ΤΕΧΝΙΚΕΣ ΕΝΔΟΣΤΕΦΑΝΙΑΙΑΣ ΑΠΕΙΚΟΝΙΣΗΣ ΓΙΑ ΤΗΝ ΚΑΘΟΔΗΓΗΣΗ ΔΙΑΔΕΡΜΙΚΩΝ ΣΤΕΦΑΝΙΑΙΩΝ ΠΑΡΕΜΒΑΣΕΩΝ

Κωνσταντίνος Τριανταφύλλου

Επιμελητής Α΄ - Επεμβατικός Καρδιολόγος,

Α΄ Καρδιολογικό Τμήμα & Αιμοδυναμικό Εργαστήριο,

Γ.Ν.Α. «Ευαγγελισμός»

Δεν υπάρχει σύγκρουση συμφερόντων με τις Χορηγούς Εταιρείες:

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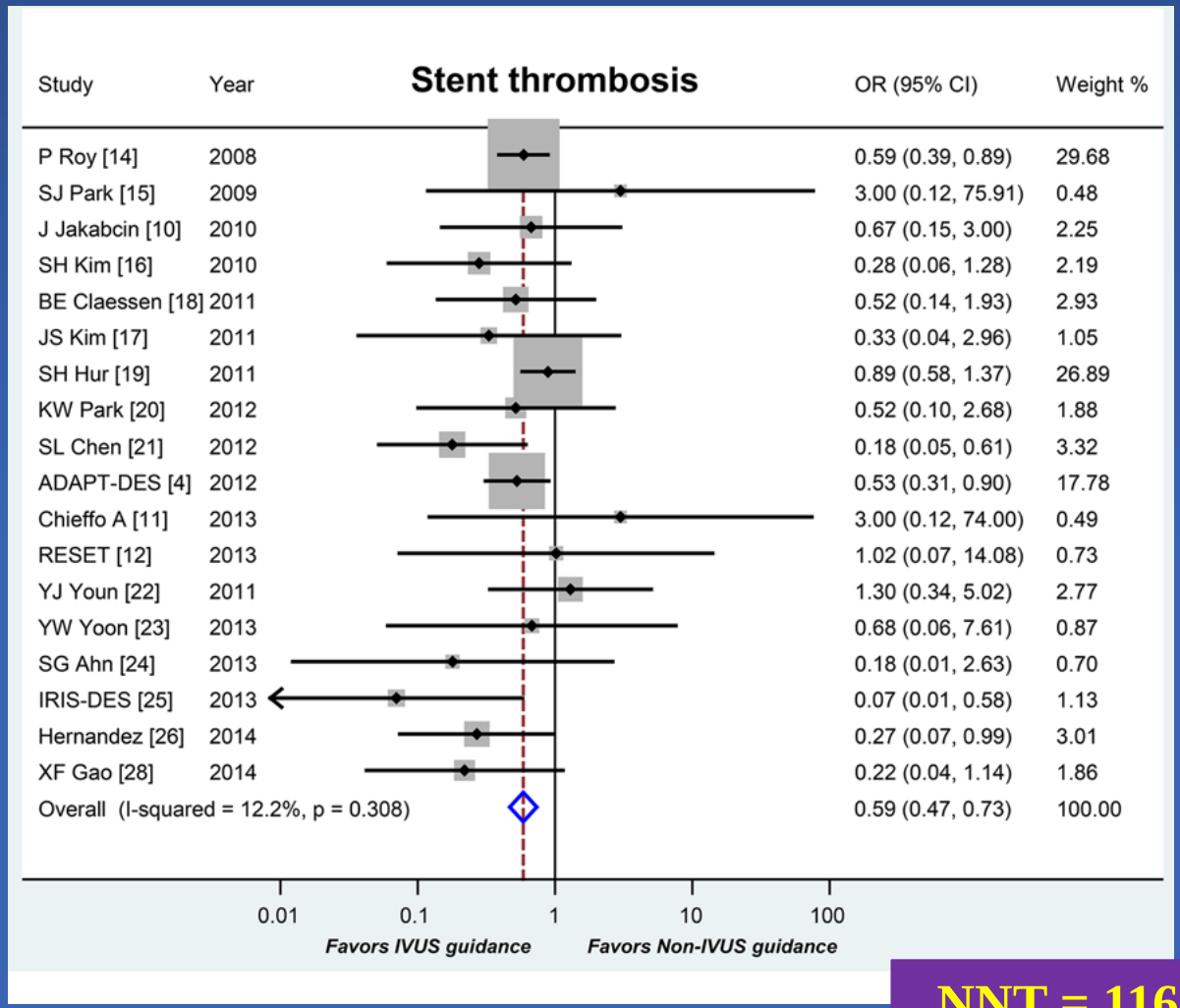
Comparison of IVUS guided versus angiography guided DES implantation: a systematic review and meta-analysis

Zhang YJ, et al.. BMC Cardiovasc Disord 2015;15:153.



NNT = 116

20 DES PCI studies M-A
20068 pts

IVUS vs angio- guidance

Death
HR 0.62 (0.54-0.71), p<0.001

MACE
HR 0.77 (0.71-0.83), p<0.001

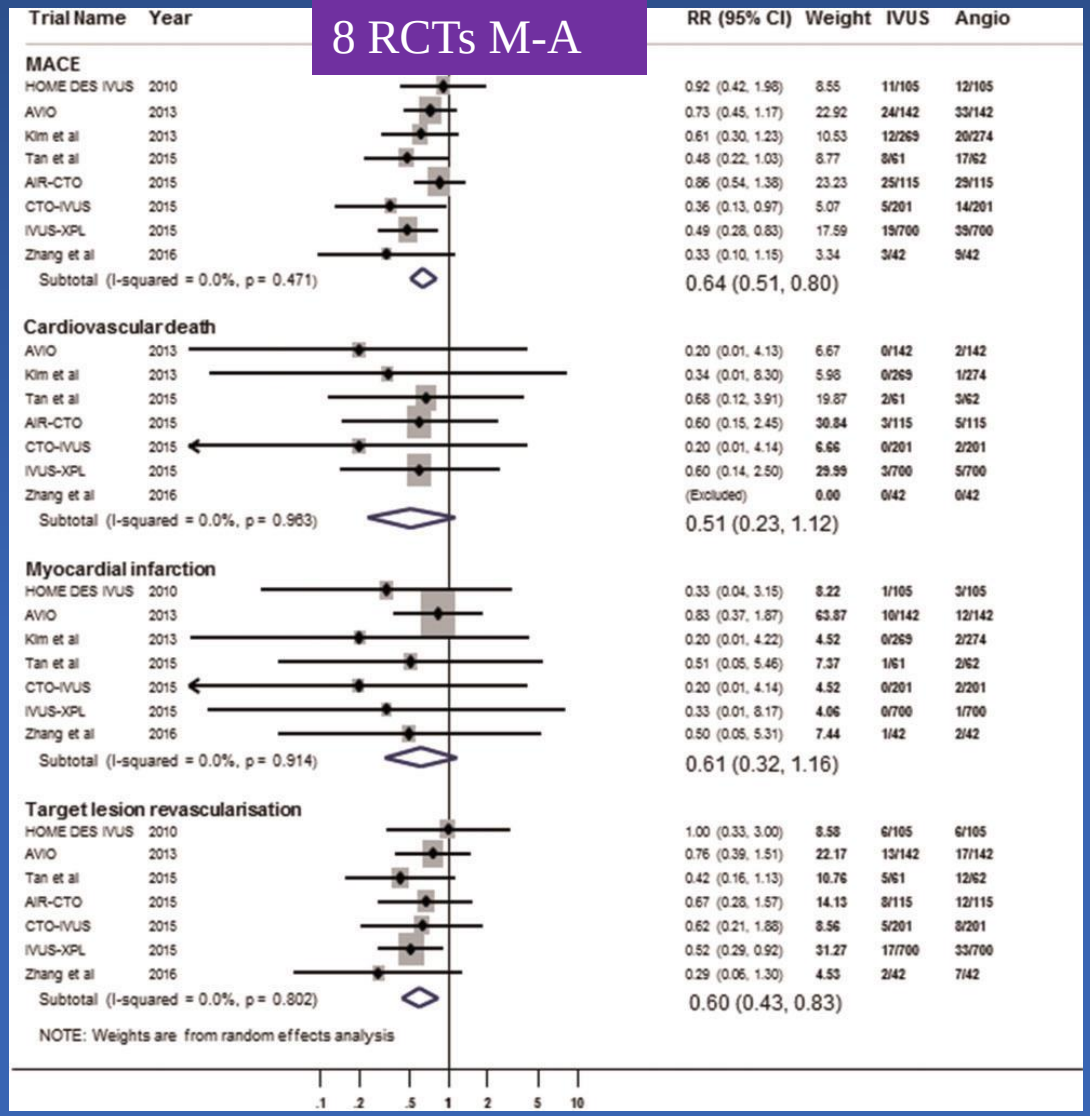
TVR
HR 0.82 (0.68-0.98), p=0.03

Stent thrombosis
HR 0.59 (0.47-0.73), p<0.001

Clinical use of intracoronary imaging. Part 1: guidance and optimization of coronary interventions. An expert consensus document of the European Association of Percutaneous Cardiovascular Interventions

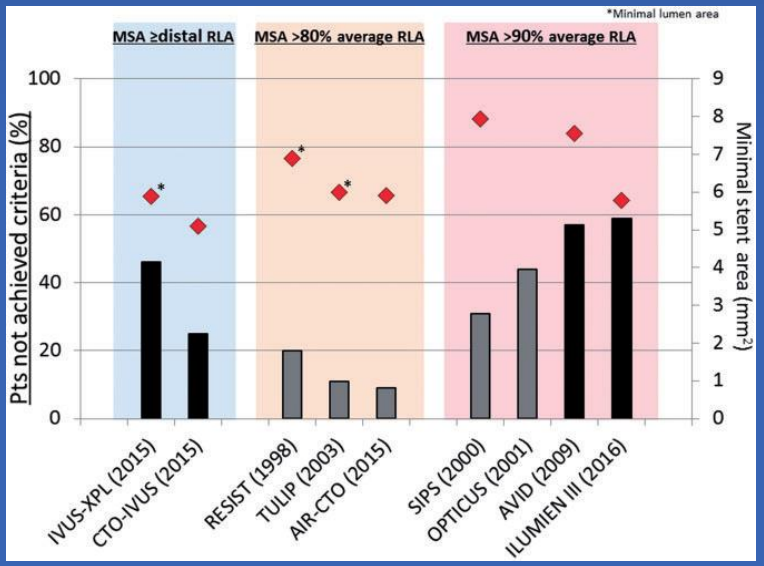
Raber L, et al. Eur Heart J 2018;39:3281-300.

8 RCTs M-A



IVUS vs. angio-guided PCI

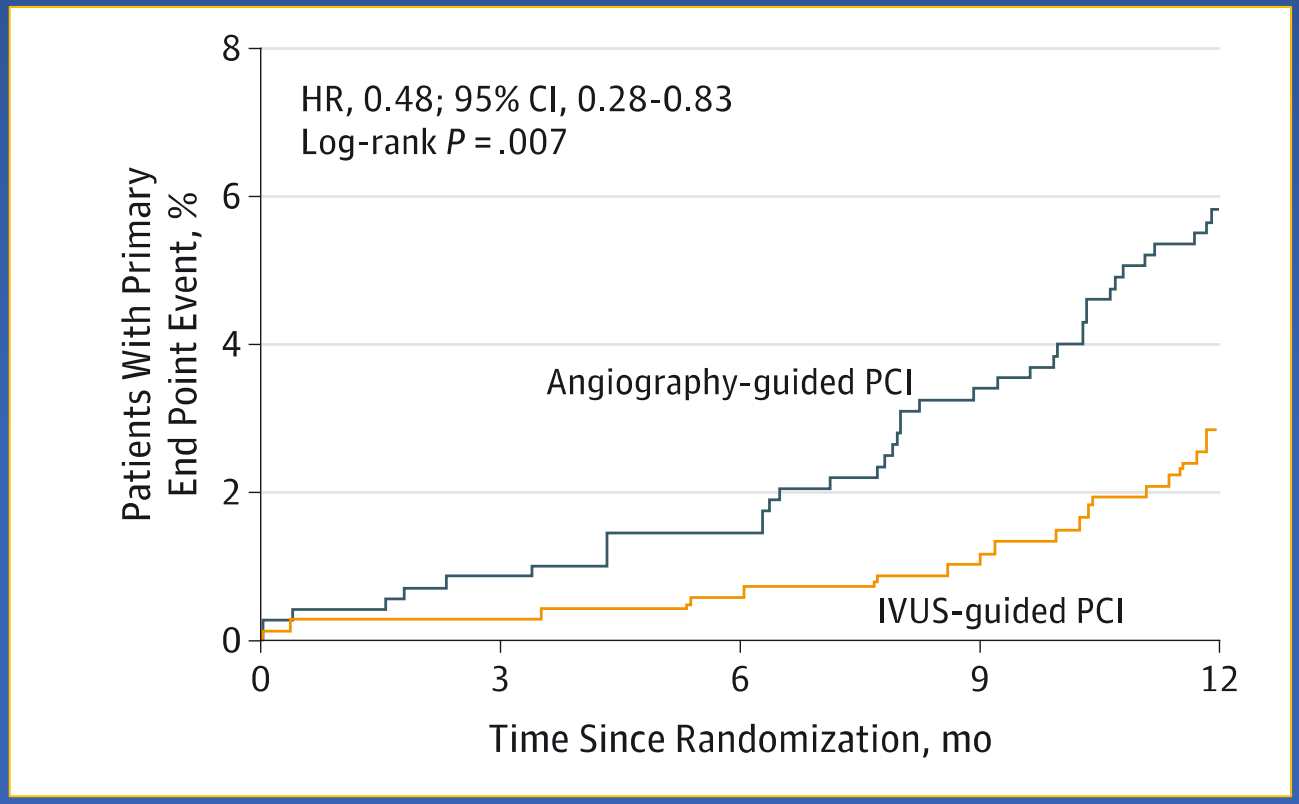
Better results despite DES optimization (target MSA)
was not obtained in numerous patients.



Effect of IVUS-Guided vs Angiography-Guided Everolimus-Eluting Stent Implantation: The IVUS-XPL RCT.

1400 patients with long coronary lesions (implanted stent ≥28 mm in length) : randomized 1:1

Endpoint at 1 year: TVF (Cardiac death, TL-R MI, TL-R revascularization)



Hong SJ, et al. JAMA 2015;314:2155-63.

IVUS-guided vs angiography-guided DES implantation in complex coronary lesions: Meta-analysis of randomized trials.

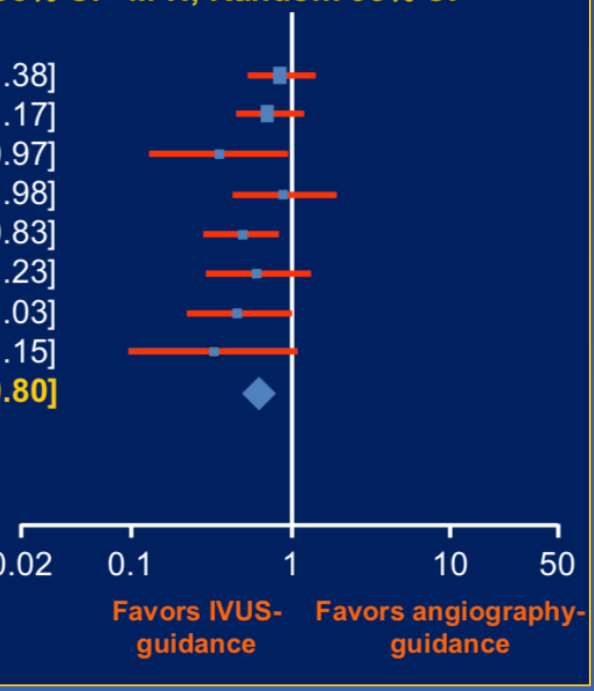
Bavishi C, et al. Am Heart J 2017;185:26-34.

8 trials , 3.276 patients, mean follow-up 1.5 ± 0.5 years

Study or Subgroup	IVUS guided PCI Events	Total	Angiography guided PCI Events	Total	Weight	Risk Ratio M-H, Random 95% CI
MACE						
AIR-CTO, 2015	25	115	29	115	23.2%	0.86 [0.54, 1.38]
AVIO, 2013	24	142	33	142	22.9%	0.73 [0.45, 1.17]
CTO-IVUS, 2015	5	201	14	201	5.1%	0.36 [0.13, 0.97]
HOME DES IVUS, 2010	11	105	12	105	8.5%	0.92 [0.42, 1.98]
IVUS-XPL, 2015	19	700	39	700	17.6%	0.49 [0.28, 0.83]
RESET, 2013	12	269	20	274	10.5%	0.61 [0.30, 1.23]
Tan et al, 2015	8	61	17	62	8.8%	0.48 [0.22, 1.03]
Zhang et al, 2016	3	42	9	42	3.3%	0.33 [0.10, 1.15]
Subtotal (95%)		**1635**		**1641**	**100.0%**	**0.64 [0.51, 0.80]**
Total events	107		173			

Heterogeneity: $Tau^2=0.00$; $Chi^2=6.67$, df=7 (P=0.46); $I^2=0\%$

Test for overall effect: Z=3.88, P=0.0001

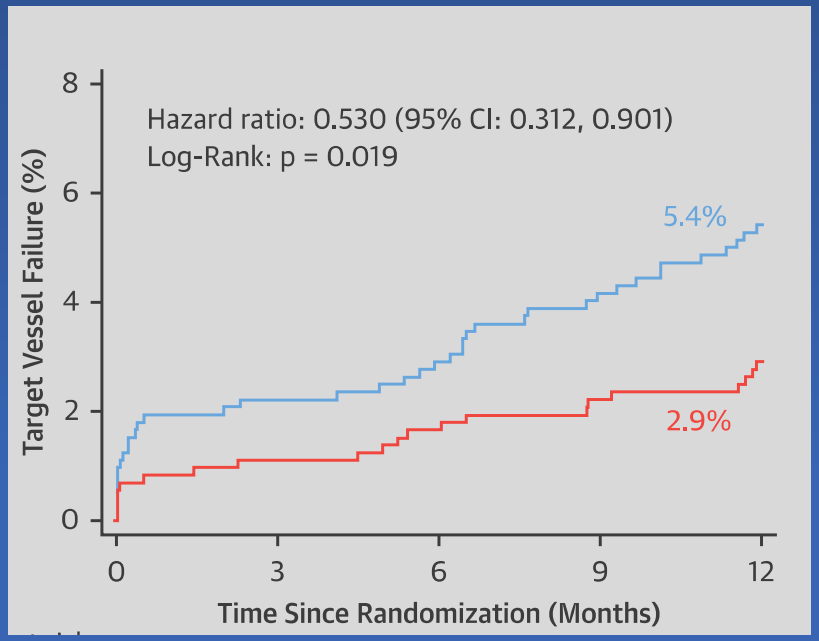


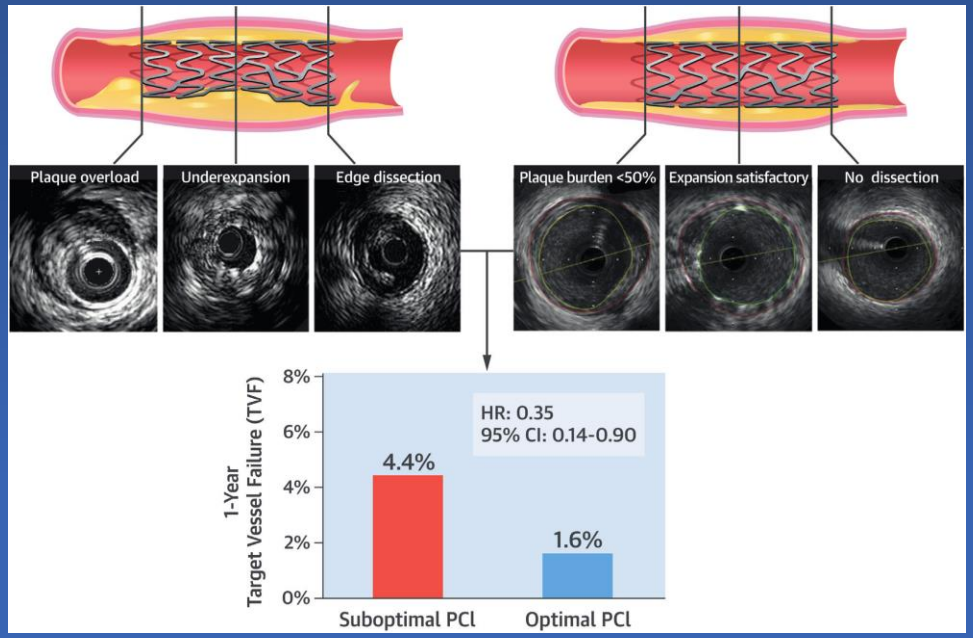
Long lesions, small vessels, >4 DES, bifurcations, CTOs, other complex lesions.

NNT = 37

IVUS Versus Angiography-Guided DES Implantation: The ULTIMATE Trial.

1.448 all-comer patients who required DES implantation were randomly assigned (1:1 ratio)



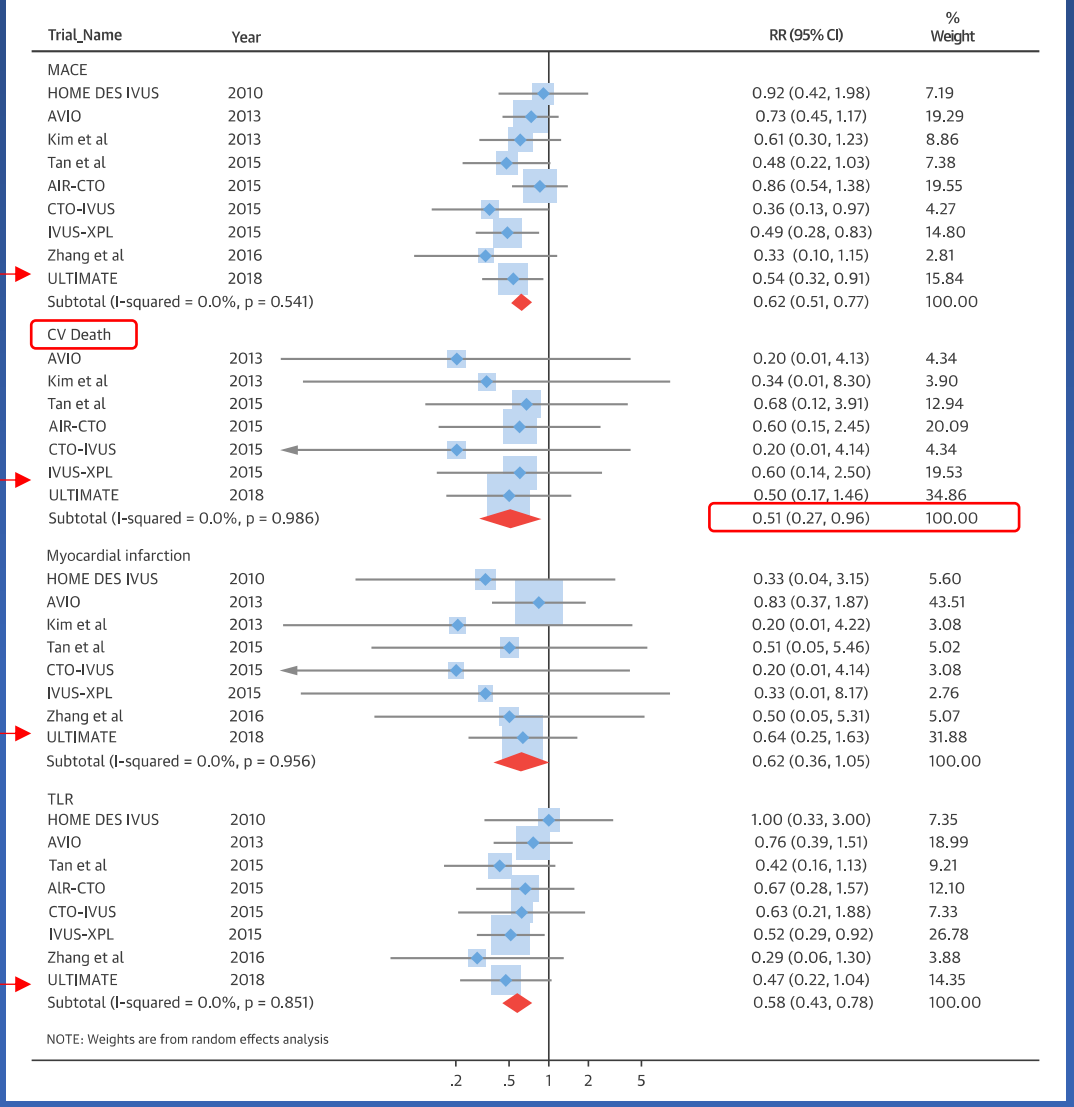


"IVUS-guided DES implantation significantly improved clinical outcome in all-comers, particularly for patients who had an IVUS-defined optimal procedure, compared with angiography guidance."

Zhang J, et al. J Am Coll Cardiol 2018;72:3126-37.

Clinical Benefit of IVUS Guidance for Coronary Stenting: The ULTIMATE Step Toward Definitive Evidence?

FIGURE 1 Forrest Plot Comparing IVUS-Guided With Angiography-Guided PCI With DES



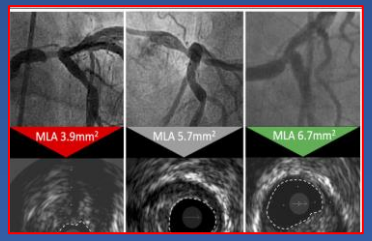
2 large RCTs with >1,000 patients both showed a reduction in MACE with IVUS guidance

di Mario C, et al. J Am Coll Cardiol 2018;72:3138-41.

PCI in LM CAD with or without IVUS: A meta-analysis.

10 studies (9 non-randomized & 1 randomized) , 6.480 pts

IVUS vs angio- guidance



All-cause death: RR 0.60 (95% CI) 0.47–0.75), p<0.001

Cardiac death : RR 0.47 (95% CI 0.33–0.66), p<0.001

TLR: RR 0.43 (95% CI 0.25–0.73), p = 0.002

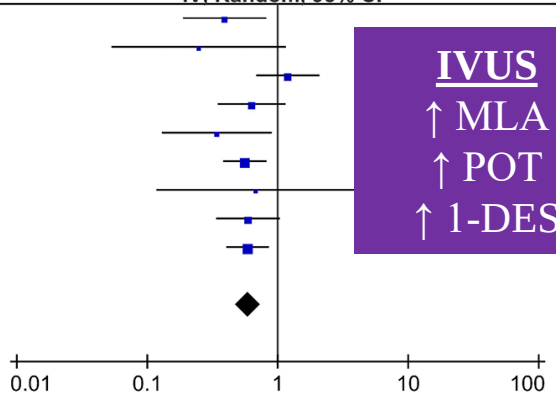
Stent thrombosis: RR 0.28 (95% CI 0.12–0.67), p = 0.004

A

Study or Subgroup	IVUS guided PCI Events	Total	Angiography guided PCI Events	Total	Weight	Risk Ratio IV, Random, 95% CI	Year
Park SJ, et al. 2009	9	145	23	145	8.3%	0.39 [0.19, 0.82]	2009
Kinoshita N, et al. 2010	2	228	8	226	2.1%	0.25 [0.05, 1.15]	2010
Jama A, et al.2011	18	111	25	184	13.1%	1.19 [0.68, 2.09]	2011
Narbute I, et al. 2012	13	294	47	671	11.7%	0.63 [0.35, 1.15]	2012
Park SH, et al. 2012	5	90	15	92	5.1%	0.34 [0.13, 0.90]	2012
De La Torre Hernandez JM, et al.2014	37	505	66	505	22.3%	0.56 [0.38, 0.82]	2014
Tan Q, et al. 2015	2	61	3	62	1.6%	0.68 [0.12, 3.91]	2015
Tang Y, et al. 2016	16	713	45	1186	12.9%	0.59 [0.34, 1.04]	2016
Andell P, et al. 2017	37	340	63	340	22.8%	0.59 [0.40, 0.86]	2016
Total (95% CI)		**2487**		**3411**	**100.0%**	**0.60 [0.47, 0.75]**	
Total events	139		295				

Heterogeneity: Tau² = 0.02; Chi² = 9.89, df = 8 (P = 0.27); I² = 19%

Test for overall effect: Z = 4.45 (P < 0.00001)



IVUS
↑ MLA
↑ POT
↑ 1-DES

Ye Y, et al. PLoS One 2017;12:e0179756.

OCT vs. angiography

Observational studies

OCT guidance was associated with a significantly lower risk of cardiac death or MI even at extensive multivariable analysis adjusting for baseline and procedural differences between the groups (OR=0.49 [0.25-0.96], p=0.037) and at propensity-score adjusted analyses (first ever, observational study).
Prati F, et al. EuroIntervention 2012;8:823-9.

An OCT-guided approach in primary PCI for STEMI reduced the number of stents used, number of patients treated with more than one stent, while there was no statistically significant difference in clinical endpoints while most of them were numerically lower, including stent thrombosis rates.
Iannaccone M, et al. Catheter Cardiovasc Interv 2017;90:E46-E52.

OCT-guided primary PCI for STEMI was associated with a larger final in-stent minimum lumen diameter. There was no significant difference in clinical outcomes at 1 year; however, the study was underpowered to detect a treatment effect.
Sheth TN, et al. Circ Cardiovasc Interv 2016;9:e003414.

ILUMIEN I study: Pre-stenting OCT imaging changed the PCI strategy more frequently (57%) compared with OCT imaging performed after stent implantation (27% of cases).
Wijns W,, et al.. Eur Heart J 2015;36:3346-55.

OCT vs. angiography (II)
RCTs without clinical outcomes

DOCTORS study: In patients with non-ST-segment elevation acute coronary syndromes, OCT-guided PCI is associated with higher post-procedure FFR than PCI guided by angiography alone.
Meneveau N, Circulation 2016;134:906-17.

OCTACS study: OCT-guided optimization of Nobori biolimus-eluting stent implantation improves strut coverage at 6-month follow-up in comparison with angiographic guidance alone (ACS pts).
Antonsen L, et al. Circ Cardiovasc Interv 2015;8:e002446.

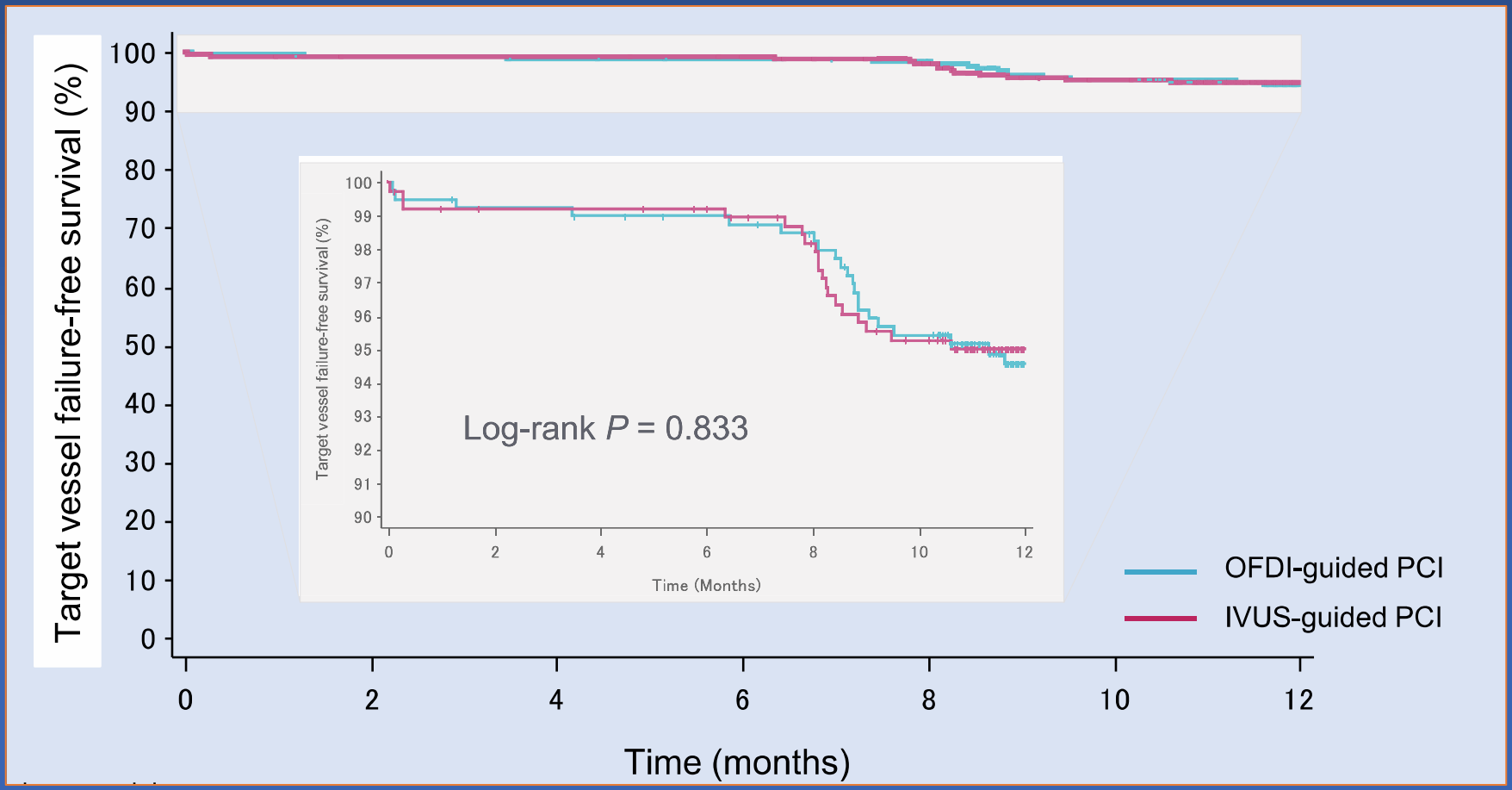
DETECT-OCT study: OCT-guided DES implantation improved early strut coverage compared with angiography-guided DES implantation (stable CAD pts)
Lee SY, et al. JACC Cardiovasc Imaging 2018;11:1810-9.

ILUMIEN III study: OCT-guided PCI using a specific reference segment external elastic lamina-based stent optimisation strategy was safe and resulted in similar minimum stent area (MSA) to that of IVUS-guided PCI. OCT was not found to be superior to angiography with respect to MSA but led to significantly improved minimum and mean stent expansion and fewer untreated dissections and persisting major malapposition compared with the IVUS and angiography groups.
Ali ZA, et al. Lancet 2016;388:2618-28.

ILUMIEN IV / OCTOBER : Ongoing RCTs

OCT vs. IVUS-guided PCI

OPINION RCT (829 pts) – Clinical endpoints



Kubo T, et al. Eur Heart J 2017;38:3139-47.

Clinical Outcomes Following Intravascular Imaging-Guided Versus Coronary Angiography-Guided PCI With Stent Implantation: A Systematic Review and Bayesian Network Meta-Analysis of 31 Studies and 17,882 Patients.

PCI guidance using either IVUS or OCT was associated with a significant reduction of :

- MACE: OR: 0.79 (95% CI: 0.67 to 0.91) and OR: 0.68 (95% CI: 0.49 to 0.97), respectively.

- Cardiovascular death: OR: 0.47 (95% CI: 0.32 to 0.66) & OR: 0.31 (95% CI: 0.13 to 0.66), respectively.

No differences in terms of comparative clinical efficacy were found between IVUS and OCT for all the investigated outcomes.

Buccheri S, et al. JACC Cardiovasc Interv 2017;10:2488-98.

IVUS /OCT for PCI guidance and optimization

Advantages - Disadvantages

IVUS

Advantages

- Extensive clinical experience → IVUS has been used clinically for almost three decades
- Pre-intervention imaging is possible in most patients without pre-dilation
- Penetration to the adventitia allows mid-wall or true vessel stent sizing
- Extensive research regarding impact of IVUS guidance of the procedural result as well as clinical outcomes
- IVUS predictors of restenosis are well established
- Better guidance for CTO techniques (e.g. wire re-entry)

Disadvantages

- Images can be difficult to interpret
- Tissue characterization is limited
- Thrombus detection is challenging
- Assessment of stent-strut tissue coverage not possible (low resolution)
- Assessment of strut malapposition is limited
- Low-resolution of the longitudinal view

OCT

Advantages

- 10× higher resolution compared with IVUS → OCT can detect fine details which are missed by IVUS (edge dissections, tissue coverage of stent struts, and malapposition that is below the resolution of IVUS)
- Better tissue characterization (calcium)
- Better suited for thrombus detection
- Images are clearer and easier to interpret
- OCT predictors of restenosis and stent thrombosis are well established
- More user friendly due to rapid availability of reliable automatic analyses (i.e. accurate lumen profile)

Disadvantages

- Additional contrast
- Flushing is necessary to clear the lumen of blood to visualize the vessel wall
- Pre-dilation may be necessary pre-intervention to allow blood to be flushed from the lumen
- Limited penetration of OCT
- Compared with IVUS, there is limited research evidence on OCT-guided vs. angiography-guided PCI with respect to surrogate endpoints and no RCT powered for clinical outcomes

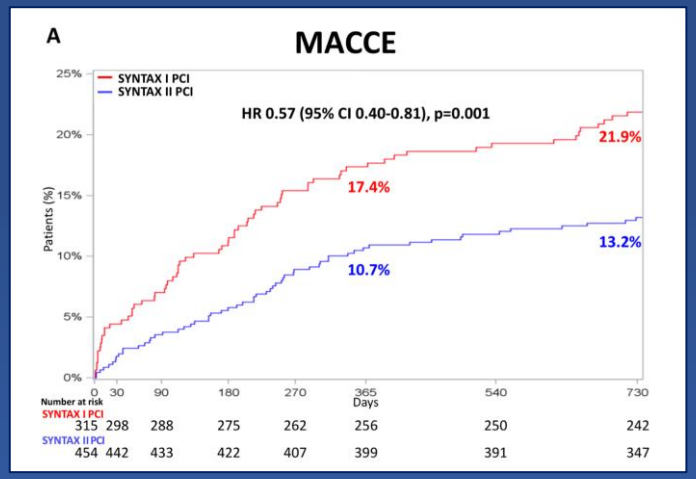
Raber L, et al. Eur Heart J 2018;39:3281-300.

BEST PRACTICE PCI

Components of "best practice" PCI based on SYNTAX II registry protocol in

1.	Calculation of SYNTAX II score for inclusion based on calculated equipoise between PCI and CABG.
2.	Targeted PCI based on physiology and anatomy using combined resting and hyperaemic indices of stenosis significance.
3.	Use of intracoronary imaging for complex procedures (intravascular ultrasound [IVUS]).
4.	PCI of chronic total coronary occlusion for complete revascularisation.
5.	Use of current-generation DES.
6.	Optimal medical care including statin treatment at discharge.

Serruys PW, et al. EuroIntervention 2019 (Epub ahead of print).



Contemporary "best practice" PCI results at 2 years (when compared to matched historical subgroups from the SYNTAX I randomized trial):

1. **Non-inferior to CABG :**

13.2% vs. 15.1% MACCE

(p=0.42).

2. **Superior to "historical" PCI:**

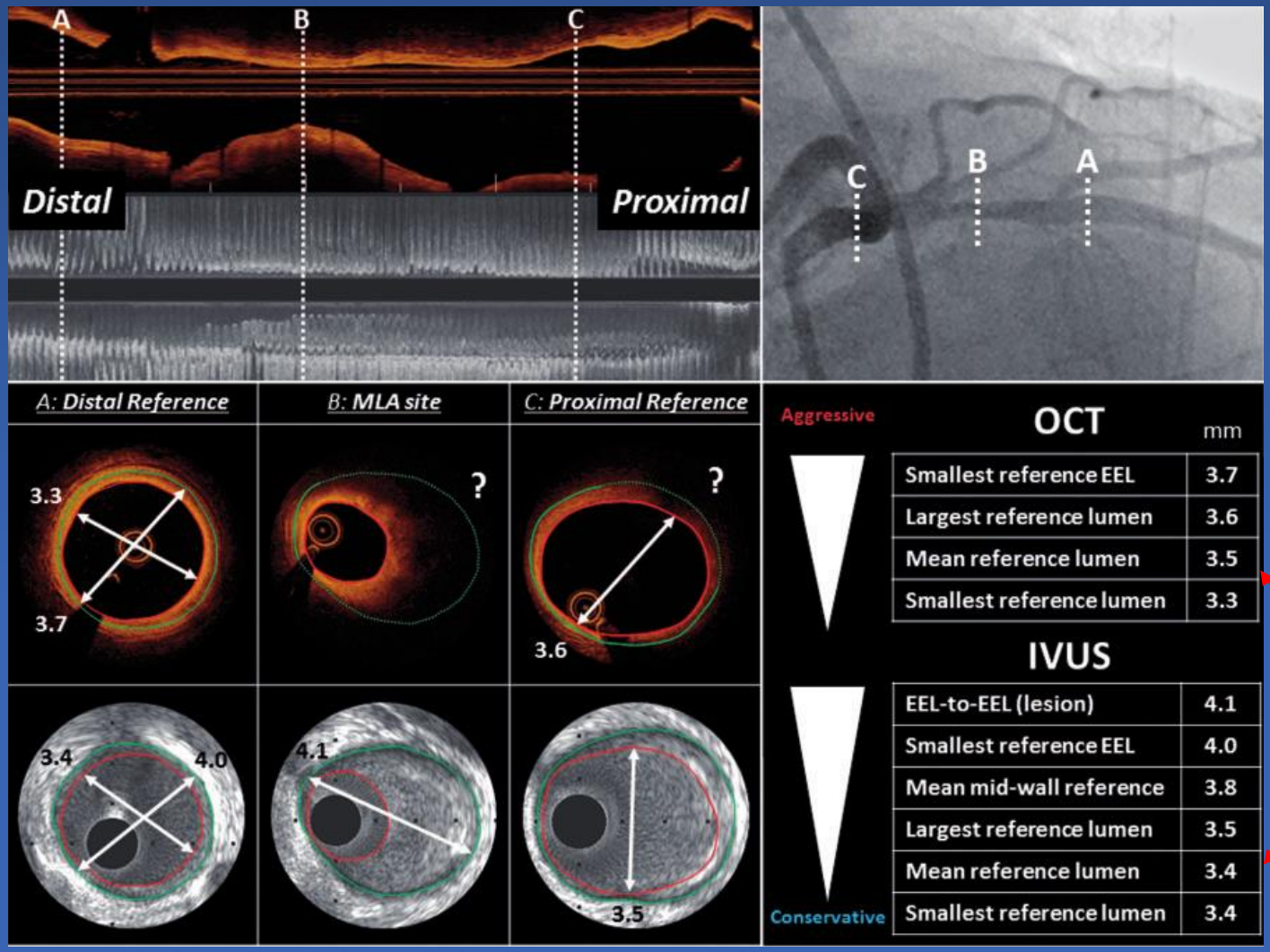
13.2% vs. 21.9% (p=0.001).

IVUS / OCT guided PCI

Systematic approach necessary

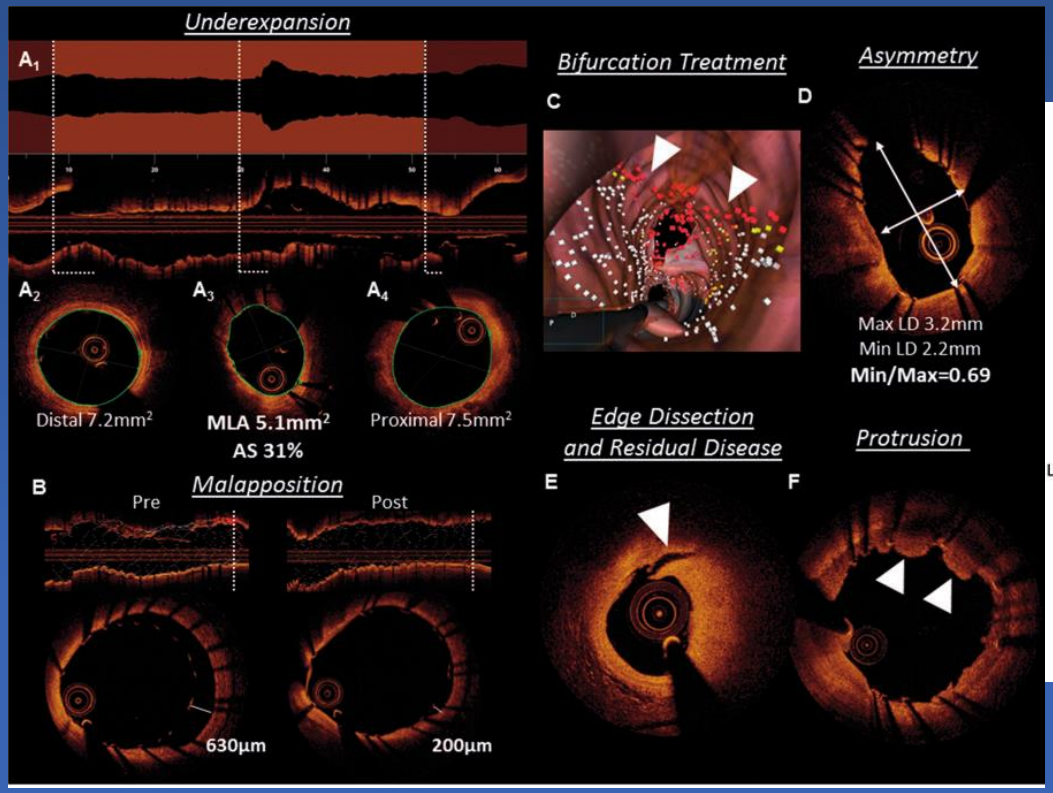
Assessment before PCI	- Proximal / distal reference - Lesion composition & length (preparation) - Choose stent size
DES implantation	- Normal to normal - Check expansion (MSA), apposition
Detect & solve possible complications	- Underexpansion - Malapposition - Tissue protrusion - Edge dissection - Residual disease

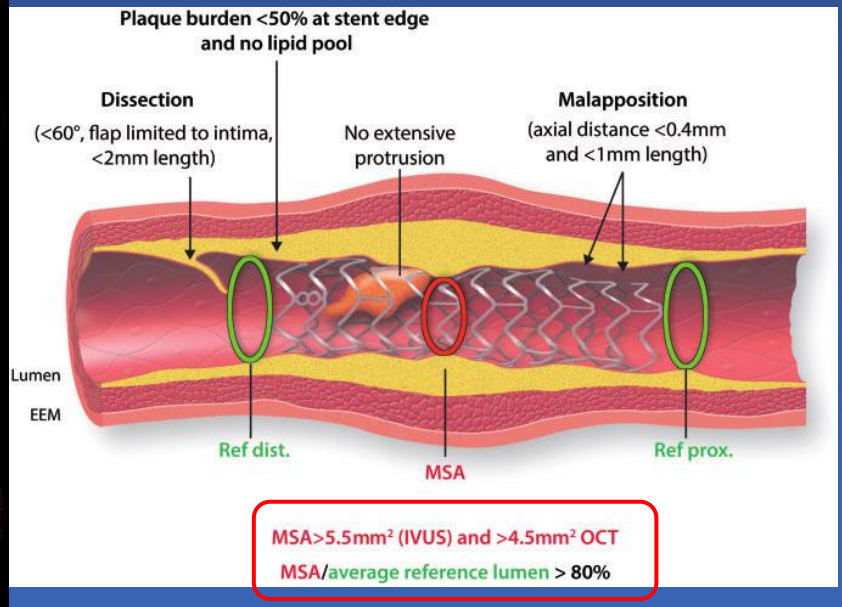
IVUS and OCT-based stent sizing approaches.



Raber L, et al. Eur Heart J 2018;39:3281-300.

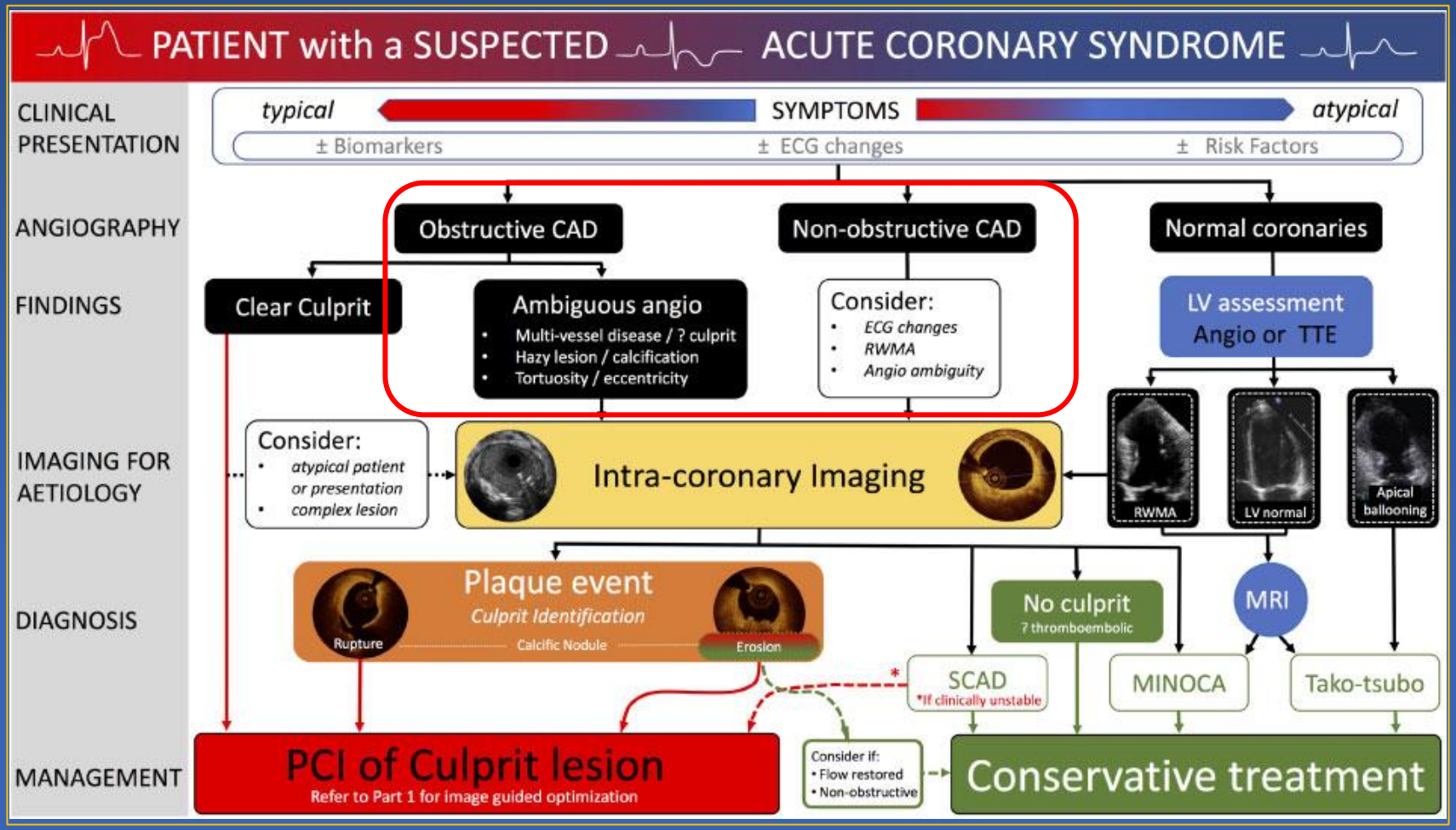
Targets for intracoronary imaging-guided PCI





Raber L, et al. Eur Heart J 2018;39:3281-300.

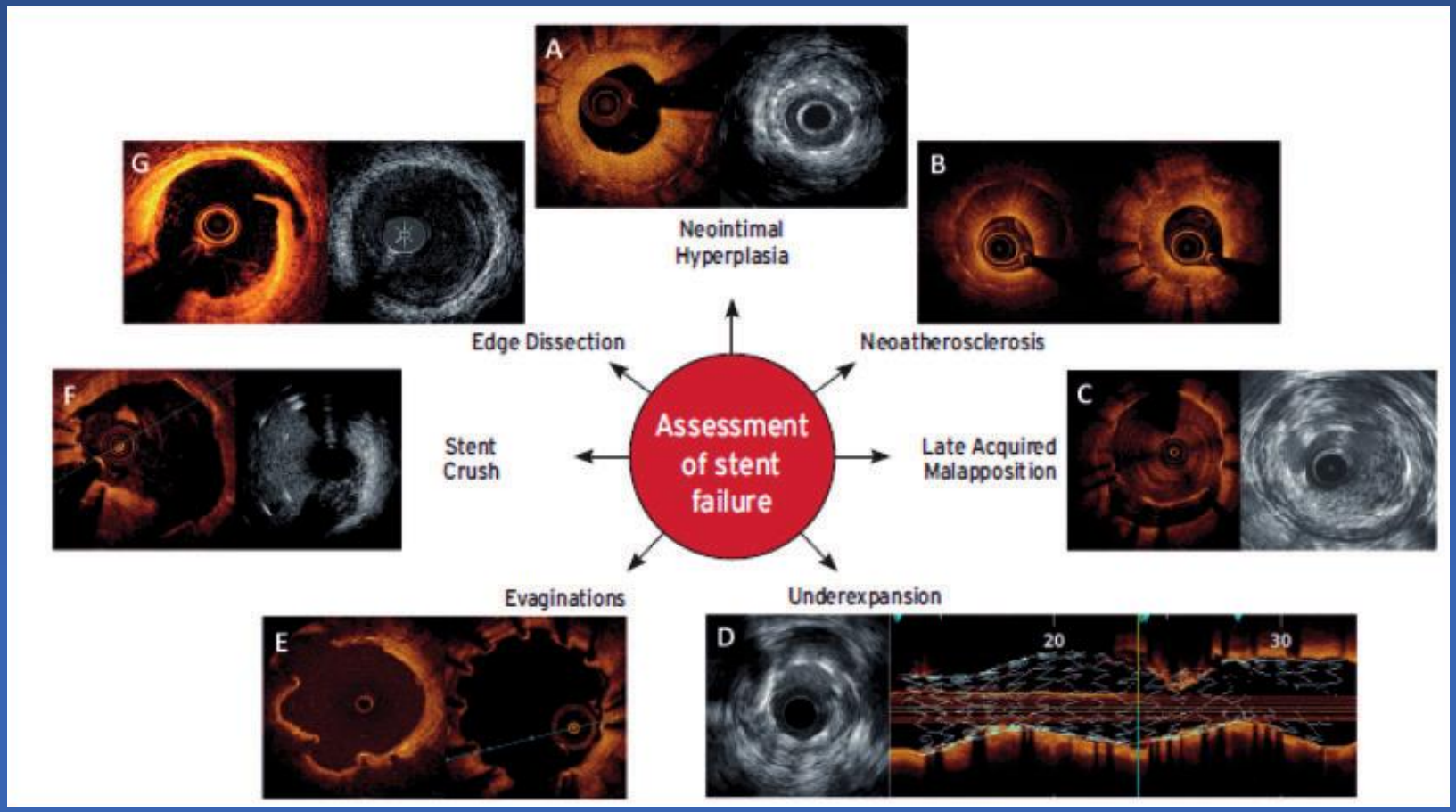
A treatment algorithm to guide the use of intravascular imaging in patients presenting with acute coronary syndromes.



Johnson TW, et al. Eur Heart J 2019.

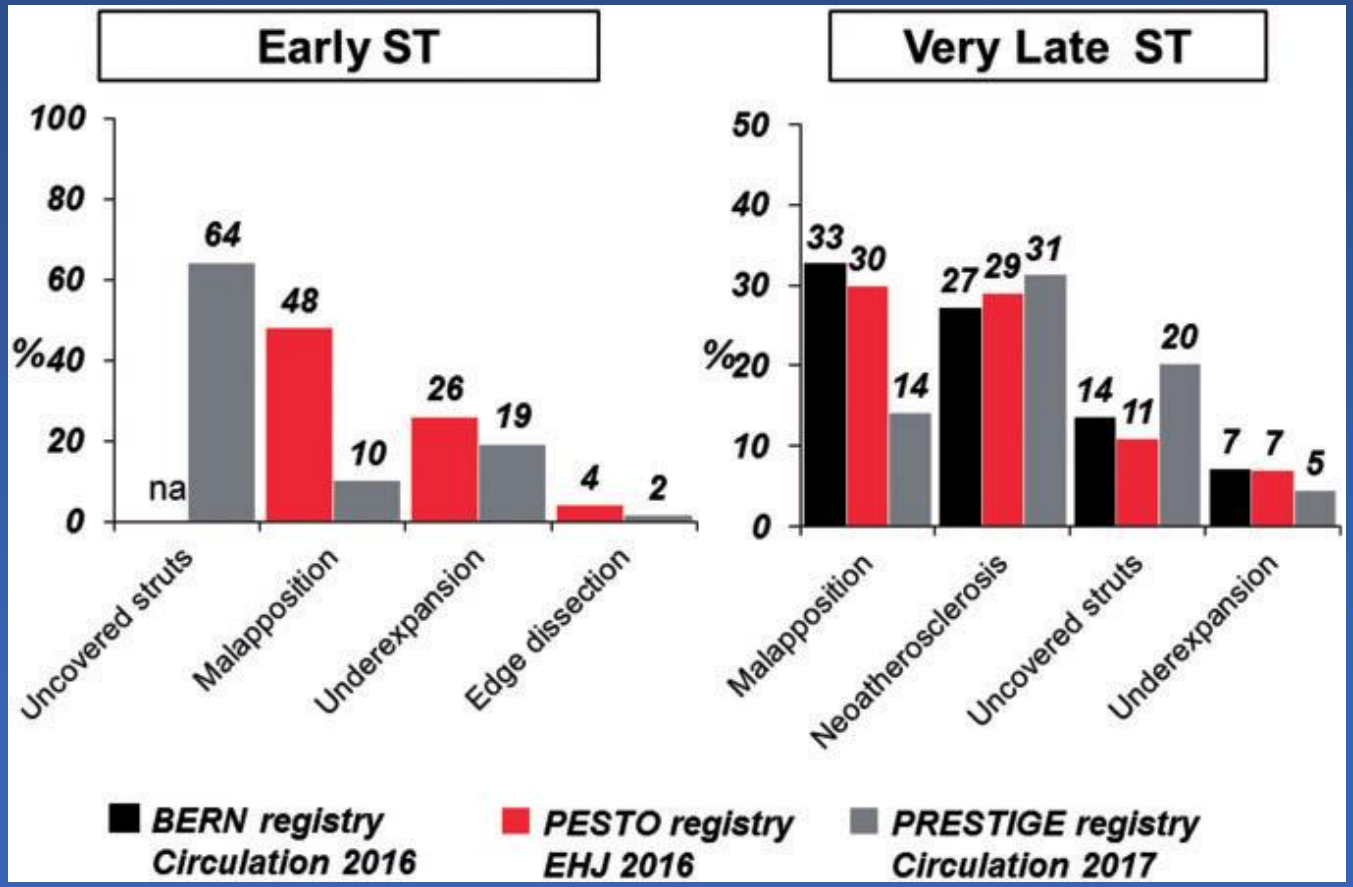
SOS

Intracoronary imaging for the assessment of stent failure.



Neumann FJ, et al. 2018
ESC/EACTS Guidelines on myocardial revascularization.
Eur Heart J 2019;40:87-165.

Frequency of presumable causes of early and very late DES thrombosis as assessed in three OCT registries.

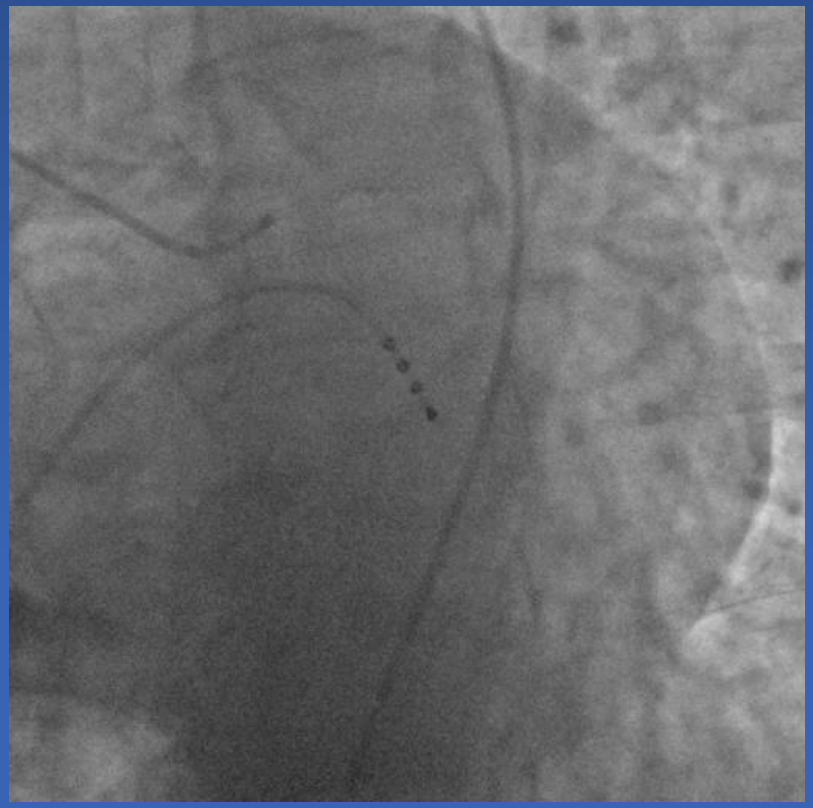


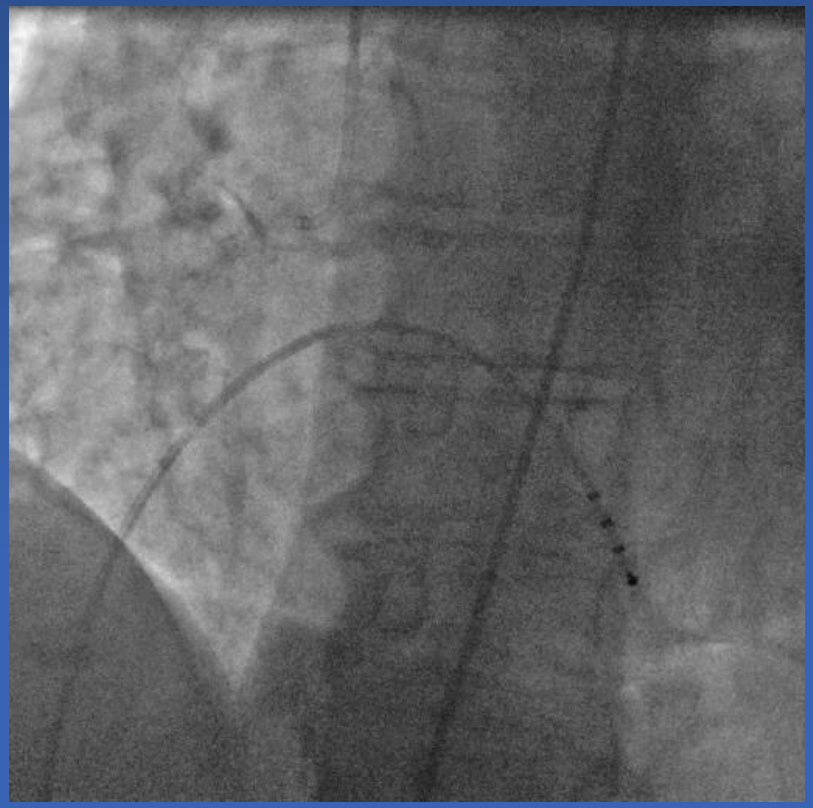
Adriaenssens T, J, et al. Circulation 2017;136:1007-21.

Souteyrand G, et al. Eur Heart J 2016;37:1208-16.

Taniwaki M, et al. Circulation 2016;133:650-60.

Subacute stent thrombosis case – Inferior STEMI

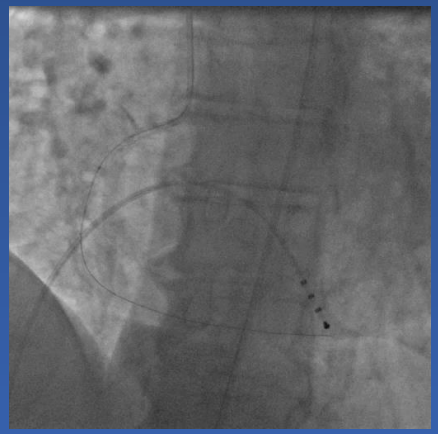


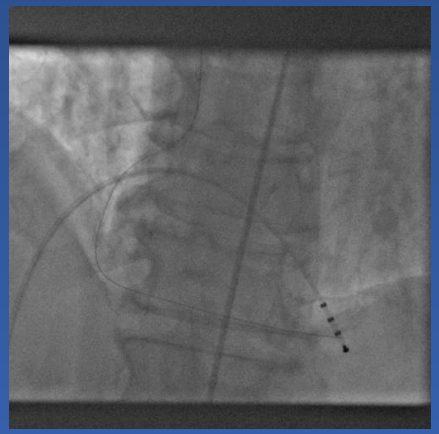


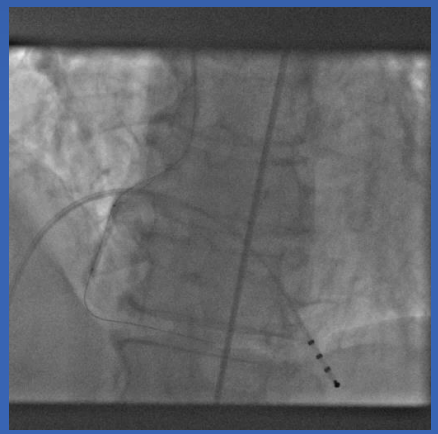
Primary PCI

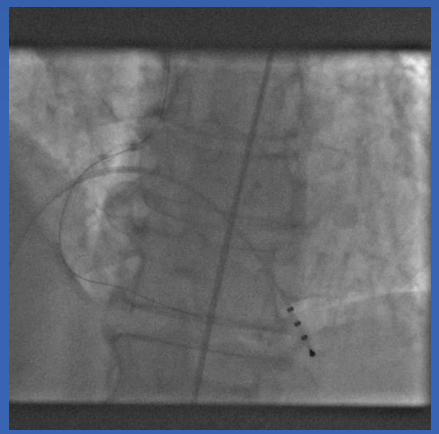
After loading dose of ticagrelor 180mg & under UFH and tirofiban.

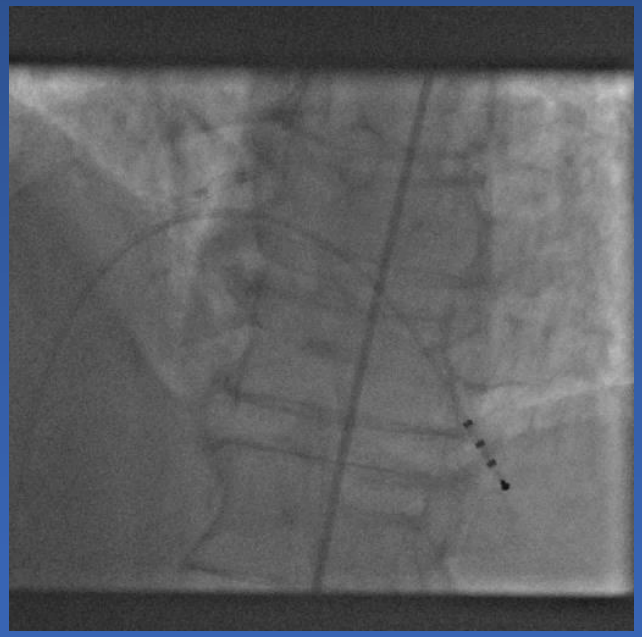
GC JR4 6 Fr











Antithrombotic treatment after PCI :

Aspirin
Ticagrelor
Tirofiban (48 hours)
Enoxaparin (5 days)

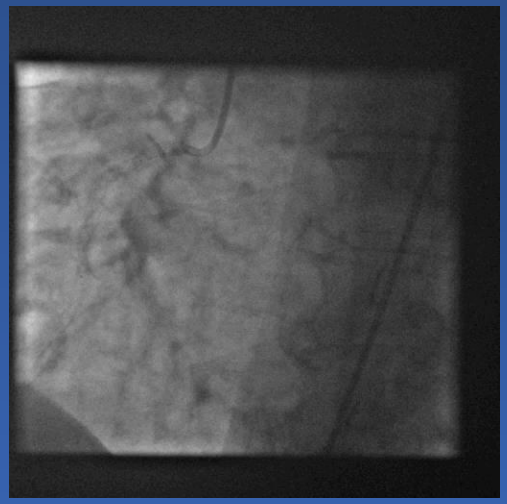
A new coronary angiography with OCT was scheduled in 6 days.

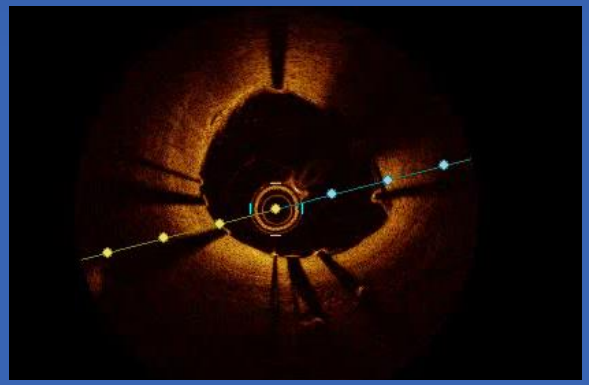
The patient remained symptom free and without complications until then.

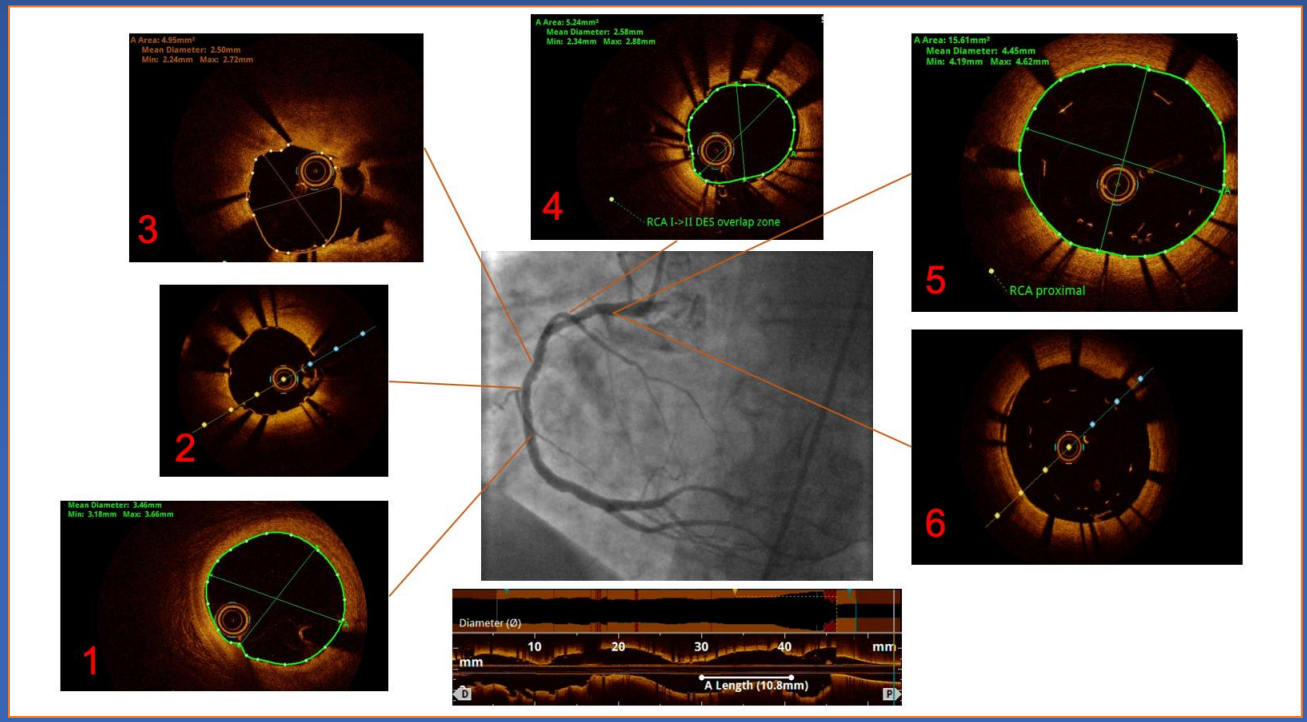
Hs TnI peaked at 10000 pg/ml at 24 hours and progressively declined afterwards.

Revision PCI under OCT guidance (I)

6 days after the primary PCI (right femoral approach)

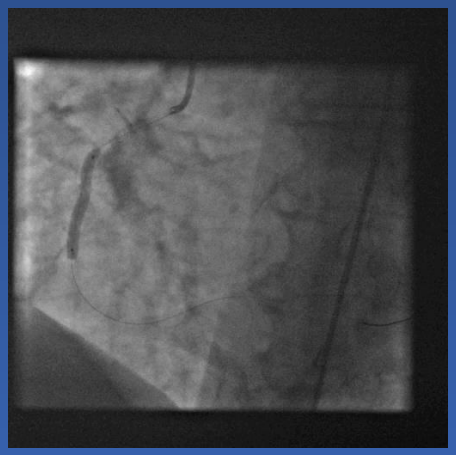


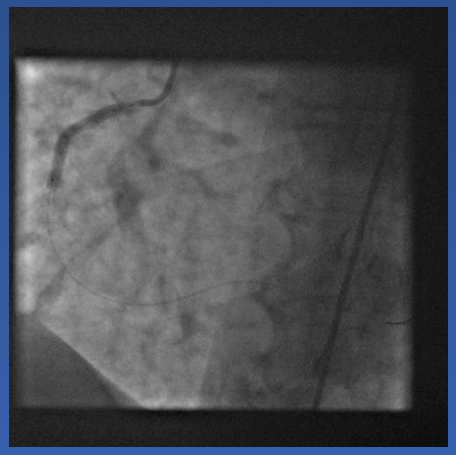


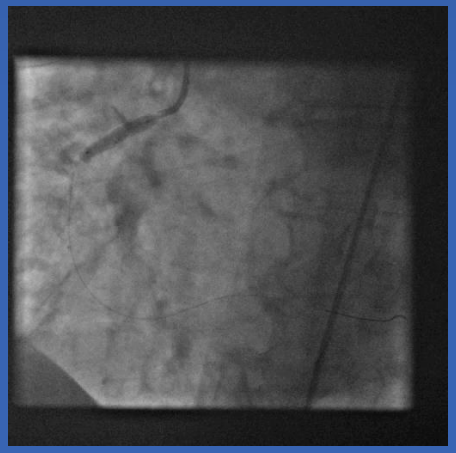


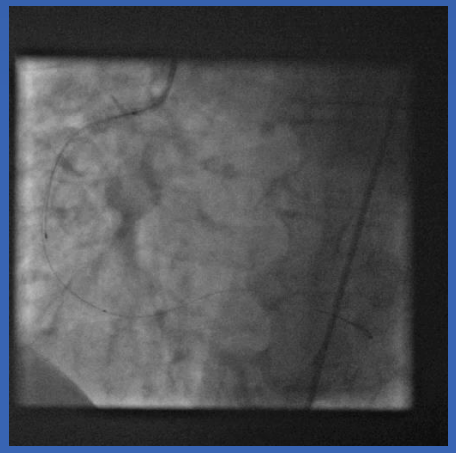
Revision PCI under OCT guidance (II)

(NC balloons 3.5x30mm & 4.5x21mm)





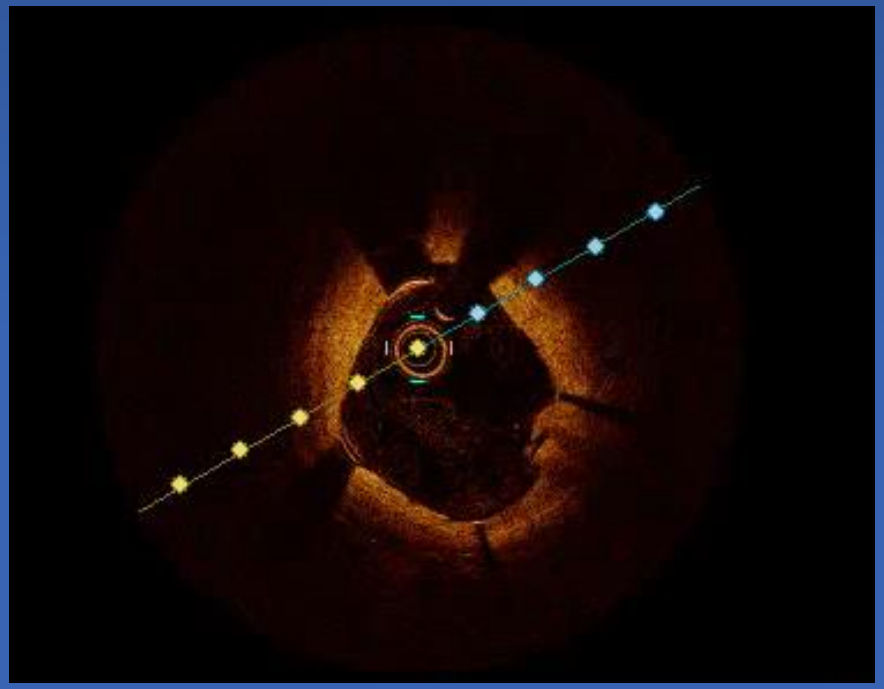




Previous DES expansion limits:

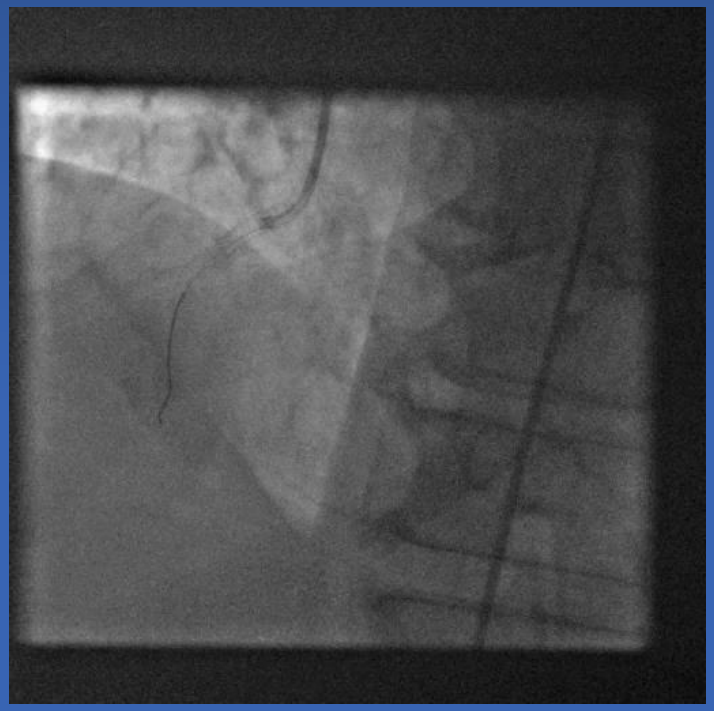
3x38mm → diameter max 3.85mm

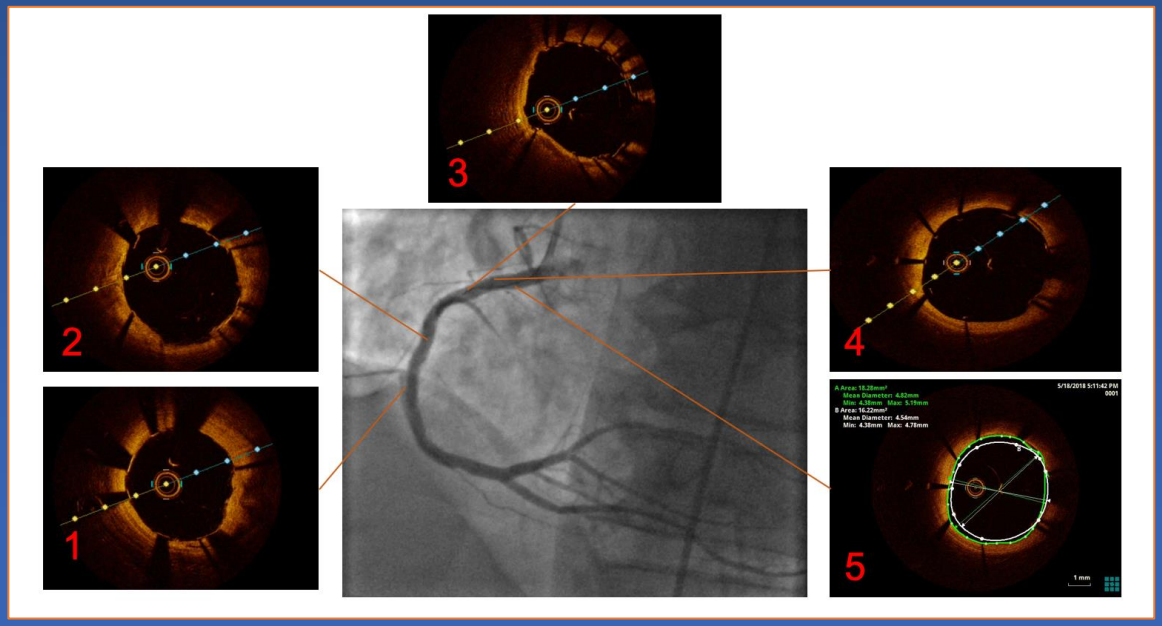
3.5x12mm → diameter max 4.75mm



Revision PCI under OCT guidance (III)

Final result





Clinical outcome:

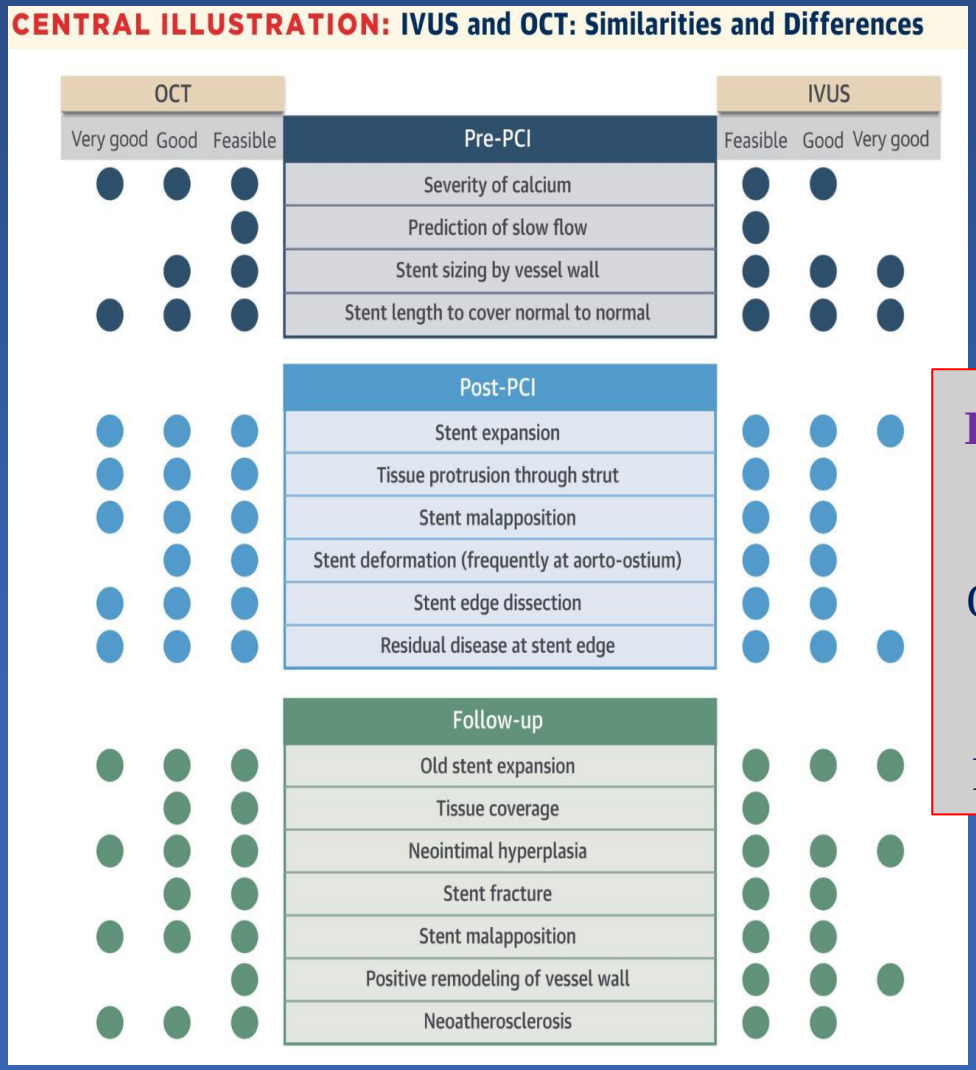
The patient was discharged without complications the following day. There was no adverse event during the initial follow-up at 6 months.

Intracoronary imaging in Revascularization guidelines

IVUS should be considered to assess the severity of unprotected left main lesions	IIa	B
IVUS and/or OCT should be considered to detect stent-related mechanical problems leading to restenosis.	IIa	C
IVUS or OCT should be considered in selected patients to optimize stent implantation	IIa	B
IVUS should be considered to optimize treatment of unprotected left main lesions	IIa	B

Neumann FJ, et al. 2018
ESC/EACTS Guidelines on myocardial revascularization.
Eur Heart J 2019;40:87-165.

IVUS-Guided Versus OCT-Guided Coronary Stent Implantation: A Critical Appraisal.



IVUS better:

Left main

Ostial lesions

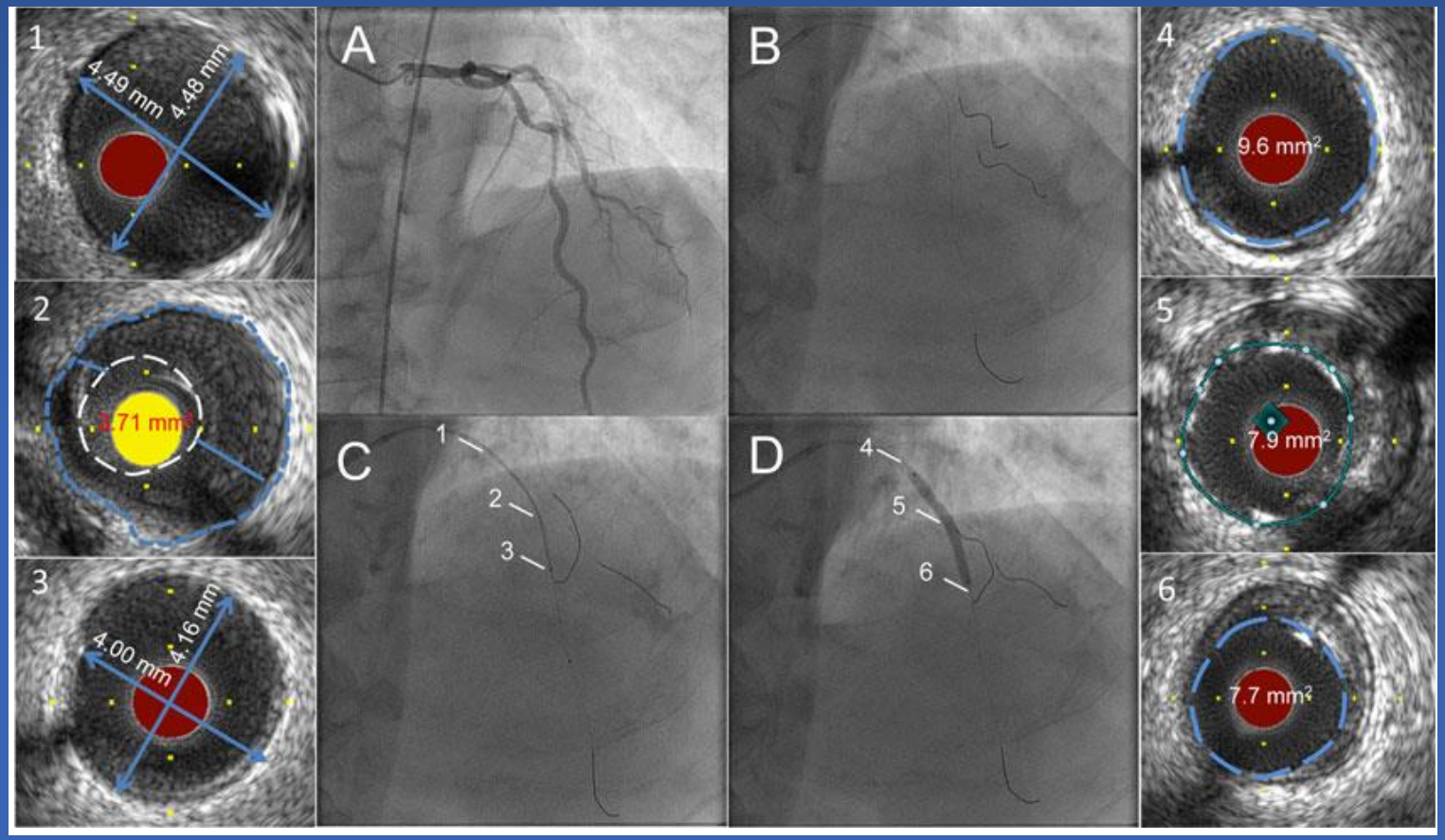
CTO

Renal failure

Maehara A, et al. JACC Cardiovasc Imaging 2017;10:1487-503.

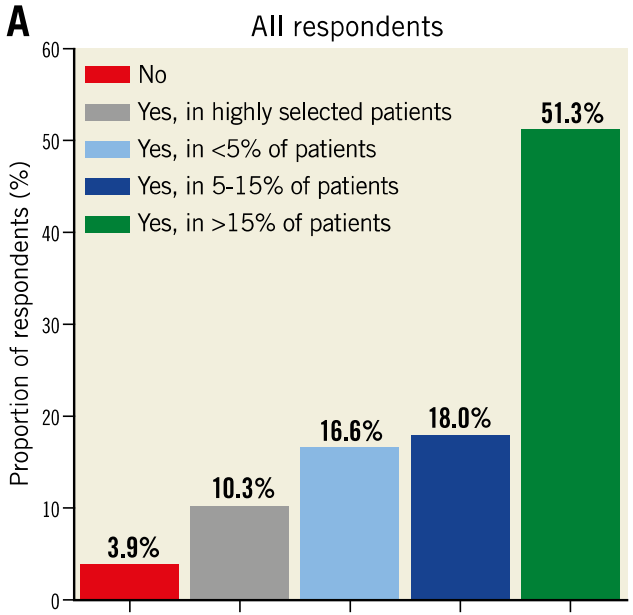
Imaging- and physiology-guided percutaneous coronary intervention without contrast administration in advanced renal failure: a feasibility, safety, and outcome study

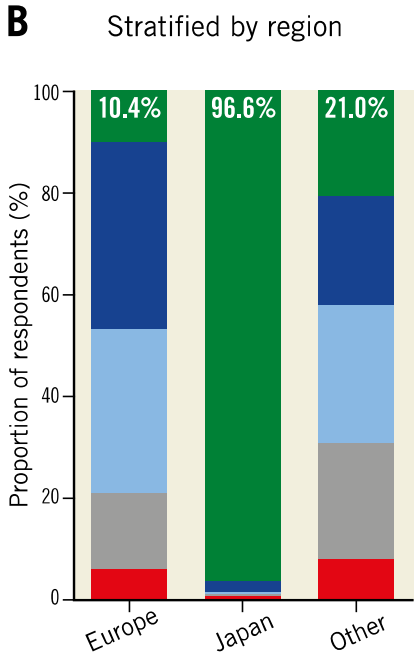
Ziad A. Ali[1,2*], Keyvan Karimi Galougahi[1], Tamim Nazif[1,2], Akiko Maehara[1,2], Mark A. Hardy[3], David J. Cohen[4], Lloyd E. Ratner[3], Michael B. Collins[1,2], Jeffrey W. Moses[1,2], Ajay J. Kirtane[1,2], Gregg W. Stone[1,2], Dimitri Karmpaliotis[1,2], and Martin B. Leon[1,2]

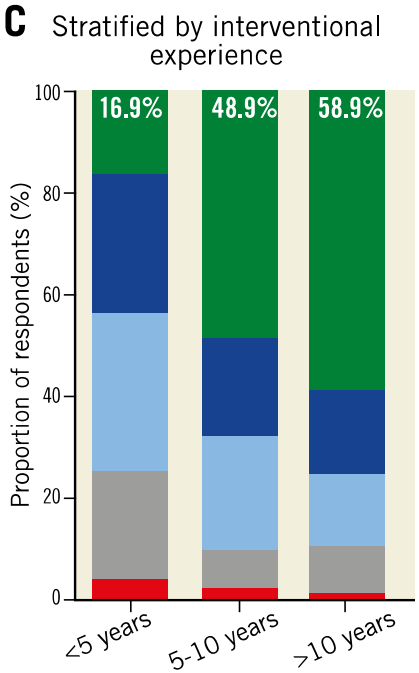


Eur Heart J 2016;37:3090-5.

Current use of intracoronary imaging in interventional practice – Results of a European Association of Percutaneous Cardiovascular Interventions (EAPCI) and Japanese Association of Cardiovascular Interventions and Therapeutics (CVIT) Clinical Practice Survey

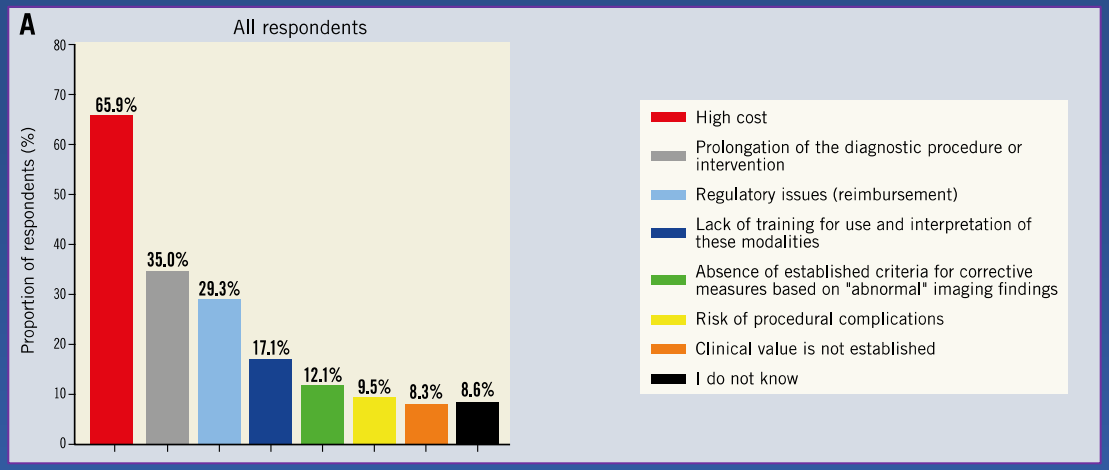






Koskinas KC, et al. EuroIntervention 2018;14:e475-e84.

Potential limitations of intracoronary imaging



Koskinas KC, et al. EuroIntervention 2018;14:e475-e84.

Cost

Time

No reimbursement

No availability

No standardized training → No confidence for interpretation

Deliverability problems in complex lesion subsets – Risk of complications

Recommendations on the adjunctive use of intravascular imaging for diagnostic evaluation of CAD, guidance and optimization of PCIs

- **Diagnostic assessment of coronary lesions**

Consensus opinion

Angiographically unclear/ambiguous findings (e.g. dissection, thrombus, calcified nodule)

Assessment of left main stenosis

Complex bifurcation lesions

Suspected culprit lesion of ACS

- **PCI guidance and optimization**

RCT evidence

Long lesions

Chronic total occlusions

Consensus opinion

Patients with acute coronary syndromes

Left main coronary artery lesions

Two stents bifurcation

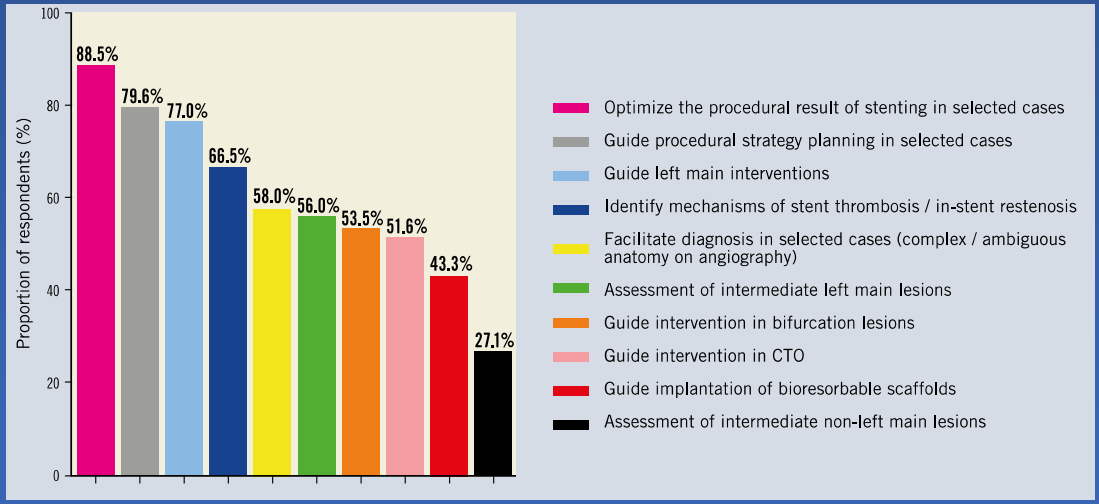
Implantation of bioresorbable scaffolds

Patients with renal dysfunction (IVUS)

- **Identification of mechanism of stent failure**

Restenosis

Stent thrombosis



Koskinas KC, et al. EuroIntervention 2018;14:e475-e84.

Raber L, et al. Eur Heart J 2018;39:3281-300.


ANGIO
*
IVUS
*
OCT


Thank you for your attention!