TCTAP2017
Inspire the Next Generation
Transcatheter Valve Therapies
Left Main and Bifurcation
IVUS & FFR
April 25-27
COEX, Seoul, Korea

OCT-Guided PCI to Improve Patient Outcomes Are we There Yet?

Evelyn Regar
Heart Center
University Hospital Zürich
Zürich, Switzerland

UniversitätsSpital Zürich

Disclosure

No conflict of interest.

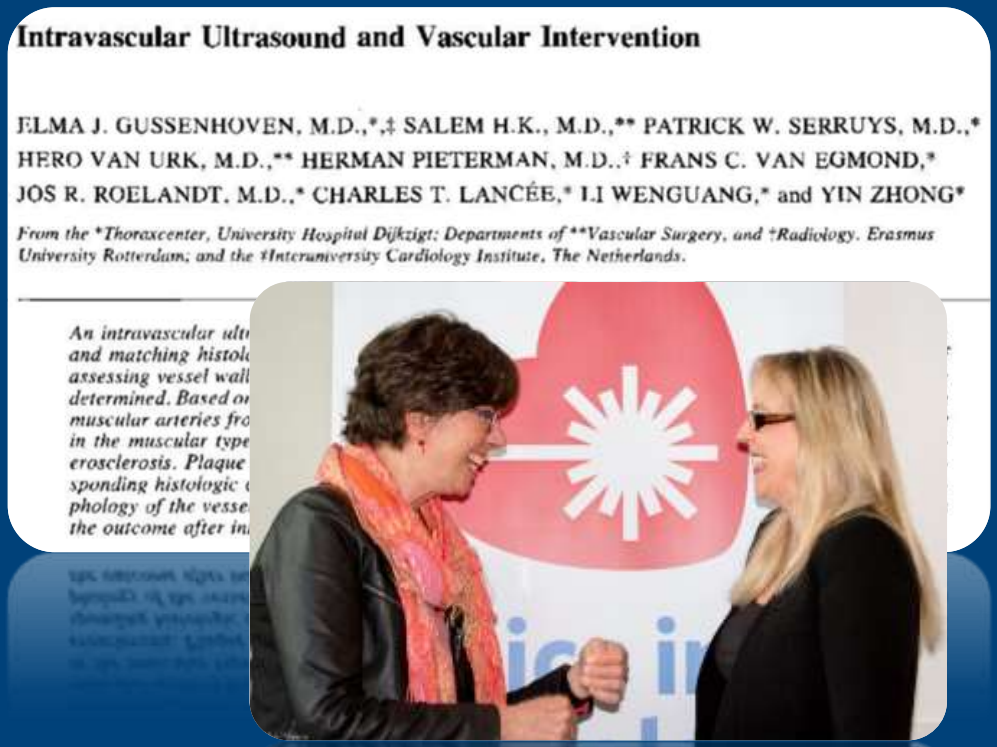
OCT-Guided PCI to Improve Patient Outcomes
Are we There Yet?

YES

…almost

Imaging-Guided PCI to Improve Patient Outcomes
How it Began…

«…I do remember the very first patient in 1989: We performed imaging with a catheter that was sterilized using gamma radiation in Wageningen. There was one catheter in between cauli flower undergoing mutations for decorative purposes. I had to travel there to pick up the catheter personally to make it in time for the intervention…»



Intravascular Ultrasound and Vascular Intervention

ELMA J. GUSSENHOVEN, M.D.,*,‡ SALEM H.K., M.D.,** PATRICK W. SERRUYS, M.D.,*
HERO VAN URK, M.D.,** HERMAN PIETERMAN, M.D.,† FRANS C. VAN EGMOND,*
JOS R. ROELANDT, M.D.,* CHARLES T. LANCÉE,* LI WENGUANG,* and YIN ZHONG*

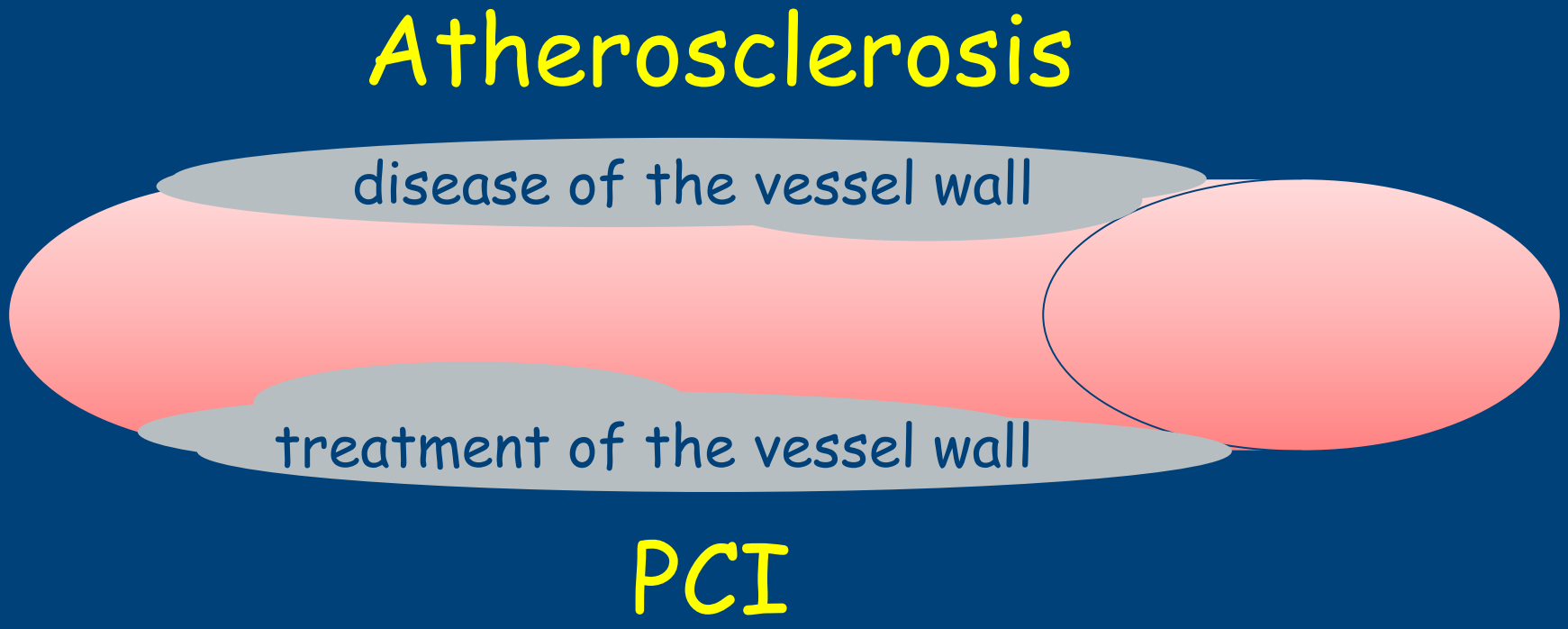
*From the *Thoraxcenter, University Hospital Dijkzigt; Departments of **Vascular Surgery, and †Radiology, Erasmus University Rotterdam; and the ‡Interuniversity Cardiology Institute, The Netherlands.*

An intravascular ultr
and matching histol
assessing vessel wall
determined. Based o
muscular arteries fro
in the muscular type
erosclerosis. Plaque
sponding histologic
phology of the vesse
the outcome after in

Gussenhoven E et al.
J Interv Cardiol. 1991;4(1):41-8.
J Am Coll Cardiol. 1989 Oct;14(4):947-52
Eur J Vasc Surg. 1989 Dec;3(6):571-6.

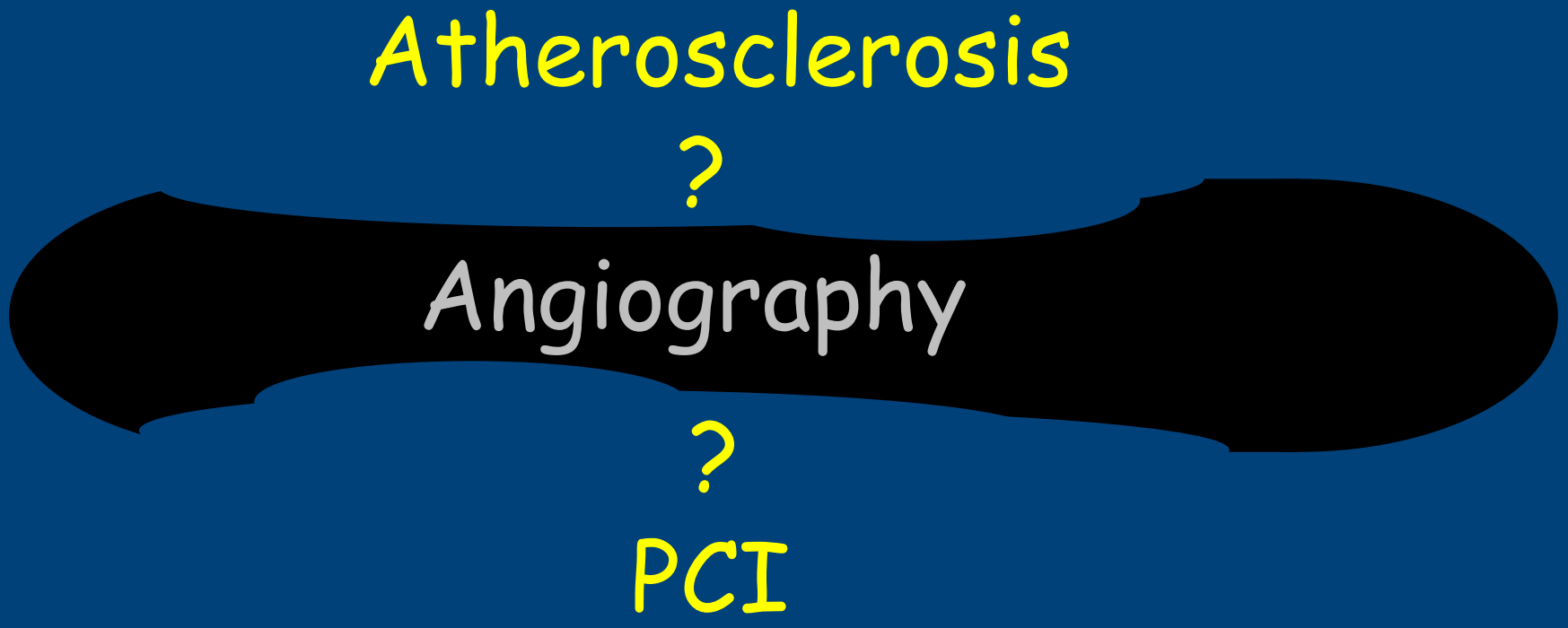
Imaging-Guided PCI to Improve Patient Outcomes

Why it Began… *Angiography Suffers From Limitations*



Imaging-Guided PCI to Improve Patient Outcomes

Why it Began… Angiography Suffers From Limitations



Imaging-Guided PCI to Improve Patient Outcomes

Why it Began… *Angiography Suffers From Limitations*

- Luminogram
- Geometric distortion
- Foreshortening
- Side branch overlap
- Flow-phenomena

Girasis et al; Catheterization and Cardiovascular Interventions 79:361–368 (2012)

Imaging-Guided PCI to Improve Patient Outcomes

Why it Began… *Angiography Suffers From Limitations*

- Luminogram
- Geometric distortion
- Foreshortening
- Side branch overlap
- Flow-phenomena

• Lesion severity:	High oberserver variability
• Left main lesion:	Low sensitivity
• Bifurcation lesions:	Low sensitivity
	Low specificity

Girasis et al; Catheterization and Cardiovascular Interventions 79:361–368 (2012)

Imaging-Guided PCI to Improve Patient Outcomes
Why it Began…

& Today?

Imaging-Guided PCI to Improve Patient Outcomes

Why it Began… *Angiography Suffers From Limitations*

& Today?

"Even experienced interventional cardiologists cannot, without functional information, accurately predict the significance of many intermediate stenoses on the basis of visual assessment or quantitative coronary angiography."


ESC/EACTS GUIDELINES

2014 ESC/EACTS Guidelines on myocardial revascularization

The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Developed with the special contribution of the European Association of Percutaneous Cardiovascular Interventions (EAPCI)

Imaging-Guided PCI to Improve Patient Outcomes Is Supported by ESC Guidelines…

European Heart Journal (2016) 37, 267–315
doi:10.1093/eurheartj/ehv320

ESC GUIDELINES

2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation

Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC)

Authors/Task Force Members: Marco Roffi* (Chairperson) (Switzerland), Carlo Patrono* (Co-Chairperson) (Italy), Jean-Philippe Collet† (France), Christian Mueller† (Switzerland), Marco Valgimigli† (The Netherlands), Felicita Andreotti (Italy), Jeroen J. Bax (The Netherlands), Michael A. Borger (Germany), Carlos Brotons (Spain), Derek P. Chew (Australia), Baris Gencer (Switzerland), Gerd Hasenfuss (Germany), Keld Kjeldsen (Denmark), Patrizio Lancellotti (Belgium), Ulf Landmesser (Germany), Julinda Mehilli (Germany), Debabrata Mukherjee (USA), Robert F. Storey (UK), and Stephan Windecker (Switzerland)

European Heart Journal (2014) 35, 2541–2619
doi:10.1093/eurheartj/ehu278

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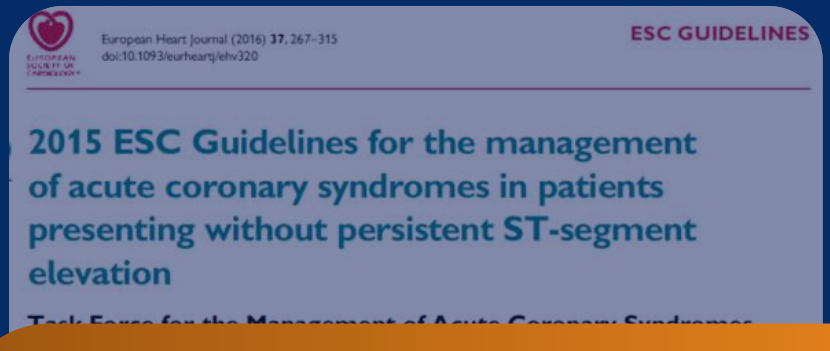
Authors/Task Force members: Stephan Windecker* (ESC Chairperson) (Switzerland), Philippe Kolh* (EACTS Chairperson) (Belgium), Fernando Alfonso (Spain), Jean-Philippe Collet (France), Jochen Cremer (Germany), Volkmar Falk (Switzerland), Gerasimos Filippatos (Greece), Christian Hamm (Germany), Stuart J. Head (Netherlands), Peter Jüni (Switzerland), A. Pieter Kappetein (Netherlands), Adnan Kastrati (Germany), Juhani Knuuti (Finland), Ulf Landmesser (Switzerland), Günther Laufer (Austria), Franz-Josef Neumann (Germany), Dimitrios J. Richter (Greece), Patrick Schauerte (Germany), Miguel Sousa Uva (Portugal), Giulio G. Stefanini (Switzerland), David Paul Taggart (UK), Lucia Torracca (Italy), Marco Valgimigli (Italy), William Wijns (Belgium), and Adam Witkowski (Poland).

Imaging-Guided PCI to Improve Patient Outcomes Is Supported by ESC Guidelines…



- Identification of culprit lesion in ACS patients
- Guidance of stent implantation
- Assessment of stent failure
- Assessment of Left Main lesions

Class 2 recommendations

"should be considered"

Imaging-Guided PCI to Improve Patient Outcomes Is Supported by ESC Guidelines…

Recommendations for the clinical value of intracoronary diagnostic techniques

Recommendations	Class[a]	Level[b]	Ref.[c]
FFR to identify haemodynamically relevant coronary lesion(s) in stable patients when evidence of ischaemia is not available.	I	A	
FFR-guided PCI in patients with multivessel disease.	IIa	B	
IVUS in selected patients to optimize stent implantation.	IIa	B	
IVUS to assess severity and optimize treatment of unprotected left main lesions.	IIa	B	
IVUS or OCT to assess mechanisms of stent failure.	IIa	C	
OCT in selected patients to optimize stent implantation.	IIb	C	

Is recommended — FFR: Stable patients; Multivessel disease

Should be considered

Should be considered — IVUS: Stent implant; Left main; Stent failure

Should be considered

May be considered

OCT: Stent implant; Stent failure

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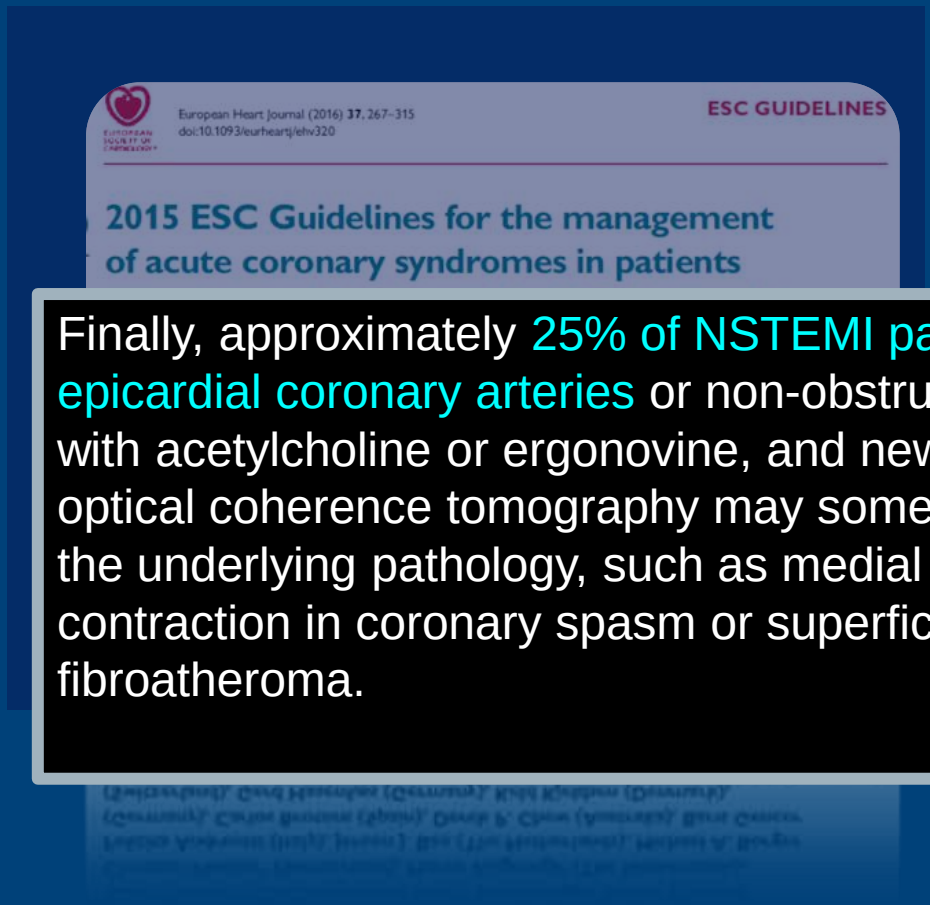

Finally, approximately 25% of NSTEMI patients have angiographically normal epicardial coronary arteries or non-obstructive CAD. A provocative test, such as with acetylcholine or ergonovine, and newer intracoronary imaging methods (i.e. optical coherence tomography may sometimes help to identify the culprit lesion or the underlying pathology, such as medial thickness due to abnormal media contraction in coronary spasm or superficial erosions of non-obstructive thin-cap fibroatheroma.

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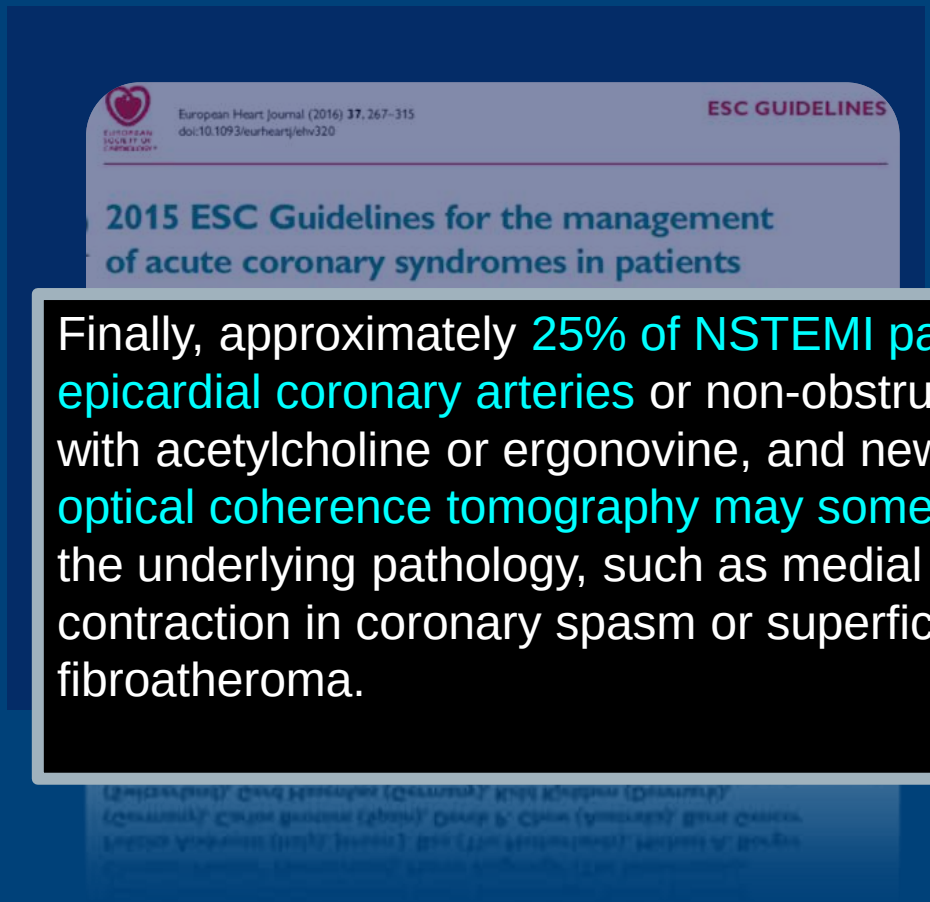

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1. If you believe that IVUS guidance improves prognosis

1. IVUS-Guided PCI Improves Patient Outcomes

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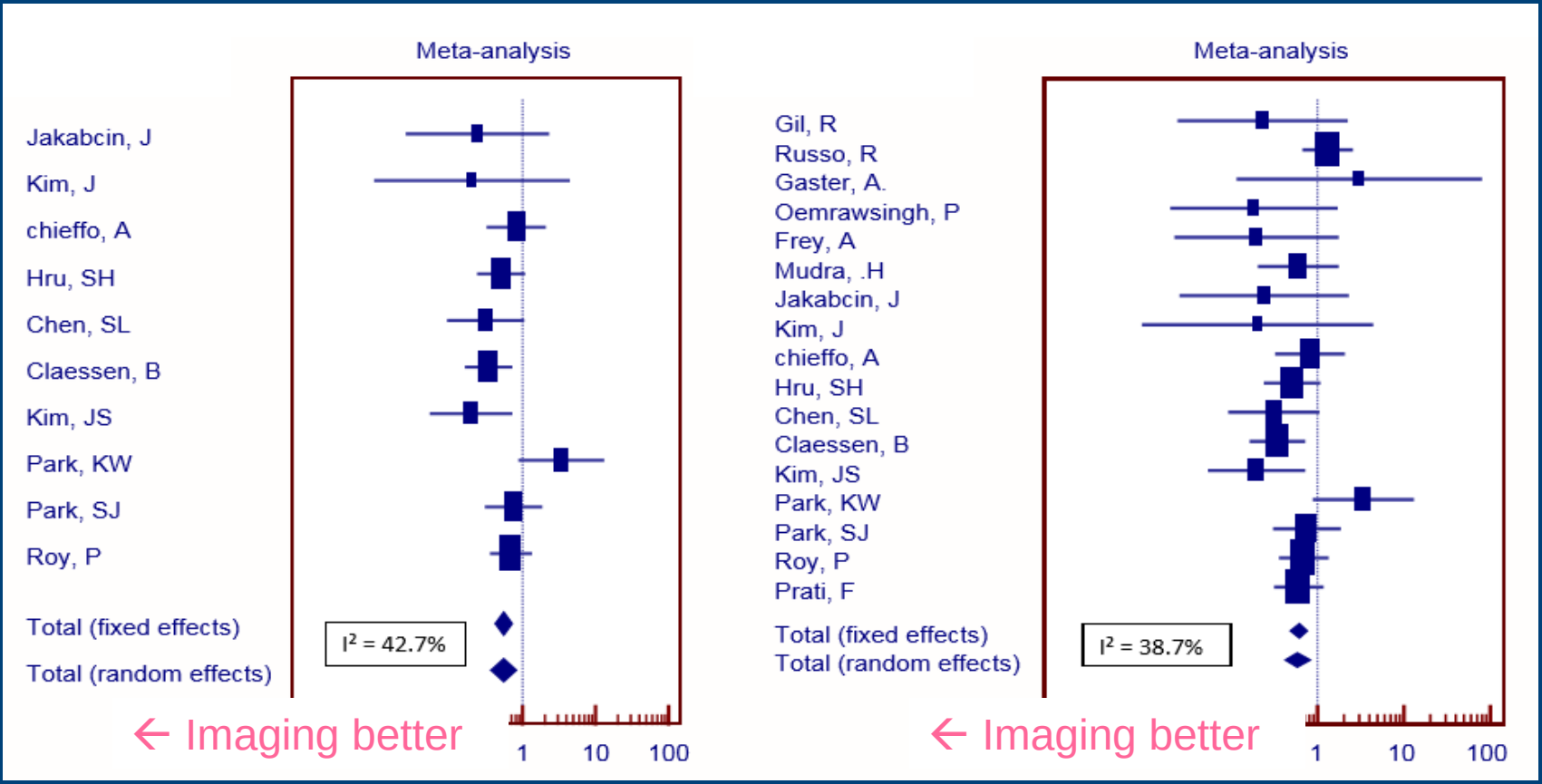
Meta-analysis n= 14,197 pts Imaging-guided vs. Angiography-guided PCI

MYOCARDIAL INFARCTION



Alsidawi S et **al.** Cardiovascular Therapeutics 2015 (33) 360–366 .

1. IVUS-Guided PCI Improves Patient Outcomes

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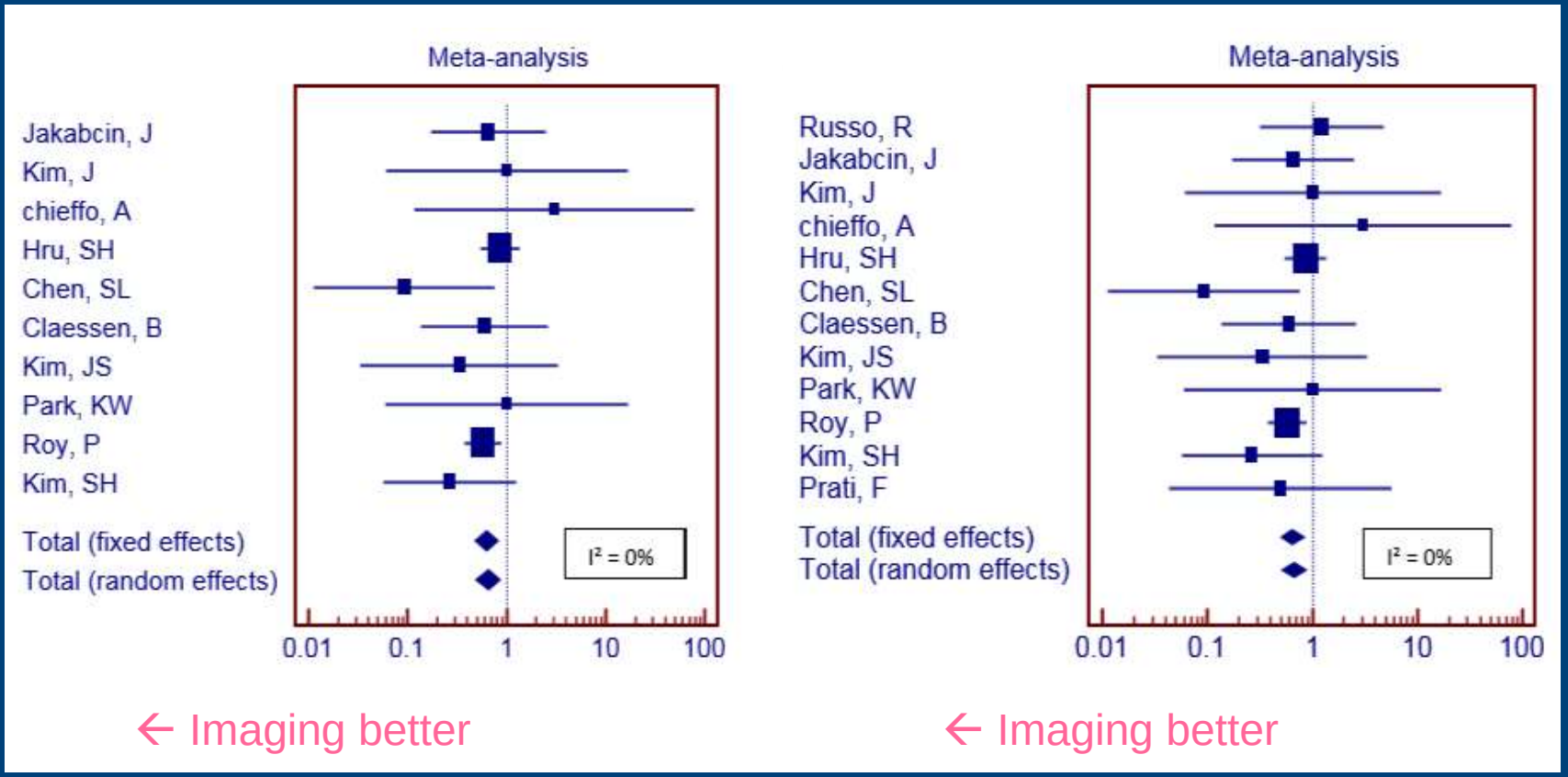
STENT THROMBOSIS



Alsidawi S et **al.** Cardiovascular Therapeutics 2015 (33) 360–366 .

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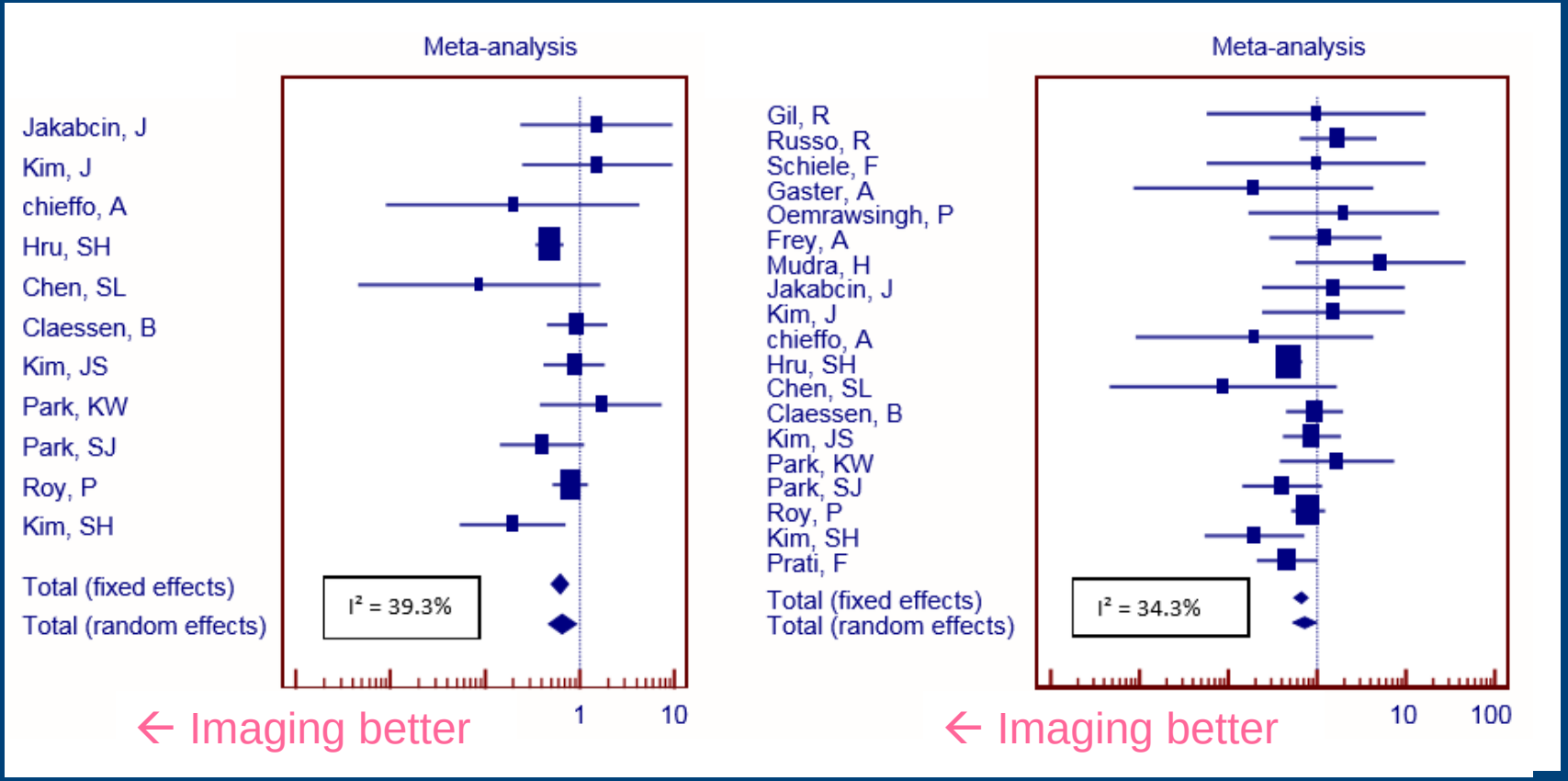
DEATH



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OCT-Guided PCI to Improve Patient Outcomes
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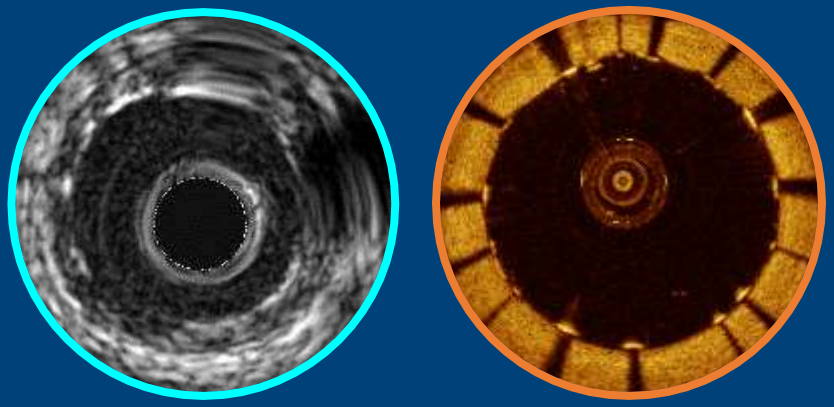
2. If you believe that
IVUS & OCT
create reliably images of the coronary

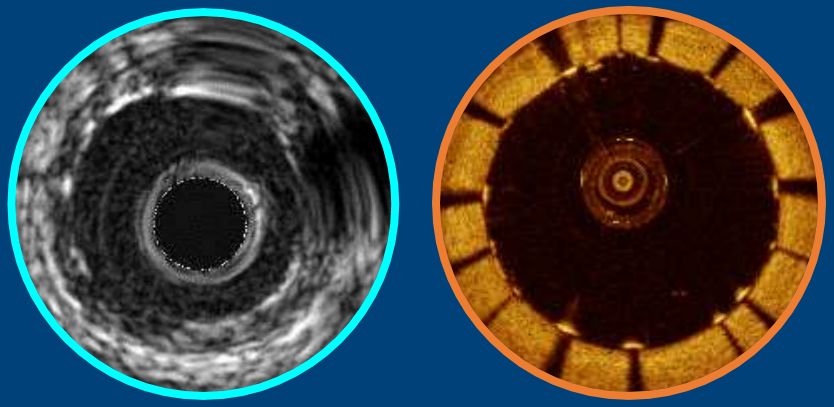
2. IVUS&OCT Create Reliably Coronary Images



Both modalities create calibrated,
accurate representations of the coronary cross section,
based on well-defined physical principles & boundary conditions;
with documented inter- intra and inter-study variability;

2. IVUS&OCT Create Reliably Coronary Images

IVUS principles can be applied to OCT



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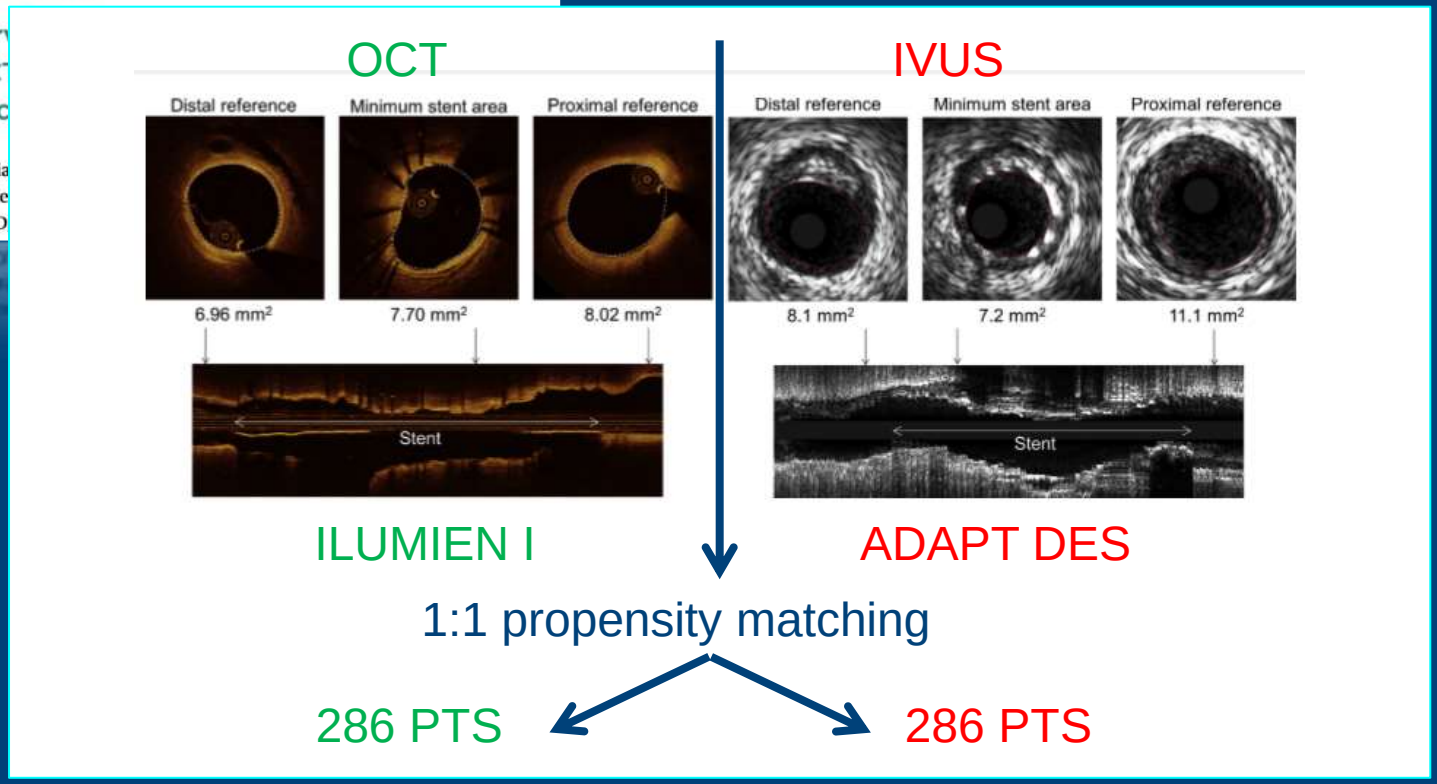
2. IVUS&OCT Create Reliably Coronary Images

OCT Can Be Used Like IVUS To Optimize Stents

Comparison of Stent Expansion Guided by Optical Coherence Tomography Versus Intravascular Ultrasound

The ILUMIEN II Study (Obser
Coherence Tomography [OCT
Flow Reserve [FFR] and Perc

Akiko Maehara, MD,*† Ori Ben-Yehuda, MD,*† Zia
Junya Shite, MD,‖ Philippe Généreux, MD,*†¶ Me
Bernhard Witzenbichler, MD,# Gary S. Mintz, MD



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Maehara A at al. JACC Cardiovasc Interv 2015; (8): 1704-8

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Intravascular Ultrasound

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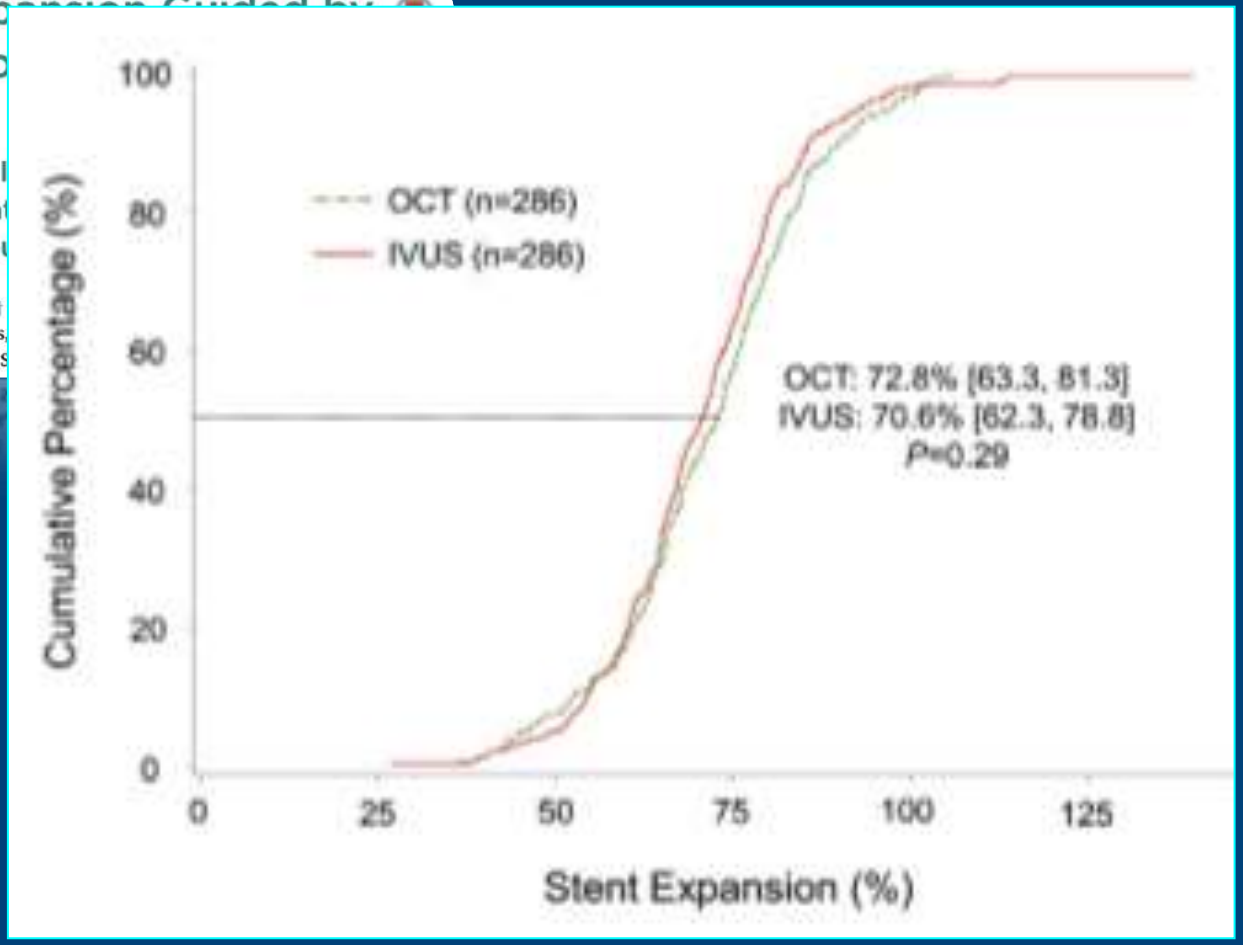

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OCT-Guided PCI to Improve Patient Outcomes Are we There Yet?

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…almost

3. If you believe that peer-reviewed OCT studies are reliable

3. OCT Studies Are Reliable

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OCT Confirms All Principles of IVUS-Guided Stenting

Studies on PCI with OCT Guidance

CLI-OPCI	Euroint 2012
Illumien I	Eur H J 2015
Illumien II	JACC CV Interv 2015
OPINION	J Cardiol 2016
DOCTORS	Circulation 2016
Illumien III	Lancet 2016

3. OCT Studies Are Reliable

OCT Confirms All Principles of IVUS-Guided Stenting

CLI-OPCI-I registry: Angio vs OCT guided stenting

	ANGIO (N = 335)	OCT (N = 335)	P value
In- hospital events:			
Cardiac death	3 (0.9%)	2 (0.6%)	0.010
Non-fatal MI	22 (6.5%)	13 (3.9%	0.096
Events at 1-year follow-up			
Death	23 (6.9%)	11 (3.3%)	0.035
Cardiac death	15 (4.5%)	4 (1.2%)	0.010
Myocardial infarction	29 (8.7%)	18 (5.4%)	0.096
TLR	11 (3.3%)	11 (3.3%)	1.0
Definite stent thrombosis	2 (0.6%)	1 (0.3%)	0.624
Cardiac death or MI	43 (13.0%)	22 (6.6%)	0.006
Cardiac death, MI, or repeat revascularization	50 (15.1%)	32 (9.6%)	0.034

Prati F et al. EuroIntervention 2012:8(1):823-9.

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OCT guidance does reduce hard clinical endpoints!

Prati F et al. EuroIntervention 2012:8(1):823-9.

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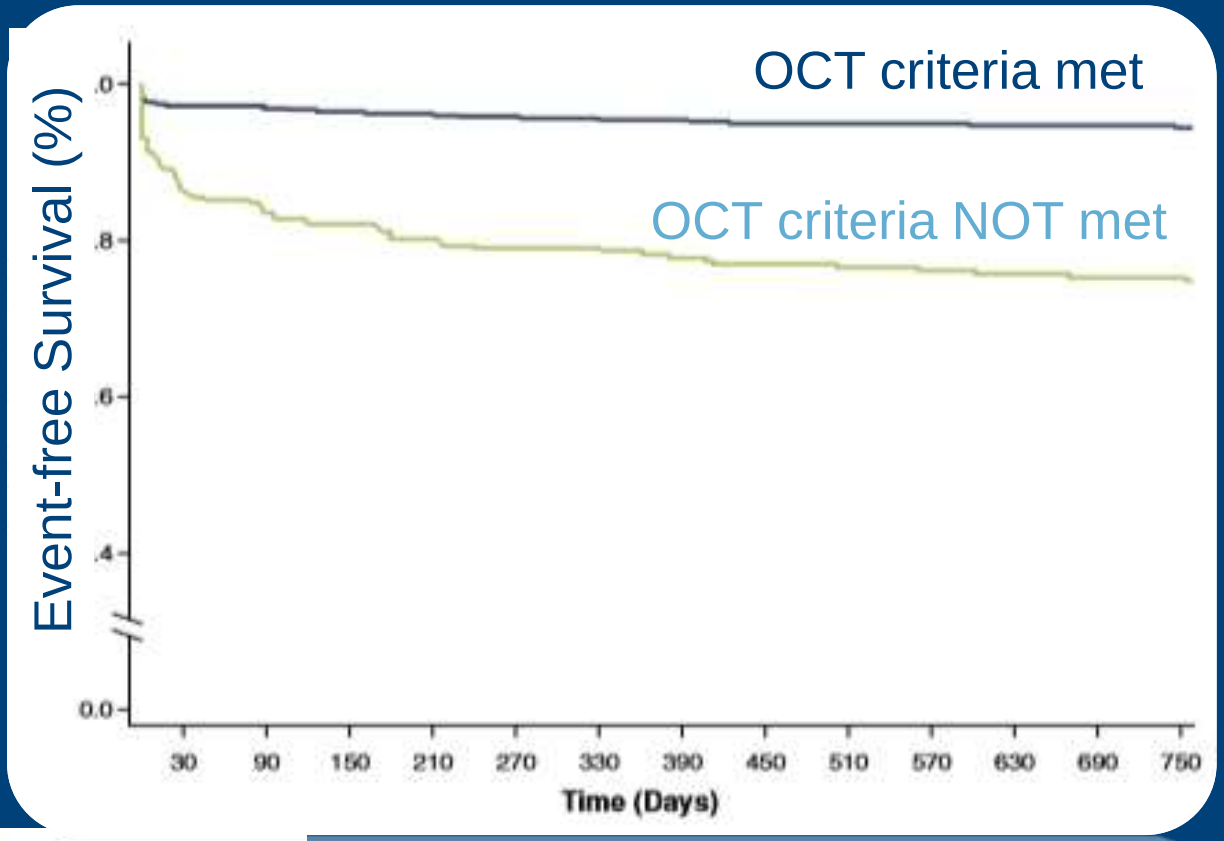
CLI-OPCI-II study: OCT guided stenting



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Prati F et al. JACC Cardiovasc Img 2015 ; 8: 1297-30

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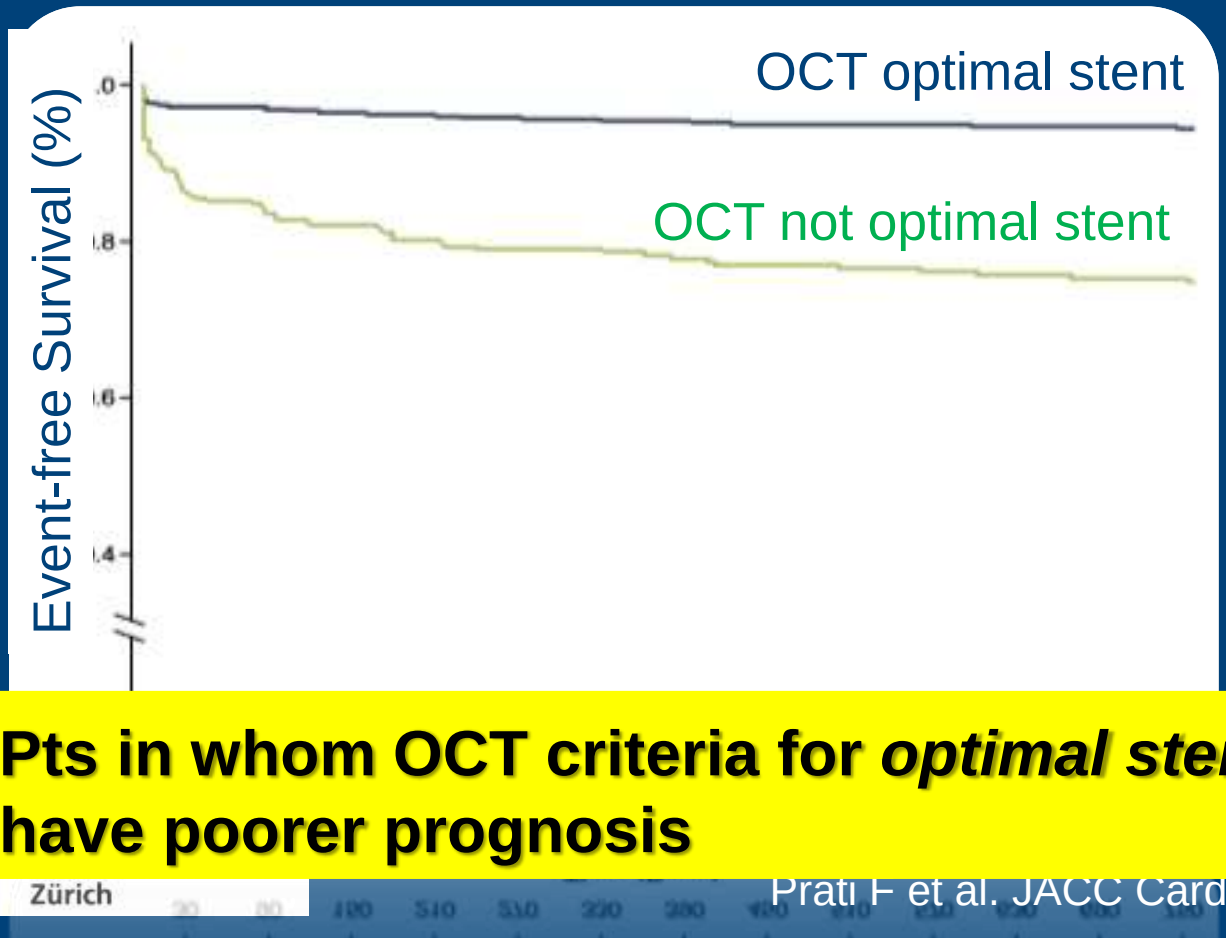

Pts in whom OCT criteria for *optimal stent* were *not* met, have poorer prognosis

Prati F et al. JACC Cardiovasc Img 2015 ; 8: 1297-30

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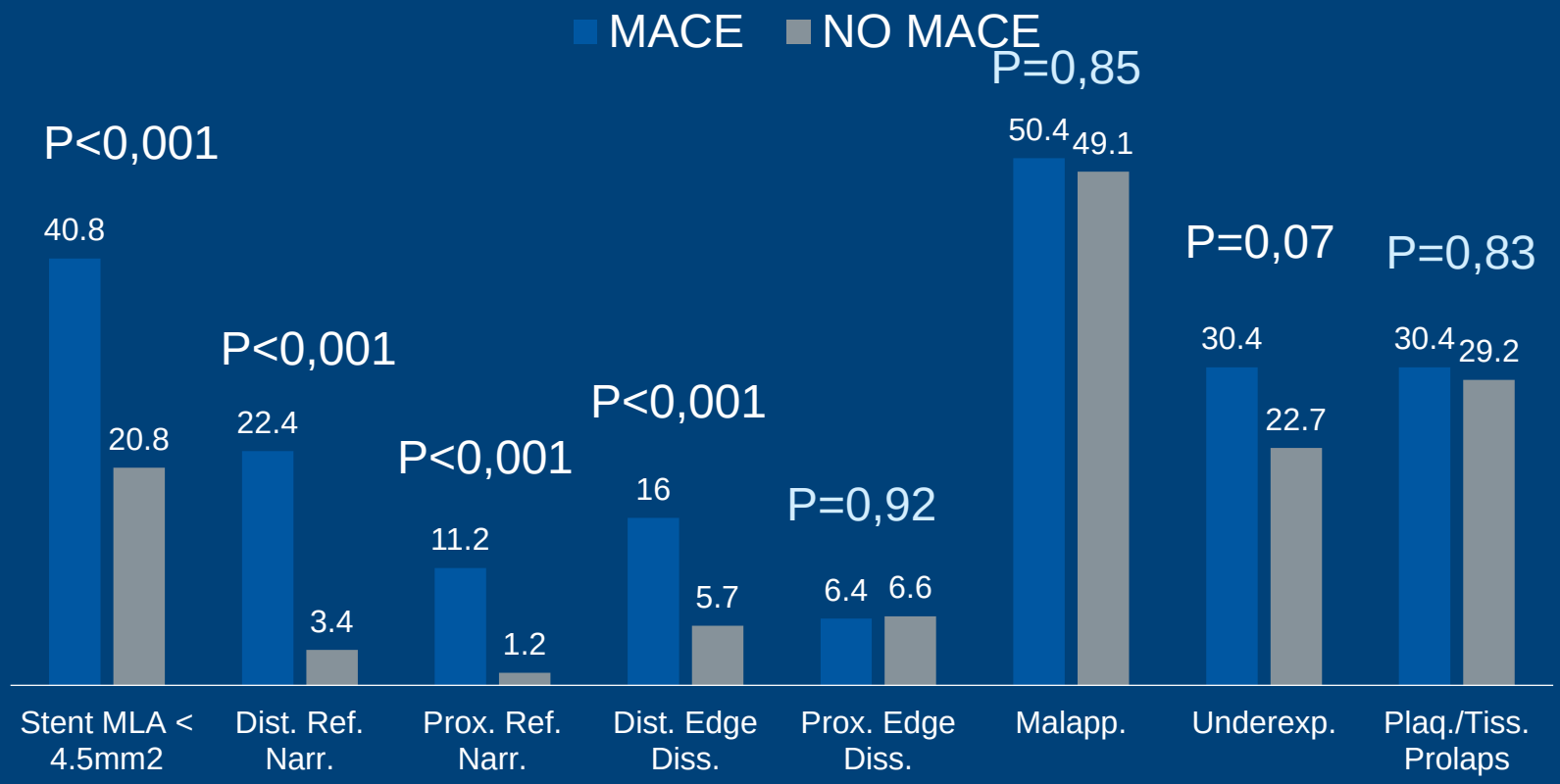
OCT Confirms All Principles of IVUS-Guided Stenting

CLI-OPCI-II study: OCT guided stenting



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c/o **F. Prati**
CLI Foundation, Rome, Italy

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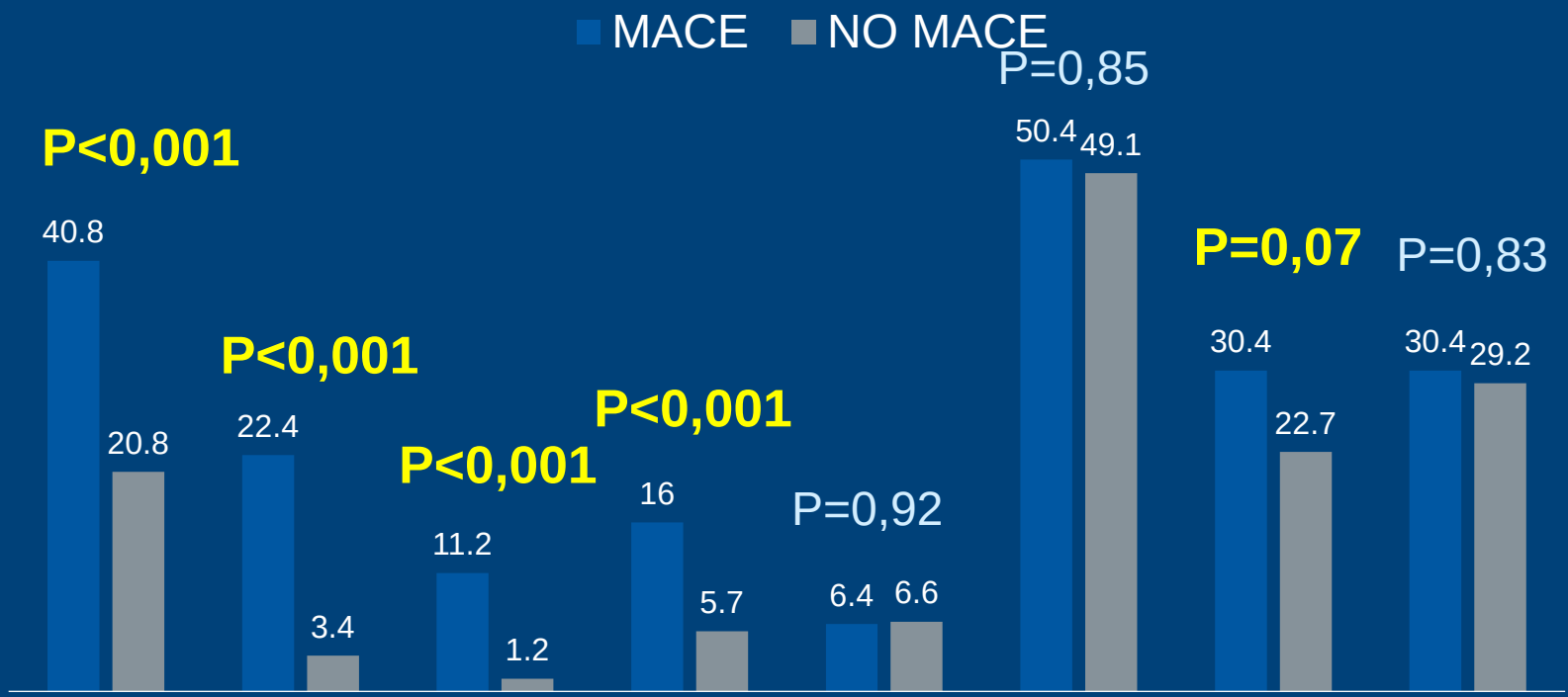

small MLA	reference narrowing	dist. edge dissection	under expansion

OCT-Guided PCI to Improve Patient Outcomes Are we There Yet?

YES

…almost

But: What's about the differences between IVUS & OCT?

OCT-Guided PCI to Improve Patient Outcomes Are we There Yet?

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But: What's about the differences between IVUS & OCT?
- Reduced penetration depth of OCT -

4. What's About The Differences Between OCT&IVUS ?

OCT Can Be Used Like IVUS To Optimize Stents

MUSIC - criteria

If minimal stent area <9.0mm2:
Minimal stent area ≥90% of the mean reference lumen area
Or Minimal stent area ≥100% of lumen lowest reference lumen area.
Proximal stent entrance ≥90% of proximal reference lumen area.

If minimal stent area >9.0 mm2:
Minimal stent area ≥80% of the mean reference lumen area
Or Minimal stent area ≥90% of lumen lowest reference lumen area.

Symmetric stent expansion defined by Stent Dmin/Dmax >0.7
Complete stent apposition against the vessel wall.

DeJaegere et al. 1998

4. What's About The Differences Between OCT&IVUS ?

OCT Can Be Used Like IVUS To Optimize Stents

Minimal stent area >80% of the mean reference lumen area

RESIST - criteria
Schiele et al. 1998

Minimal stent diameter 80% of the mean reference diameters
Minimal stent area (MLA) ≥ 100% of distal reference lumen area
Complete stent apposition

TULIP - criteria

Oemrawsingh et al. 2003

Minimal stent area >80% of mean reference lumen area
or minimal stent area >7.5 mm^2 with full stent apposition.

DIPOL-criteria

Gil et al. 2007

Minimal stent area ≥90% of distal reference lumen area
Stent fully apposed to vessel wall.
Dissections covered by stent.

AVID - criteria

Russo et al. 2009

Minimal stent area > 5mm^2 or >90% of distal reference lumen area
Apposition of all stent struts
No edge dissections.

HOME DES - criteria

Jakabcin et al. 2010

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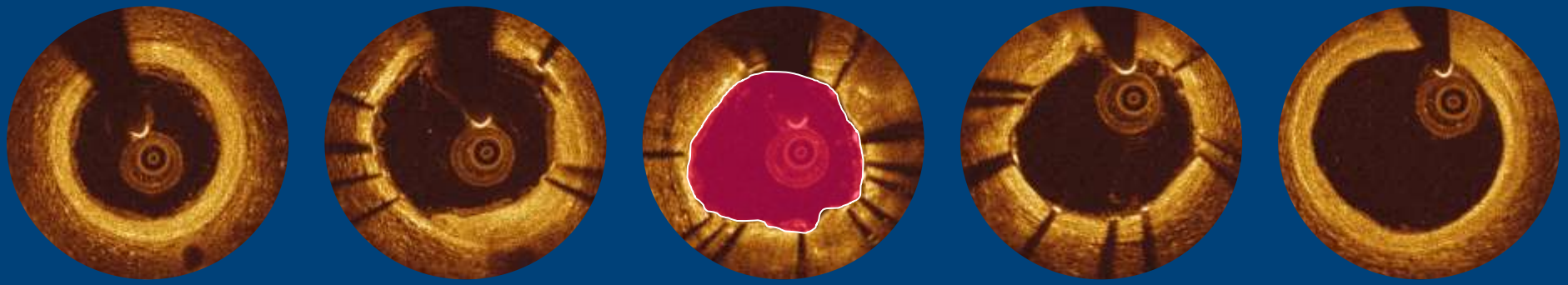

distal reference | distal stent | **minimal stent area** | proximal stent | proximal reference

e.g. MUSIC criteria; deJaegere et al. 1998

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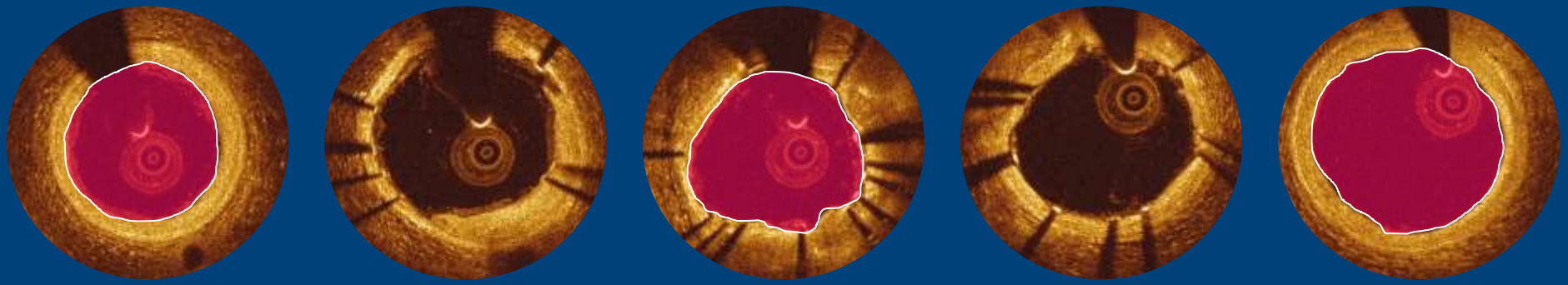

distal reference

distal stent

minimal stent

proximal stent

proximal reference

lumen area

area

lumen area

e.g. MUSIC criteria; deJaegere et al. 1998

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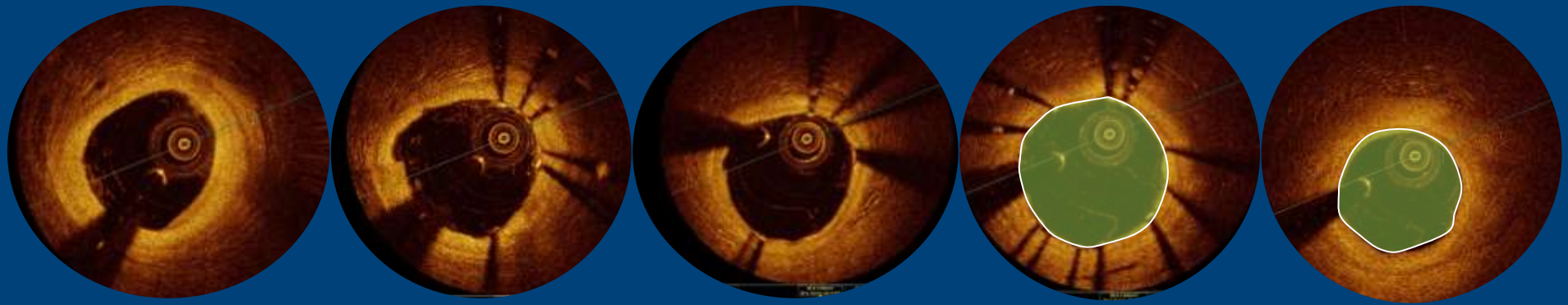

distal reference | distal stent | minimal stent | proximal stent | proximal reference

area **lumen area**

e.g. MUSIC criteria; deJaegere et al. 1998

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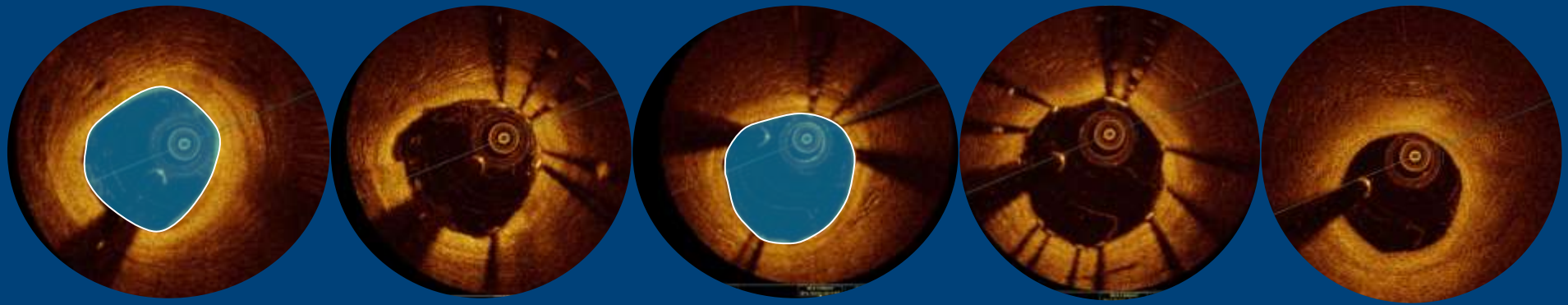

distal reference

distal stent

minimal stent area

proximal stent

proximal reference

lumen area

e.g. Tulip criteria; Oemrawsingh et al. 2003

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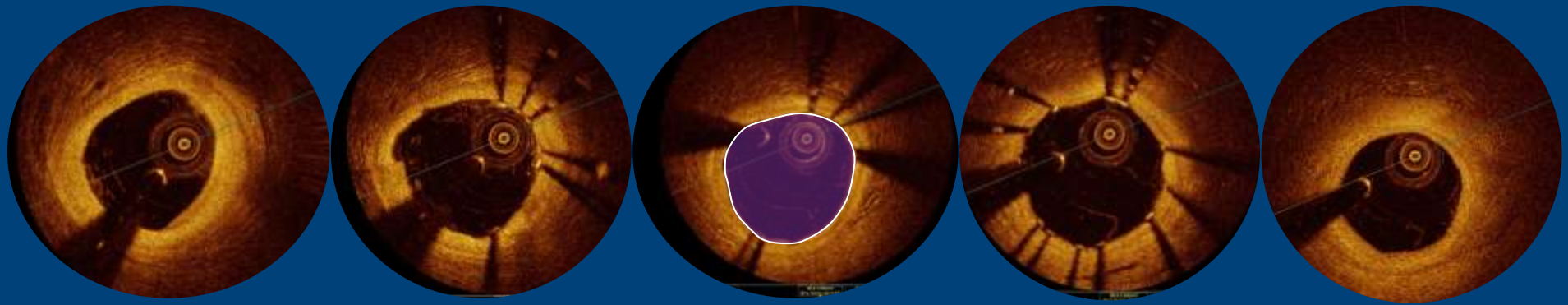

distal reference | distal stent | **minimal stent area** | proximal stent | proximal reference

> 7.5mm²

e.g. DIPOL criteria; Gil et al. 2007

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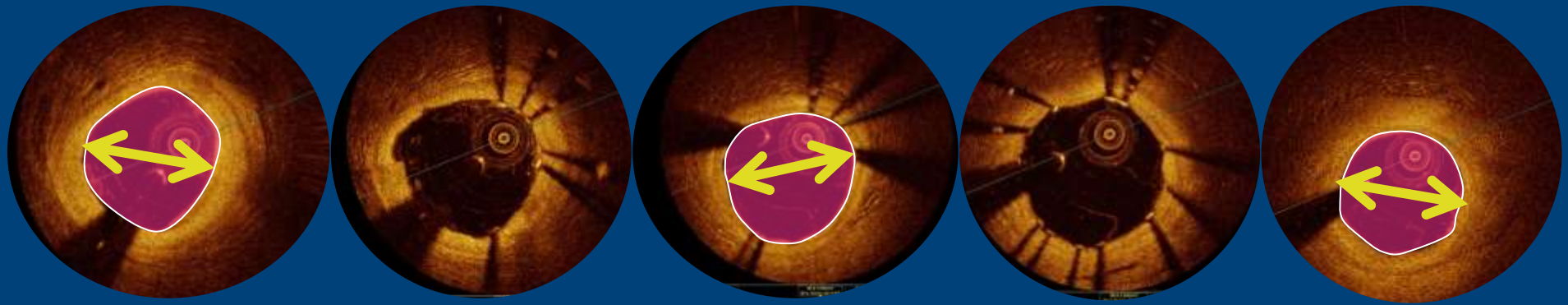

distal reference lumen diameter

distal stent

minimal stent diameter

proximal stent

proximal reference lumen diameter

e.g. Tulip criteria; Oemrawsingh et al. 2003

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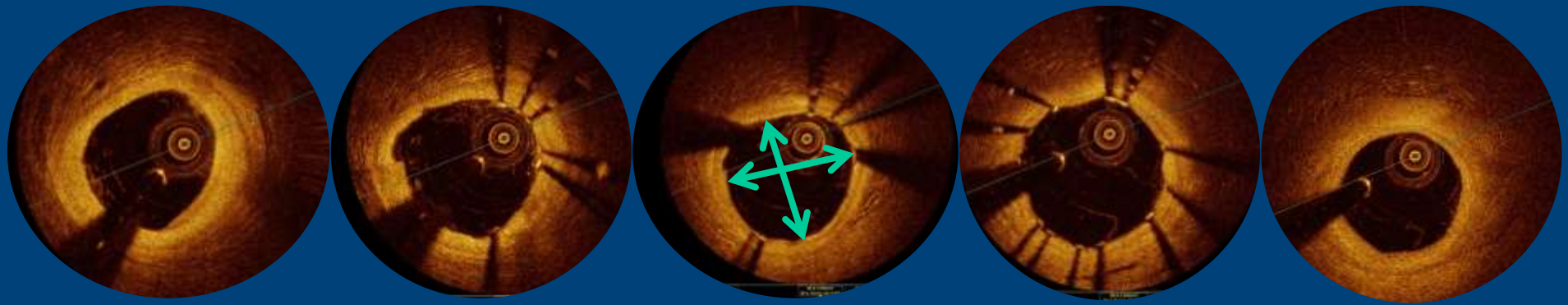
OCT Can Be Used Like IVUS To Optimize Stents



distal reference | distal stent | minimal stent area | proximal stent | proximal reference

Eccentricity:
Dmin/Dmax

e.g. MUSIC criteria; deJaegere et al. 1998

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If you prefer
to asses media
to media…

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Wijns et al. Eur Heart J 2015.

4. What's About The Differences Between OCT&IVUS ?

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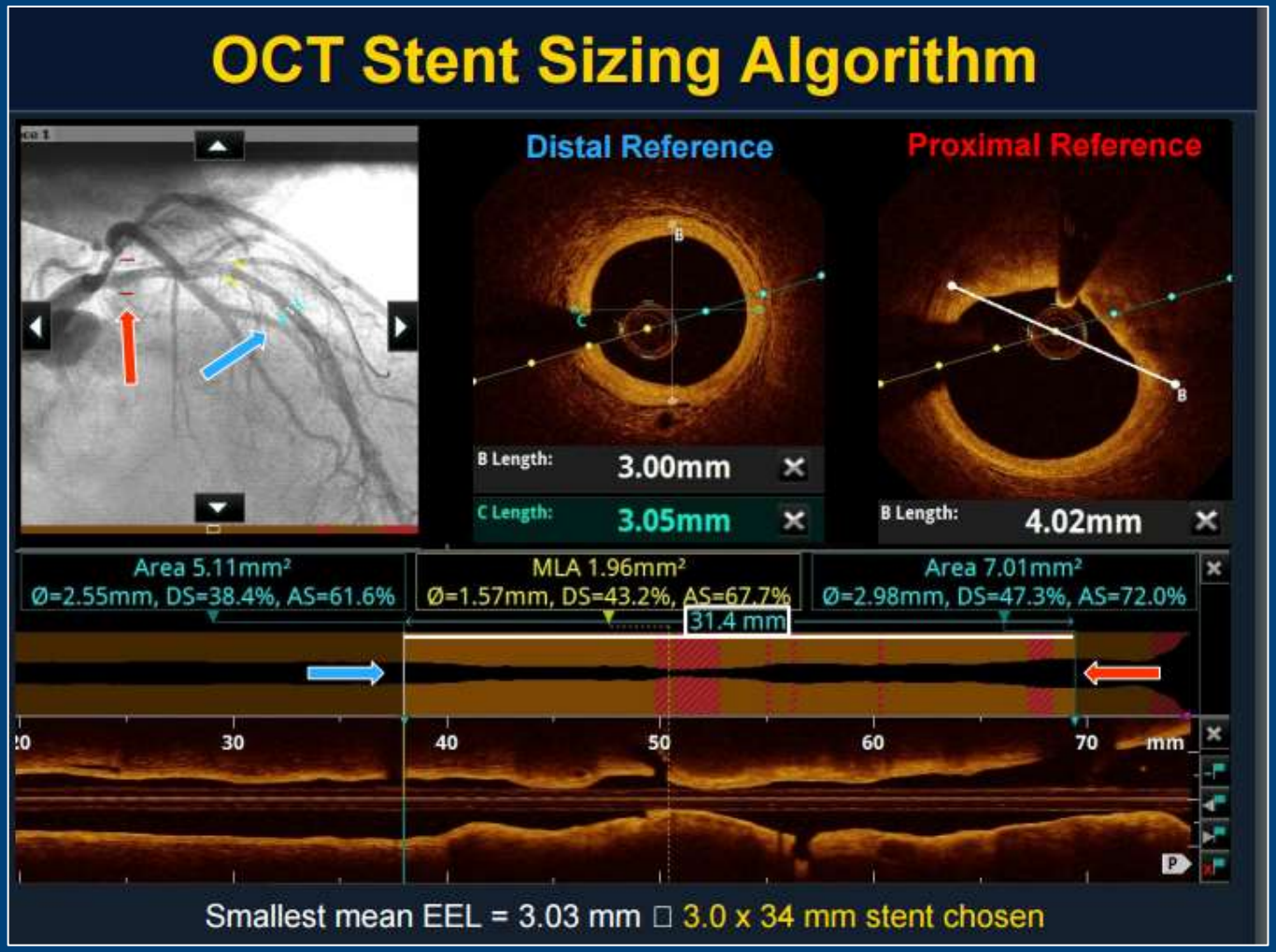
If you prefer to asses media to media…

Ilumien III: Stent selection is based on EEL measurement



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Ziad A et al. Lancet 2016.

4. What's About The Differences Between OCT&IVUS ?

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	OCT n=140	IVUS n=140	p-value
Minimum stent area, mm²	5·79	5·89	0·42
Minimum stent expansion,%	87·6	86·5	0·77
Mean stent expansion,%	105·8	106·3	0·63

Ilumien III:
Stent selection
is based on EEL
measurement

Modified from Ziad A et al. Lancet 2016.

OCT-Guided PCI to Improve Patient Outcomes Are we There Yet?

YES

…almost

But: What's about the differences between IVUS & OCT?

OCT-Guided PCI to Improve Patient Outcomes
Are we There Yet?

YES

…almost

But: What's about the differences between IVUS & OCT?
- Higher resolution of OCT -

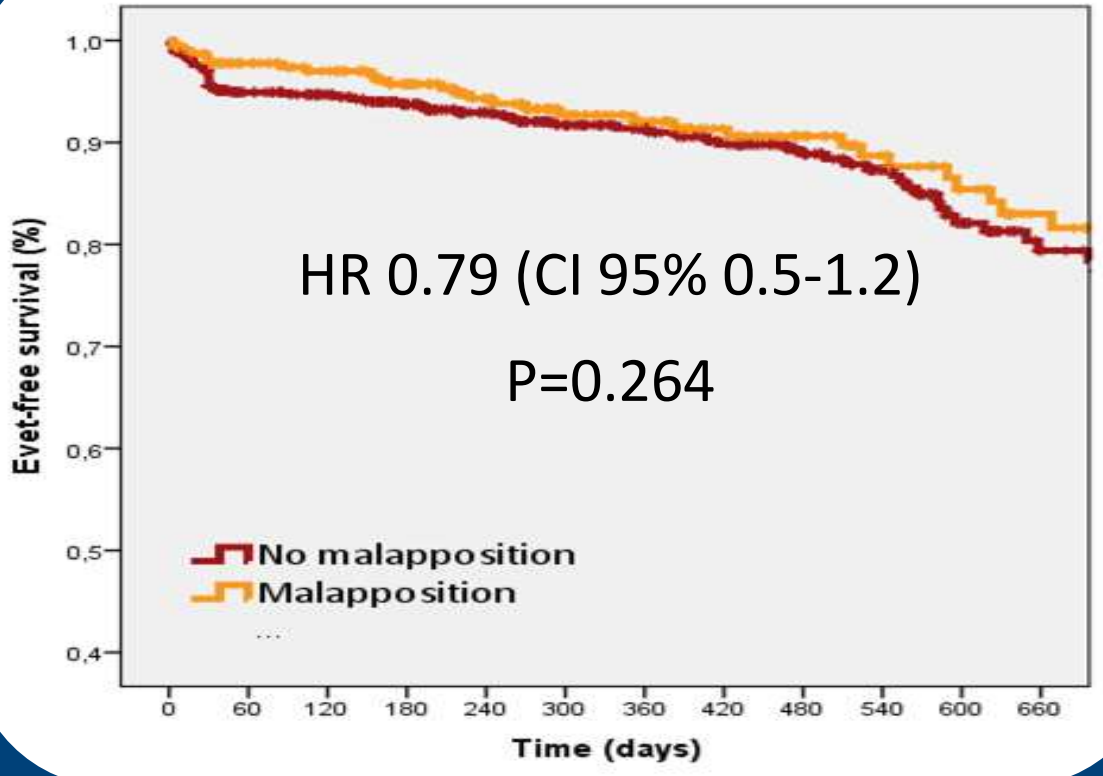
4. What's About The Differences Between OCT&IVUS ?

Small details, as *only* revealed by OCT … do not matter!

4. What's About The Differences Between OCT&IVUS ?

Small details, as *only* revealed by OCT … do not matter!

Small malapposition does not affect prognosis



Impact of residual acute malapposition

>0.2mm in thickness & >2.0mm in length

on event free-survival

Romagnoli et al. Cath Cardiov. Int 2016

c/o **F. Prati**
CLI Foundation, Rome, Italy

4. What's About The Differences Between OCT&IVUS ?

Small details, as *only* revealed by OCT … do not matter!

CLI-OPCI-III Study Criteria for Optimal Stent

Edge dissection	**width**	**> 200µm**
Strut malappostion	**distance**	**> 500µm**
Thrombus	**thickness**	**> 500µm**
Absence of res. stenosis, adjacent to stent ends	**MLA**	**< 4.5mm²**
Underexpansion	**MSA**	**< 4.5mm²**
	MSA/av. RA	**< 60%**

…study ongoing

c/o **F. Prati**
CLI Foundation, Rome, Italy

OCT-Guided PCI to Improve Patient Outcomes
Are we There Yet?

…almost

OCT-Guided PCI to Improve Patient Outcomes
Are we There Yet?

YES

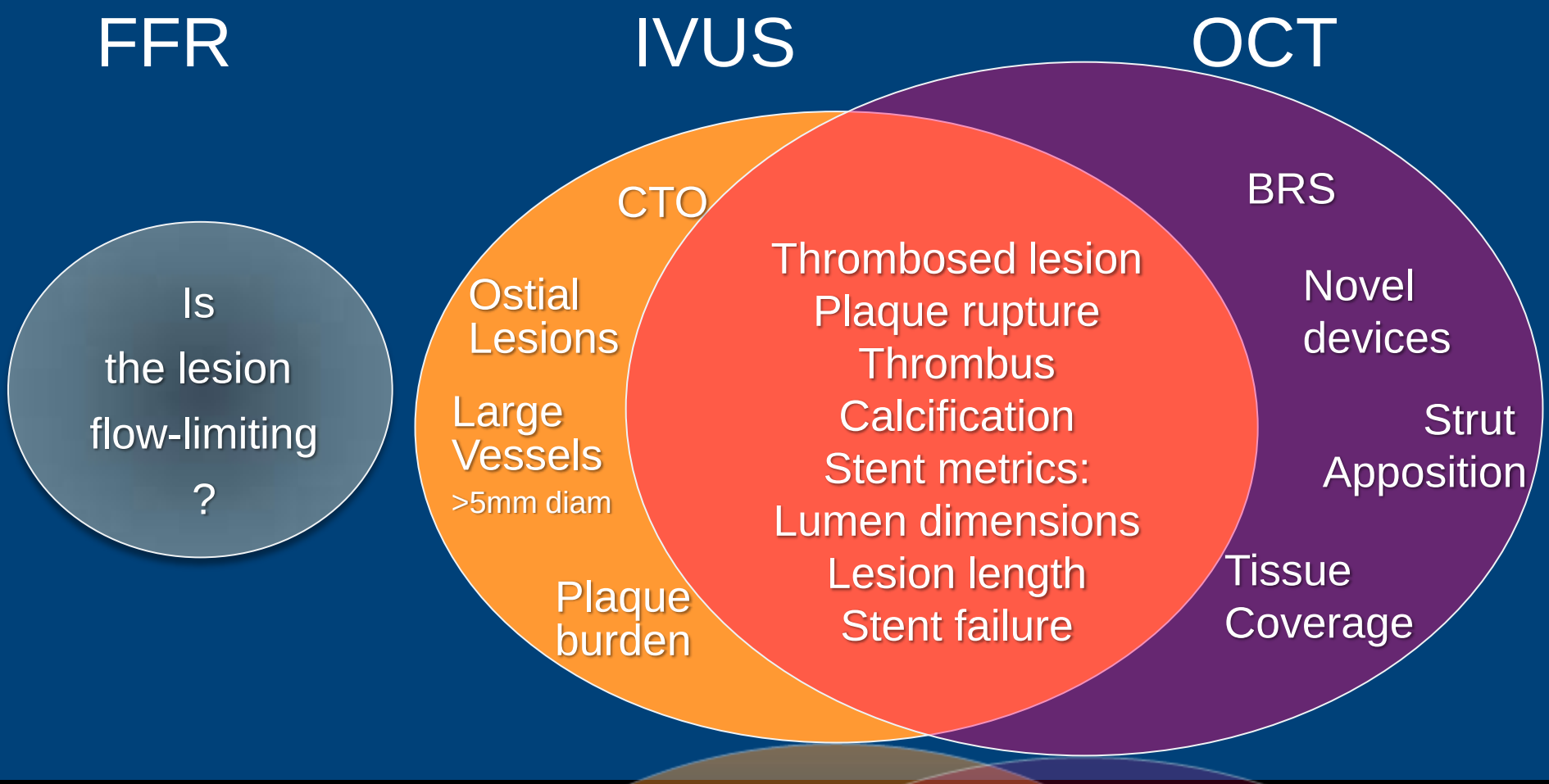
…almost

We do have evidence that

- IVUS guidance reduces hard clinical enpoints.
- IVUS guidance improves prognosis.
- OCT creates similar information than IVUS.
- OCT and IVUS can achieve similar final stent results.
- OCT studies confirm IVUS principles for optimal stent implantation.

Guided PCI (Intracoronary Physiology, Imaging)

When To Use? – My Personal Road Map



Thank You For Your Attention!

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