

IVUS Findings in DES Restenosis

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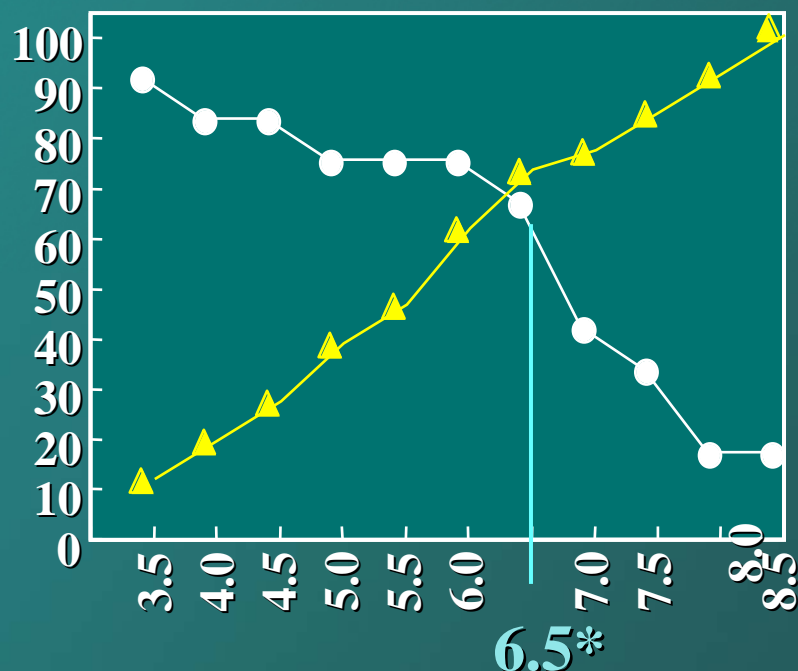
Stent Underexpansion



The 90% predictive value for underexpansion as a cause of Cypher stent restenosis in SIRIUS suggested that most causes of Cypher stent failure will be “mechanical”

Bare Metal Stents

F/U MLA >4.0mm² (%)

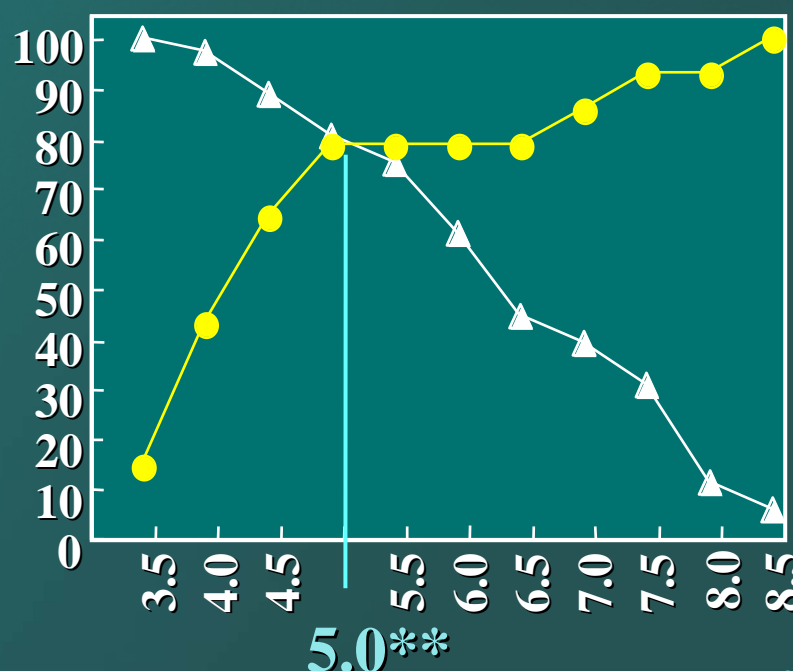


Minimum stent area (mm²)

*predictive value=56%

Cypher

F/U MLA >4.0mm² (%)



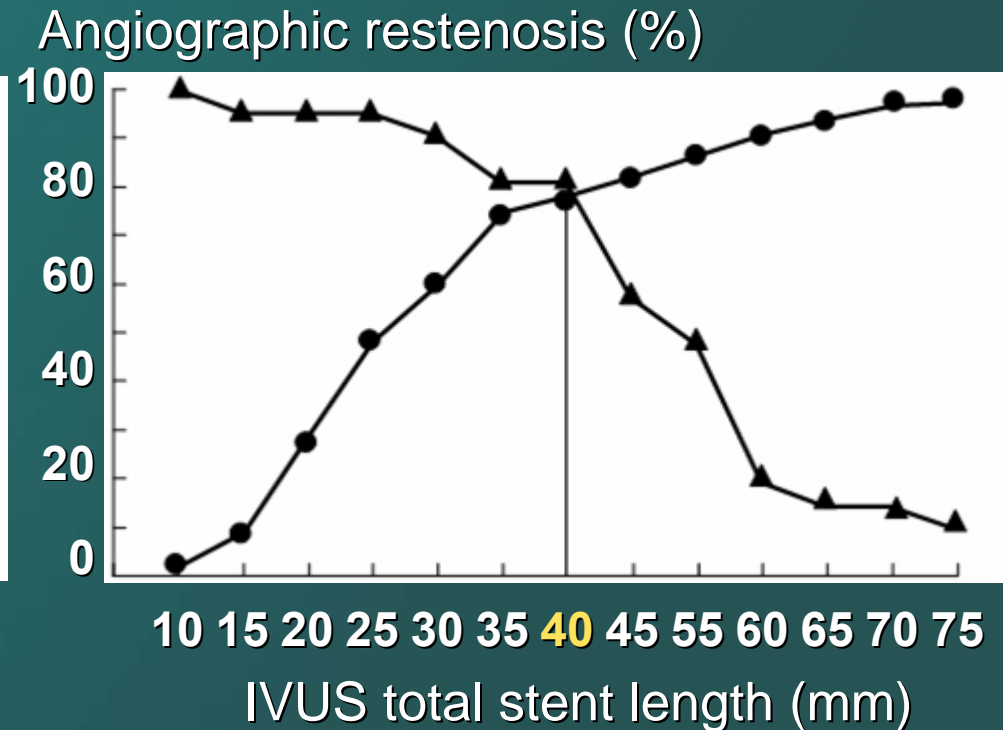
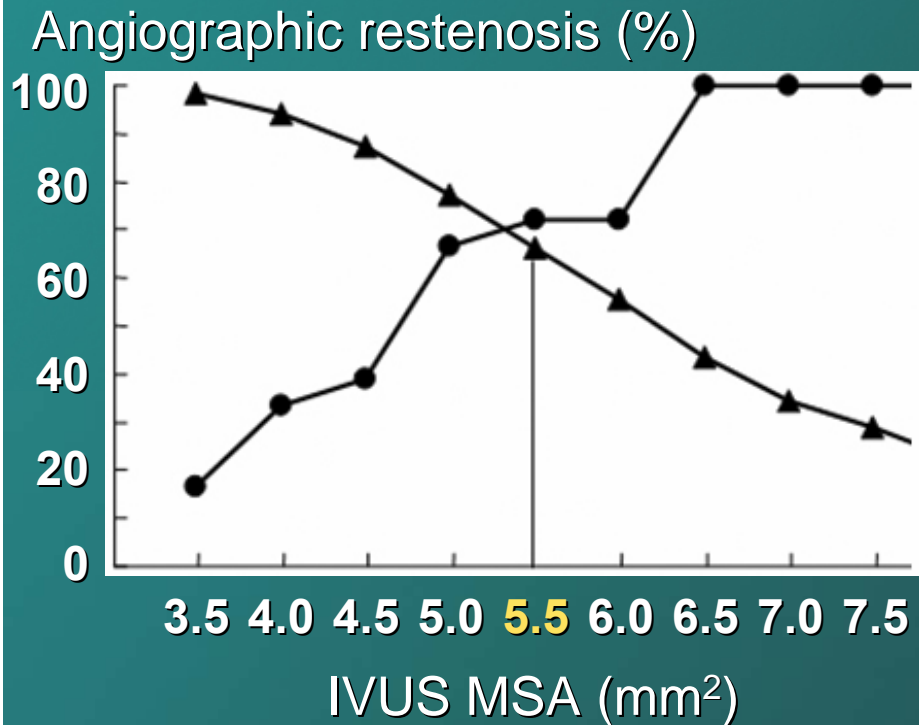
Minimum stent area (mm²)

**predictive value=90%

(Sonoda et al. J Am Coll Cardiol 2004;43:1959-63)



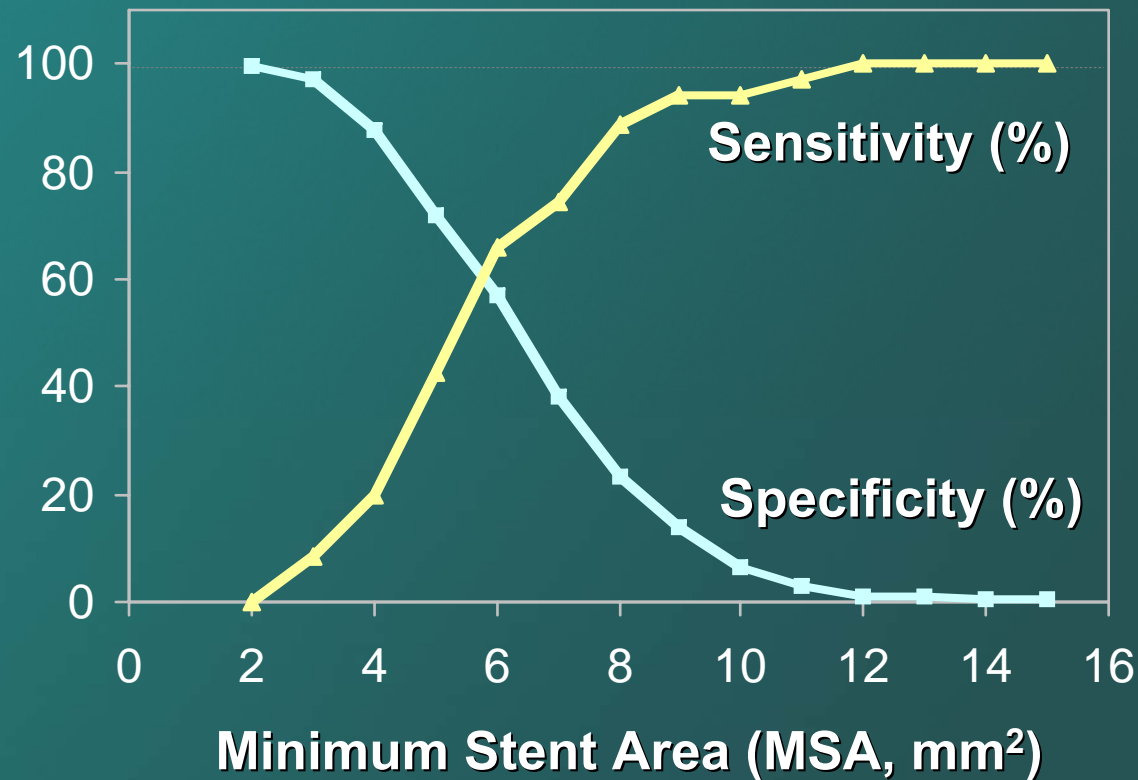
Predictors of angiographic restenosis in 550 patients with 670 native artery lesions treated with Cypher stents



	<5.5mm ²	≥5.5mm ²
≤40mm	2.4%	0.4%
>40mm	17.7%	8.6%

(Hong et al. *Eur Heart J* 2006;27:1305-10)

Post-Procedure MSA and Binary Restenosis at 9-Months: TAXUS IV, V, and VI



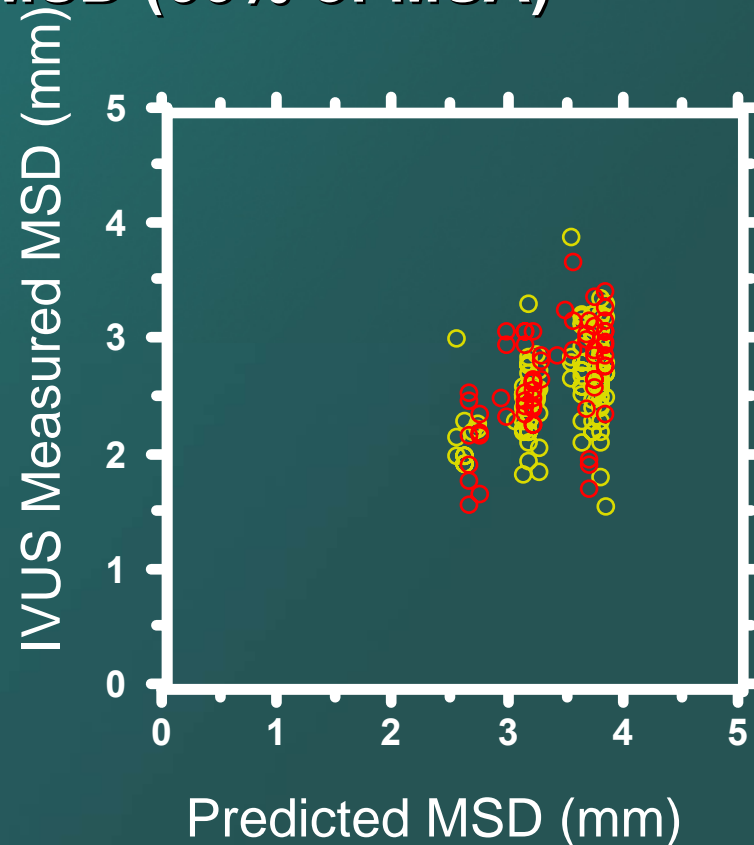
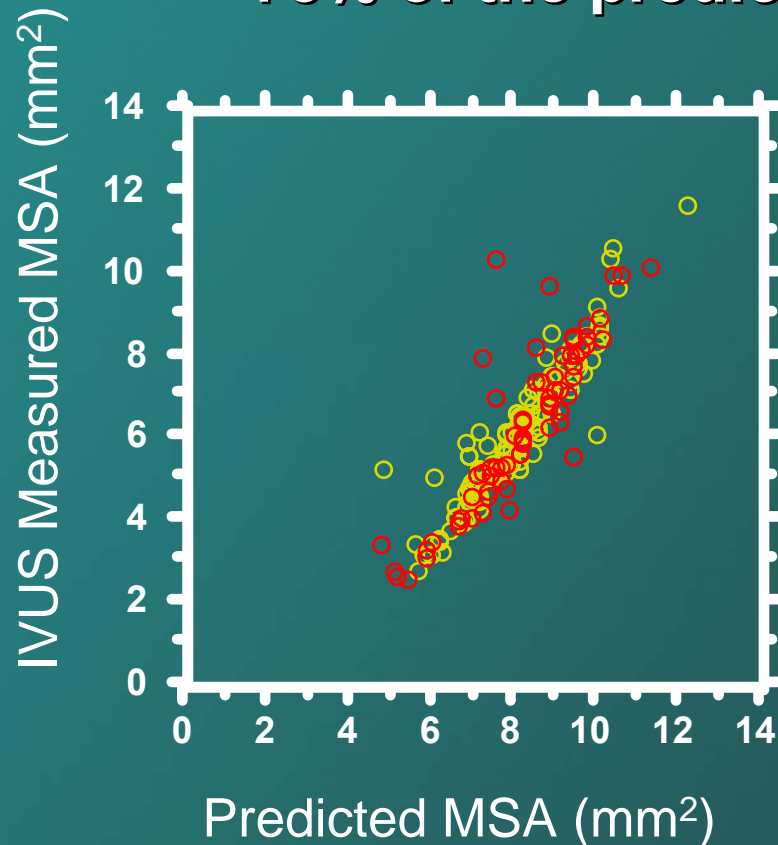
MSA \approx 5.5 mm²



94% Neg. Predictive Value

- While each of these studies reported a single MSA that best discriminated restenosis from no restenosis, there was still a stepwise relationship between a larger MSA and a lower rate of DES restenosis.

Comparison of IVUS-measured minimum stent diameter (MSD) and minimum stent area (MSA) with the predicted measurements from Cordis (Cypher in yellow, n=133) and BSC (Taxus in red, n=67). DES achieve an average of only 75% of the predicted MSD (66% of MSA)



(de Rebamar Costa et al, Am Heart J 2007;153:297-303)

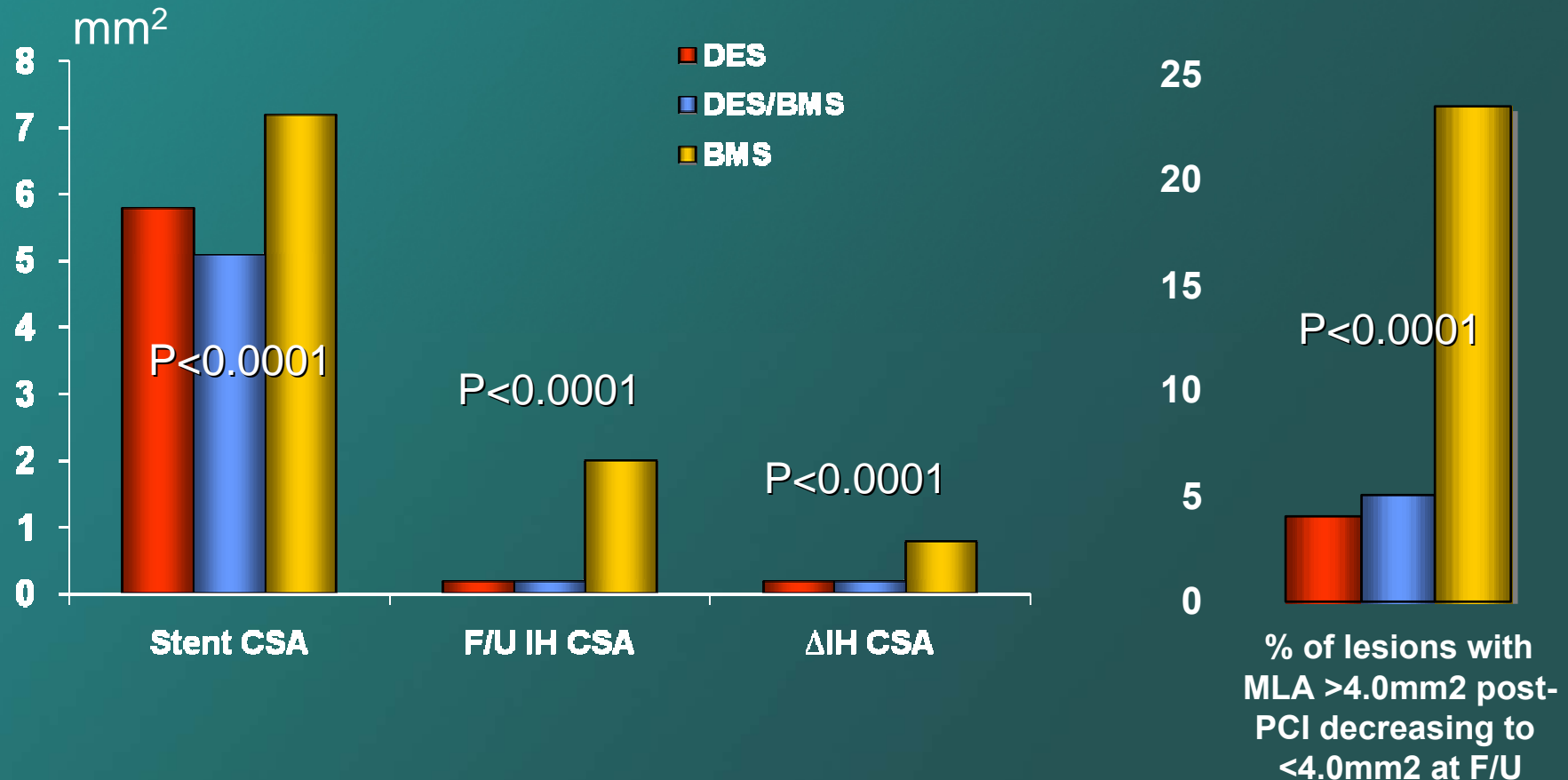
Failure of Cypher Stent Treatment of In-stent Restenosis @ CRF

- Recurrence in 10 of 41 patients with in-stent restenosis treated with Cypher stents
 - Stent underexpansion (MSA $<5.0\text{mm}^2$) in 8/10 recurrence in-stent restenosis lesions (80% vs 12/38 [38%] of non-recurrent lesions, $p=0.02$) and 6/10 (60%) recurrent lesions had a MSA $<4.0\text{mm}^2$ vs 8/38 (18%) non-recurrent lesions ($p=0.02$)
 - Gap between multiple Cypher stents was detected in 3/10 recurrent lesions: vs 1/38 non-recurrent lesion ($p=0.005$). The gap was not detectable angiographically, and it measured $<1\text{mm}$ in length by IVUS.
- Therefore, complete lesion coverage and adequate stent expansion are important in the DES treatment of ISR.

(Fujii et al. Circulation 2004;109:1085-1088)



Serial IVUS Findings after Cypher Stent Treatment of BMS Restenosis



(Sakurai et al. Am Heart J, in press)

“Uncovered” (Residual) Edge Stenoses



IVUS Predictors of Stent Edge Restenosis in SIRIUS

Baseline Parameters	Peri-stent Stenosis	No Peri-stent Stenosis	p
Reference MLA (mm ²)	4.7 ± 2.3	6.5 ± 2.3	0.06
<i>Reference Residual Plaque (%)</i>	<i>60.5 ± 9.0</i>	<i>49.1 ± 11.5</i>	<i>0.03</i>
<i>Edge SA / Reference MLA</i>	<i>1.5 ± 0.3</i>	<i>1.2 ± 0.3</i>	<i>0.03</i>
Maximum Pressure (mm)	15.4 ± 3.2	16.9 ± 2.7	ns
Balloon / Artery Ratio	0.9 ± 0.1	1.0 ± 0.1	ns

(Sakurai et al. Am J Cardiol 2005;96:1251-3)

Plaque Prolapse



Intra-stent acute plaque prolapse in the DIABETES-I and DIABETES-II Trials

	Cypher		Taxus	
	Plaque prolapse	No plaque prolapse	Plaque prolapse	No plaque prolapse
N	9	60	15	65
Mean intra-stent tissue				
Post-PCI	0.72mm ²	0	0.63mm ²	0
F/U	0.55mm ²	0.77mm ²	1.71mm ²	1.49mm ²
Restenosis	0	3.3%	6.3%	7.3%
Stent thrombosis	0	0	0	0

P<0.05

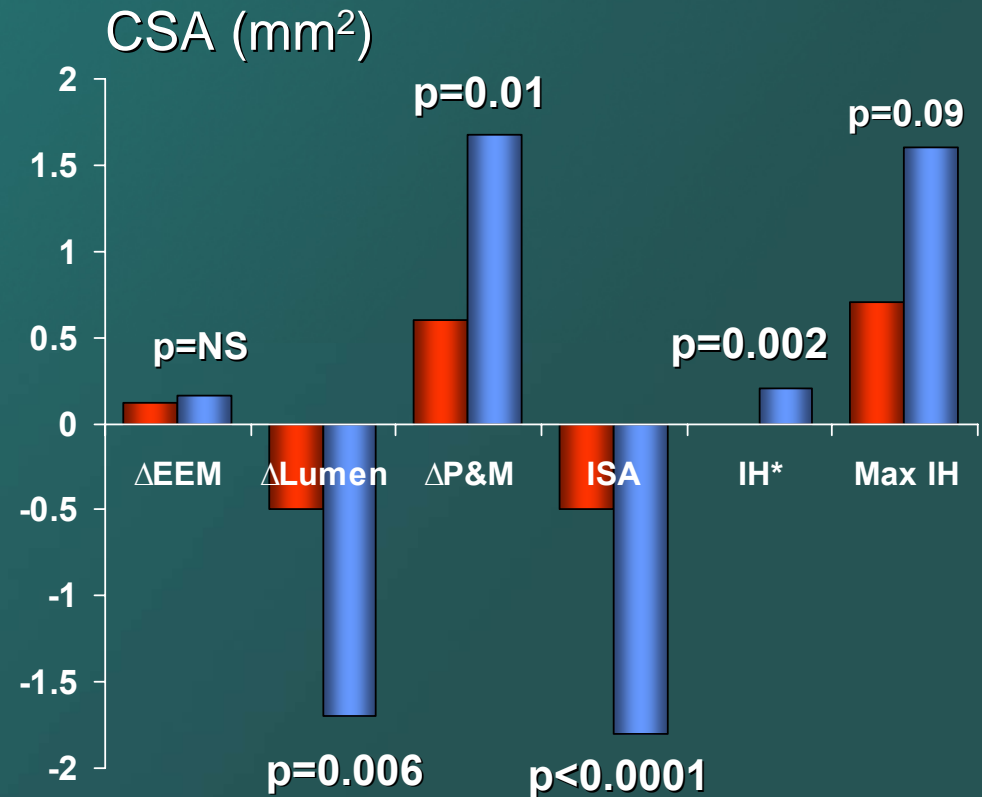
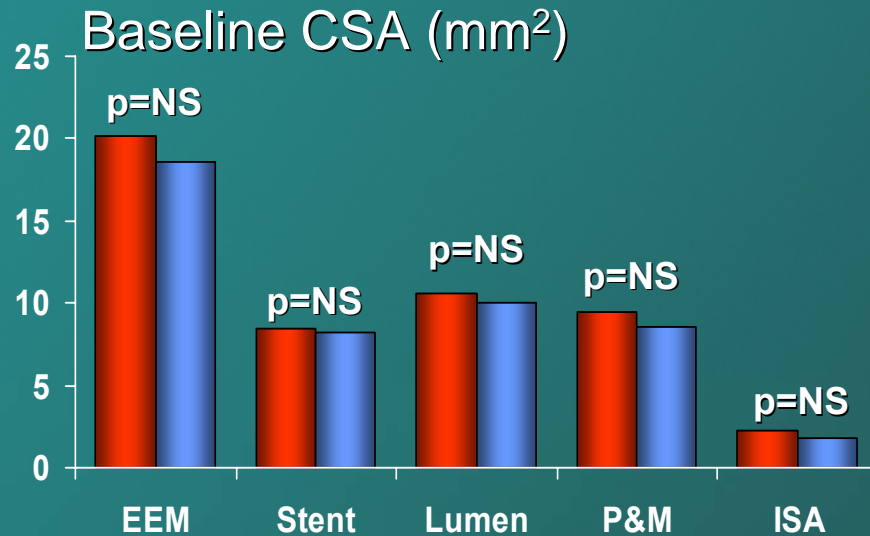
(Futamatsu et al. J Am Coll Cardiol 2006;48:1139-45)

Acute Stent Malapposition



Acute Incomplete Cypher Apposition @ CRF

- Persistent ISA (n=40, 83% decreased in size)
- Completely resolved ISA (n=15)



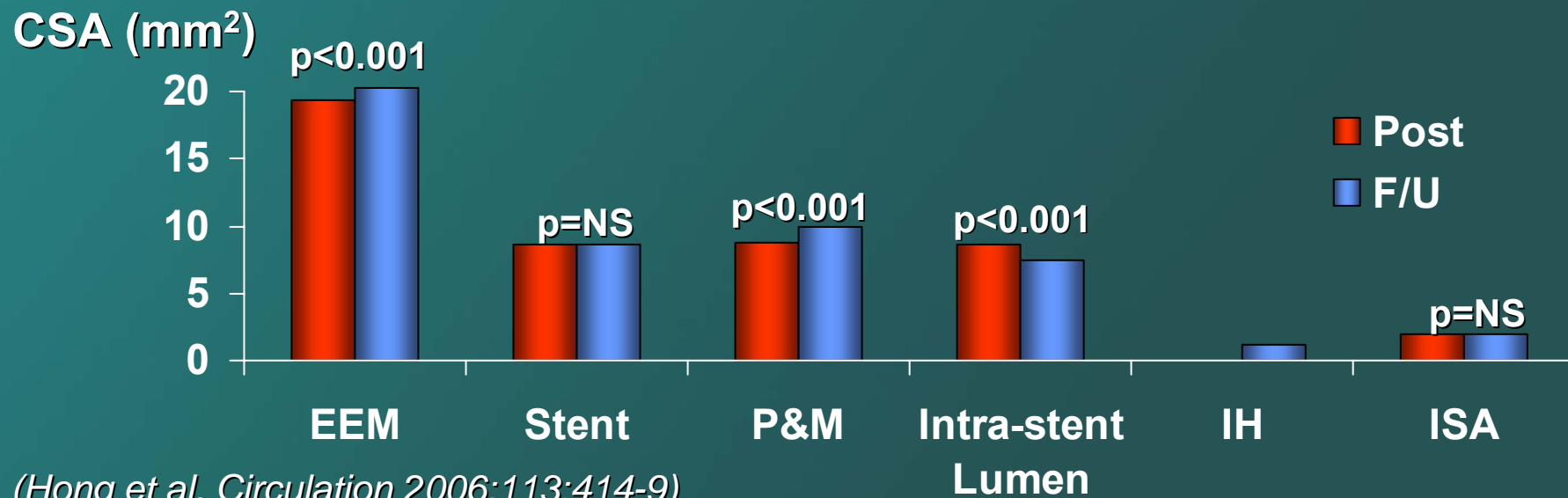
*at malapposition site

- The only independent predictor of persistent ISA was the amount of superficial lesion calcium
- ΔISA correlated with ΔP&M, but not with ΔEEM

(Kimura, et al. Am J Cardiol 2006;98:436-42)

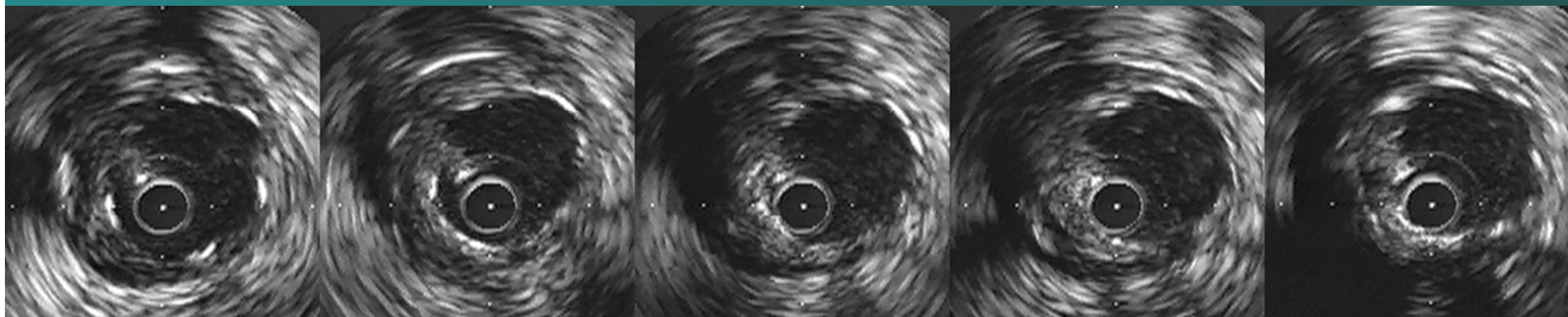
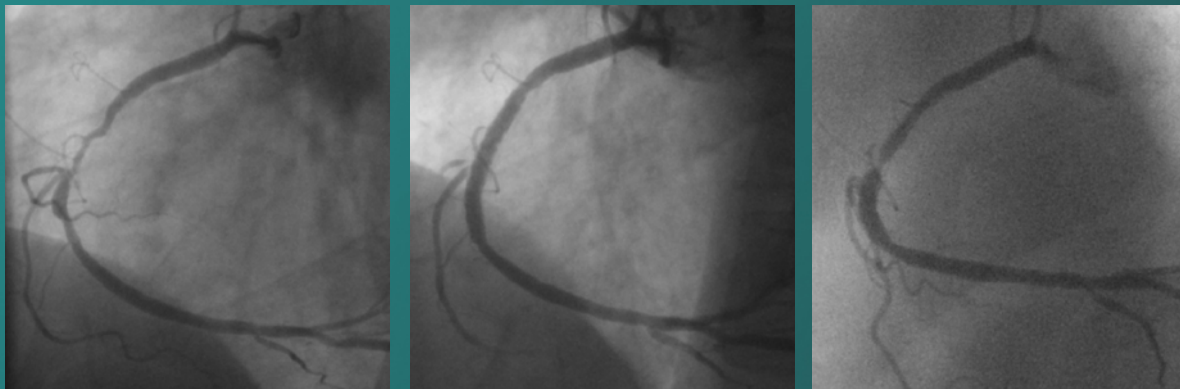
Acute Incomplete DES Apposition @ AMC

- 51/705 (7.2%) lesions (7.2%)
 - 47/705 in sirolimus-eluting stents
 - 4/167 in paclitaxel-eluting stents.
- Malapposition was persistent in all 51 lesions at 6-month F-U with no TLR or MACE events

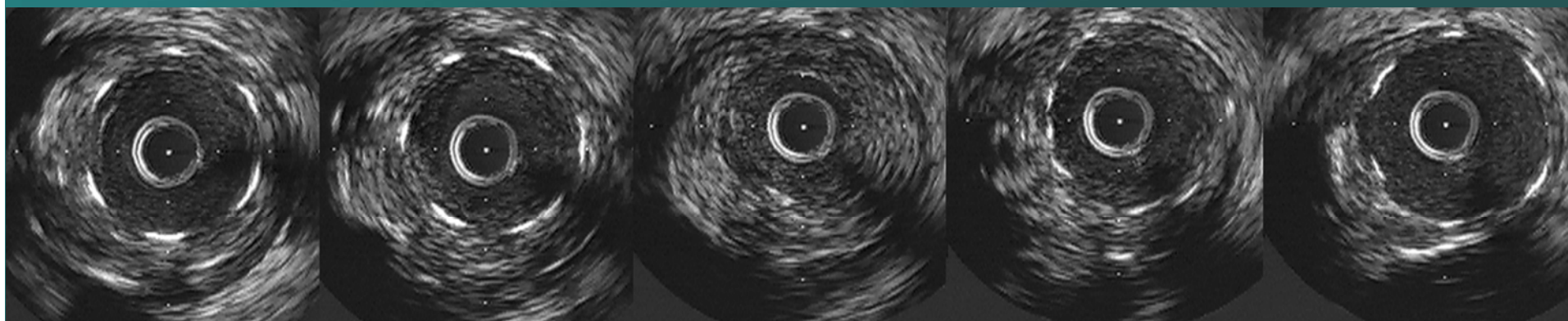


Strut Fracture and Inhomogeneous Strut Distribution





0 → 1.5 → 6.0mm



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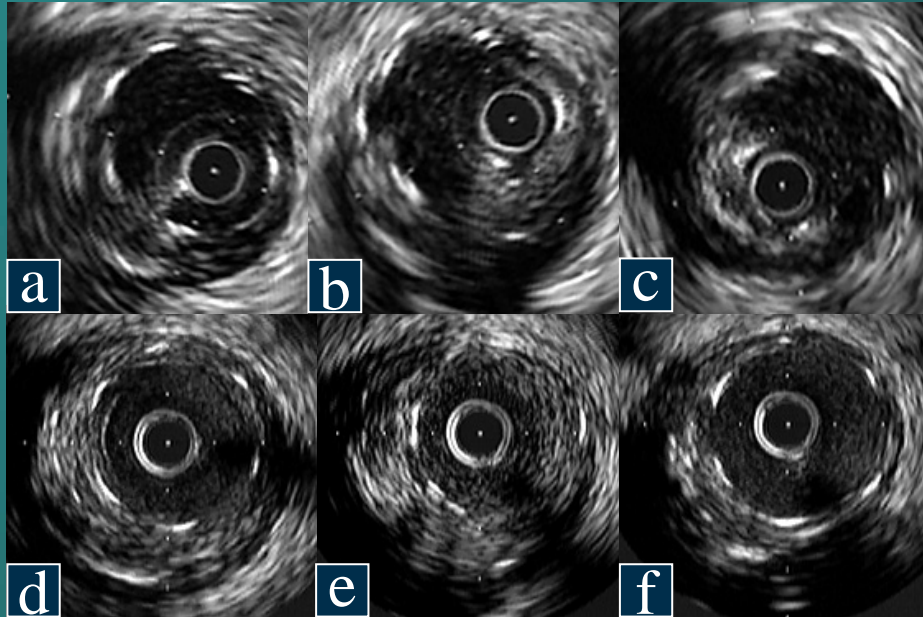
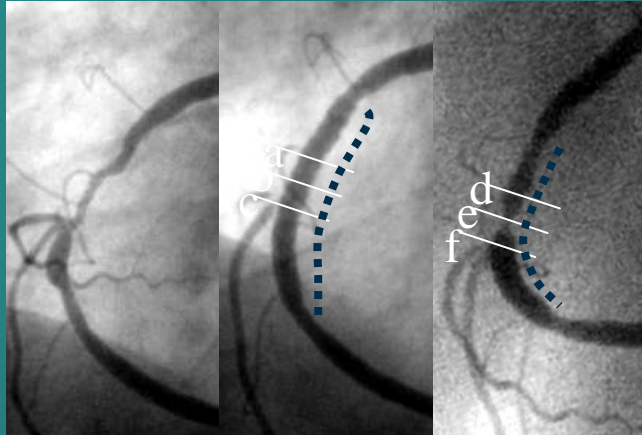
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However. . .

- **Most suspected cases of strut fracture did not have baseline and follow-up IVUS**
- **Most suspected or documented cases of strut fracture did not result in restenosis or other complications**
- **Strut fracture has only been found in a small minority of DES restenosis or thrombosis cases**

When compared to either neointima-free sections in the same stent or non-restenotic stents, the maximum IH area correlated with fewer stent struts and with a larger angle between adjacent stent struts.

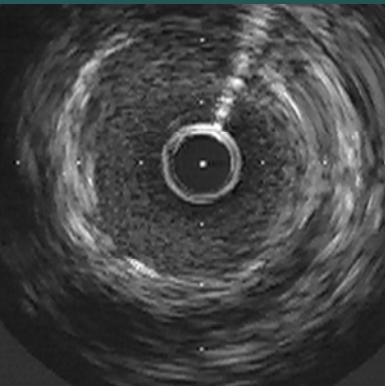
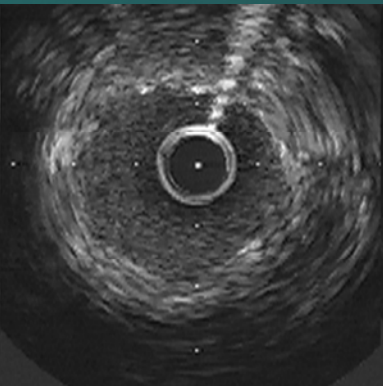
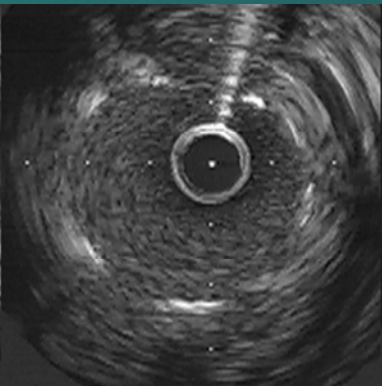
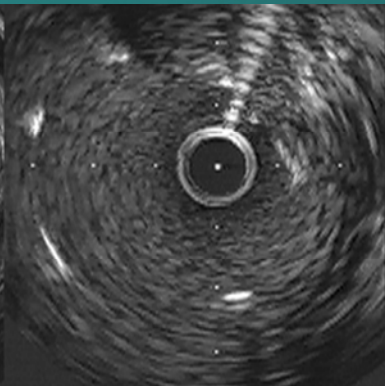
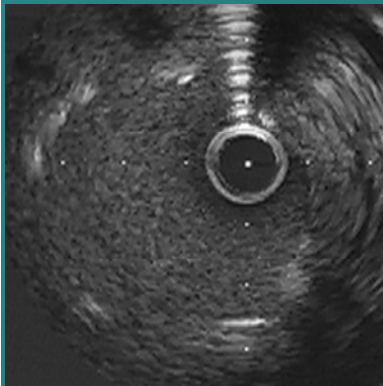
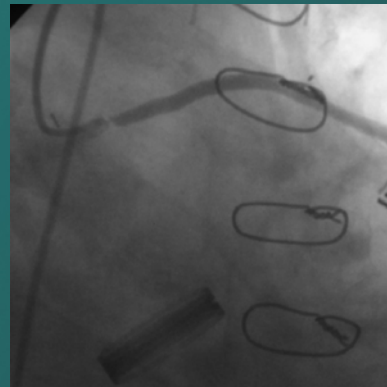


Independent predictors of IH CSA, IH thickness, and MLA

- EEM CSA ($p < 0.05$)
- P&M CSA ($p < 0.05$)
- Normalized # of struts ($p < 0.0001$)
- Maximum interstrut angle ($p < 0.0001$)

(Takebayashi et al. *Circulation*. 2004;109:1244-9)

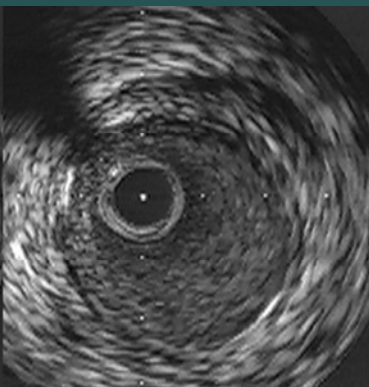
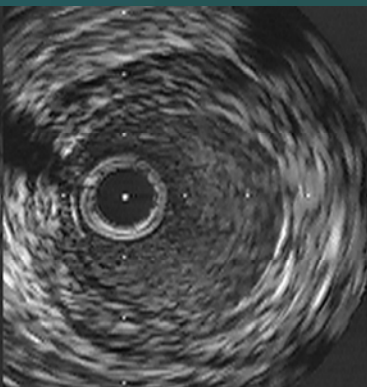
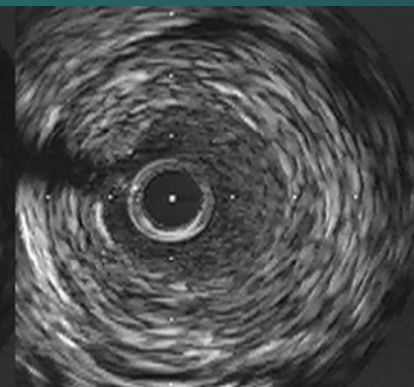
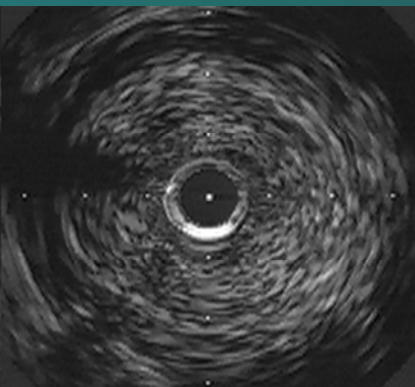
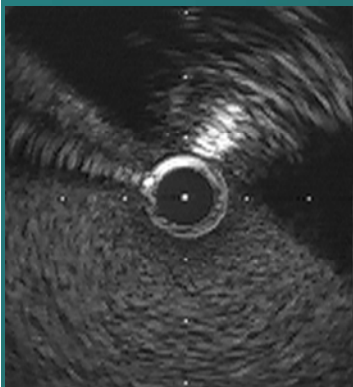




0

2.5

10.0mm



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Conclusions

- **The most important IVUS findings in patients with DES restenosis continue to be stent underexpansion and inflow/outflow stenoses**
- **Other findings include stent strut fracture and inhomogeneous stent strut distribution.**
- **All cases of DES failure deserve IVUS interrogation.**