CRT 19 CARDIOVASCULAR RESEARCH TECHNOLOGIES

How to Optimize Bifurcation PCI

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CRT 19 CARDIOVASCULAR RESEARCH TECHNOLOGIES

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Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

- **Grant/Research Support:**
  Abbott Vascular Japan
  Boston Scientific Japan
  Nipro Inc.
  Terumo Inc.
- **Consulting Fees/Honoraria:**
  Abbot Vascular Japan
  HeartFlow Japan
  Nipro Inc.
  Terumo Inc.

PCI for LM bifurcation lesions

- **Bifurcation lesion PCI might be 15-20% of all PCI cases in daily clinical practice, and complex procedure may be required sometimes.**

  Lefe` vre T et al. Catheter Cardiovasc Interv 2000; 49:274–283
  Iakovou I et al. J Am Coll Cardiol 2005; 46:1446–1455

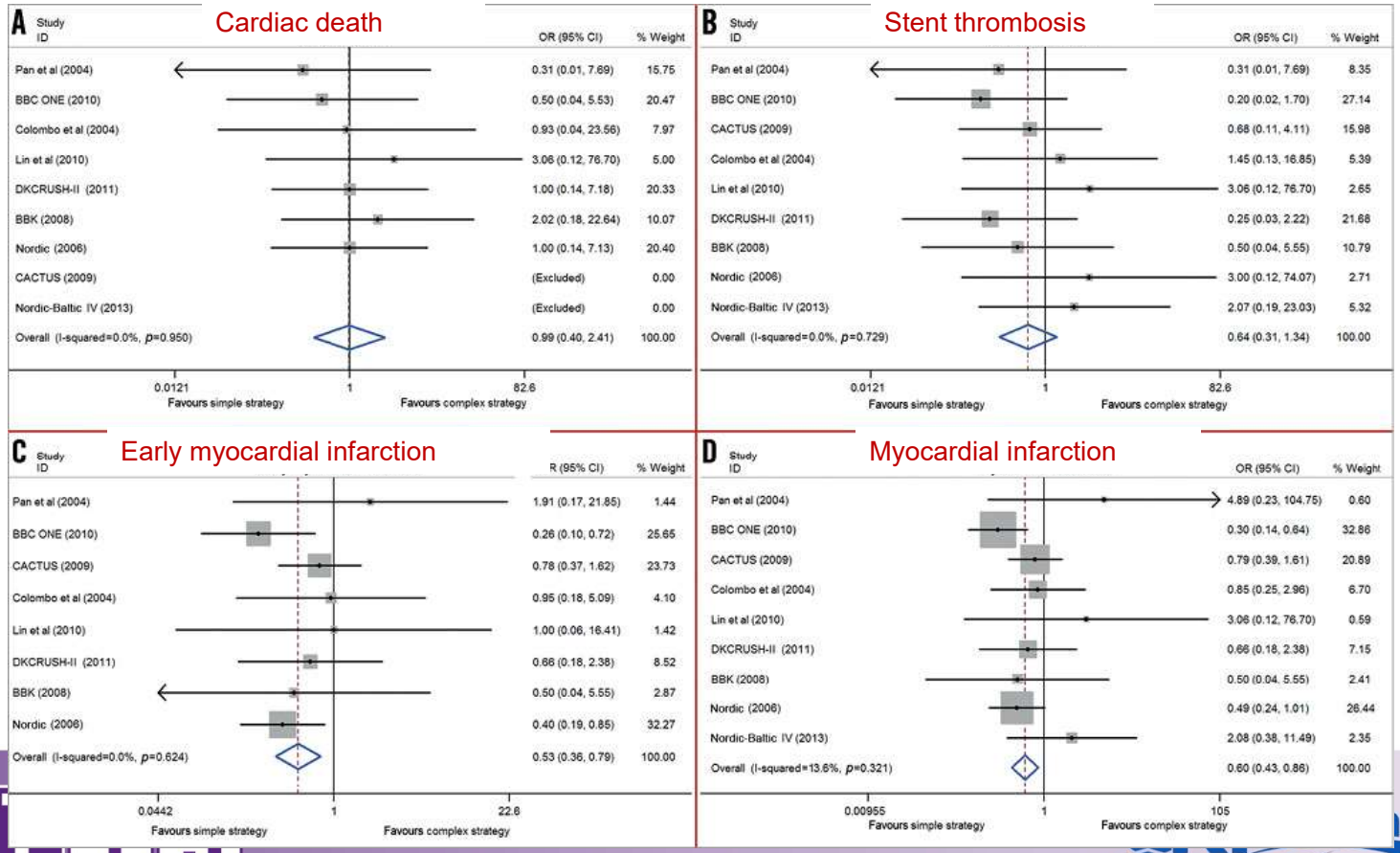
- **Higher risk for complications such as side branch occlusion, stent thrombosis, restenosis, etc. have been reported more frequently in bifurcation lesion PCI.**

  Iakovou I et al. JAMA 2005; 293 : 2126-2130
  Colombo A et al. Circulation 2004; 109 : 1244-1249

- **Better clinical outcomes have been demonstrated in simple stent strategy compared with various 2 stents strategies.**

  Gao GF, et al. EuroIntervention 2014;10:561-569
  Cho S, et al. J Am Coll Cardiol Interv 2018; 11 : 1247-1258
  Kandzari DE, et al. Circ Cardiovasc Interv. 2018; 11 : e007007

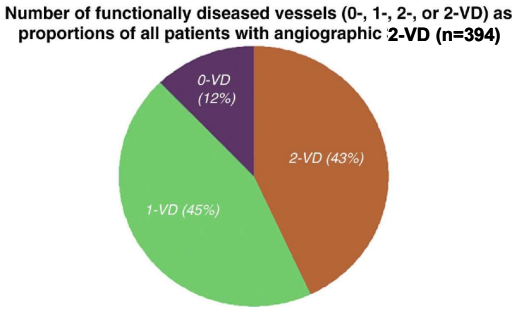
Simple vs complex stent strategies for bifurcation with DES: a meta-analysis of nine randomized trials



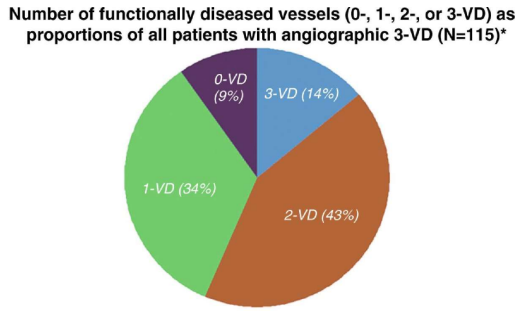
Gao CF, et al. EuroInterv 2014;10:561-569

Lesion assessment in FAME Study
Angiography vs FFR

Tonino PAL, et al. J Am Coll Cardiol 2010;55:2816-2821



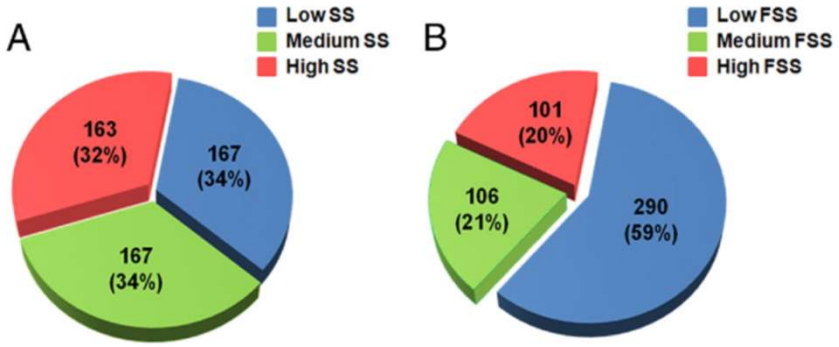
Angiographic 2-VD



Angiographic 3-VD

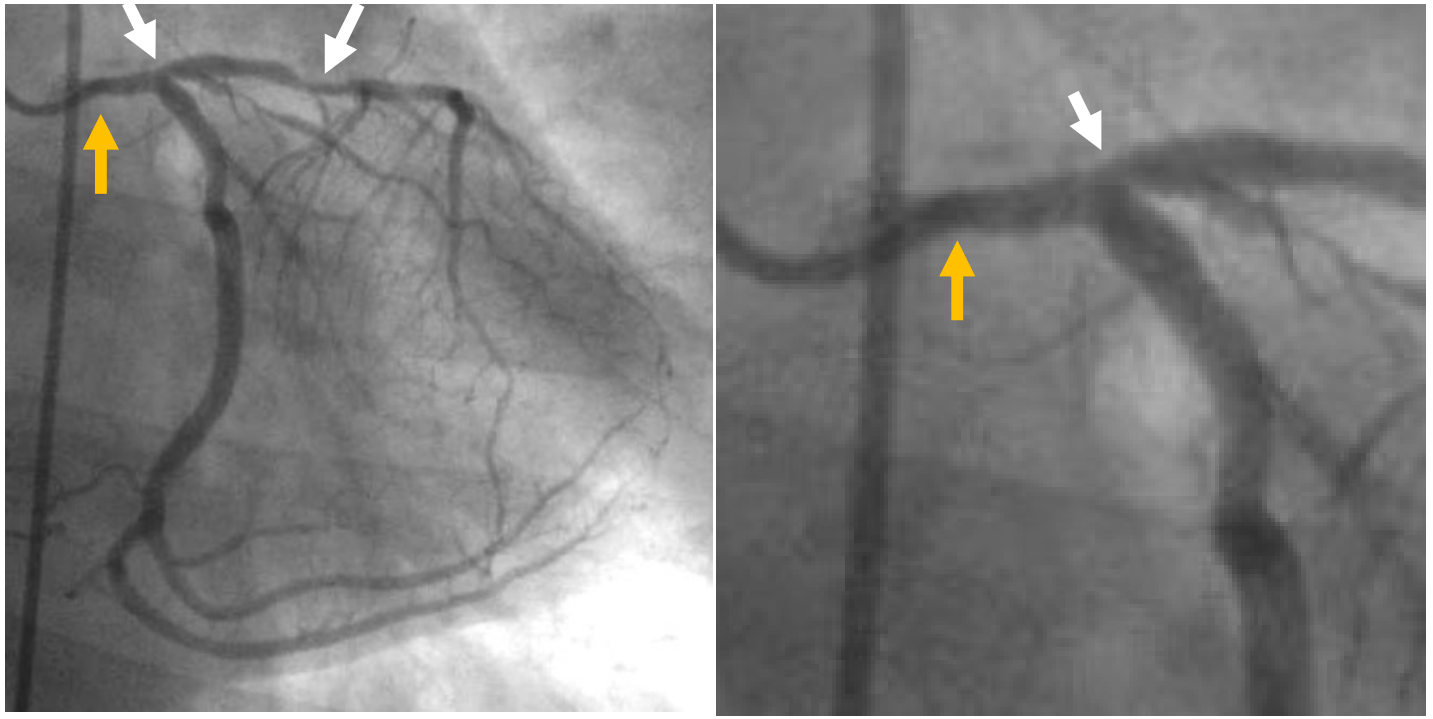
Comparison between
Classic & Functional SYNTAX Score

Nam CW, et al. J Am Coll Cardiol 2011;58:1211-1218



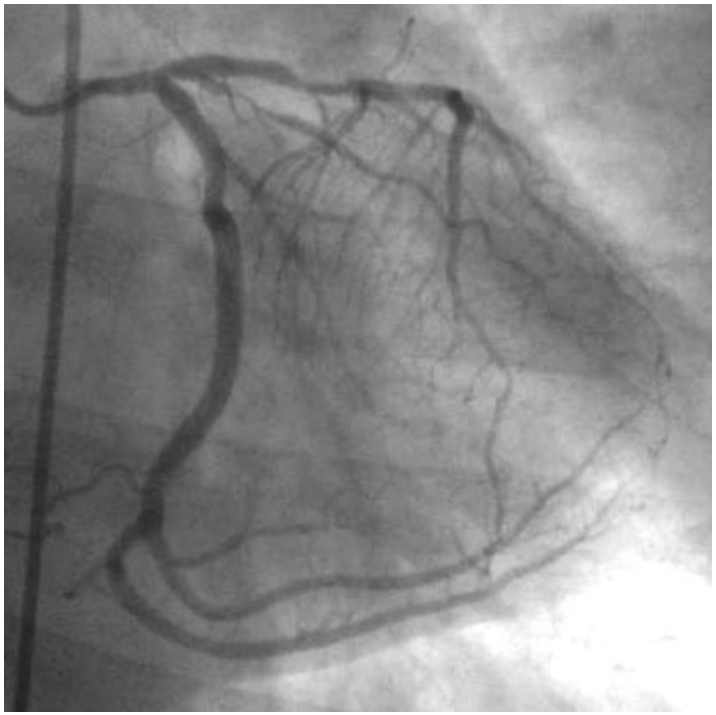
Classic SYNTAX score Functional SYNTAX score

LMCA disease + LAD/Lcx lesion



Is LMCA stenosis significant ?

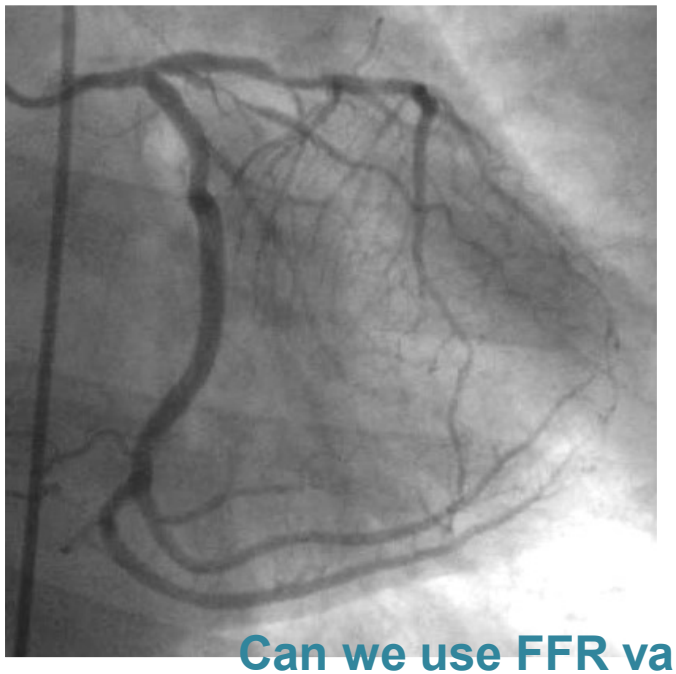
LMCA disease + LAD/Lcx lesion

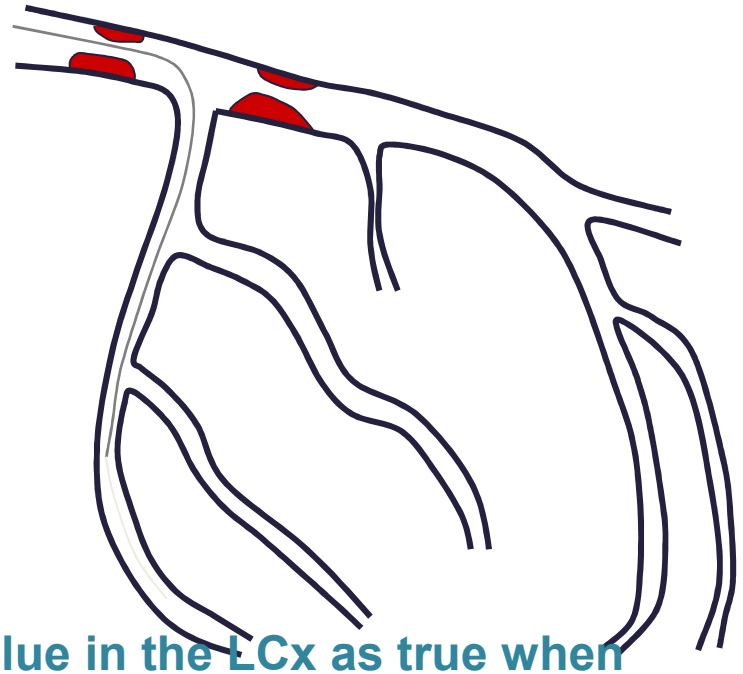


Severe stenosis in the prox. LAD

Mild stenosis in the LMCA

LM / bifurcation lesion
- Effect of downstream disease-

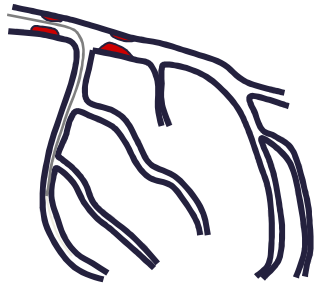




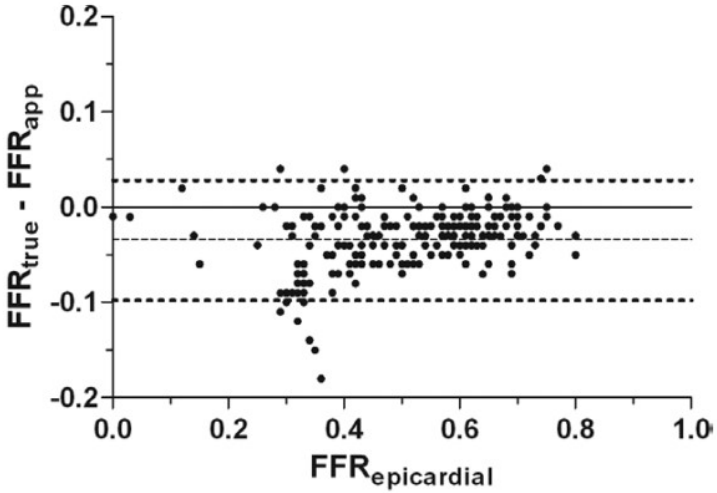
Can we use FFR value in the LCx as true when there is a significant stenosis in the LAD ?

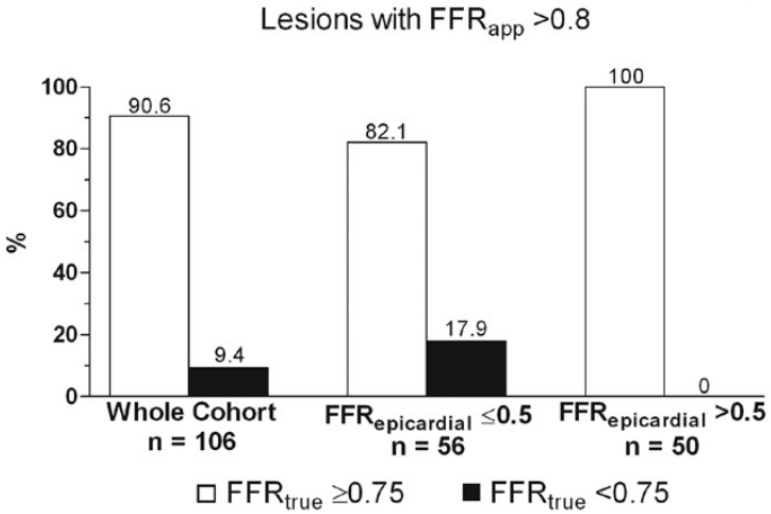
Circulation
Cardiovascular Interventions
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Heart Association
Learn and Live

LM / bifurcation lesion
- Effect of downstream disease-



Fractional Flow Reserve Assessment of Left Main Stenosis in the Presence of Downstream Coronary Stenoses
Andy S.C. Yong, David Daniels, Bernard De Bruyne, Hyun-Sook Kim, Fumiaki Ikeno, Jennifer Lyons, Nico H.J. Pijls and William F. Fearon
Circ Cardiovasc Interv 2013;6;161-165; originally published online April 2, 2013;
DOI: 10.1161/CIRCINTERVENTIONS.112.000104
Circulation: Cardiovascular Interventions is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514
 Print ISSN: 1941-7640. Online ISSN: 1941-7632

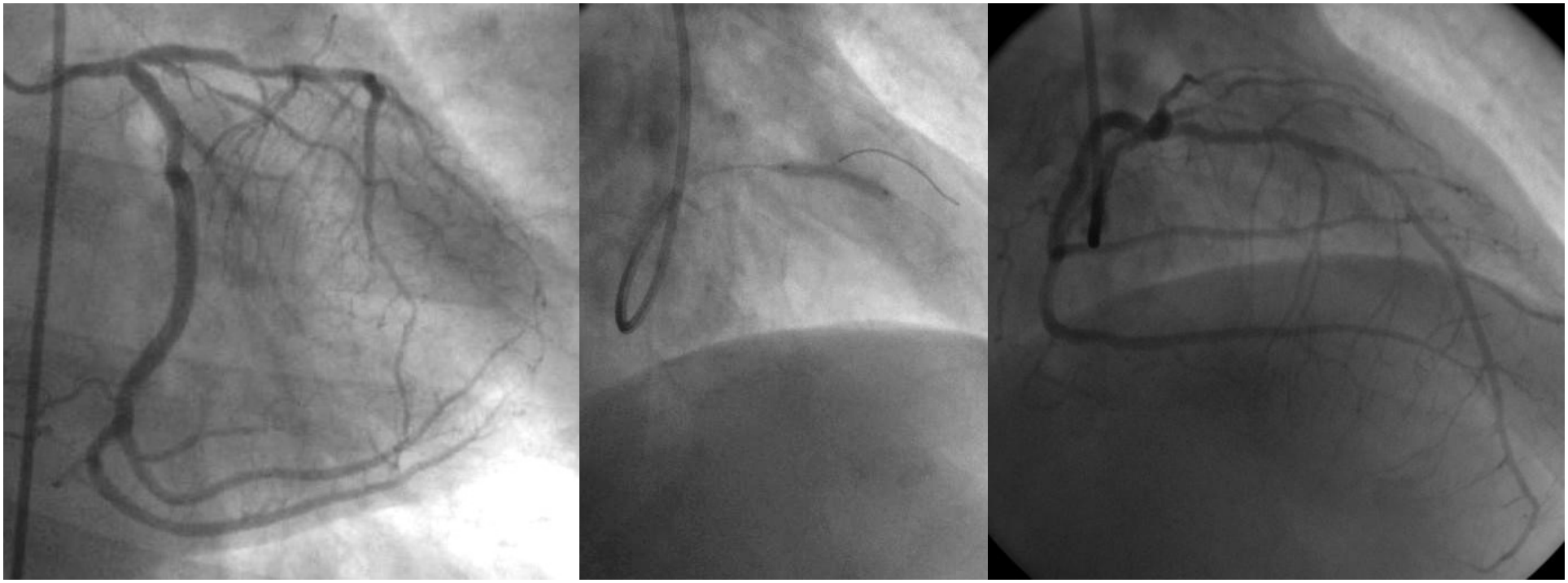




In cases with FFR_{LAD} ≦0.5, true FFR_{LCx} would be <0.75 even if apparent FFR_{LCx} is >0.8 .

Yong A, et al. Circ Cardiovasc Interv. 2013;6:161-165

PCI to LAD



Comparative Analysis of Sequential Proximal Optimizing Technique Versus Kissing Balloon Inflation Technique in Provisional Bifurcation Stenting

Fractal Coronary Bifurcation Bench Test

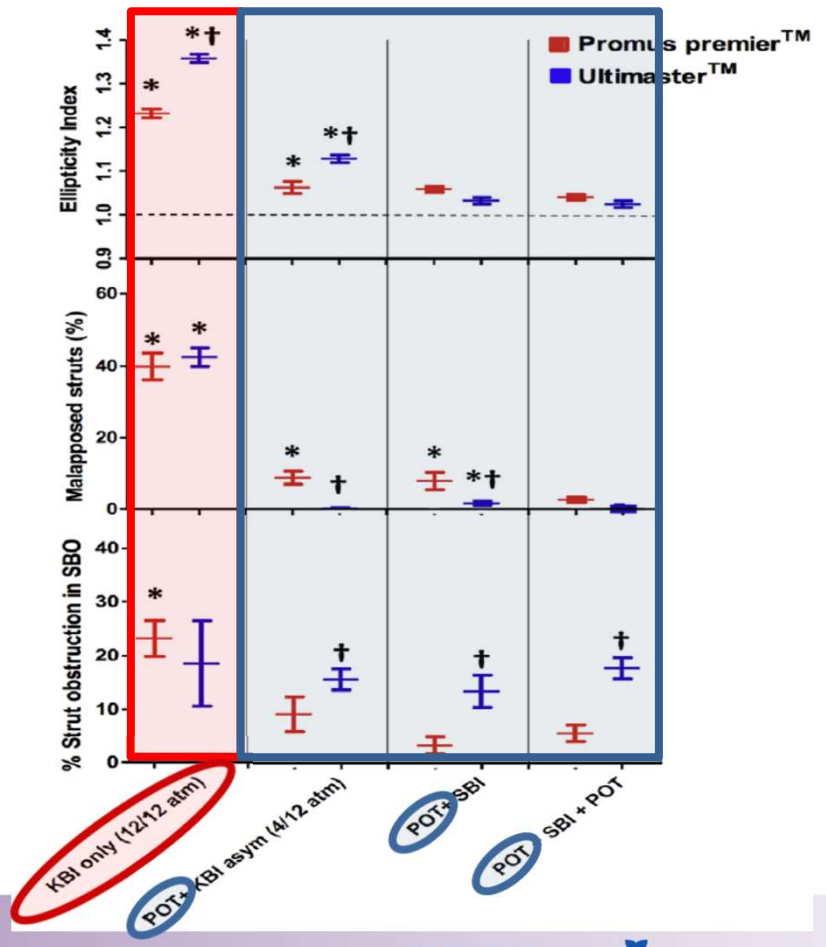
Gérard Finet, MD, PhD,* François Derimay, MD, MSc,* Pascal Motreff, MD, PhD,† Patrice Guerin, MD, PhD,‡ Paul Pilet, B Eng,† Jacques Ohayon, PhD,§ Olivier Darremont, MD,‖ Gilles Rioufol, MD, PhD*

BACKGROUND In provisional bifurcation stenting, KBI fails to improve the rate of major adverse cardiac events. Proximal geometric deformation increases the rate of in-stent restenosis and target lesion revascularization.

METHODS A bifurcation bench model was used to compare KBI alone, KBI after POT, KBI with asymmetric inflation pressure after POT, and 2 sequences without KBI: initial POT plus SBI, and initial POT plus SBI with final POT (called "re-POT"). For each protocol, 5 stents were tested using 2 different drug-eluting stent designs: that is, a total of 60 tests.

RESULTS Compared with the classic KBI-only sequence and those associating POT with modified KBI, the re-POT sequence gave significantly ($p < 0.05$) better geometric results: it reduced SB ostium stent-strut obstruction from 23.2 ± 6.0% to 5.6 ± 8.3%, provided perfect proximal stent apposition with almost perfect circularity (ellipticity index reduced from 1.23 ± 0.02 to 1.04 ± 0.01), reduced proximal area overstretch from 24.2 ± 7.6% to 8.0 ± 0.4%, and reduced global strut malapposition from 40 ± 6.2% to 2.6 ± 1.4%.

CONCLUSIONS In comparison with 5 other techniques, the re-POT sequence significantly optimized the final result of provisional coronary bifurcation stenting, maintaining circular geometry while significantly reducing SB ostium strut obstruction and global strut malapposition. These experimental findings confirm that provisional stenting may be optimized more effectively without KBI using re-POT. (J Am Coll Cardiol Intv 2015;8:1308-17)

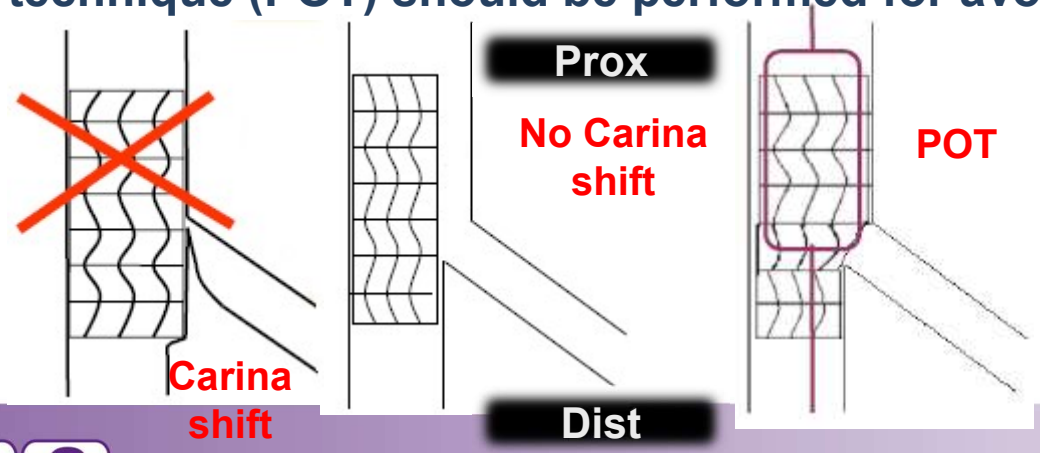


Importance of proximal optimization technique (POT)

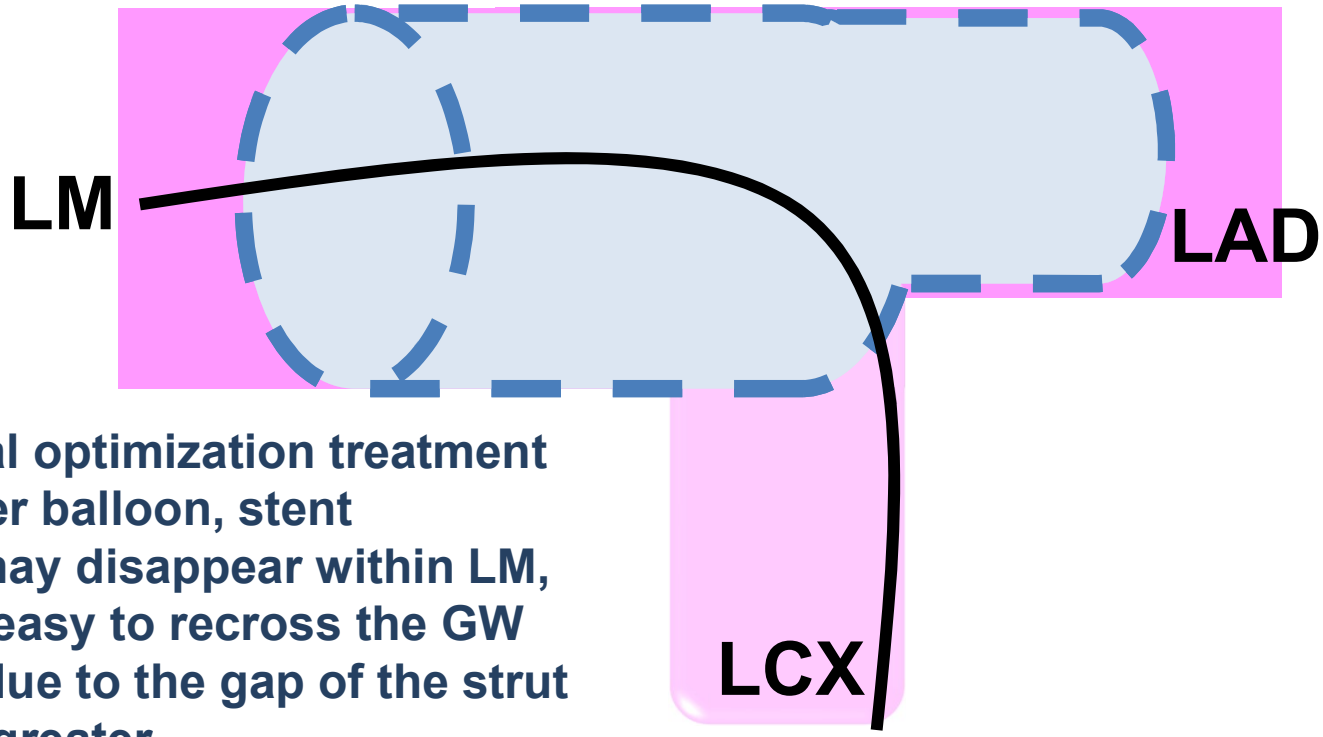
In bifurcation, there is a vessel size change in main vessel at proximal and distal of side branch.

If the stent size selected to adjust proximal reference, stent distal edge dissection and carina shift may happen.

If the stent selected to adjust distal reference, no edge dissection and no carina sift may happen, however, stent malapposition may occur. Proximal optimization technique (POT) should be performed for avoiding carina shift.

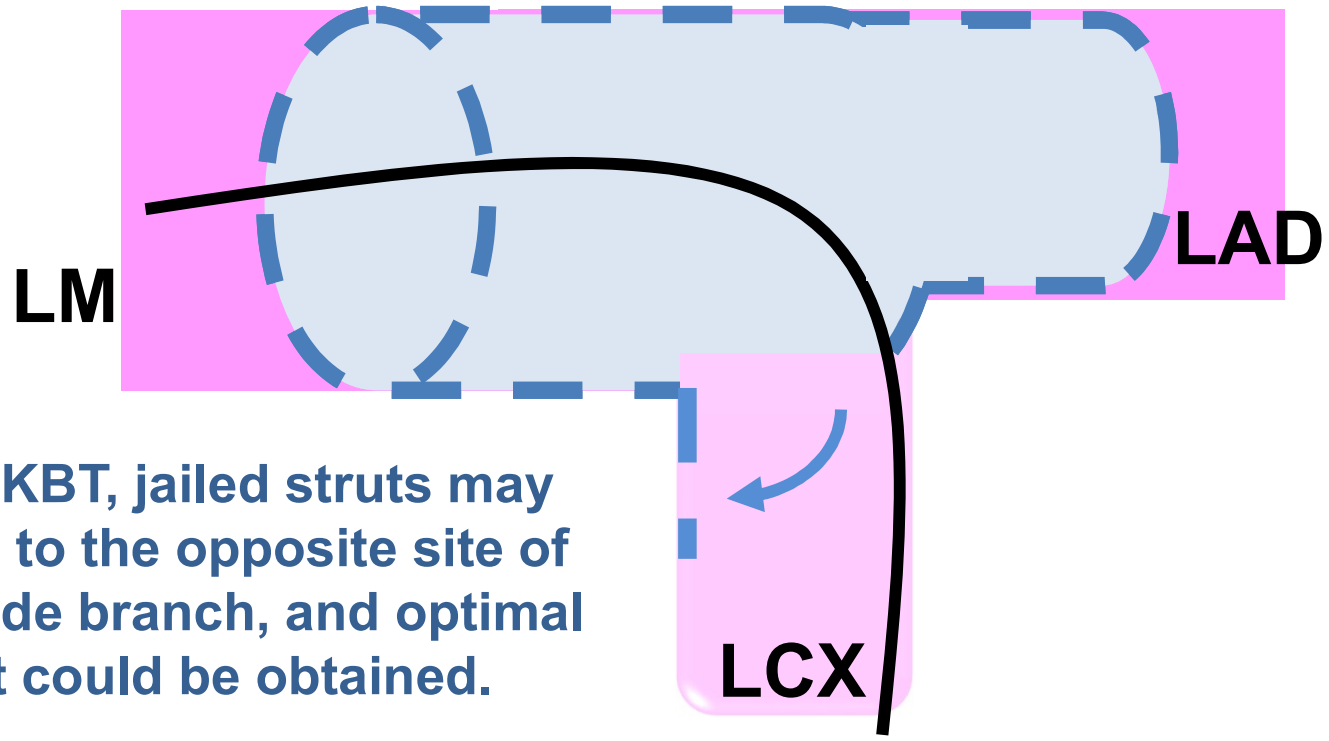


Importance of proximal optimization technique (POT)



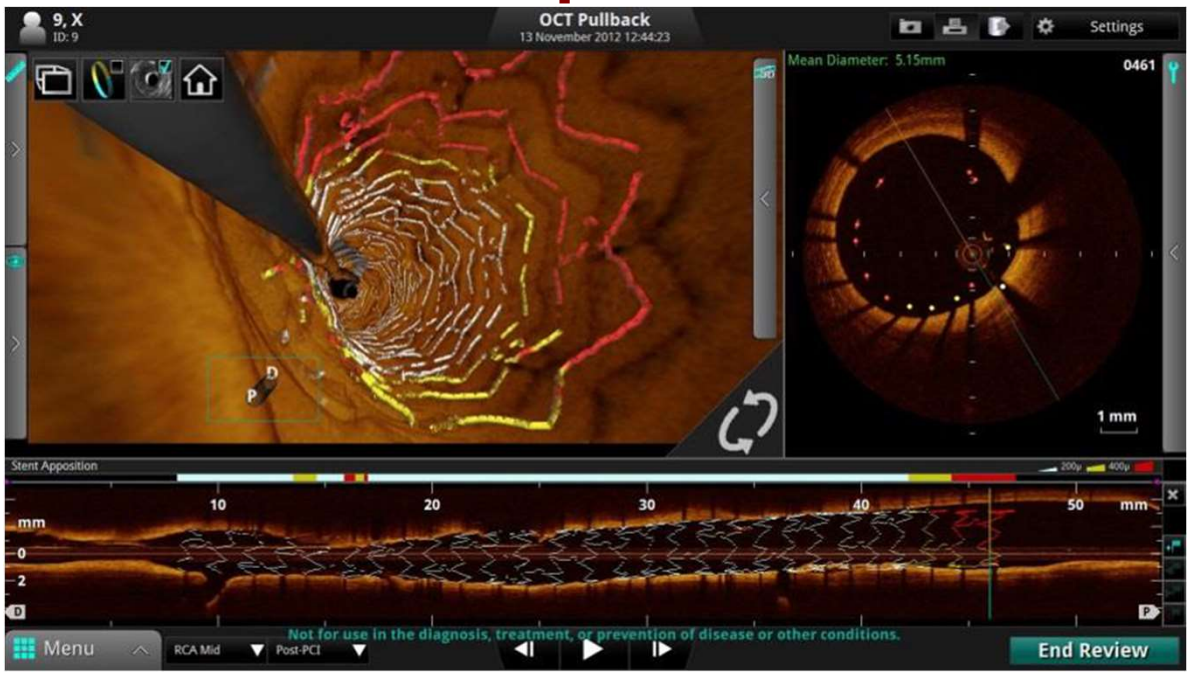
If we do proximal optimization treatment (POT) with bigger balloon, stent malapposition may disappear within LM, and it becomes easy to recross the GW close to carina due to the gap of the strut becomes much greater.

Importance of proximal optimization technique (POT)



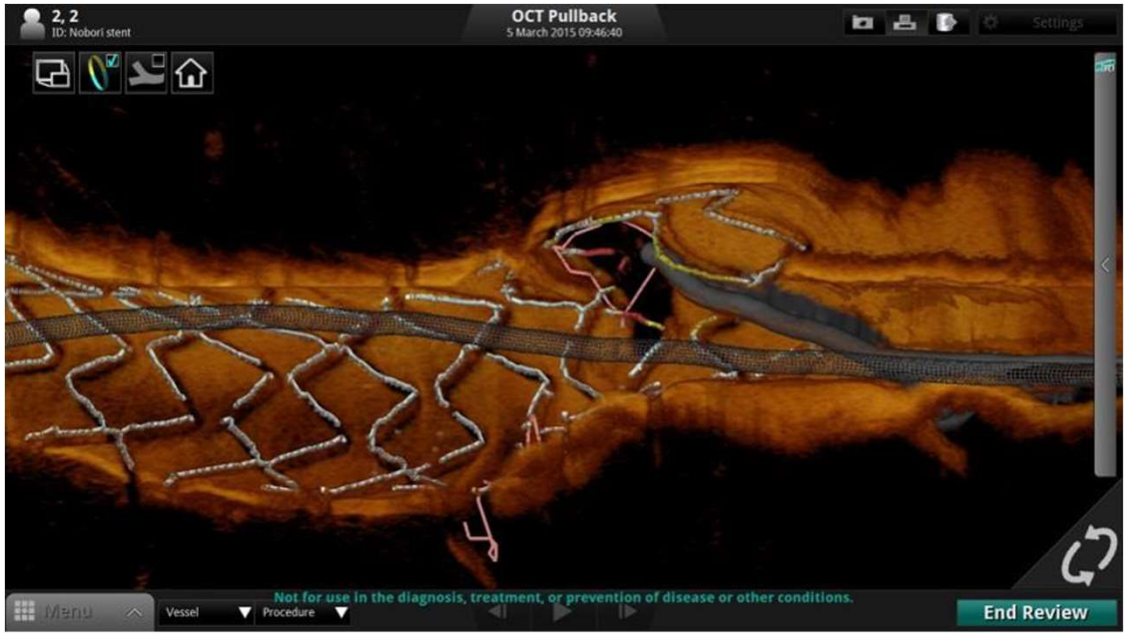
After KBT, jailed struts may move to the opposite site of the side branch, and optimal result could be obtained.

New Development in OCT



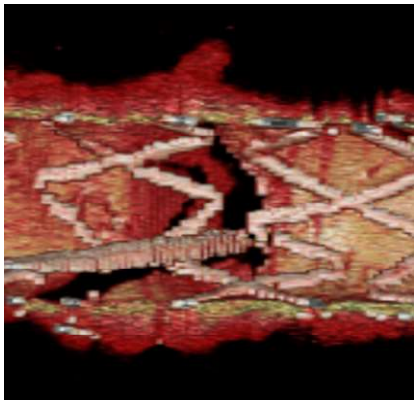
3-D reconstruction & auto-detection of incomplete apposition of stent can be demonstrated as fly through image in addition to cross sectional & longitudinal images by newly developed OCT.

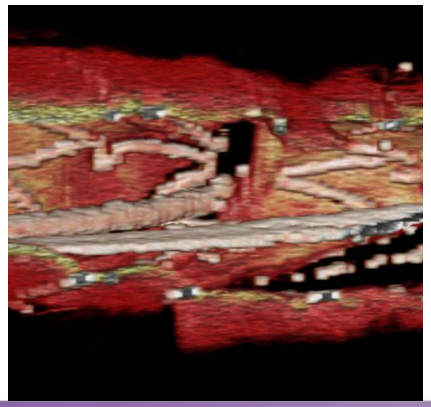
New Development in OCT



Re-crossing wire position in the jailed side branch can be easily identified by newly developed OCT software and improvement of side branch KBT procedure could be expected by the guidance of new OCT.

Relation between stent link & side branch orifice





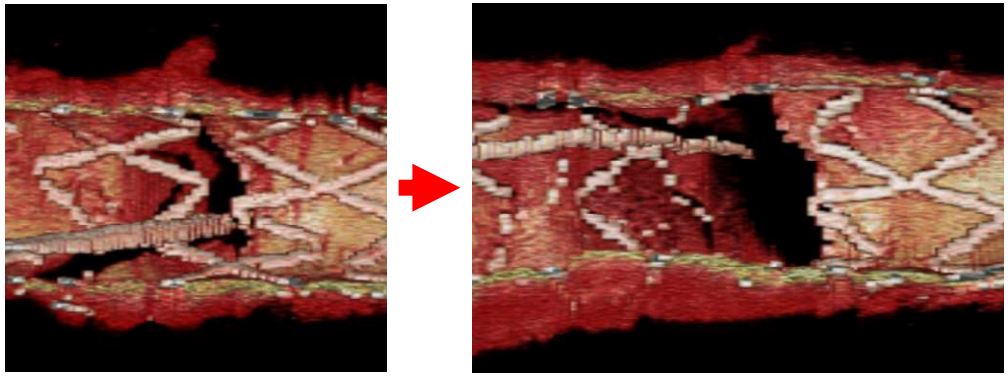
Stent link did not locate at side branch orifice:

Link Free type

Optimal GW re-cross point:

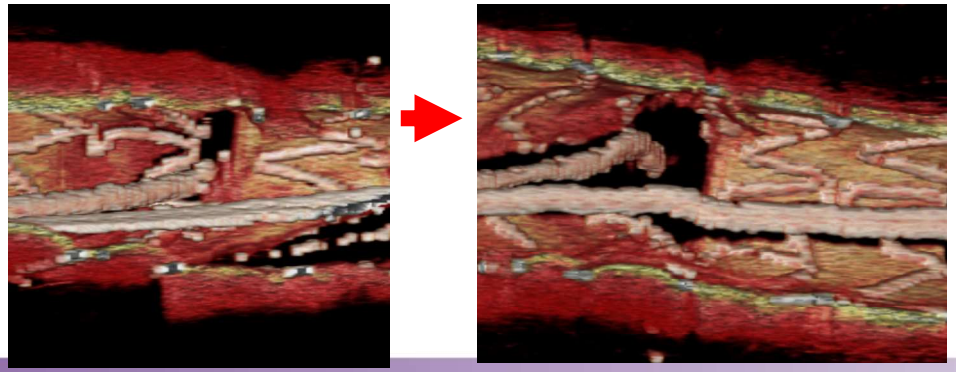
Distal cell close to carina

Link Free type



GW distal cell re-cross

Kissing ballooning

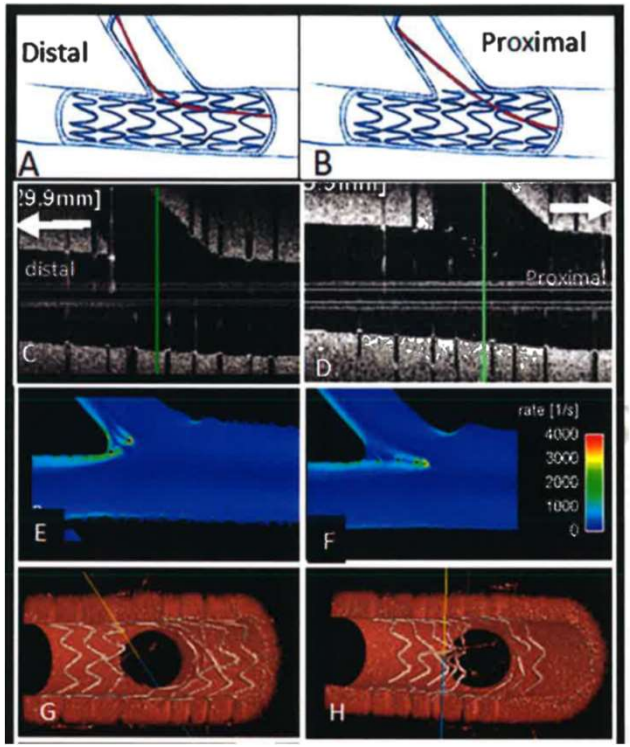


Optimal

Impact of the rewiring position

Strut malapposition & shear stress

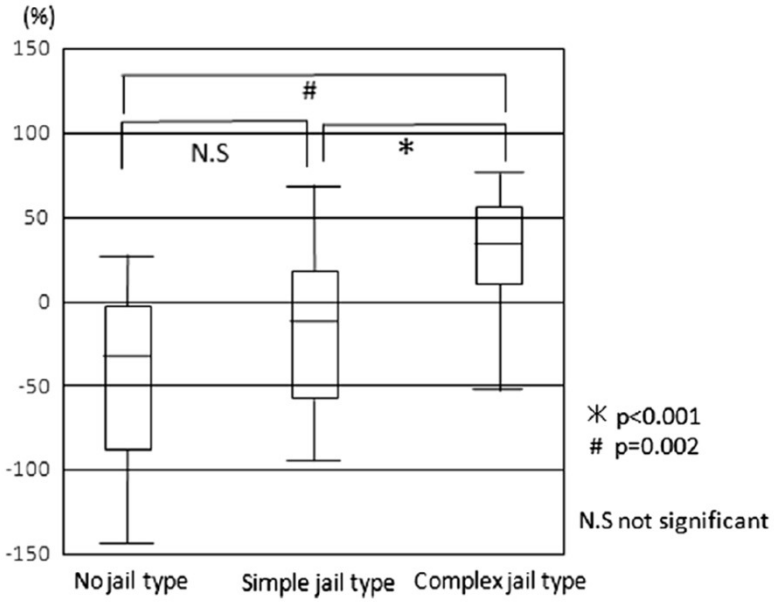
Onuma Y, et al. EuroInterv 2018;accepted



Comparison of % reduction of the side branch flow area

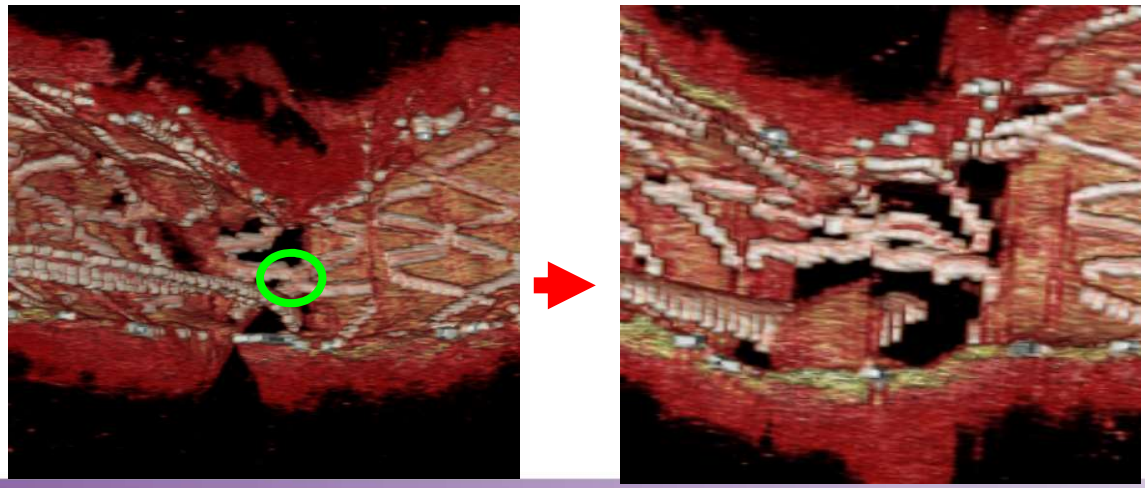
Comparison among each jailed type

Nakamura T, et al. Int J CV Imag 2017;33: 797 – 806



Relation between stent link & side branch orifice

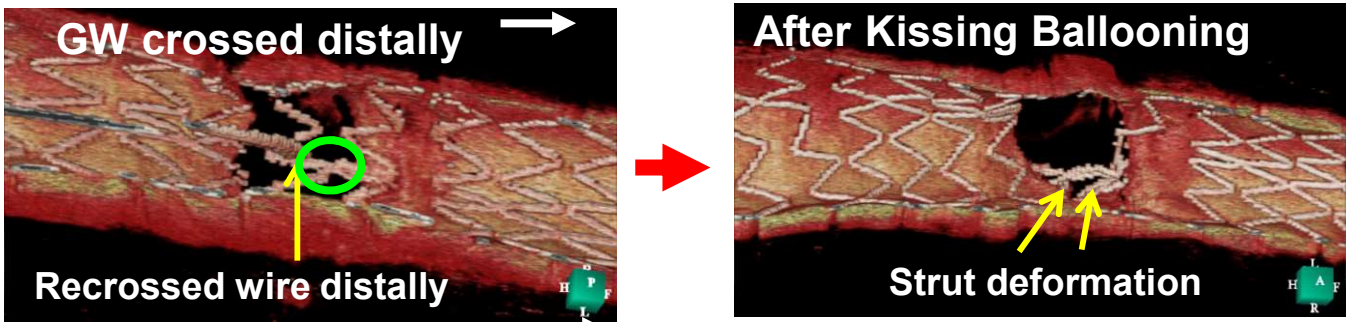
If the stent link locates closed to carina, it would be difficult to remove the jailed struts by KBT:
Link connecting to carina type



Suboptimal

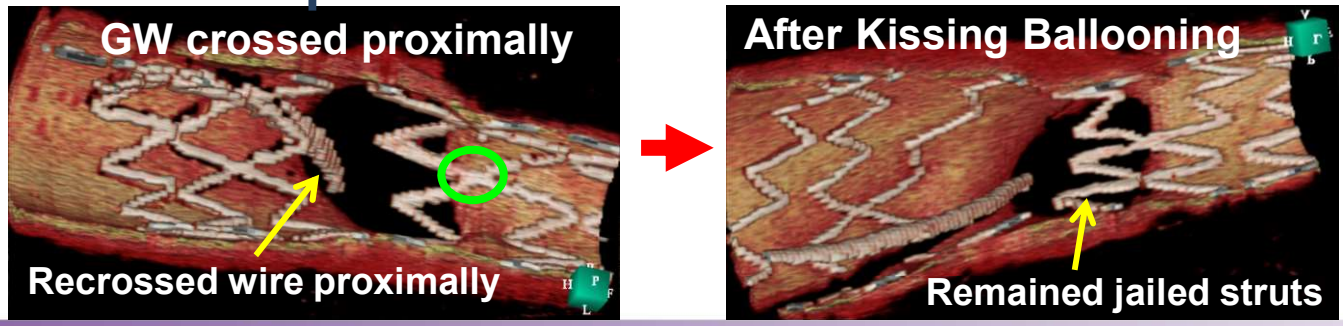
Link connecting to carina type

GW recross distal cell



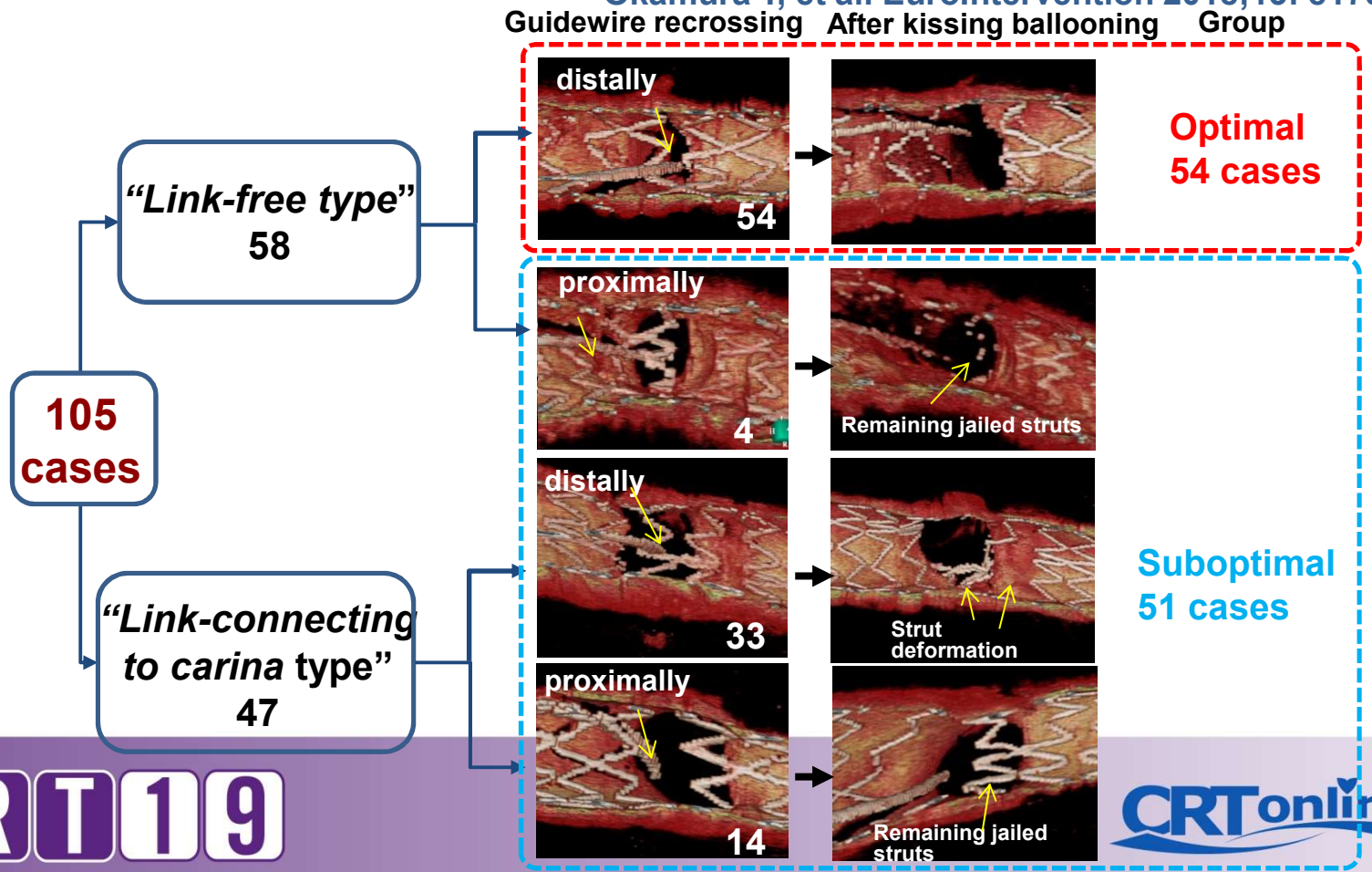
suboptimal

GW recross proximal cell



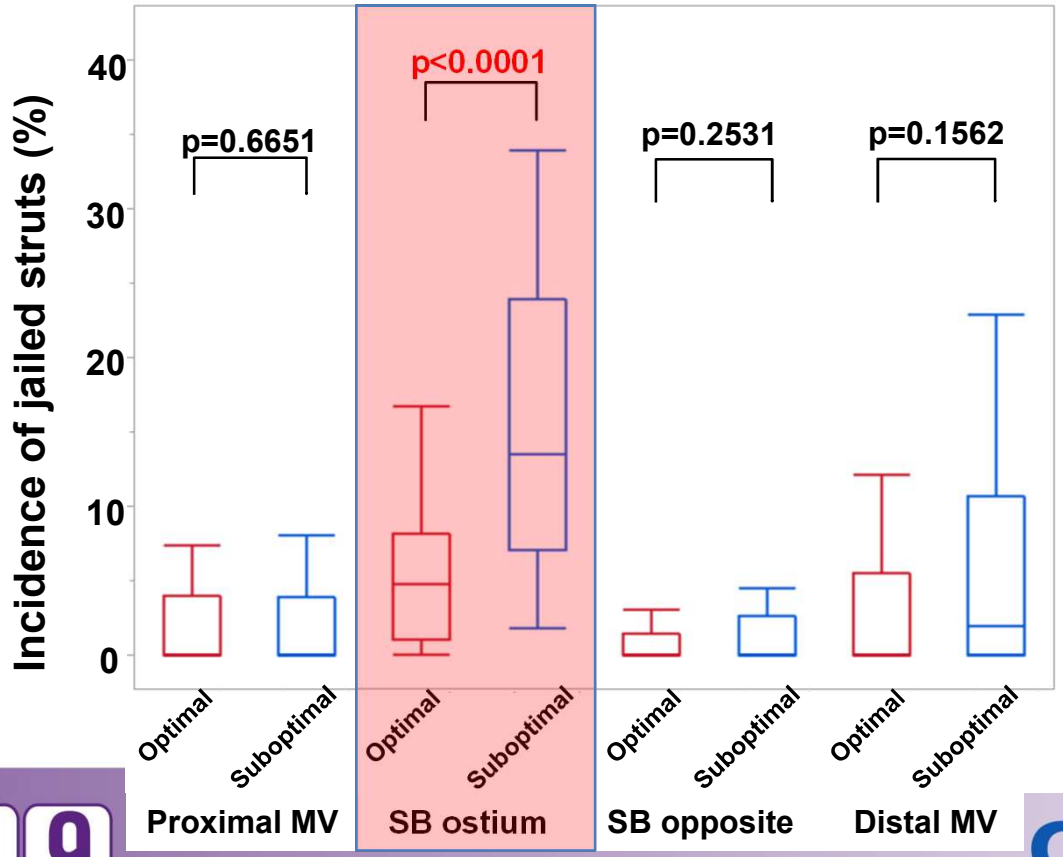
Frequency of jailing configuration & GW rewiring position

Okamura T, et al. EuroIntervention 2018;13: e1785 – e1793



Incidence of ISA at each segment

Okamura T, et al. EuroIntervention 2018;13:e1785-e1793



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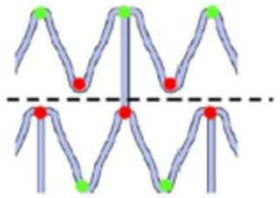
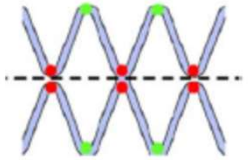
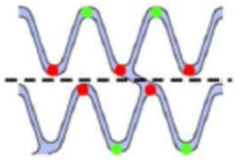
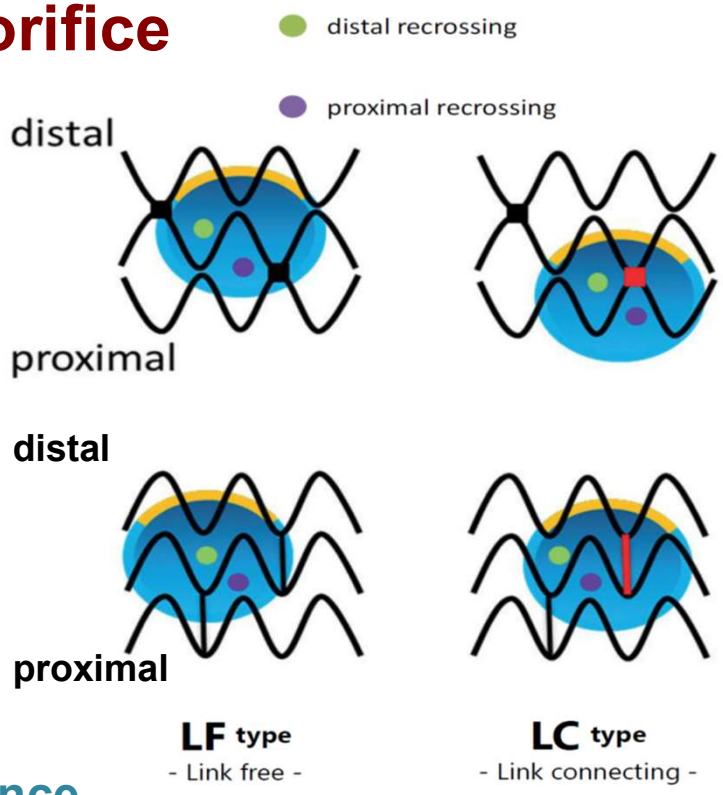
Angiographic ISR at 9 Month

Okamura T, et al. EuroIntervention 2018;13:e1785-e1793

	All	Optimal	Suboptimal	P value
n	87	48	39	
ISR	12(13.8%)	4(8.3%)	8(20.5%)	0.1254
PMV	0(0%)	0(0%)	0(0%)	-
DMV	1(1.1%)	1(2.1%)	0(0%)	1.0000
Side Br Orifice	12(13.8%)	4(8.3%)	8(20.5%)	0.1254

Stent design based on the rink position & wire re-cross point at bifurcation orifice

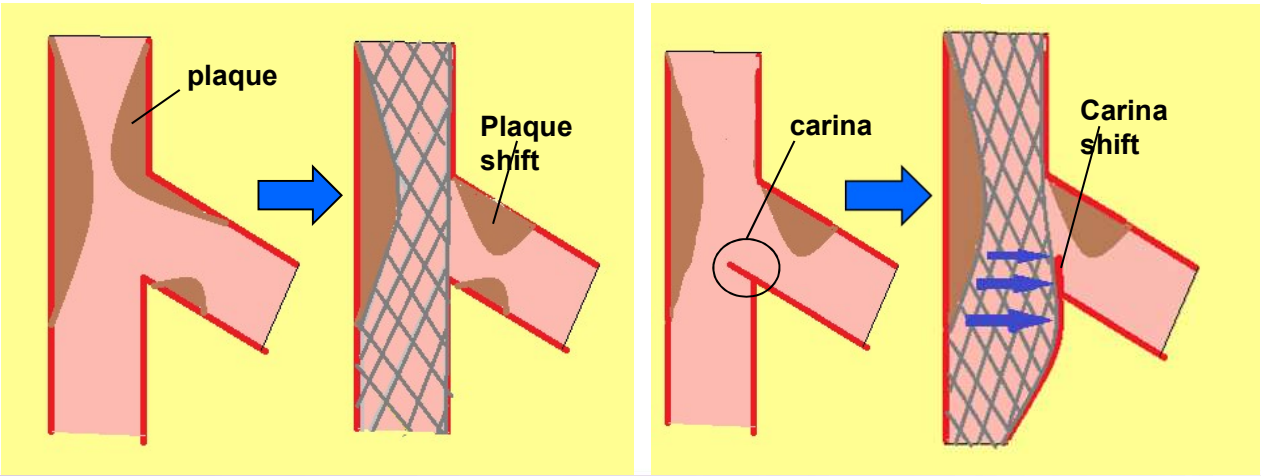
Peak to Valley (P-V) DES	Peak to Peak (P-P) DES
XIENCE	Synergy Resolute Onyx Ultimaster
	Peak to Peak  Offset Peak to Peak 



We cannot control the rink position on the side branch orifice, and it should be by chance.

Mechanism of side branch occlusion after stenting

Although plaque shift, carina shift, side branch dissection, spasm, thrombus formation, etc. have been proposed as the cause of side branch occlusion, plaque shift and carina shift are thought to be main mechanisms of side branch occlusion .



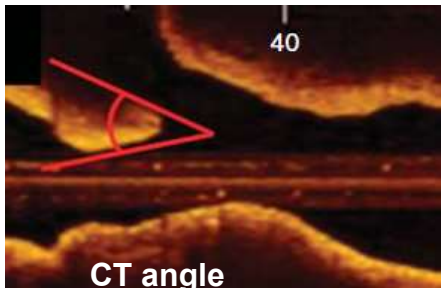
Plaque shift

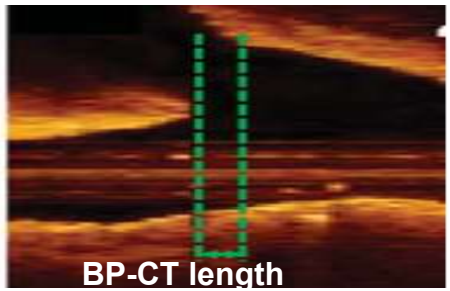
Carina shift

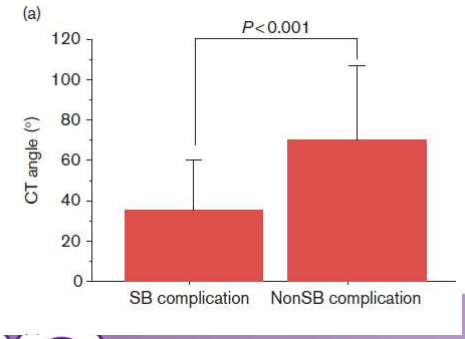
Prediction of side branch occlusion by OCT

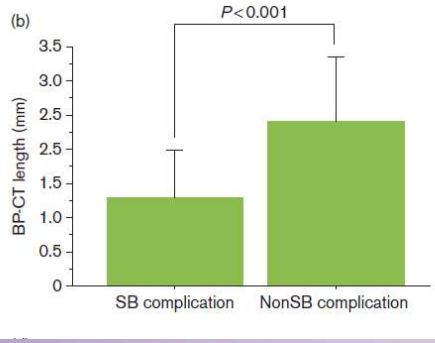
Watanabe M et al. Coron Artery Dis 2014; 25: 321-329

Side branch occlusion might be occurred less frequently in cases with carina tip (CT) angle≧50 degree and branch point to carina tip(BP-CT) length≧1.7mm.



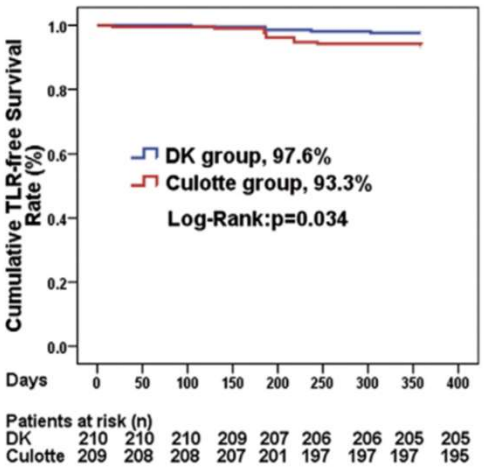




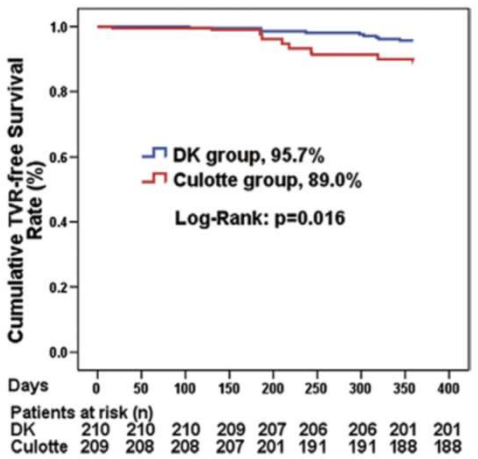


Comparison between DK crush & culotte stenting for LM bifurcation lesions: DKCRUSH-III study

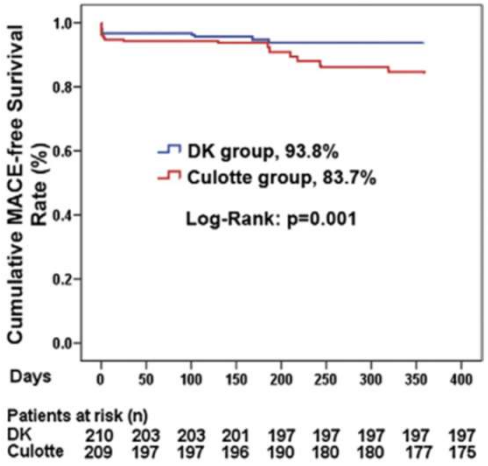
TLR free survival rate at 12 months



TVR free survival rate at 12 months



MACE free survival rate at 12 months



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Chen SL, et al. J Am Coll Cardiol 2013:61:1482-1488

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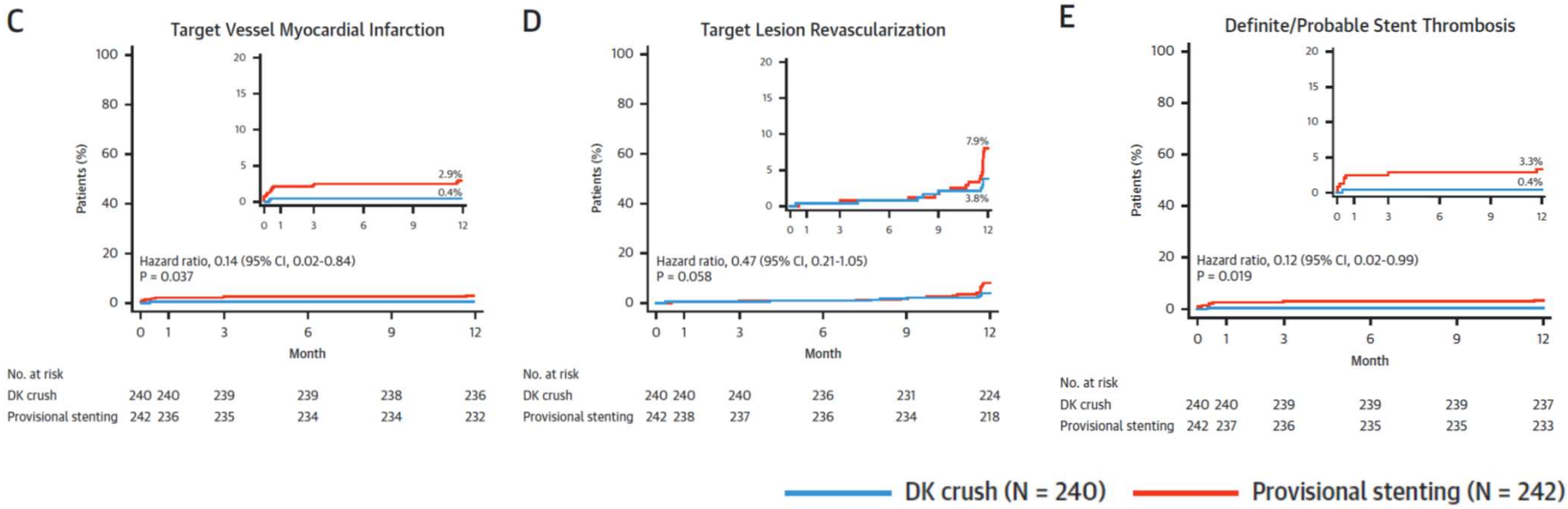
Comparison between DK crush & provisional T stenting for LM bifurcation lesions: DKCRUSH-V study



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Chen SL, et al. J Am Coll Cardiol 2017:70:2605-2617

CRTonline.org

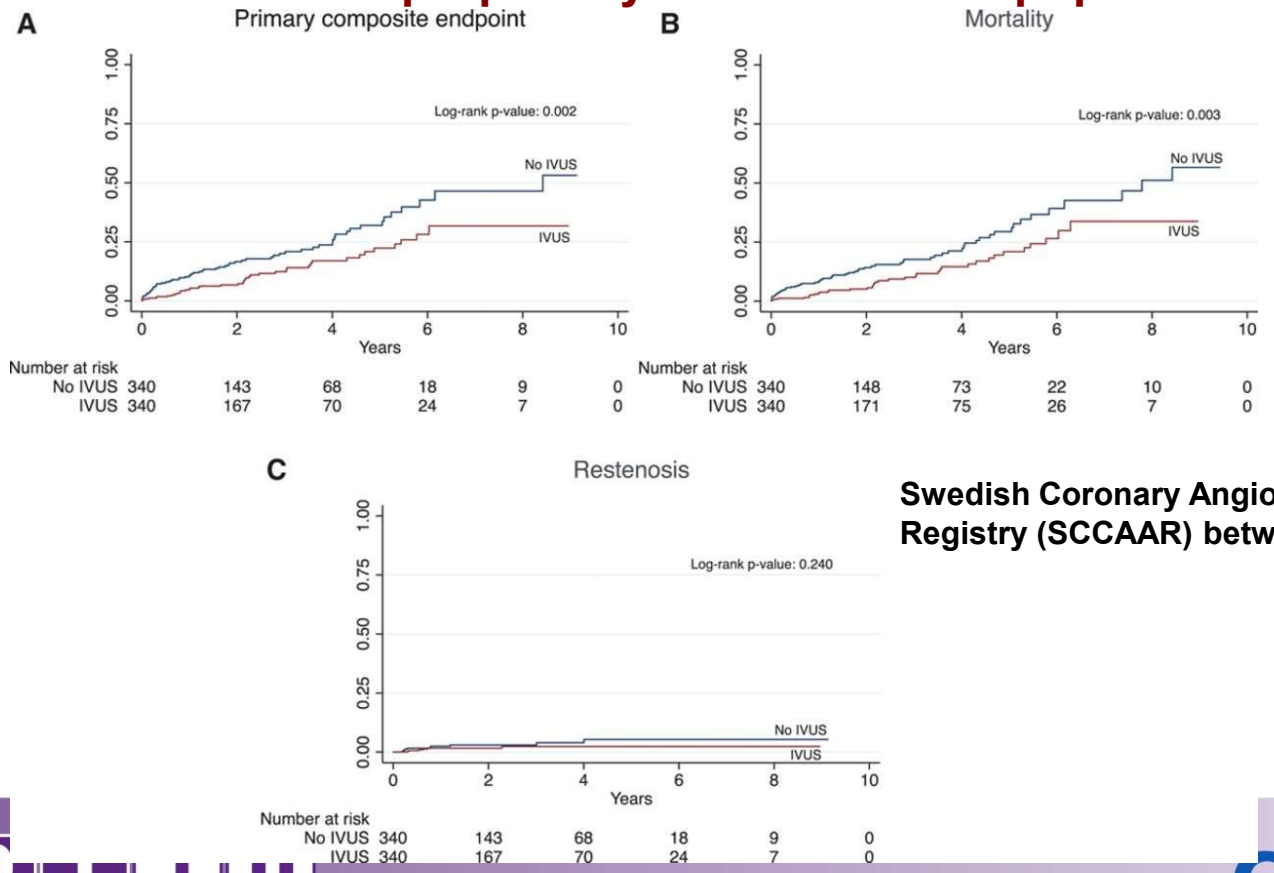
Advantages & disadvantages of different double-stent techniques for unprotected LMCA bifurcation lesions?

	Advantages	Disadvantages
Culotte	Compatible with 6 Fr guider Independent of bifurcation angle Predictable scaffolding	Leaves multiple layers of strut Potential acute closure of MB
Classic crush	Relatively simple Low risk of SB occlusion Good coverage of SB ostium	Difficult FKI Requires 7 or 8 Fr guider Leaves multiple layers of strut
Mini-crush	Minimises multiple layers of strut Good scaffolding at SB ostium Facilitates FKI Compatible with 6 Fr guider using balloon crushing	Still leaves multiple layers of strut
DK-crush	Good scaffolding at SB ostium Facilitates FKI Compatible with 6 Fr guider	Complex procedural steps
Simultaneous kissing stenting	No risk of occlusion for both branches No need to re-cross any stent Technically easy and quick	Requires 7 or 8 Fr guider Leaves long metallic carina Over-dilatation in proximal MB Diaphragmatic membrane formation at the overlapped stents Difficulty in repeat revascularisation
T-stenting	Good SB scaffolding with angles >70°	Potential gap at SB ostium Protrusion of SB stent into the MB (in the case of TAP)

FKI: final kissing balloon inflation; MB: main branch; SB: side branch; TAP: T-stenting and protrusion

Rho JH, et al. EuroIntervention 2015;11:V125-V128

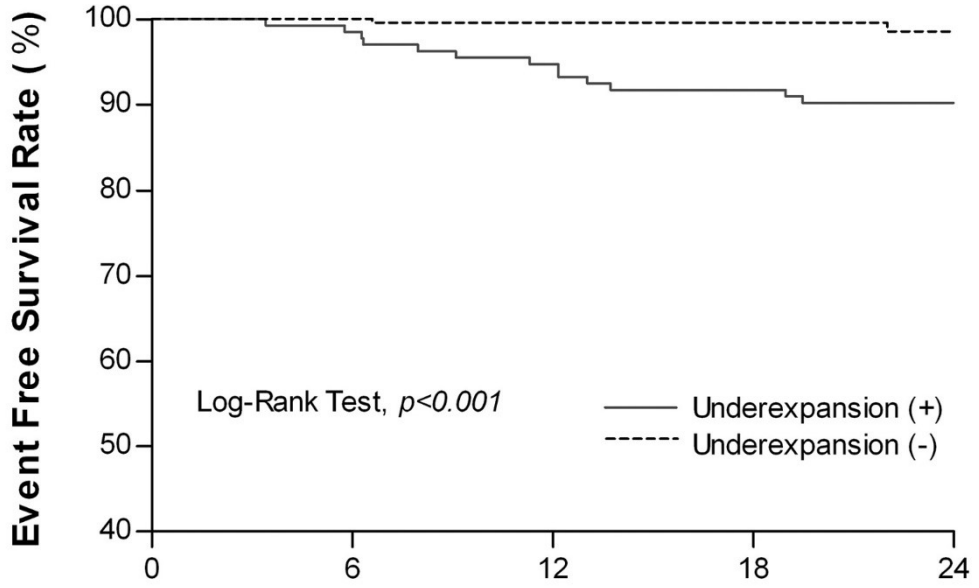
Comparison between IVUS- vs angio-guided PCI for LM disease in the propensity score-matched population.



Swedish Coronary Angiography & Angioplasty Registry (SCCAAR) between 2005 & 2014

Andell P, et al. Circ Cardiovasc Interv. 2017;10:e004813

Kaplan-Meier curve for MACE-free survival in cases with and without underexpansion

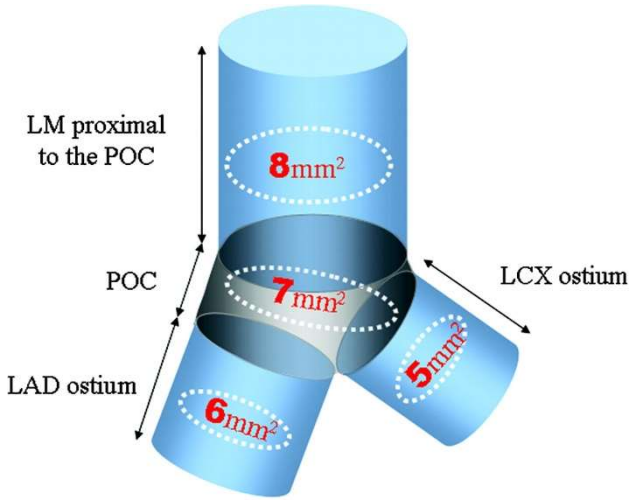


No. at risk

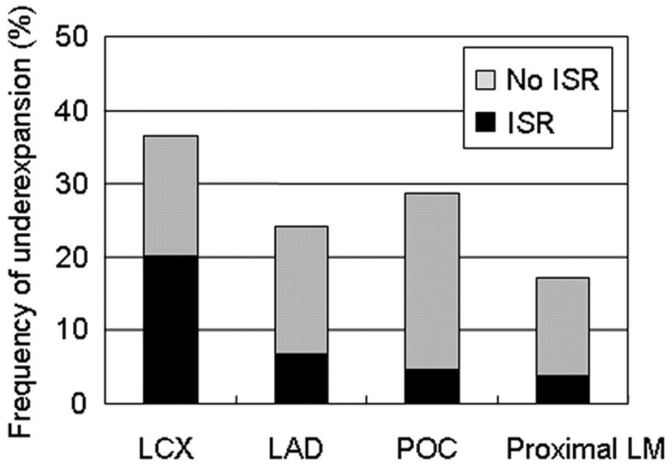
Underexpansion (+)	133	131	126	121	75
Underexpansion (-)	260	260	255	246	129

Kang SJ, et al. Circ Cardiovasc Interv. 2011;4:562-569

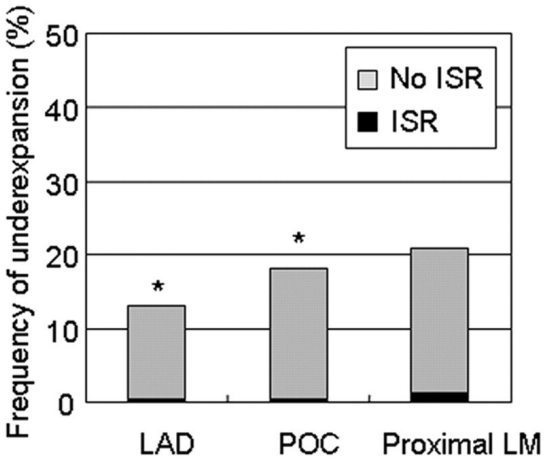
Minimal stent area (MSA) cut-off values for the prediction of angiographic in-stent restenosis (ISR)



2 stents



Single stent



CRT19

Soo-Jin Kang et al. Circ Cardiovasc Interv. 2011;4:562-569

CRTonline.org

Take home message

- Better clinical outcomes have been demonstrated in simple stent strategy compared with 2 stents strategies, and proximal optimization technique (POT) may provide much better PCI prognosis within simple stent strategy.

- Improvement of clinical outcomes in bifurcation lesion PCI can be expected by the guidance of FFR, IVUS, and 3D-OCT, although there are not enough data to support the reduction of the adverse clinical events using OCT guided PCI for bifurcation lesions at the moment.

- Randomized prospective studies with greater number of study population should be planned to demonstrate the improvement of clinical outcome by 3D-OCT guided PCI for LM bifurcation lesions in the near future.

Thank you for your kind attention !!

Welcome to APSC 2020 in Kyoto, Japan!!

CR

CRTonline.org

ESC European Society of Cardiology
European Heart Journal (2018) **00**, 1–96
doi:10.1093/eurheartj/ehy394

2018 ESC/EACTS Guidelines on myocardial revascularization

**The Task Force on myocardial revascularization of the Eu
Society of Cardiology (ESC) and European Association fo
Cardio-Thoracic Surgery (EACTS)**

**Developed with the special contribution of the European
Association for Percutaneous Cardiovascular Interventio**

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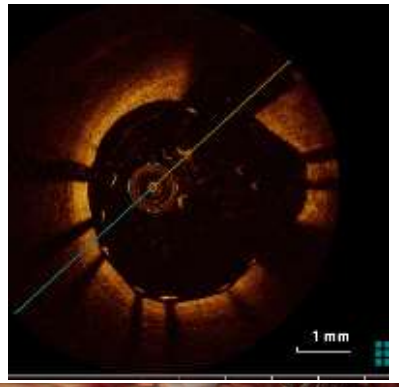
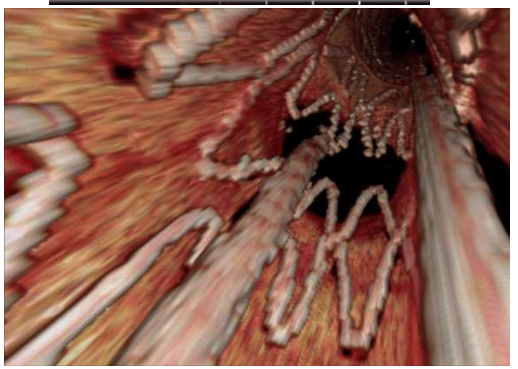
Recommendations on intravascular imaging for procedural optimization

Recommendations	Class[a]	Level[b]
IVUS or OCT should be considered in selected patients to optimize stent implantation.[603,612,651–653]	IIa	B
IVUS or OCT should be considered to optimize treatment of unprotected left main lesions.[35]	IIa	B

3D-OCT image information

- Stent apposition
- Stent cell figure
- Location of stent link in relation to side branch orifice
- GW recrossing position





Using specific off-line
3D-software provided by Dr. Okamura

3-D OCT guided bifurcation stenting (pilot study)

Okamura T, et al. EuroIntervention 2018;13:e1785-e1793

Study population

105 bifurcation lesions

Primary endpoint

Frequency of re-wiring by 3-D OCT guidance:
re-wiring should be required again more than 30 % cases.

Frequency of incomplete stent apposition by 3-D OCT guidance.

Secondary endpoint

Incidence of ISA:
MACE:

Japanese registry for 3-D OCT guided bifurcation stenting

Study population

600 bifurcation lesions

Side branch opening guided by 3-D OCT:400
- **Optimal**
- **Suboptimal**

No side branch opening:200

Primary endpoint

Incidence of side branch restenosis at 1 year.

Secondary endpoint

MACE at 3 years