

How and When to Use Intravascular Imaging

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Outline

01

Why intravascular imaging (IVI) for guiding PCI?

02

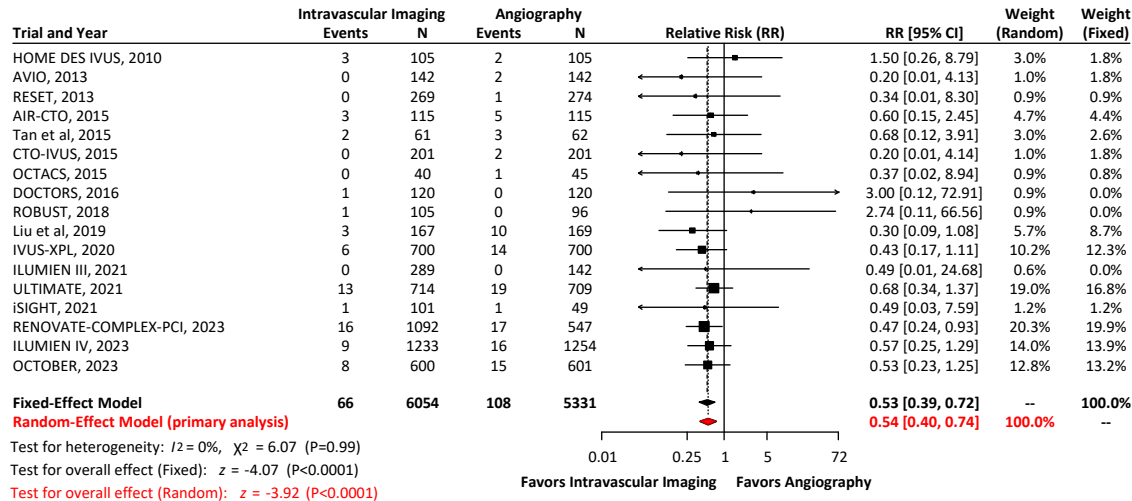
When can we use IVI?

03

How can we use IVI?

Why? ... because **IVI** saves lives

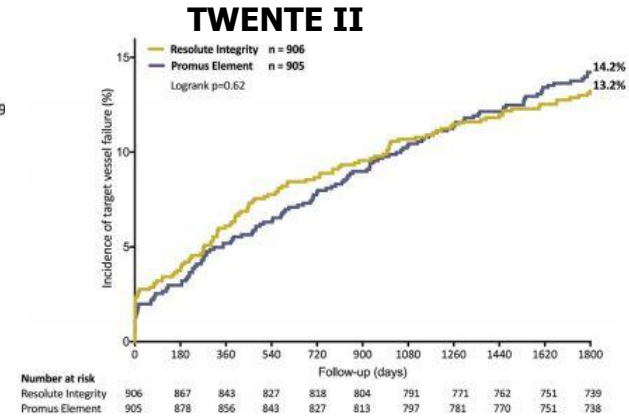
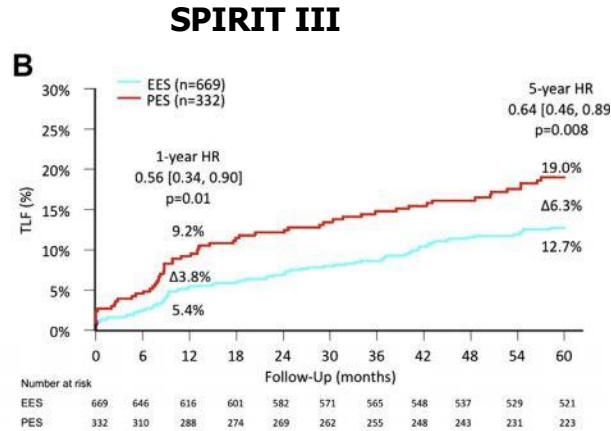
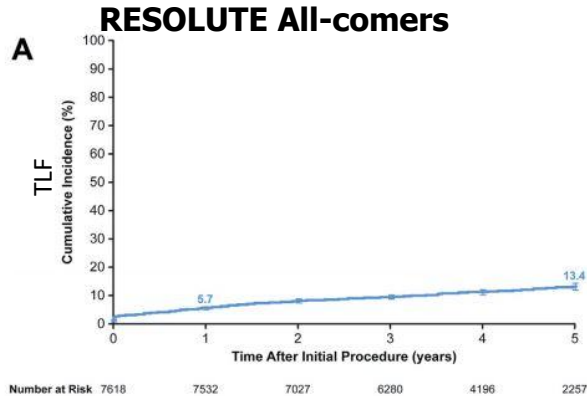
Cardiac Death (Direct Evidence): IV Imaging vs. Angio 17 trials, 11,385 patients, 174 events



RR 0.54, 95% CI 0.40-0.74

The Problem:

By five years, TLF/TVF with contemporary DES occurs in nearly 1 in 7 patients

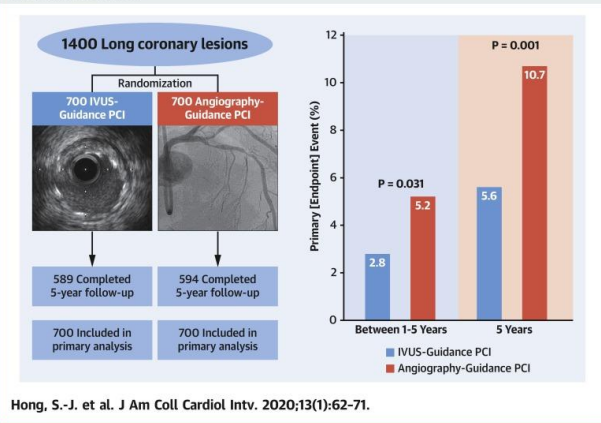


The Problem: IVUS addresses it

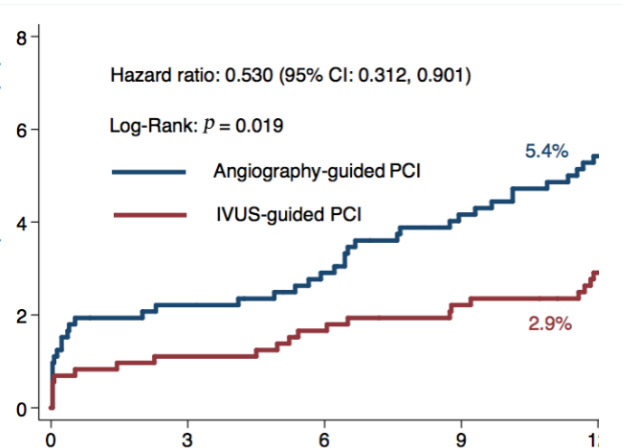
At short- and long-term the CV outcomes are lower

IVUS-XPL

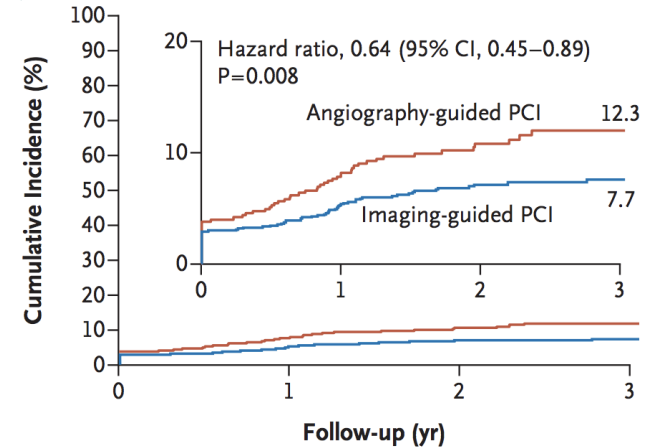
CENTRAL ILLUSTRATION: 5-Year Follow-Up of the IVUS-XPL Randomized Trial



ULTIMATE



RENOVATE



2024 European Society of Cardiology (ESC) Endorsed by the European Association for Cardio-Thoracic Surgery (EACTS)

Assessment of procedural risks and post-procedural outcomes

Intracoronary imaging guidance by IVUS or OCT is recommended for performing PCI on anatomically complex lesions, in particular left main stem, true bifurcations and long lesions.

I

A

Patient/Lesion Characteristics Included In Ongoing Intravascular Ultrasound Guided PCI Studies

Left Main Coronary Artery (LMCA)



Bifurcation lesions



Chronic Total Occlusions



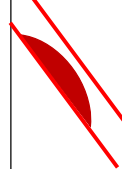
In Stent Restenosis



Calcified Lesions



Long Lesions



Special considerations



IVUS-ACS

TVF according to pre-specified optimal IVUS criteria

Target criteria for optimal IVUS

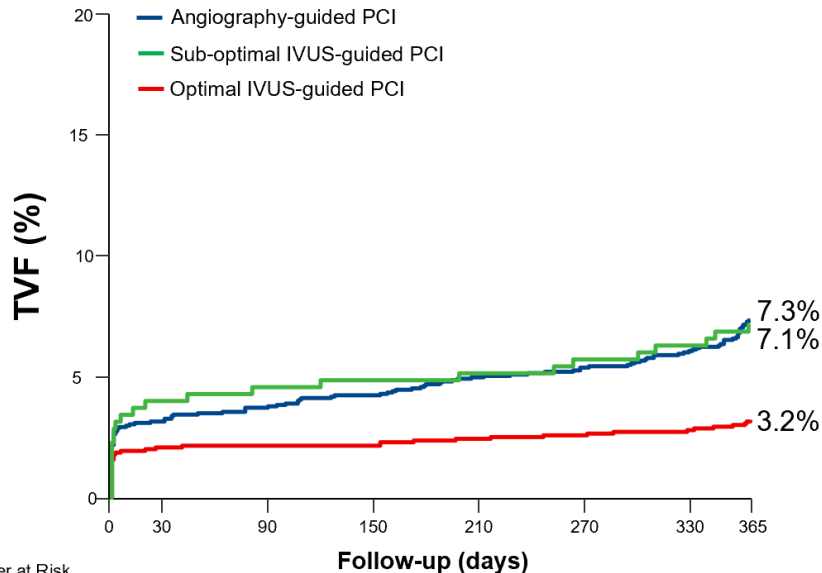
Non-left main lesions:

- (1) MSA $>5.0 \text{ mm}^2$ or $>90\%$ of the MLA at the distal reference segment; and
- (2) plaque burden $<55\%$ within 5 mm proximal or distal to the stent edge; and
- (3) absence of medial dissection $>3 \text{ mm}$ in length.

Left main lesions:

MSA $>10 \text{ mm}^2$ for the left main segment, $>7 \text{ mm}^2$ for the ostial/proximal LAD and $>6 \text{ mm}^2$ for the ostial/proximal LCX (if stented).

In the IVUS group, optimal post-PCI IVUS criteria were met in 1392 of 1743 (79.9%) patients



	Number at Risk							
	0	30	90	150	210	270	330	365
Angiography-guided PCI	1752	1697	1687	1677	1664	1655	1642	1625
Optimal IVUS-guided PCI	1392	1363	1361	1361	1357	1353	1350	1347
Sub=optimal IVUS-guided PCI	351	336	334	333	1330	328	326	324

2025 ACC/AHA/ACEP/NAEMSP/SCAI Guideline for the Management of Patients With ACS

Recommendation for Use of Intracoronary Imaging Referenced studies that support recommendation are summarized in the Evidence Table.		
COR	LOE	Recommendation
1	A	1. In patients with ACS undergoing coronary stent implantation in left main artery or in complex lesions, intracoronary imaging with intravascular ultrasound (IVUS) or optical coherence tomography (OCT) is recommended for procedural guidance to reduce ischemic events.* ^{1–11}

*Adapted from the “2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization.”¹²

Intravascular Imaging During PCI

JACC State-of-the-Art Review

TABLE 3 Programmatic Recommendations for Intravascular Imaging

Operator level

IVI is recommended as an essential adjunct to angiography for specific lesion subsets (eg, LM, proximal LAD, in-stent restenosis, stent thrombosis, calcified coronary arteries, chronic total occlusions) or any scenario where angiography may inadequately elucidate anatomy

Initial and ongoing training and education are critical to properly utilize and interpret images obtained from IVI

Procedure reports should adequately and objectively describe both angiographic and IVI findings and how the interpretation of results influenced clinical and procedural decisions

Institution level

IVI capability should be included in all U.S. CCLs

Most CCLs should ideally have both IVUS and OCT

Routine (vs selective) IVI use may help develop and maintain high-level competency of CCL operators and staff

Images should be transferred to an image-archiving and communications systems (PACS)

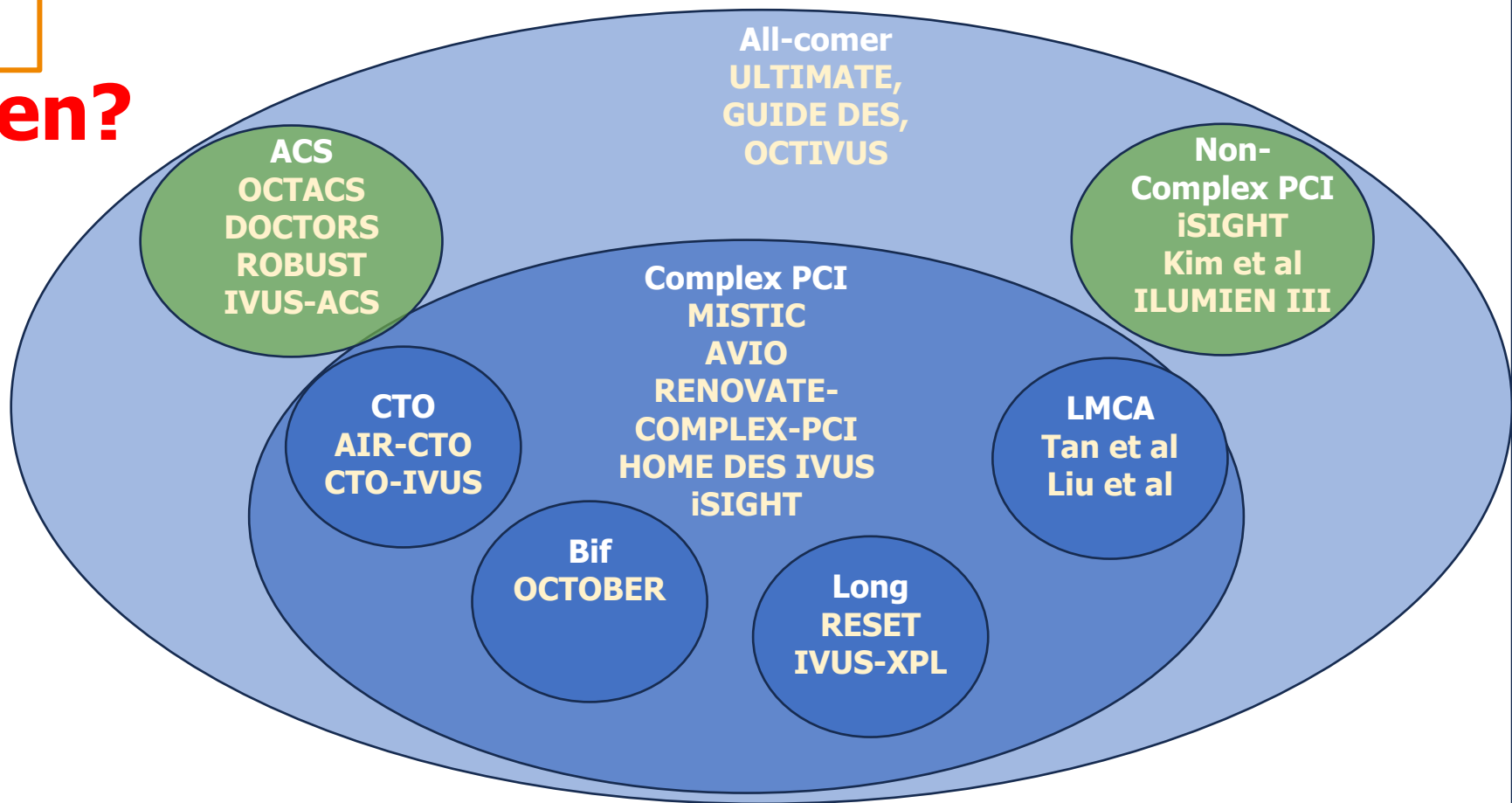
National level

Training programs should prioritize exposing trainees to an adequate volume of IVI to achieve competency

Professional societies should continue to develop and offer lifelong training opportunities and competency tools

02

When?



#OCT/IVUS are helping in ALL phases of the PCI

Pre-PCI

Morphology¹

ISR

Length²

Diameter³

A

Deep calcium

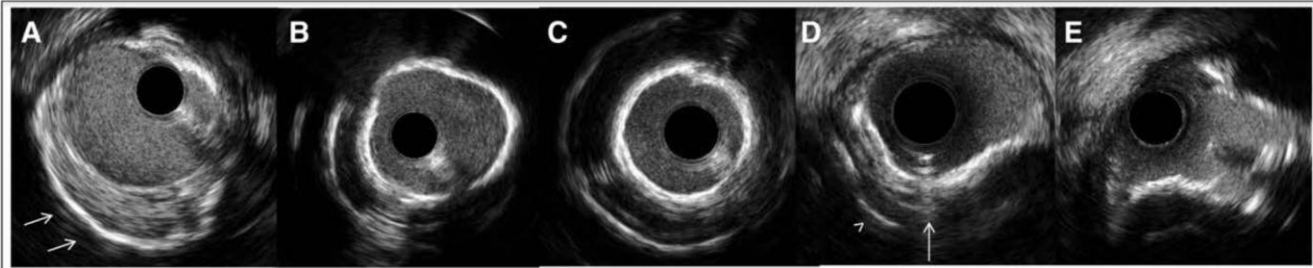
Superficial calcium

Concentric calcium

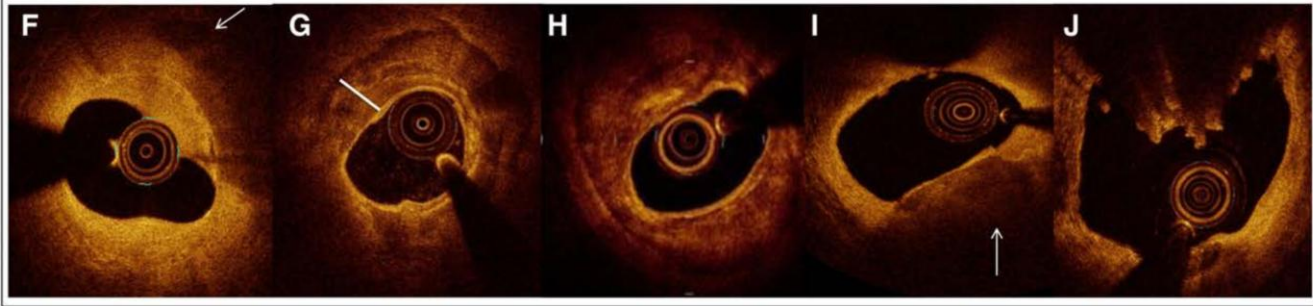
Eccentric calcium

Calcified nodule

IVUS



OCT



Shlofmitz E, et al. *Circ Cardiovasc Interv.* 2020

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Pre-PCI

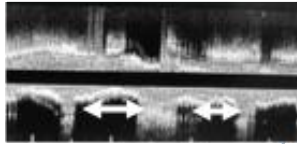
Morphology
1

ISR

Length²

Calcified Plaques

SCORE EVALUATION



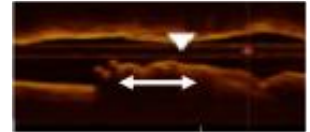
Length

IVUS
>360 = 1 point
NA
>270 in ≥ 5mm = 1 point
If yes = 1 point
<3.5mm = 1 point

Variable
Maximum calcium angle (°)
Maximum calcium thickness (mm)
Calcium length (mm)
Calcified nodule
Vessel diameter (mm)

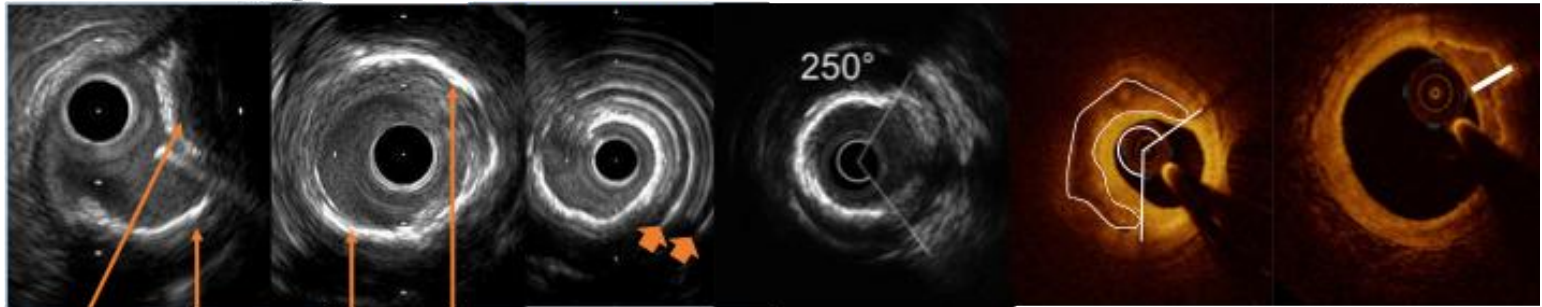
OCT
>360 = 1 point
> 0.3 = 1 point
>270 in ≥ 3mm = 1 point
NA
NA

SCORE EVALUATION



Length

[J Am Coll Cardiol Interv.](#) 2025 Mar, 18 (5) 622–633



Nodular

Superficial

Deep

Reverberations

Angle

Area and Angle

Thickness

#OCT/IVUS are helping in ALL phases of the PCI

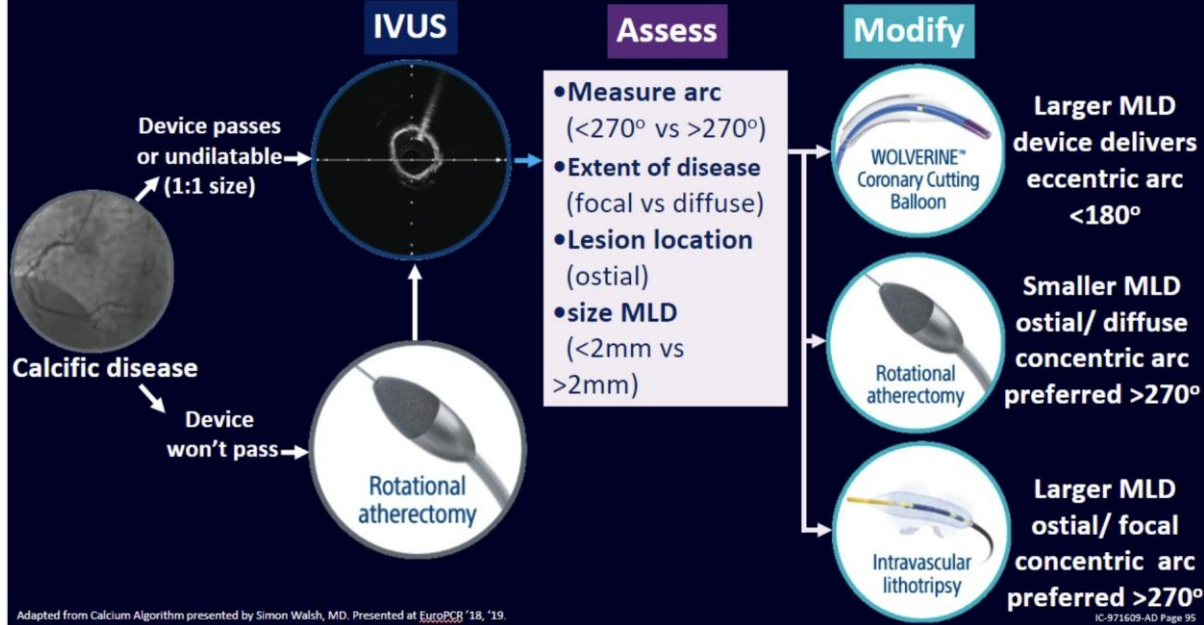
Pre-PCI

Morphology
1

ISR

Length²

Calcific Lesion Modification Strategy



#OCT/IVUS are helping in ALL phases of the PCI

	Morphology ¹	ISR ²	Length ²	Diameter ³
Pre-PCI	Type I			
	Type II Biologic			
	Type III Mixed			

#AI OCT/IVUS are helping in ALL phases of the PCI

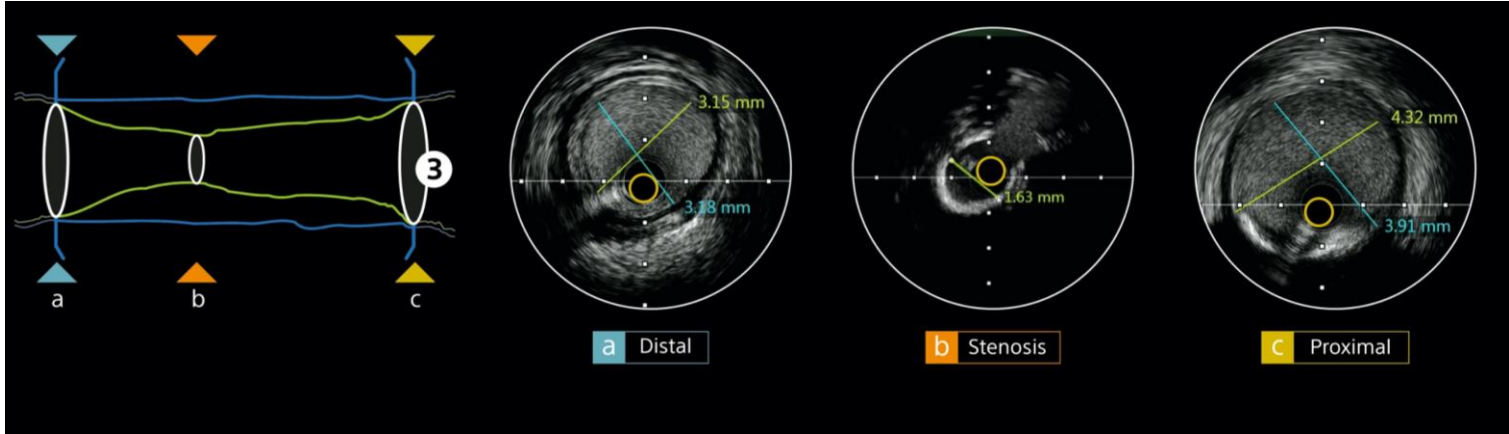
Pre-PCI

M₁orphology

ISR

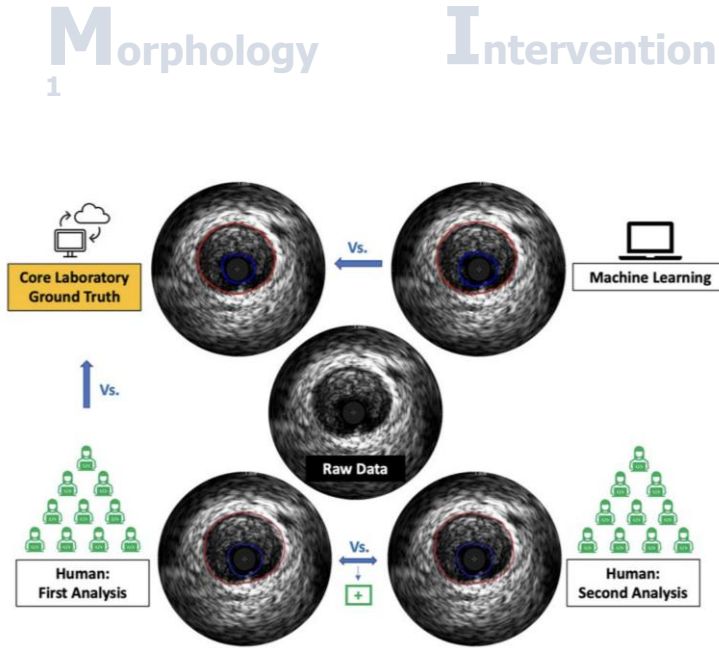
Length²

Diameter³

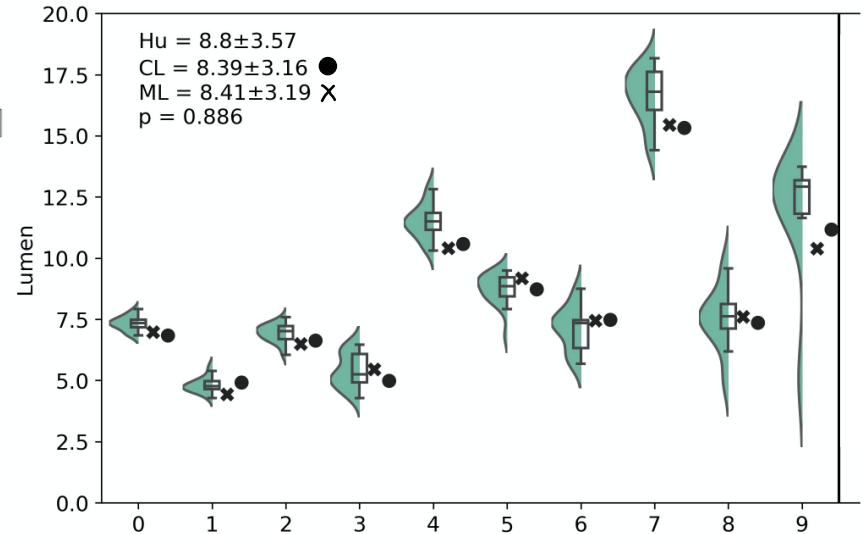


#AI IVUS is helping in ALL phases of the PCI

Pre-PCI



For lumen area, relative differences between the human readers and the Core Lab ranged from 0.26% to 12.61%.



•DL Algorithm vs 10 experts vs CoreLab

DOI: 10.1007/s10554-022-02563-6

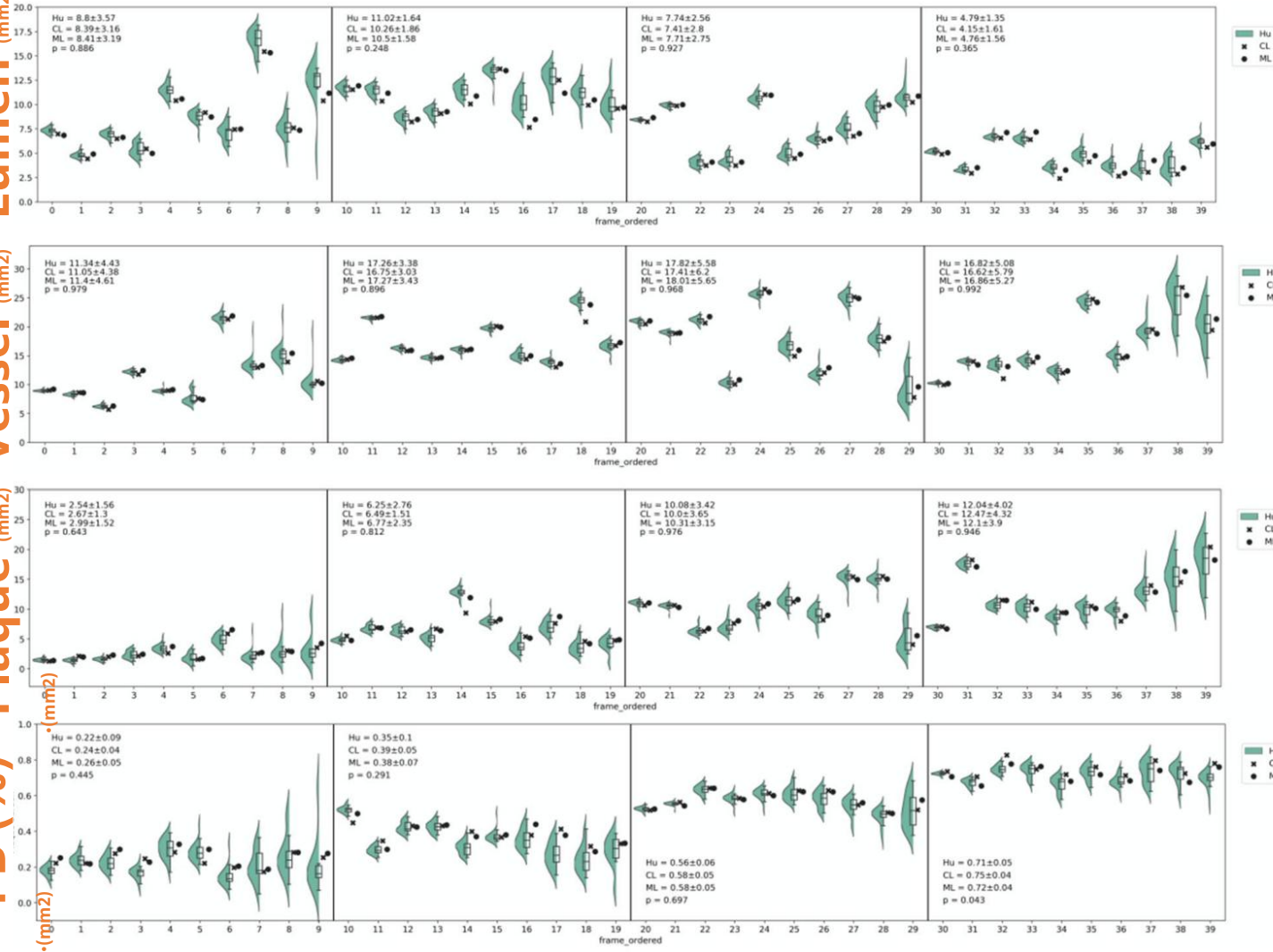
•PB (%)
(mm²)

•Plaque (mm²)

•Vessel (mm²)

•Lumen (mm²)

•Lumen (mm²)



#AI OCT/IVUS are helping in ALL phases of the PCI

Pre-PCI

Morphology¹

ISR

Length²

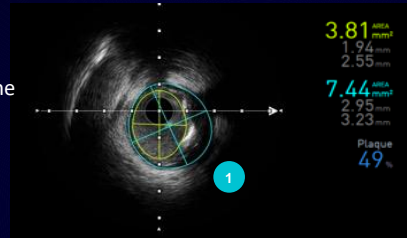
Diameter³

AVIGO+ Automated Lesion Assessment ALA™ System

ALA leverages Machine Learning to automatically deliver with accuracy key measurements and borders

1 Vessel and Lumen Borders

- Vessel and lumen borders on every frame
- Vessel area, lumen area and diameter measurements on every frame

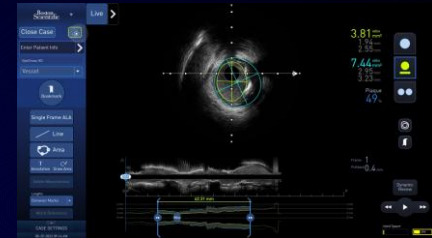


2 Vessel Profile

Graphical representation of the average vessel and lumen diameters

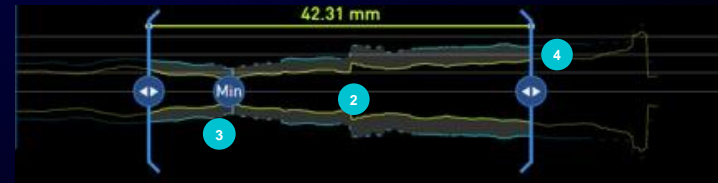
3 Min Key Frame marker

Minimum lumen area in IVUS run



4 Distal & Proximal Key Frame markers

Proximal and distal key frame markers represented at ≤50% plaque burden from minimum frame.



#AI OCT/IVUS are helping in ALL phases of the PCI

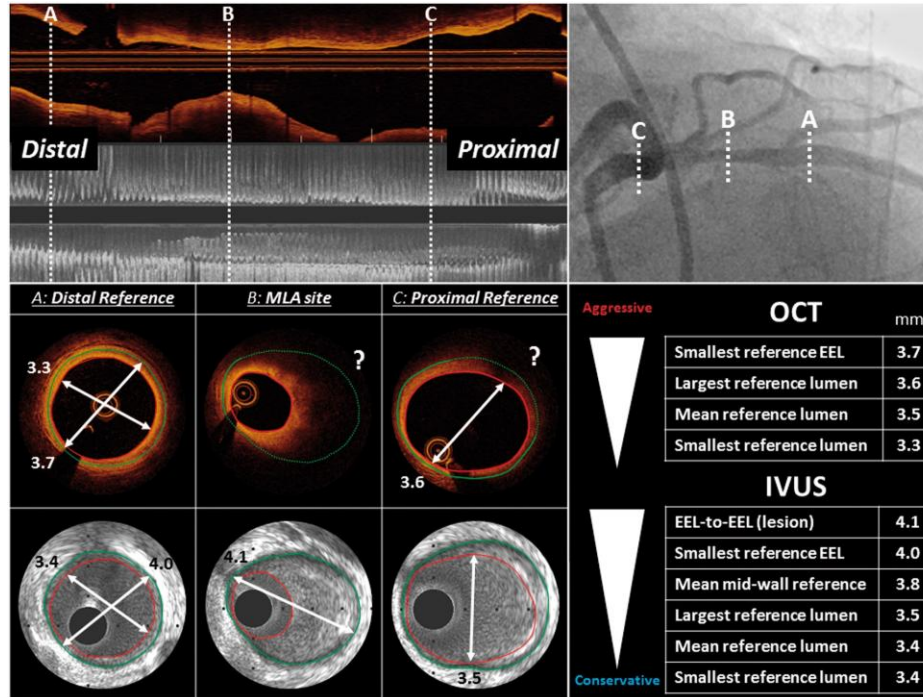
Pre-PCI

Morphology₁

ISR

Length²

Diameter³



#AI OCT/IVUS are helping in ALL phases of the PCI

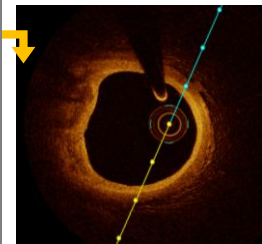
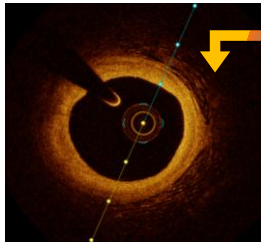
Pre-PCI

Morphology¹

ISR

Length²

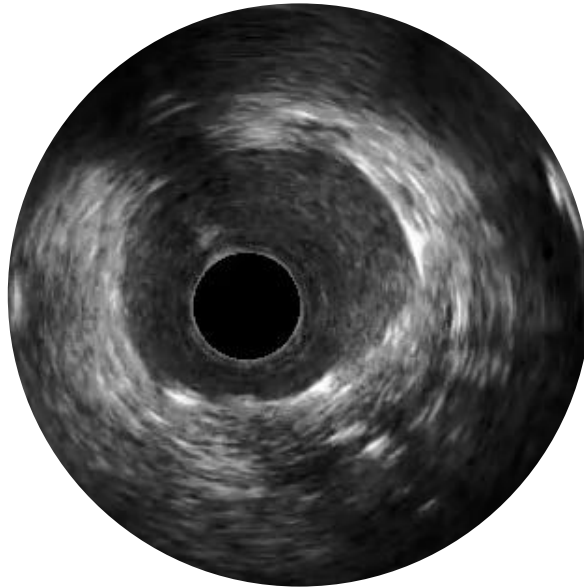
Diameter³



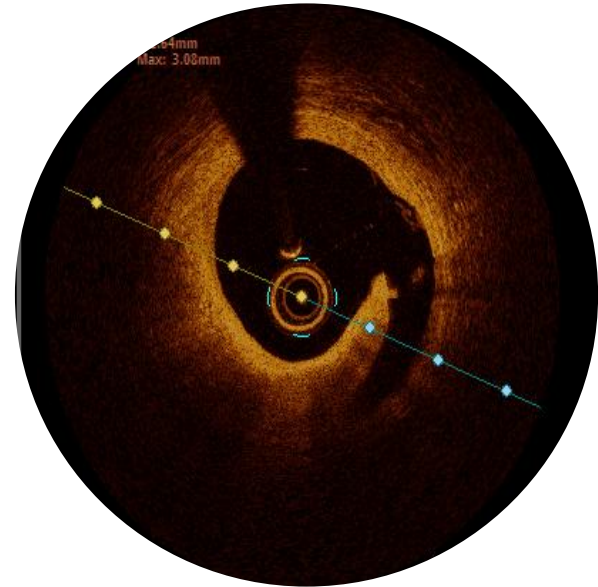
#AI OCT/IVUS are helping in ALL phases of the PCI

Post-
PCI

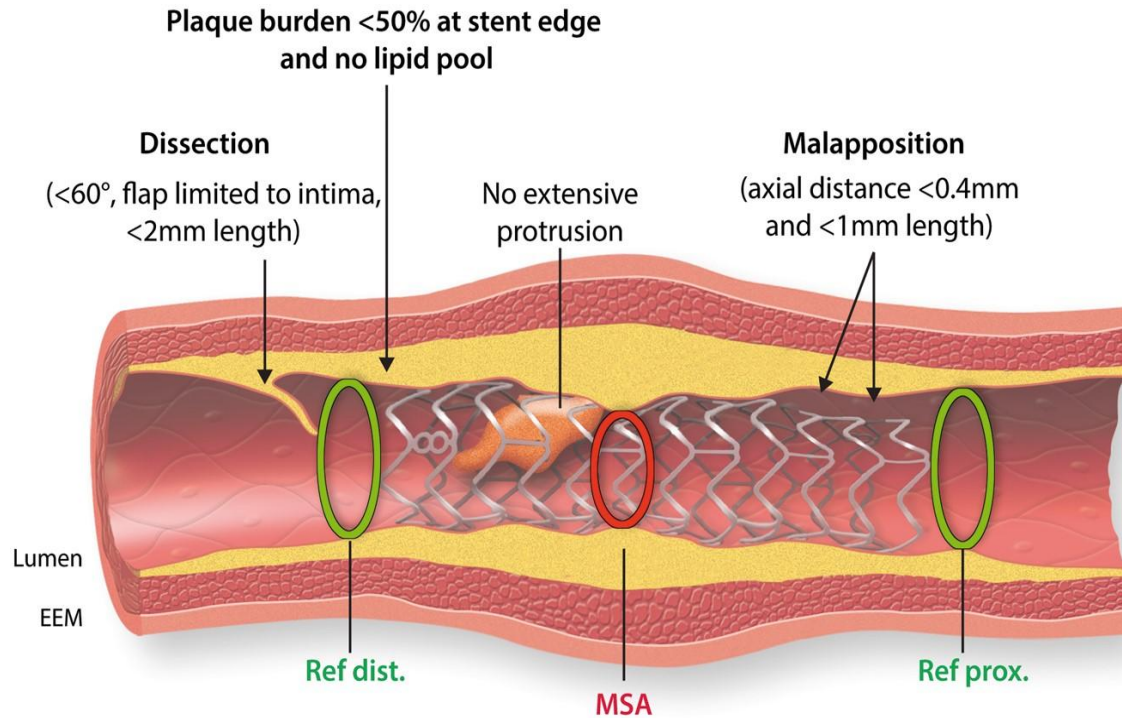
Medial dissection⁴



Apposition⁵

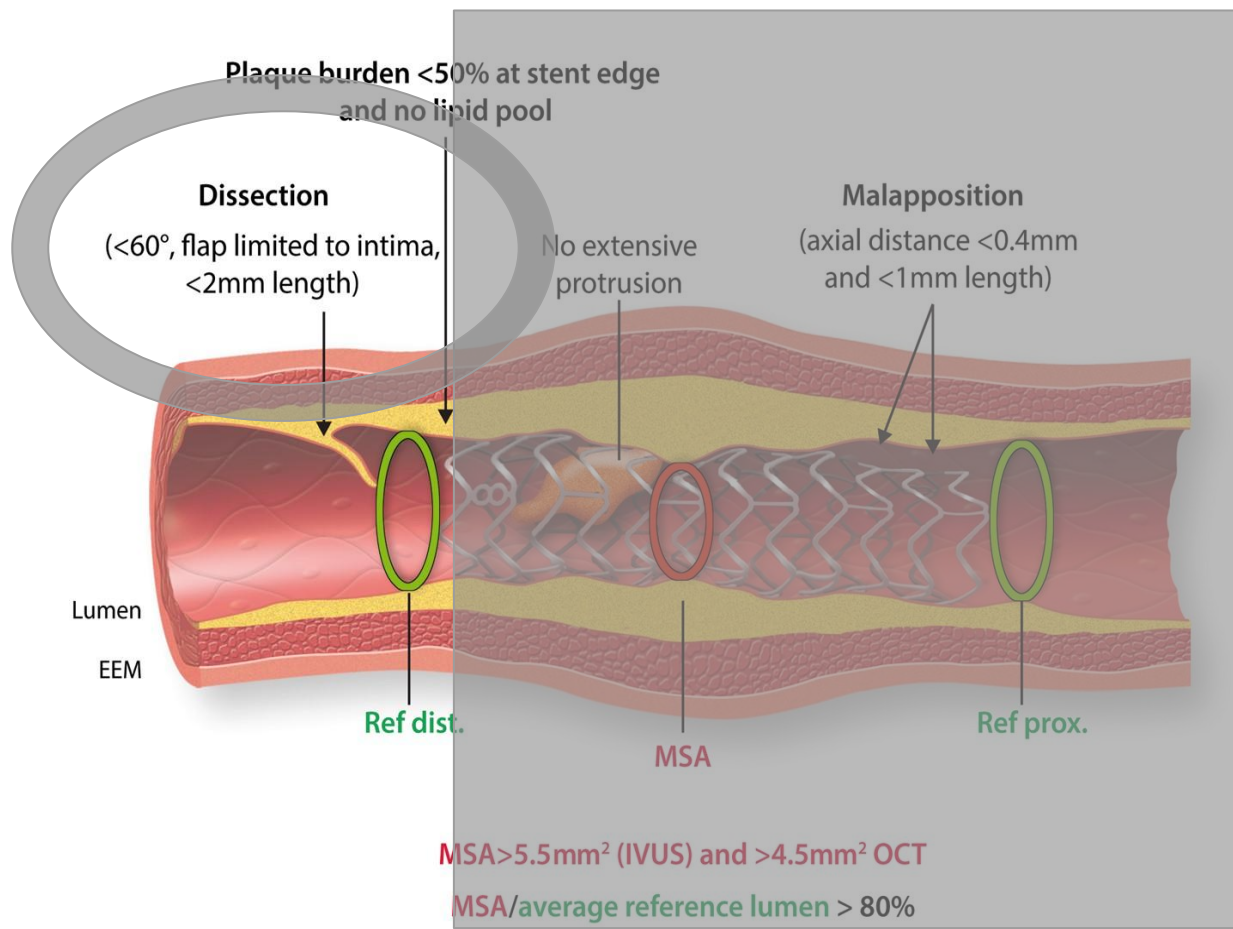


Xpansion⁶



MSA > 5.5mm² (IVUS) and > 4.5mm² OCT

MSA / average reference lumen > 80%



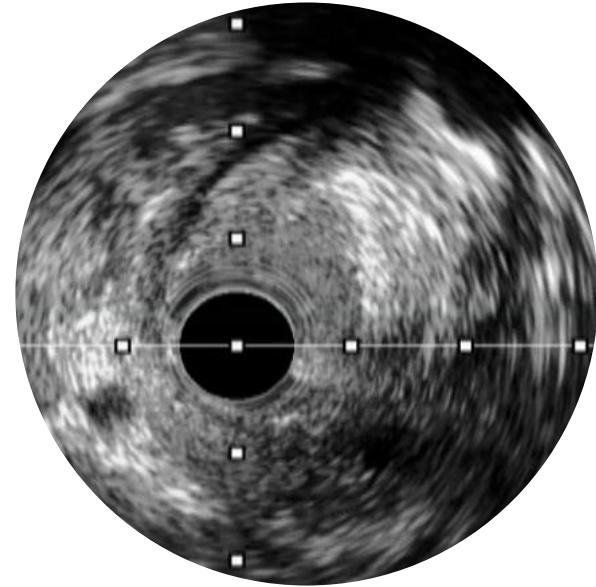
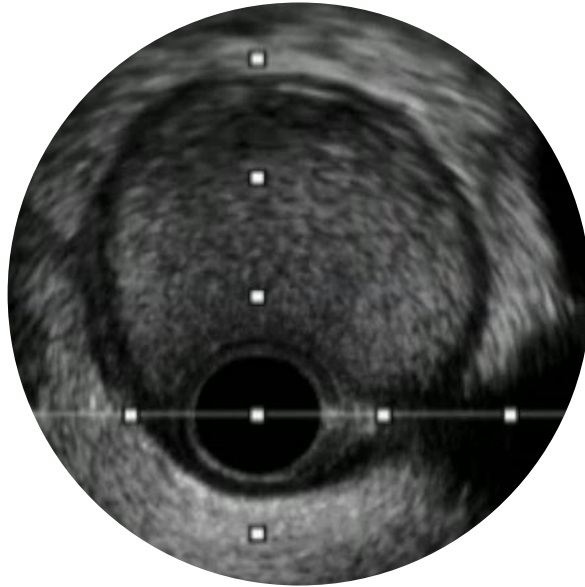
#AI OCT/IVUS are helping in ALL phases of the PCI

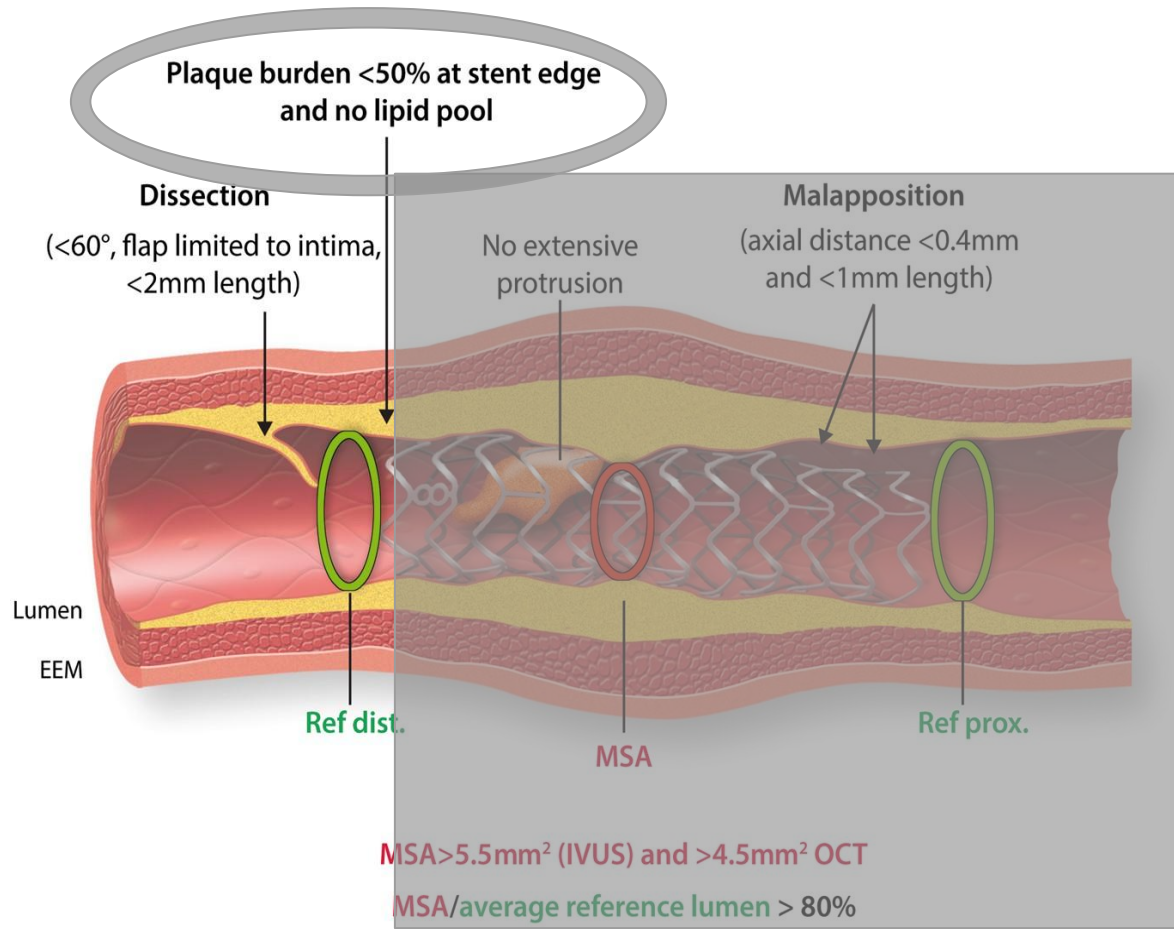
M²issed plaque

Apposition⁵

Xpansion⁶

Post-
PCI





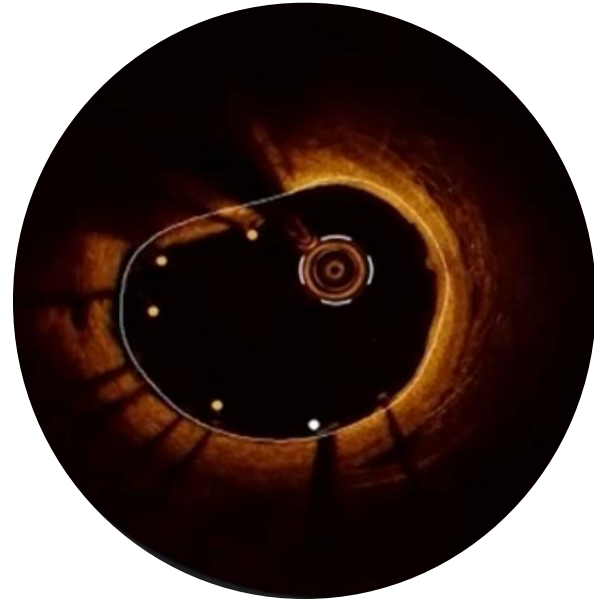
#AI OCT/IVUS are helping in ALL phases of the PCI

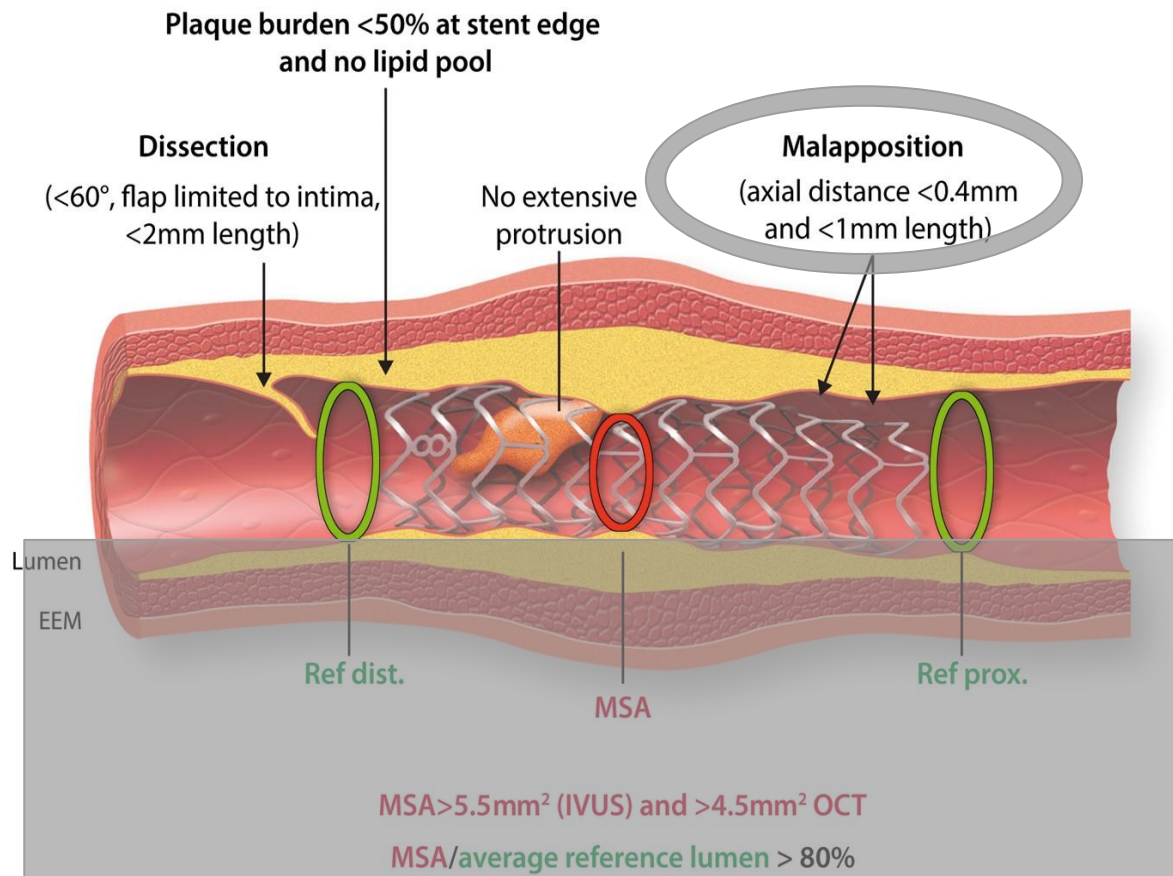
Medial dissection⁴

Apposition⁵

Xpansion⁶

**Post-
PCI**





#AI OCT/IVUS are helping in ALL phases of the PCI

Post-PCI

Medial dissection⁴

Apposition⁵

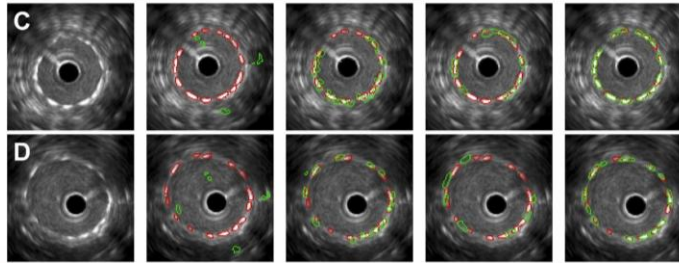
Xpansion⁶



#AI OCT/IVUS are helping in ALL phases of the PCI

Post-PCI

Medial dissection⁴

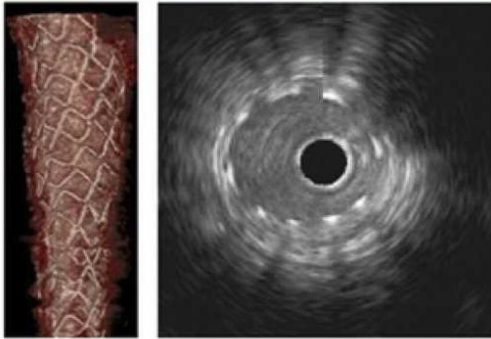


Apposition⁵

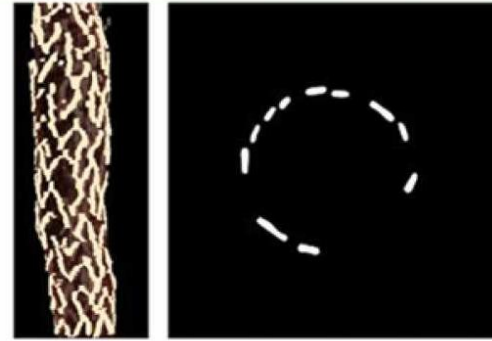
Xpansion⁶

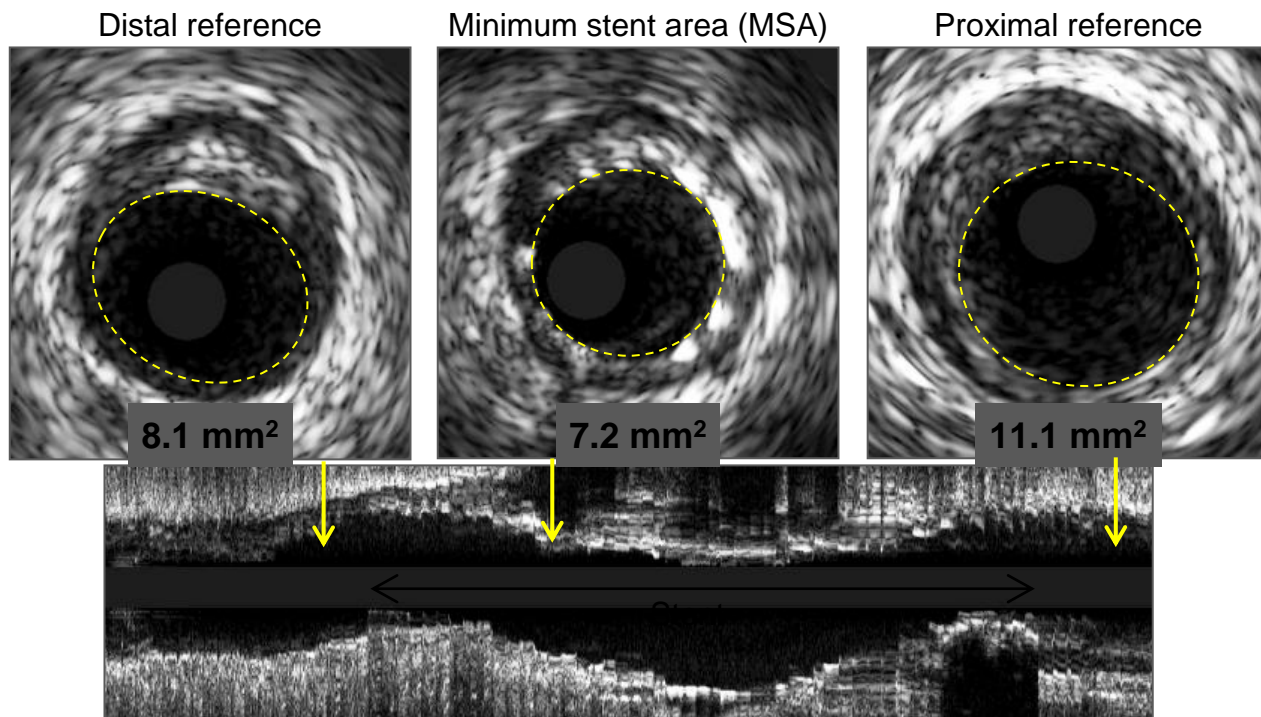
ML stent 3D reconstruction
in
both HD-IVUS and IVUS
with good performance

Synthetic Post-PCI IVUS

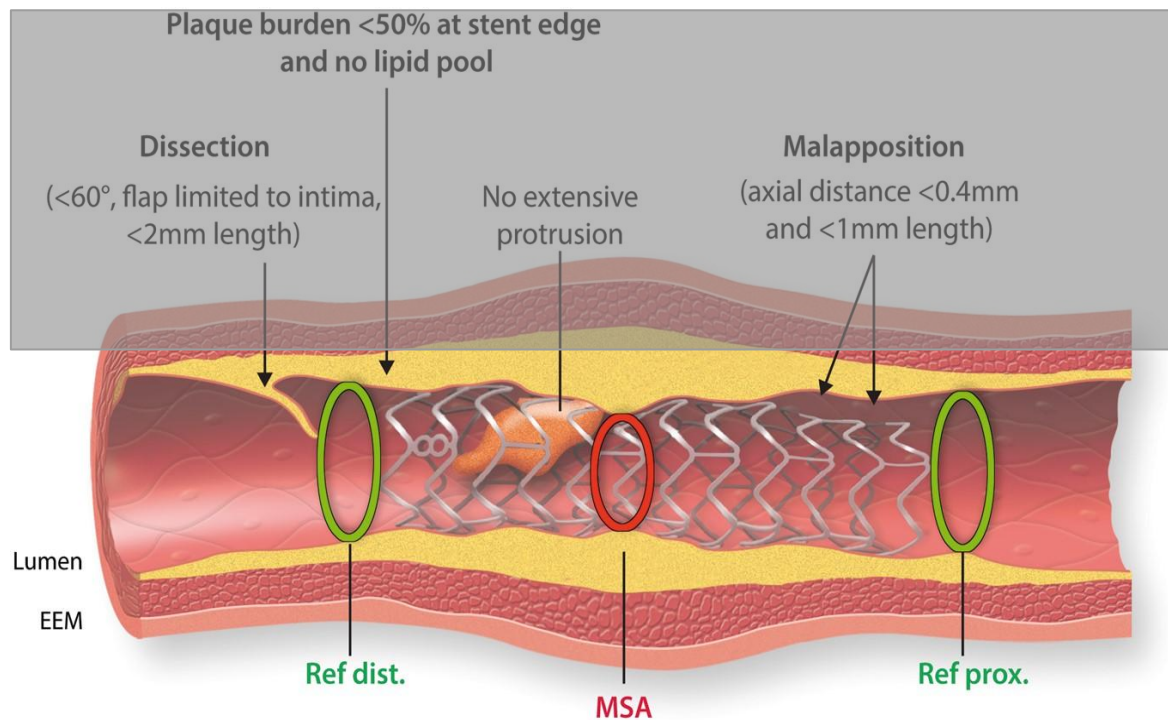


Post-PCI IVUS Stent Mask





$$\% \text{ stent expansion} = \text{MSA} / \text{average of reference lumen area}$$
$$75.0\% = 7.2 / [(8.1 + 11.1) / 2] * 100$$



MSA > 5.5mm² (IVUS) and > 4.5mm² OCT

MSA / average reference lumen > 80%

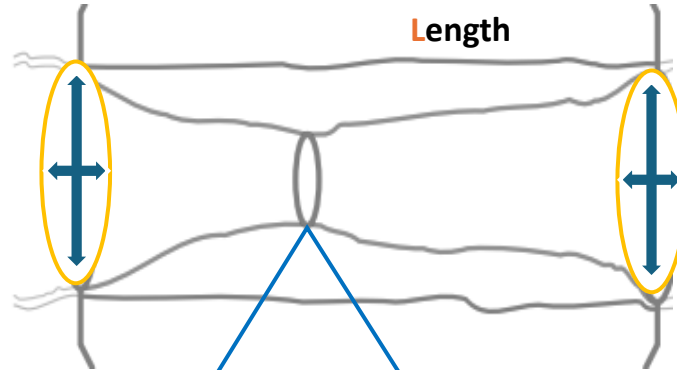
In Summary Pre-PCI – CALL-Di

Actionable variables

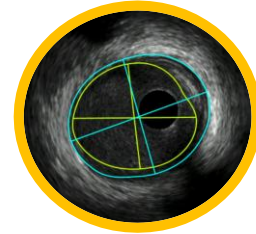
Calcium*

Length

Diameter

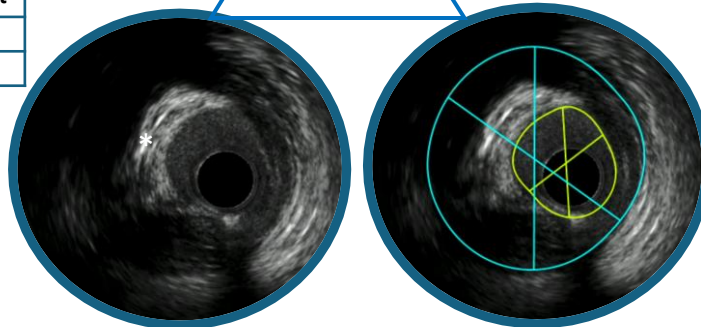


Diameter
Max and Min



Variable	IVUS Calcium* Score
----------	---------------------

Max calcium angle (°)	>360 = 1 point
Calcium length (mm)	>270 in ≥ 5mm = 1 point
Calcified nodule	If yes = 1 point
Vessel diameter (mm)	<3.5mm = 1 point



IVUS Device Sizing
all are diameters

EEM to EEM diam at the lesion

Smallest reference EEM

Mean mid-wall

Largest reference lumen

Mean reference lumen

Smallest reference lumen

In Summary Post-PCI – DIAL-X

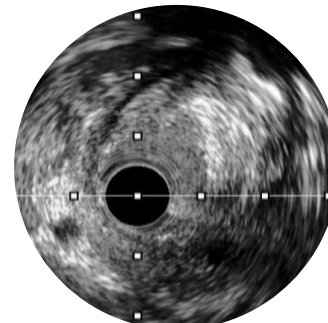
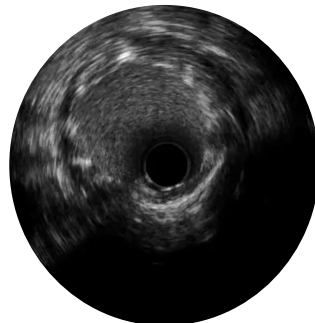
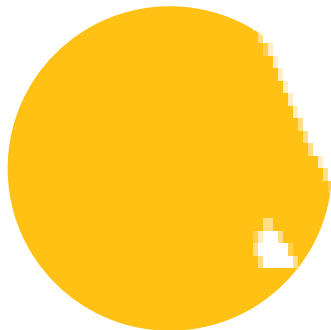
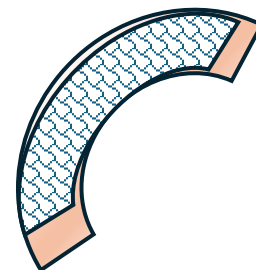
Actionable variables

Dissection

Apposition

Lesion residual

Xpansion



% stent expansion =
MSA / average of reference
lumen area

In Summary Post-PCI – DIAL-X

Actionable variables

Dissection

Apposition

Lesion residual

Xpansion

Consistent, Accurate,

Reproducible, Efficient/effective &

Safe

% stent expansion =
MSA / average of reference
lumen area