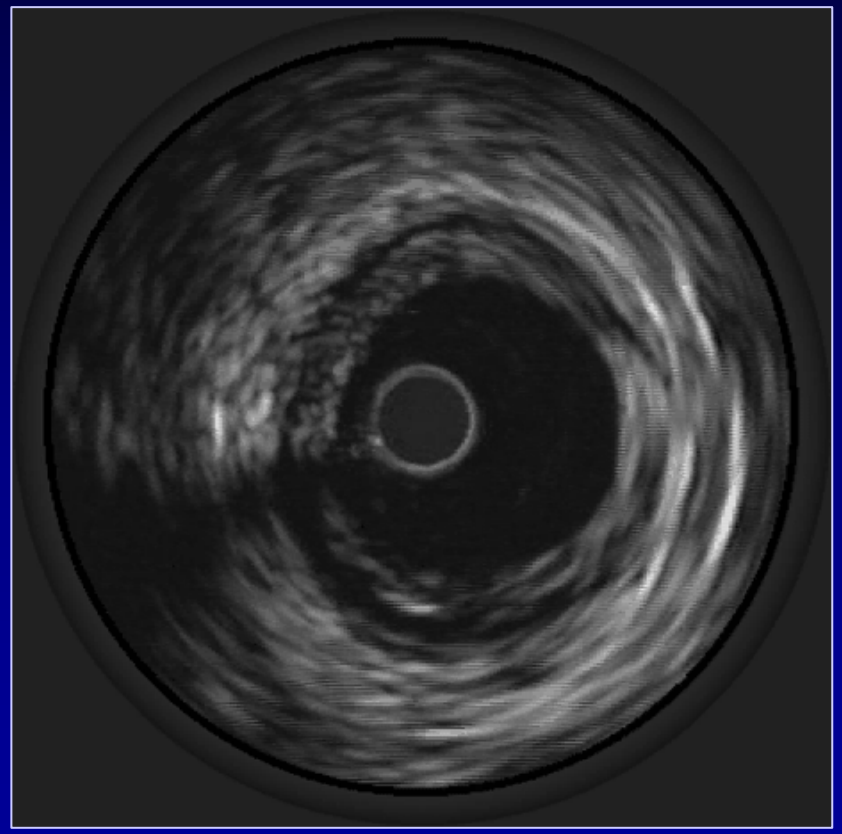
IVUS and DES in Complex PCI

- Alan C. Yeung, MD
- Interventional Cardiology Professor of Medicine
- Stanford University School of Medicine

Intravascular Ultrasound Imaging

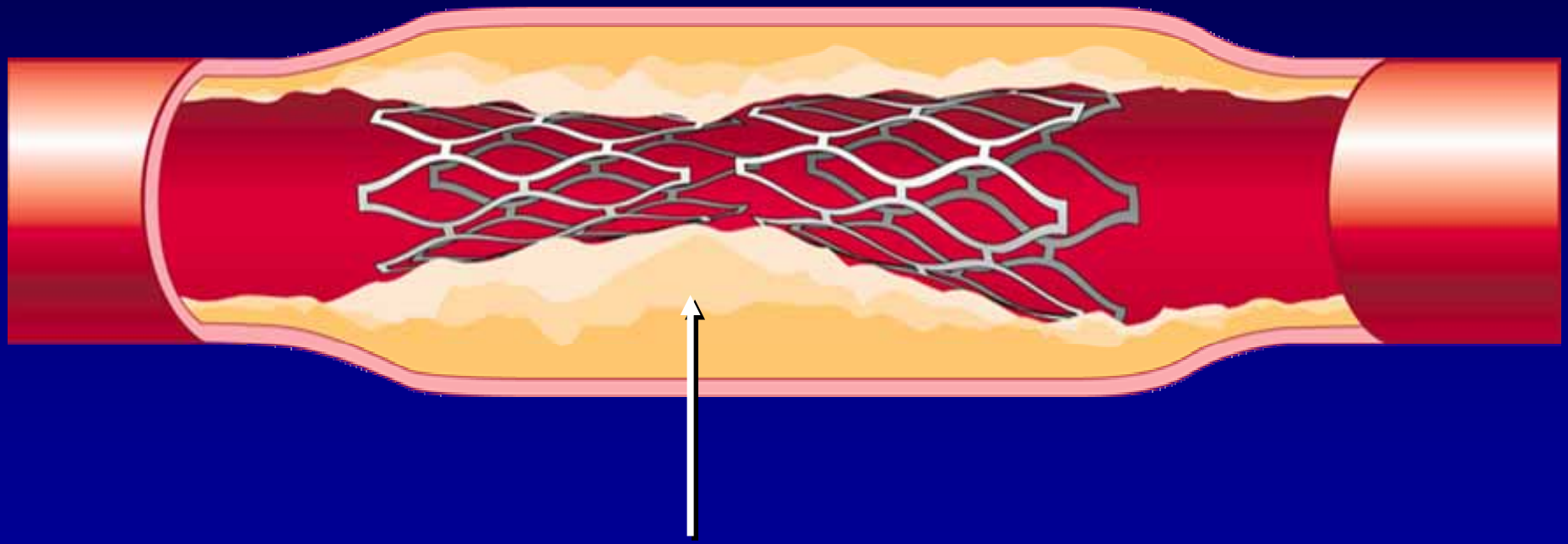
…the inside view of DES…



Korea, 2005

Stanford

Everyone gets a stent (mechanical)



Plaque Residual

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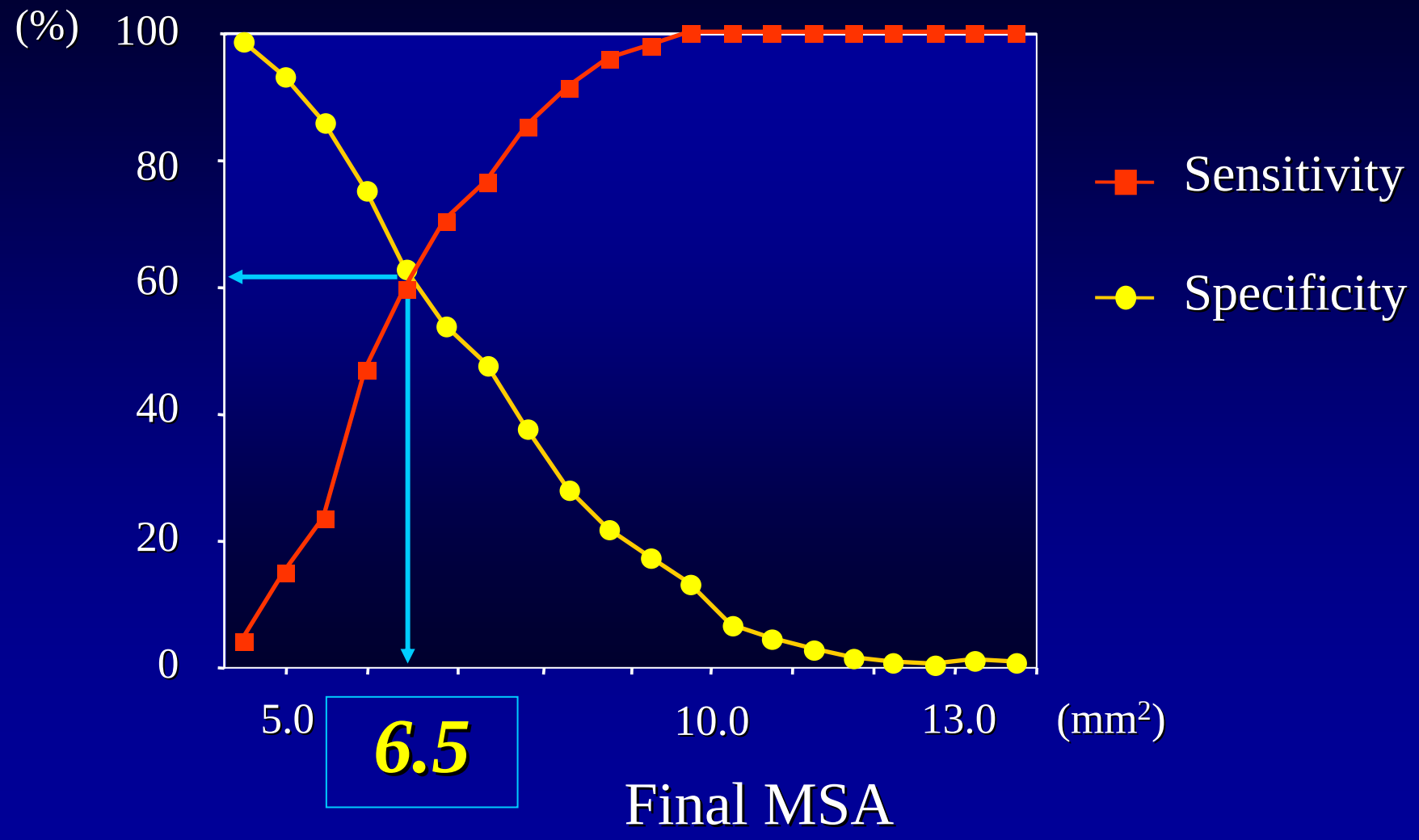
CRUISE: Final MSA to Predict TLR

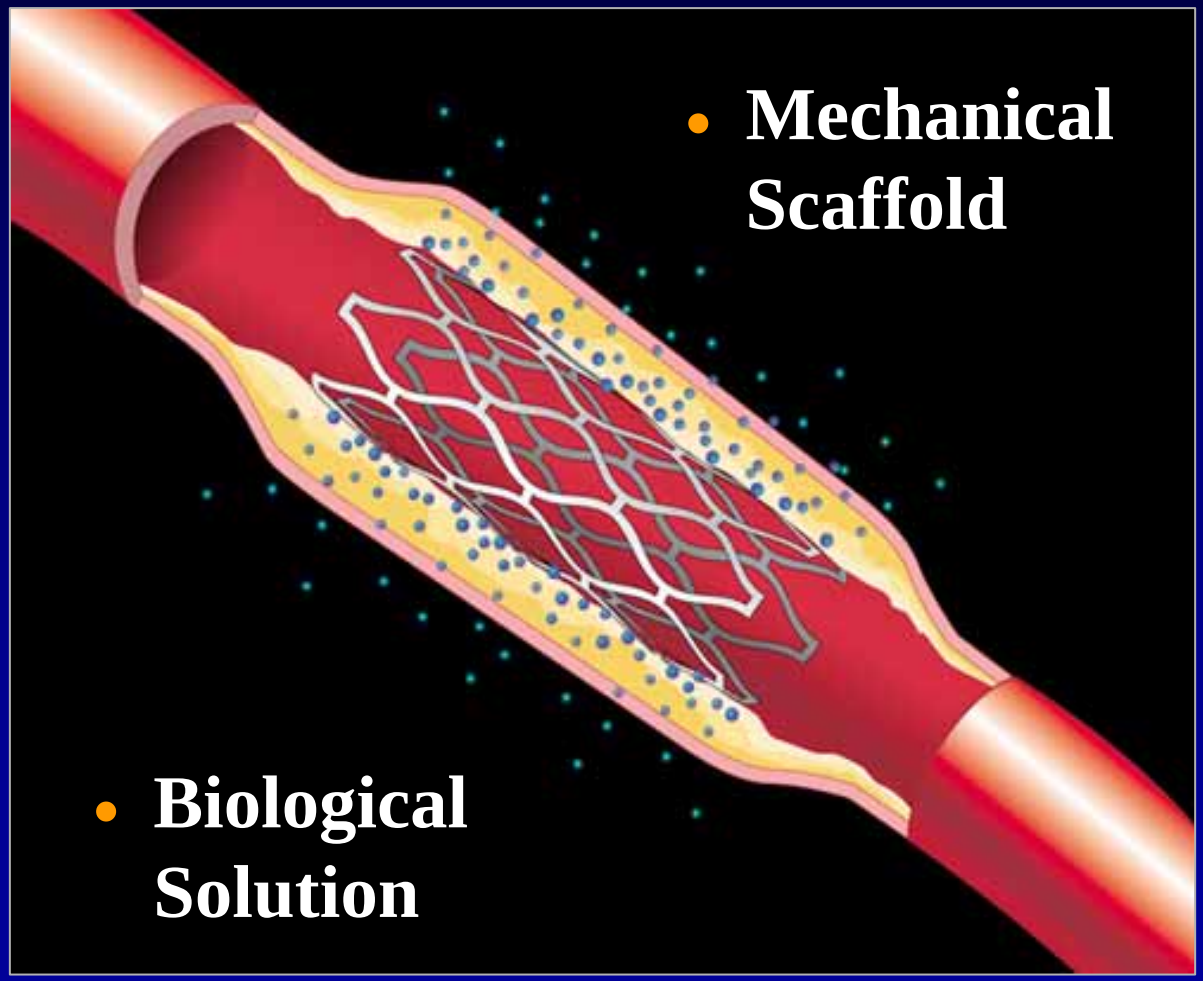


Morino Y, Fitzgerald PJ, et al. Am J Cardiol 2001

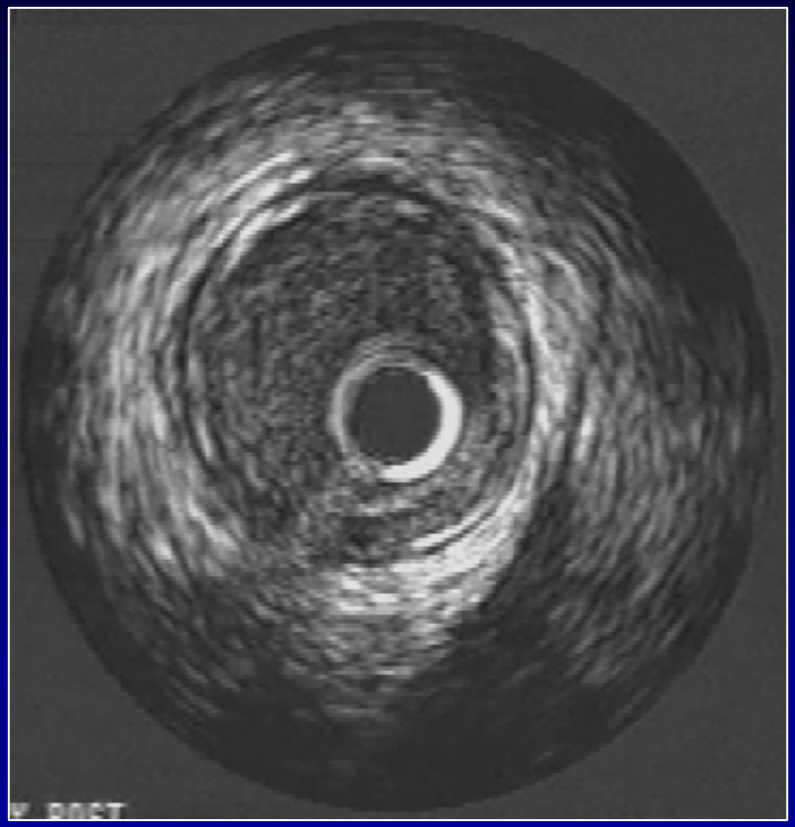
Stanford

Revolutional Technologies: Drug Eluting Stents

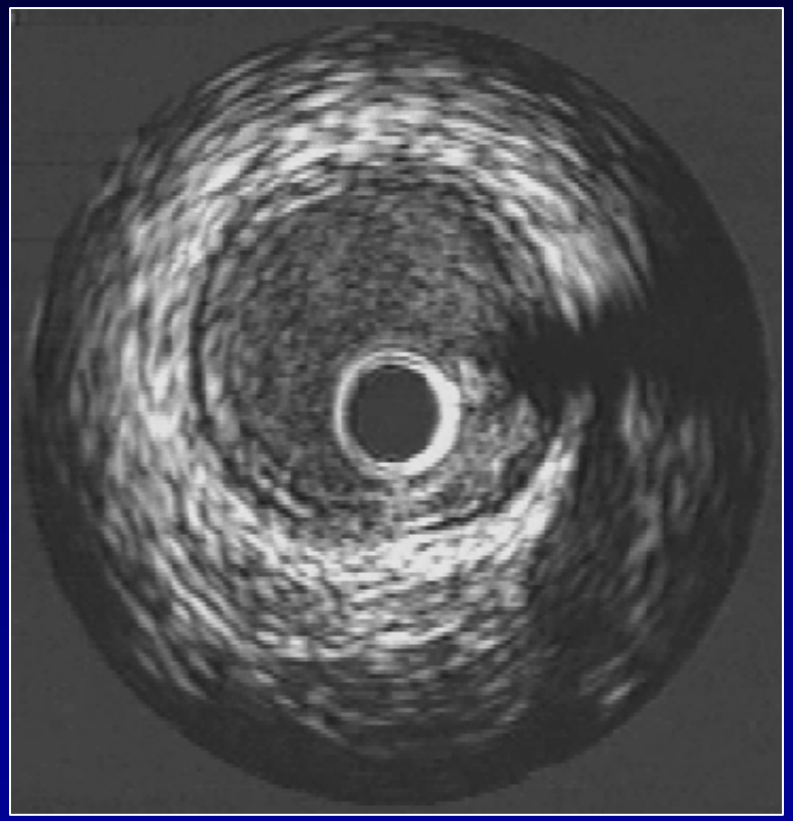
Stent as a Drug-Delivery Platform



DES Trial: Case Example
Bare metal stent



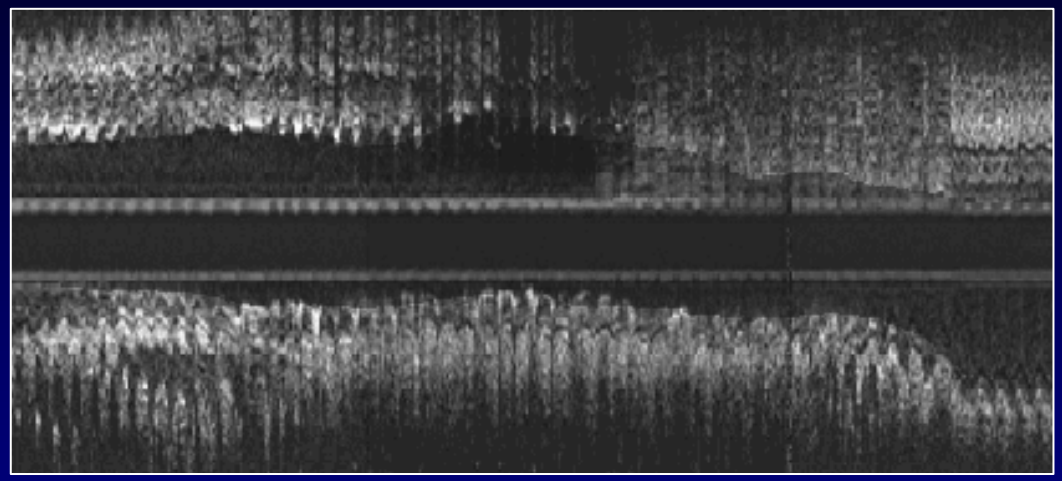
Baseline

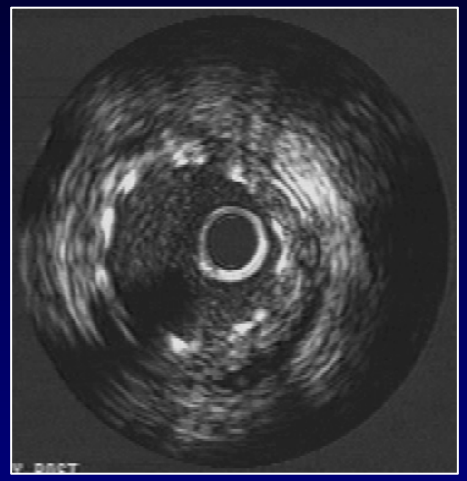


6M follow-up

DES: Case Example
Bare metal stent

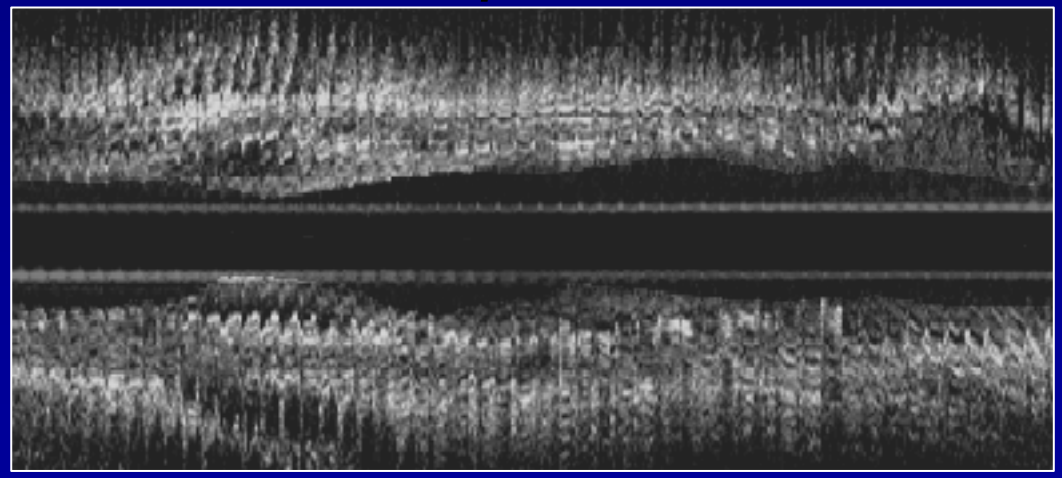
Baseline

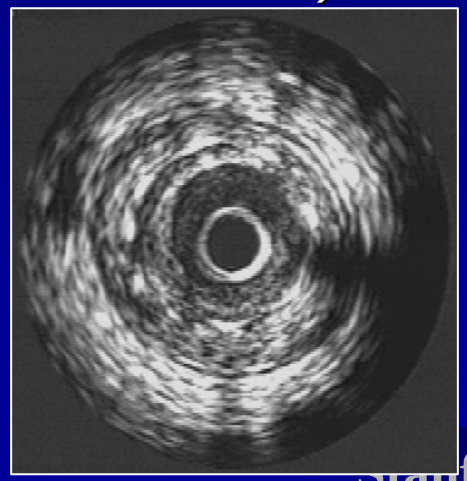




6-month follow up

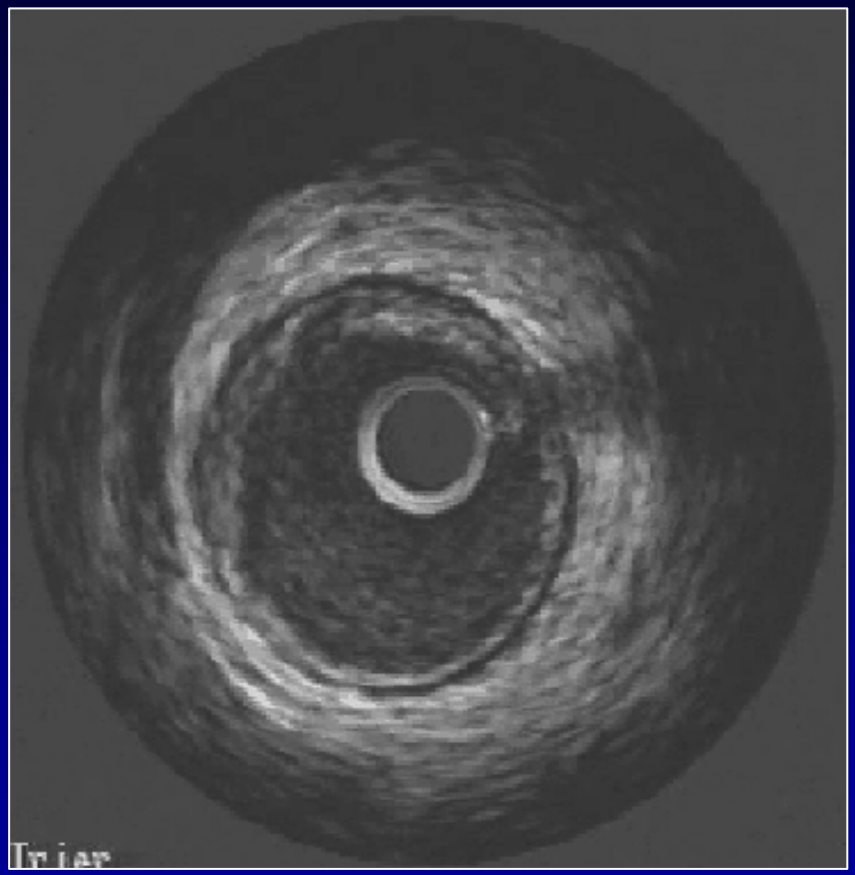
(%neointimal volume=50%,
late lumen area loss=5.72mm^2)



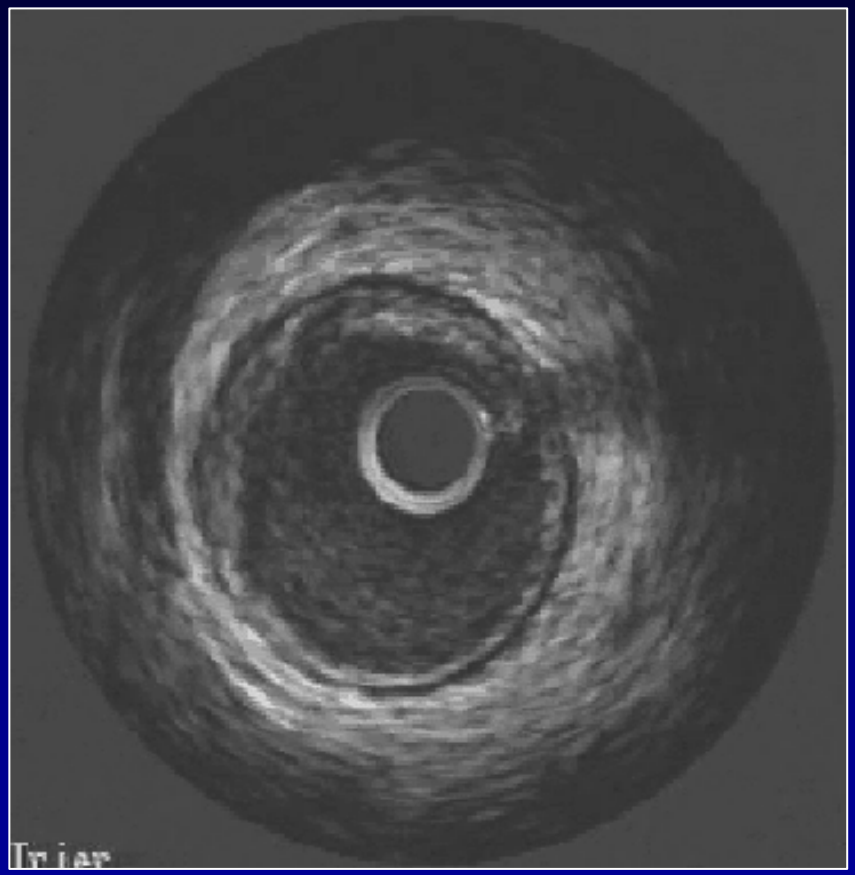


DES: Case Example

Drug-eluting stent



Baseline

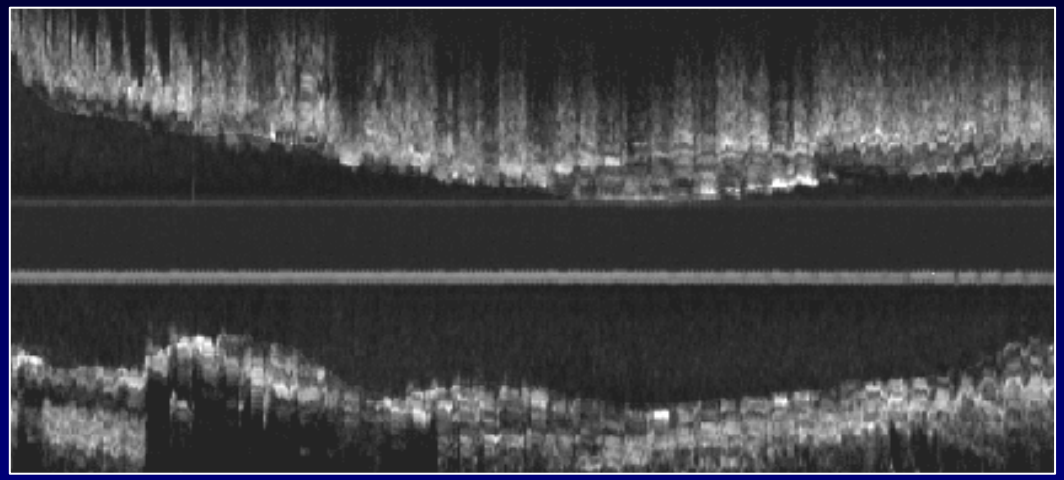


6M follow-up

DES: Case Example

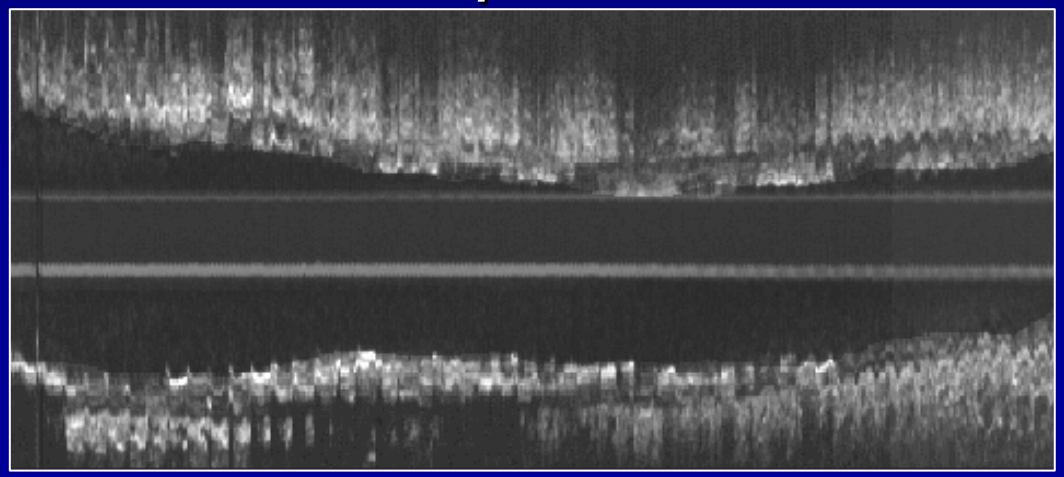
Drug-eluting stent

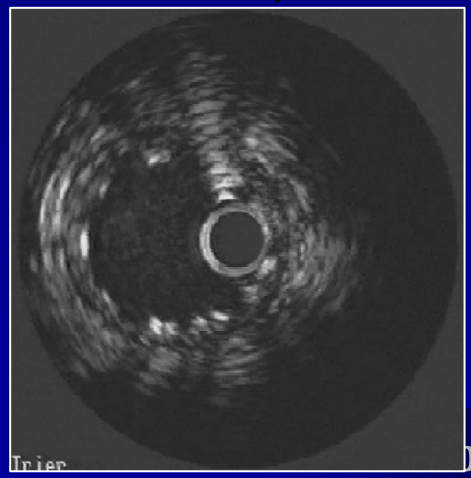
Baseline



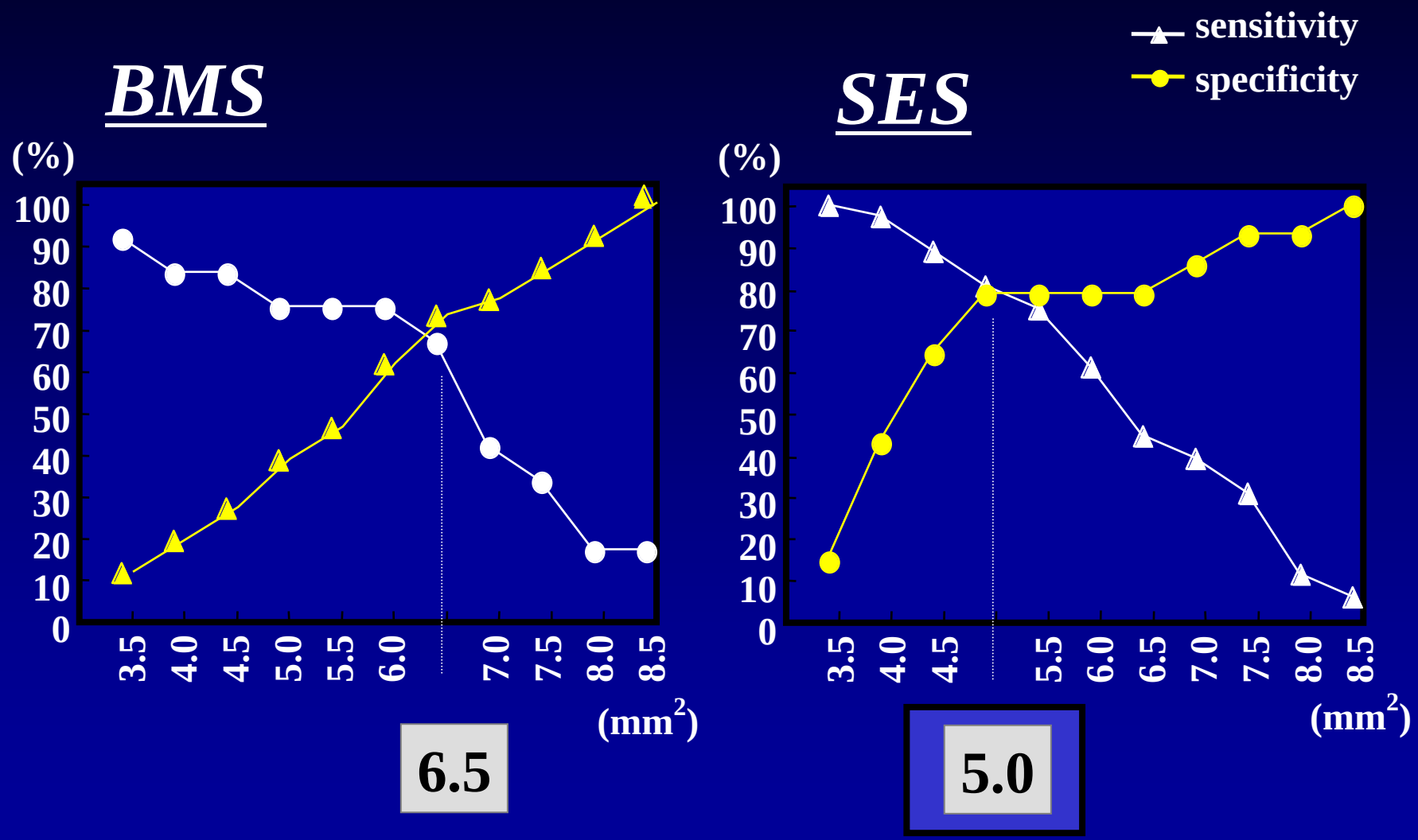
6-month follow up

(%neointimal volume= 0 %,
late lumen area loss= 0 mm^2)





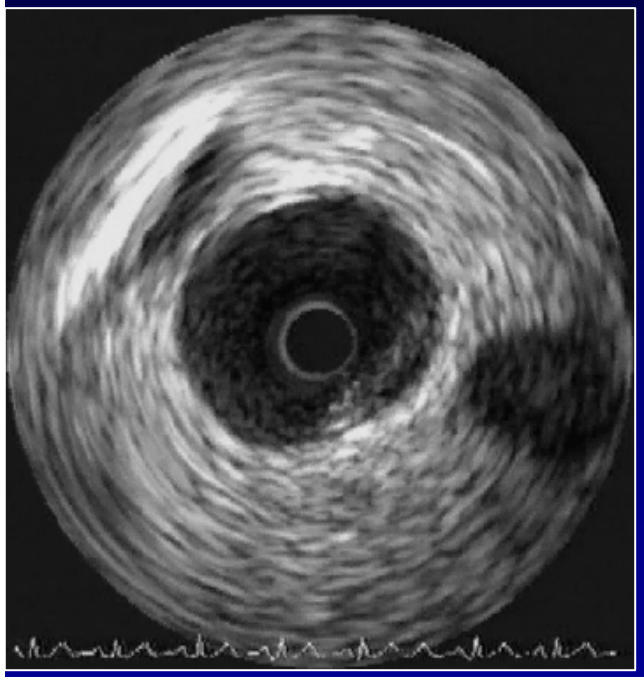
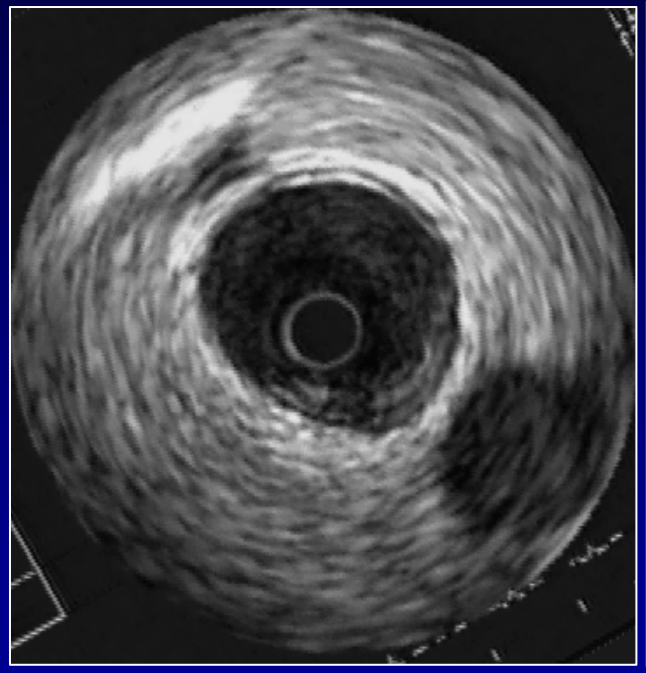
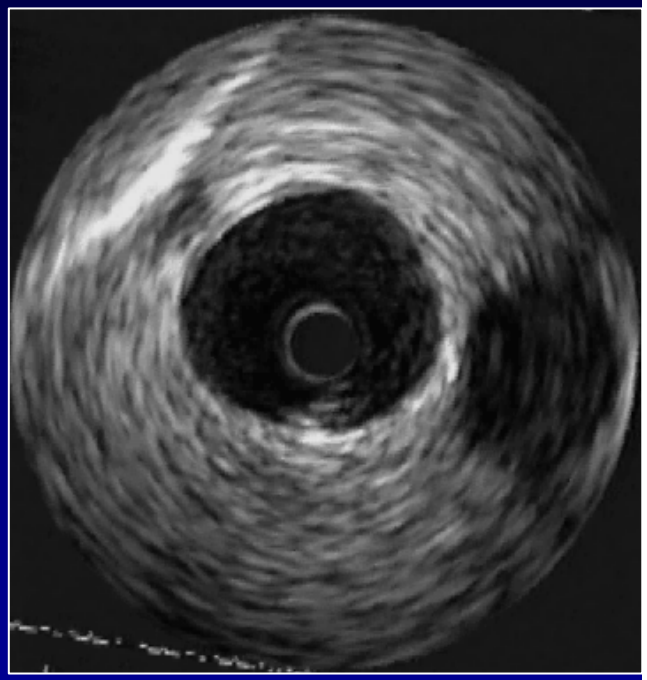
Optimal Threshold of MSA for Long-Term Stent Patency Following Sirolimus-Eluting Stent Implantation



JACC, 2004 (Sonoda et al)

Stanford

Drug-eluting Stent

POST	4 months	1 year
		
% NIV = 0 %	% NIV = 1.3 %	% NIV = 3.5 %
MLA = 5.13 mm^2	MLA = 5.09 mm^2	MLA = 4.83 mm^2

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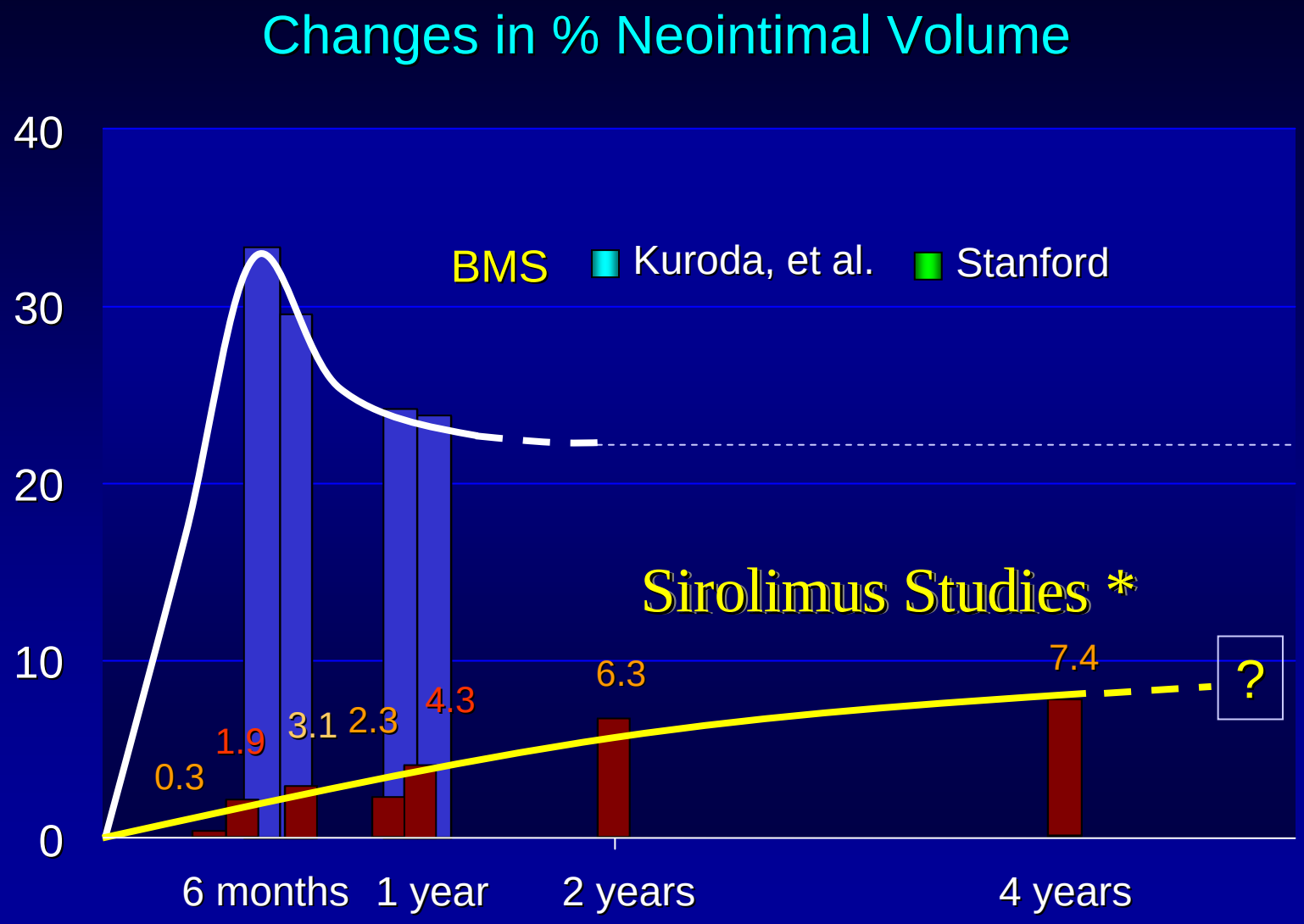
Chronological Change of NIH

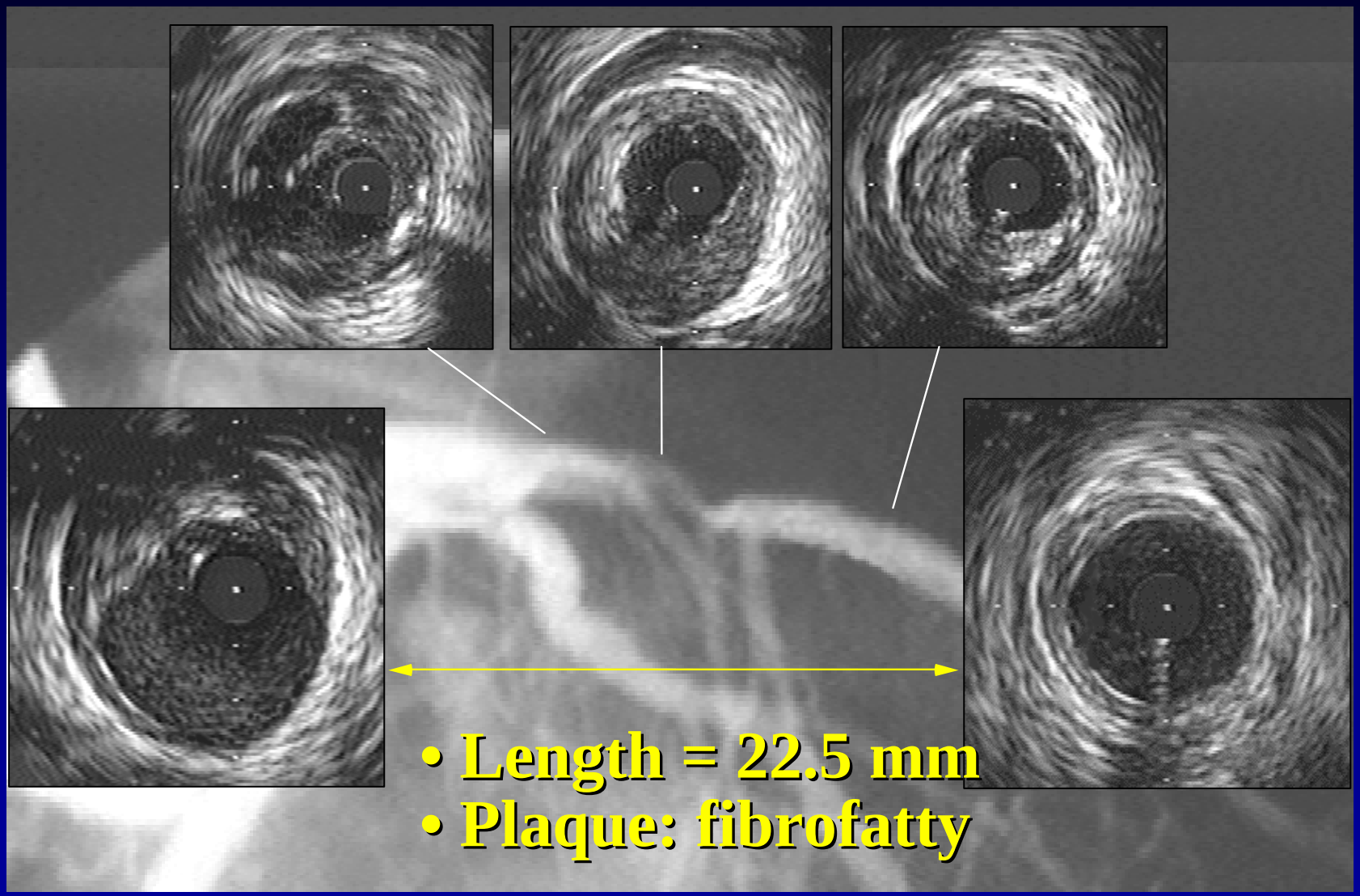


* Stanford Database 2004

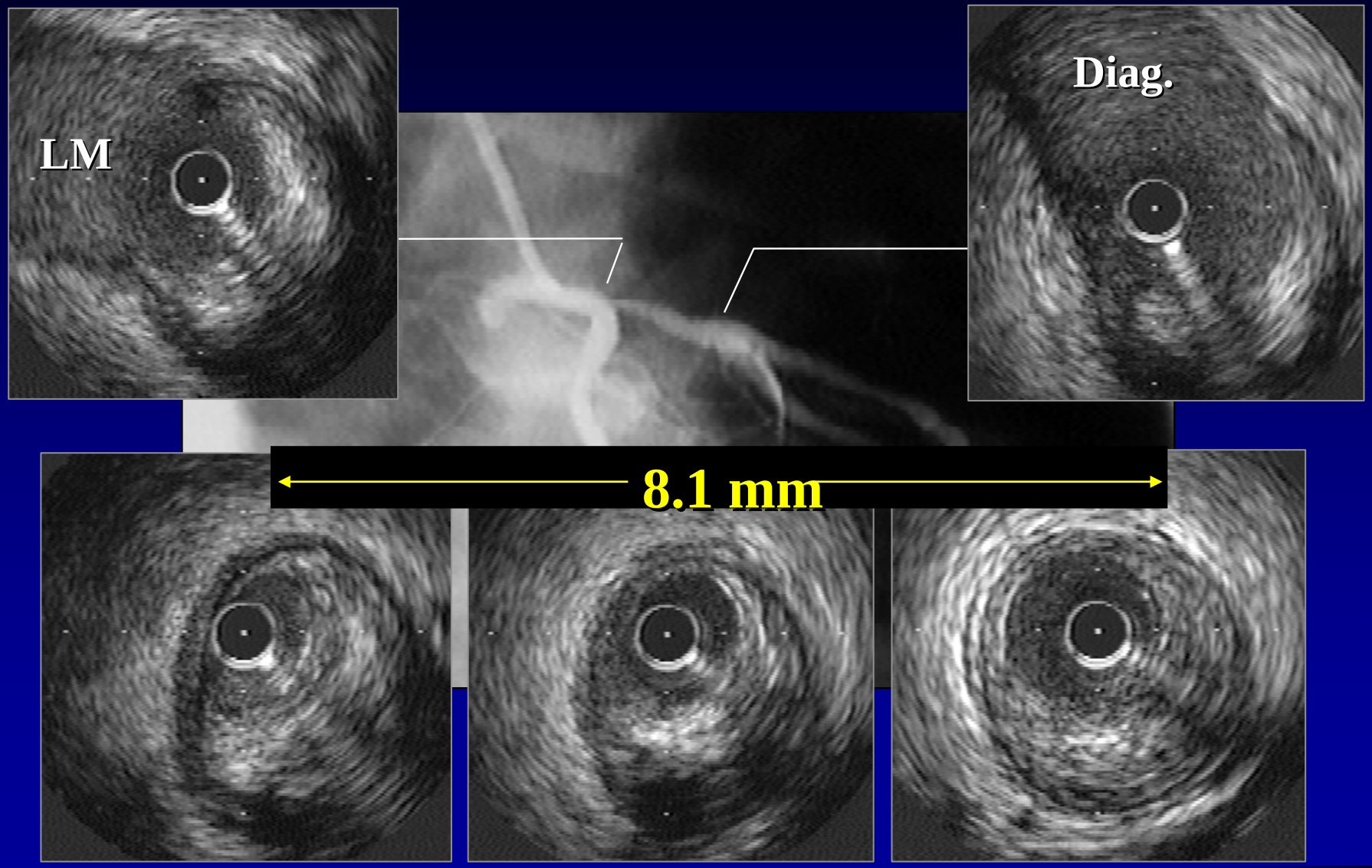
Clinical Use of IVUS in DES stenting

- Improve precision: length, diameter
- Ostial location, side branch involvement (e.g. left main)
- BMS and DES failure

On-Line IVUS: Length Assessment

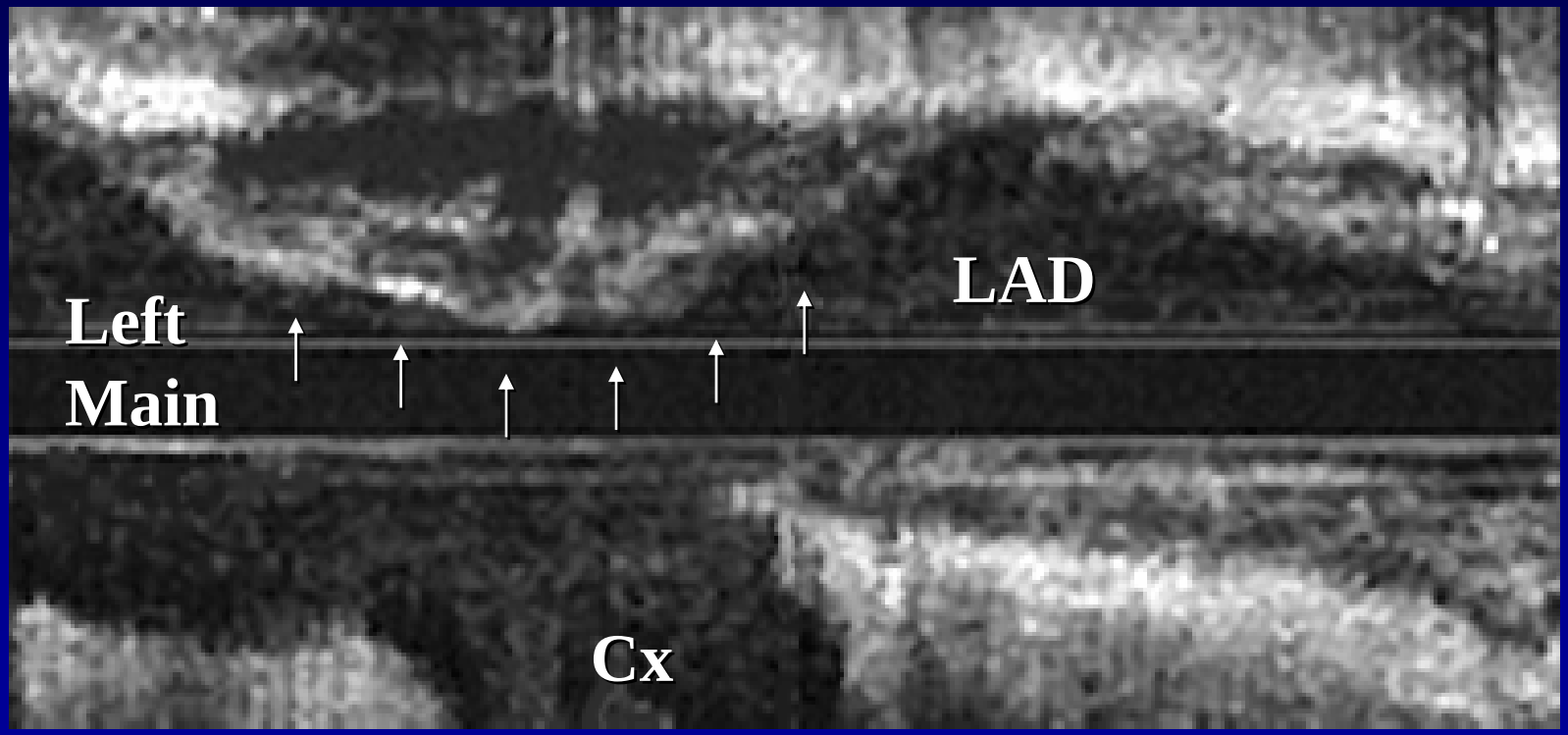


On-Line IVUS: Length Assessment



Longitudinal Reconstruction

Ostial Disease



Case 4M: C.C.

- 88 year old woman with left main disease, referred for CABG
- Recurrent SOB, all SVG has failed.
- H/O anterior (apex HK to AK) infarction, EF 35 to 40% range

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Stanford

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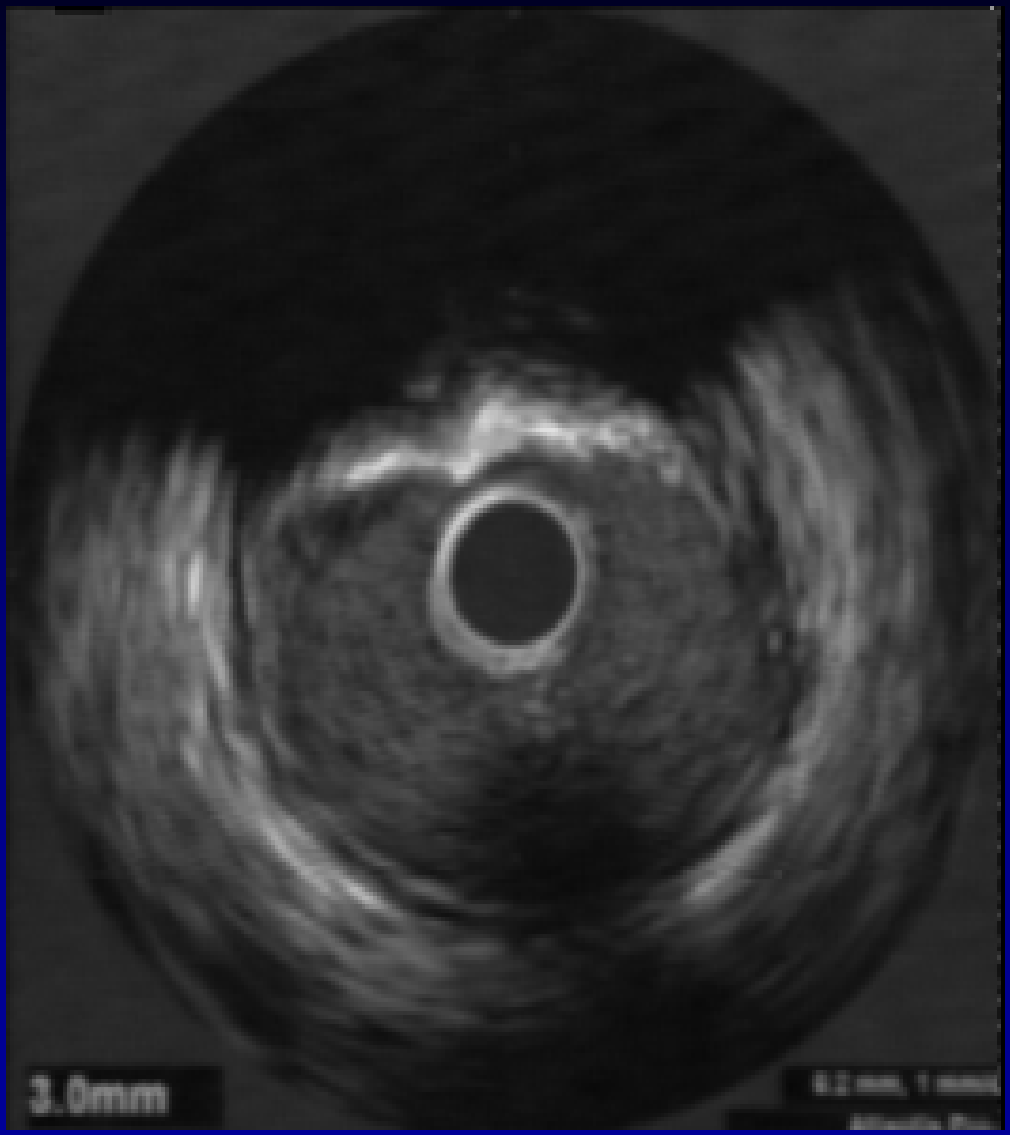
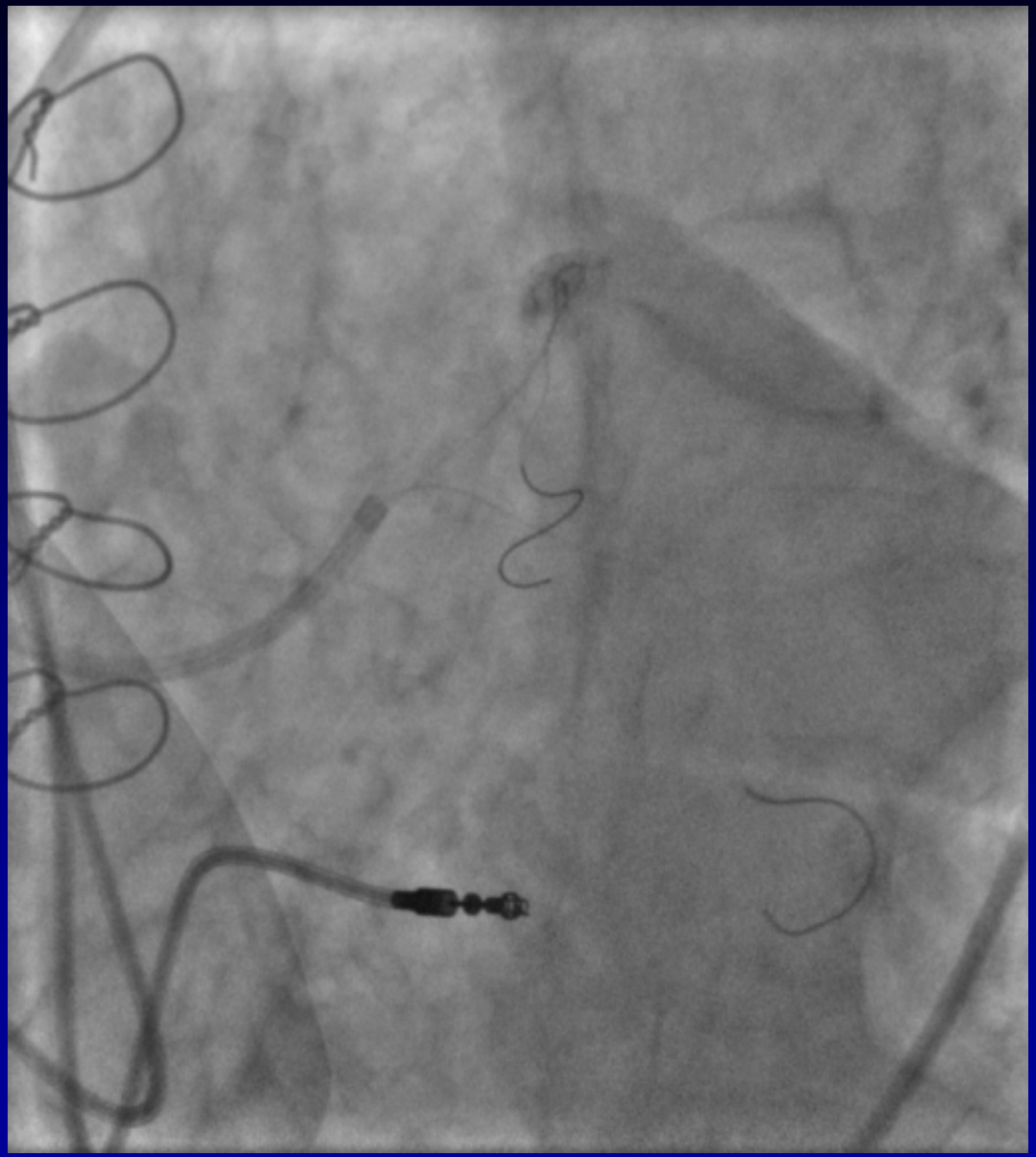
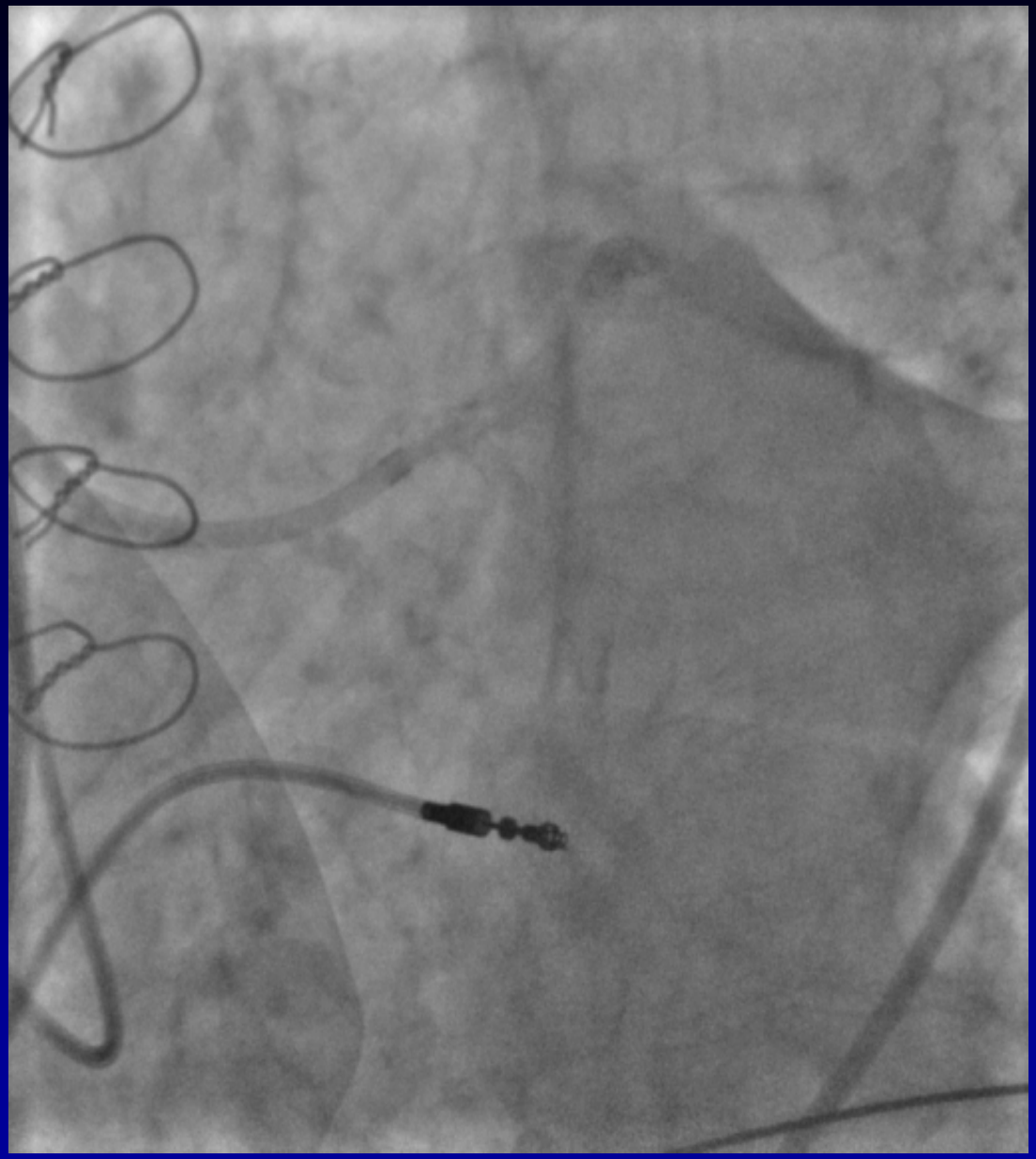


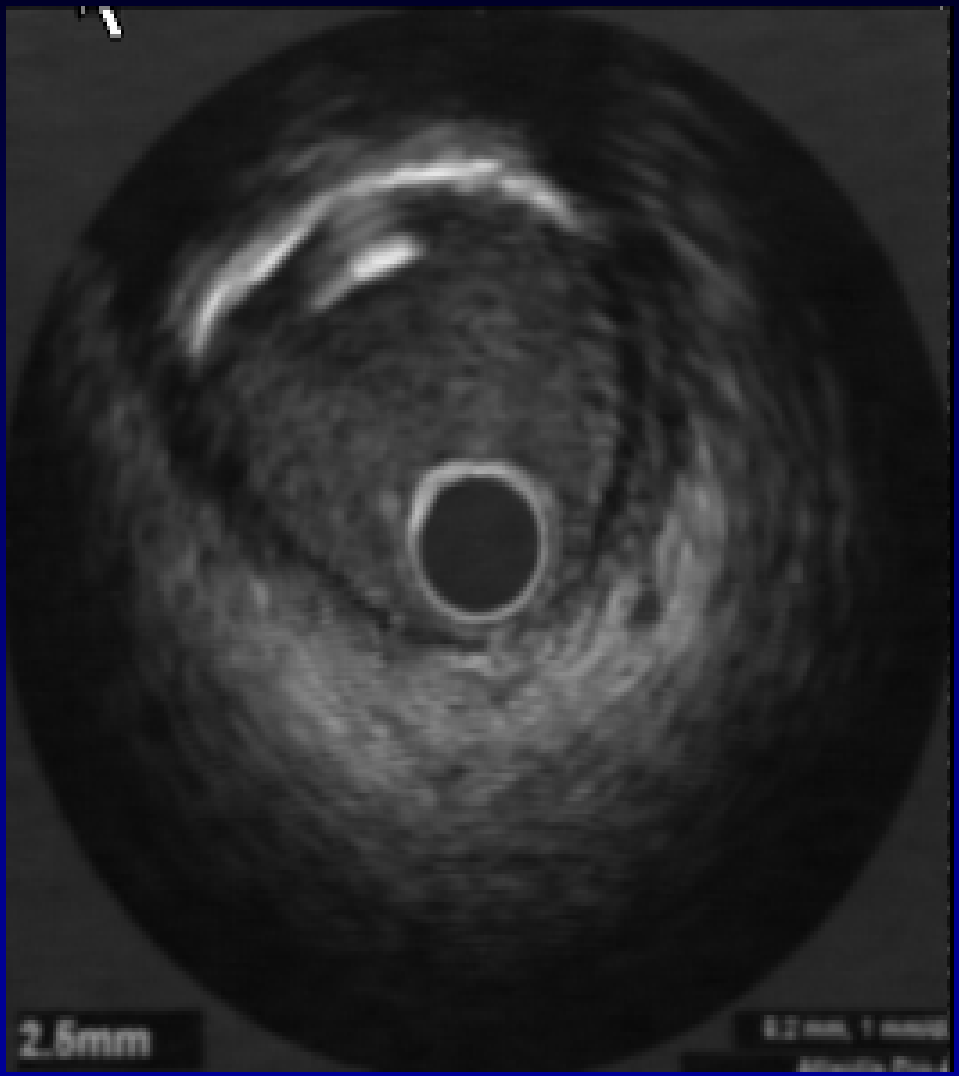
Stanford



Stanford

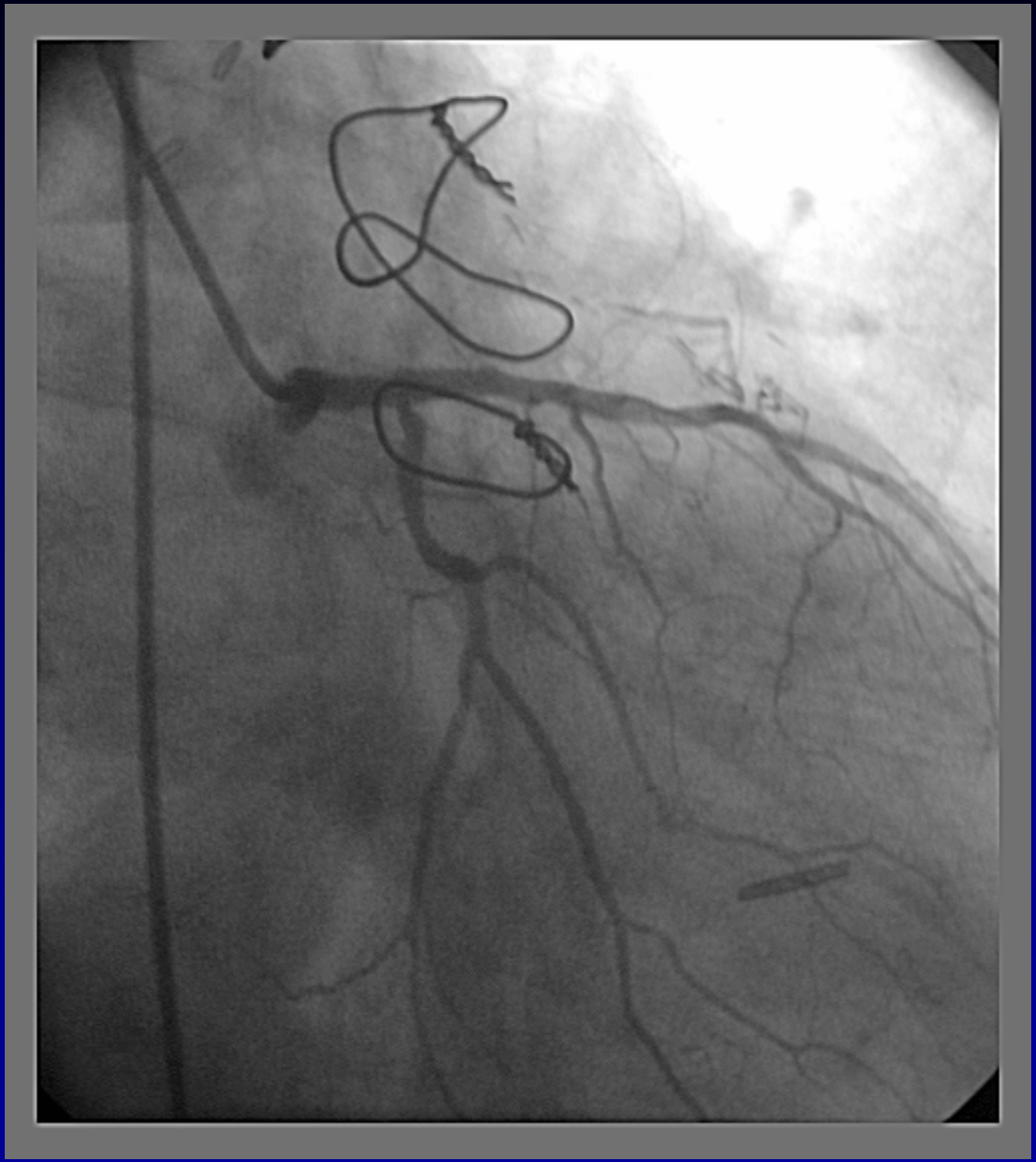


Stanford

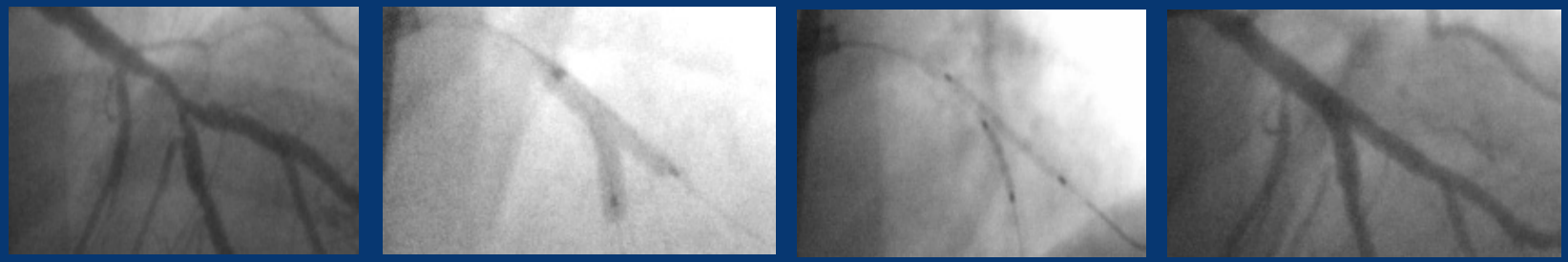


Stanford

9 months

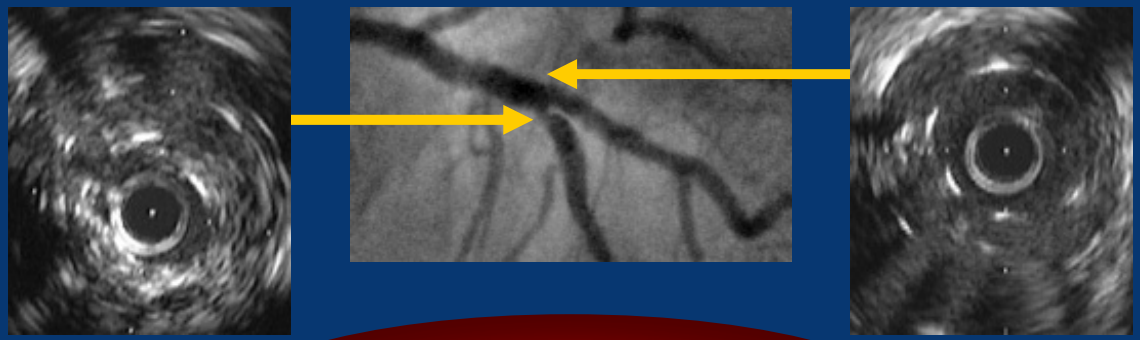


IVUS Issues in DES



Bifurcation stenosis treated with two Cypher™ Stents without IVUS guidance

Seven-Month Follow-Up

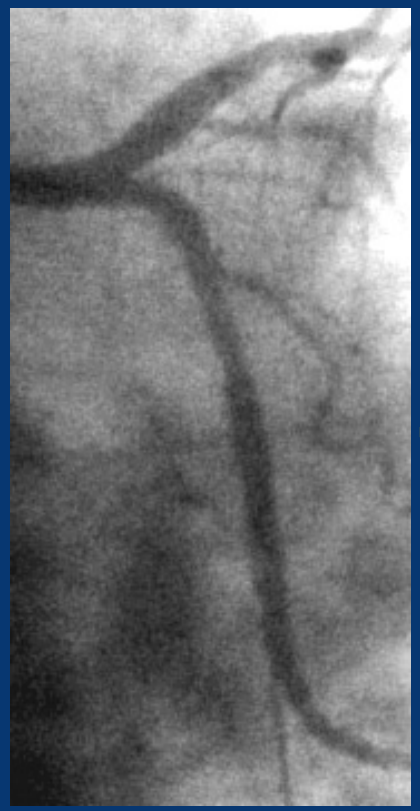


DES "failure" 2° chronic LAD stent underexpansion just distal to the diagonal

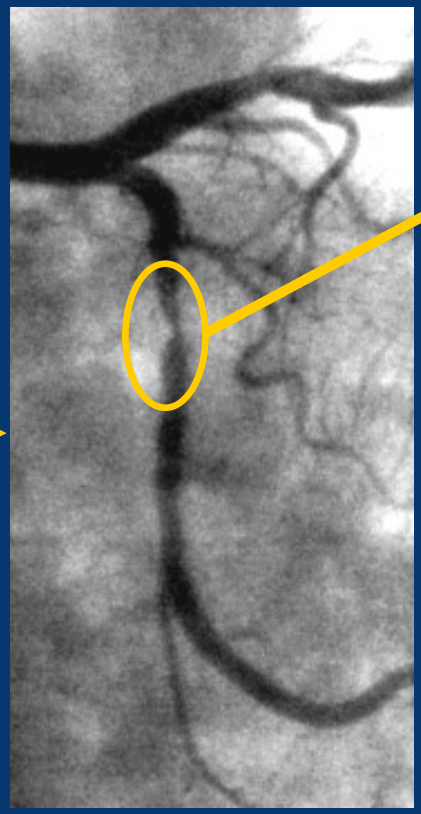
IVUS Issues in DES

- DES failure 2º intimal hyperplasia

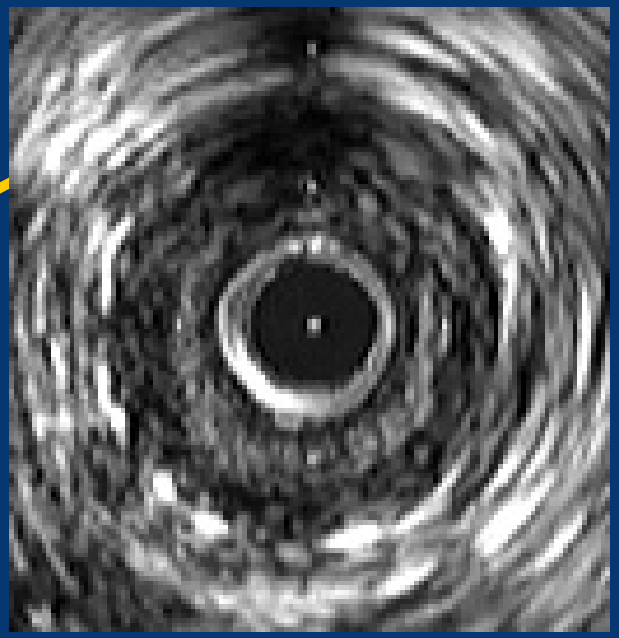
After 3x18 mm Cypher™ Stents



Three Months Later



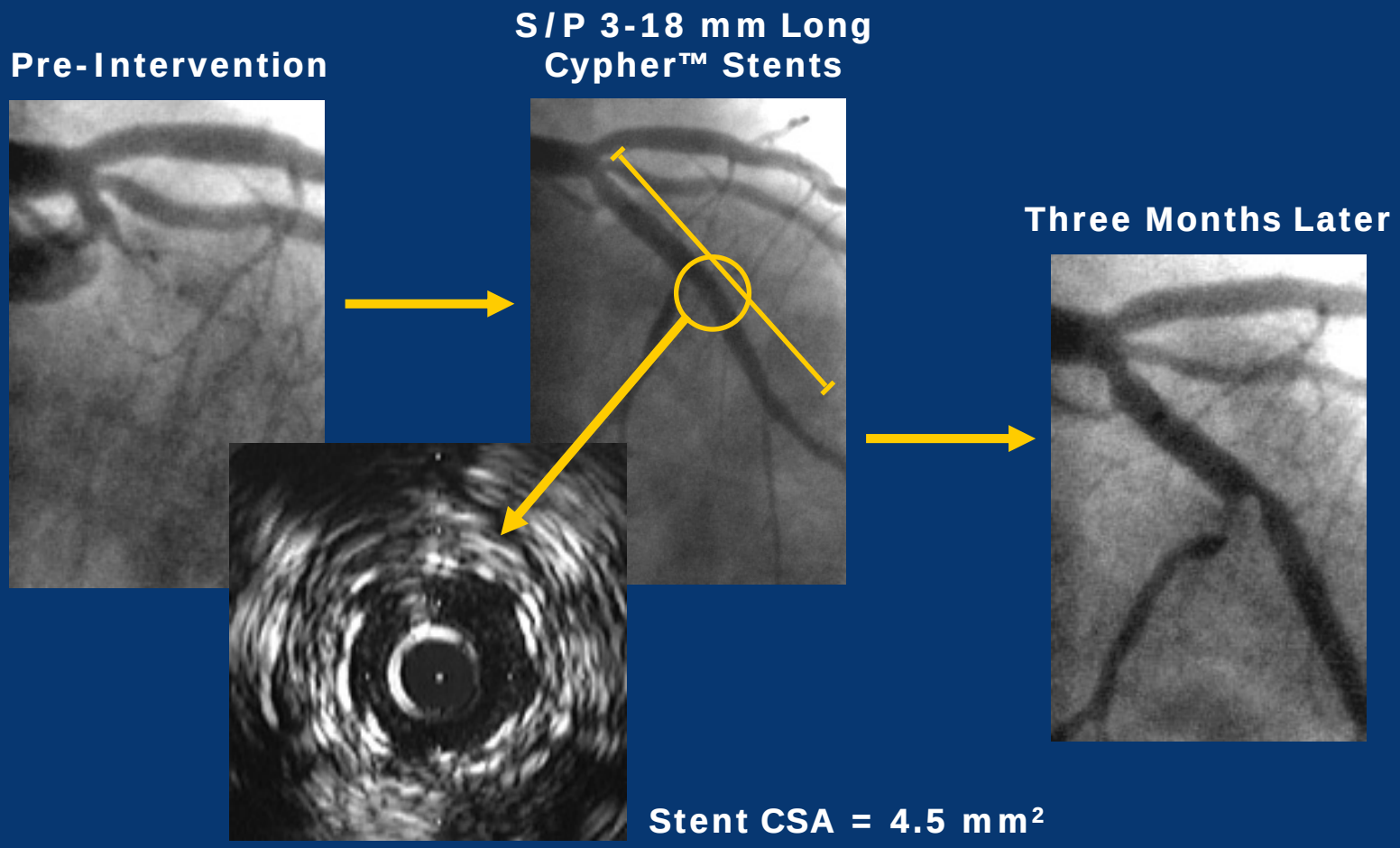
IVUS



Stent CSA = 7.4 mm^2
MLA = 1.8 mm^2

IVUS Issues in DES

- DES failure 2º stent underexpansion

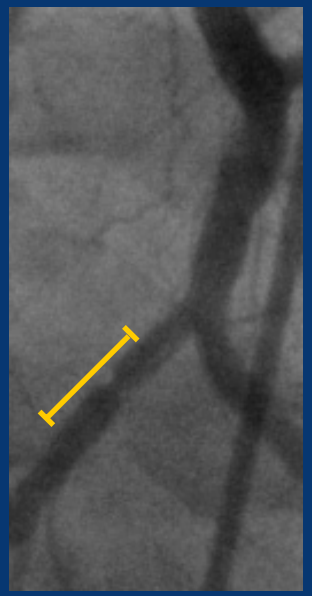


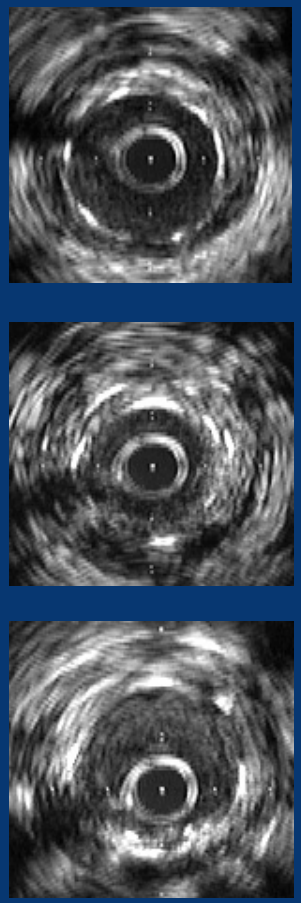
IVUS Issues in DES

- DES failure 2º stent underexpansion in a diabetic

Post 3.0x18 and 3.0x8 Cypher™ Stents

Eight Months Later





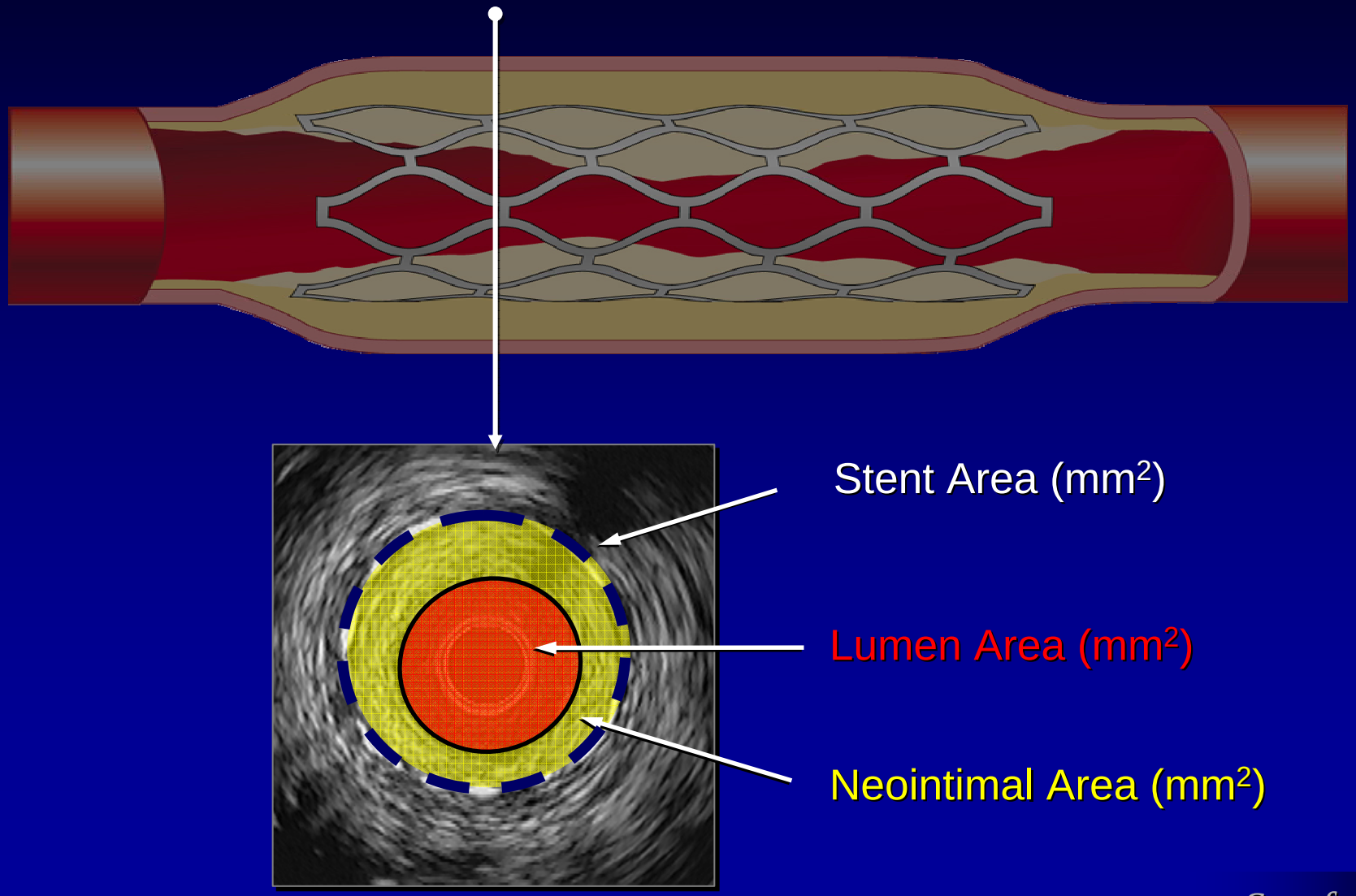
Proximal

Stent CSA = 5.2 mm^2

MLA= 3.7 mm^2

Distal

Quantitative IVUS Analysis

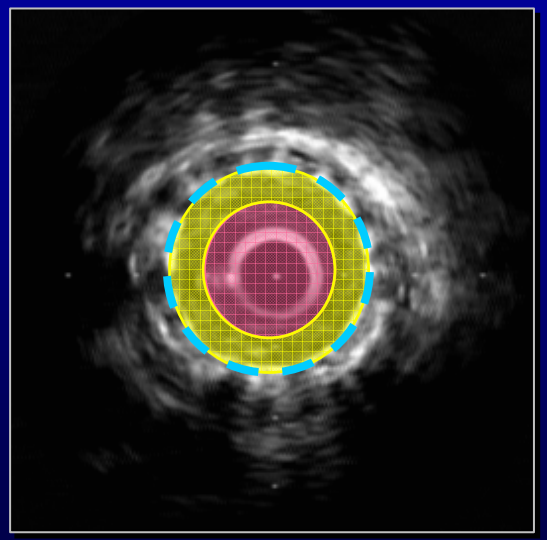


Cross-Sectional (2-D) Analysis

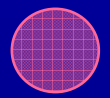
ENDEAVOR I

IVUS can precisely evaluate:

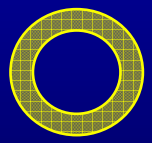
- *Minimal Luminal Area (MLA)*
- *Maximal Neointimal Area (Max.NIA)*
- *Maximal % Neointimal Area Obstruction (Max.%NIA)*



LA :

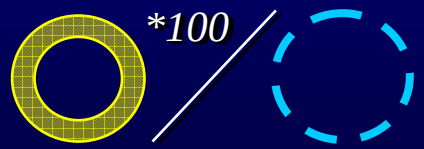


NIA :



%NIA

*= NIA*100 / stent area :*



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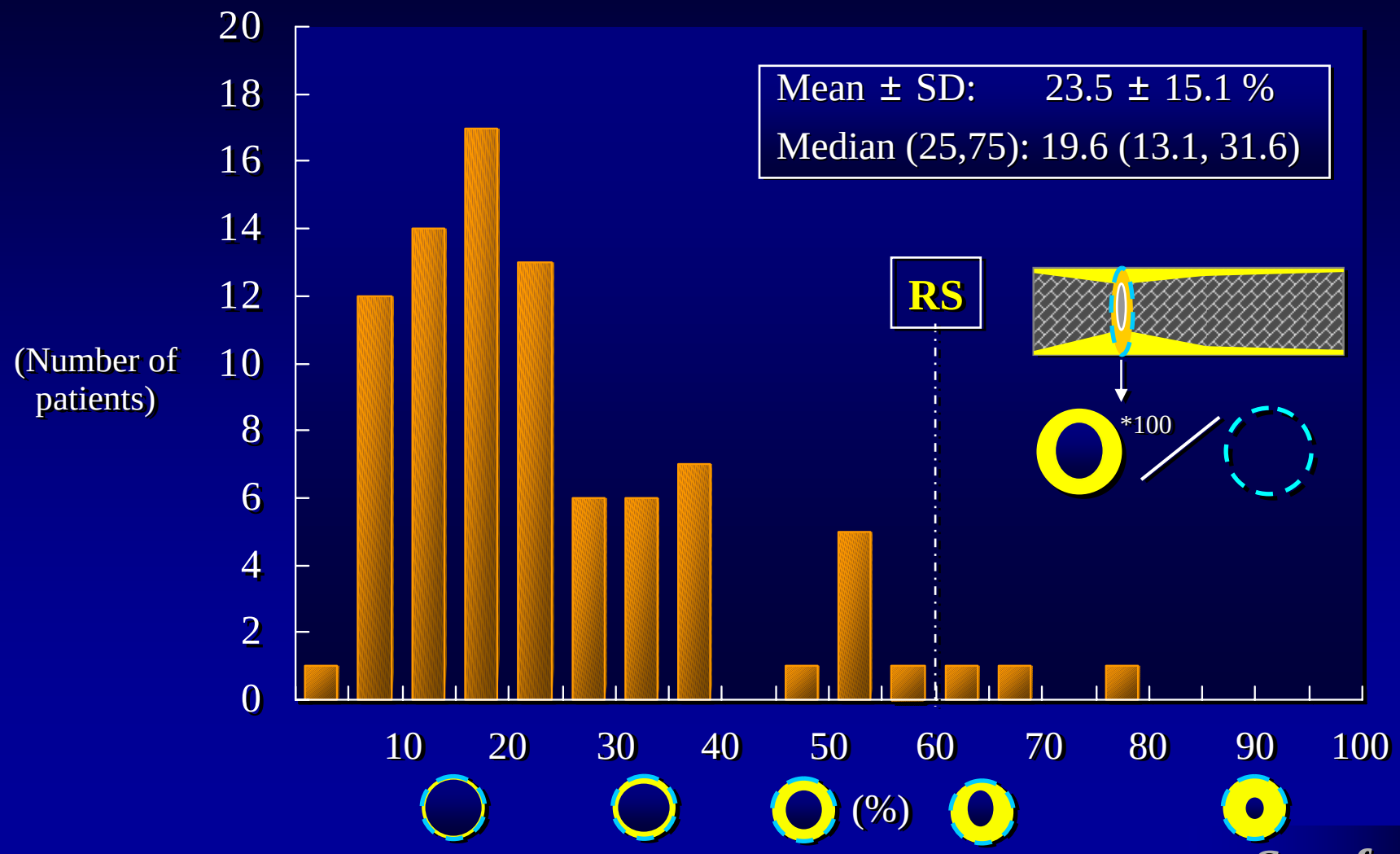
Maximal % Neointimal Area Obstruction (Max.%NIA)

Example Trial



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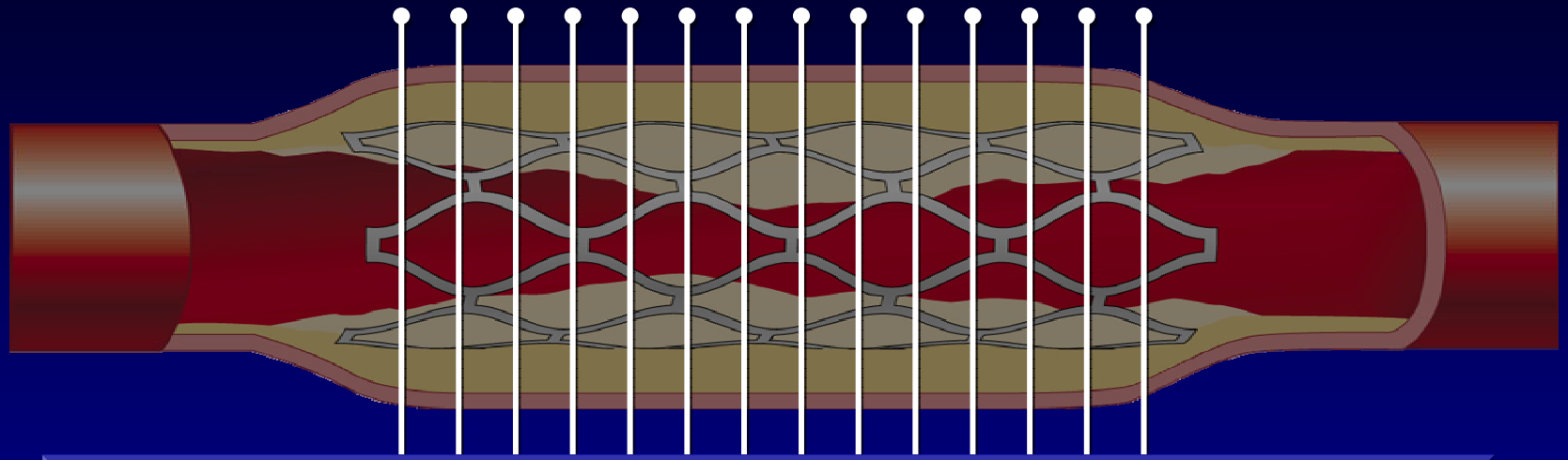
Volumetric IVUS Analysis

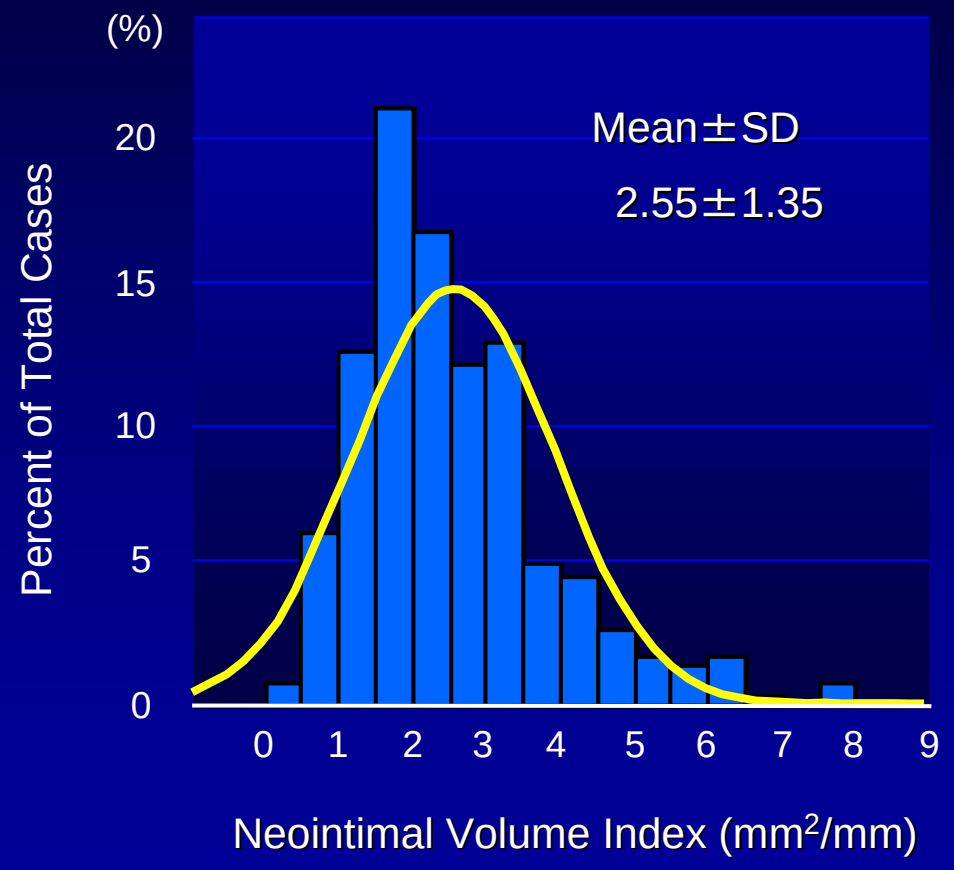


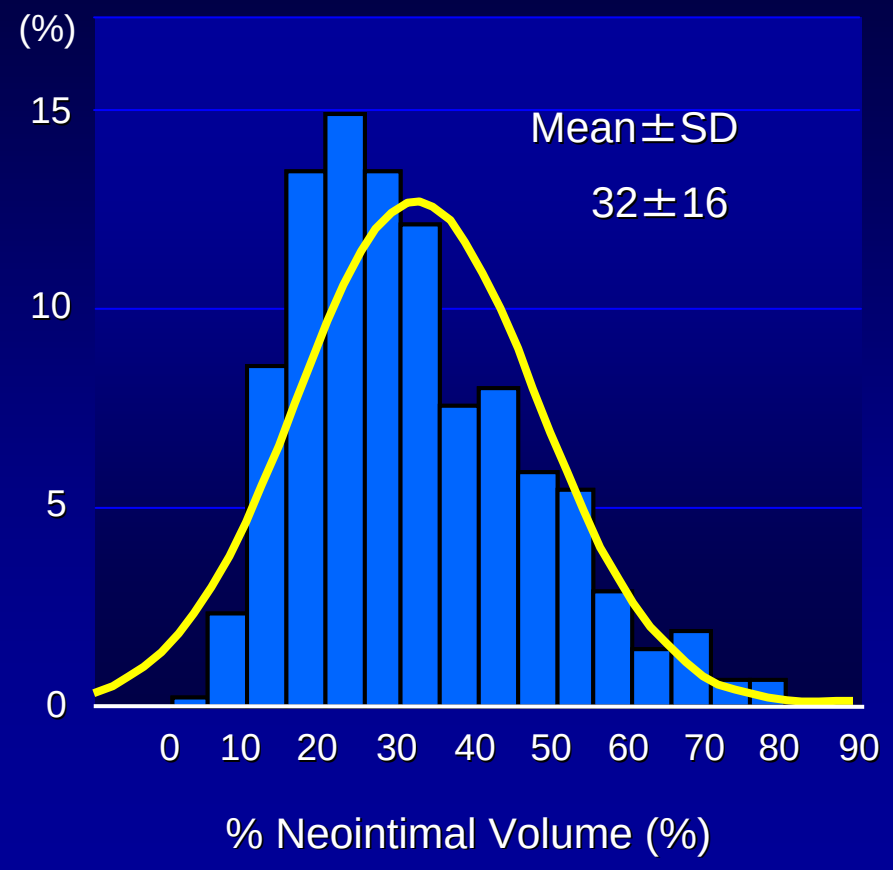
- *Volumes: Stent, Lumen, Neointima (mm^3)*
- *Volume Index = Volume / length (mm^3/mm)*
- *% Neointimal Volume = Neointima / Stent (%)*

Statistical Distributions of NIH

Bare Metal Stents

n=1421





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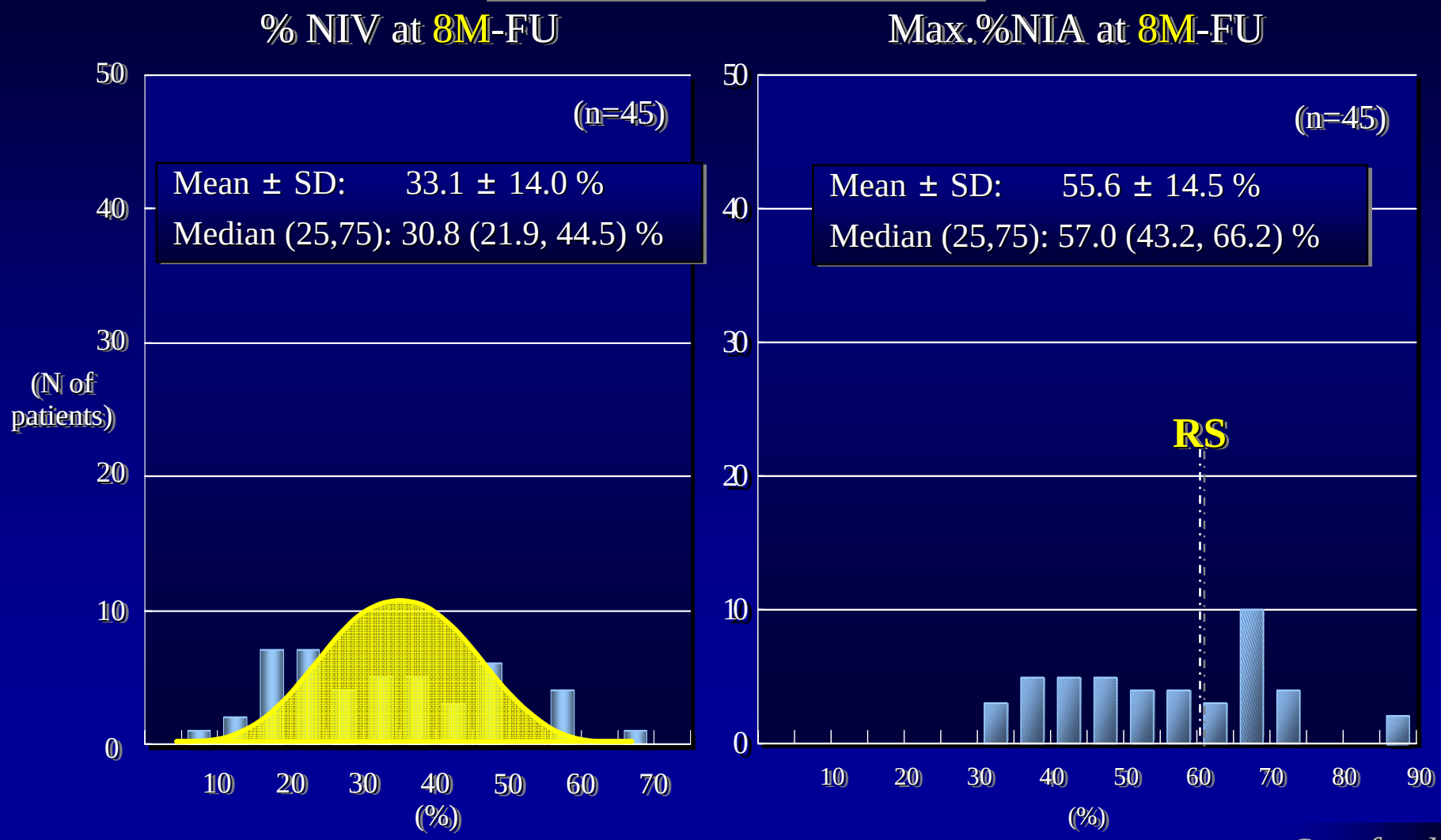
Volumetric Analysis Vs. Cross-sectional Analysis

SIRIUS Trial BMS Arm



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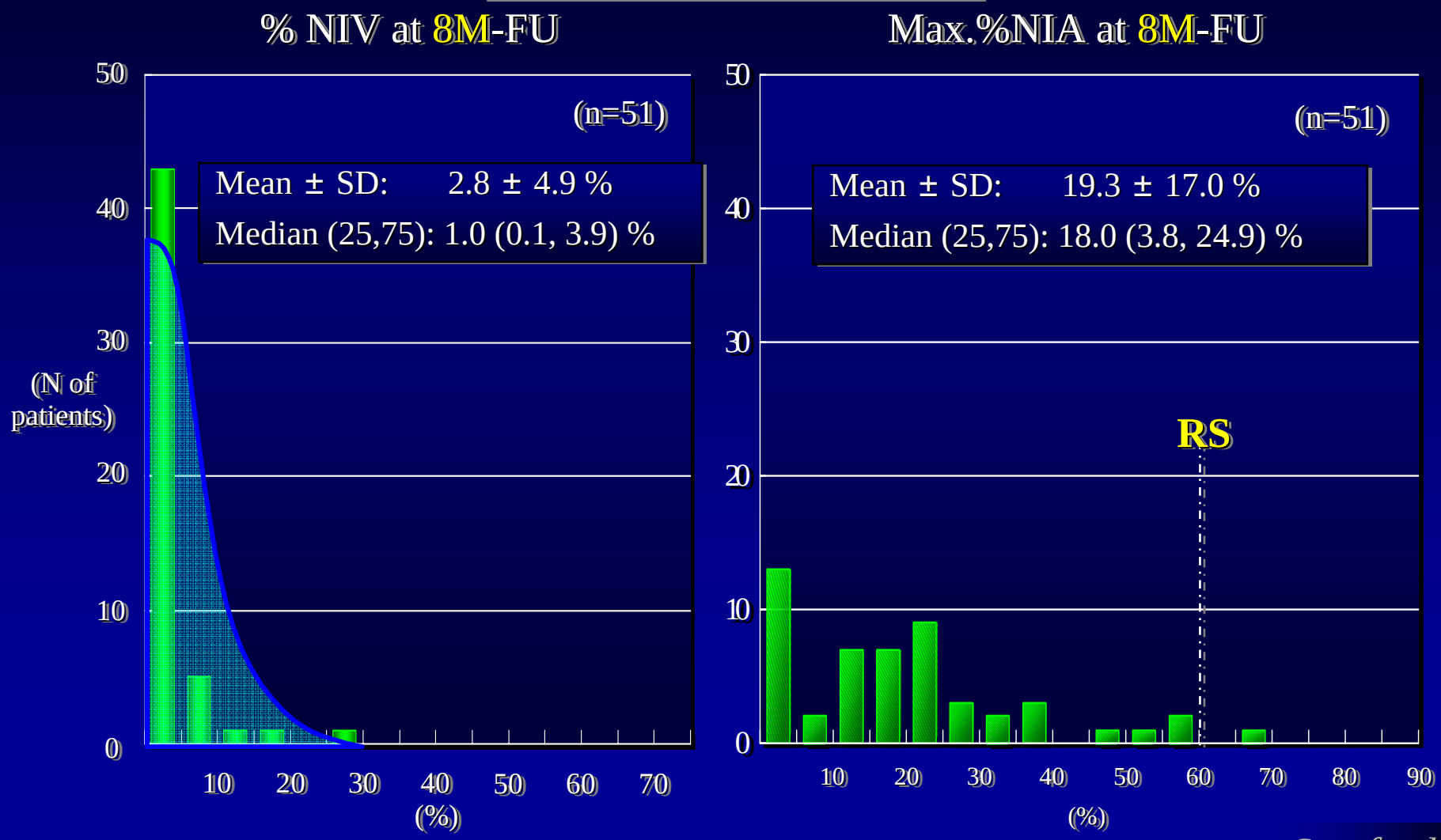
Volumetric Analysis Vs. Cross-sectional Analysis

SIRIUS Trial Cypher® Arm



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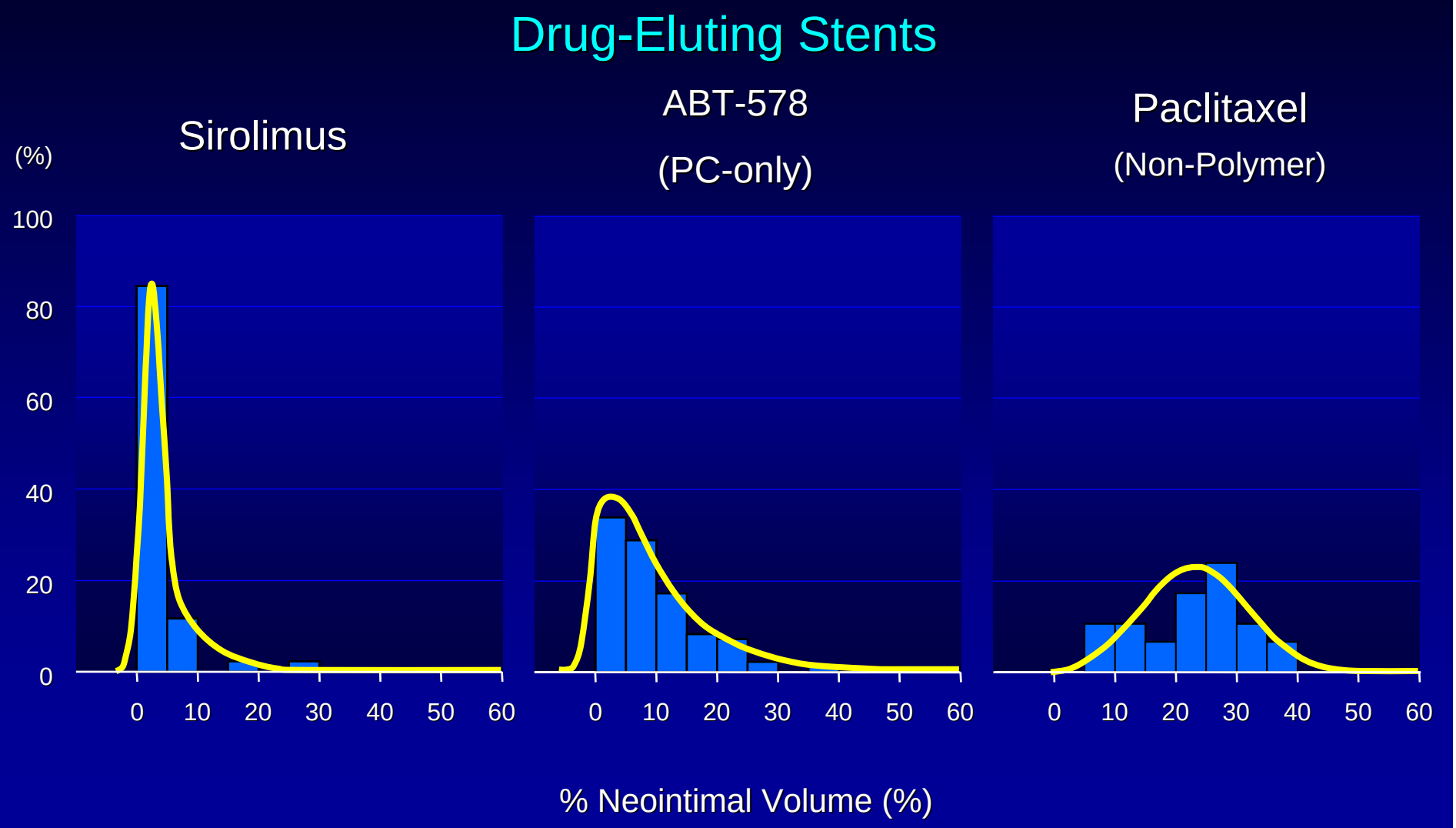
Impact of Biological Modification



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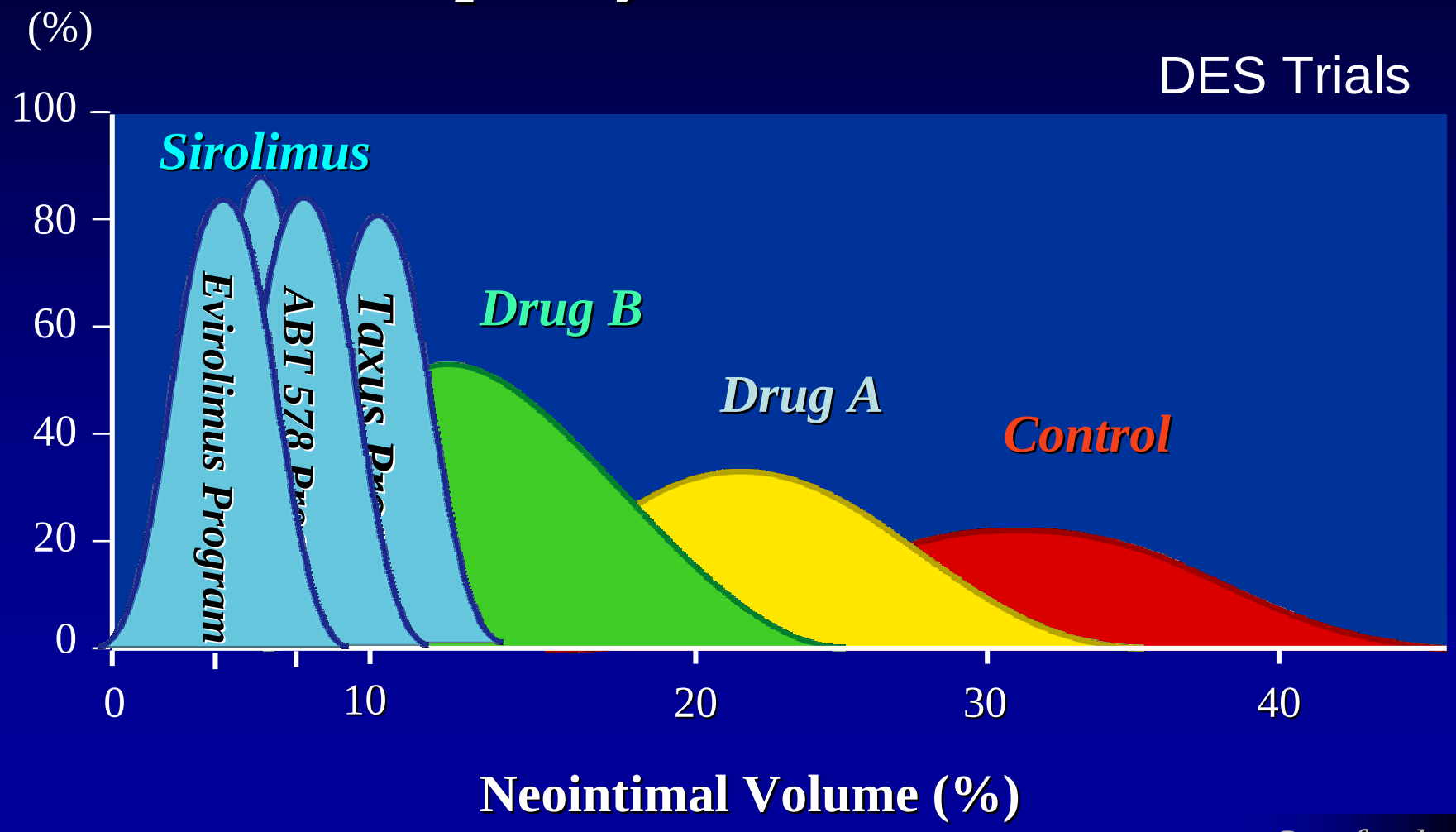
3-D Intravascular Ultrasound Drug-Eluting Stents: Neointimal Volume

Frequency Distributions:



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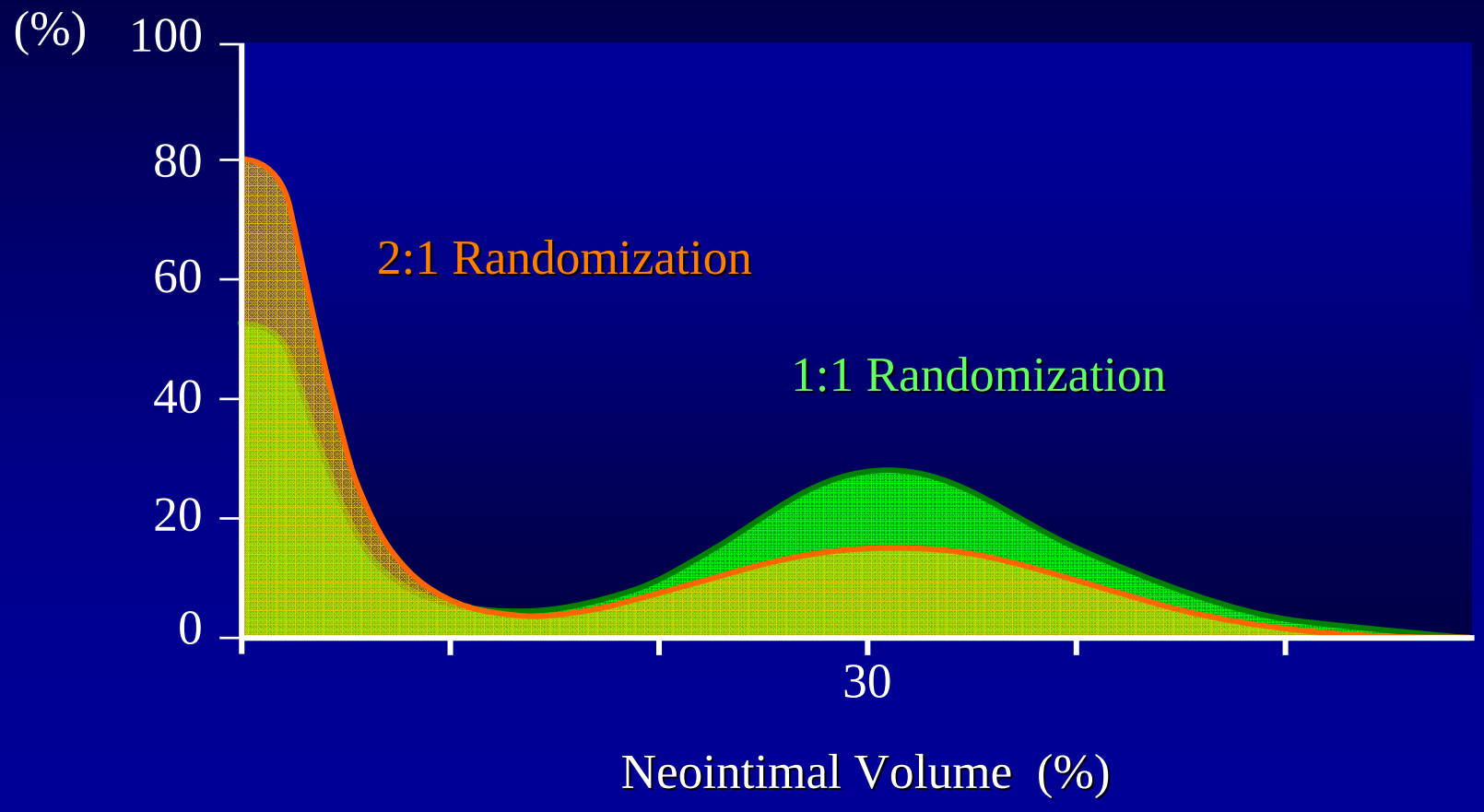
Stent Trials: Frequency Distributions of NIH

Randomized Trials

DES + BMS



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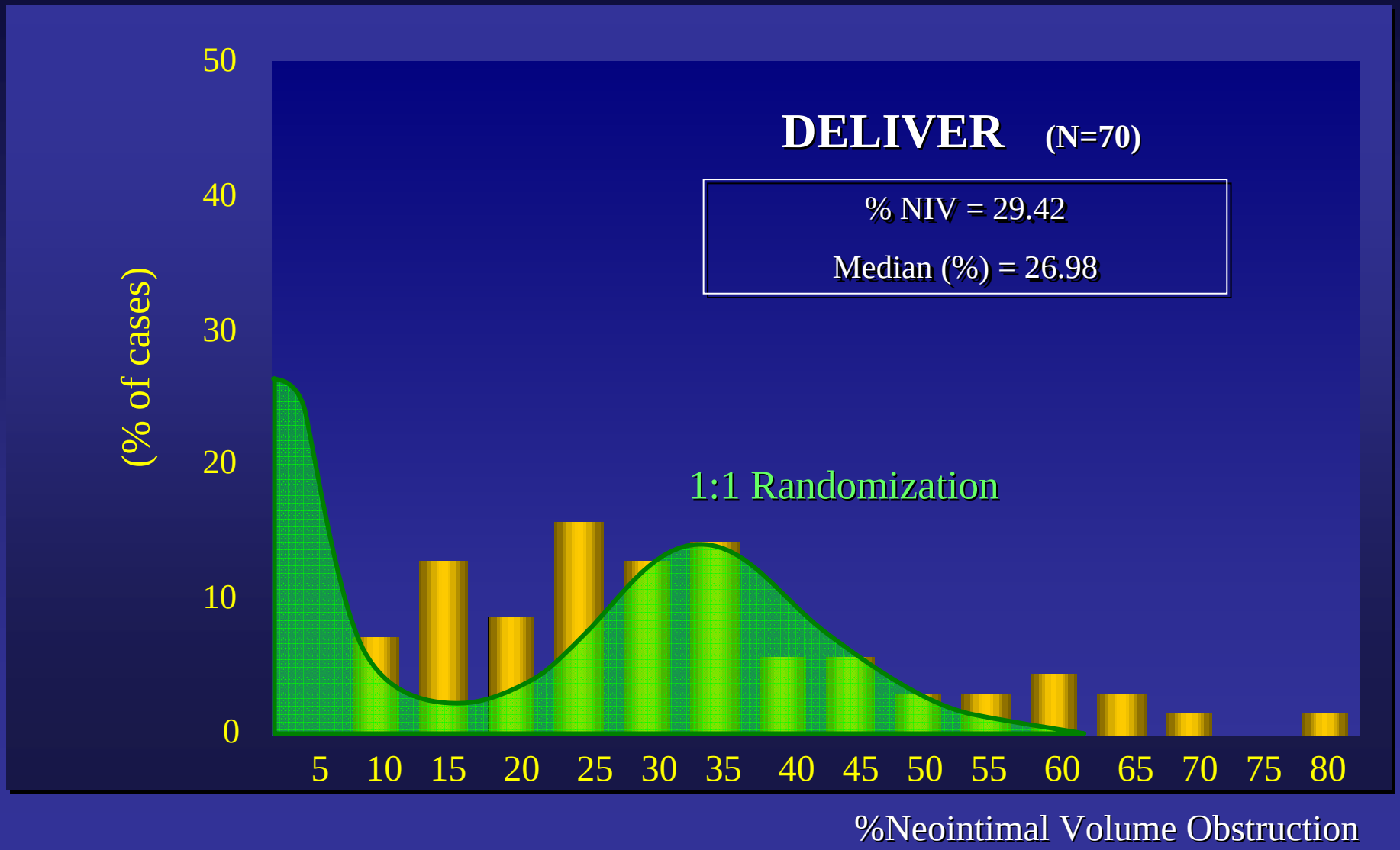
Neointimal Volume Obstruction



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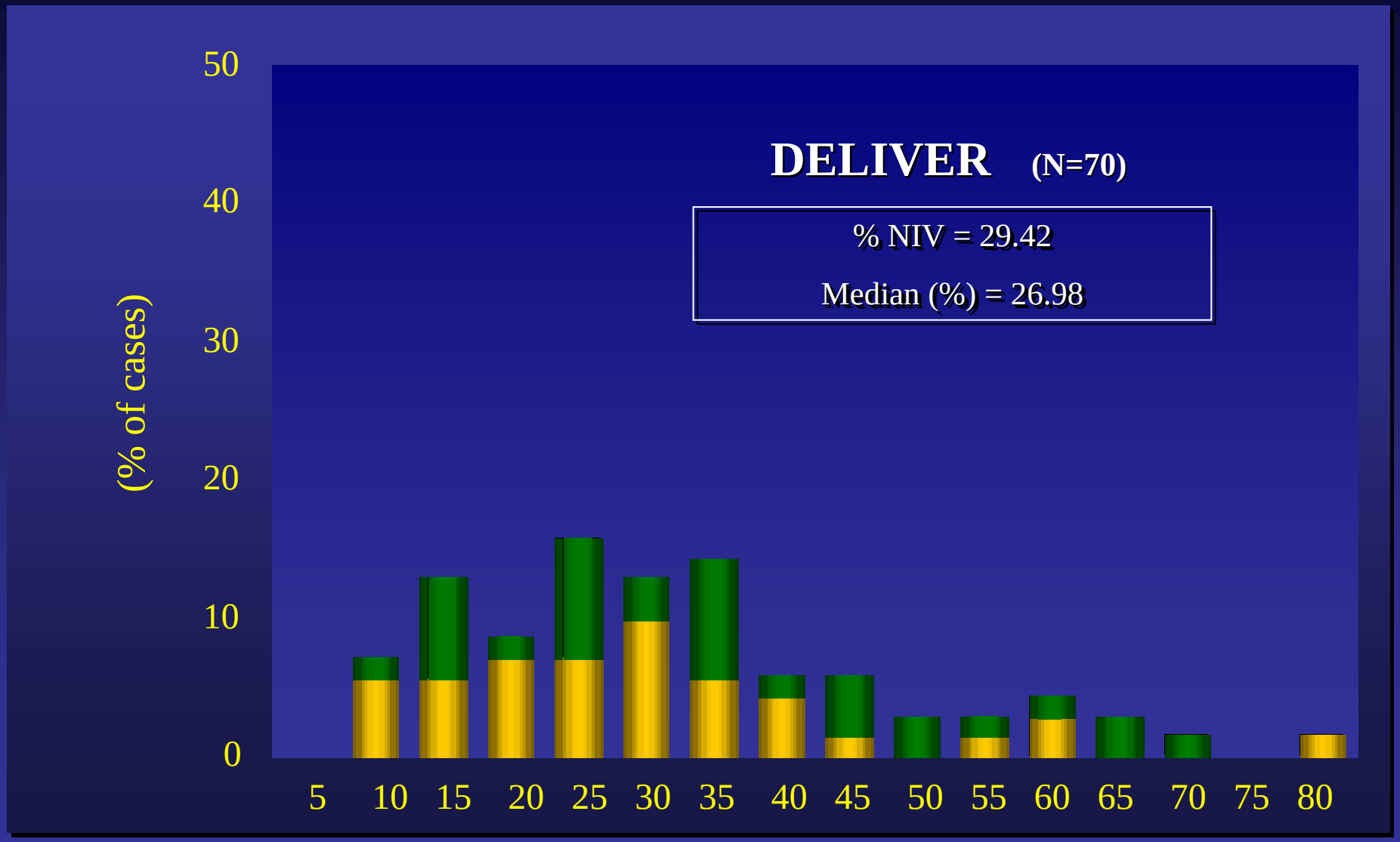
Neointimal Volume Obstruction



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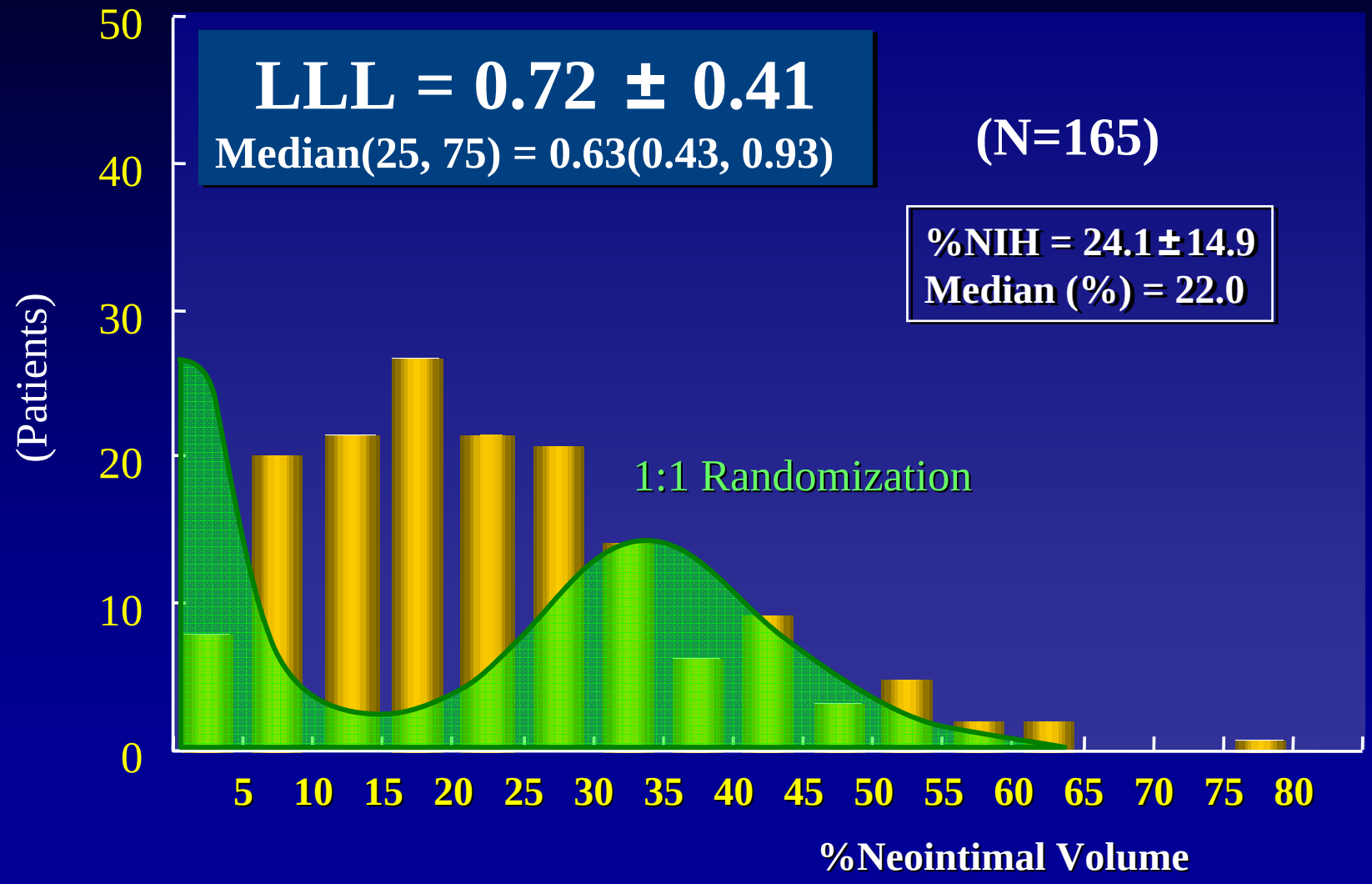
%Neointimal Volume



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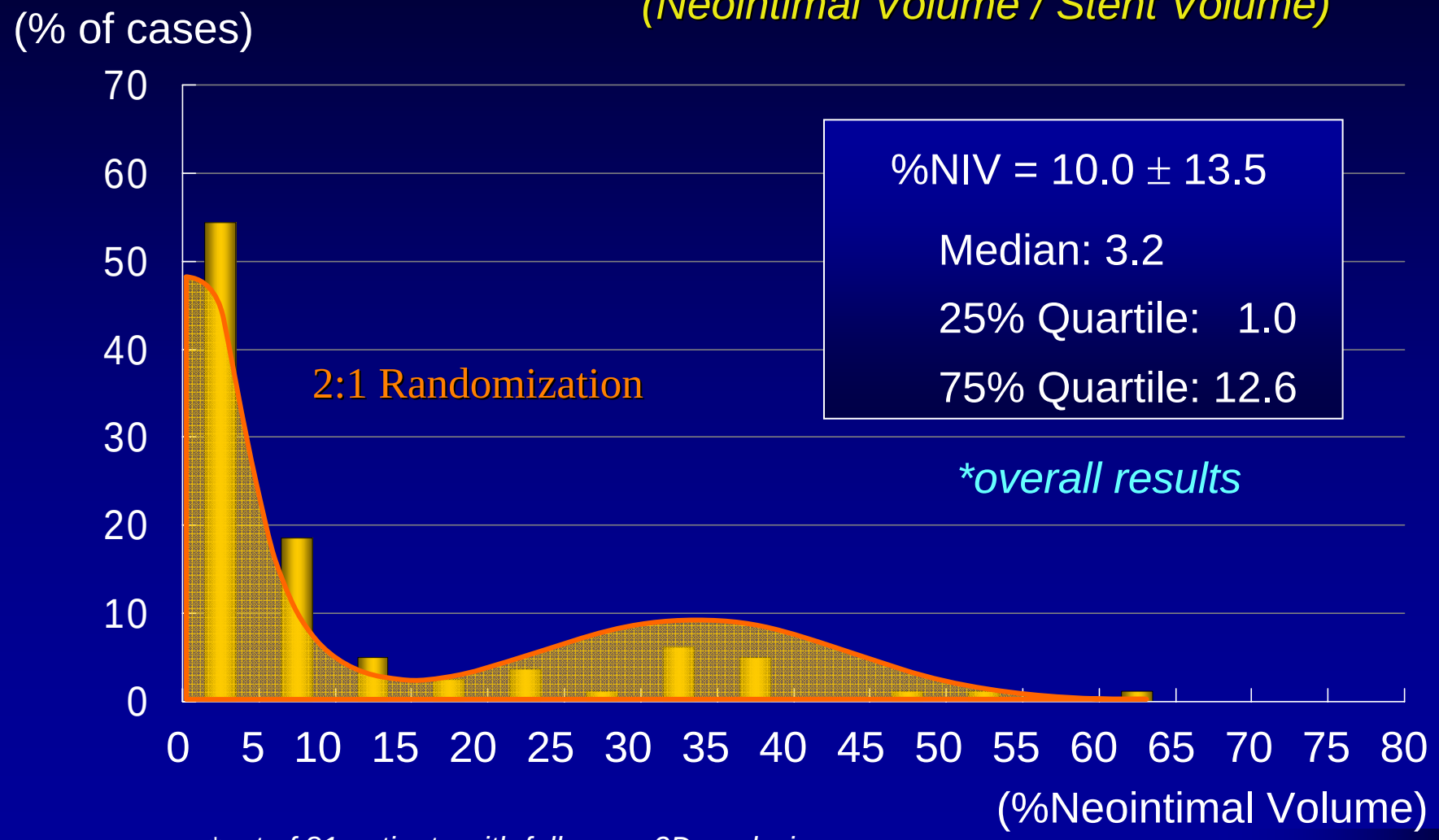
STEALTH 1 IVUS Results

~ Distribution of %Neointimal Volume ~

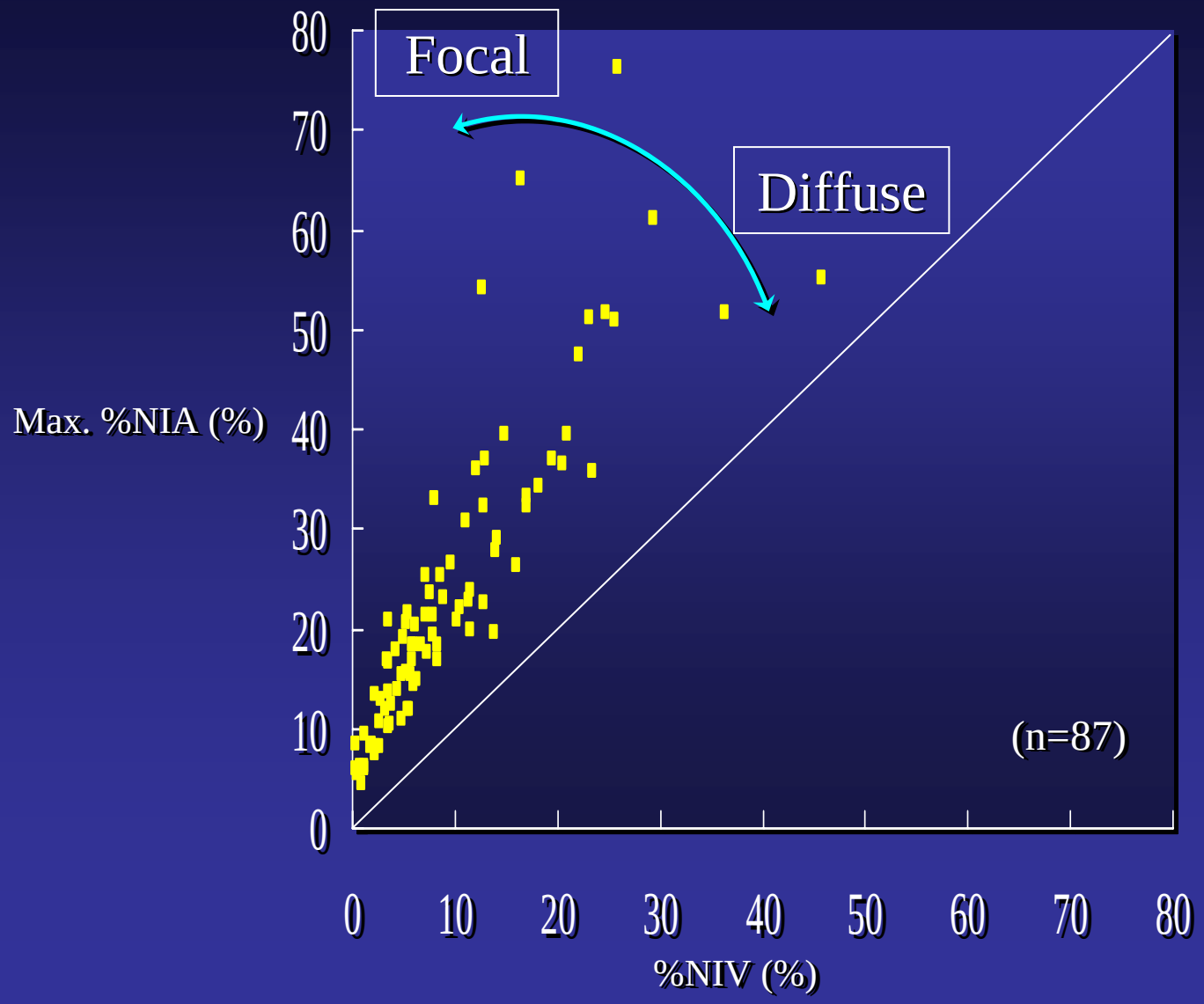
(Neointimal Volume / Stent Volume)



**out of 81 patients with follow-up 3D analysis*

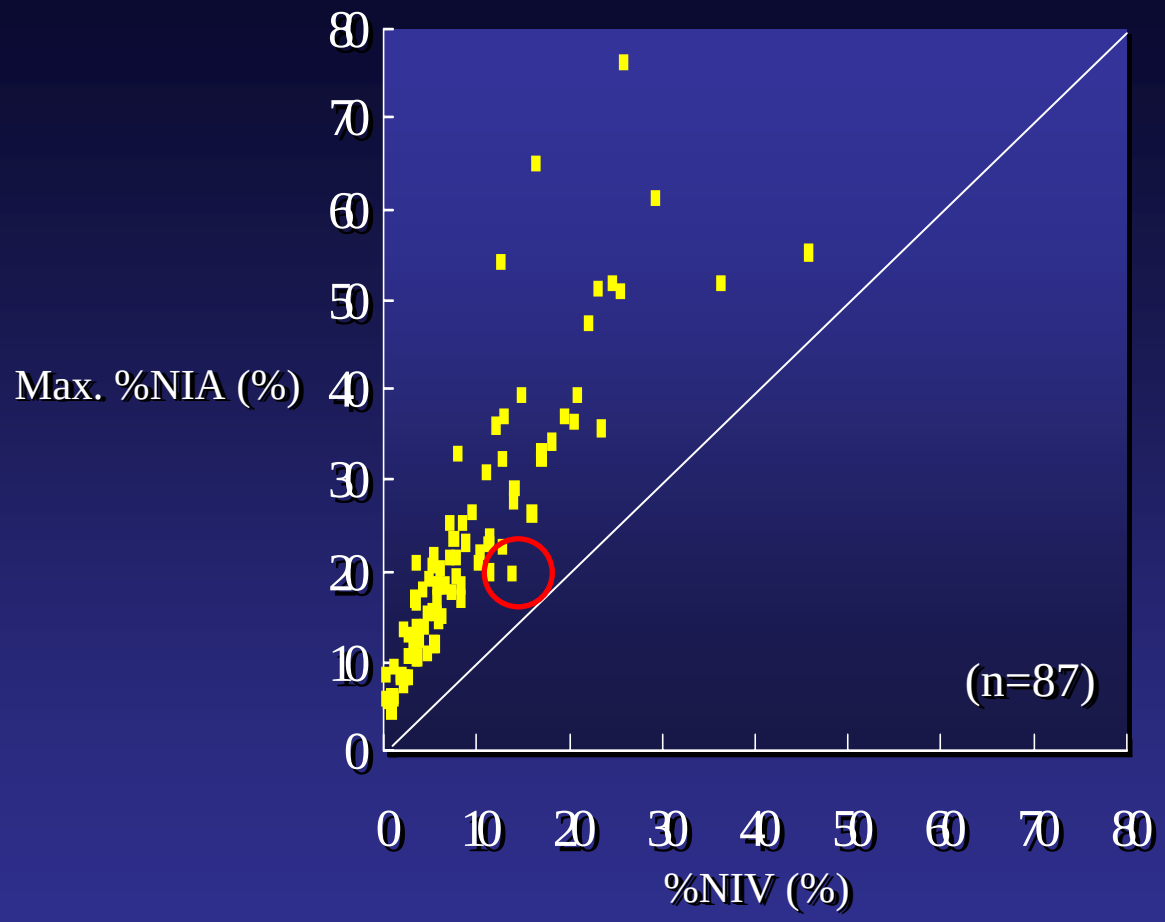
Stanford

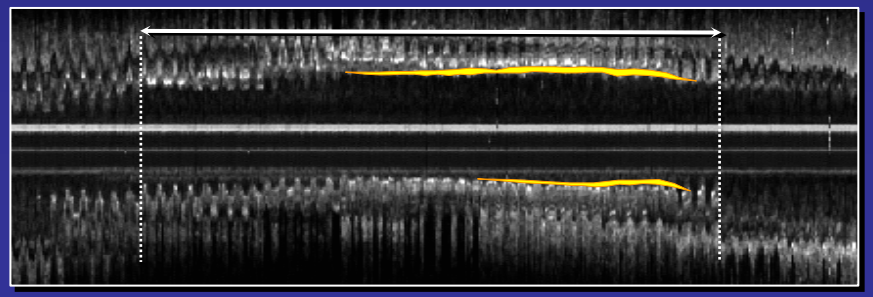
Relationship between Volume and Area Obstruction

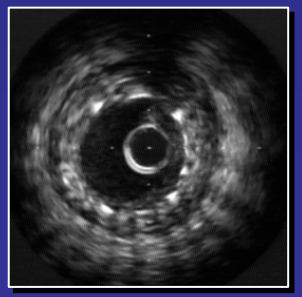


Stanford

Relationship between Volume and Area Obstruction





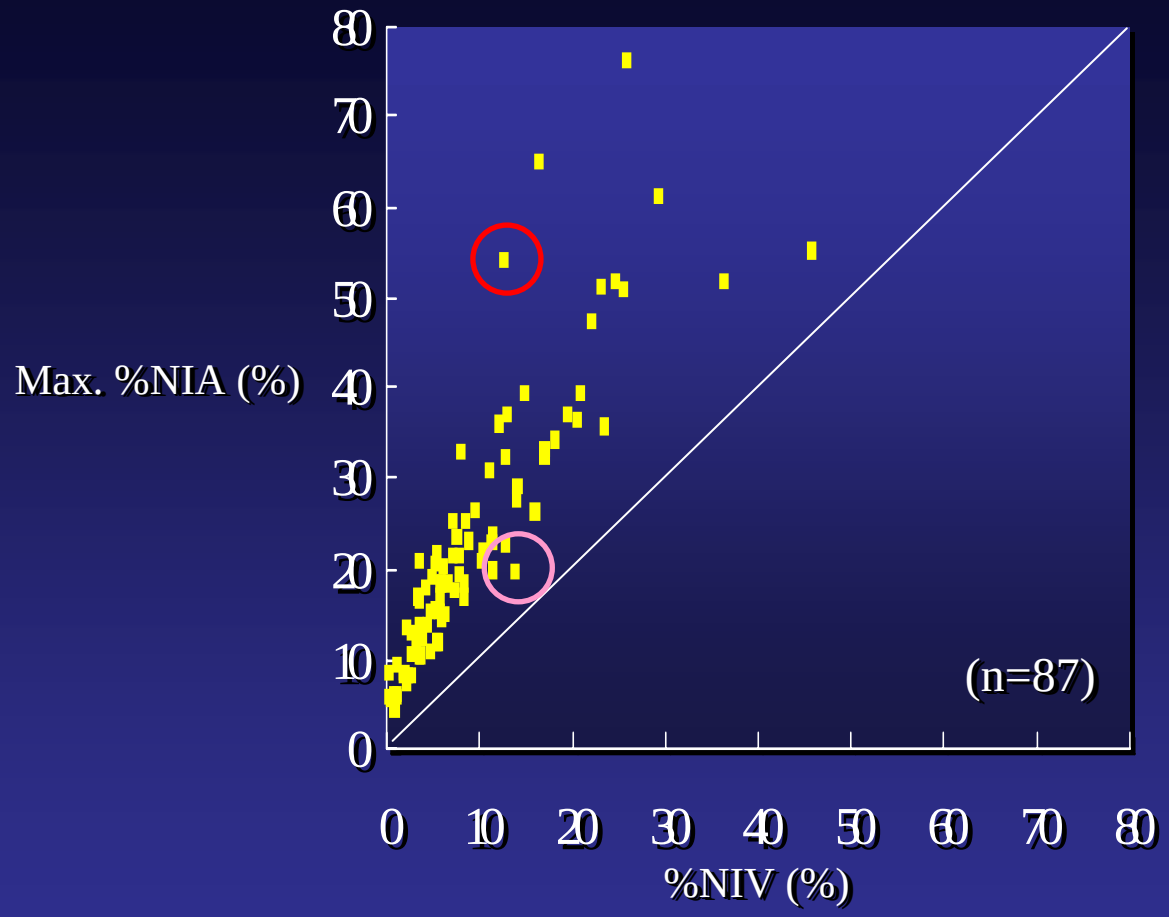


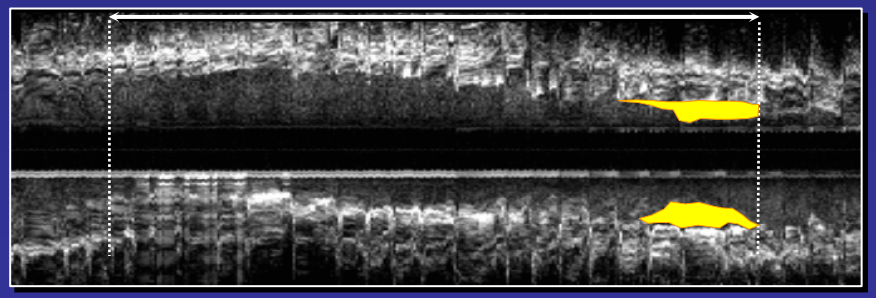
%NIV: 13.7 %

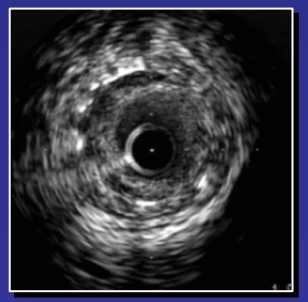
Max%NIA: 19.6 %

Stanford

Relationship between Volume and Area Obstruction





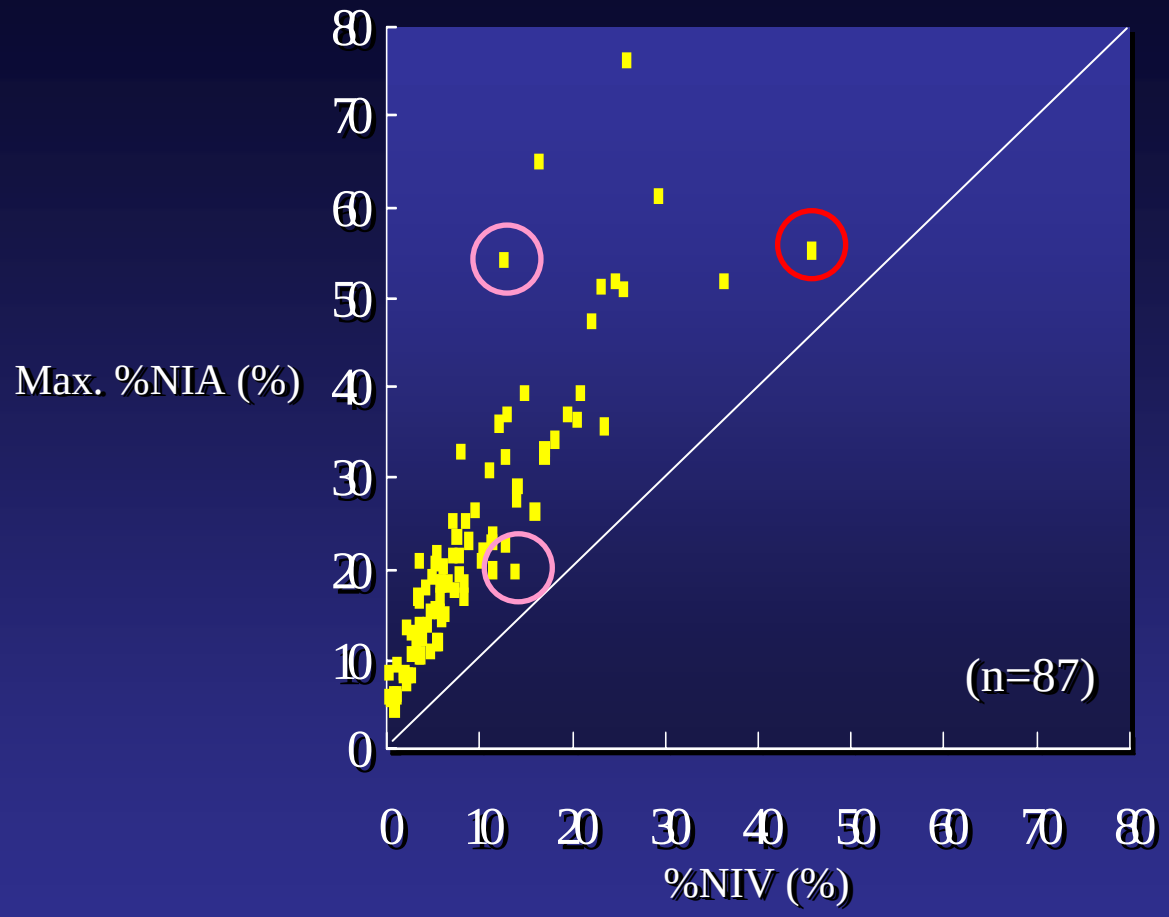


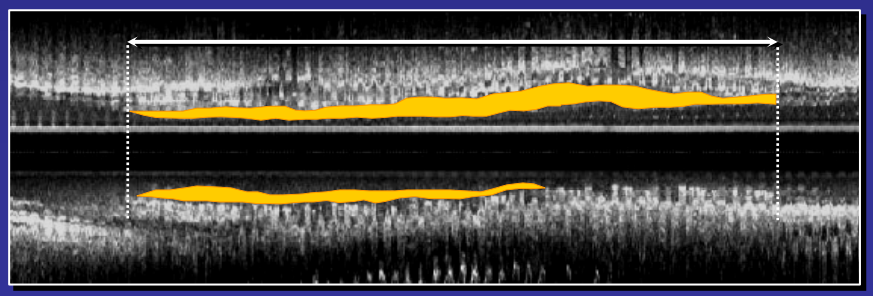
%NIV: 12.6 %

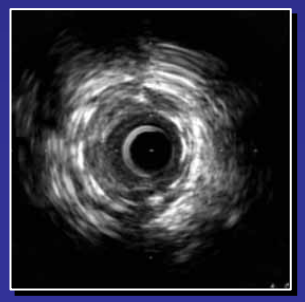
Max%NIA: 54.2 %

Stanford

Relationship between Volume and Area Obstruction







%NIV: 45.8 %

Max%NIA: 55.1 %

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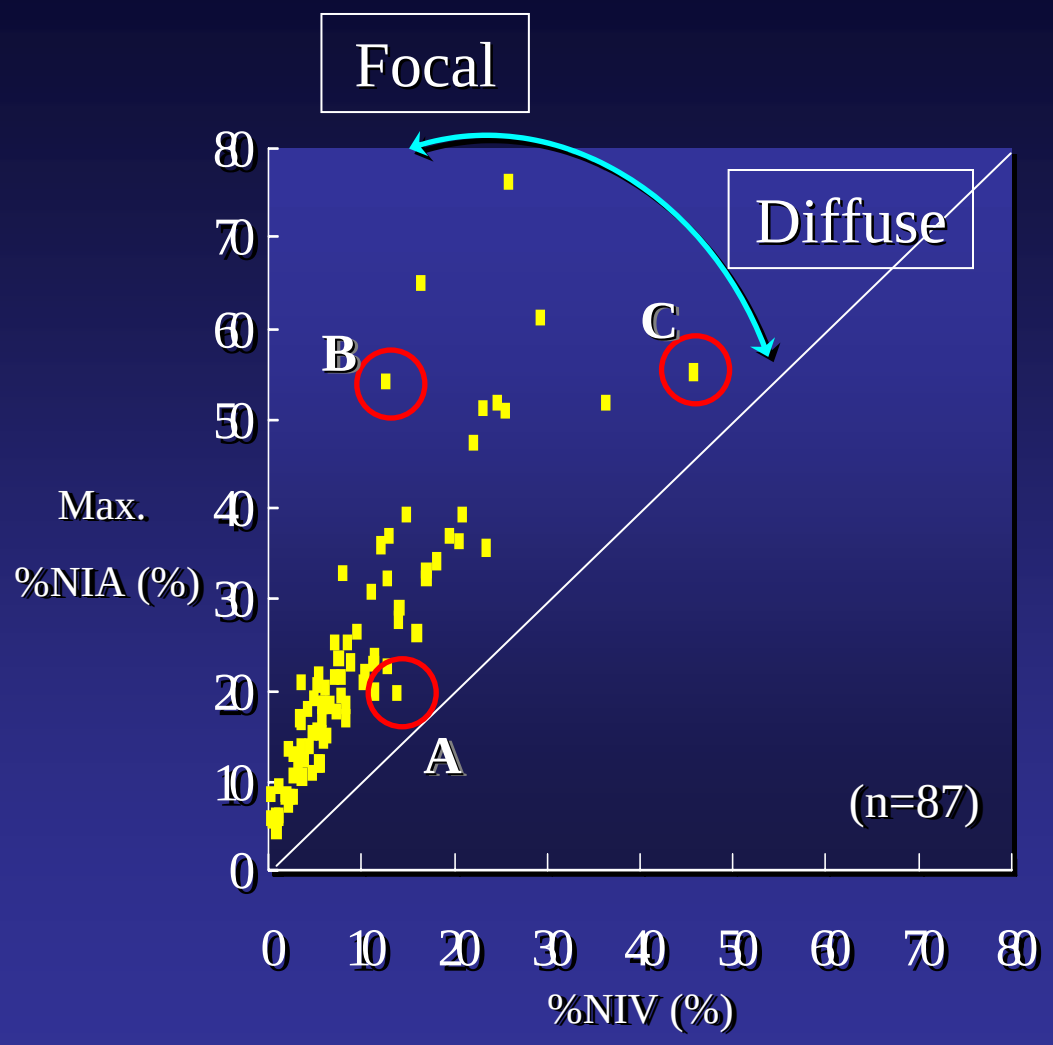
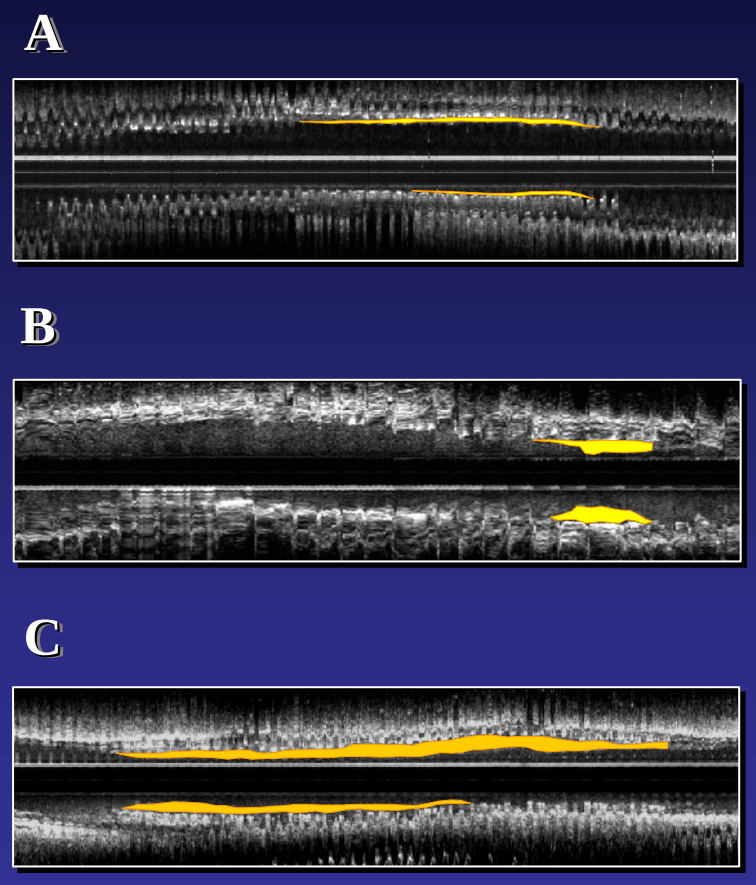
Relationship between Volume and Area Obstruction



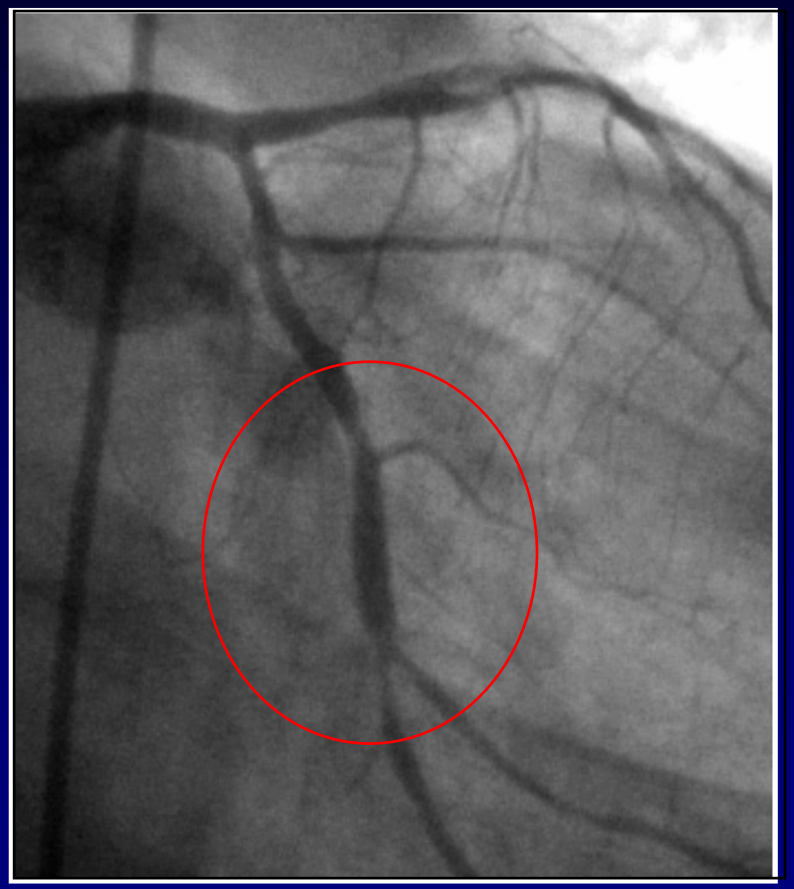


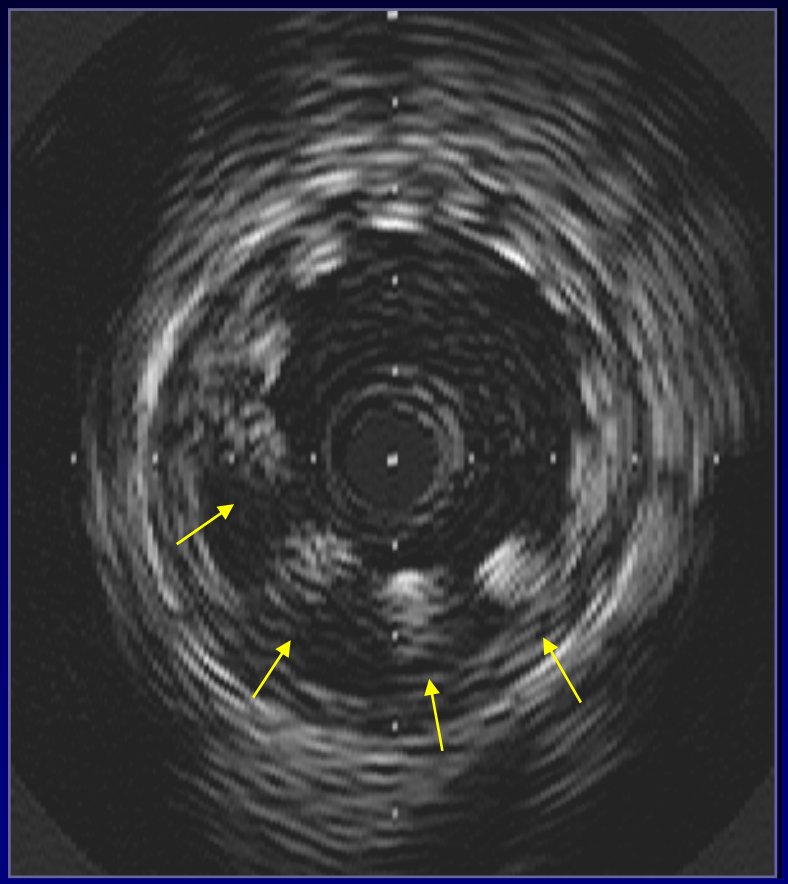
Stanford

Intravascular Ultrasound: The view from within …

* Magnitude of IH
* Statistical Distribution
* Distribution of IH in stent
* Safety issues

The changing landscape by DES…

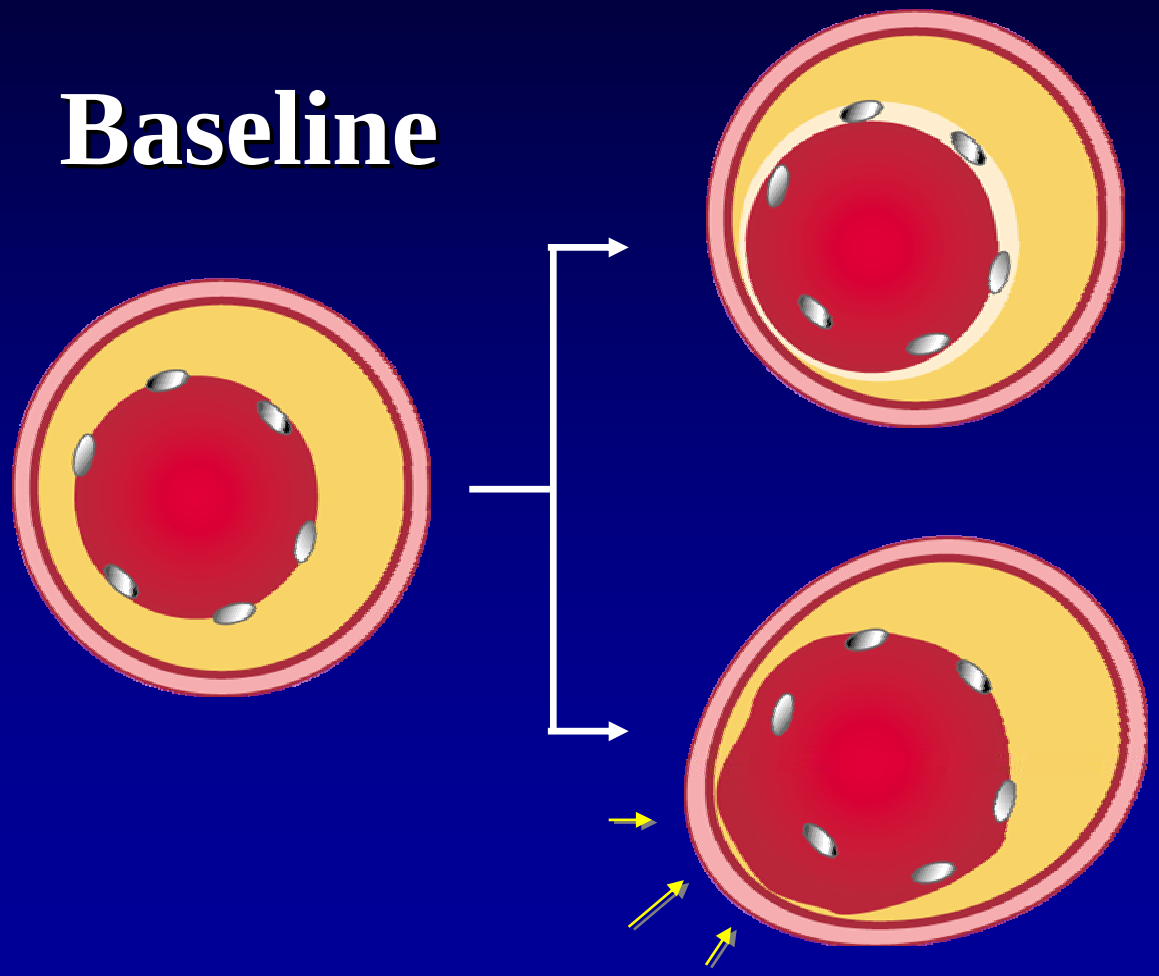




…the edges are important

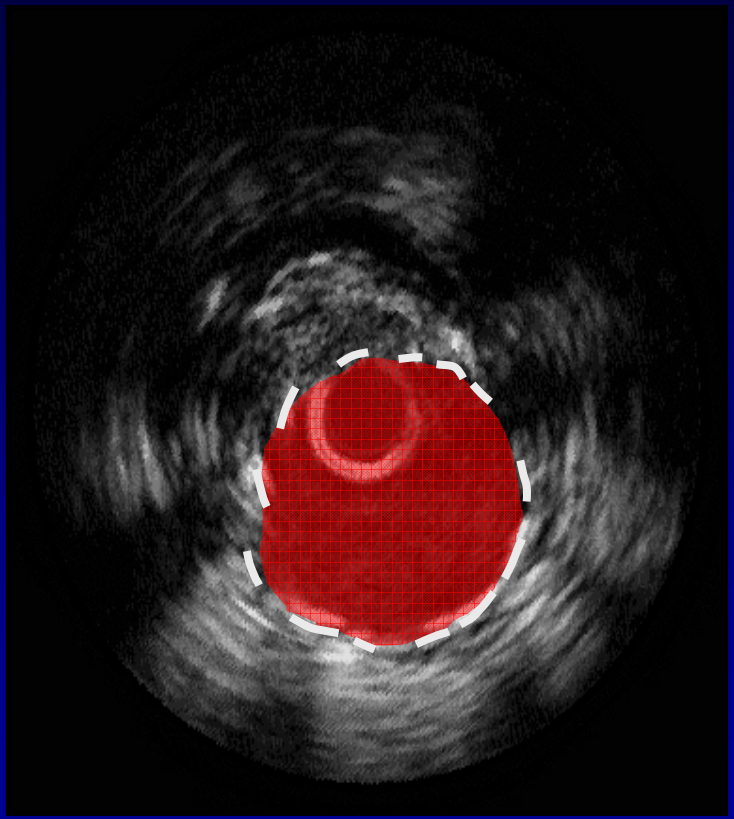
…incomplete apposition

Follow-up Incomplete (± remodeling)

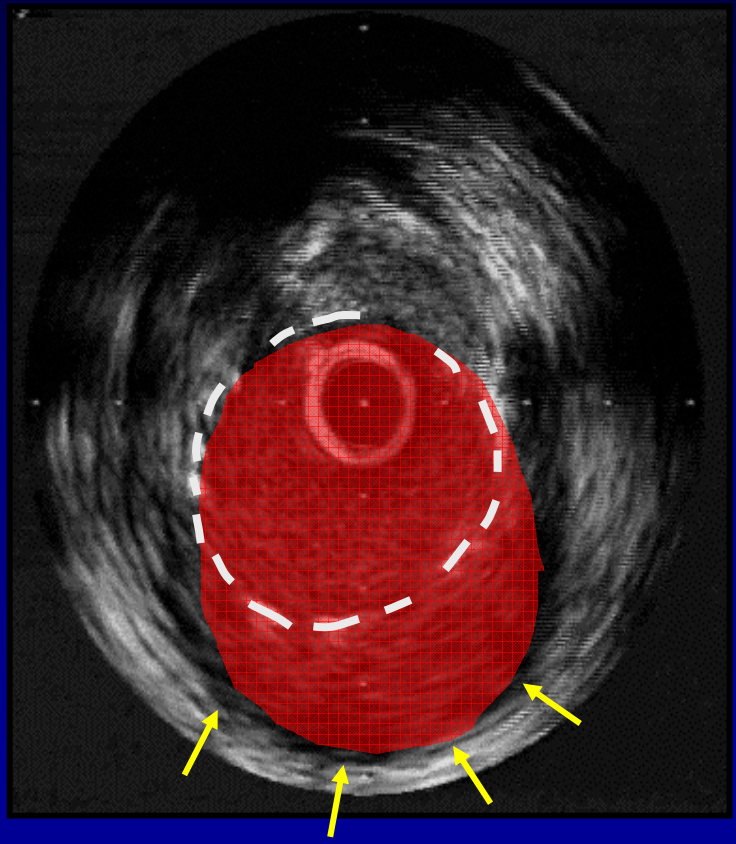


Late Incomplete Apposition

Drug-eluting stent group

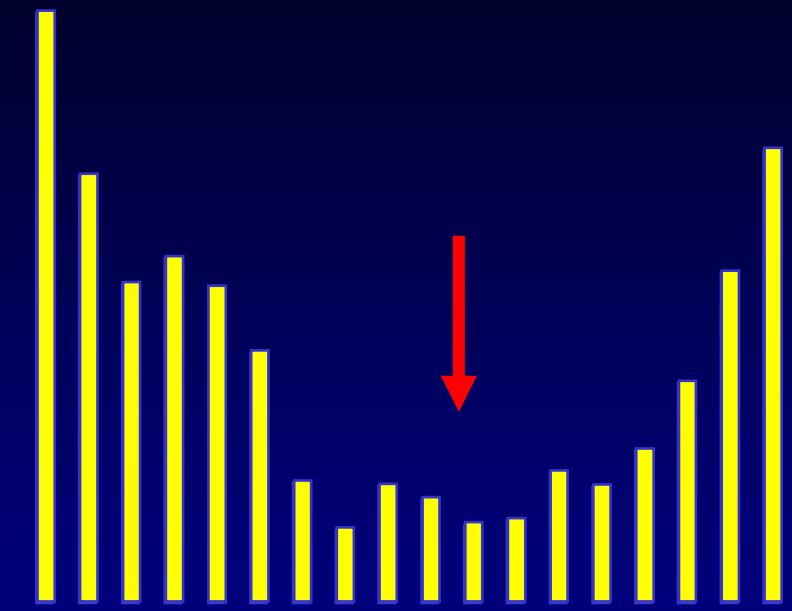


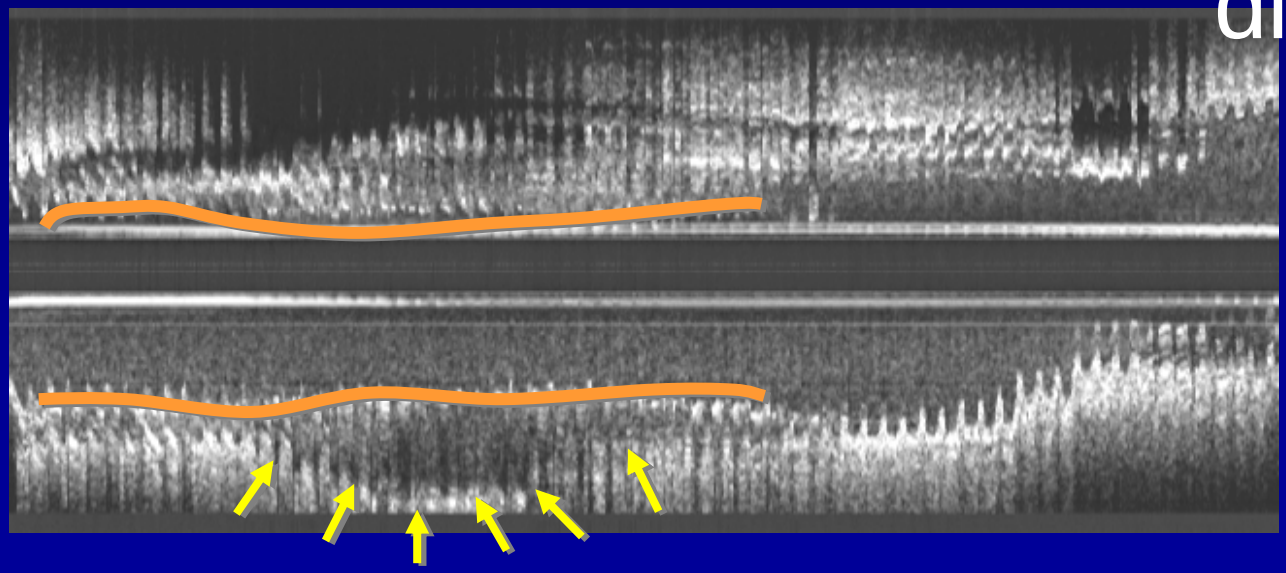
Baseline



Follow-up

Rapa-eluting stent: IH distribution





Mid-stent location of late IA … asymmetric IH distribution

8.9 %

Drug-eluting stent: IH distribution

(more even distibution…fills in gaps)

Ptx / Express II

Incidence of LIA = 1.2 %

.. drug and platform

Stanford

Intravascular Ultrasound: The view from within …

* Clinical Subset adjunct
* Clinical efficacy and safety
* New Applications