European Guidelines for Treatment of Bifurcation Coronary Lesions

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TCT Asia Pacific 2010
No conflict of interest to declare
Side branch diameter and length can both be used as surrogates for volume of muscle at risk.

Myocardial mass / Diameter / Flow

Normalized Myocardial Mass / Length

Kassab, EBC 2009
SB diameter as an index of MI

\[
\% \text{Infarct}_\text{artery} = M_{SB}/M_{MP} \times 100 = (\text{CSA}_{SB}/\text{CSA}_{MP})^{4/3} \times 100
\]

where SB-Side branch; MP-Most proximal artery (e.g., LAD, LCx or RCA)

- A quantitative relation between SB diameter/area and \%Infarct (relative to main artery or entire heart) exists in swine hearts and needs to be established in patients
- Correlate with clinical biomarkers (biological, molecular, imaging, etc.)
Microinfarction after minor SB occlusion

Side branch < 1.5 mm / CK 260 U/l

Ricciardi et al., Circulation 2001; 103: 2780
How to Define a Bifurcation Lesion?

A coronary artery narrowing occurring adjacent to, and/or involving, the origin of a significant side branch.

A significant SB is a branch that you don't want to lose in the global context of a particular patient.
Bifurcation branching law (Murray)

Finet’s law

\[ D_1 = 0.67(D_2 + D_3) \]

From Koo, EBC, 2008
Branching law and main vessel stenting

In single stent techniques, the primary stent should be sized according to the distal main vessel diameter.

Postdilatation, or kissing balloon inflations, are required to optimise the proximal main vessel stent diameter.
Fractal geometry and QCA

Reference diameter function is not linear

From PIE medical
Medina Classification

1,1,1  
1,1,0  
1,0,1  
0,1,1  
1,0,0  
0,1,0  
0,0,1
Name the bifurcation

Why?:
- for Medina classification (which branch is the SB ?)
- for stenting technique definition
- for intention to treat analysis
MADS classification of bifurcation stenting techniques

<table>
<thead>
<tr>
<th>M</th>
<th>A</th>
<th>D</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main prox. first</td>
<td>Main across side first</td>
<td>Distal first</td>
<td>Side branch first</td>
</tr>
<tr>
<td>1 Stent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After balloon</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Skirt</td>
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<tr>
<td>PM stenting</td>
<td>MB stenting across SB</td>
<td>DM stenting</td>
<td>SB ostial stenting</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>2 Stents</td>
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<tr>
<td>Elective T stenting</td>
<td>Internal crush</td>
<td>Culate</td>
<td>TAP</td>
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<td></td>
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<tr>
<td>3 Stents</td>
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<td></td>
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<tr>
<td>Extended V</td>
<td>Inverted</td>
<td>Trouser legs and seat</td>
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</tbody>
</table>

# Bifurcation Stenting with DES: A Meta-Analysis

## A.

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Events / Total</th>
<th>Two stents</th>
<th>MH risk ratio and 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisional</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Pan et al.</td>
<td>2004</td>
<td>1 / 47</td>
<td>1 / 44</td>
<td>MH risk ratio: 0.94, Lower limit: 0.06, Upper limit: 14.52</td>
</tr>
<tr>
<td>Colombo et al.</td>
<td>2004</td>
<td>0 / 22</td>
<td>1 / 63</td>
<td>MH risk ratio: 0.93, Lower limit: 0.04, Upper limit: 21.97</td>
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<tr>
<td>NORDIC</td>
<td>2006</td>
<td>2 / 207</td>
<td>2 / 206</td>
<td>MH risk ratio: 1.00, Lower limit: 0.14, Upper limit: 7.00</td>
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<tr>
<td>Ferenc et al.</td>
<td>2008</td>
<td>2 / 101</td>
<td>1 / 101</td>
<td>MH risk ratio: 2.00, Lower limit: 0.18, Upper limit: 21.71</td>
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<tr>
<td>BBC ONE</td>
<td>2008</td>
<td>1 / 250</td>
<td>2 / 250</td>
<td>MH risk ratio: 0.50, Lower limit: 0.05, Upper limit: 5.48</td>
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<tr>
<td>CACTUS</td>
<td>2009</td>
<td>1 / 173</td>
<td>0 / 177</td>
<td>MH risk ratio: 3.07, Lower limit: 0.13, Upper limit: 74.82</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>7 / 800</td>
<td>7 / 841</td>
<td>MH risk ratio: 1.12, Lower limit: 0.42, Upper limit: 3.02</td>
</tr>
</tbody>
</table>

**Death**

- **Favors Provisional**
  - Test for heterogeneity: $Q=1.1$, df=5, $P=0.96$, $\phi=0\%$
  - Test for overall effect: $Z=0.23$, $P=0.82$

- **Favors Two Stents**

Brar SS, EuroIntervention. 2009 Sep;5(4):475-84
Bifurcation Stenting with DES: A Meta-Analysis

### Myocardial Infarction

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<tr>
<td>Ferenc et al. 2008</td>
<td>1 / 101</td>
<td>2 / 101</td>
<td>MH risk ratio: 0.50, Lower limit: 0.05, Upper limit: 5.43</td>
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<td>9 / 250</td>
<td>28 / 250</td>
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<tr>
<td>CACTUS</td>
<td>2009</td>
<td>15 / 173</td>
<td>19 / 177</td>
</tr>
<tr>
<td>Overall</td>
<td>2009</td>
<td>29 / 800</td>
<td>57 / 841</td>
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</table>

Test for heterogeneity: Q=5.72, df=5, P=0.33 \(\neq\) 0.05
Test for overall effect: Z= -2.56, P=0.01

Brar SS, EuroIntervention. 2009 Sep;5(4):475-84
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<th>Provisional Events / Total</th>
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<th>Statistics for each study</th>
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<td>BBC ONE</td>
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<td>18 / 250</td>
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<td>CACTUS</td>
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<td>13 / 177</td>
<td>0.87</td>
<td>0.40</td>
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<td>42 / 800</td>
<td>50 / 841</td>
<td>0.91</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Test for heterogeneity: $Q=2.2, df=5, P=0.82 I^2=0\%$
Test for overall effect: $Z=-0.49, P=0.63$

Fixed Effects Model

Brar SS, EuroIntervention. 2009 Sep;5(4):475-84
Bifurcation Stenting with DES: A Meta-Analysis

E.

Stent Thrombosis

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<td></td>
<td>6 / 800</td>
<td>14 / 841</td>
</tr>
</tbody>
</table>

Favors Provisional: Q=2.2, df=3, P=0.52 θ=0%
Favors Two Stents: Z=-0.76, P=0.45

Test for heterogeneity: θ=0%
Test for overall effect: θ=0%

Fixed Effects Model
Randomized trial on routine vs. Provisional T-stenting in the treatment of de novo coronary bifurcation lesions (BBK)
More stent thrombosis with complex techniques?

Predictors of LST / VLST

Multivariable analysis

<table>
<thead>
<tr>
<th>Factors</th>
<th>R.R.</th>
<th>95% C.I.</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemodialysis</td>
<td>1.91</td>
<td>(1.29 - 2.65)</td>
<td>0.002</td>
</tr>
<tr>
<td>ESRD (e-GFR &lt; 30/Non-HD)</td>
<td>1.81</td>
<td>(1.2 - 2.65)</td>
<td>0.007</td>
</tr>
<tr>
<td>Two stents for bifurcation</td>
<td>1.81</td>
<td>(1.17 - 2.59)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

LST / VLST in 67 lesions among 16,801 lesions treated exclusively by Cypher

Those variables with p value < 0.1 in the univariable analysis were incorporated into the multivariable model.

Nakamura, EBC 2009
Provisional SB stenting
The POT technique should be used in any case of difficulty recrossing into a side branch with either a wire or balloon.

*Proximal Optimisation Technique

from O. Darremont
Provisional SB stenting
Provisional SB stenting
NORDIC III

Primary end point event free survival
MACE (cardiac death, index lesion MI, TLR, stent thrombosis)

% 100 95 90 85 80 75
0 5 10 15 20 25

Weeks

KISSING
NO KISSING

ns

Lassen, EBC 2009
Value of kissing inflations in simple stenting

- Systematic kissing: no advantage / no harm

- When using a single stent technique, in the absence of kissing balloon inflations, the proximal main vessel stent should be postdilated to an appropriate diameter.

- Kissing balloon inflations, or pressure wire interrogation, should be used when an angiographically significant (>75%) side branch lesion remains after main vessel stenting.
>1 mm ST-depression @ ergometric test within 5 days

\[ P = 0.046 \]

- No kissing Inflation: 64%
- Final Kissing Inflation performed: 37%

F. Burzotta, EBC 2009
Significant Post Stenting SB Stenosis: QCA vs FFR
(jailed side branch lesions, n=94)

Functionally significant stenosis

\[ r = -0.464 \]
\[ p < 0.001 \]

38% of lesions

Provisional SB stenting
Non compliant high pressure balloons for kissing

Results

Cypher (J&J)

Semi-Compliant Balloon
(Ryujin Plus, Terumo)

Non-Compliant Balloon
(Hiryu, Terumo)


Kinoshita, EBC 2009
When to use two stents?

– Provisional T stenting remains the gold standard technique for most bifurcations.

– Large side branches with ostial disease extending >5mm from the carina are likely to require a two-stent strategy.

– Side branches whose access is particularly challenging should be secured by stenting once accessed.

Hildick-Smith, EuroIntervention, May 2010
Which 2 stent technique?

Influence of Bifurcation Angle

Y-Shape
- Cush
- MiniCrush
- Culotte
- Χ T Stenting

T-Shape
- T Stenting
- Χ Cush
- Χ MiniCrush
- Χ Culotte

Nordic II

Rate of main vessel and/or side branch in-stent diameter stenosis >50% at 8 months follow-up

<table>
<thead>
<tr>
<th></th>
<th>CRUSH</th>
<th>CULOTTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>10.5</td>
<td>4.5</td>
</tr>
<tr>
<td>p</td>
<td>0.046</td>
<td></td>
</tr>
</tbody>
</table>

Gunnes ACC 2008
Provisional Side Branch Stenting
Mandatory final kissing in complex techniques

Final Kissing Ballooning Is Important in 2-Stent Technique

**Crush Technique**

- FKB
- No-FKB

<table>
<thead>
<tr>
<th>MV restenosis</th>
<th>SB Restenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
</tr>
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</table>

**Crush and Provision-T Technique**

- FKB
- No-FKB

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<td>10</td>
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</table>

1. Ge L, JACC 2005
2. Colombo A, CACTUS, Circulation 2009

Future of bifurcation stenting?

- Dedicated bifurcation stent systems remain limited but are likely ultimately to prevail (David Hildick-Smith)(BBC 1).

- “Bifurcation treatment without permanent implants = No discussions on bifurcation techniques” (Biodegradable stents)(Leif Thuesen)(NORDIC)
Conclusions

• Provisional SB stenting strategy is the gold standard: POT

• No advantage, no harm of **systematic** final KB: result, SB size, FFR … non compliant balloons?

• When using 2 stents? With a mandatory kissing
  - long SB lesions (> 3 mm, > 5 mm ?)
  - but why not provisional strategy?
  - very difficult SB access: SB first?

• When not to using SB stent first ?: Wide B angle

• Dedicated stents: randomized studies / biodegradable stents!
Consensus from the 5th European Bifurcation Club meeting

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