Complex Coronary Interventions: Bifurcations

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Disclosures

• Advisory Board - Boston Scientific, St. Jude Medical

• Speaker- Abiomed, AGA Medical/St. Jude Medical, Eli Lilly
Objectives

• Recognize the importance of complex bifurcation lesions in modern PCI

• Recognize that provisional stenting is preferred for most bifurcation lesions

• Understand novel provisional stenting strategies, including the jailed-balloon technique

• When using a two-stent approach, recognize the importance of IVUS-guided PCI
Bifurcations Overview

- Quite common in modern PCI (20% of all PCI’s)
- More complications
- Lower success rates
- Bifurcation PCI is associated with more restenosis/TLR
  - Restenosis 21 - 57%
  - TLR 8-43%
Bifurcation Classification: Medina
The Rise of Provisional Stenting

• One (MB) vs. Two Stents (MB/SB)

• Provisional Stenting of the SB Preferred in Most Cases
  • Pros:
    • Decreased fluoro/procedure time
    • Less contrast
    • Less MACE
  • Cons:
    • Up to 30% of cases need provisional stenting
    • Change in bifurcation angle
    • Compromise of the SB ostium
    • Difficulty in delivery balloon/stent if stenting of SB required
The Rise of Provisional Stenting

- NORDIC Trial
- CACTUS
- BBC One
The Rise of Provisional Stenting

Nordic Trial- 413 patients randomized to simple or complex stenting strategies

*MACE = Cardiac death, MI, TVR, & Stent Thrombosis
Steigen et al. Circ 2006
The Rise of Provisional Stenting

CACTUS- 350 randomized to Crush or Provisional Stenting (180 Day Cumulative MACE)

Colombo et al. Circ 2009
The Rise of Provisional Stenting

BBC One Trial - 500 patients randomized to simple or complex strategy (9 Month Data)

- Primary Endpoint: p = 0.009, HR 2.02
- Death: p = 0.001, HR 3.24

Hildick-Smith et al. Circ 2010
NORDIC-3: True Bifurcation Subgroup

MACE & TLR at 6 Months

- **MACE**
  - FKBD: 1.7%
  - No-FKBD: 0.8%
  - p = 0.68

- **TLR**
  - FKBD: 1.7%
  - No-FKBD: 2.5%
  - p = 0.62

*Neimel et al. Circ 2011*
Provisional Stenting Techniques

Jailed-Balloon Technique

- Both limbs are wired

Patel et al. JACC 2010 (Abstr)
Provisional Stenting Techniques

Jailed-Balloon Technique

- Balloon pre-dilatation of the MB
- Helps assess degree of plaque shift
- Balloon SB if necessary only

Patel et al. JACC 2010 (Abstr)
Provisional Stenting Techniques

Jailed-Balloon Technique

- Position stent in MB
- Long 1.5-2.0 mm balloon extends proximal to stent and distally past SB ostium

Patel et al. JACC 2010 (Abstr)
Provisional Stenting Techniques

Jailed-Balloon Technique

- Deploy MB stent jailing SB balloon

Patel et al. JACC 2010 (Abstr)
Provisional Stenting Techniques

Jailed-Balloon Technique

- Perform angiography - if no SB compromise, remove SB balloon after low pressure inflation or no inflation (if possible)

- Otherwise balloon angioplasty of SB if needed prior to removal

Patel et al. JACC 2010 (Abstr)
Provisional Stenting Techniques

Jailed-Balloon Technique

- Stent balloon is left in same position and not removed

*Patel et al. JACC 2010 (Abstr)*
Provisional Stenting Techniques

Jailed-Balloon Technique

- MB stent balloon inflation corrects stent deformation (if any)
- If rewiring SB is necessary, do so before balloon inflation

*Patel et al. JACC 2010 (Abstr)*
Provisional Stenting Techniques

Jailed-Balloon Technique

- Successful JBT will allow MB stent deployment with reduced risk of SB compromise

Patel et al. JACC 2010 (Abstr)
JBT Clinical Experience (WashU)

102 patients reviewed between 2007 and 2010 utilizing JBT

- 62% Male
- Most with multiple CV risk factors
- 91% with Medina 1,1,1 (Duke’s D) Bifurcations

<table>
<thead>
<tr>
<th>Procedural Outcomes (n = 102)</th>
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<tbody>
<tr>
<td>Balloon Rupture</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>MB TIMI 3 Flow</td>
<td>102 (100%)</td>
</tr>
<tr>
<td>SB TIMI 3 Flow</td>
<td>101 (99%)</td>
</tr>
<tr>
<td>Recross MB Stent</td>
<td>6 (6%)</td>
</tr>
<tr>
<td>Kissing Balloon Angioplasty</td>
<td>4(4%)</td>
</tr>
<tr>
<td>Angioplasty SB</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Stent SB</td>
<td>1 (1%)</td>
</tr>
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Unpublished Data
One Year Later
Two Stents: Not Always Optional

- In general provisional stenting strategy is preferred
  - Especially true if SB is small and not amenable to PCI
  - Focal SB ostial disease (< 3 mm) or minimal SB involvement

- Elective bifurcation PCI
  - Diffuse SB disease (vessel > 2.25 mm)
  - SB will be exceedingly difficult to recross after MB stenting (unfavorable angle)

- Angle
  - >70° (approaching 90°) - Modified T or TAP
  - <70° - Mini-Crush, V-stent, Culotte, ?TAP
Two Stents: What’s Best?

**Bifurcation Lesion**

- Main vessel
- Side-branch

**Stent+PTCA**
- (*V* - ≤ 5mm)

**Stent+stent (“Kissing” “SKS”)**

**Stent+stent (“T stenting”)**

**Stent+stent (“reverse-T”)**

**Stent+stent (“Crush”)**

**Stent+stent (“Culotte”)**

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Two Stents: What’s Best?

TLR may be driven by multiple procedural factors

- Inadequate coverage of the SB ostium (i.e. T-stent)
- Excess crushed metal at SB ostium (i.e. mini-crush/TAP)
- Too much metal (i.e. Culotte, Crush, SKS)
- No 2-step kissing inflation
- Inappropriate stenting strategy for anatomy

Unpublished Data
Two Stent Strategies: When to Use?

- SB d >2.5 mm - 3 mm and large distribution territory [1,2]
- Ostial disease extends >5 - 20 mm beyond the ostium [1,3]
- Challenging SB access [3]
- Unfavorable re-crossing angle following MB stent implantation [1]
- Bifurcation angle > 60° should be approached with single stent strategies [3]

- If using two stent strategy Culotte stenting is associated with lower restenosis rate than Crush (Nordic II)
- Culotte can be used irrespective of the bifurcation angle [1]
- Avoid Culotte if there is proximal MBd to SBd mismatch (to avoid incomplete proximal MB apposition of SB stent)
- Avoid Crush in wide angle bifurcations [1]

Culotte Stenting

**Advantages**
- Perfect SB coverage
- Suitable for all angles
- Data

**Disadvantages**
- High metal concentration (double stent layer proximally and at carina)
- Difficult rewiring and balloon recross
- Time consuming
- Not ideal if MB d and SB d mismatch
A View From Inside Reverse Culotte
Overcoming challenges: Rewiring and Recrossing

- **Difficulty rewiring**
  - SB crossing proximal strut ~ use second wire / prolapse pullback / distal strut / balloon tip guidance
  - MB proximal under expanded stent ~ POT / IVUS
  - Wire wrapping ~ exchange wires / twin pass catheter

- **Difficulty balloon crossing**
  - Wire wrap ~ exchange wires
  - MB underexpanded stent ~ POT
  - Strut over SB ~ 1.25 balloon / second wire / Glider Balloon / open cell stent with rounded struts
  - Crushed struts
Overcoming challenges: Rewiring and Recrossing

- Difficulty rewiring
  - SB crossing proximal strut ~ use second wire / prolapse pullback / distal strut / balloon tip guidance
Overcoming challenges: Rewiring and Recrossing

- Difficulty rewiring
  - MB proximal under expanded stent ~ POT/IVUS to avoid complication
Overcoming challenges: Rewiring and Recrossing

- Difficulty rewiring & balloon crossing
  - crossing proximal strut, balloon tip guidance for rewiring
Jailed Stent Balloon

An alternative to Culotte for two stents
LESION ASSESSMENT (IVUS and FFR)

**SB Diameter and Lesion Length**

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

- **D: ≥ 2.5 mm and L: ≥ 10 mm**
  - Two-Stent Technique

**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

- If YES, consider Jailed Balloon Technique

**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
A Modified Provisional Stenting Approach to Coronary Bifurcation Lesions:

Clinical

JASVINDA MATHEWS M.D., JOHN

From the Division

Objectives:
bifurcation lesions.
Method:
JBT, Bal et al.
Results:
Bifurcation revealed.
Nine patients.
Conclusions:
Procedure warranted.

SB, MB
Jailed Stent Balloon - *Two Stent Technique (JSBT)*

**Step 1:**
Wire both MB/SB
Jailed Stent Balloon - *Two Stent Technique (JSBT)*

**Step 2:**

Angioplasty SB
Step 3:
Angioplasty MB
Jailed Stent Balloon - *Two Stent Technique (JSBT)*

**Step 4:**
Deploy SB Stent
Step 5:
Partially Withdraw SB Stent Balloon and Deploy MB Stent

Jailed Stent Balloon - Two Stent Technique (JSBT)

Visible Heart Laboratory
University of Minnesota

Washington University in St. Louis
School of Medicine
Step 6: Inflate SB Stent Balloon to Correct SB Stent Deformation

Jailed Stent Balloon - Two Stent Technique (JSBT)
Jailed Stent Balloon - *Two Stent Technique (JSBT)*

**Step 7:**

Inflate MB Stent Balloon to Correct MB Stent Deformation

Jail SB Wire To Facilitate Recross
Step 8 Optional:

Recross SB if Needed and Pull Jailed Wire

Proximal Optimization of MB Stent
Step 9 Optional:

Recross SB and Pull Jailed Wire

“Kissing” OR Sequential “Side-Main” Inflation at Neo-Carina
Jailed Stent Balloon - Two Stent Technique (JSBT) Final Result
Two Stents: What’s Best?

- IVUS-Guided Bifurcation Stenting (WashU)
  - Retrospective review of bifurcation lesions (majority Medina 1,1,1 [Duke D])
  - 202 IVUS-guided vs. 209 Non-IVUS guided bifurcation PCI
  - Majority with multiple cardiovascular risk factors

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<thead>
<tr>
<th></th>
<th>IVUS (N = 195)</th>
<th>Non-IVUS (N = 204)</th>
<th>p-Value</th>
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<tbody>
<tr>
<td>TLR</td>
<td>15 (7.7%)</td>
<td>54 (26.5%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Non-TVR</td>
<td>33 (16.9%)</td>
<td>72 (35.3%)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>CABG</td>
<td>2 (1%)</td>
<td>6 (2.9%)</td>
<td>0.2851</td>
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<tr>
<td>MI</td>
<td>8 (4.1%)</td>
<td>29 (14.2%)</td>
<td>0.0005</td>
</tr>
<tr>
<td>CV Death</td>
<td>4 (2.1%)</td>
<td>4 (2.0%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Death</td>
<td>14 (7.2%)</td>
<td>26 (12.7%)</td>
<td>0.0679</td>
</tr>
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Final Thoughts

- Bifurcation Lesions are Common- 6Fr guiders are only appropriate if the SB is inadequate for PCI.

- Provisional stenting is preferred, especially if the SB is not diseased or has focal disease.

- The Jailed-Balloon Technique is a relatively easy provisional stenting strategy that may help avoid a SB stent and is associated with low TLR.

- There are many bifurcation techniques. Choose based on anatomic and other clinical variables.

- IVUS can guide optimal placement of stents and verify appropriate expansion in the neocarina.