Bifurkace s double stenting:
role imaging a funkčního testování

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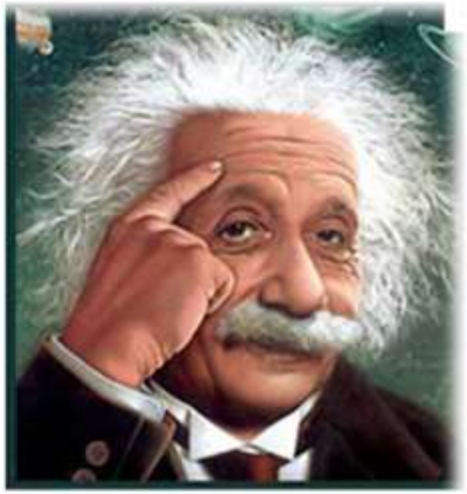
(11.-13.4. 2018, Hradec Králové)

Bifurkace s double stenting: role imiging….

'Jak vzniká vynález? To všichni vědí, že je něco nemožné, a pak se objeví nějaký blázen, který neví, že je to nemožné, a udělá vynález.„

Albert Einstein



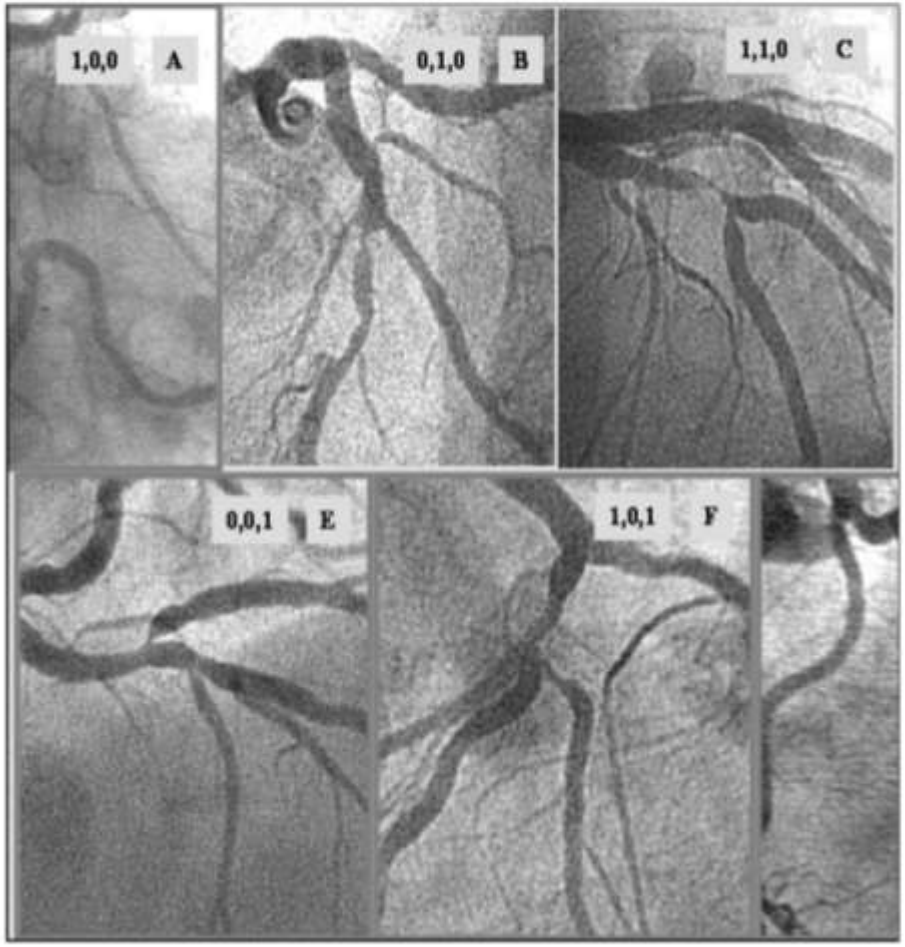
Bifurkace s double stenting: role imiging

Treatment of bifurcation lesions is still chalenging…

To crush or not to crush …???

Bifurkace s double stenting: role imiging….

Bifurcation PCI



- Account for 15-20% of PCI
- Why an indivdualized approach?
  - Variations in Anatomy
    - Left main bifurcation disease
    - Plaque burden & location of plaque
    - Angle between MB and SB
  - Dynamic changes in anatomy during treatment
    - Plaque shift
    - Dissection

No two bifurcations are identical

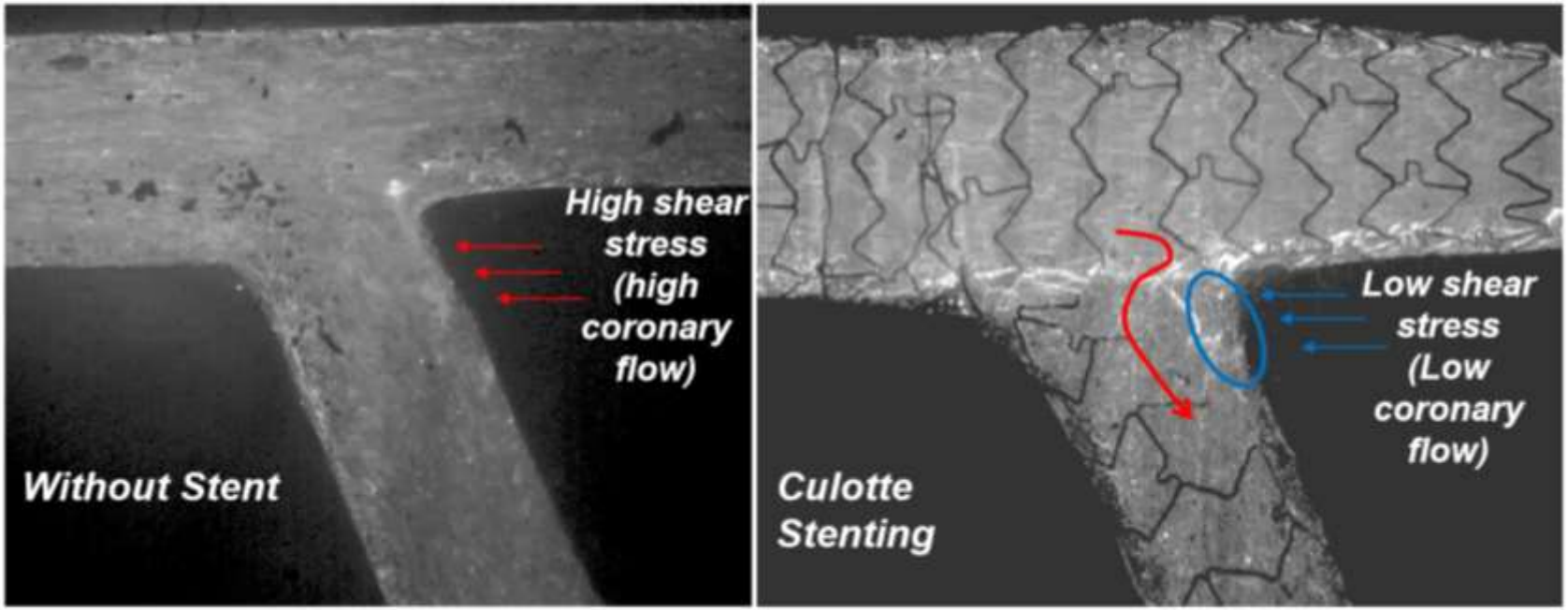
Bifurkace s double stenting: role imiging….

- ***Atherosclerosis of the carina is unusual***

Experimental model to study flow pattern

Without stent placement
Blood flow at carina is quite fast.

After stent implantation
Flow is delayed, causing turbulence.



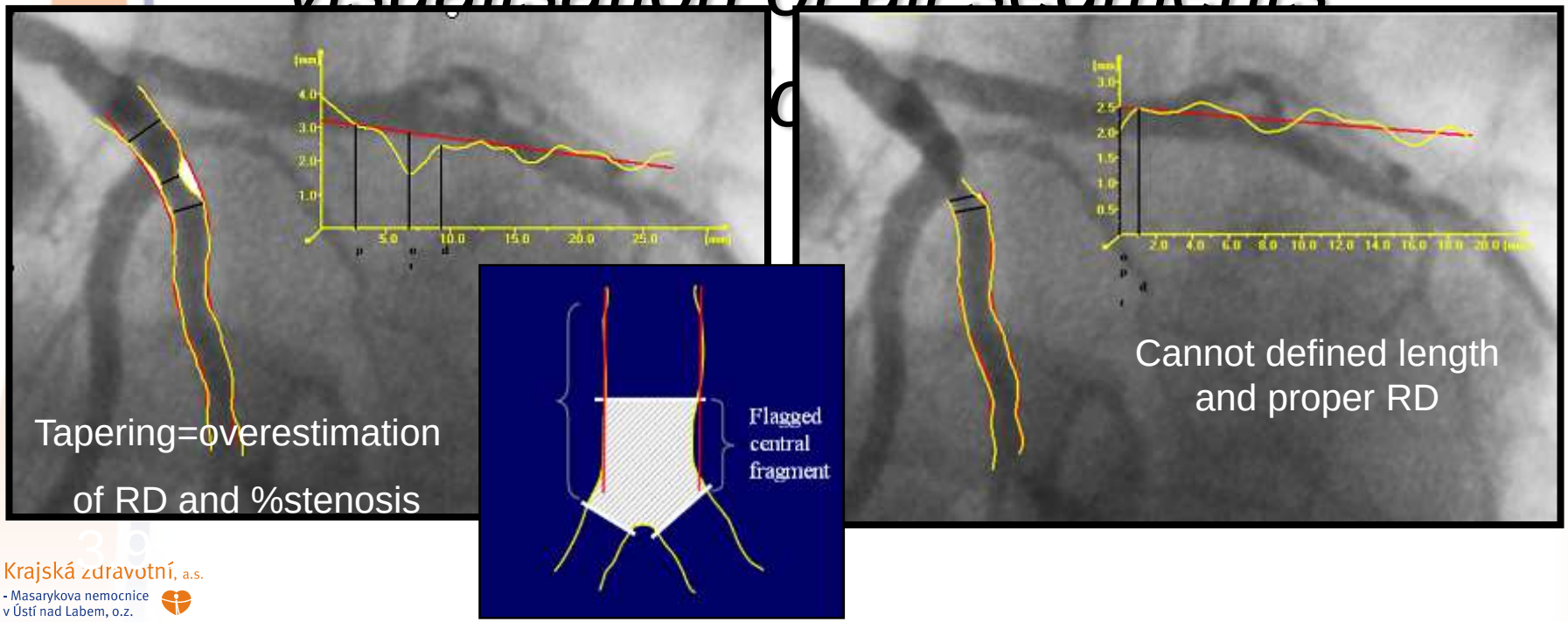
Low shear stress status: It is speculated that stent struts remaining at orifice of SB negatively affect the flow.

Bifurkace s double stenting: role imiging….

- foreshortening
- for the proper angiographic guid
- overlapping
- limitation of QCA

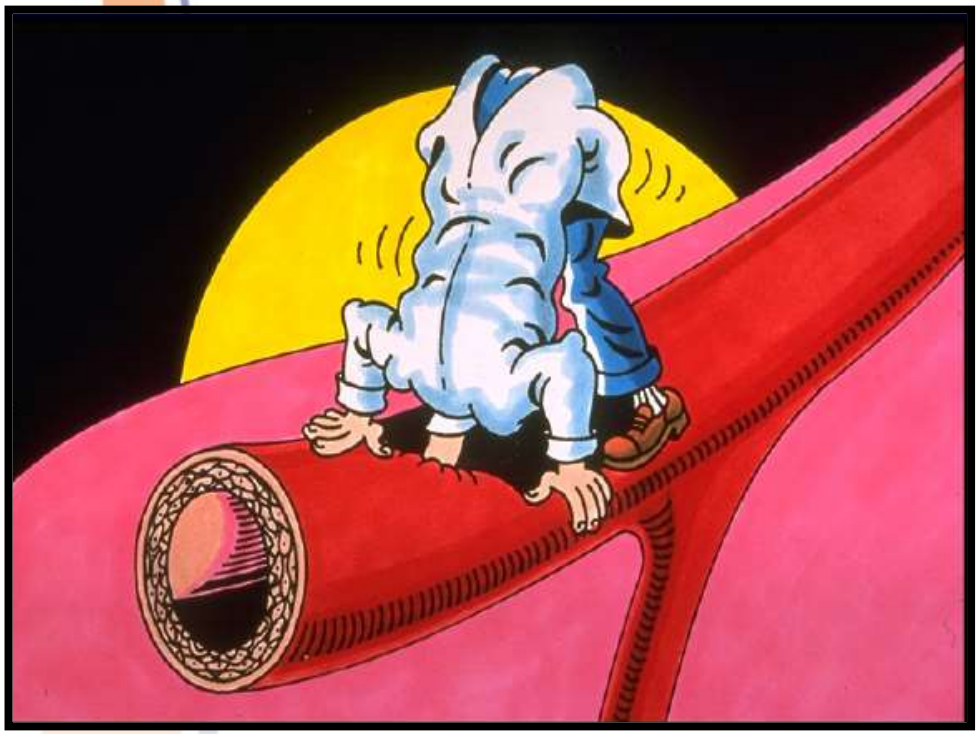
Limitation of angiography

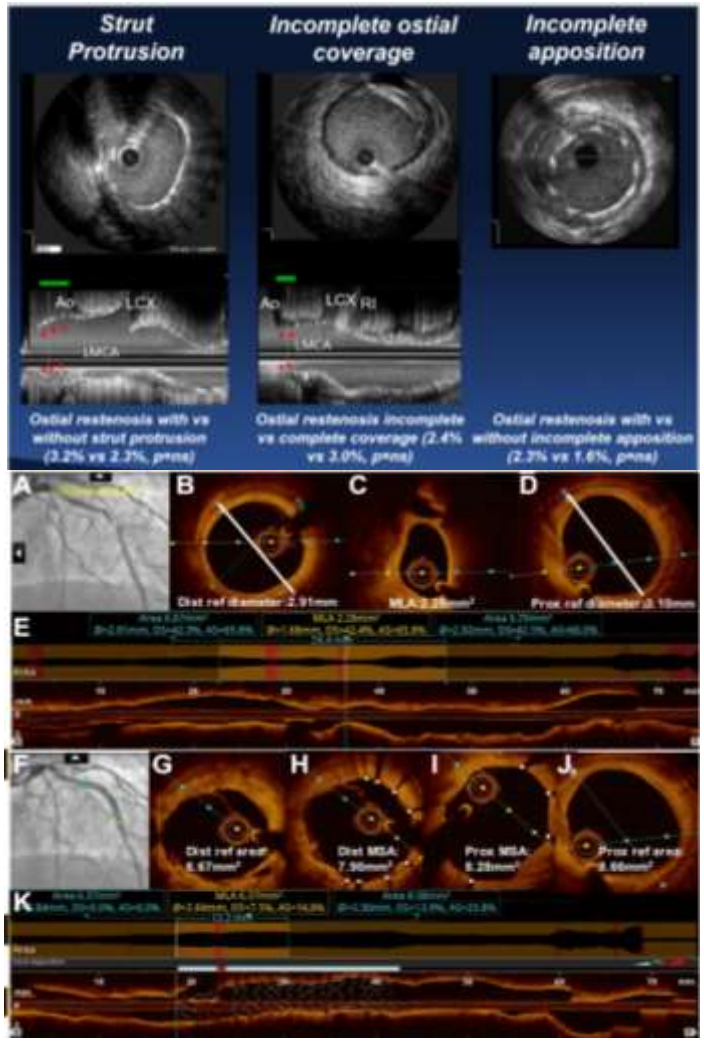
treatment of bifurcation lesions, optimal visualisation of all segments



Bifurkace s double stenting: role imiging….

- Unlike angiography, IVUS/OCT are able to provide comprehensive information pre, during and post PCI





Bifurkace s double stenting: role imiging….

Srovnání jednotlivých modalit

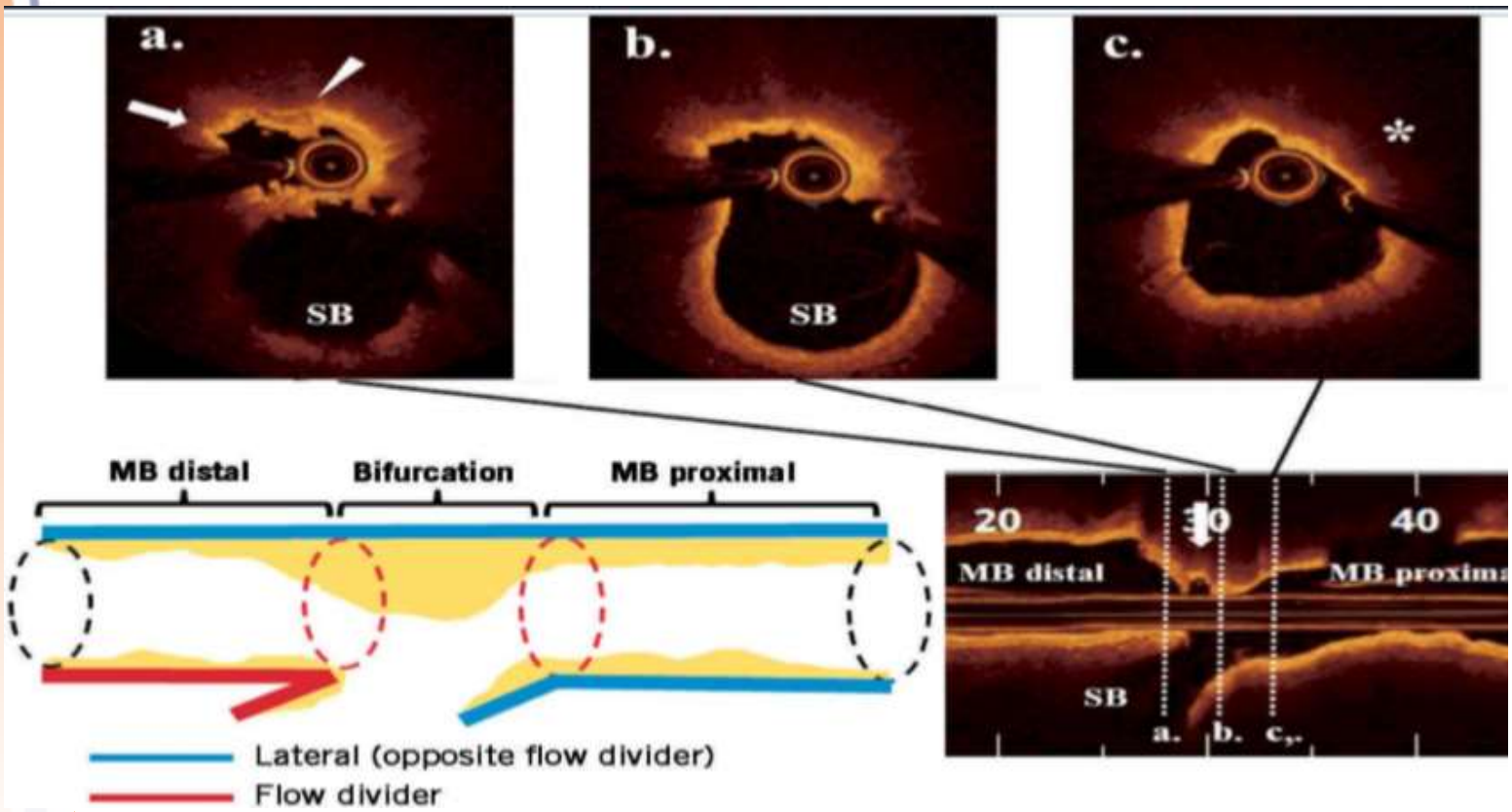
	OCT	Angioscopy	IVUS
Feasibility	+++	+	+++
Proximal occlusion	-	+++	-
Guide cath	5F	8F	5/6F
Lumen contour	+++	NA	++/+
Area measurement	+++	NA	++
Plaque detection	++/+	+	++
Thrombus detection	+++	++	+
Stent coverage	+++	+	+
Limitation	ostium/large	ostium	Ca
Resolution	12-20μm		120-540μm
Profile	2.6F		2,7/3.2F
Pull back speed	20mm/s		0.5-1.0mm/s
Depth penetration	up to 8mm		4-8mm

Bifurkace s double stenting: role imiging….

IVUS/OCT:

Pre-procedure

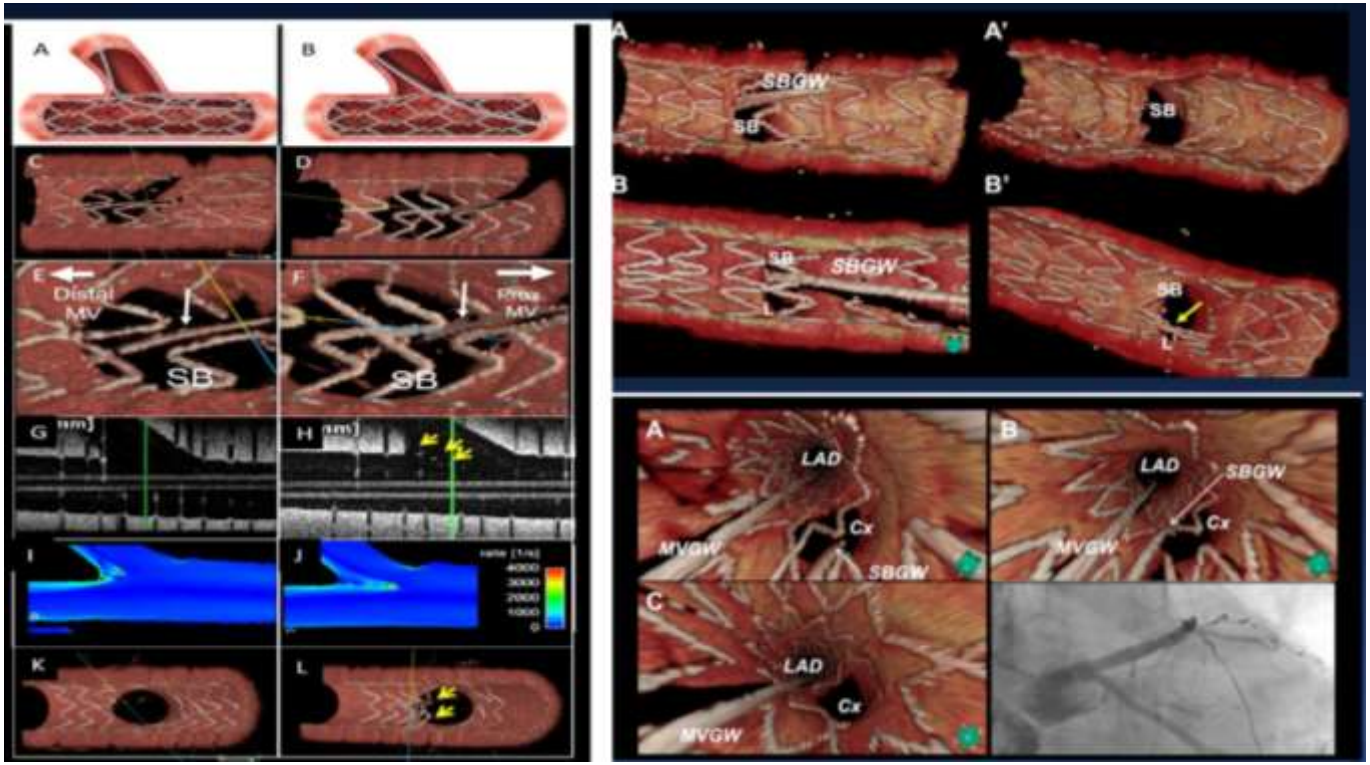
- unique informations regarding diameters, length, plaque morphology, distribution and plaque burden, calcification, bifurcation angle and prediction of SB occlusion = ***strategy, device selection***



(Gonzalo N, at al. Quantitative ex vivo and in vivo comparison of lumen dimensions measured by optical coherence tomography and intravascular ultrasound in human coronary arteries. Rev Esp Cardiol 2009;62:615-24.)

Bifurkace s double stenting: role imiging….

- ***IVUS/OCT:*** **During procedure**
  - ✓ intraprocedural guidance – recrossing SB in the proper location (the most distal strut)

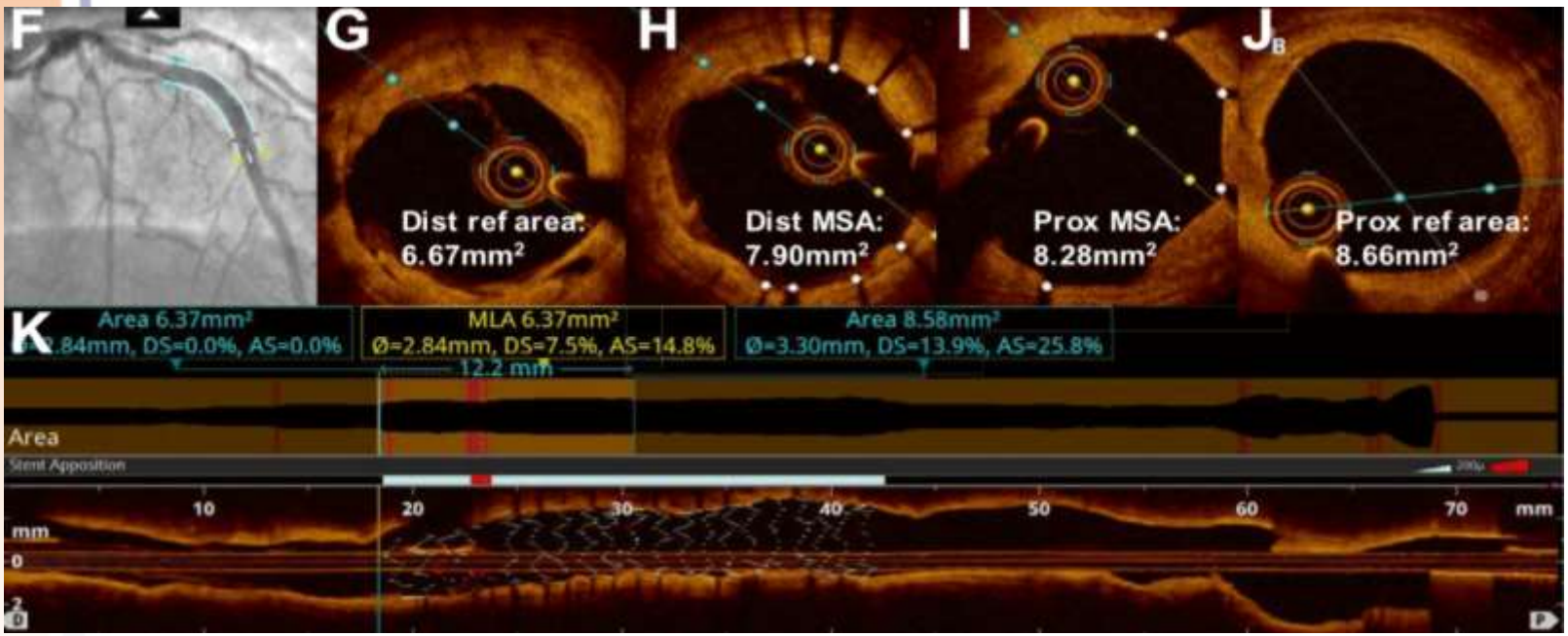


(Alegria-Barrero E, et al.. Optical coherence tomography for guidance of distal cell recrossing in bifurcation stenting: choosing the right cell matters. EuroIntervention. 2012;8:205-13)

Bifurkace s double stenting: role imiging….

➢ IVUS/OCT: **Post-procedure**

- ✓ ***”true” result of intervention:***
  - stent over/underexpansion, jailing struts
  - geographical miss, plaque prolaps, thrombus
  - edge dissection



(Pratti F, at al. Expert review document, Eur Heart J. 2012;33:2513-20)

Bifurkace s double stenting: role imiging….

IVUS/OCT: Post-procedure

Impact of Intravascular Ultrasound Guidance on Long-Term Mortality in Stenting for Unprotected Left Main Coronary Artery Stenosis

Seung-Jung Park, MD, PhD*; Young-Hak Kim, MD, PhD*; Duk-Woo Park, MD, PhD; Seung-Whan Lee, MD, PhD; Won-Jang Kim, MD, PhD; Jon Suh, MD; Sung-Cheol Yun, PhD; Cheol Whan Lee, MD, PhD; Myeong-Ki Hong, MD, PhD; Jae-Hwan Lee, MD, PhD; Seong-Wook Park, MD, PhD; for the MAIN-COMPARE Investigators

Background—Although intravascular ultrasound (IVUS) guidance has been useful in stenting for unprotected left main coronary artery stenosis, its impact on long-term mortality is still unclear.

Methods and Results—In the MAIN-COMPARE registry, patients with unprotected left main coronary artery stenosis in a hemodynamically stable condition underwent elective stenting under the guidance of IVUS (756 patients) or conventional angiography (219 patients). Patients with acute myocardial infarction were excluded. The 3-year outcomes between the 2 groups were primarily compared using propensity-score matching in the entire and separate populations according to stent type. In 201 matched pairs of the overall population, there was a tendency of lower risk of 3-year morality with IVUS guidance compared with angiography guidance (6.0% versus 13.6%, log-rank $P=0.063$; hazard ratio, 0.54; 95% CI, 0.28 to 1.03; Cox-model $P=0.061$). In particular, in 145 matched pairs of patients receiving drug-eluting stent, the 3-year incidence of mortality was lower with IVUS guidance as compared with angiography guidance (4.7% versus 16.0%, log-rank $P=0.048$; hazard ratio, 0.39; 95% CI, 0.15 to 1.02; Cox model $P=0.055$). In contrast, the use of IVUS guidance did not reduce the risk of mortality in 47 matched pairs of patients receiving bare-metal stent (8.6% versus 10.8%, log-rank $P=0.35$; hazard ratio, 0.59; 95% CI, 0.18 to 1.91; Cox model $P=0.38$). The risk of myocardial infarction or target vessel revascularization was not associated with the use of IVUS guidance.

Conclusions—Elective stenting with IVUS guidance, especially in the placement of drug-eluting stent, may reduce the long-term mortality rate for unprotected left main coronary artery stenosis when compared with conventional angiography guidance. (***Circ Cardiovasc Intervent.* 2009;2:167-177.**)

Bifurkace s double stenting: role imiging….

Percutaneous coronary intervention for coronary bifurcation disease: 11th consensus document from the European Bifurcation Club

The role of imaging

- ***Intravascular imaging is valuable supplement in bifurcation treatment and is especially useful in complex lesions due to limitations of angiography alone;***
- ***It is strongly recommended to have access to intravascular imaging modalities (IVUS, OCT, OFDI) during elective PCI of LM;***

- IVUS is strongly recommended for LM bifurcation treatment
- OCT may be used with the provision that aorto-ostial assessment is often not possible
- Wire positions in stent recrossing can be evaluated by OCT

tct2017 *Lassen J. et at. 12th EBC consensus, Eurointervention 2017.* Cardiovascular Research Foundation

EuroIntervention 2016;12:38-46

Bifurkace s double stenting: role imiging….

FFR in bifurcation stenting:

- ✓ *When FFR is measured for SB ostial lesions, the influence of proximal and distal lesions should be considered.*
- ✓ *As the bifurcation lesion is basically the combination of three ostial lesions, a greater discrepancy can exist between the anatomical evaluations and FFR*

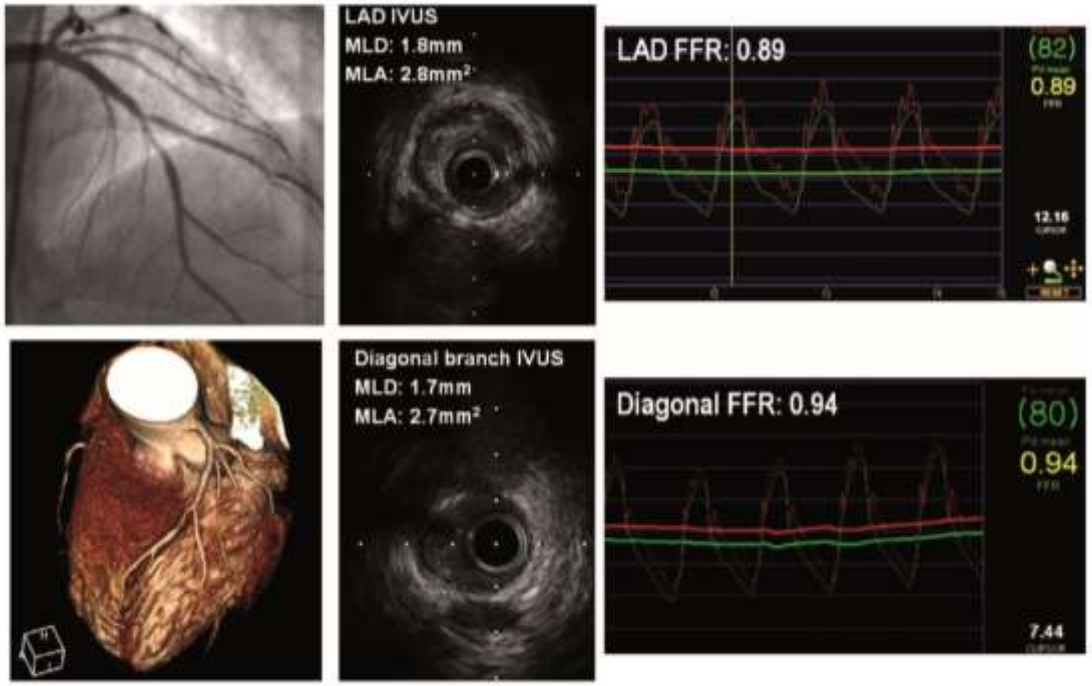
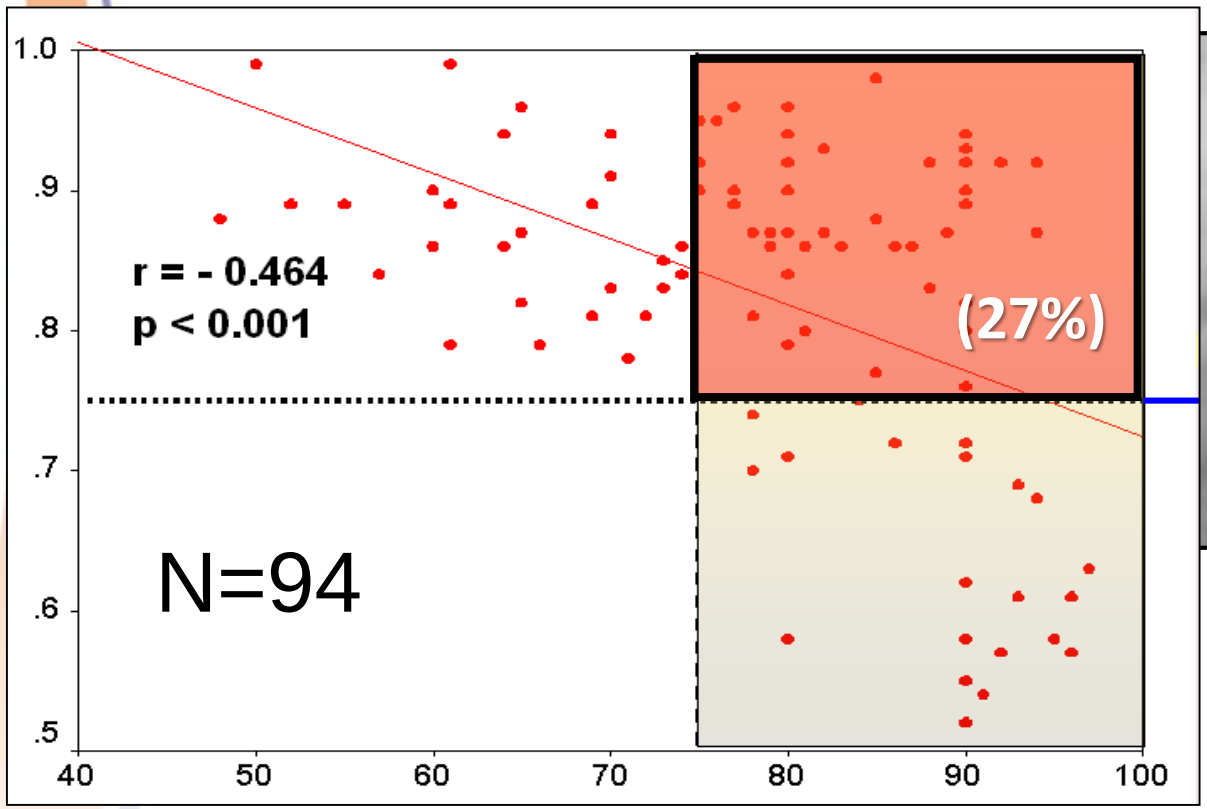


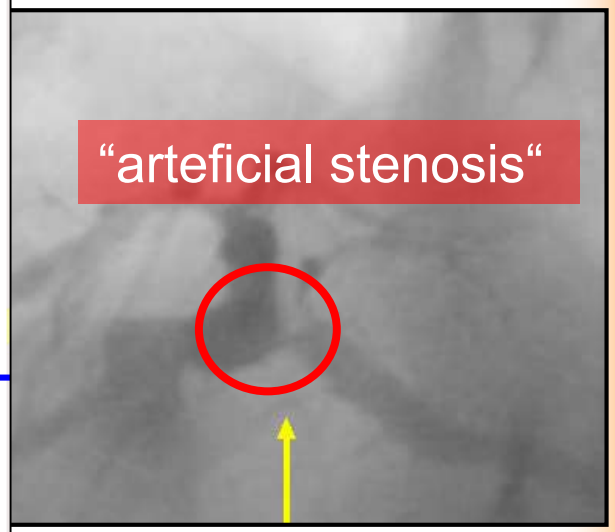
Figure 1. A case example which shows the discrepancy between the results of anatomical evaluations and fractional flow reserve. LAD: left anterior descending coronary artery; IVUS: intravascular ultrasound; MLD, minimum lumen diameter; MLA: minimum lumen area; FFR: fractional flow reserve

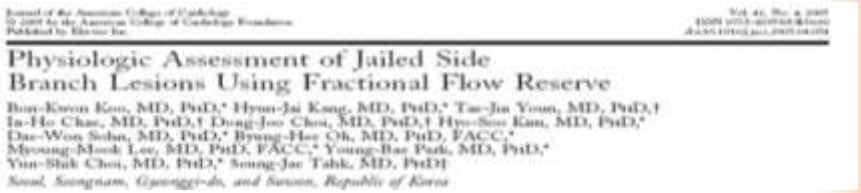
(Koh J, et al. Relationship between FFR and angiographic and IVUS parameters in ostial leasions. JACC Cardiovasc Interv;2012 (5):409-15)

Bifurkace s double stenting: role imiging….

Angiography overestimates functional significance of jailed SB





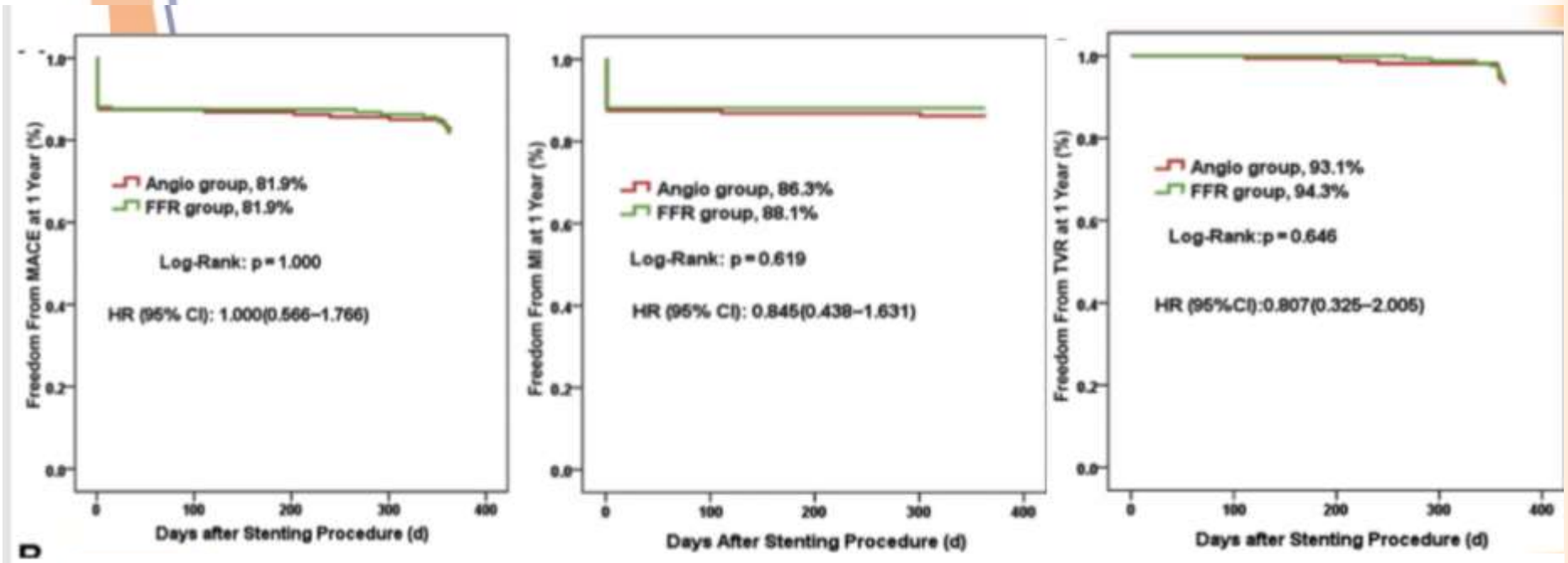

Physiologic Assessment of Jailed Side Branch Lesions Using Fractional Flow Reserve

Bifurkace s double stenting: role imiging….

BIFURCATION INTERVENTIONS FOCUS

Randomized Comparison of FFR-Guided and Angiography-Guided Provisional Stenting of True Coronary Bifurcation Lesions

The DKCRUSH-VI Trial (Double Kissing Crush Versus Provisional Stenting Technique for Treatment of Coronary Bifurcation Lesions VI)



- ✓ FFR <0,80 u 52% lesions
- ✓ SB access failure: 9.4%

Chen, SL, JACC:Cardiovascular interventions; 2015, 8(4):536-46)

Bifurkace s double stenting: role imiging….

Percutaneous coronary intervention for coronary bifurcation disease: 11th consensus document from the European Bifurcation Club

✓ *Role of fractional flow reserve (FFR) in bifurcations*

– MV FFR is recommended in stable patients when no other objective evidence of ischaemia is available

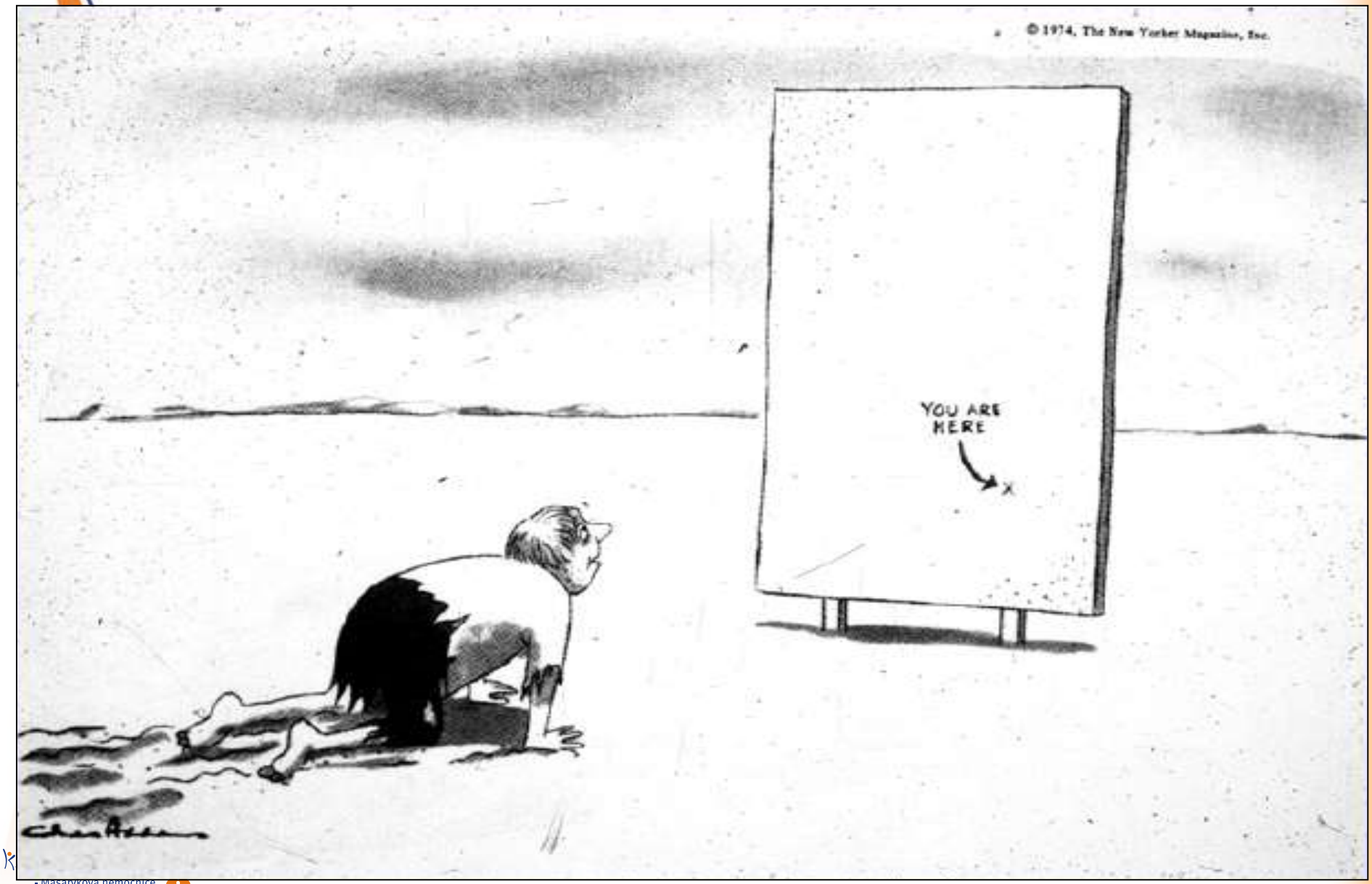
– FFR in large SBs before intervention may be used to support choice of treatment strategy but careful interpretation of measurements is required.

– SB FFR after MV stent implantation remains controversial due to potential safety concerns and due to unknown validity when performed after MV stenting

- Cx evaluation by FFR after MV implantation was however shown to reduce SB intervention without increasing subsequent revascularisation.

EuroIntervention 2016;12:38-46

Bifurkace s double stenting: role imiging….



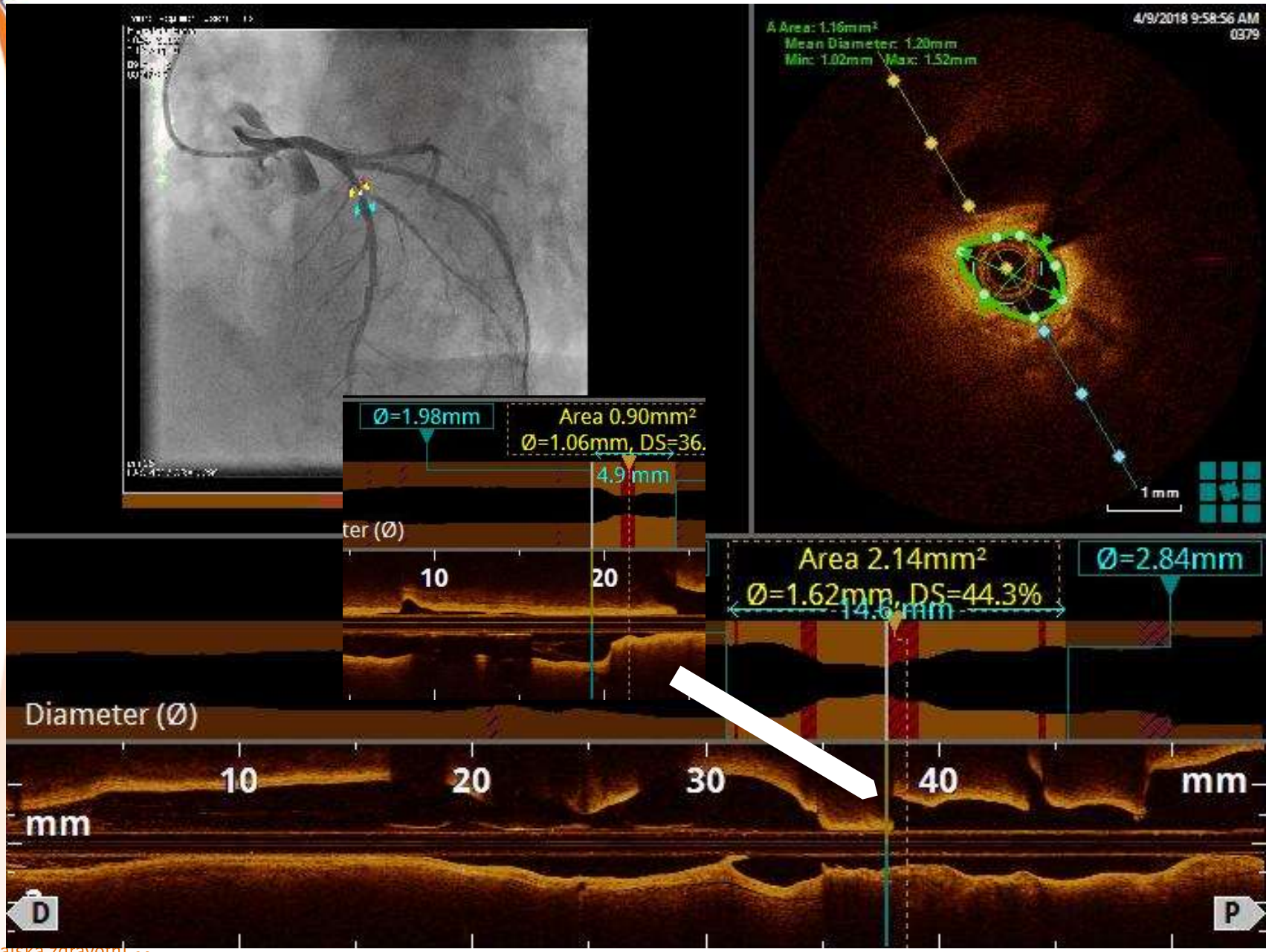
Bifurkace s double stenting: závěry

- ***Imaging/(funkční hodnocení):***
  - ✓ *Díky podrobným informacím před výkonem = volba strategie, typu stentu, hodnocení rizika*
  - ✓ *Guidance během samotného výkonu (OCT) = určení správného místa pro proniknutí skrz stent do SB*
  - ✓ *Hodnocení výsledku po výkonu = „skutečný“ výsledek výkonu v obou větvích,*
  - ✓ *Vždy u LM intervencí (IVUS)*
  - ✓ *Nevýhoda cena, prolongace výkonu, (spotřeba KL u OCT)*

Bifurkace s double stenting: case report

- *HH, F, 78 y*
- *Stable AP*
- *LV failure, EF 30%*

- *Hypertension*
- *Current smoker*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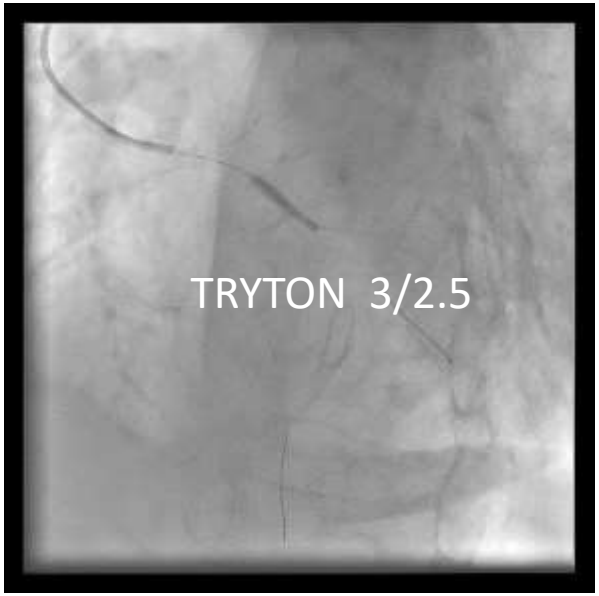
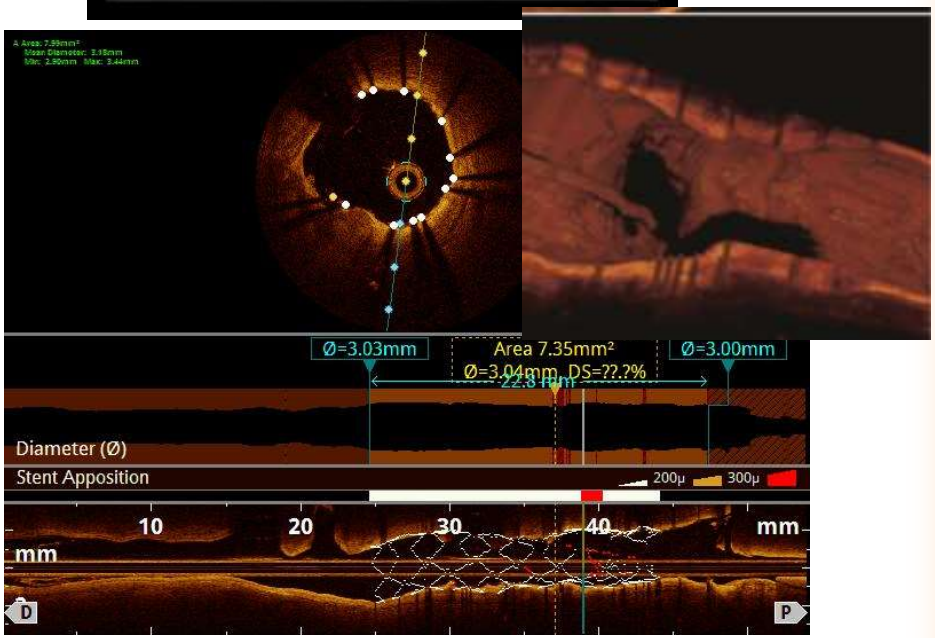

TRYTON 3/2.5


Biomatrix alpha 3/19


POT 3.5/8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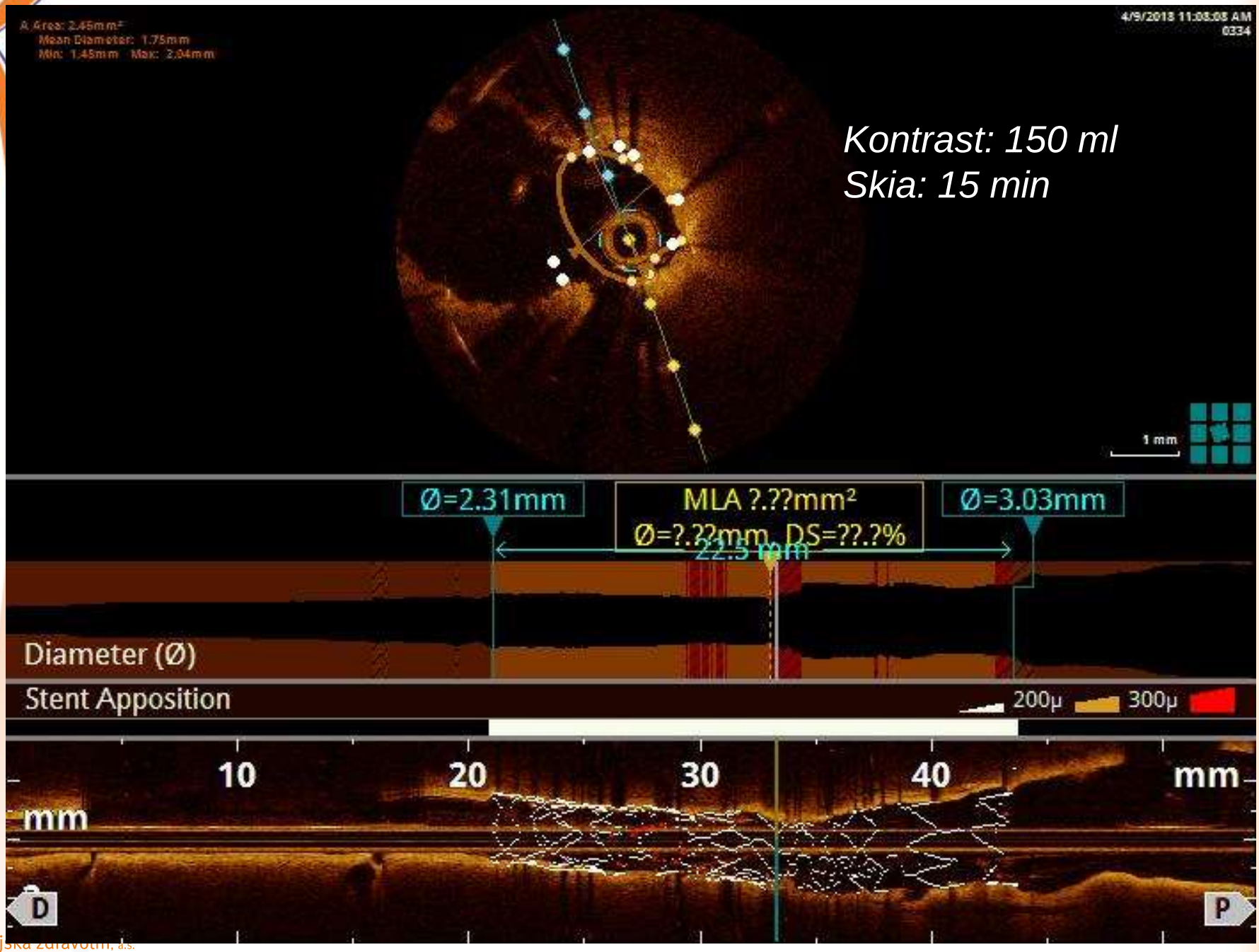
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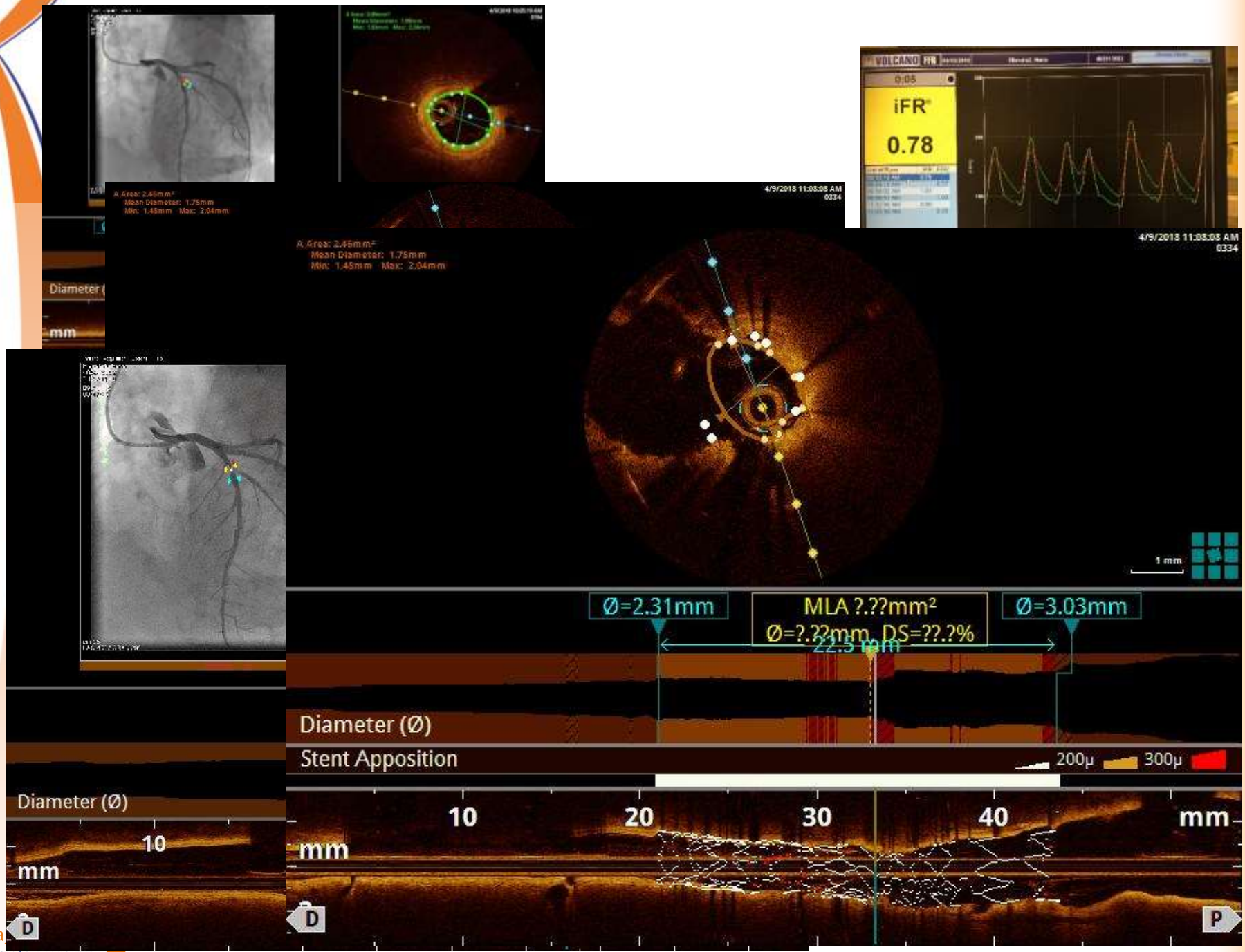
Bifurkace s double stenting: role imiging….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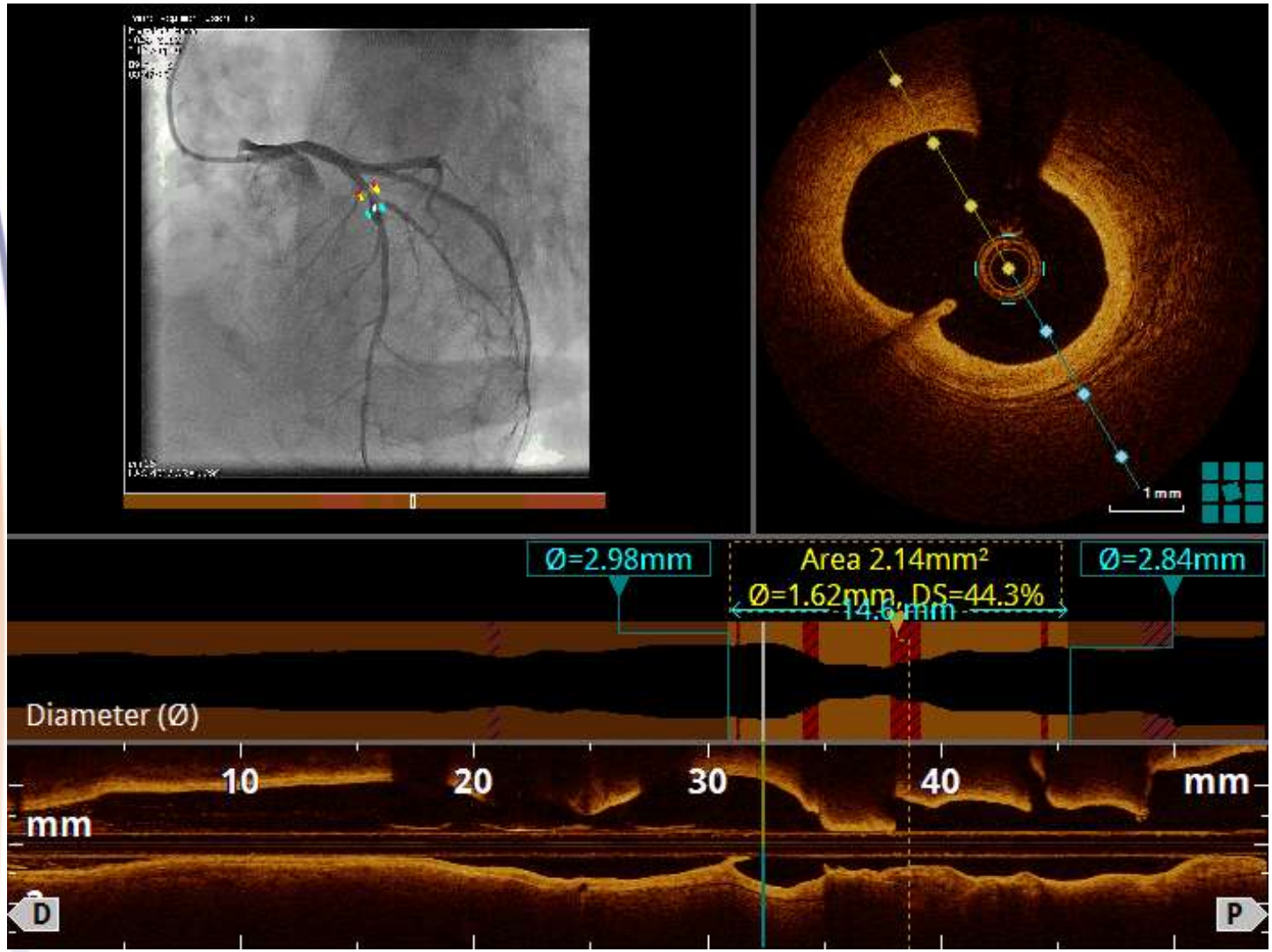
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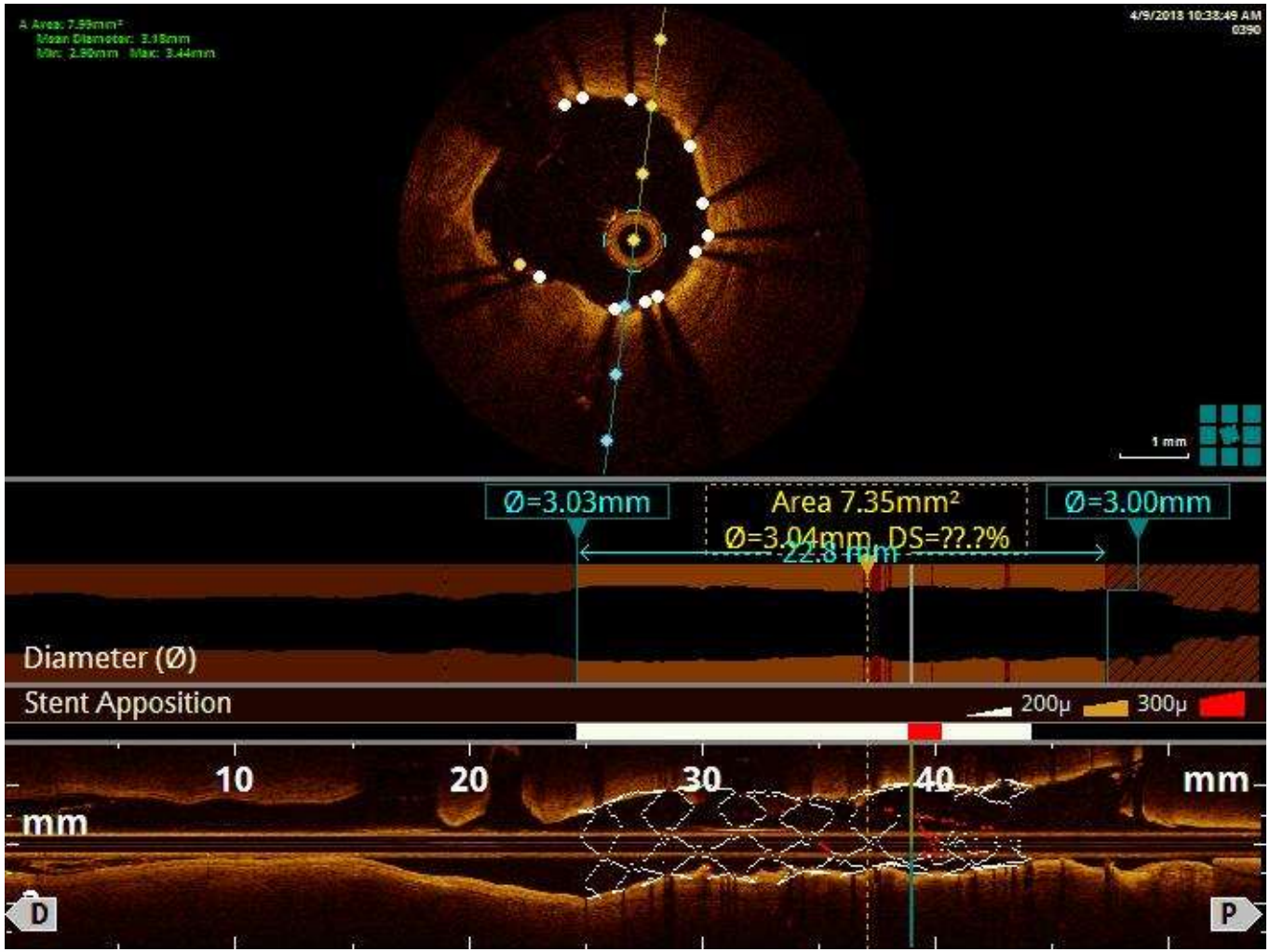
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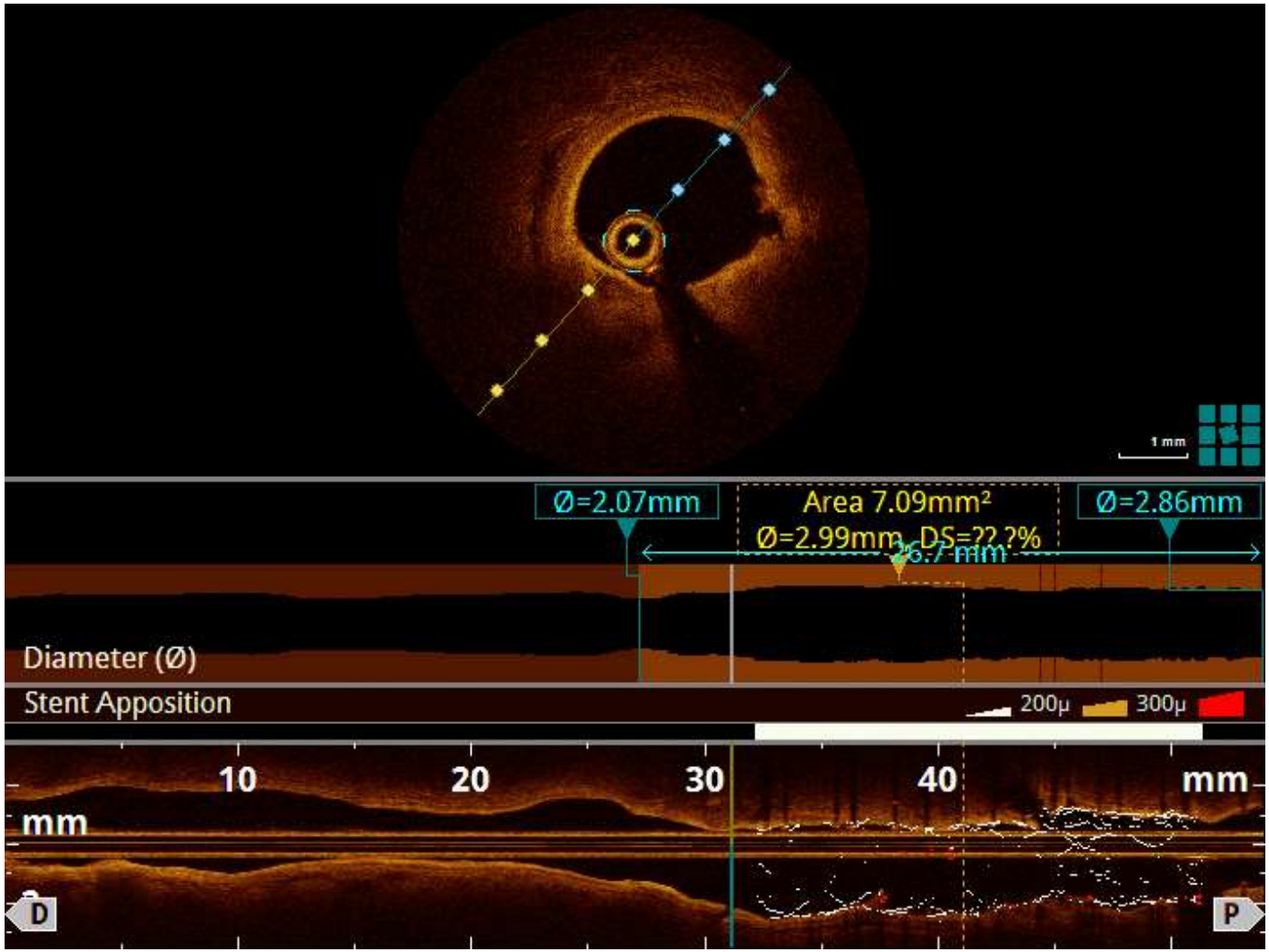
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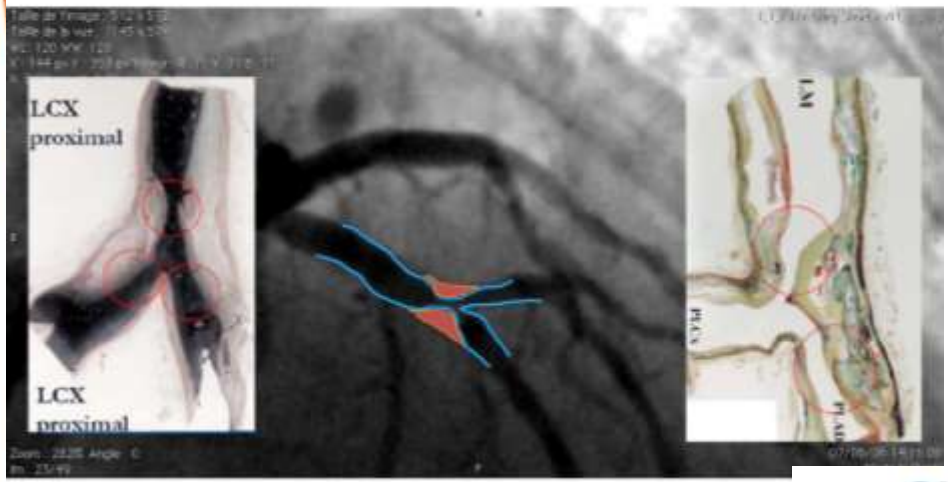
Anticipate plaque distribution



Should we use one stent or two?

7 Randomized Studies with DES comparing one vs. two stents approach and 8 Meta-analyses showed:

- No advantage in using systematic 2 stents;
- Stepwise provisional T is the gold standard for most bifurcation lesions;

- **BUT, this does not mean there will not be occasions when a 2-stent strategy is required (expert consensus)**

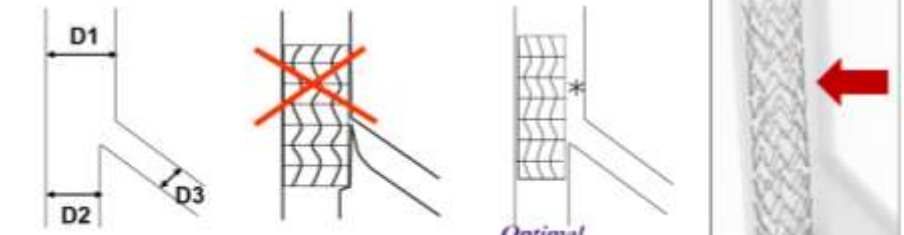
Lassen JF. EuroIntervention. 2014 Sep;10(5):545-60
Stankovic G. EuroIntervention. 2013 May 20;9(1):36-45
Hildick-Smith D. EuroIntervention 2010;6(1):34-8

Percutaneous coronary intervention for coronary bifurcation disease: 11th consensus document from the European Bifurcation Club

- ✓ OCT/IVUS may be of particular value in guiding bifurcation treatment due to high degree of angiographic ambiguity.
- ✓ IVUS is recommended for LM bifurcation treatment and OCT may be used with the provision that aorto-ostial assessment is most often not possible.
- ✓ OCT may be superior to IVUS in evaluation of the SB ostium, stent positions, stent strut malapposition, wire position, and detection of thrombus.
- ✓ Wire positions in stent re-crossing affect stent appositions and can be evaluated by OCT.
- ✓ Accidental abluminal stent rewiring is a concern and may be ruled out by OCT.
- ✓ Pullbacks in both MV and SB are recommended when guiding two-stent treatment by intravascular imaging.

EuroIntervention 2016;12:38-46

How to select MV stent: Murray's law



Recommendations:

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

Routine final kissing in provisional stenting

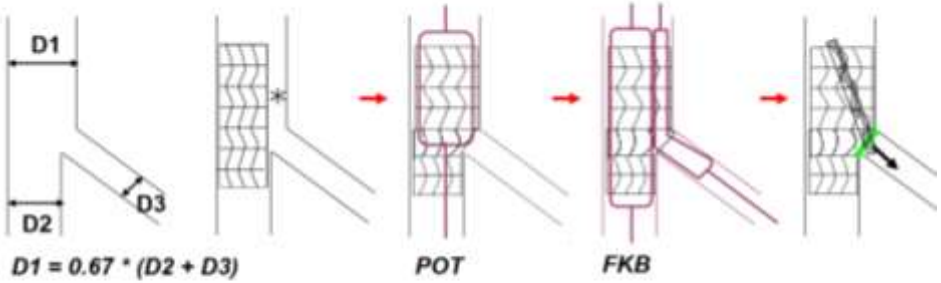
WHAT IS STILL DEBATED:

- A validated software for QCA of bifurcations is still being waited for.
- An accurate evaluation of the functional significance of ostial SB stenosis is necessary.
- Should we do systematic kissing balloon inflation?

EBC consensus:

— Kissing balloon inflations may be used when an angiographically significant (>75% DS or TIMI flow <3) ostial SB lesion remains after MV stenting.

Proximal Optimisation Technique (POT)

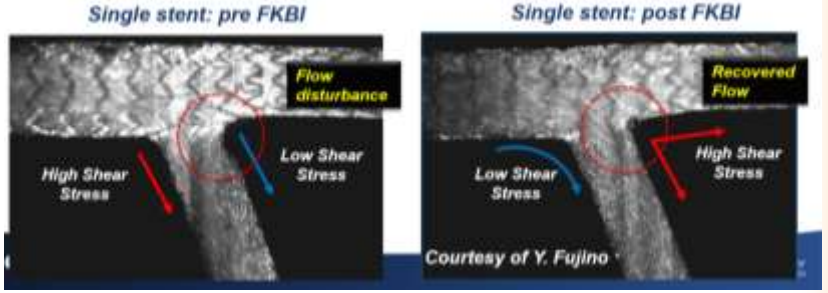


Recommendations:

- *Postdilatation, expansion of the stent at the carina, using a short oversized balloon (POT), or kissing balloon inflations (FKB), are required to optimize the proximal main vessel stent diameter*

How to perform optimal Final Kissing?

- Optional for simple techniques, obligatory for complex techniques;
- Balloon size according to distal reference;
- Short & non-compliant balloons;
- Side branch first (equal or 12 atm vs. 4 atm);
- Longer inflation and simultaneous deflation;



Two stents required for large SB with diffuse disease?

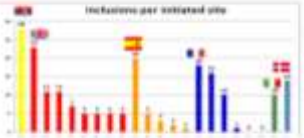
EBC consensus:

- Main vessel (MV) stenting with provisional SB treatment, if needed, is recommended as the preferred technique for the majority of bifurcation lesions.
- Large SBs with significant ostial disease extending further into the SB are likely to require a two-stent strategy.
- Larger SBs whose access is particularly challenging should be secured by stenting once accessed.

Two stents required for large SB with diffuse disease?

Nordic-Baltic Bifurcation Study IV PCR 2015

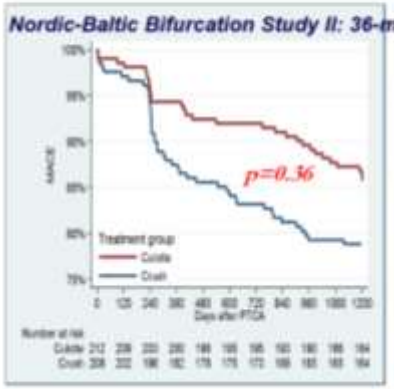
- After 2 years, two-stent techniques for treatment of true bifurcation lesions with a large side branch showed no significant difference in MACE rate compared to provisional side branch stenting

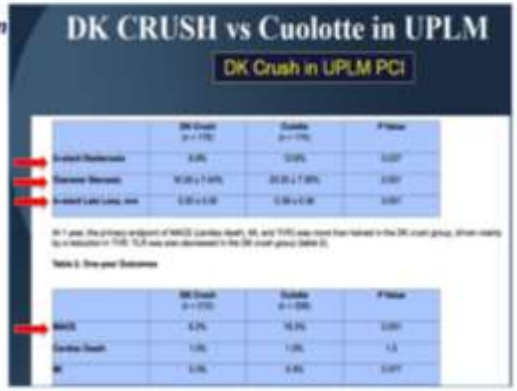


EBC TWO: Circ. Interv 2016

- When treating coronary bifurcation lesions with large side branches incorporating significant length of ostial disease, there is no difference between a provisional T stent strategy and a systematic two-stent culotte strategy MACE rate revascularization at 12 months.

Either TAP, culotte or DK crush could be used as a two stent technique





Chen SL. J Am Coll Cardiol. 2013 Apr 9;61(14):1482-8 *Lassen JF. EuroIntervention. 2014 Sep;10(5):545-*
Kervinen K. JACC Cardiovasc Interv. 2013 Nov;6(11):1160-5 *Hildick-Smith D. EuroIntervention 2010;6(1):34-*

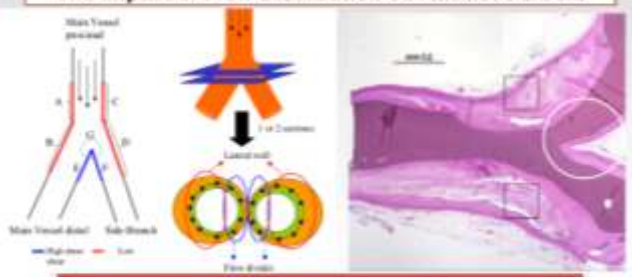
The role of imaging

- ***Intravascular imaging is valuable supplement in bifurcation treatment and is especially useful in complex lesions due to limitations of angiography alone;***
- ***It is strongly recommended to have access to intravascular imaging modalities (IVUS, OCT, OFDI) during elective PCI of LM;***

- IVUS is strongly recommended for LM bifurcation treatment
- OCT may be used with the provision that aorto-ostial assessment is often not possible
- Wire positions in stent recrossing can be evaluated by OCT

tct2017 **Lassen J. et al. 12th EBC consensus, Eurointervention 2017.**

Pathological Findings at Bifurcation Lesions: The Impact of Flow Distribution on Atherosclerosis



Low shear progress the coronary artery plaque accumulation

Nakazawa, G. et al. J Am Coll Cardiol. 2010;16:1679-1687

Unique vessel reaction at carina side after 2-stent LMCA PCI

New Tokyo Hospital
Department of Cardiology

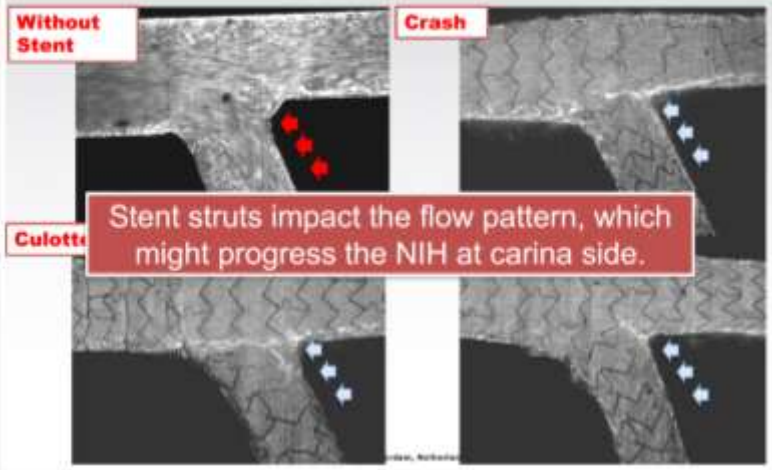
Usually, there is little plaque accumulation at carina side, however there is NIH accumulation at carina side of LCX proximal after 2 stent technique. Why does it happen?

Fujino, Y. , Nakamura, S, et al. Int J Cardiol. 2016:219:285-92.

XII European Bifurcation Club meeting - Rotterdam, Netherlands - 14th & 15th October 2016

New Tokyo Hospital
Department of Cardiology

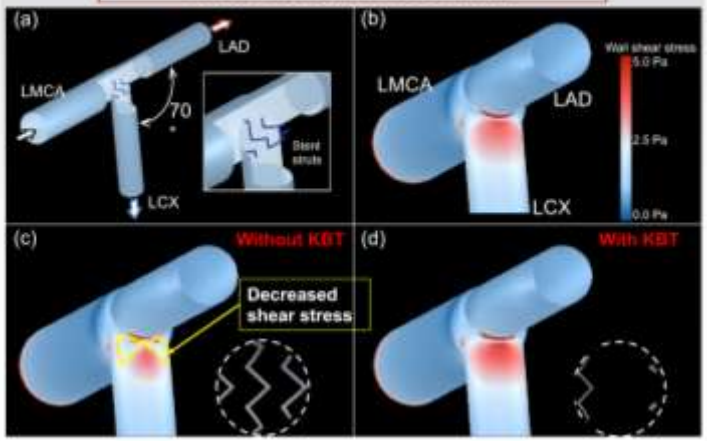
Flow dynamics in 2 stent technique



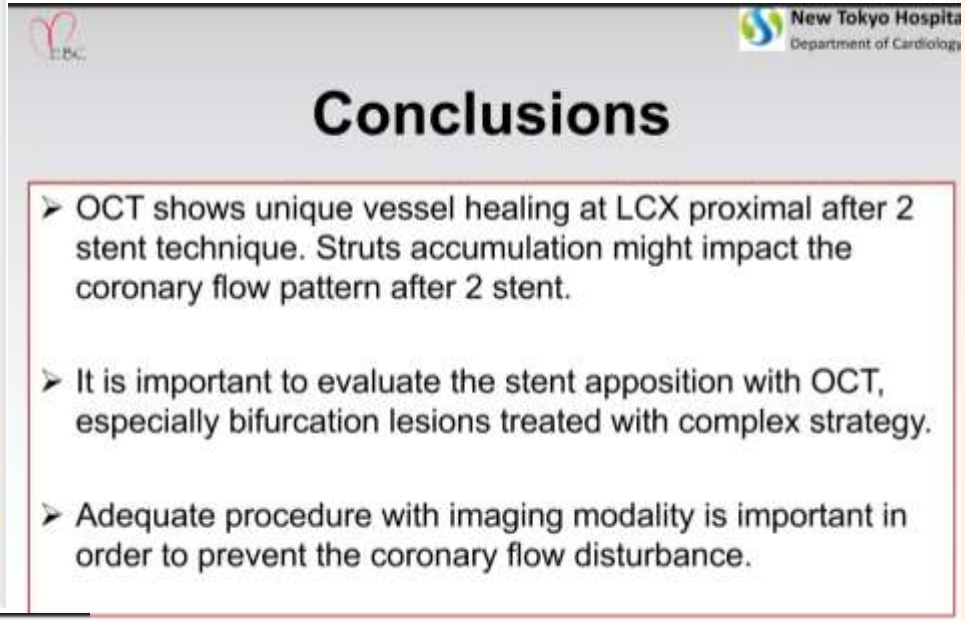
Stent struts impact the flow pattern, which might progress the NIH at carina side.

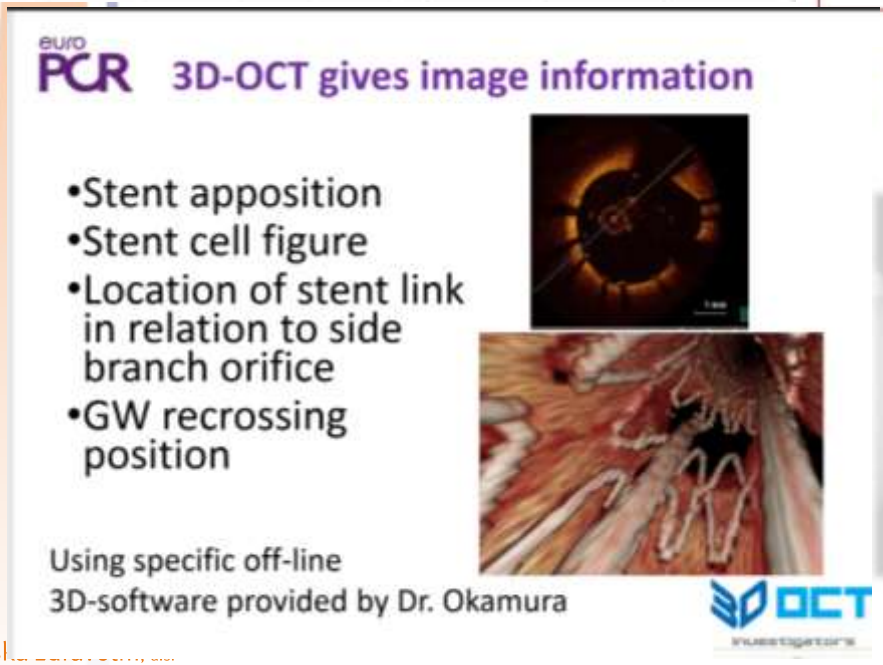
The Wall Shear Stress distribution on the left main coronary

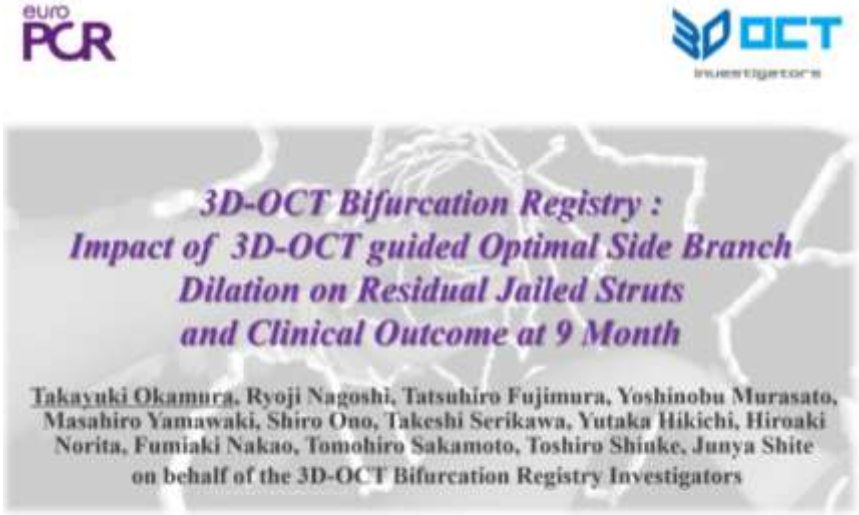
New Tokyo Hospital
Department of Cardiology




New Tokyo Hospital
Department of Cardiology
Favorable Culotte
Unfavorable Culotte
LMCA
LAD
LMCA
LAD
If we do not perform the adequate 2 stent, it might influence the coronary flow
LMCA
LAD
LCX
LMCA
LAD
LCX
Home Dat


New Tokyo Hospita
Department of Cardiolog
Conclusions
OCT shows unique vessel healing at LCX proximal after 2 stent technique. Struts accumulation might impact the coronary flow pattern after 2 stent.
It is important to evaluate the stent apposition with OCT, especially bifurcation lesions treated with complex strategy.
Adequate procedure with imaging modality is important in order to prevent the coronary flow disturbance.


euro PCR
3D-OCT gives 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
OCT
investigators


euro PCR
OCT
investigators
3D-OCT Bifurcation Registry :
Impact of 3D-OCT guided Optimal Side Branch Dilation on Residual Jailed Struts and Clinical Outcome at 9 Month
Takayuki Okamura, Ryoji Nagoshi, Tatsuhiro Fujimura, Yoshinobu Murasato, Masahiro Yamawaki, Shiro Ono, Takeshi Serikawa, Yutaka Hikichi, Hiroaki Norita, Fumiaki Nakao, Tomohiro Sakamoto, Toshiro Shiuke, Junya Shite
on behalf of the 3D-OCT Bifurcation Registry Investigators
Subject entry: June 2014 ~ December 2015.