atm
Final Inflations

- After POT, LAD rewired
- 4 x 8 mm NC Balloon in LAD and 3.5 x 12 mm NC balloon LM to Circumflex
- Sequential inflations @ 20 atm and final kissing balloon
TIMI 3 flow, No dissection, and No residual stenosis
Therapeutic Algorithm
LESION ASSESSMENT (IVUS and FFR)

If YES, consider Jailed Balloon Technique

One-Stent Technique with Provisional SB Stenting

Does the lesion contain any of the following:
1) Bifurcation Angle > 70°
2) SB Diameter > 2.0 mm
3) Moderate to large area of myocardium supplied by SB
4) IVUS Eyebrow Sign

TREAT PRIMARY MB LESION

Does the following occur:
1) Chest Pain
2) < TIMI 3 Flow in the SB
3) Flow limiting dissection

NO

FKI/SMS and POST-PCI FFR /IVUS Imaging

Perform the following:
1) Proximal Optimization Technique
2) Provisional SB PTCA/Stenting

Yes
How Can IVUS help to optimize PCI of bifurcation lesions?
IVUS: Pre-Intervention

- Measure vessel size
- Measure lesion length
  - helps to select stent size and length
- Assess plaque composition and distribution at bifurcation
- Mark side branch ostium
- Vulnerable carina anatomy or “Eyebrow sign”
- Assess unusual lesion morphology
Vulnerable carina - Eyebrow sign
Vulnerable carina - Eyebrow sign
IVUS: Post-Intervention

- Can be used to assess for:
  - Stent underexpansion
  - Stent Apposition (i.e. contact between stent and vessel wall)
  - Full lesion coverage (is side branch covered?)
  - Complications from PCI
    - Edge dissection
    - Plaque protrusion
Long-Term Outcomes With Use of Intravascular Ultrasound for the Treatment of Coronary Bifurcation Lesions

Yogesh Patel, MD, Jeremiah P. Depta, MD, Eric Novak, MS, Michael Yeung, MD, Kory Lavine, MD, PhD, Sudeshna Banerjee, MD, C. Huie Lin, MD, PhD, Alan Zajarias, MD, Howard I. Kurz, MD, John M. Lasala, MD, PhD, Richard G. Bach, MD, and Jasvindar Singh, MD*

• Retrospective analysis of 449 patients with 471 distinct coronary bifurcation lesions of PCI with and without the use of IVUS between December 2007 and August 2010

<table>
<thead>
<tr>
<th>Clinical Outcomes</th>
<th>IVUS (N=247 patients, 258 lesions)</th>
<th>NO IVUS (N=202 patients, 213 lesions)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death or myocardial infarction</td>
<td>20 (8%)</td>
<td>42 (21%)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Death</td>
<td>14 (6%)</td>
<td>24 (12%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>7 (3%)</td>
<td>24 (12%)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Stent thrombosis</td>
<td>0 (0%)</td>
<td>5 (2%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Periprocedural MI</td>
<td>16 (6%)</td>
<td>24 (12%)</td>
<td>0.06</td>
</tr>
<tr>
<td>Target vessel revascularization</td>
<td>19 (7%)</td>
<td>52 (24%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Target lesion revascularization</td>
<td>15 (6%)</td>
<td>45 (21%)</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

*Site of target TLR*

<p>| Both MB and SB                            | 2 (13%)                           | 3 (7%)                               | 0.82    |
| MB                                        | 7 (47%)                           | 25 (55%)                             |         |
| SB                                        | 6 (40%)                           | 17 (38%)                             |         |</p>
<table>
<thead>
<tr>
<th>IVUS Findings</th>
<th>Total (n = 258 lesions)</th>
<th>Lesions developing TLR (n = 15 lesions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVUS used pre-stenting</td>
<td>87 (34%)</td>
<td>3 (15%)</td>
</tr>
<tr>
<td>IVUS used post-stenting</td>
<td>258 (100%)</td>
<td>15 (100%)</td>
</tr>
<tr>
<td>Well apposed stent/no complications</td>
<td>131 (51%)</td>
<td>8 (53%)</td>
</tr>
<tr>
<td>Post-stenting IVUS findings requiring</td>
<td>127 (49%)</td>
<td>7 (46%)</td>
</tr>
<tr>
<td>intervention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edge dissection</td>
<td>7 (3%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Lesion re-characterization requiring</td>
<td>35 (14%)</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>stenting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaque shift</td>
<td>14 (5%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Stent underexpansion</td>
<td>71 (27%)</td>
<td>5 (33%)</td>
</tr>
</tbody>
</table>
Conclusions

• IVUS is associated with lower rates of adverse cardiac events including death or MI, MI, and TLR
  – Even after adjustment for baseline differences
• IVUS is associated with a trend towards lower rates of all-cause mortality and stent thrombosis
• Stent underexpansion was found in 25% of patients in the IVUS group
  – Recognition and treatment may have lead to improved clinical outcomes with IVUS
LESION ASSESSMENT (IVUS and FFR)

D: < 2.5 mm or L: < 10 mm
- One-Stent Technique with Provisional SB Stenting
  - TREAT PRIMARY MB LESION
  - Does the following occur:
    1) Chest Pain
    2) < TIMI 3 Flow in the SB
    3) Flow limiting dissection
      - Yes

D: > 2.5 mm and L: > 10 mm
- Two-Stent Technique

SB Diameter and Lesion Length
- Does the lesion contain any of the following:
  1) Bifurcation Angle > 70º
  2) SB Diameter > 2.5 mm
  3) Moderate to large area of myocardium supplied by SB
- If YES, consider Jailed Balloon Technique

If YES, consider Jailed Balloon Technique
- performs the following:
  1) Proximal Optimization Technique
  2) Provisional SB Stenting

FKI and POST-PCI IVUS Imaging
- NO

Performs the following:
  1) Proximal Optimization Technique
  2) Provisional SB Stenting
The “Jailed-Balloon” Technique
The “Jailed-Balloon” Technique

**Step 1:**

Wire both MB/SB

Angioplasty MB
Step 2:
Position SB balloon

Angioplasty SB if needed

The “Jailed-Balloon” Technique
Step 3:
Deploy MB stent and jail SB balloon
The “Jailed-Balloon” Technique

Step 3:
Maintain stent balloon position post-inflation
Step 4:

Inflate jailed SB balloon to low ATM
The “Jailed-Balloon” Technique

**Step 5:**
Correct stent deformation with stent balloon

Jail SB wire to maintain position and SB angle
Step 6:

Reaccess SB if provisional stenting required

Remove jailed wire

The “Jailed-Balloon” Technique
A Modified Provisional Stenting Approach to Coronary Bifurcation Lesions: Clinical Application of the “Jailed-Balloon Technique”

JASVINDAR SINGH, M.D., YOGESH PATEL, M.D., JEREMIAH P. DEPTA, M.D., SANTHOSH J. MATHEWS, M.D., M.S., TILLMANN CYRUS, M.D., ALAN ZAJARIAS, M.D., HOWARD I. KURZ, M.D., JOHN M. LASALA, M.D., Ph.D., and RICHARD G. BACH, M.D.

From the Division of Cardiology, Department of Medicine, Washington University School of Medicine, St. Louis, Missouri

- Retrospective analysis of 100 patients with 102 bifurcation lesions of PCI utilizing “jailed-balloon technique” (JBT) between December 2007 and August 2010
# PROCEDURAL OUTCOMES (n = 102 lesions)

<table>
<thead>
<tr>
<th>Event</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMI 3 Flow after procedure</td>
<td>102</td>
<td>100%</td>
</tr>
<tr>
<td>Main branch</td>
<td>102</td>
<td>100%</td>
</tr>
<tr>
<td>Side branch</td>
<td>101</td>
<td>99%</td>
</tr>
<tr>
<td>Periprocedural MI</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Coronary edge dissection</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>Side branch loss</td>
<td>1</td>
<td>1%</td>
</tr>
<tr>
<td>Recross side branch</td>
<td>9</td>
<td>9%</td>
</tr>
<tr>
<td>Side branch stenting</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>Rescue kissing balloon</td>
<td>7</td>
<td>7%</td>
</tr>
<tr>
<td>Jailed-balloon or wire entrapment</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Jailed-balloon rupture</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>
### CLINICAL OUTCOMES
**(n = 100 patients, 102 lesions)**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-cause mortality</td>
<td>3 (3%)</td>
</tr>
<tr>
<td>Cardiovascular death</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Myocardial Infarction</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Periprocedural MI</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>CABG</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Stent thrombosis</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Target Lesion Revascularization</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Target Vessel Revascularization, non-TL</td>
<td>2 (2%)</td>
</tr>
</tbody>
</table>

Mean follow-up duration = 1.4 ± 0.7 years
Conclusions

• Our experience with the “jailed-balloon technique” for bifurcation lesions results in:
  – Excellent procedural success
  – Almost 100% patency of the SB
  – Preservation of the bifurcation angle Post-PCI
  – Very low rates of TLR
  – Low incidence of adverse cardiac events

• Improved long-term outcomes with the use of the JBT primarily through lower rates of TLR
LESION ASSESSMENT (IVUS and FFR)

- D: < 2.5 mm or L: < 10 mm
  - One-Stent Technique with Provisional SB Stenting
  - TREAT PRIMARY MB LESION

- SB Diameter and Lesion Length
  - Does the lesion contain any of the following:
    1) Bifurcation Angle > 70°
    2) SB Diameter > 2.5 mm
    3) Moderate to large area of myocardium supplied by SB
  - If YES, consider Jailed Balloon Technique

- D: > 2.5 mm and L: > 10 mm
  - Two-Stent Technique
  - FKI and POST-PCI IVUS Imaging

Does the following occur:
1) Chest Pain
2) < TIMI 3 Flow in the SB
3) Flow limiting dissection

- NO
  - Perform the following:
    1) Proximal Optimization Technique
    2) Provisional SB Stenting

- YES
  - NO
  - NO
Proximal Optimization Technique

- Post dilatation of stent performed to optimize strut apposition

- May improve success of re-crossing of side-branch

Summary

- Pre-treatment IVUS and FFR is strongly encouraged.
- One-stent approach with provisional SB stenting will suffice for most lesions with the use of JBT.
- POT and FKI should be performed in all provisional stenting cases.
- Post-treatment IVUS should be used to optimize the results.
Thank you