

In-Depth Technical Aspect of LM PCI

-Insights From the MITO Registry-

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FACC, FAHA, FESC, FSCAI

Preamble

Due to Prof. S.J. Park's and Staff of ASAN medical center's great achievement, PCI treating LMT lesion may bring an equivalent result with CABG if lesion is not complicated

If PCI on LMT is further improved in its precision level, restenosis rate would be further reduced, which leads to expand the field of PCI equivalent to CABG.

For its optimization, IVUS guided approach , POT technique, full cover approach for LMT and using FFR etc.... have become important determinant factors....

Other contributing factors for enhancing PCI treatment are discussed in this presentation.

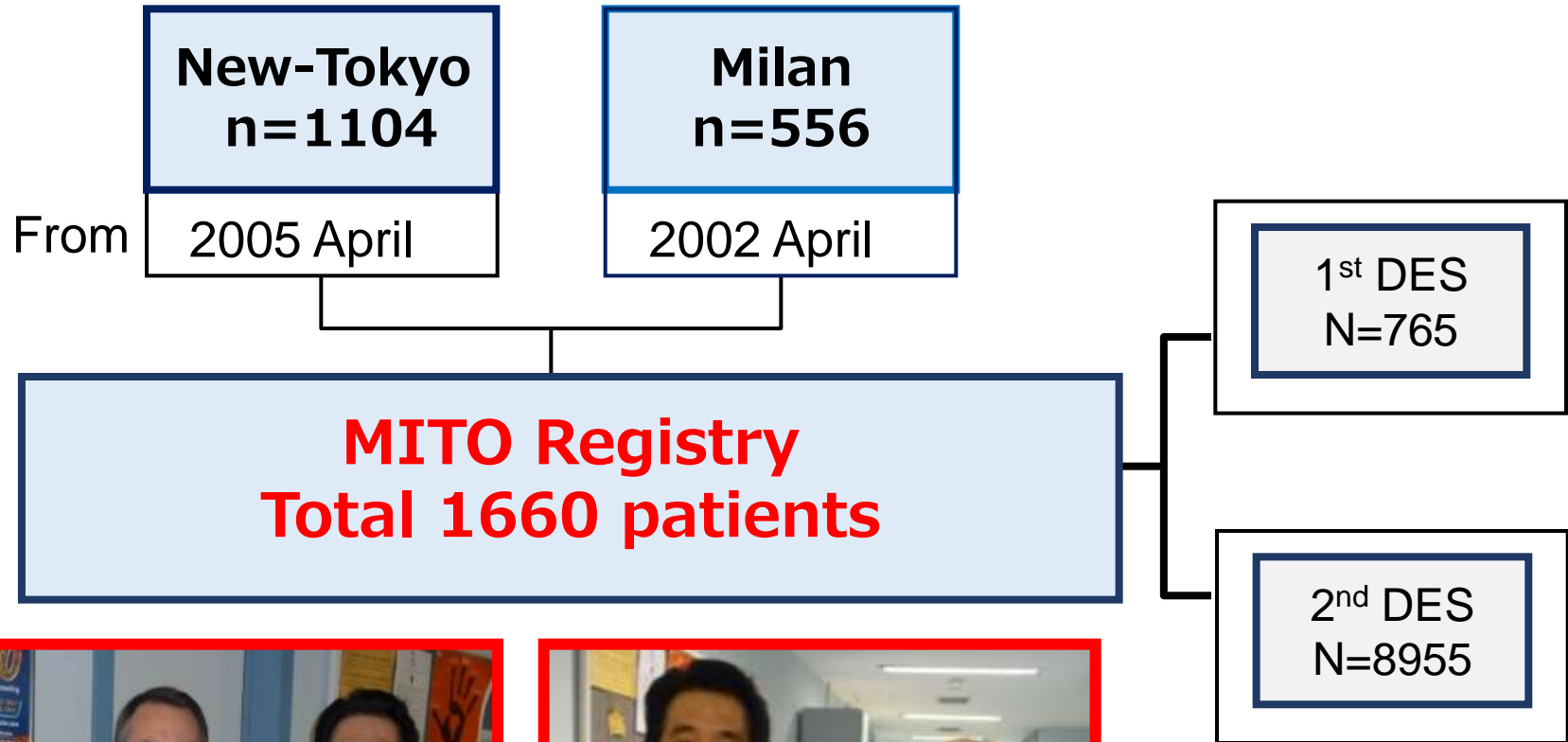
The Milan and New-Tokyo (MITO) Registry

Among LMT PCI, some specific cases are still challenged with restenosis and MACE. Seeking for solution of these unsolved challenges, we decided to conduct data review of our own cases. Under the guidance of Dr. Antonio Colombo and Dr. Alaide Chieffo, our staff compiled data of our hospital and that of Milan as **MITO Registry**.



Milan and New-Tokyo (MITO) Registry

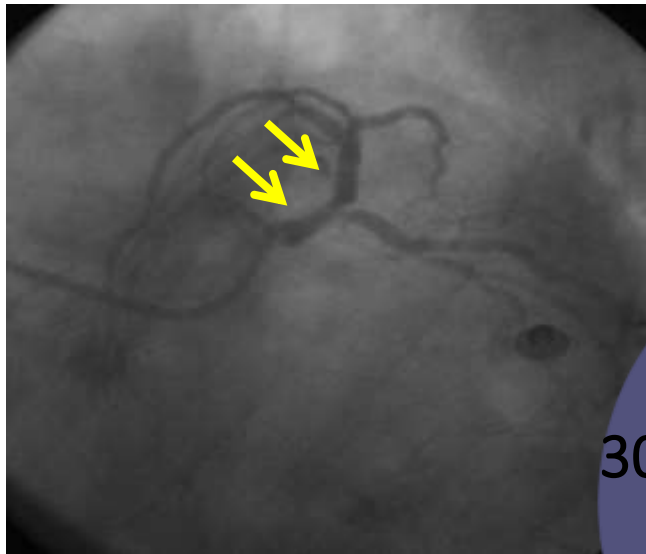
Between April 2002 and Jun 2016



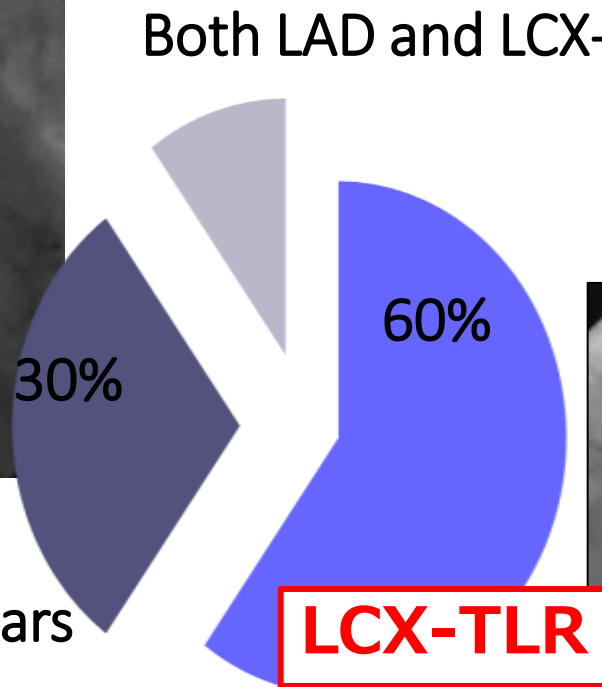
The impact of Main Branch Restenosis on Long Term Mortality Following Drug-eluting Stent Implantation in Patients with De Novo Unprotected Distal Left Main Bifurcation Coronary Lesions: The MILan and New-TOKyo (MITO) Registry

Catheter Cardiovasc Interv. 2013 Sep 2 by K.Takagi, S.Nakamura A.Colombo et.al

Distal LAD-ISR

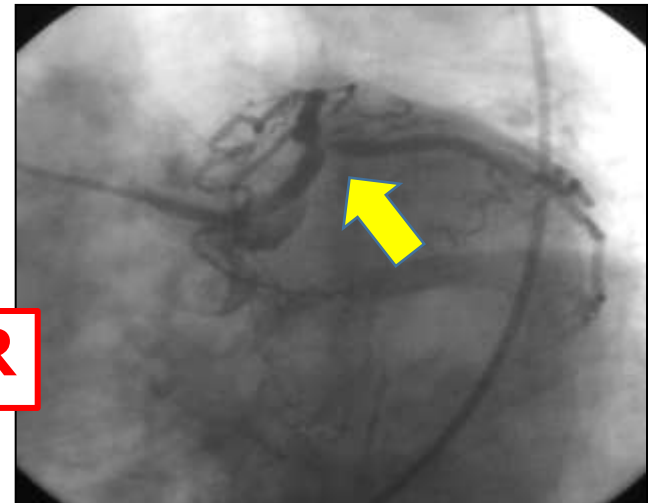


LAD-TLR
9.2% at 2-years



Both LAD and LCX-TLR

LCx ostial ISR alone



LCX-TLR

Kaplan Meier 8-year patients survival

n=753



Lesson 1

Among restenosis after LMT PCI, restenosis at LCX ostium is not directly link to fatal prognosis in most of the cases. Therefore our focus should be shift to restenosis at LM toward LAD, which strongly affect on patients' fatal prognosis.



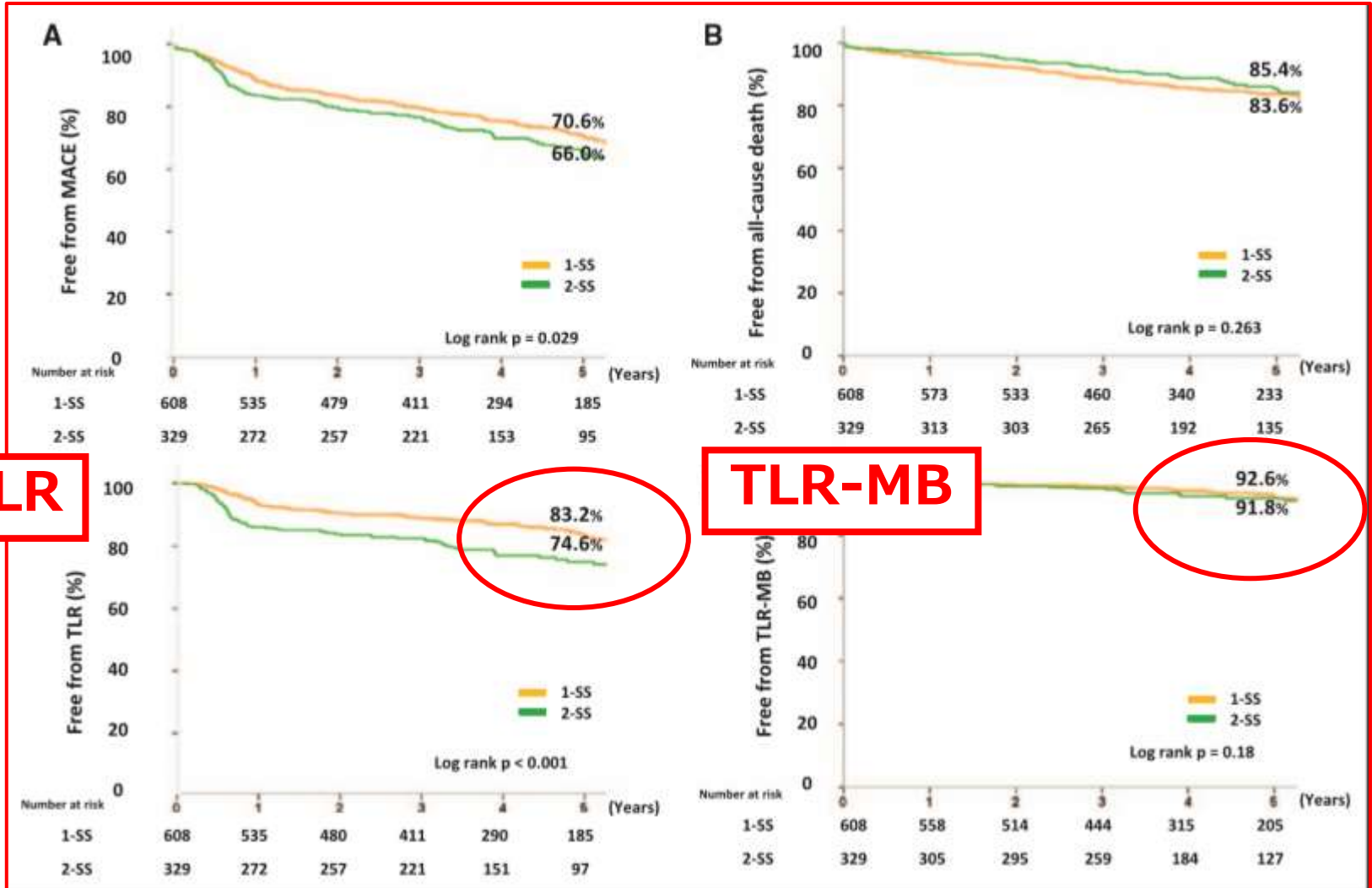
Kensuke Takagi M.D. FACC

Catheter Cardiovasc Interv. 2013 Sep 2

Circ Cardiovasc Interv. 2016

Comparison Between 1- and 2-Stent Strategies in Unprotected Distal Left Main Disease The Milan and New-Tokyo Registry

Circ Cardiovasc Interv. 2016 by K.Takagi, S.Nakamura A.Colombo et.al



Comparison Between 1- and 2-Stent Strategies in Unprotected Distal Left Main Disease The Milan and New-Tokyo Registry

Circ Cardiovasc Interv. 2016 by K.Takagi, S.Nakamura A.Colombo et.al

Table 3. Clinical Outcome According to Stent Strategy in Unprotected Distal Left Main Patients

| Event at Follow-Up | 1-stent (n=108) | 2-stent (n=108) | HR, 95% CI; P Value | Adjusted HR, 95% CI; P Value |
|----------------------|-----------------|-----------------|-------------------------|------------------------------|
| MACE | 180 (29.6) | 126 (38.3) | 1.29, 1.03–1.62; 0.03 | 1.19, 0.92–1.54; 0.20 |
| All-cause death | 101 (16.6) | 48 (14.6) | 0.82, 0.58–1.16; 0.26 | 0.88, 0.60–1.29; 0.53 |
| Cardiac death | 52 (8.6) | 18 (5.5) | 0.60, 0.35–1.02; 0.06 | 0.52, 0.29–0.92; 0.03 |
| TLR | 96 (15.8) | 92 (28.0) | 1.91, 1.43–2.54; <0.001 | 1.59, 1.15–2.20; 0.005 |
| TLR-MB | 44 (7.2) | 37 (11.2) | 1.35, 0.84–2.10; 0.18 | 1.05, 0.64–1.72; 0.86 |
| TLR-SB | 63 (10.4) | 76 (23.1) | 2.38, 1.71–3.33; <0.001 | 1.94, 1.33–2.82; 0.001 |
| MI | 21 (3.5) | 9 (2.8) | 0.73, 0.33–1.59; 0.42 | 0.53, 0.23–1.24; 0.14 |
| Definite/probable ST | 11 (1.8) | 6 (1.8) | 0.99, 0.37–2.69; 0.99 | 0.86, 0.29–2.62; 0.80 |

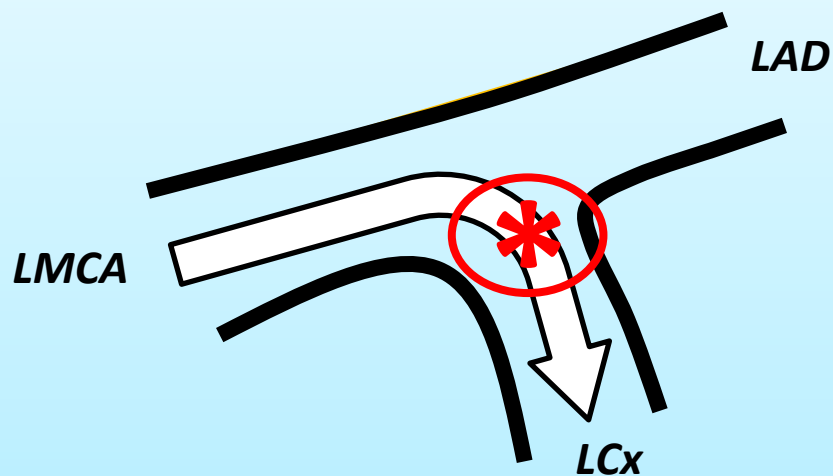
CI indicates confidential interval; HR, hazard ratio; MACE, major adverse cardiovascular events; MB, main branch; MI, myocardial infarction; SB, side branch; ST, stent thrombosis; and TLR, target lesion revascularization.

The 2-SS might have been caused by the high development of SB restenosis mostly of the ostium of the LCx. ,
However overall this had little impact on long-term mortality.

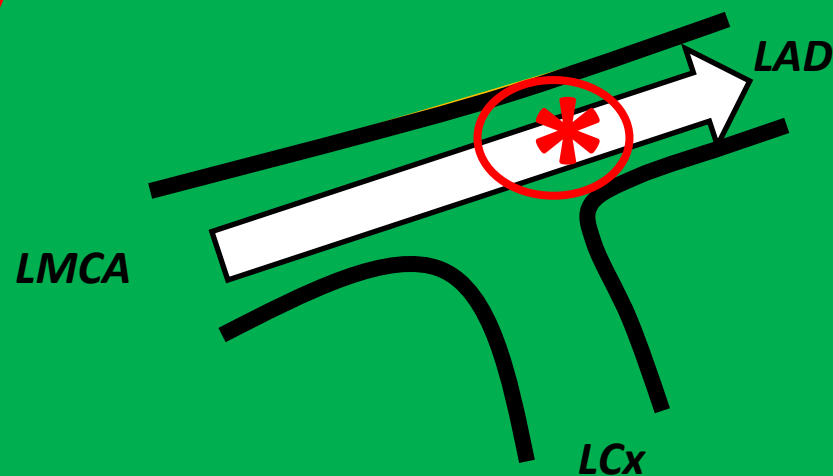
Long-term Clinical Outcome of Single-stent Crossover Technique from Unprotected Left Main Coronary Artery to the Left Circumflex Artery

Naganuma T, Chieffo Alaide, Nakamura S, Colombo A, et al. Catheter Cardiovasc Interv. 2013

Comparison of LCX ost and LAD ost after Stenting

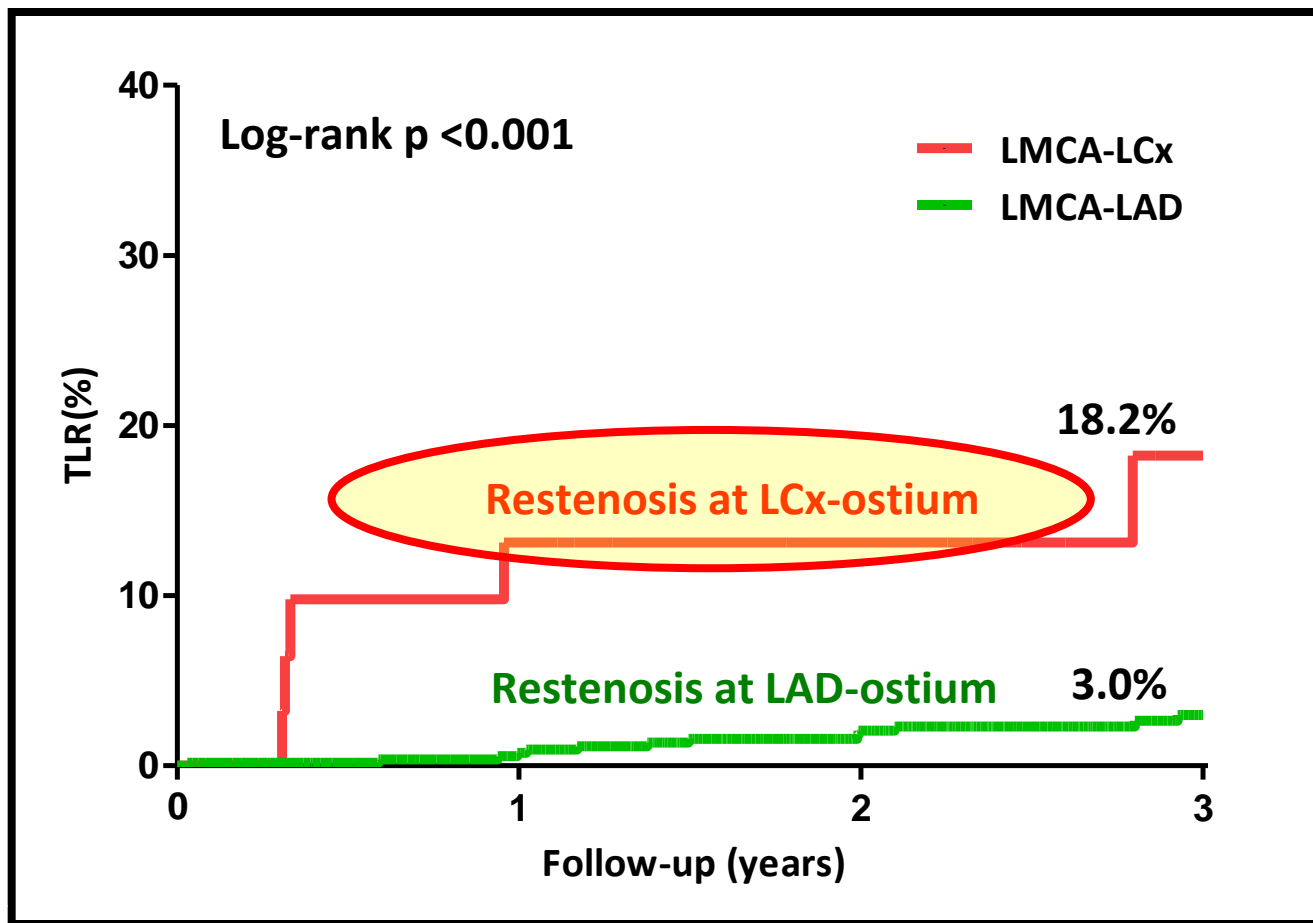


➤ Restenosis at the LCx-ostium in LMT-LCx stenting group



➤ Restenosis at the LAD-ostium in LMT-LAD stenting group

Cumulative event rate of TLR at 3 years follow-up by Kaplan-Meier Method



LMCA-LCx

31

27

23

15

LMCA-LAD

553

512

400

279

Lesson 2

LCX ostium itself independently shows high restenosis rate in patients with LMT-PCI.



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Catheter Cardiovasc Interv. 2013

JACC cardiovascular imaging vol. 7 2014

Delayed Disruption of a Bioresorbable Vascular Scaffold

JACC: CARDIOVASCULAR IMAGING, VOL. 7, NO. 8, 2014

AUGUST 2014:843-50

Toru Naganuma, MD

Antonio Colombo, MD*

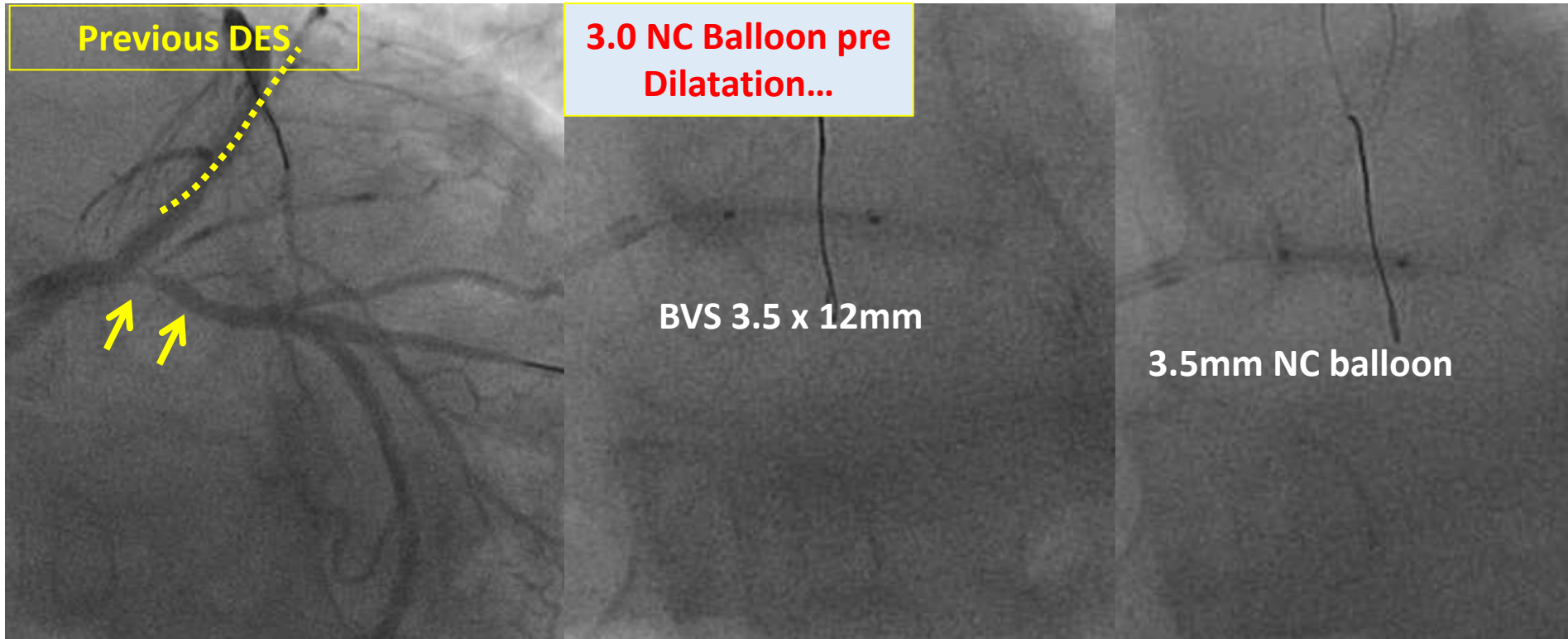
*EMO-GVM Centro Cuore Columbus

Previous DES

3.0 NC Balloon pre Dilatation...

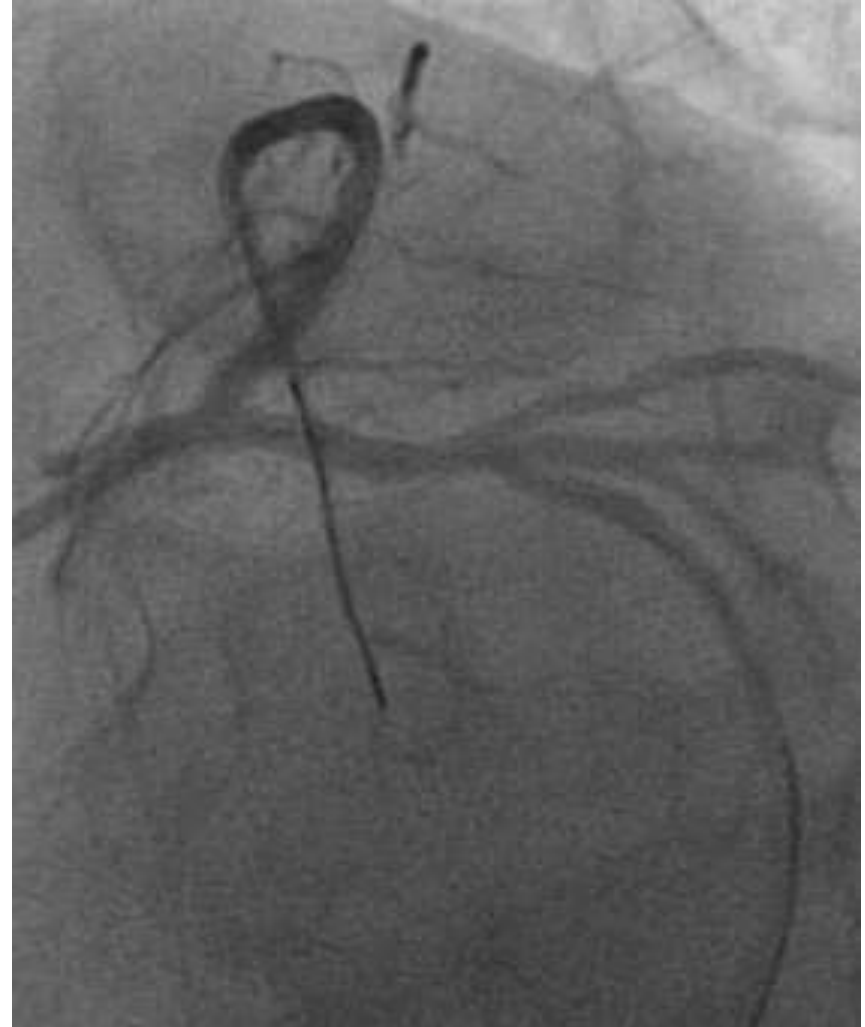
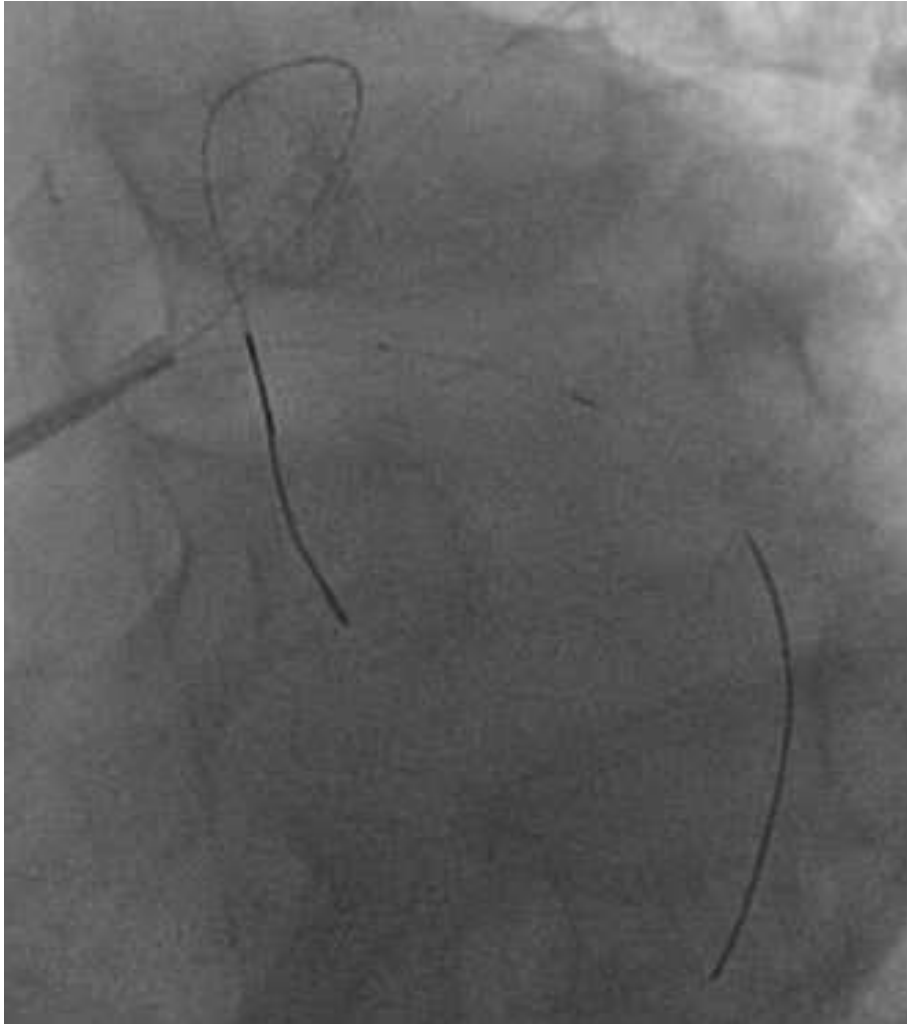
BVS 3.5 x 12mm

3.5mm NC balloon



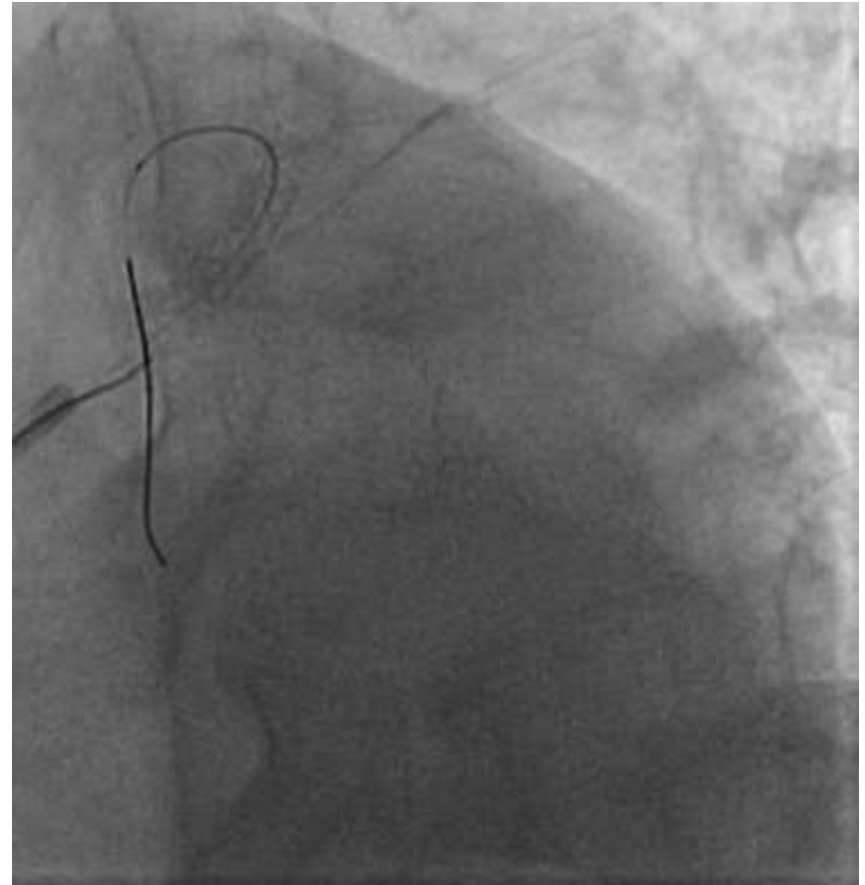
Delayed Disruption of a Bioresorbable Vascular Scaffold

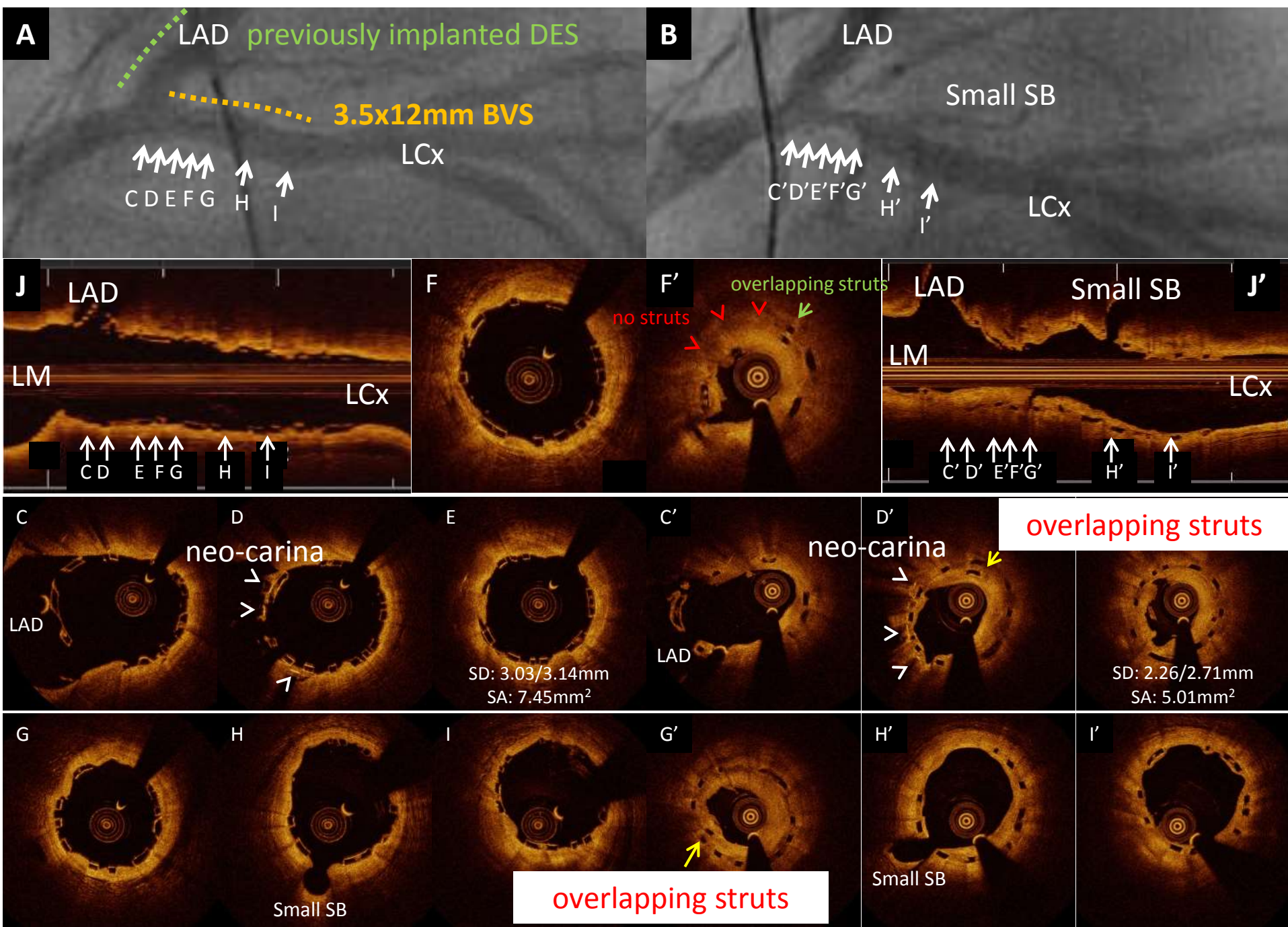
Final Angiogram



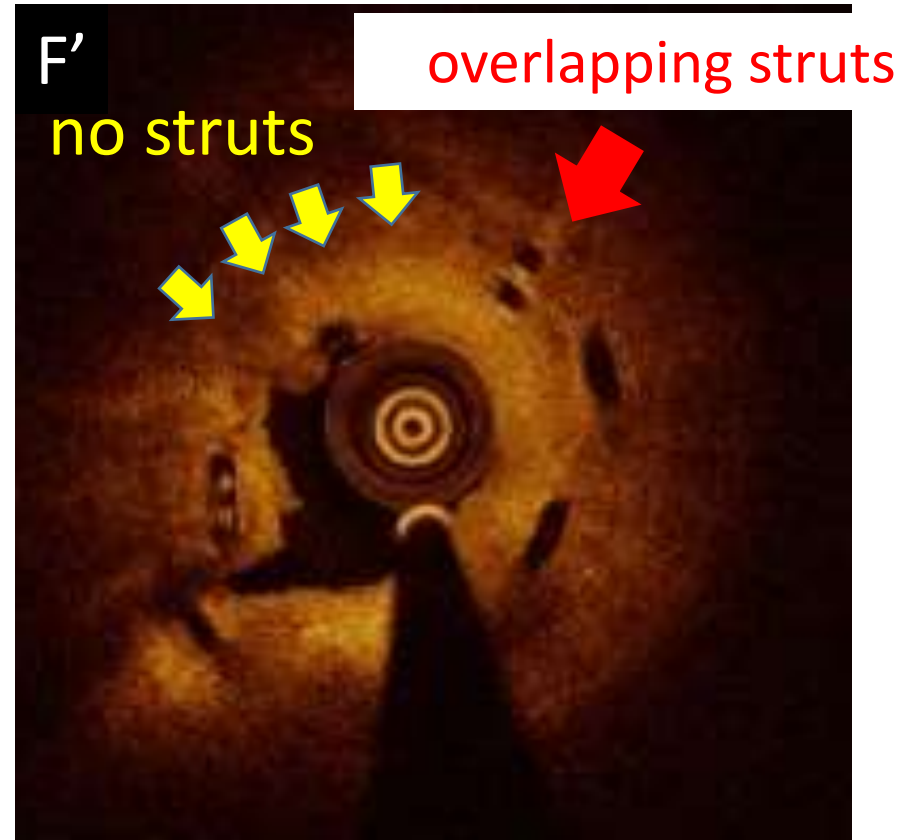
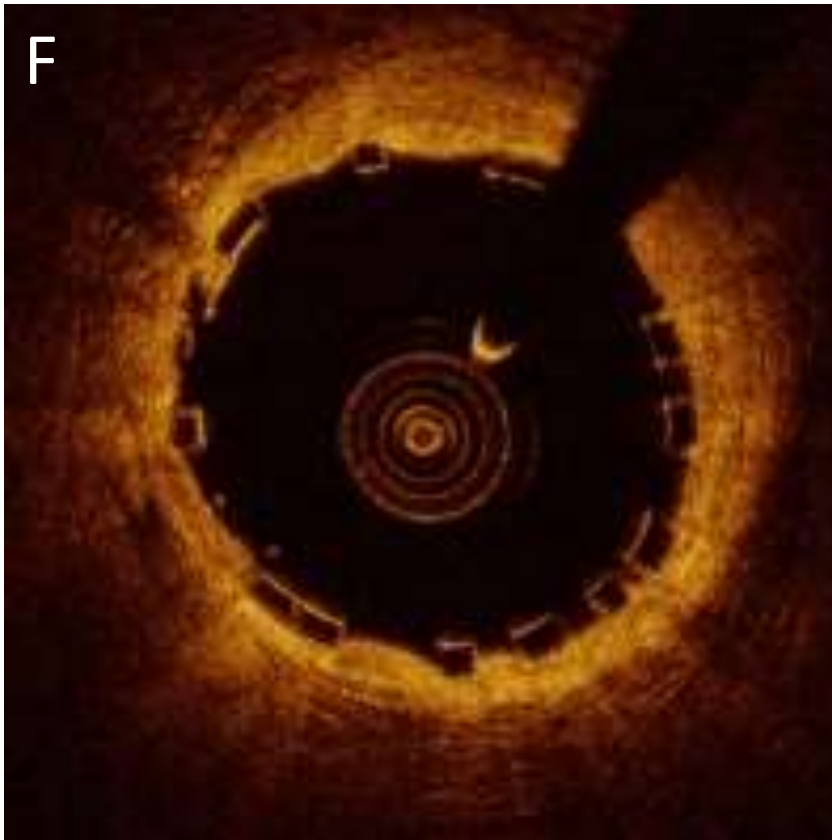
Delayed Disruption of a Bioresorbable Vascular Scaffold

Only 6month later...Severe Restenosis in LCX ost.





BVS may not be an optimistic solution for an ostial LCX lesion



Lesson 3

Implantation of BVS at ostium of LCX
may be problematic.



Toru Naganuma M.D. FACC, FESC

JACC cardiovascular imaging vol. 7 2014

Do not chase to much !!

“LCX” is a different animal

This is very unique part of coronary artery !!!

So called, **HINGE POINT...**

But point is “moving and Twitching”

And not so much important as compared with LAD and RCA
for keeping Ejection fraction of the patient’s HEART.

..... LCX is not directly relevant to the patient prognosis

About Endothelial activation ??

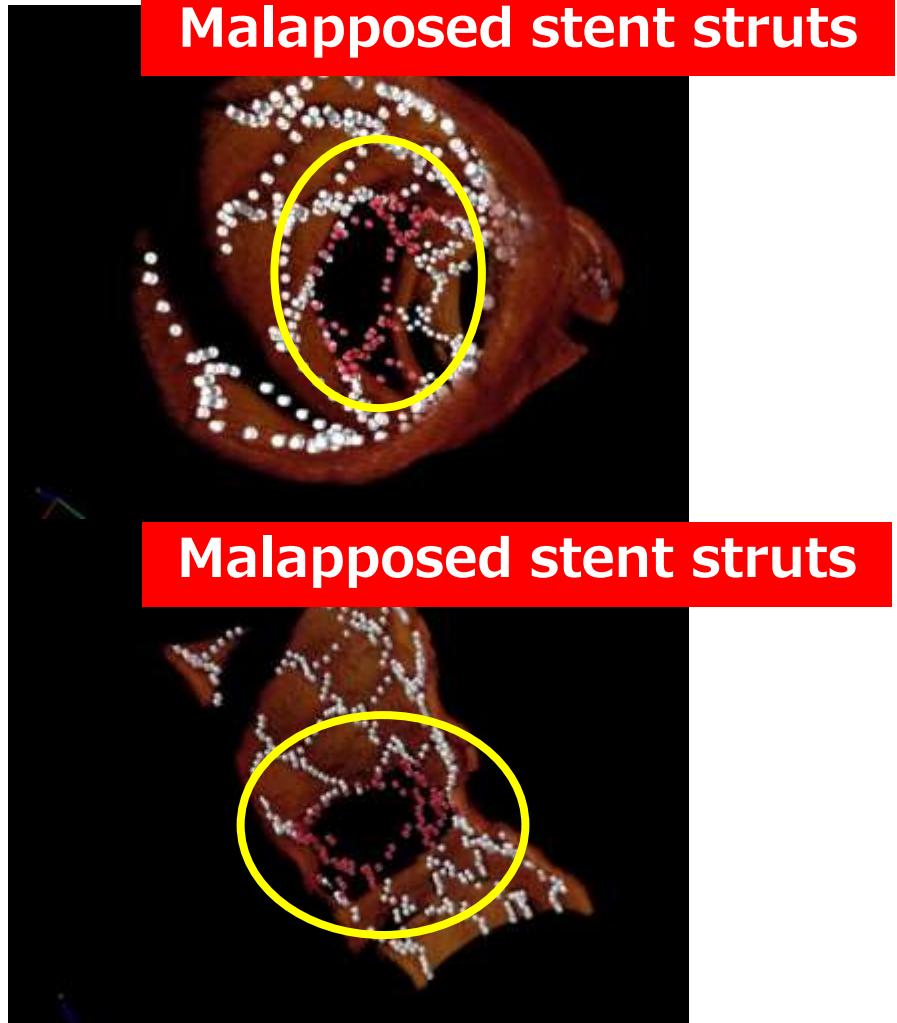
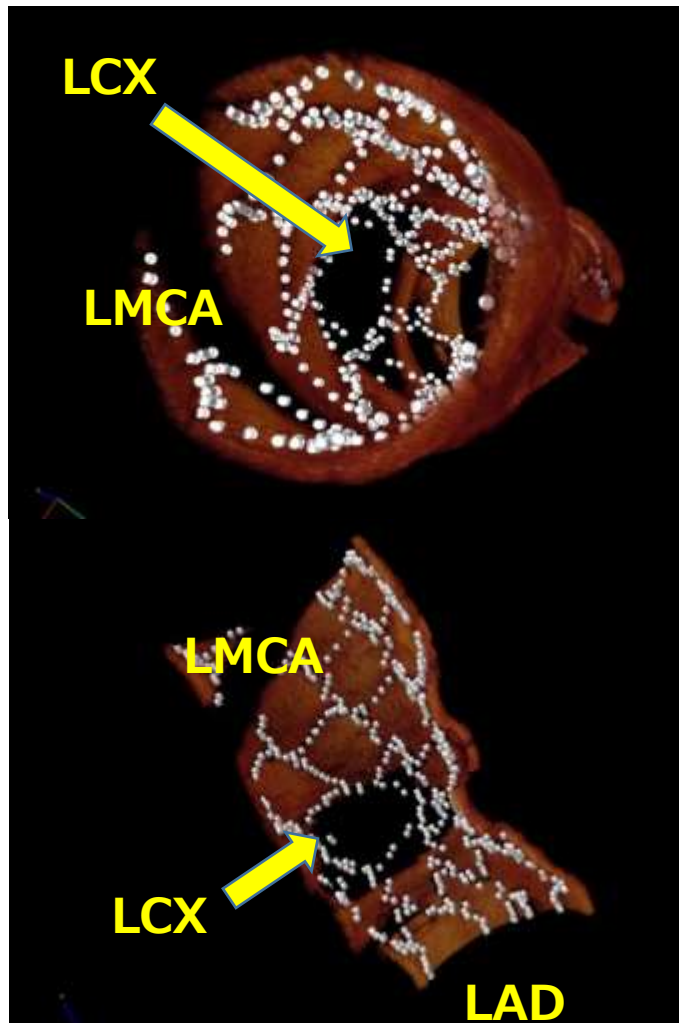
- Let's Think about Jailed Strut in LCX Ost.-

Let's think about 2 stent technique ?
Is it related with restenotic event ??

Yusuke Fujino M.D.

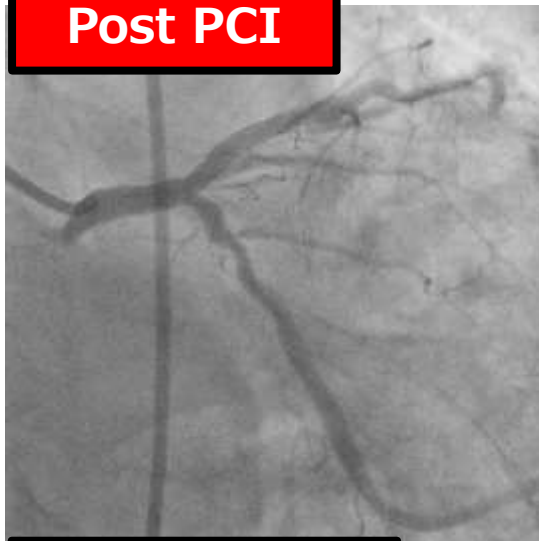


3D OCT Image After SES Implantation with inappropriate KBT



OCT Assessment of LCX ostium at F/U

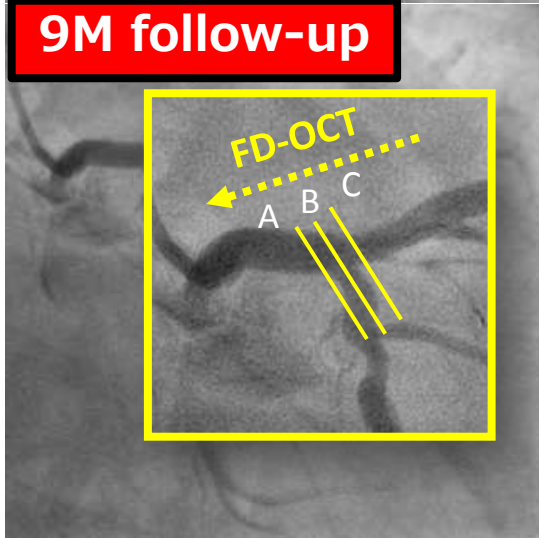
Post PCI



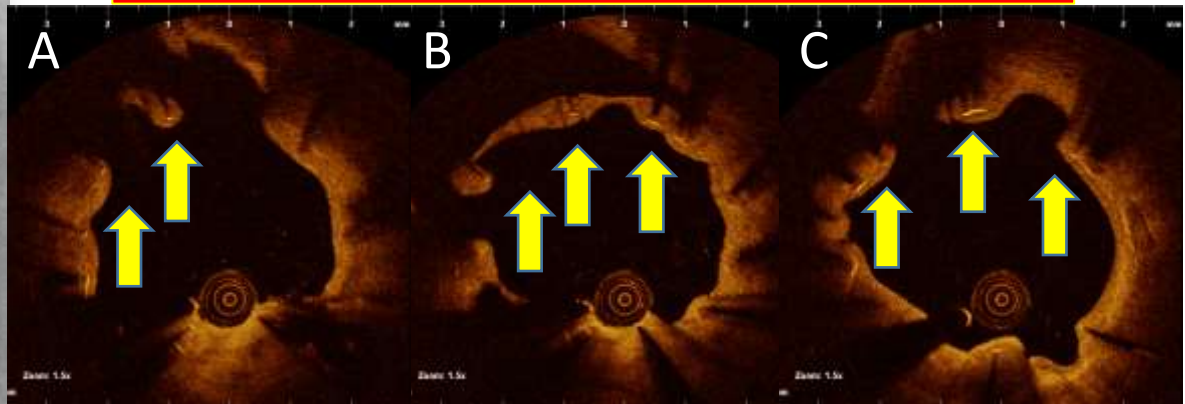
malapposed stent struts



9M follow-up

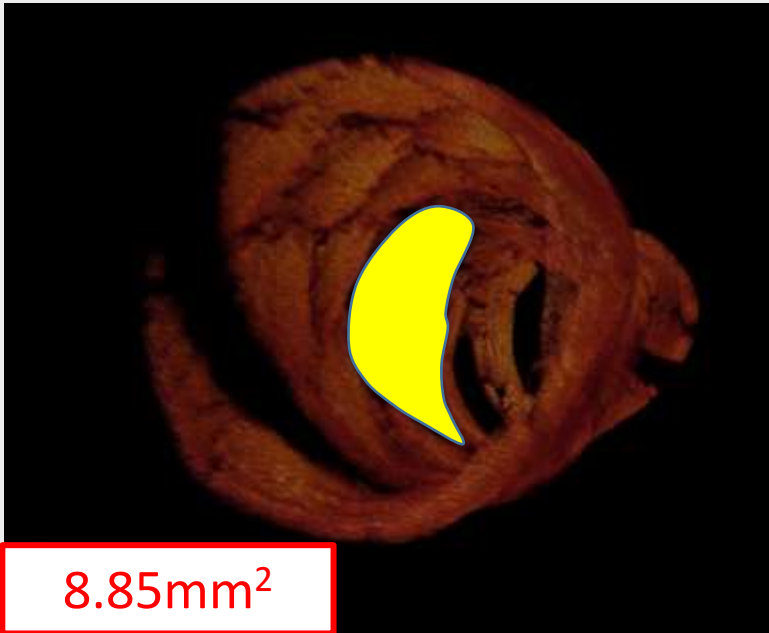


Neointimal proliferation over the malapposed stent struts

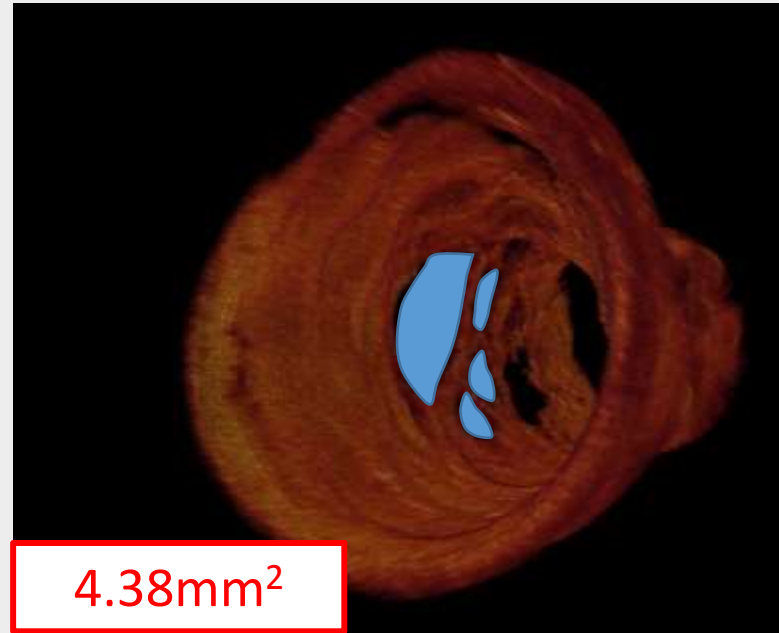


Area Narrowing of LCX ostium by 3D-OCT

Post PCI



Follow-up



We calculated area narrowing(%) with this formula

$$\text{Area Narrowing (\%)} = \frac{\text{Area (post)} - \text{Area (follow-up)}}{\text{Area (post)}} \times 100$$

Area Shrinkage of LCX Ostium

Sirolimus-Eluting Stent
Cypher: Johnson and Johnson



Everolimus-Eluting Stent
Xience V: abott vascular



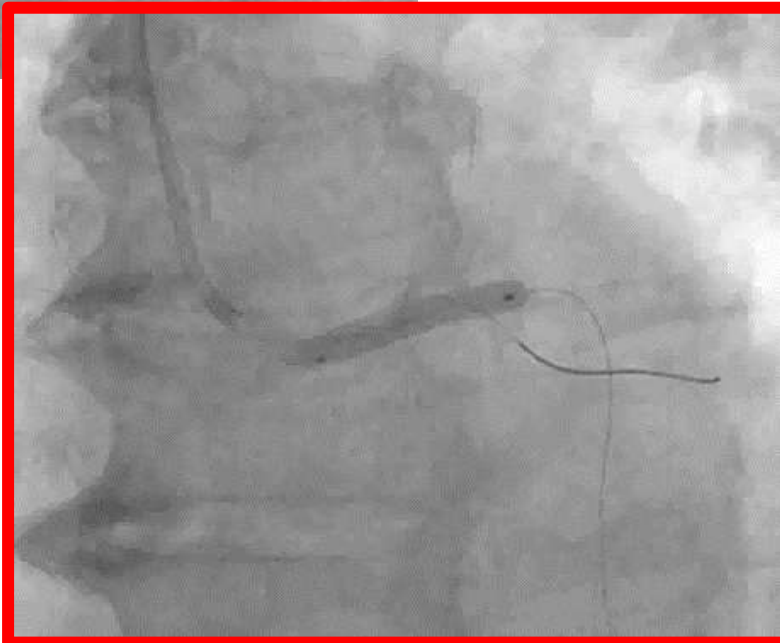
| | SES (n=10) | EES (n=15) | p Value |
|----------------------------------|---------------------|---------------------|--------------|
| Post-PCI | | | |
| LCX ostium area, mm ² | 5.41 ± 1.81 | 5.14 ± 2.59 | 0.785 |
| 9M follow-up | | | |
| LCX ostium area, mm ² | 3.52 ± 1.03 | 4.46 ± 2.59 | 0.220 |
| Area Shrinkage (%) | 32.4 ± 15.73 | 9.78 ± 23.08 | 0.013 |

Case: LMT ost.~body stenosis: EES single crossover stenting without KBT

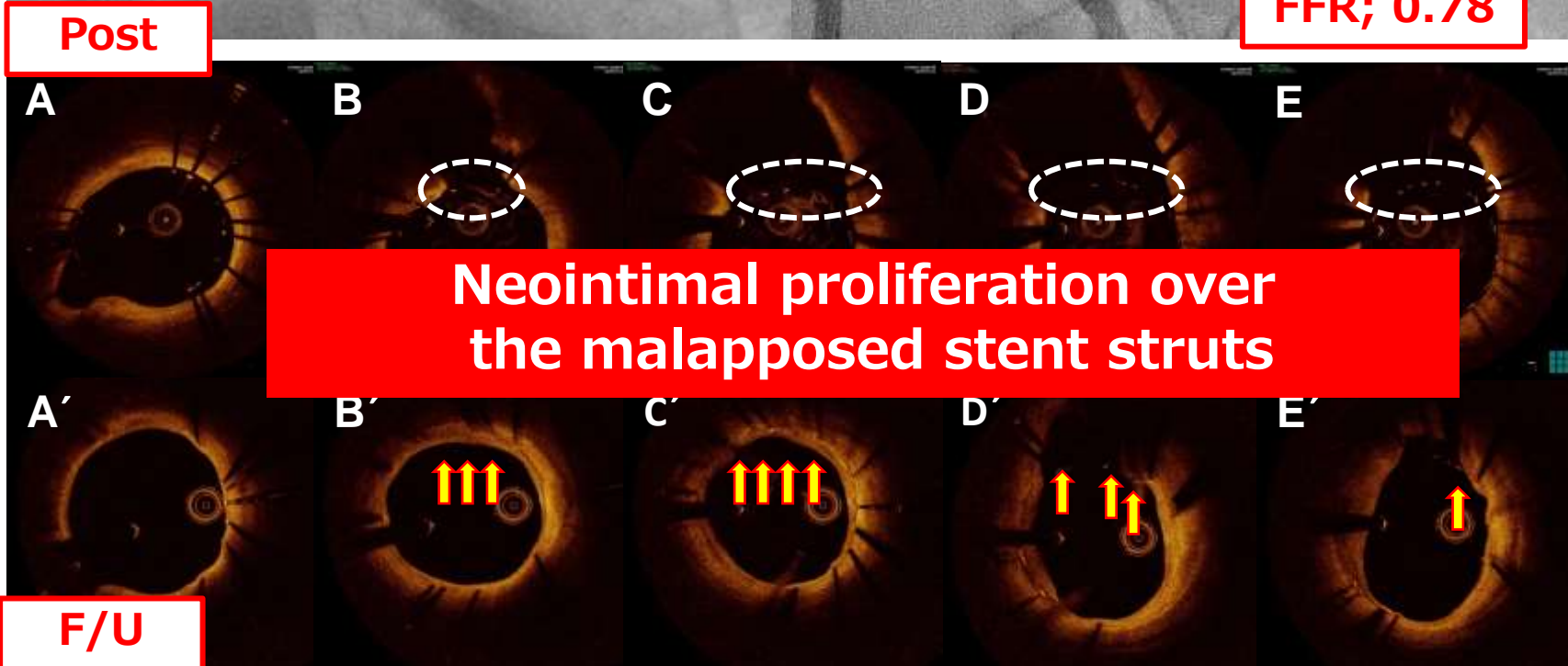
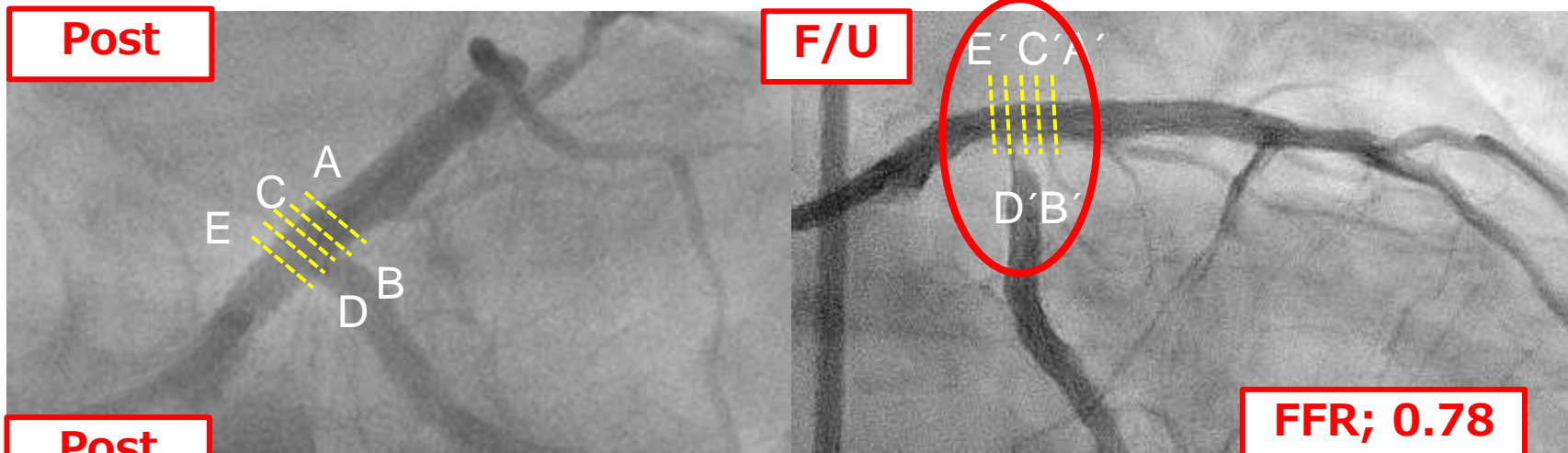


LMT Ost~Body Lesion

**Single Stenting with Xience
POT, Full Cover W/O KBT**



EES single crossover stenting without KBT



Lesson 4

Finishing the case with optimum KBT is very indispensable for LMT bifurcation PCI

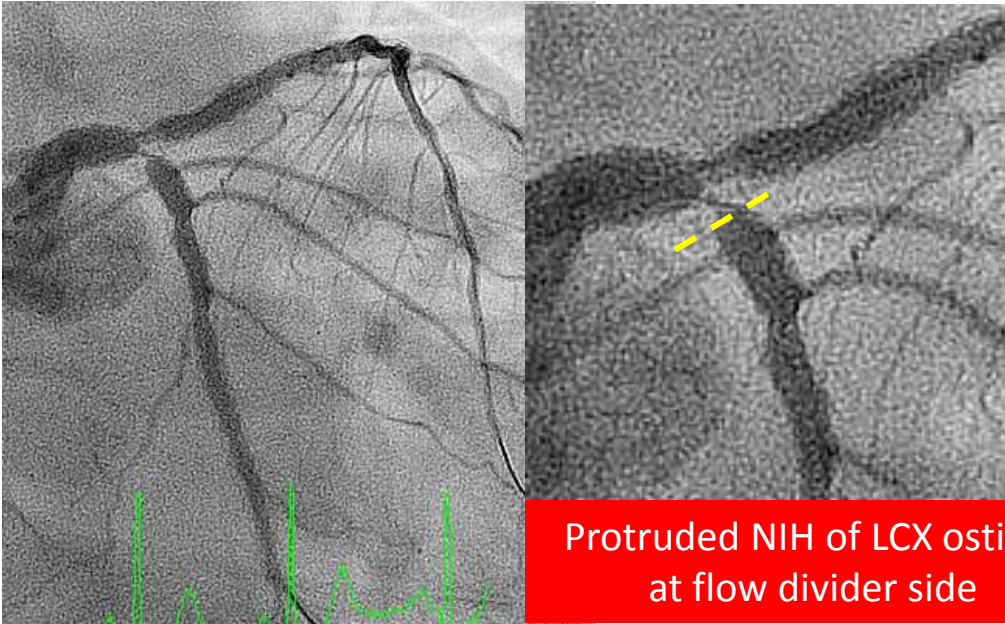
How many jailed struts, or how much area that jailed struts occupies in the area of ostium of LCX seems to be a determinant factor of **Future Endothelialization** for the coverage of these jailed struts.



Yusuke Fujino M.D. FACC

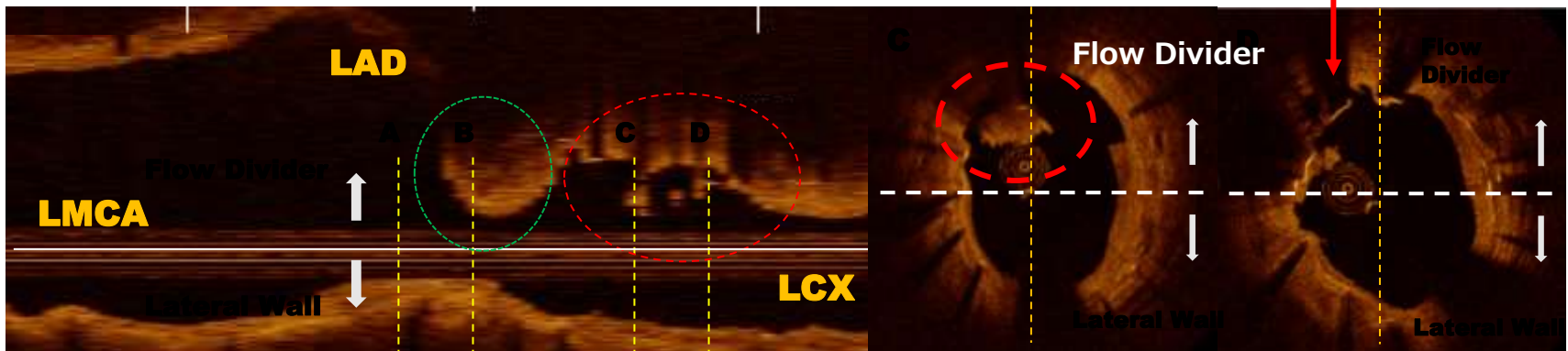
JACC Imaging Vol 7 No.8 2014

Why ?? NIH?? after Two-Stent Technique

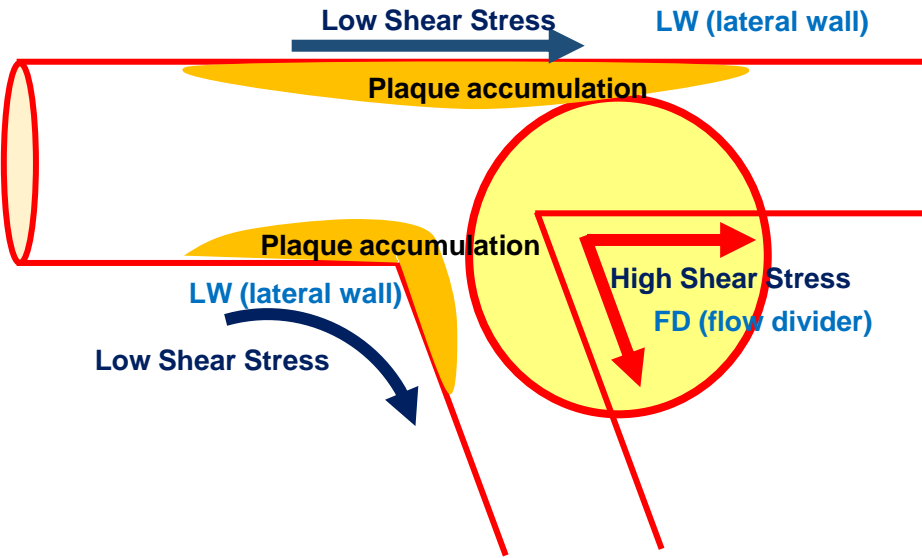


Fujino Y, Nakamura S, et al
Int J Cardiol. 2016 May 20;219:285-292

Protruded NIH of LCX ostium
at flow divider side



Pre Stent Implantation (physiological)



After Stent Implantation (non-physiological)

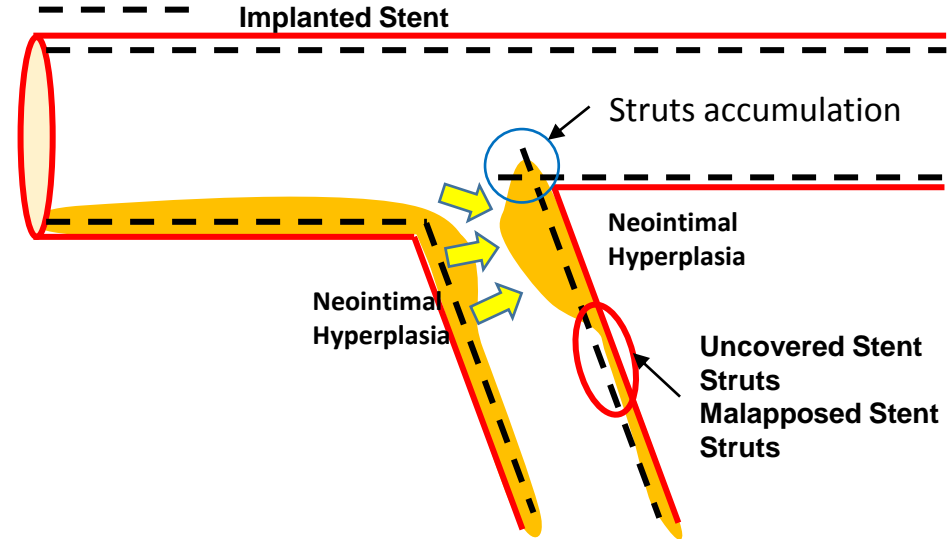


Table 4
OCT findings in the flow divider and lateral wall.

| | FD (N = 22) | LW (N = 22) | p-Value |
|--|-------------------------|-------------------------|---------|
| Chords numbers | 180.25 (178.00, 181.67) | 179.75 (178.33, 182.00) | 0.79 |
| Analyzed struts | 32.50 (30.00, 39.00) | 23.50 (21.00, 30.00) | <0.001 |
| <u>Analyzed struts/cross-sections</u> | 5.42 (5.00, 6.50) | 3.92 (3.50, 5.00) | <0.001 |
| <u>Uncovered struts (%)</u> | 11.32 (0.00, 19.44) | 0.00 (0.00, 4.55) | <0.001 |
| <u>Uncovered, nonmalapposed struts (%)</u> | 8.97 (0.00, 16.13) | 0.00 (0.00, 4.55) | <0.001 |
| <u>Uncovered, malapposed struts (%)</u> | 0.00 (0.00, 3.23) | 0.00 (0.00, 0.00) | 0.016 |
| <u>NIH thickness (mm)</u> | 0.31 (0.19, 0.47) | 0.15 (0.09, 0.31) | <0.001 |
| <u>Malapposition area (mm²)</u> | 0.00 (0.00, 0.07) | 0.00 (0.00, 0.03) | 0.004 |
| <u>NIH area (mm²)</u> | 1.03 (0.56, 1.80) | 0.75 (0.41, 1.44) | <0.001 |

Values are Median (IQR)

FD = flow divider; LW = lateral wall; NIH = neointimal hyperplasia

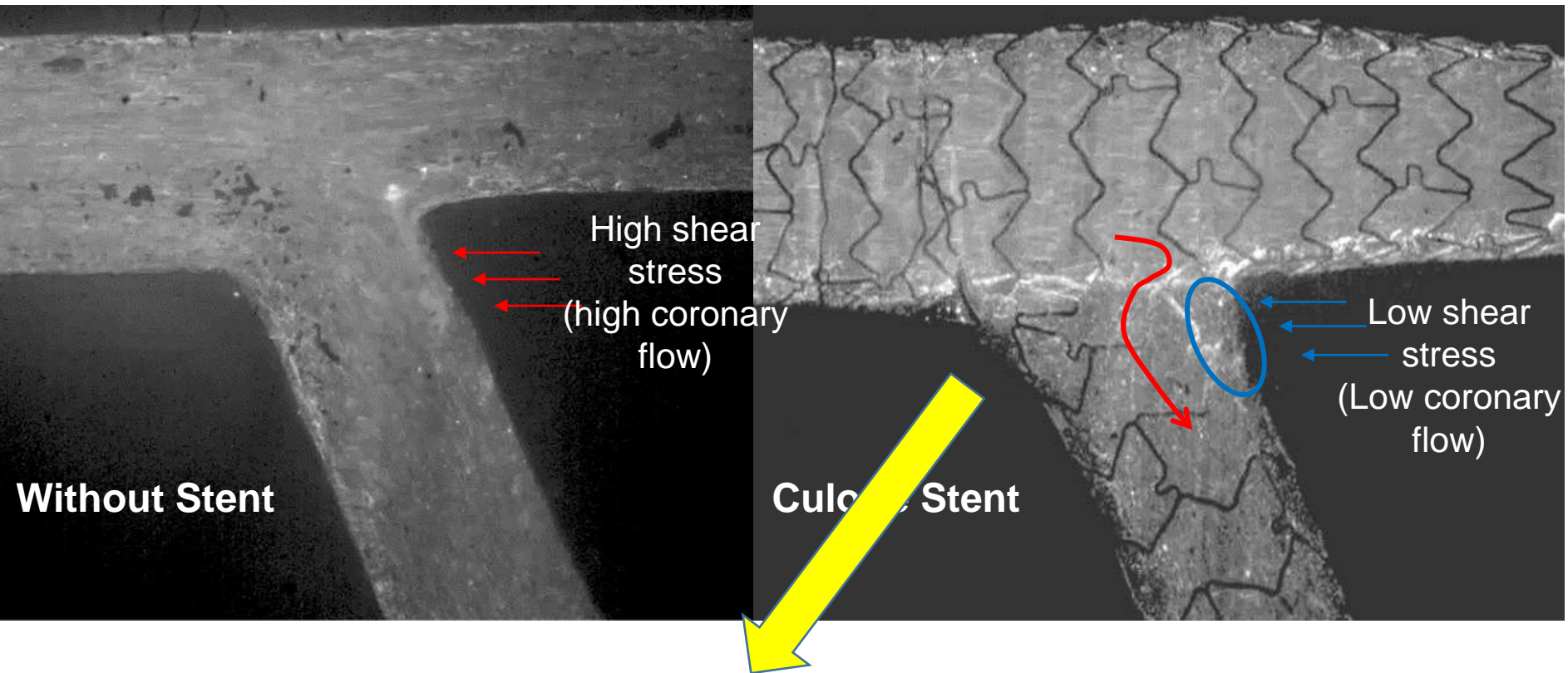
Experimental model to study flow pattern

Without stent placement

Blood flow at carina is quite fast.

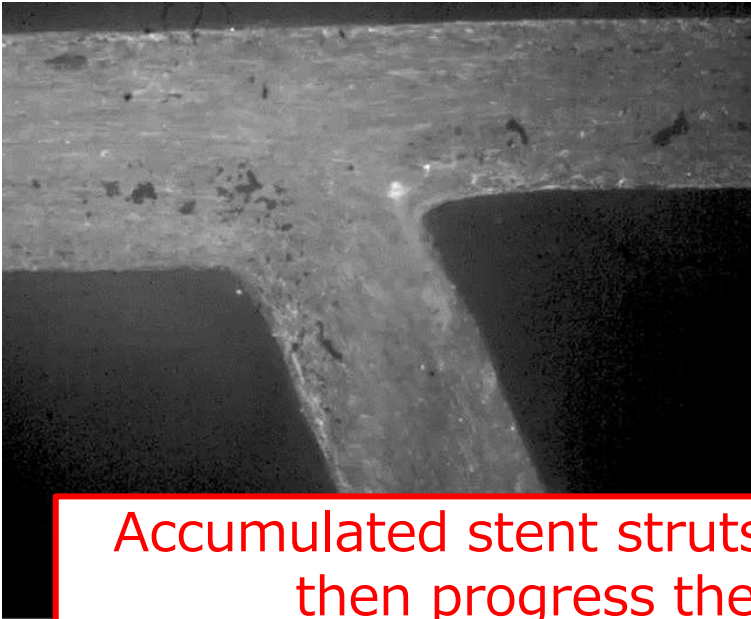
After stent implantation

Flow is delayed, causing turbulence.

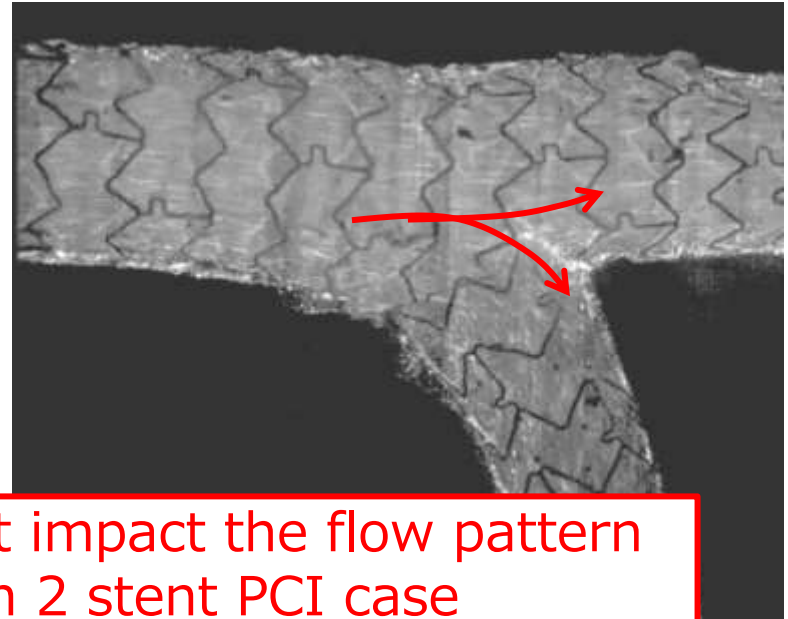


This is so-called low shear stress status. It is speculated that stent struts remaining at orifice of circumflex negatively affect the flow.

Without stent

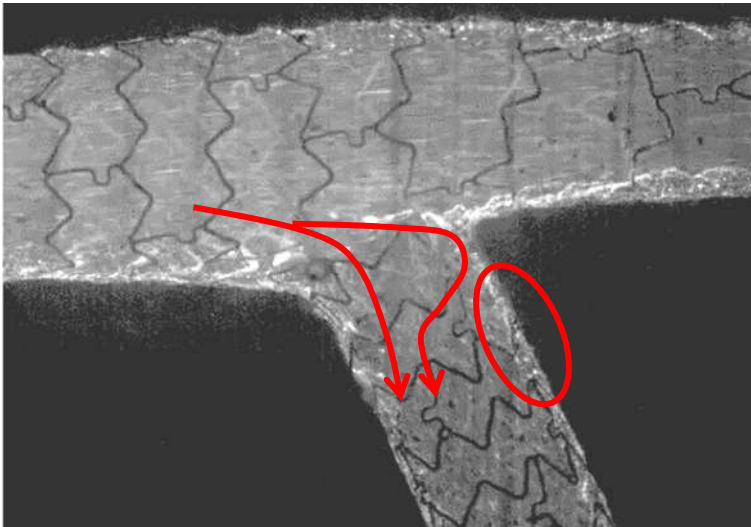


T- stent

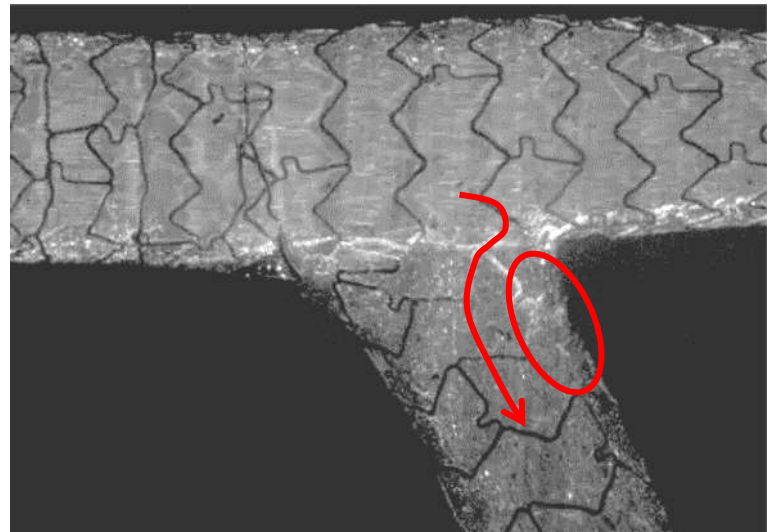


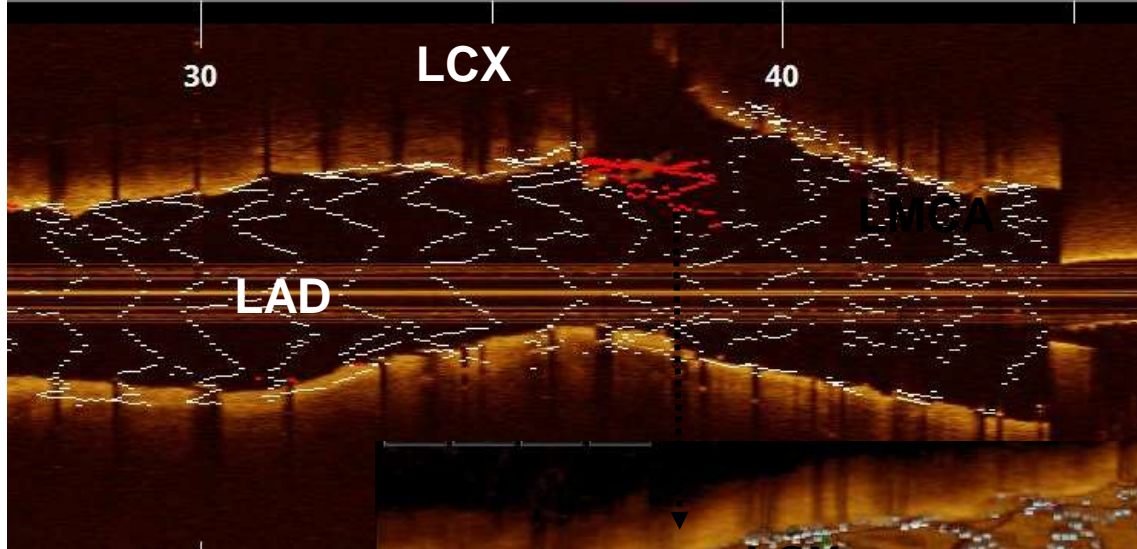
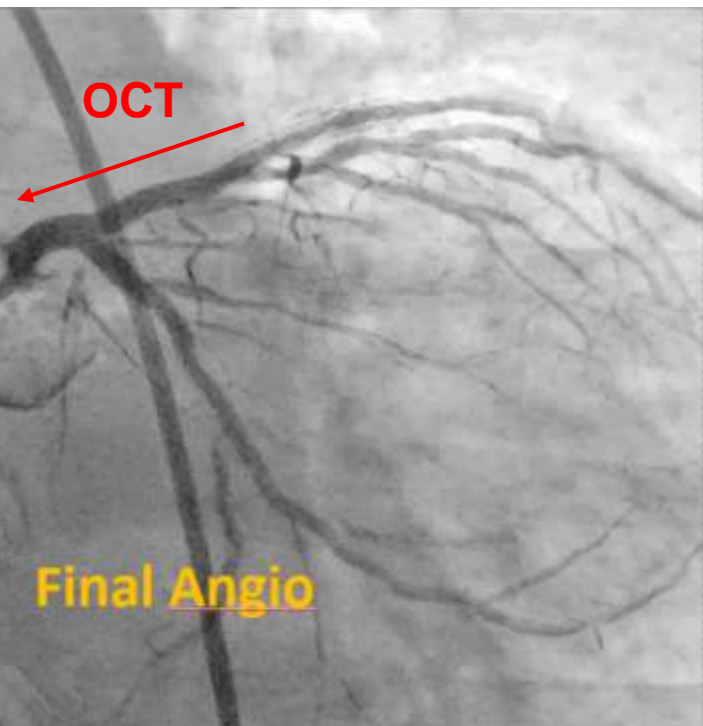
Accumulated stent struts might impact the flow pattern then progress the NIH in 2 stent PCI case

Crush stent

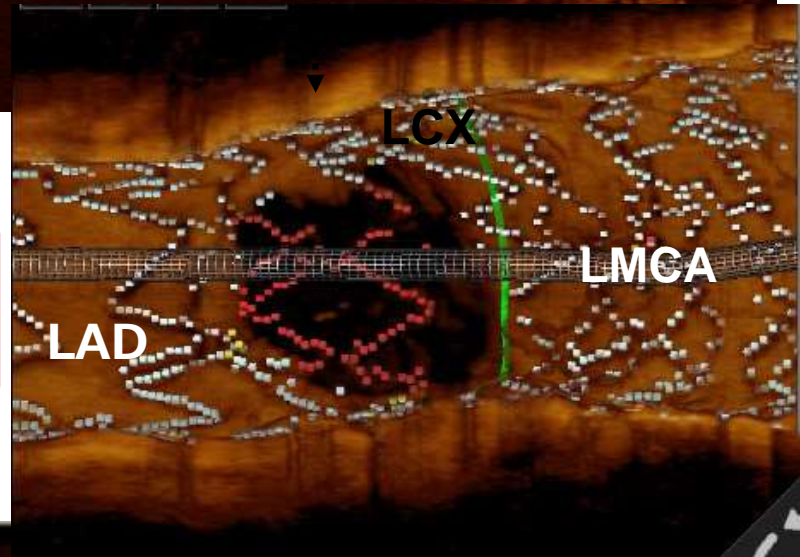


Culottes stent

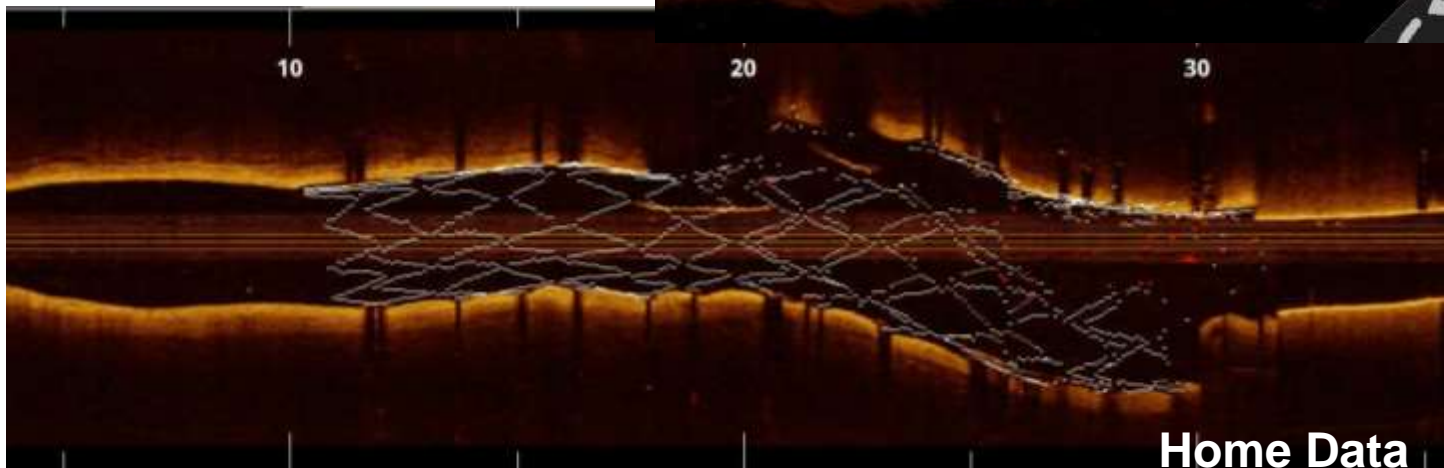




Unfavorable
culotte

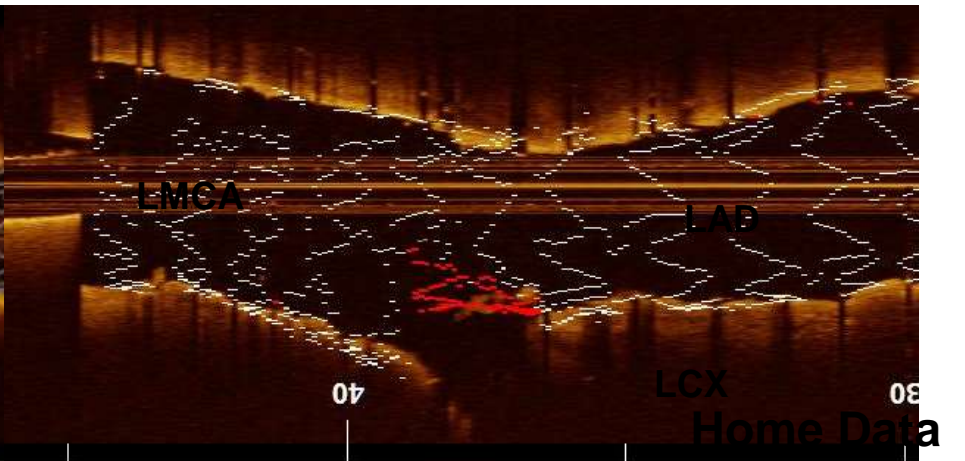
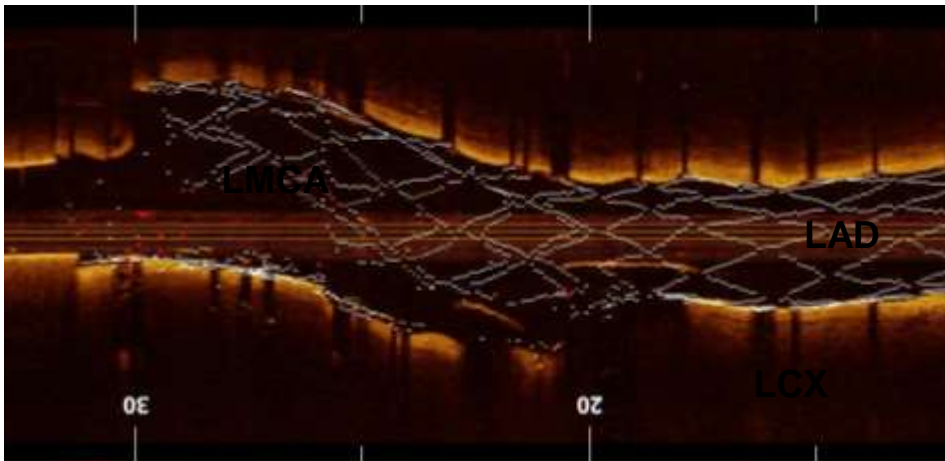
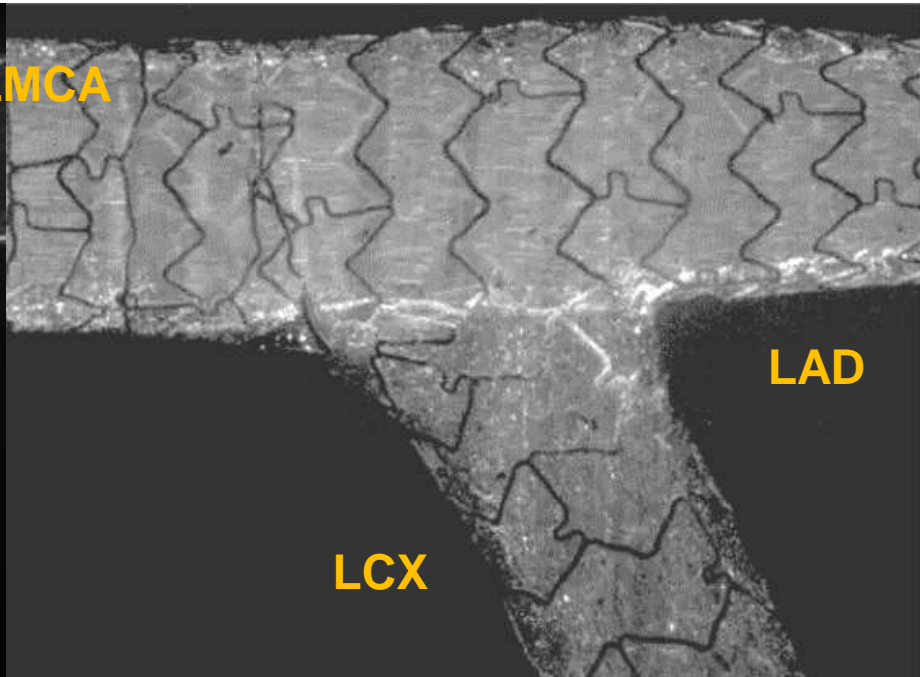
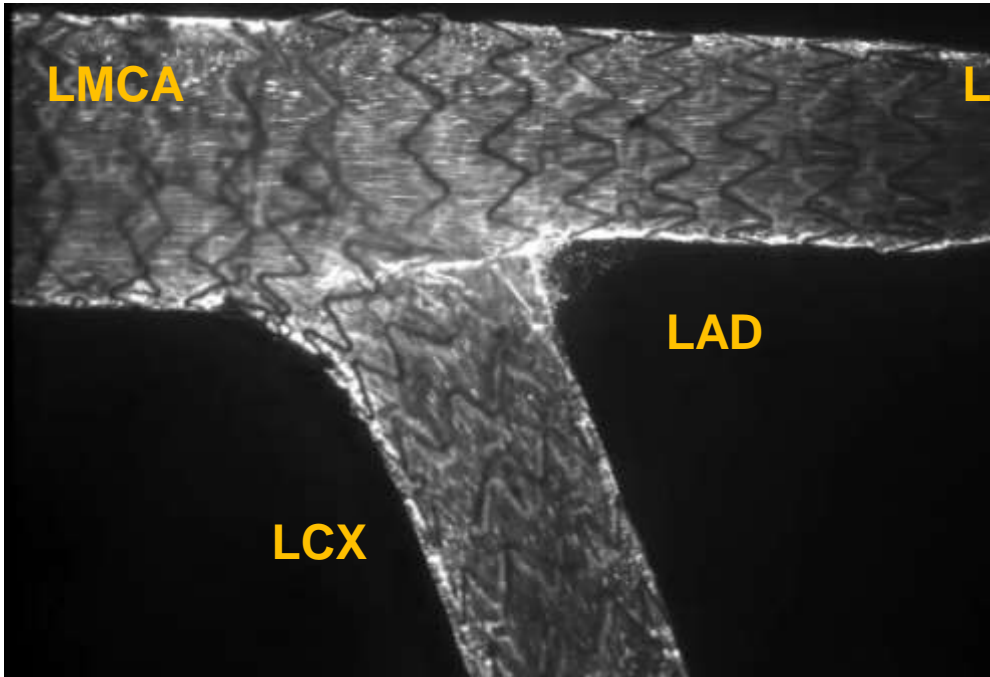


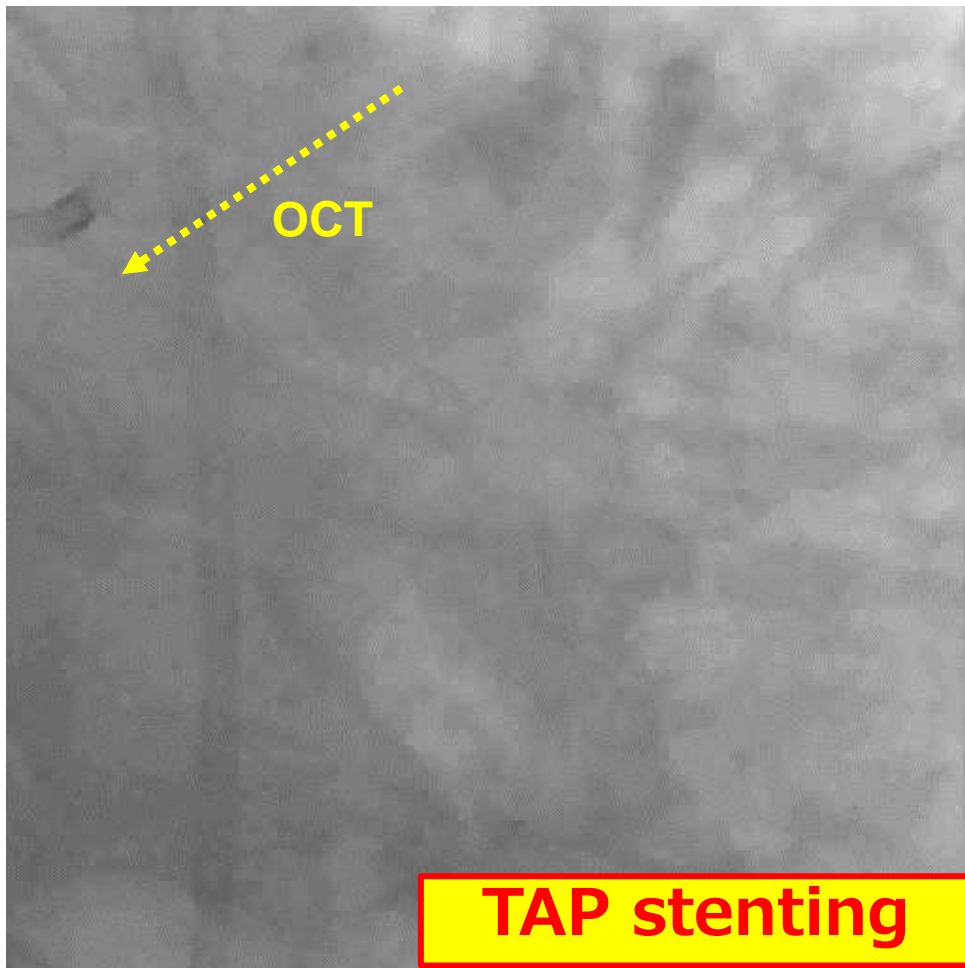
Favorable
culotte



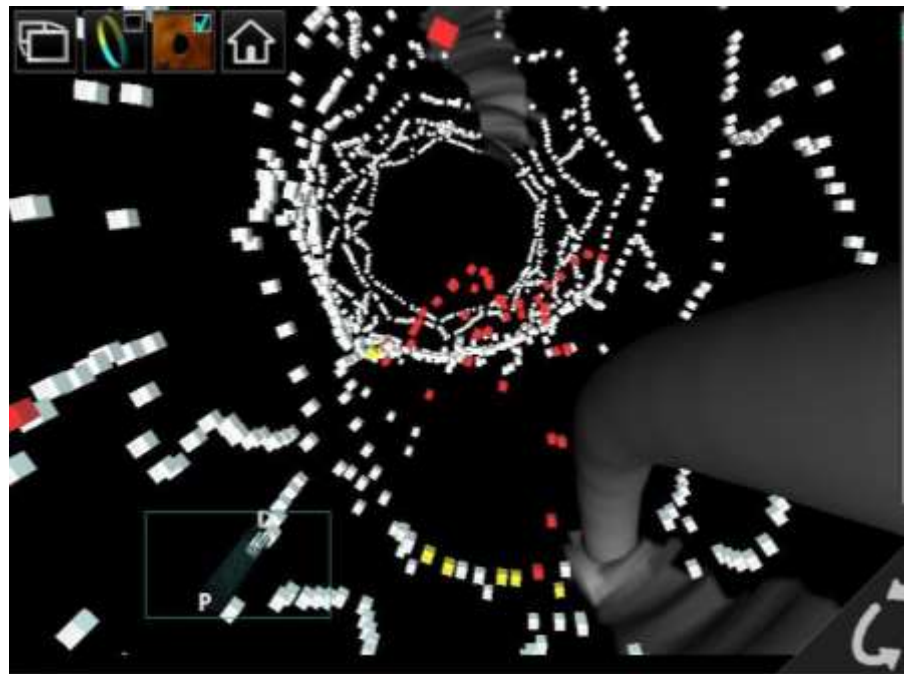
**Favorable
culotte**

**Unfavorable
culotte**

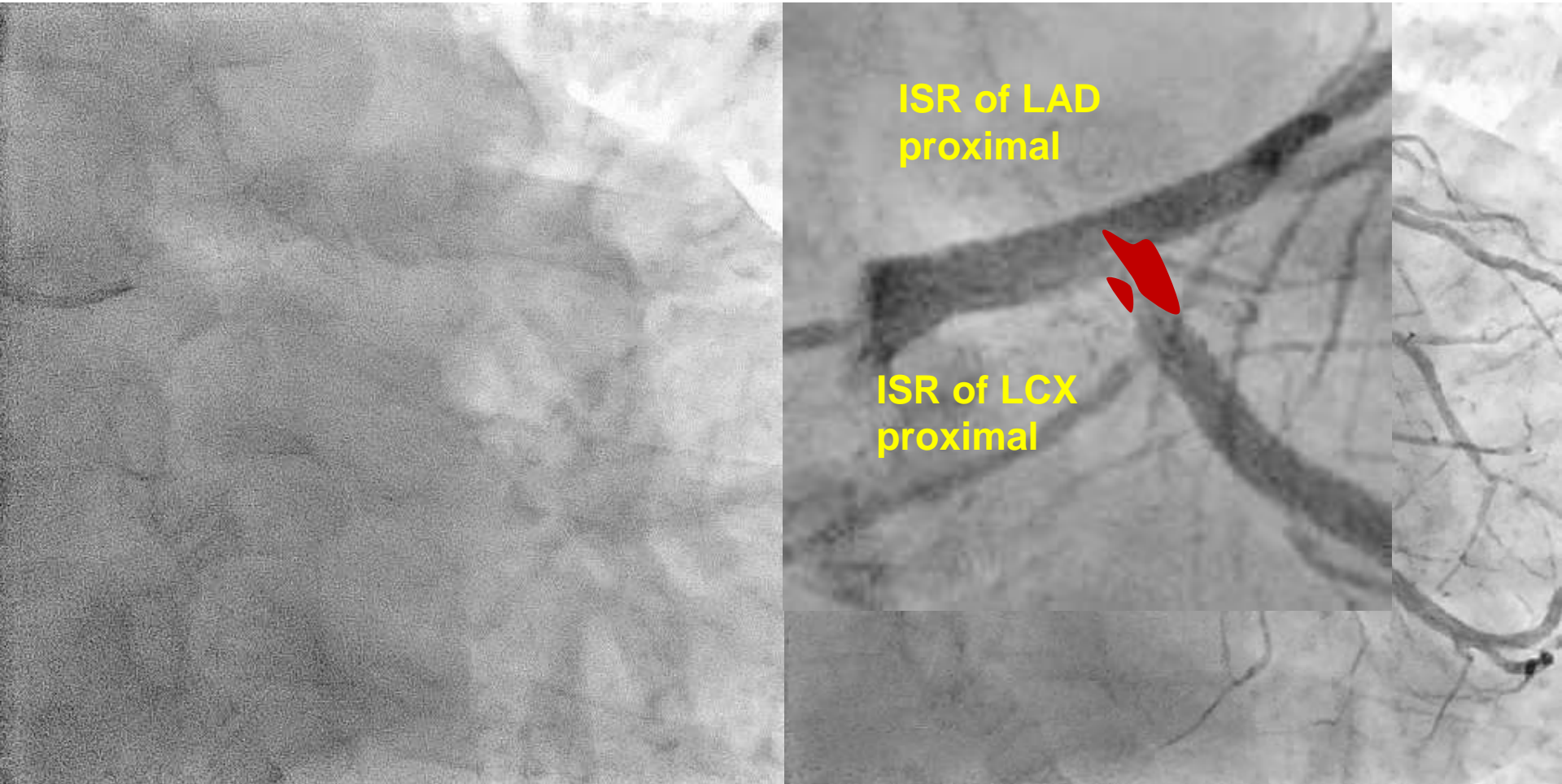




TAP stenting



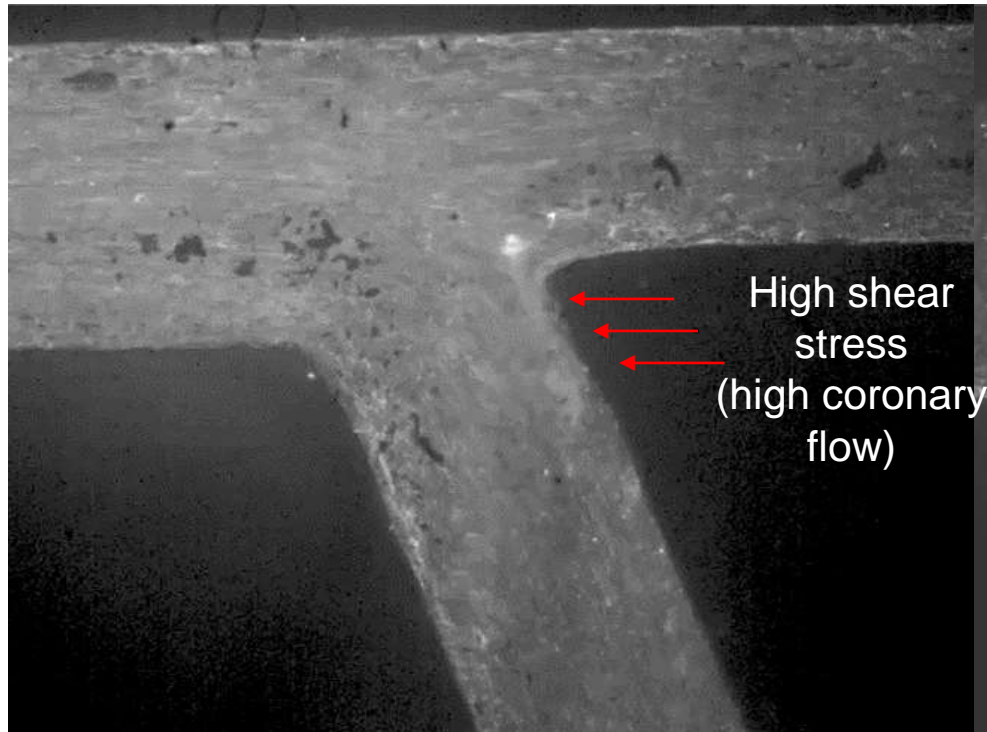
Follow-up CAG after PCI



Experimental model to study flow pattern

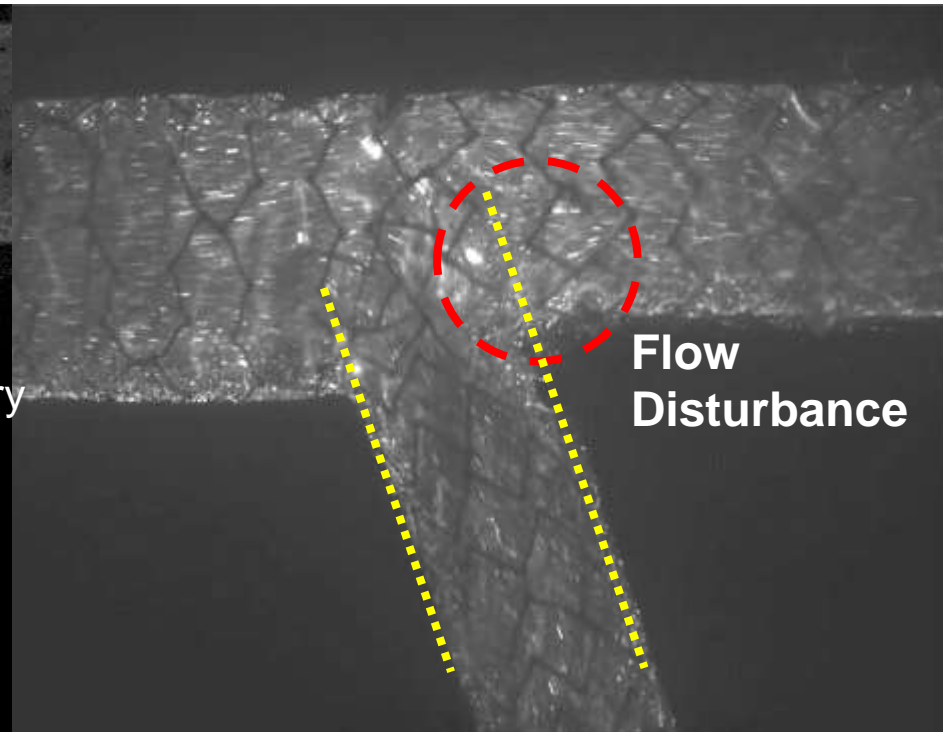
Without stent placement

Blood flow at carina is quite fast.



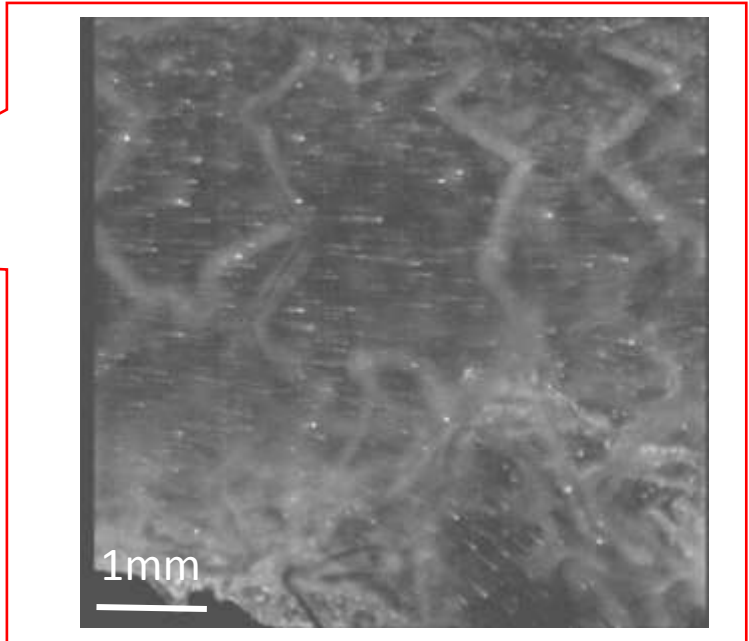
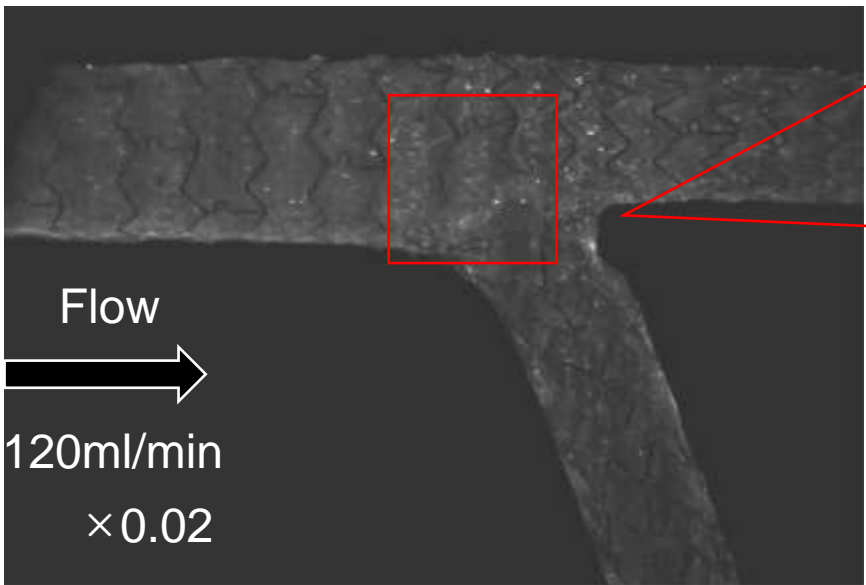
Unfavorable TAP stent

Flow is roiling, causing turbulence.

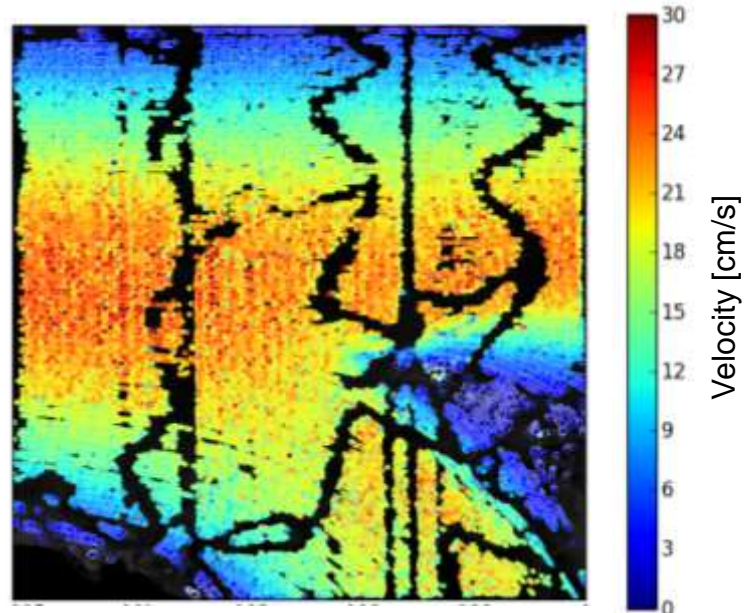
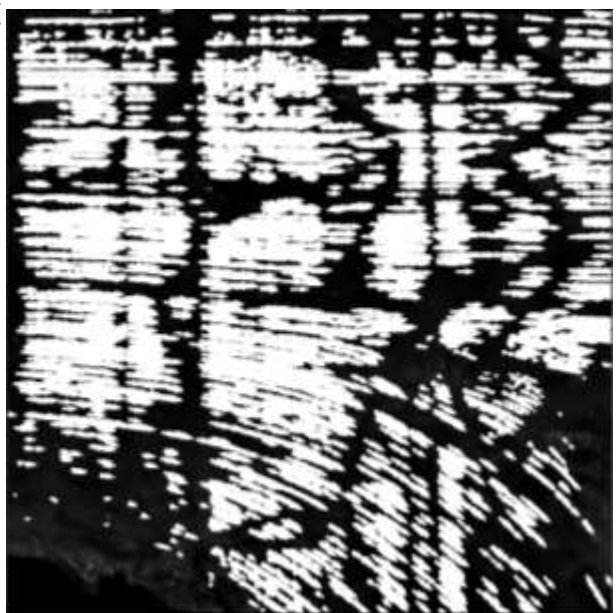


Quantification of flow dynamics

➤ Model (Mini crash)

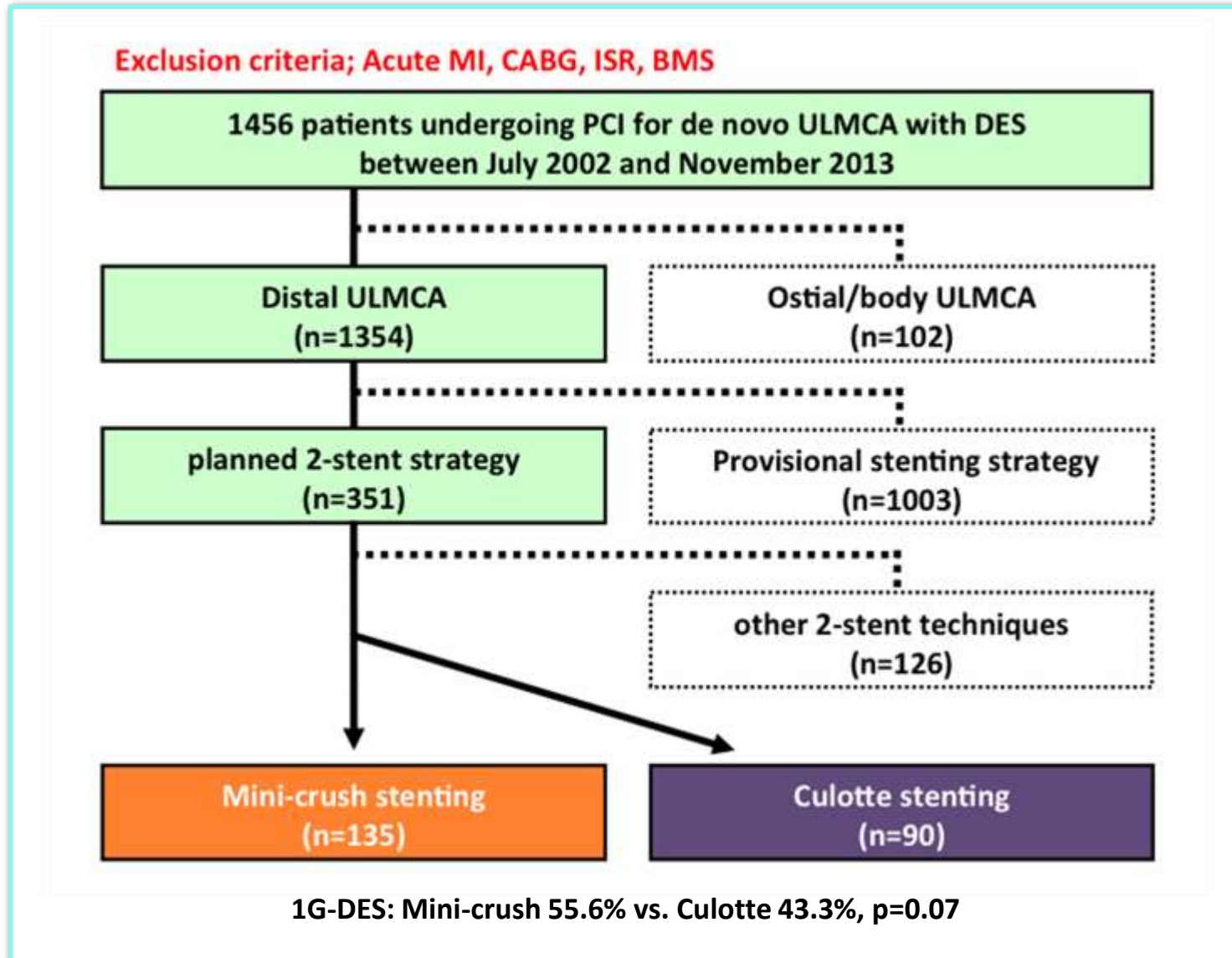


➤ Result

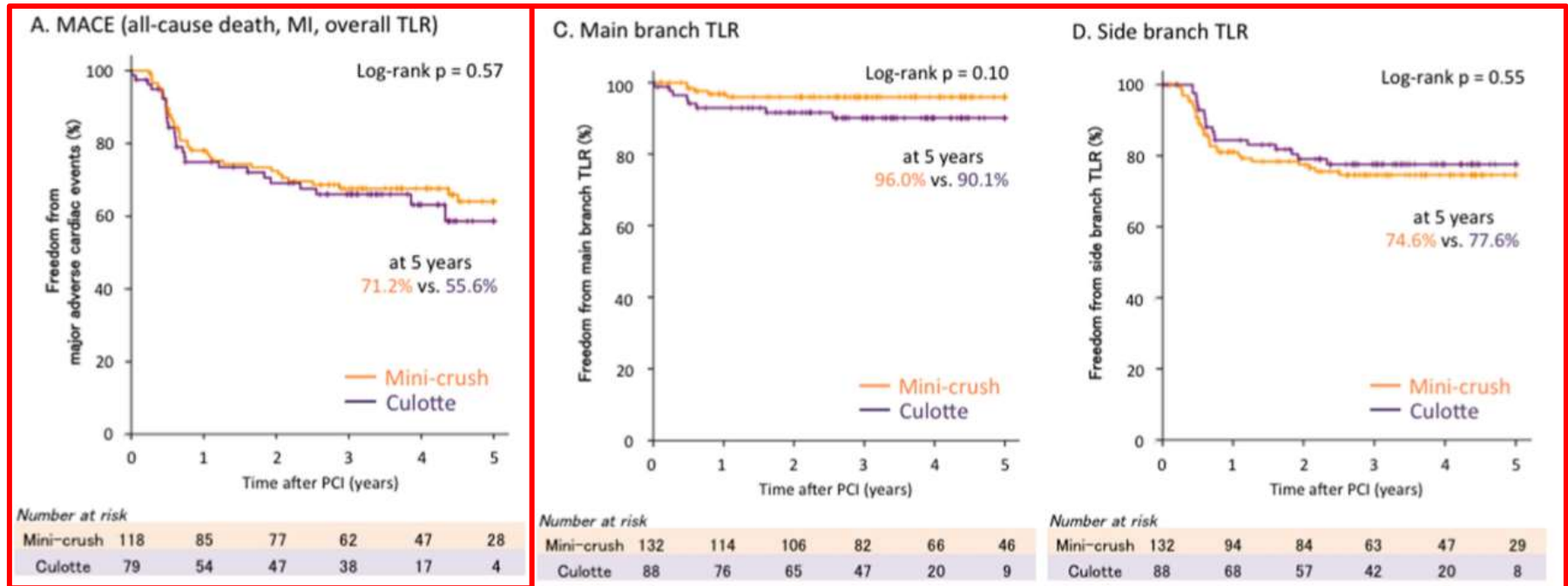


Long-term Outcomes following Mini-crush vs. Culotte Stenting: the Insights from Milan and New-Tokyo (MITO) Registry

Kawamoto H, Nakamura S, et al. CCI 2017;89(1):13-24



Freedom from MACE, Main and Side branch TLR



1. MACE rate between mini-crush and culotte stenting are comparable
2. The rates of ST are significantly higher at 5-years in the culotte group when compared to mini-crush group (0% vs. 6.3% at 5-years, p=0.02).
3. Cox regression analysis demonstrated that LMCA full-cover stenting and SYNTAX score were independent predictors for MACE.

Lesson 5

1. As far as bifurcation lesion is untreated, its flow around carina is fast and plaque is not accumulated.
2. However once two stents are placed, flow is delayed and causing turbulence, which is so called low shear stress area, susceptible to plaque deposition.
3. Depending on which double stenting technique is used, flow of CX would be different, and... even whether favorable stenting is achieved or not makes flow pattern different.

My Message

1. Focus on LAD stenting !!,
Do not chase to much LCX!!
2. Better to do KBT !! (We need more Data)
3. Imaging Device is necessary !!
4. If you can finish One stent ,
You have a big advantage in terms of restenosis.
5. If you can not avoid Two stenting strategy,
You need to optimize the apposition of stent strut.

Happy End... Not Always !!

