

All about Bifurcation: KBC-JBC-EBC



# Japanese Bifurcation Club (JBC)

## History and Recent Academic Works

**Yoshinobu Murasato, MD, PhD**  
Department of Cardiology,  
National Hospital Organization Kyushu Medical Center,  
Fukuoka, Japan

# Japanese Bifurcation Club

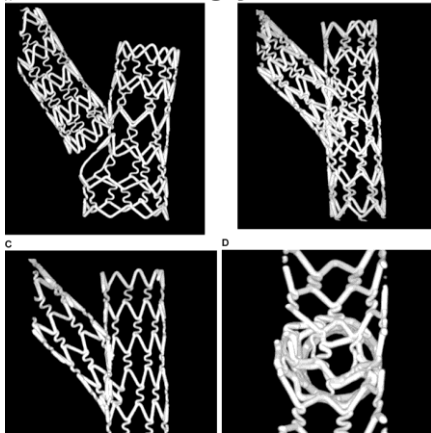
- Japanese Bifurcation Club (JBC) was established as an academic organization belong to Japanese Cardiovascular Interventional Therapeutics in 2012.
- Our aim is to promote the consensus of optimal coronary bifurcation treatment in Japan collaborating with the areas of medical engineering, physiology, and device technology.
- President : Yutaka Hikichi (Saga University)
- Directors: Yoshihisa Kinoshita (Toyohashi Heart Center)  
Yoshinobu Murasato (Kyushu Medical Center)  
Junya Shite (Saiseikai Nakatsu Hospital)

# Micro focus CT

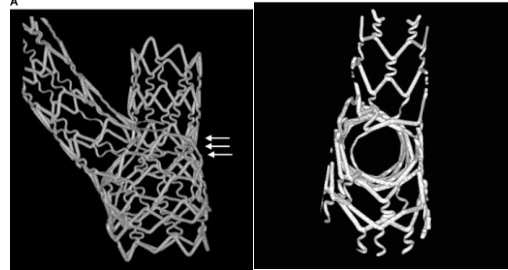
We are first openers of “Sesame Gate”.



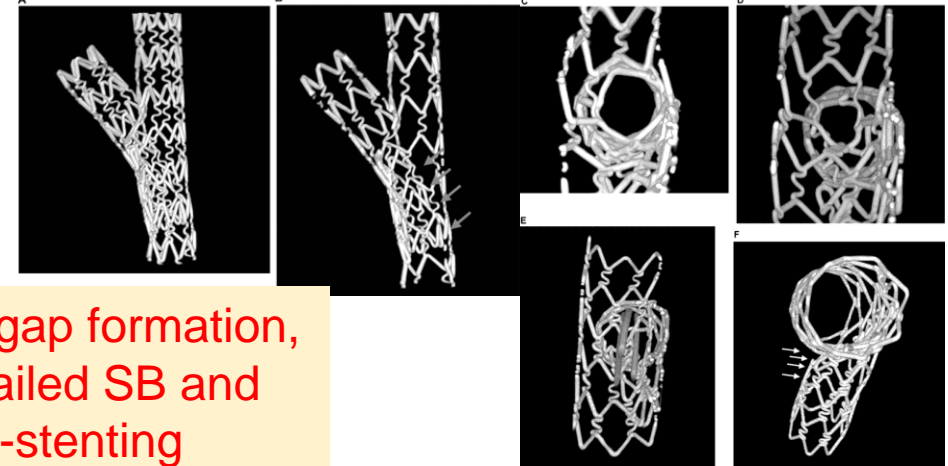
T-stenting



Culotte



Crush

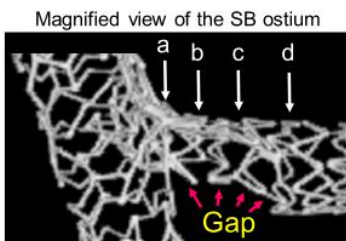
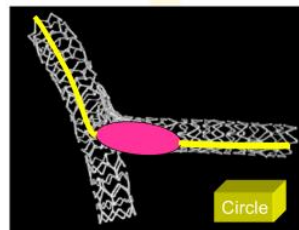


Risks of metal overlap, gap formation, incomplete opening of jailed SB and malapposition in each 2-stenting

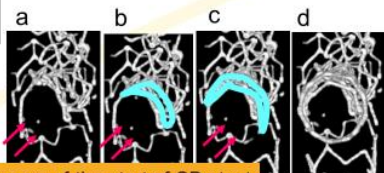
Hikich Y. EBC 2007  
JOIC, 2009, 22:128–134



Crush stenting  
Worst case



Cross sectional view

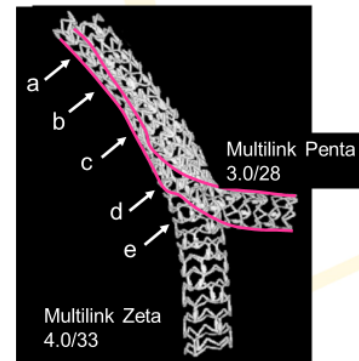


Absence of the strut of SB stent

Avoid distal wiring in crush stenting

Murasato Y. EBC 2007  
CCI, 2007, 70:211–220

Long kissing stenting



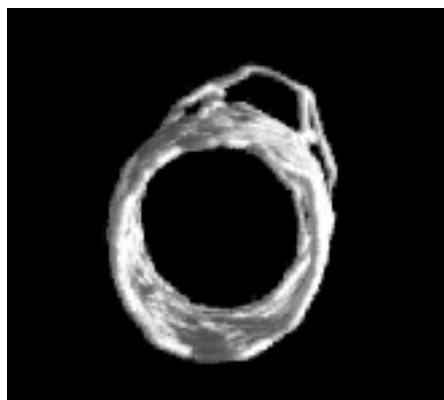
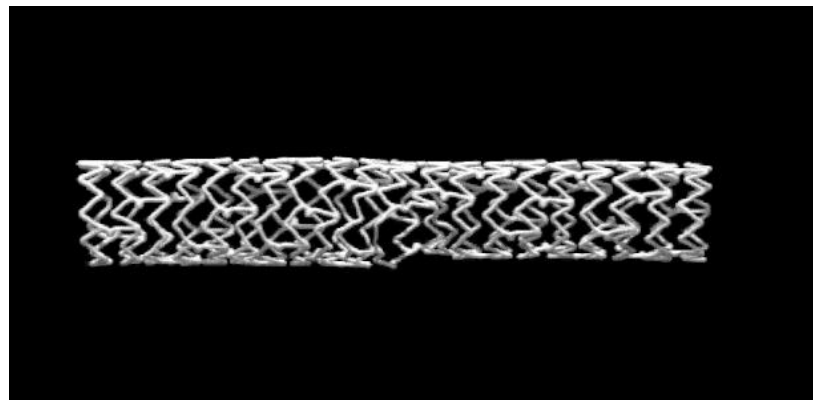
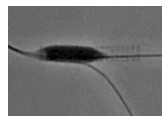
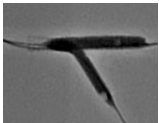
Cross sectional view



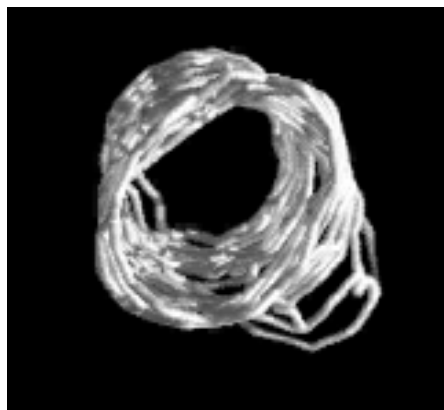
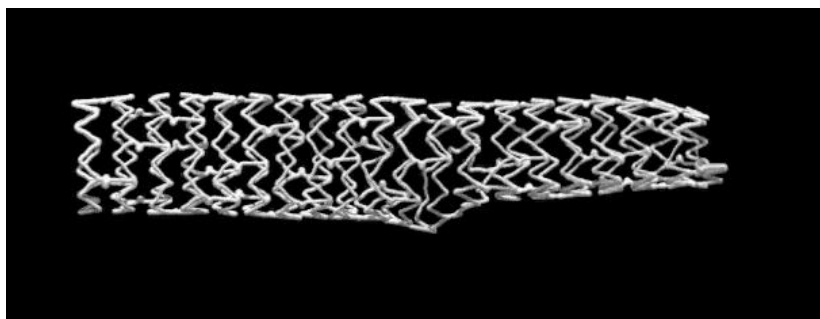
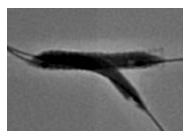
Avoid SKS except for emergent and hemodynamically collapsed cases

# POT + minimal overlapping KBI

Minimal overlapping + POT



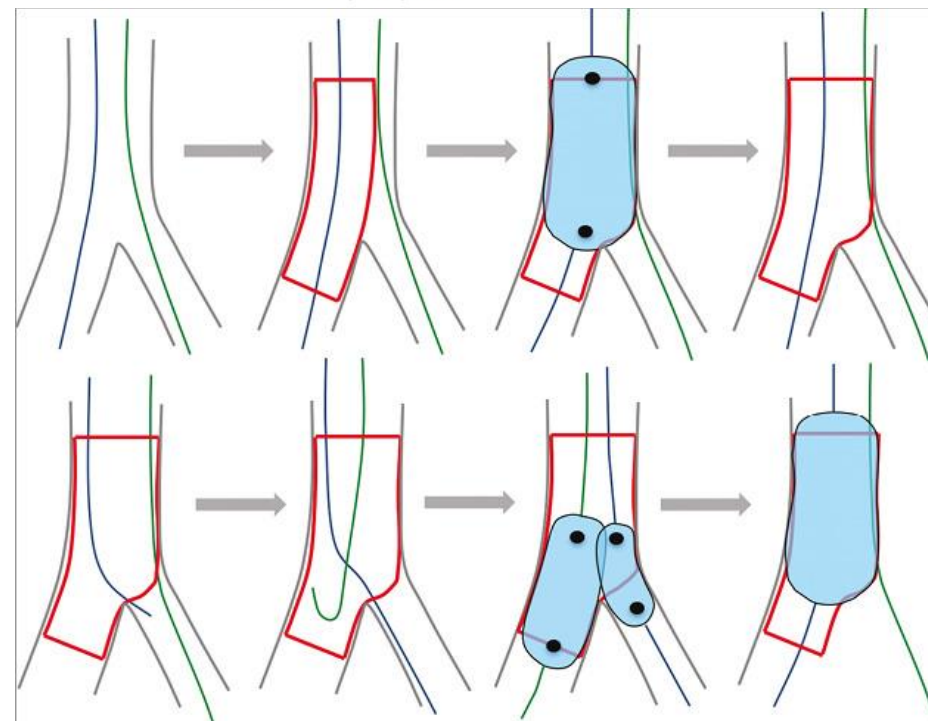
Long overlapping



Percutaneous coronary intervention for the left main stem and other bifurcation lesions: 12<sup>th</sup> consensus document from the European Bifurcation Club



Jens Flensted Lassen<sup>1\*</sup>, MD, PhD; Francesco Burzotta<sup>2</sup>, MD; Adrian P. Banning<sup>3</sup>, MD, PhD; Thierry Lefèvre<sup>4</sup>, MD; Olivier Darremont<sup>5</sup>, MD; David Hildick-Smith<sup>6</sup>, MD; Alaide Chieffo<sup>7</sup>, MD; Manuel Pan<sup>8</sup>, MD; Niels Ramsing Holm<sup>9</sup>, MD; Yves Louvard<sup>4</sup>, MD; Goran Stankovic<sup>10</sup>, MD, PhD



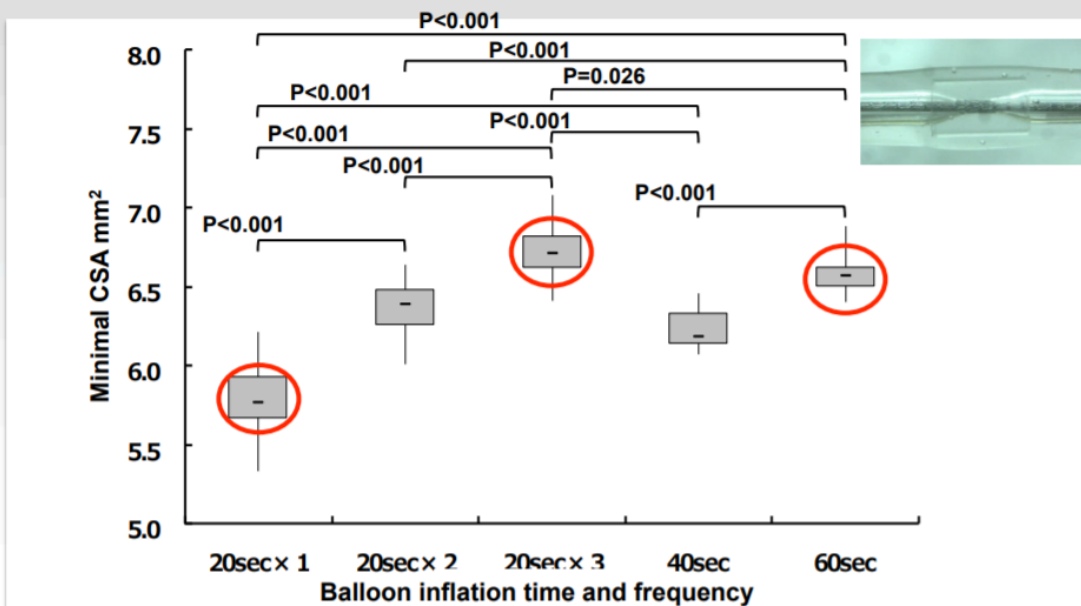
# 3-times balloon inflation



Iwasaki K, PhD  
(Waseda Univ)

3-times KBI reduces incomplete stent apposition at the SB ostium.

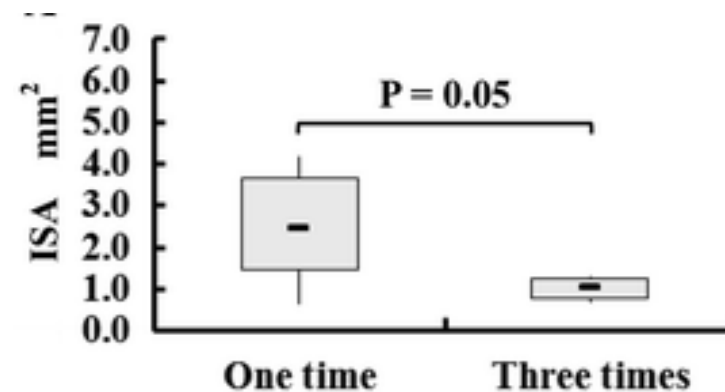
## Influence of Balloon Inflation Time and Frequency on Post-Procedural Minimal CSA "3-times balloon inflation method"



Iwasaki K, et al., AHA 2009, Circulation 120, S916, Orlando, November 2009.  
XIII European Bifurcation Club meeting - Porto, Portugal - 13th & 14th October 2017  
Kiyotaka Iwasaki, TWins, Waseda University

3-times of 20-sec balloon inflation introduces more stent expansion compared to 1-time inflation for 60 sec.

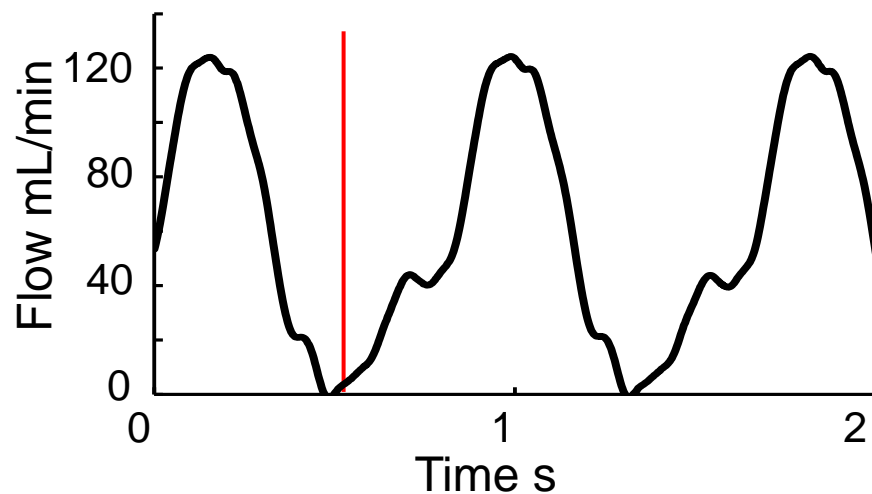
Stent	KBI time	ISA					
Nobori	1						
	3						



# Coronary flow visualization after bifurcation stenting



Iwasaki K, PhD  
(Waseda Univ)

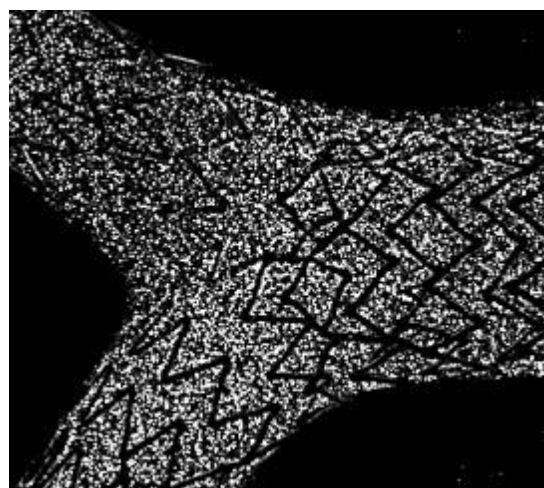


EBC 2017

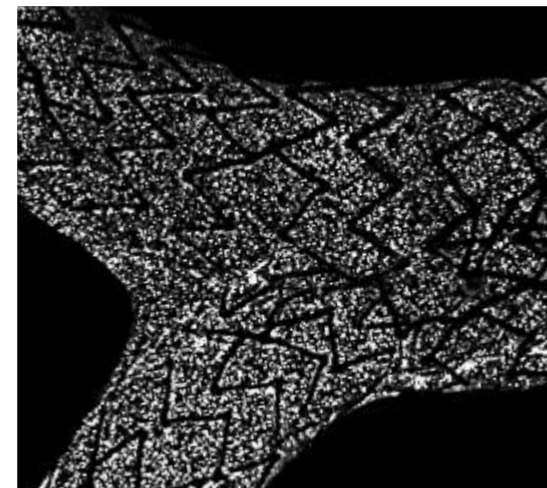
**2-stenting introduces flow retardation in the carina. Provisional stenting is still gold standard even in the current DES era.**



Before stenting



Culottes



DK Crush

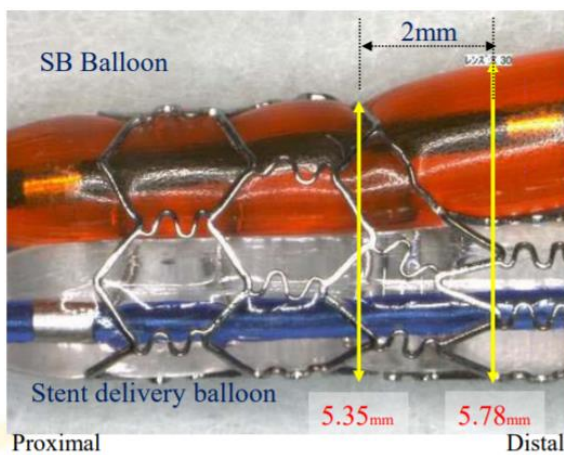
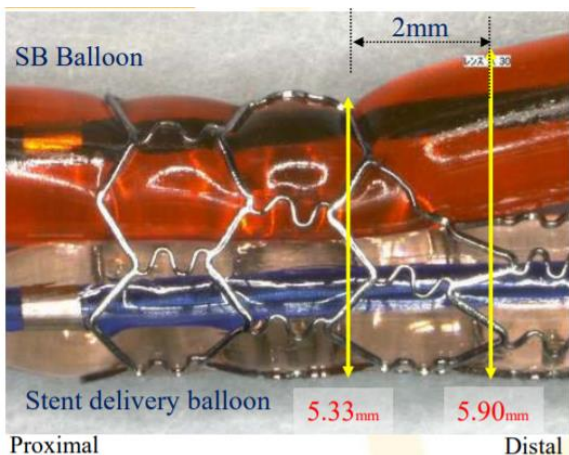
# Non-compliant balloon for KBI



KBI using non-compliant reduces a risk of edge dissection due to over expansion.

Semi-compliant balloon

Non-compliant balloon



Kinoshita Y, EBC 2009

## French feasibility study

Table 4. Clinical outcomes.

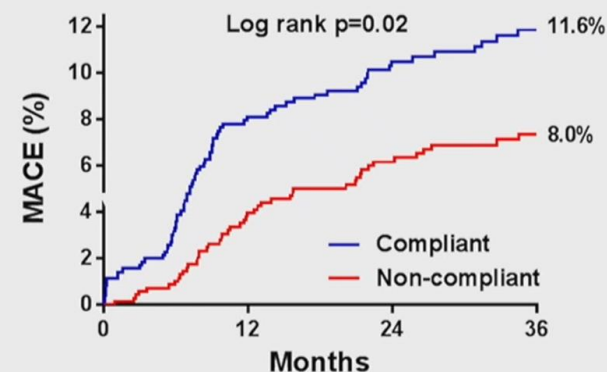
Variable	Number of patients, n/P%	1 year	n=99
30 days	n=100		
Target lesion revascularisation	0	Target lesion revascularisation	3
Stent thrombosis	0	Stent thrombosis	0
Myocardial infarction	0	Myocardial infarction	0
Cardiac death	0	Cardiac death	1
Non-cardiac death	1	Non-cardiac death	2
Total MACE	0	Total MACE	4

Values are expressed as number and percentage; MACE: major adverse cardiac event

Mylotte D et al. EuroInterv. 2012;7:1162-9

## COBIS II

- Propensity score-matching population (N=1,420)
- Median follow-up duration was 36 [24-52] months



Number at risk	0	12	24	36
Compliant	710	593	478	333
Non-compliant	710	643	547	340

Park TK et al. EuroInterv. 2016;12:456-64

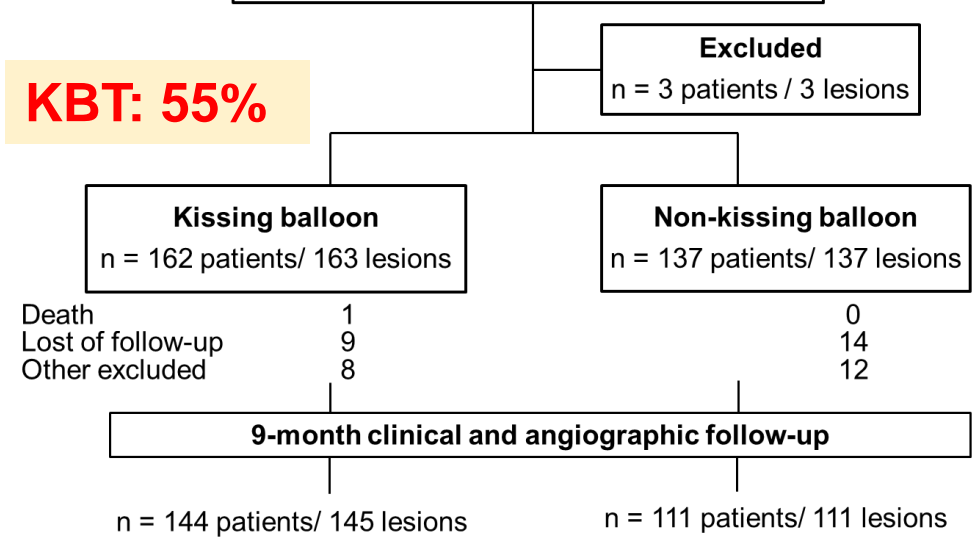
# J-REVERSE: under complete IVUS-guidance KBT vs. non-KBT



**Registry entry criteria**

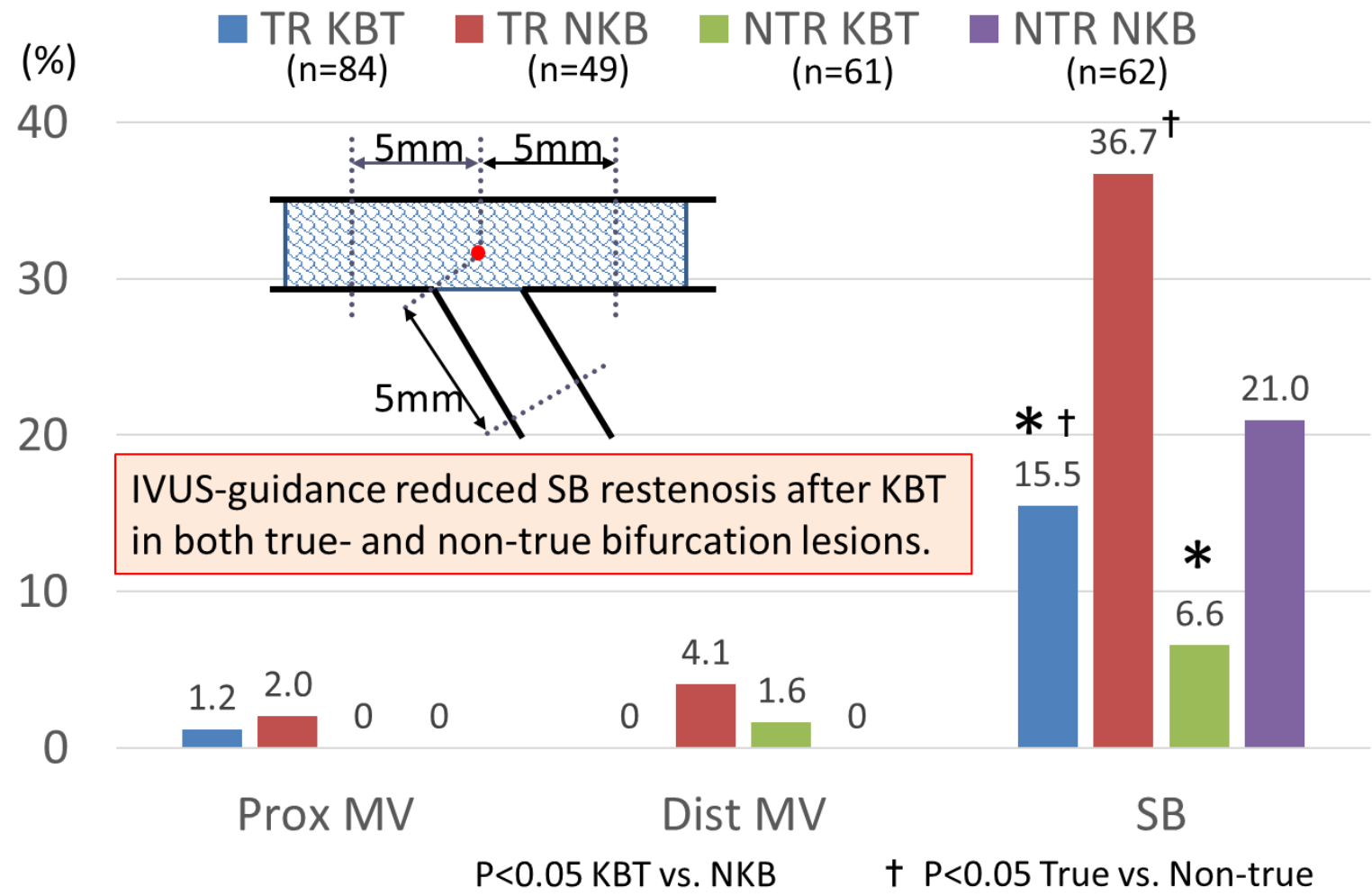
- Lesion of non-left main coronary bifurcation
- Provisional stenting
- Intravascular ultrasound-guided procedure
- n = 301 patients / 303 lesions

**KBT: 55%**



**Less SB stenting**  
**KBT: 5.6%**  
**Non-KBT: 0.7%**

## True vs. non-true bifurcation lesion

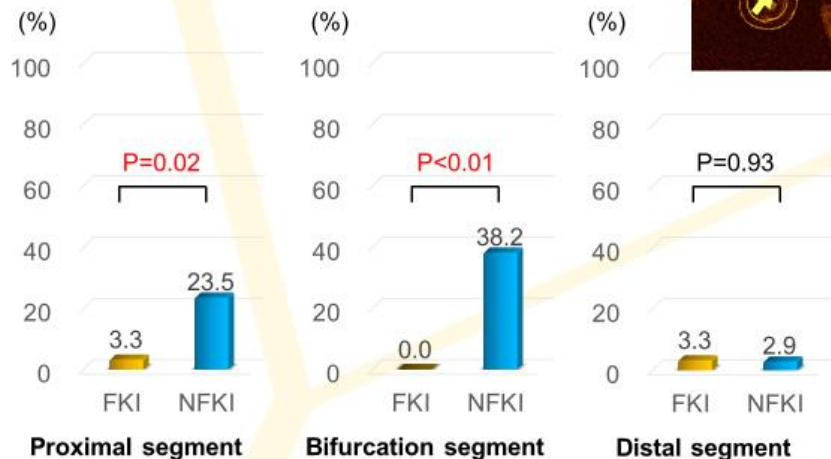
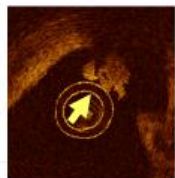




# J-REVERSE: F/U OCT study

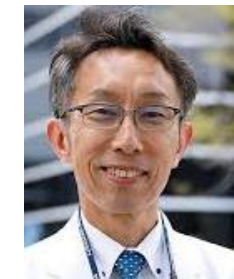
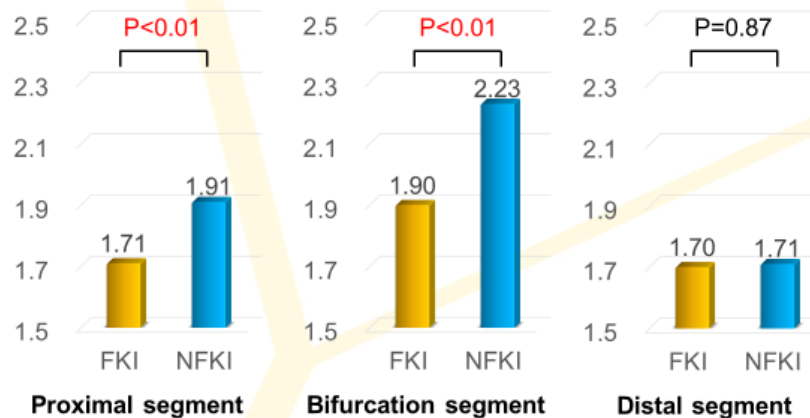


## Incidence of Thrombus attachment



## Average Neointimal Unevenness Score (NUS)

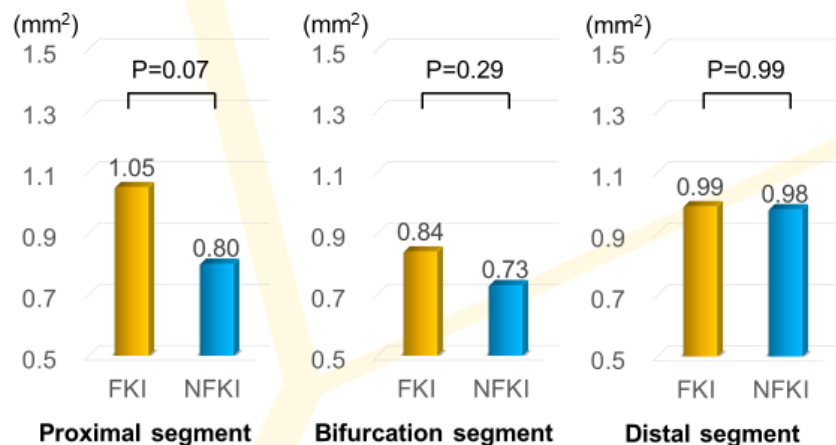
NUS = Maximum NIT / Average NIT



Shinke T  
(Showa Univ)



## Average Neointimal Area

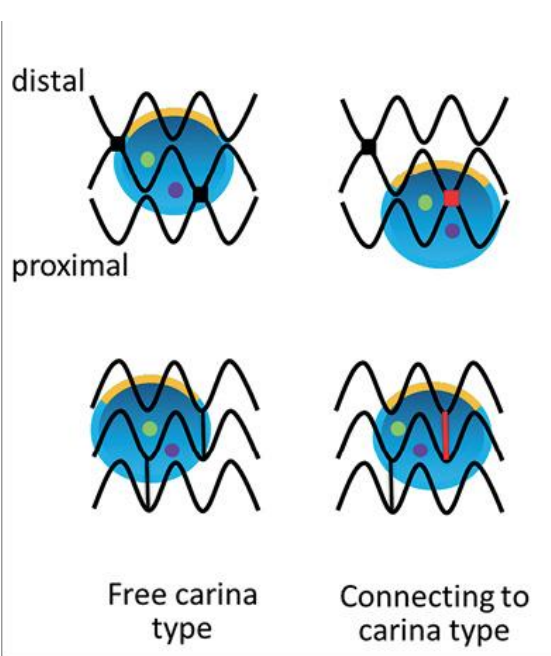


The incidence of thrombus were significantly lower in FKI group.

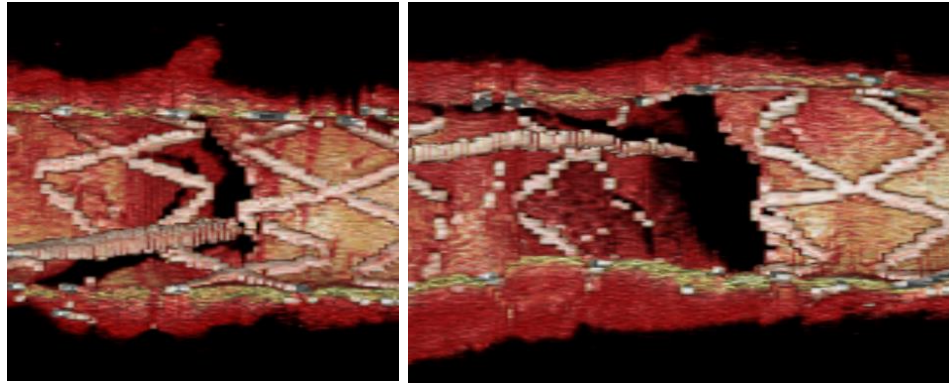
FKI was associated with a trend of greater reactive neointimal proliferation and a significantly smaller NUS.

# 3D OCT Bifurcation Registry

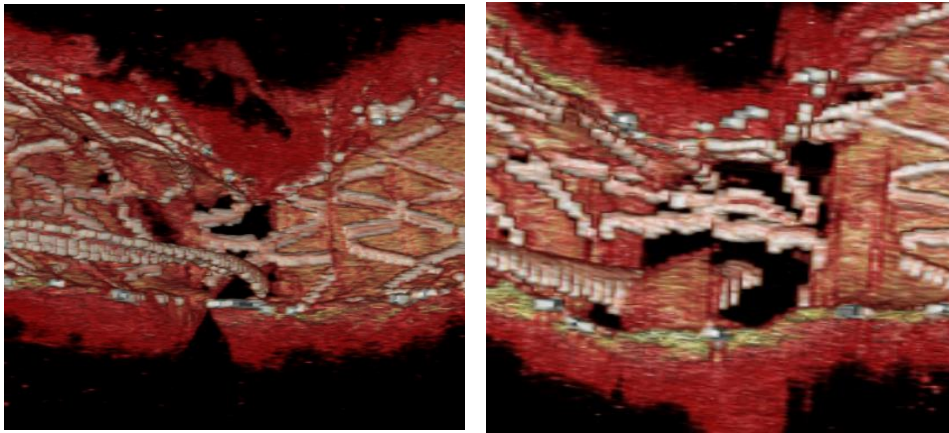
## Link-free vs. Link-connected type



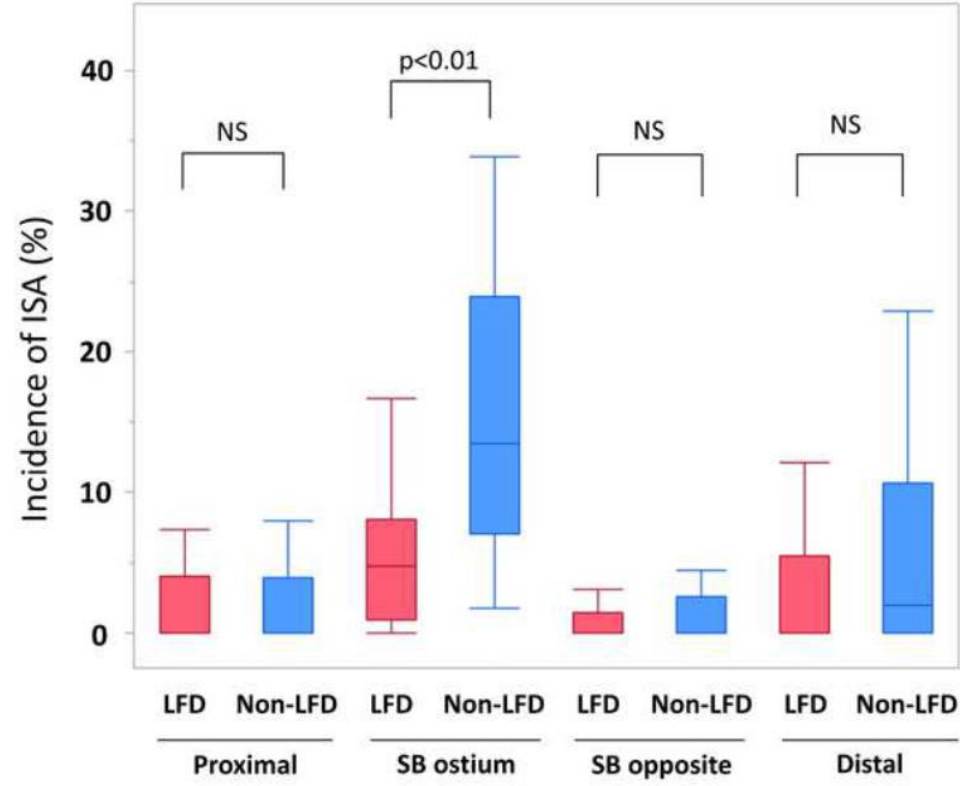
Free carina type



Connecting to carina type



Incomplete strut apposition (ISA) after KBI



LFD: Link free + distal wiring



Okamura T.  
(Yamaguchi Univ)



Shite J. (Saiseikai  
Nakatsu Hp)

# 3D OCT Bifurcation Registry

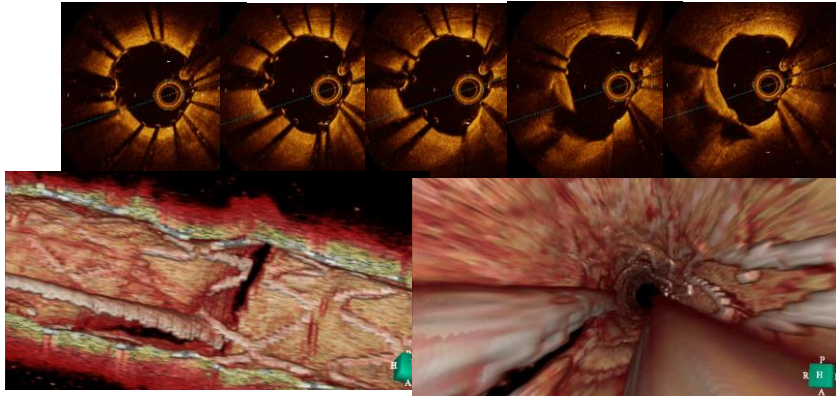
## 2D OCT vs. 3D OCT



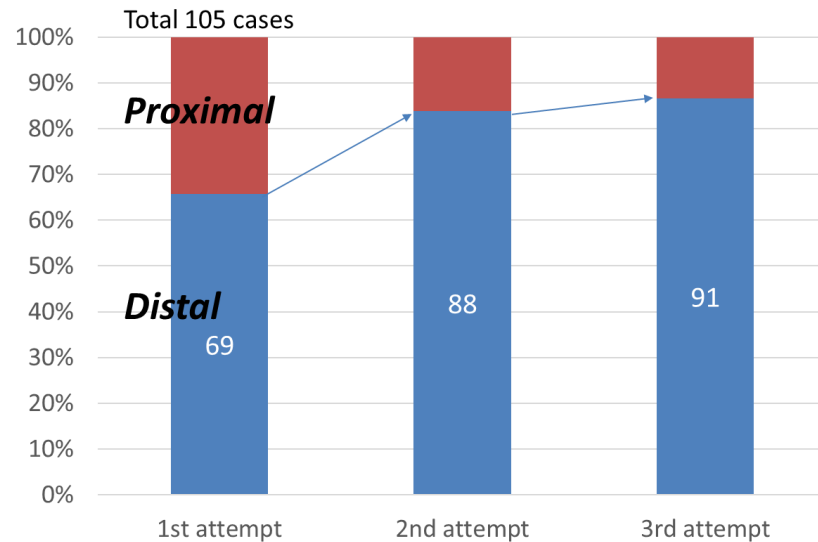
Nagoshi R, Okamura T, Murasato Y, Shite J et al. Int J Cardiol 2018



Nagoshi R.  
(Saiseikai  
Nakatsu Hp)

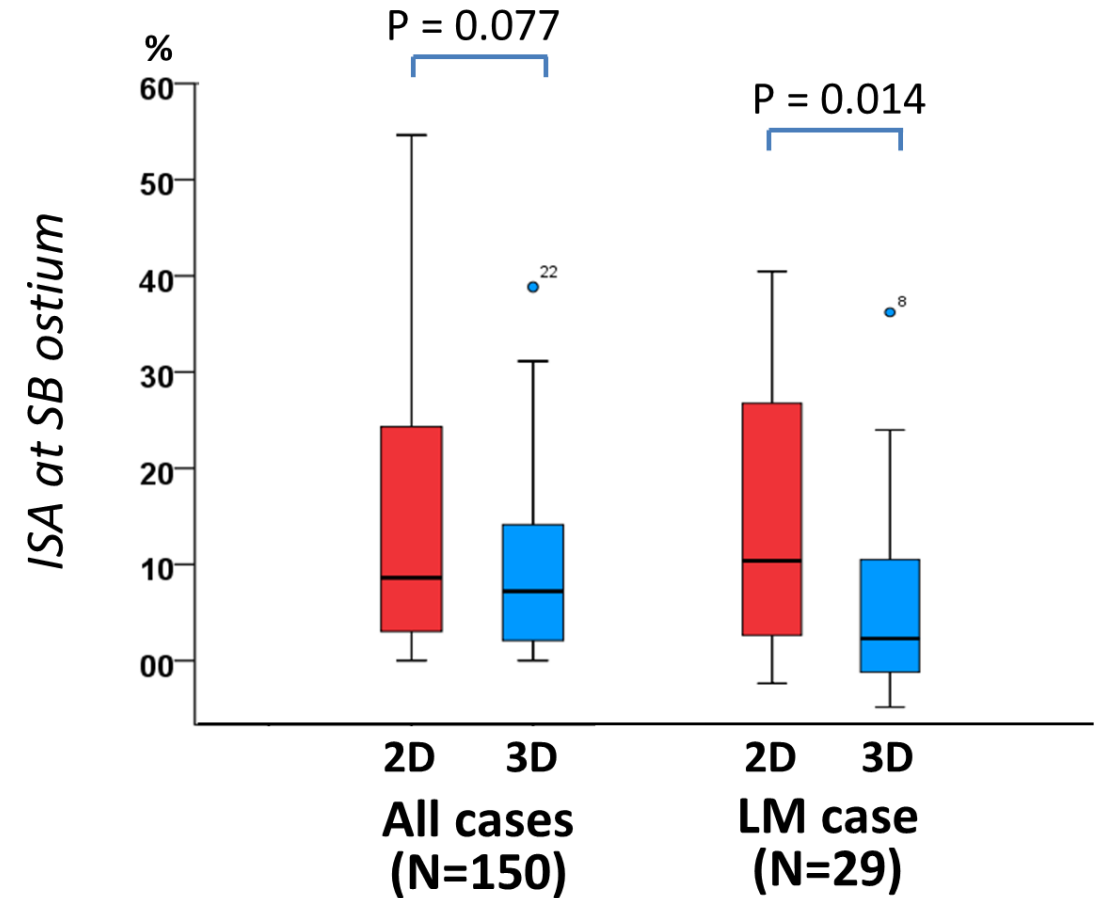


### Success rate of optimal distal wiring



Angio-guide 66%  
3-D OCT guide 87%

### Incomplete strut apposition (ISA)



3-D OCT guidance is more favorable in LM bifurcation.



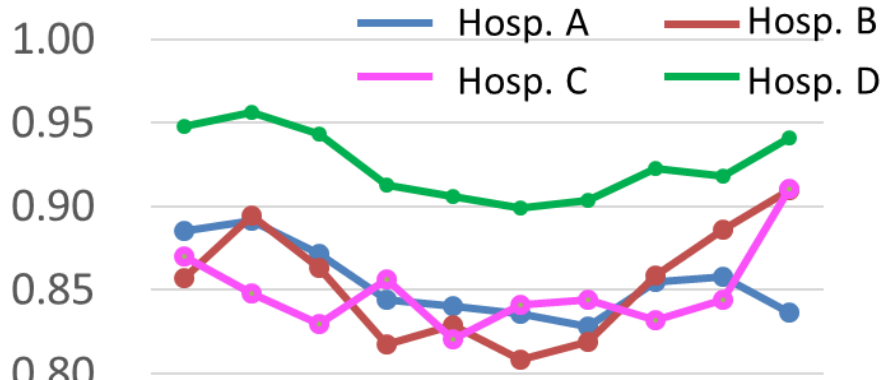
# 3D OCT Bifurcation Registry

## Efficacy of POT

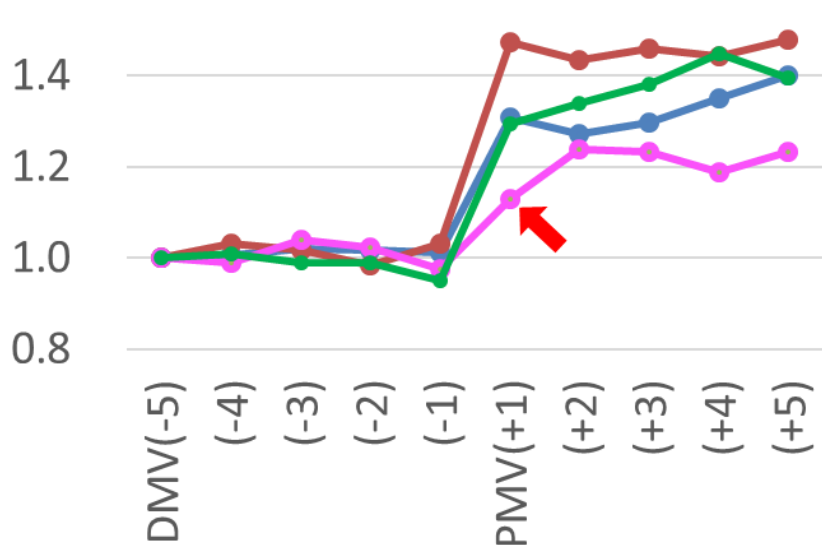


Murasato Y et al. Int J Cardiovasc Imaging. 2019;35:981-990

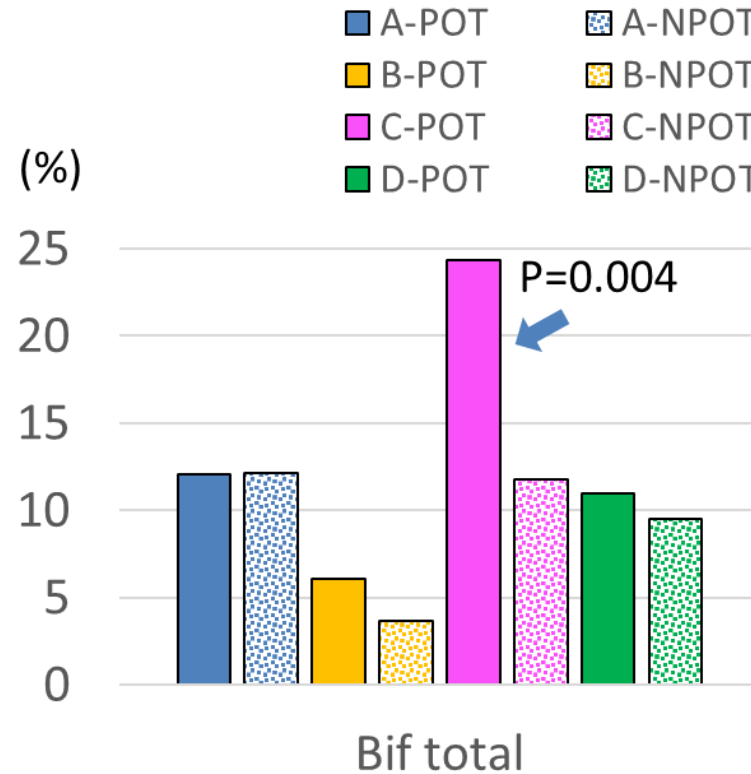
### Stent eccentricity index



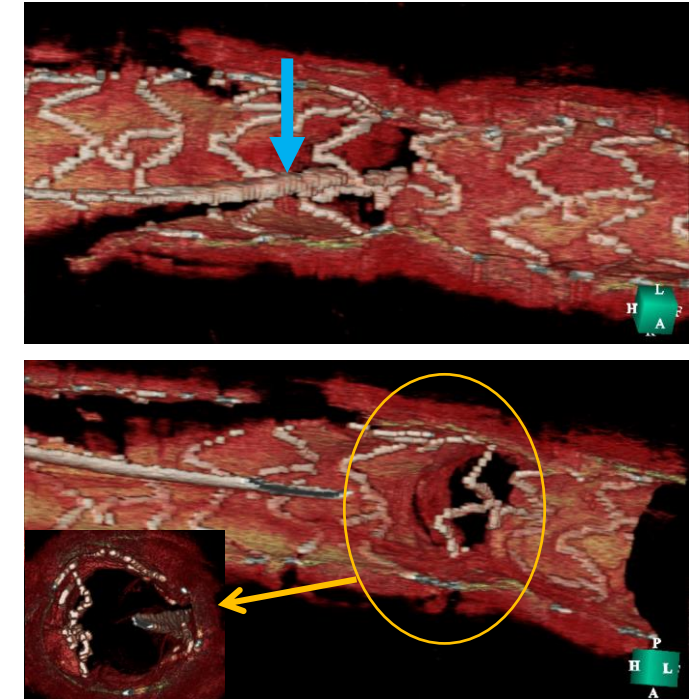
### Stent expansion ratio



### Incomplete stent apposition

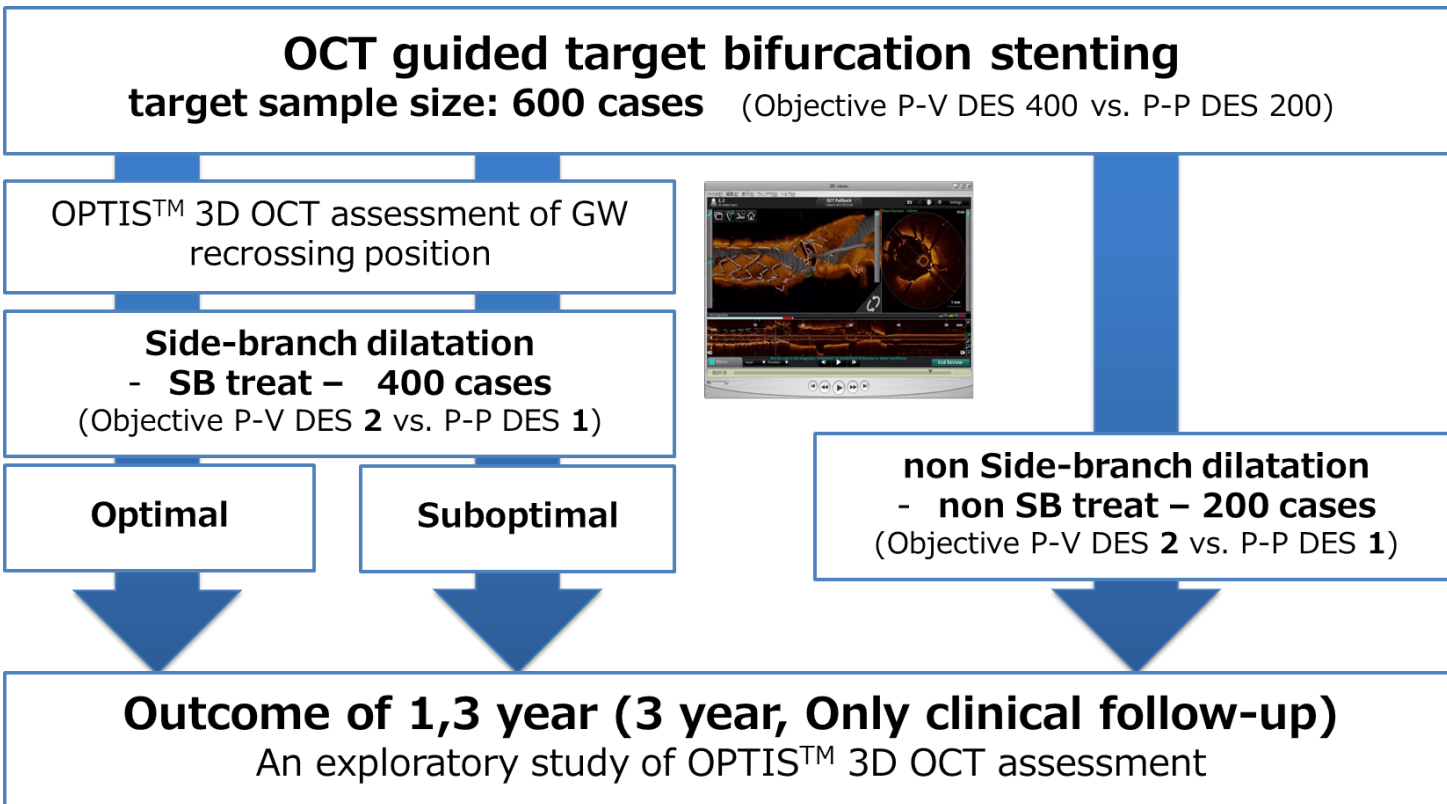


Insufficient expansion in the carinal site (red arrow) led to large ISA (blue arrow) in Hospital C.



Lack of consensus in the POT was clarified in the comparison among 4 hospitals where  $\geq 20$  cases were enrolled.

# 3D OCT Bifurcation Registry II



- Optimal GWR vs. Suboptimal GWR
  1. Angiographic restenosis
  2. Clinical events
  3. Post-PCI stent configuration (Incomplete strut apposition, deformation)
- SB dilatation vs. Non-SB dilatation
- Peak-Valley: 3-link (Xience) vs. Peak-Peak: 2-link stents (Resolute, Synergy, Ultimaster)
- Enrollment: April, 2018 – March, 2020

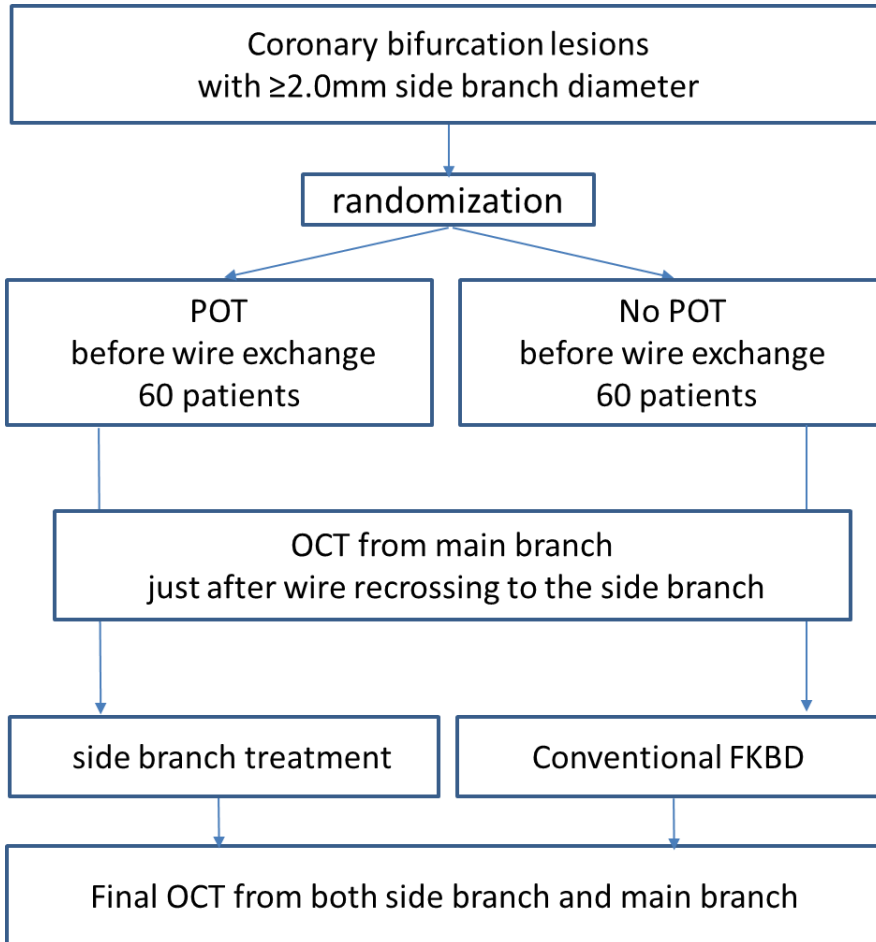


# PRO POT

**PRO**spective randomized study to evaluate **PRO**ximal **OPT**imization **TECH**nique in coronary bifurcation lesions

Kozuma K, (Teikyo Univ)

**POT+SBD vs.  
Non-POT (Conventional FKB)**



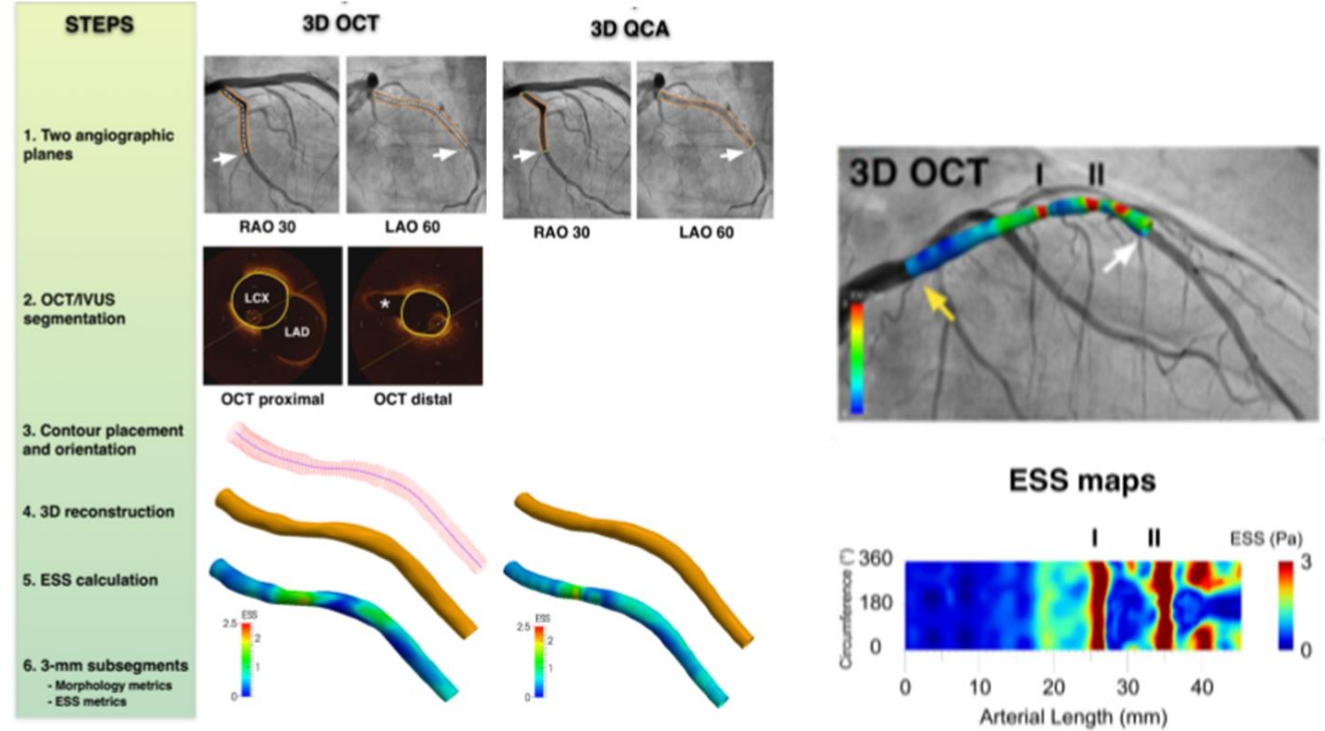
# FLOW ISR Study

**EFF**ect of **LOCAL** **BIOMECHANICAL** Factors on **BIFURCATION** **STENT** **RESTENOSIS** and Thrombosis

Chatzizisis YS  
(Nebraska Univ)



Toutouzas K, Chatzizisis YS et al. Atherosclerosis. 2015



1. Validation of pre-stenting Computational Simulation
2. Evaluation of post-stenting Coronary Flow Dynamics
3. Obtaining bifurcation atlas

Enrollment has been finished and analysis is now proceeding.

# Our Contribution on Consensus and Review Articles



## Bench testing and coronary artery bifurcations: a consensus document from the European Bifurcation Club



**John A. Ormiston**<sup>1,2,3\*</sup>, MBChB; Ghassan Kassab<sup>4</sup>, PhD; Gerard Finet<sup>5</sup>, MD; Yiannis S. Chatzizisis<sup>6</sup>, MD; Nicholas Foin<sup>7</sup>, PhD; Timothy J. Mickley<sup>8</sup>, BSME; Claudio Chiastra<sup>9</sup>, PhD; Yoshinobu Murasato<sup>10</sup>, MD; Yutaka Hikichi<sup>11</sup>, MD; Jolanda J. Wentzel<sup>12</sup>, PhD; Olivier Darremont<sup>13</sup>, MD; Kiyotaka Iwasaki<sup>14</sup>, PhD; Thierry Lefèvre<sup>15</sup>, MD; Yves Louvard<sup>16</sup>, MD; Susann Beier<sup>2</sup>, PhD; Hikmat Hojeibane<sup>17</sup>, MS; Ashley Netravali<sup>17</sup>, MS; Jeffery Wooton<sup>18</sup>, PhD; Brett Cowan<sup>2</sup>, MBChB; Mark W. Webster<sup>3</sup>, MBChB; Pau Medrano-Gracia<sup>2</sup>, PhD; Goran Stankovic<sup>19</sup>, MD

1. Mercy Angiography, Auckland, New Zealand; 2. University of Auckland, Auckland, New Zealand; 3. Auckland City Hospital, Auckland, New Zealand; 4. California Medical Innovations Institute, San Diego, CA, USA; 5. Hôpital Cardiologique, Claude Bernard University, Lyon, France; 6. University of Nebraska Medical Center, Omaha, NE, USA; 7. National Heart Research Institute, Singapore; 8. Boston Scientific, Minneapolis, MN, USA; 9. Politecnico di Milano, Milan, Italy; 10. Kyushu Medical Center, Fukuoka, Japan; 11. Saga University School of Medicine, Saga, Japan; 12. Erasmus MC, Biomedical Engineering, Rotterdam, the Netherlands; 13. Clinique Saint Augustin, Bordeaux, France; 14. Waseda University, Tokyo, Japan; 15. Hôpital Privé Jacques Cartier, Massy, France; 16. Stentys, Paris, France; 17. Abbott Vascular, Santa Clara, CA, USA; 18. Medtronic Corp, Santa Rosa, CA, USA; 19. University of Belgrade, Belgrade, Serbia

## Lessons from the real bench: non-BRS

John Ormiston<sup>1,2,7\*</sup>, MBChB; Olivier Darremont<sup>3</sup>, MD; Kiyotaka Iwasaki<sup>4</sup>, PhD; Yoshinobu Murasato<sup>5</sup>, MD; Yutaka Hikichi<sup>6</sup>, MD; Bruce Webber<sup>1</sup>, MHS; Mark Webber<sup>2,7</sup>, MBChB

1. Mercy Angiography, Auckland, New Zealand; 2. University of Auckland School of Medicine, Auckland, New Zealand; 3. Clinique Saint-Augustin, Bordeaux, France; 4. Waseda University, Tokyo, Japan; 5. Kyushu Medical Center, Fukuoka, Japan; 6. Saga University, Saga, Japan; 7. Auckland City Hospital, Auckland, New Zealand

**EuroIntervention 2015;11:V27-V30**

## Coronary bifurcation stenting: insights from *in vitro* and virtual bench testing

Peter Mortier<sup>1,2</sup>, PhD; Matthieu De Beule<sup>1,2</sup>, PhD; Gabriele Dubini<sup>3</sup>, PhD; Yutaka Hikichi<sup>4</sup>, MD; Yoshinobu Murasato<sup>5</sup>, MD, PhD; John A. Ormiston<sup>6</sup>, MD

1. IBItech-bioMeda, Ghent University, Ghent, Belgium; 2. FEops, Ghent, Belgium; 3. Laboratory of Biological Structure Mechanics, Dept. of Structural Engineering, Politecnico di Milano, Milan, Italy; 4. Department of Cardiovascular Medicine, Saga University, Saga, Japan; 5. Department of Cardiovascular Medicine, Heart Centre, New Yukuhashi Hospital, Yukuhashi, Japan; 6. Mercy Angiography, Newmarket, Auckland, New Zealand

EuroIntervention Supplement (2010) Vol. 6 (Supplement J) J53-J60

## Biomechanical Modeling to Improve Coronary Artery Bifurcation Stenting

Expert Review Document on Techniques and

Clinical Implementation JACC Cardiovasc Interv. 2015;8:1281-96.

Antonios P. Antoniadis, MD, PhD,\*†† Peter Mortier, PhD,§|| Ghassan Kassab, PhD,¶ Gabriele Dubini, PhD,# Nicolas Foin, PhD,\*\* Yoshinobu Murasato, MD, PhD,†† Andreas A. Giannopoulos, MD,\*† Shengxian Tu, PhD,††† Kiyotaka Iwasaki, MD,§§ Yutaka Hikichi, MD,||| Francesco Migliavacca, PhD,# Claudio Chiastra, PhD,#¶¶ Jolanda J. Wentzel, PhD,¶¶ Frank Gijzen, PhD,¶¶ Johan H.C. Reiber, PhD,## Peter Barlis, MBBS, PhD,\*\*\* Patrick W. Serruys, MD, PhD,††† Deepak L. Bhatt, MD, MPH,\* Goran Stankovic, MD,†††† Elazer R. Edelman, MD, PhD,††††† George D. Giannoglou, MD, PhD,† Yves Louvard, MD,||| Yiannis S. Chatzizisis, MD, PhD\*†

**Recent Perspective on Coronary Bifurcation Intervention: Statement of the “Bifurcation Club in KOKURA”** J Interv Cardiol. 2010;23:295-304

YOSHINOBU MURASATO, M.D.,<sup>1</sup> YUTAKA HIKICHI, M.D.,<sup>2</sup> SUNAO NAKAMURA, M.D.,<sup>3</sup> FUMIHIKO KAJIYA, M.D.,<sup>4</sup> KIYOTAKA IWASAKI, M.D.,<sup>5</sup> YOSHIHISA KINOSHITA, M.D.,<sup>6</sup> MASAHIRO YAMAWAKI, M.D.,<sup>7</sup> TOSHIRO SHINKE, M.D.,<sup>8</sup> SHNICHIRO YAMADA, M.D.,<sup>9</sup> TAKEHIRO YAMASHITA, M.D.,<sup>10</sup> GIM-HOOI CHOO, M.D.,<sup>11</sup> CHANG-WOOK NAM, M.D.,<sup>12</sup> YOUNG-HAK KIM, M.D.,<sup>13</sup> NIGEL JEPSON, M.D.,<sup>14</sup> and MIROSLAW FERENC, M.D.<sup>15</sup>

From the <sup>1</sup>New Yukuhashi Hospital, Japan; <sup>2</sup>Saga University, Japan; <sup>3</sup>New Tokyo Hospital, Japan; <sup>4</sup>Kawasaki University of Medical Welfare, Japan; <sup>5</sup>Waseda University, Japan; <sup>6</sup>Toyohashi Heart Center, Japan; <sup>7</sup>Saiseikai Yokohama-Eastern Hospital, Japan; <sup>8</sup>Kobe University, Japan; <sup>9</sup>Himeji Cardiovascular Center, Japan; <sup>10</sup>Cardiovascular Center Hokkaido Ohno Hospital, Japan; <sup>11</sup>KPJ Selangor Specialist Hospital, Malaysia; <sup>12</sup>Keimyung University, Korea; <sup>13</sup>Asan Medical Center, Korea; <sup>14</sup>Eastern Heart Clinic, Australia; and <sup>15</sup>Hertz-Zentrum Bad Krozingen, Germany

## IVUS in bifurcation stenting: what have we learned?

Jacek Legutko<sup>1\*</sup>, MD, PhD; Masahiro Yamawaki<sup>2</sup>, MD, PhD; Ricardo A. Costa<sup>3</sup>, MD, PhD; Marco A. Costa<sup>4</sup>, MD, PhD

1. Institute of Cardiology, Jagiellonian University Medical College, Krakow, Poland; 2. Saiseikai Yokohama City Eastern Hospital, Yokohama, Japan; 3. Instituto Dante Pazzanese de Cardiologia, Sao Paulo, Brazil; 4. Center for Research and Innovation, UH Harrington Heart and Vascular Institute, Case Western Reserve University, Cleveland, OH, USA

**EuroIntervention 2015;11:V55-V58**

## Final kissing balloon inflation: the whole story

Yoshinobu Murasato<sup>1,2\*</sup>, MD, PhD; Gérard Finet<sup>3</sup>, MD, PhD; Nicolas Foin<sup>4</sup>, MSc, PhD

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## Joint consensus on the use of OCT in coronary bifurcation lesions by the European and Japanese bifurcation clubs

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# Thank you for your attention!

