

# **The Art of CTO PCI: Being Selective in Our Approach Achieves the Best Outcomes!**

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# Financial Conflict of Interest Disclosure

- Dr. Kirtane reports Institutional funding to Columbia University and/or Cardiovascular Research Foundation from Medtronic, Boston Scientific, Abbott Vascular, Amgen, CathWorks, CSI, Philips, ReCor Medical, Neurotronic, Biotronik, Chiesi, Bolt Medical, Magenta Medical, Canon, SoniVie, and Shockwave Medical. In addition to research grants, institutional funding includes fees paid to Columbia University and/or Cardiovascular Research Foundation for consulting and/or speaking engagements in which Dr. Kirtane controlled the content. Personal: Travel Expenses/Meals from Amgen, Medtronic, Biotronik, Boston Scientific, Abbott Vascular, CathWorks, Edwards, CSI, Novartis, Philips, Abiomed, ReCor Medical, Chiesi, Zoll, Shockwave, and Regeneron.

# The CTO Conundrum...

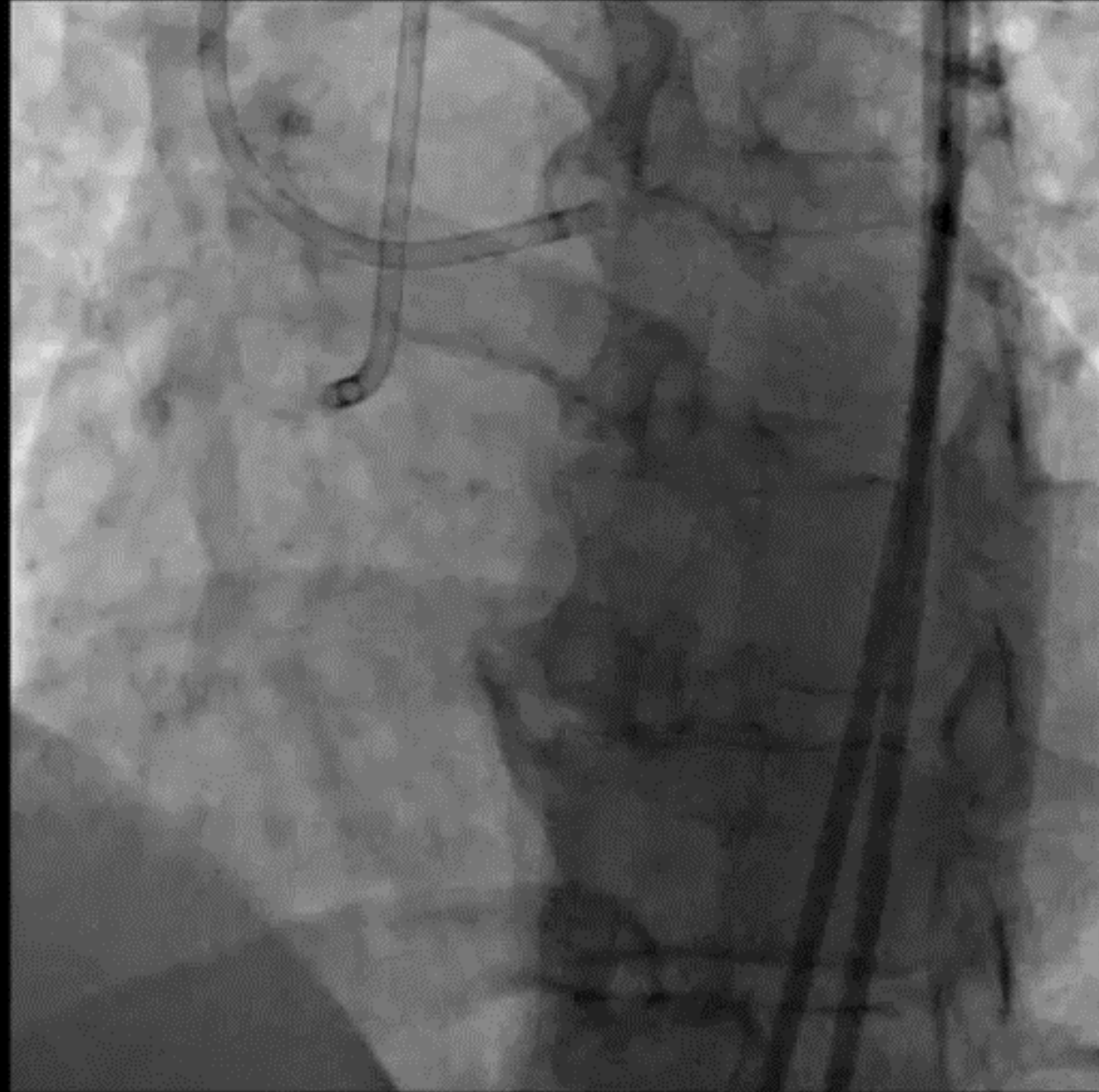
- 55 y.o male with HTN, HLD
- 4 months of exertional angina despite meds
- Nuclear stress test positive for inferior wall ischemia with normal EF



# A Different Patient...

- 55 y.o male with HTN, HLD
- 4 months of exertional angina despite meds
- Nuclear stress test positive for inferior wall ischemia with normal EF

Lossy Compression - not intended for diagnosis



***Why Do We Treat This So Differently?***

# Why CTO PCI Should Be Selective

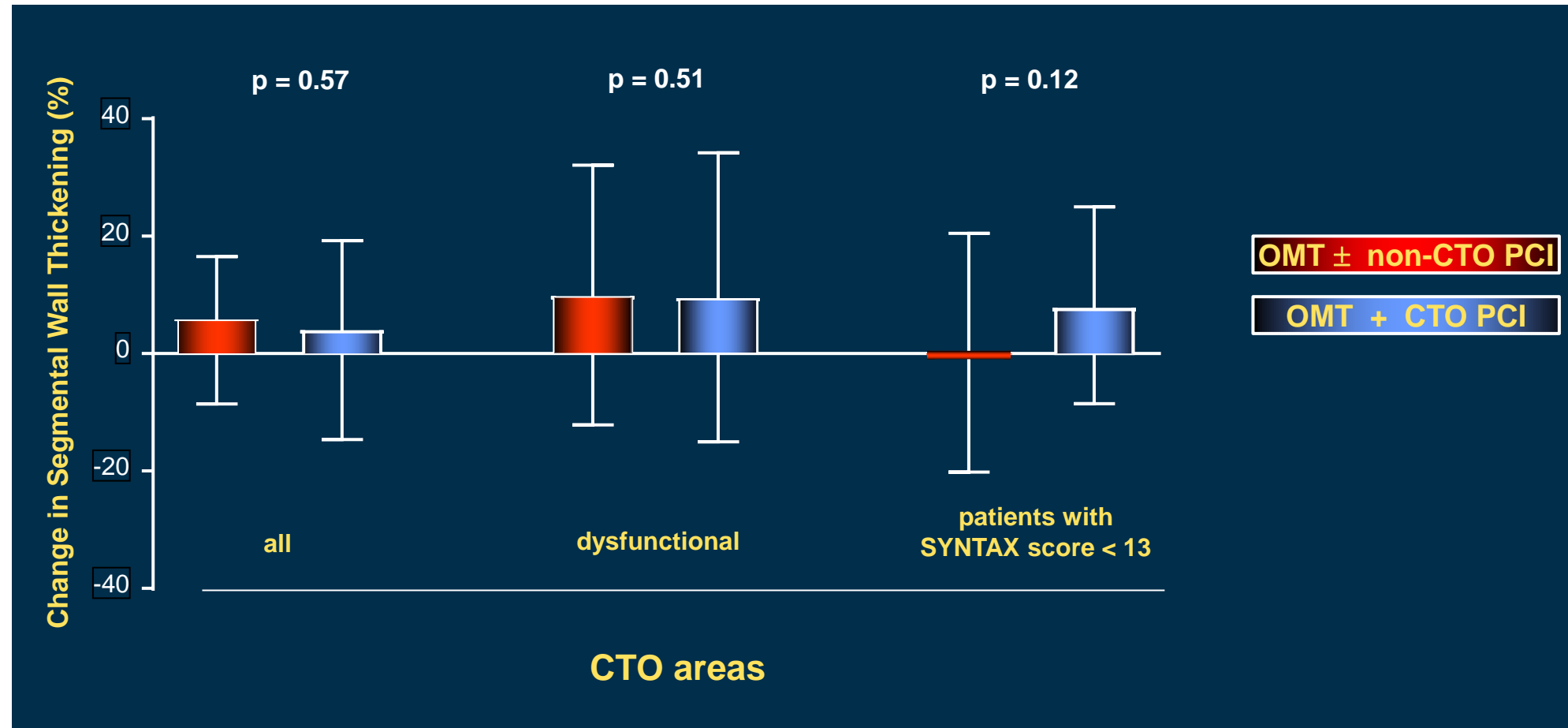
- The data in favor of CTO PCI are entirely for symptom relief (and for those with the most severe symptoms)

# REVASC Primary Endpoint: Change in Segmental Wall Thickening at 6 Mo

205 CTO patients randomized to CTO PCI vs. no CTO PCI  
(no CTO PCI group included 60% non-CTO PCI)

Mean EF 54.7% vs. 59.6%

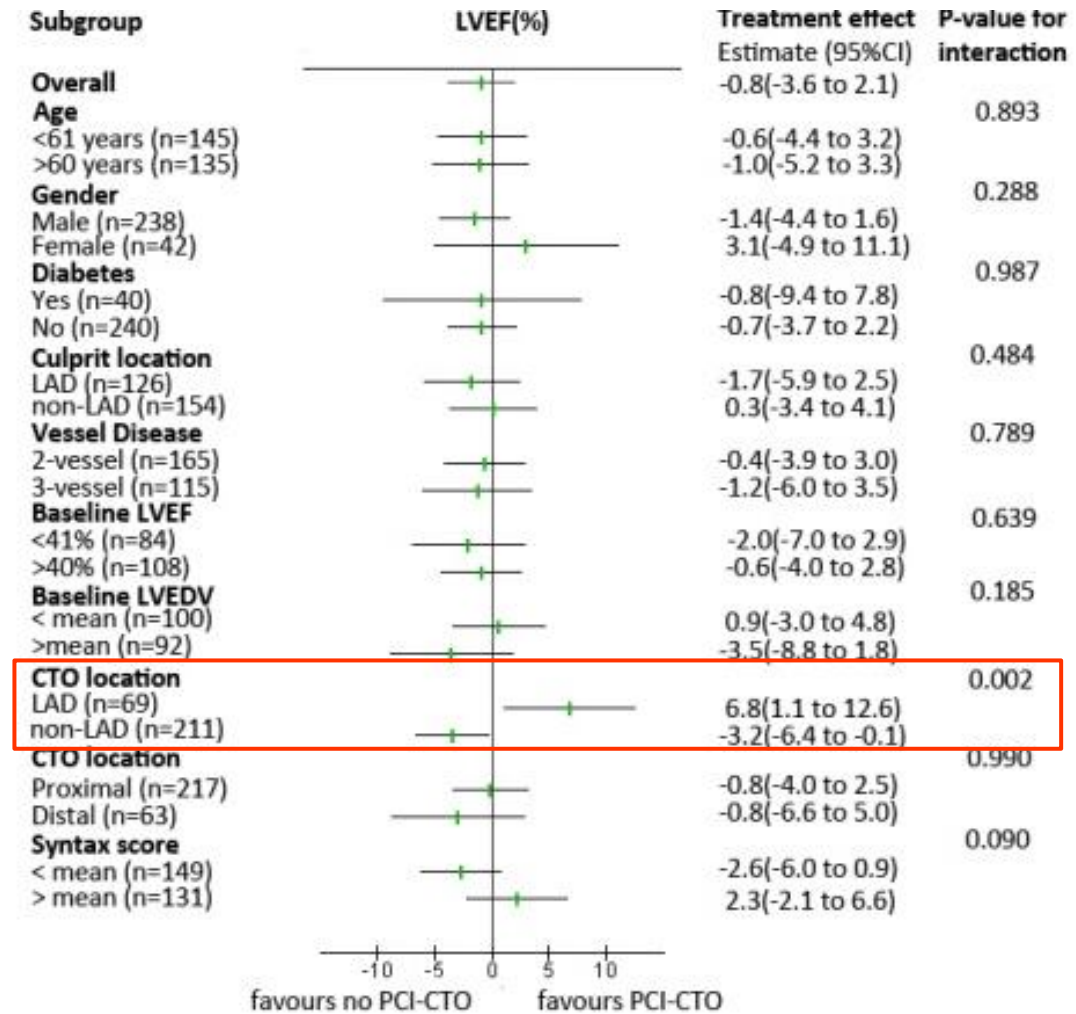
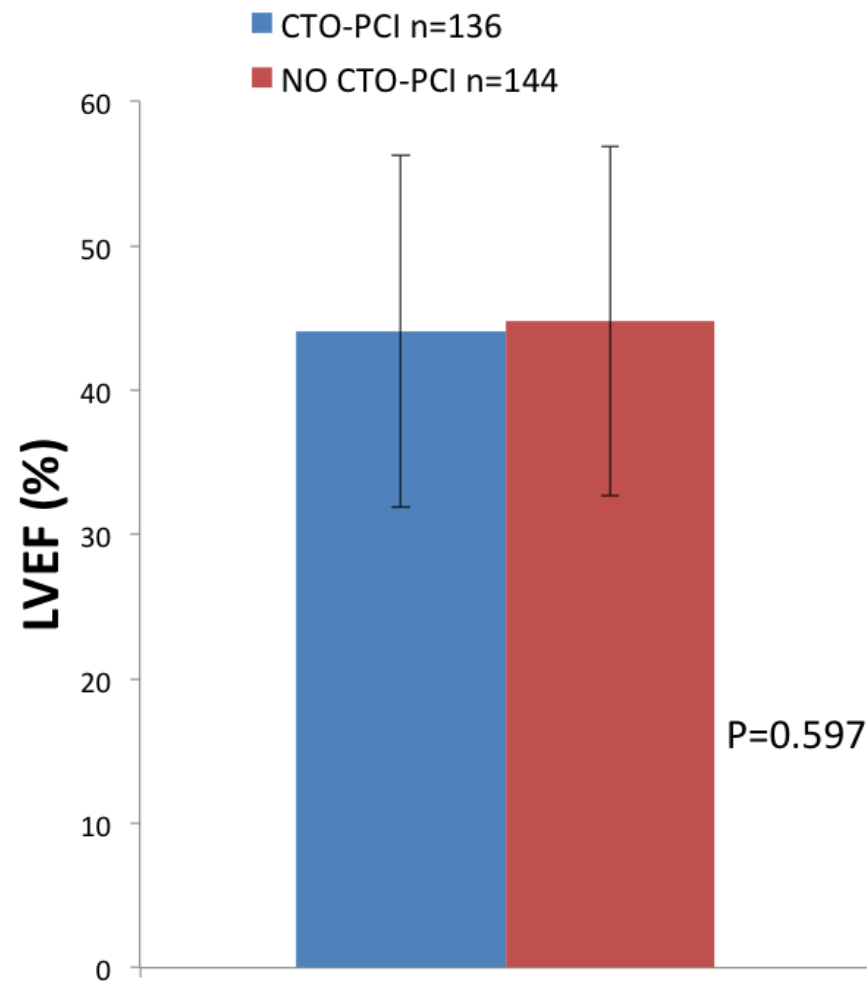
Baseline SYNTAX Score 14 vs. 16; rSS 2 vs. 11



# EXPLORE: MRI-Assessed LVEF at 4 months

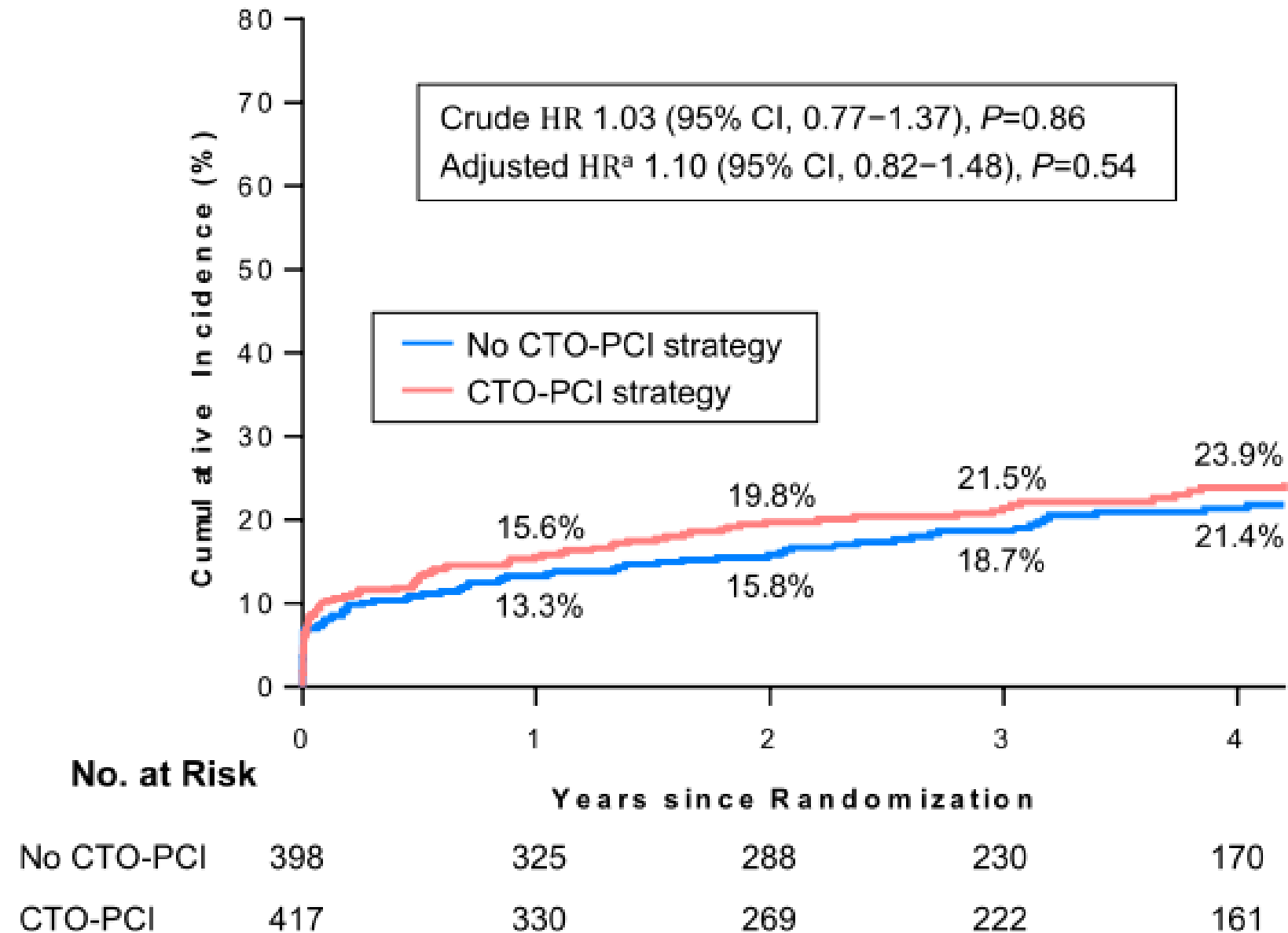


280 STEMI pts with CTO randomized: CTO PCI (73% success) vs. no CTO PCI



	CTO-PCI (n=136)		No CTO-PCI (n=144)		Difference p (95%CI)	
<b>LVEF (%)</b>	44.1	(12.2)	44.8	(11.9)	-0.8	(-3.6 to 2.1) 0.597

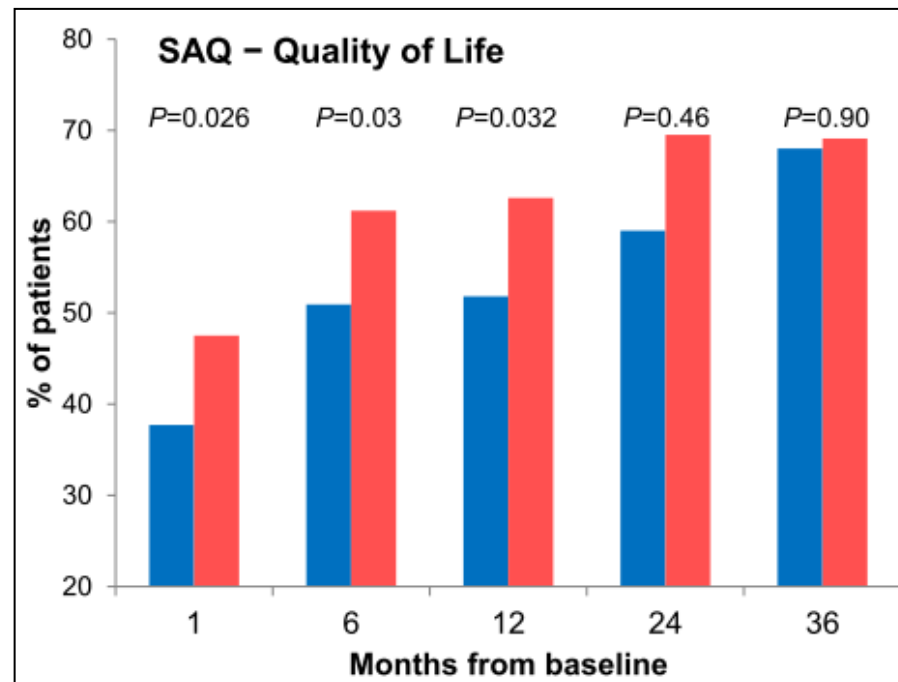
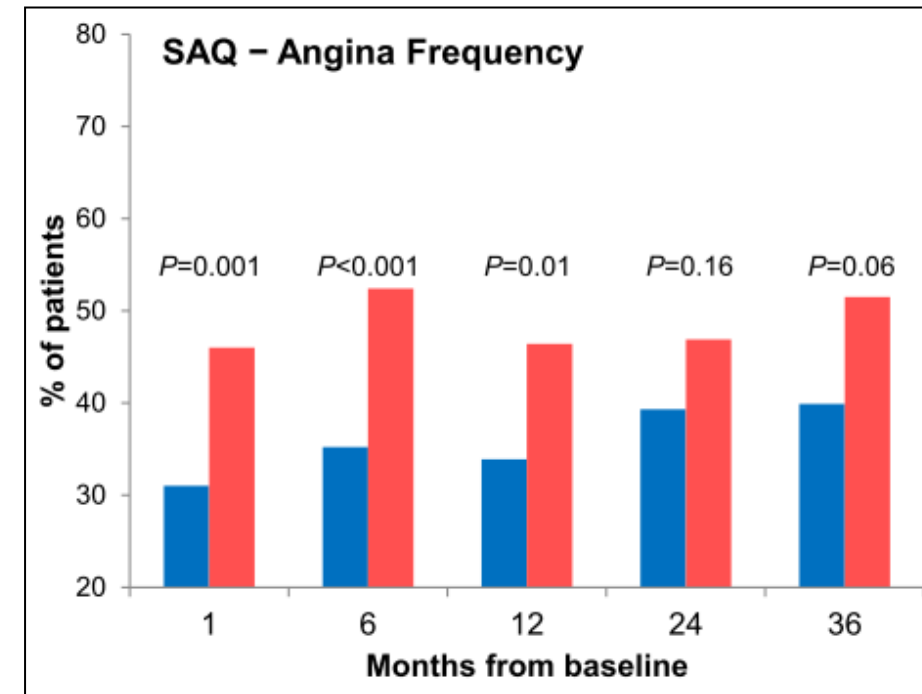
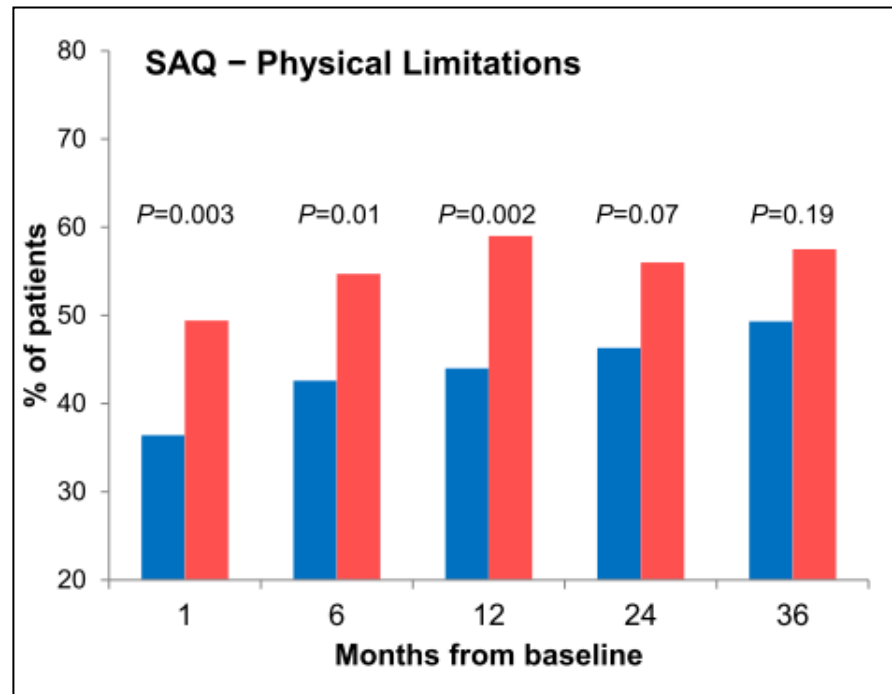
# DECISION-CTO: Primary End Point (Death, MI, Stroke, Any Revascularization)



<sup>a</sup>Adjusted for age, body mass index, hypercholesterolemia, previous stroke, renal dysfunction, atrial fibrillation, clinical presentation, location of chronic total occlusion, number of diseased vessels, and stratifying covariates.

# DECISION CTO: Responder Analyses

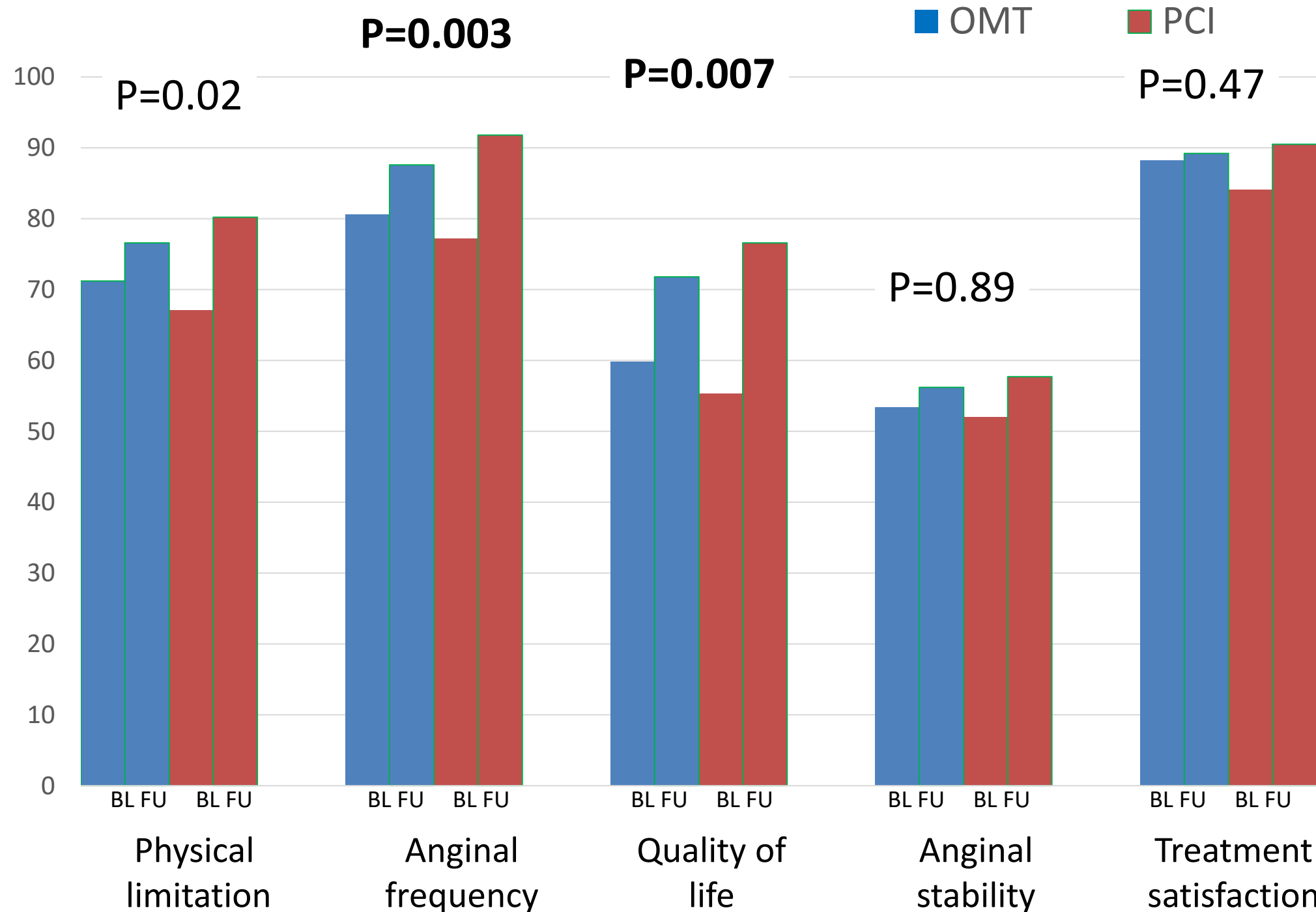
## Clinically meaningful increases



A change of  $\geq 8$ ,  $\geq 20$ , and  $\geq 16$  points for the SAQ-physical limitation, angina frequency, and QOL domain, respectively, was considered clinically meaningful.

■ No CTO-PCI strategy    ■ CTO-PCI strategy

# EuroCTO Primary Endpoint: SAQ health status (ITT)

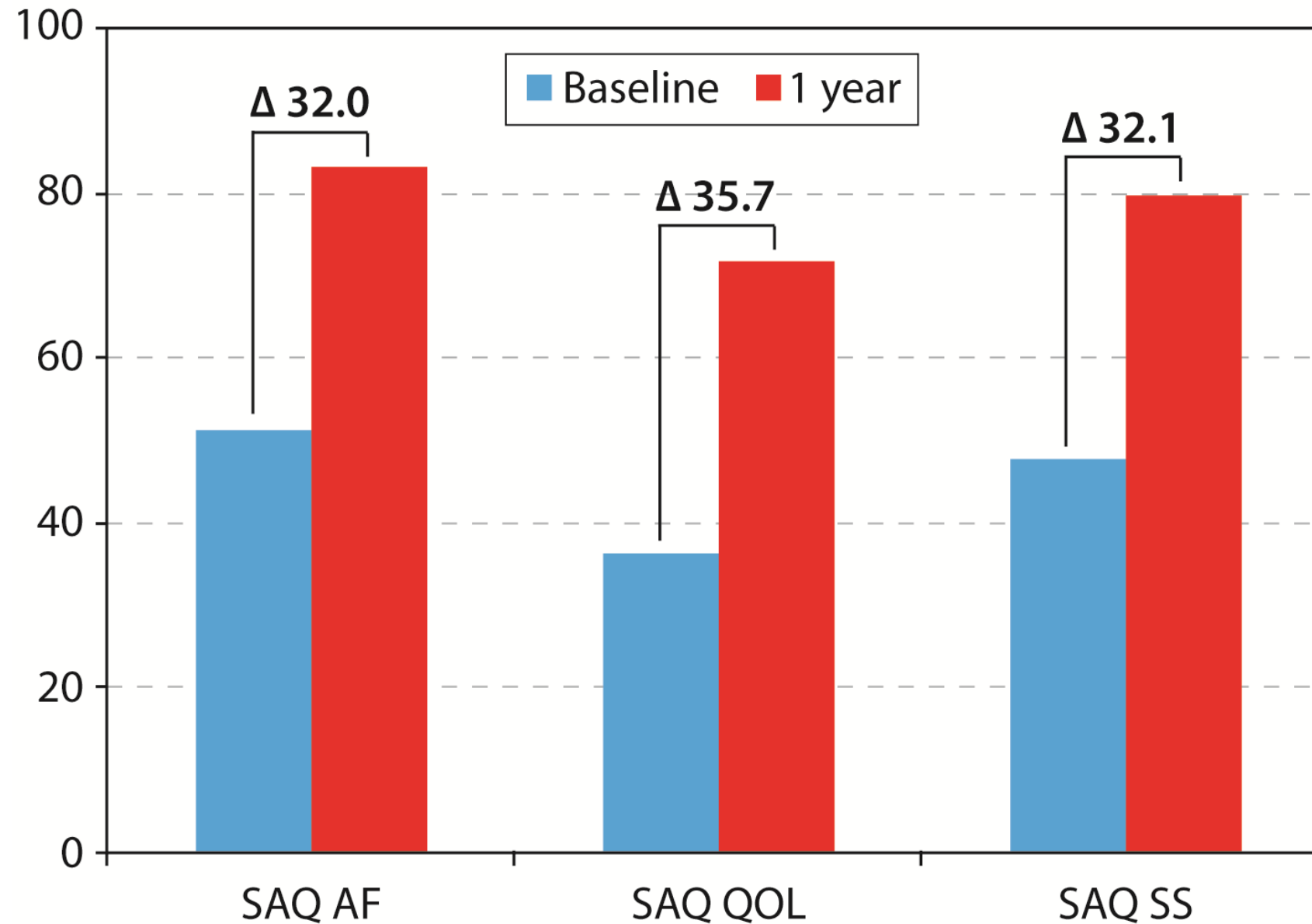


For multiple testing the significance level is 0.01

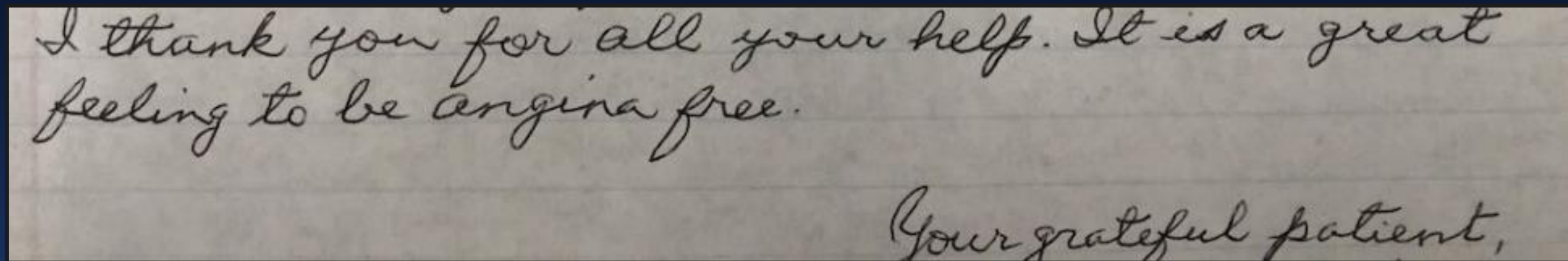
Werner et al, Eur Heart J 2018

# QoL Improvements in Refractory Angina Patients

Refractory angina defined as angina despite 3+ meds (n=148, 14.8%)



# How Do Our Patients *with Real Symptoms* Actually Feel After Revascularization?

A photograph of a handwritten note on lined paper. The text is written in cursive and reads: "I thank you for all your help. It is a great feeling to be angina free." followed by "Your grateful patient," on the right side.

I thank you for all your help. It is a great feeling to be angina free.

Your grateful patient,

(and on less medication)

# Why CTO PCI Should Be Selective

- The data in favor of CTO PCI are entirely for symptom relief (and for those with the most severe symptoms)
- CTOs are inherently STABLE
  - Because these vessels are already occluded, there is no rush to treat them, and medical therapy / other options can be explored

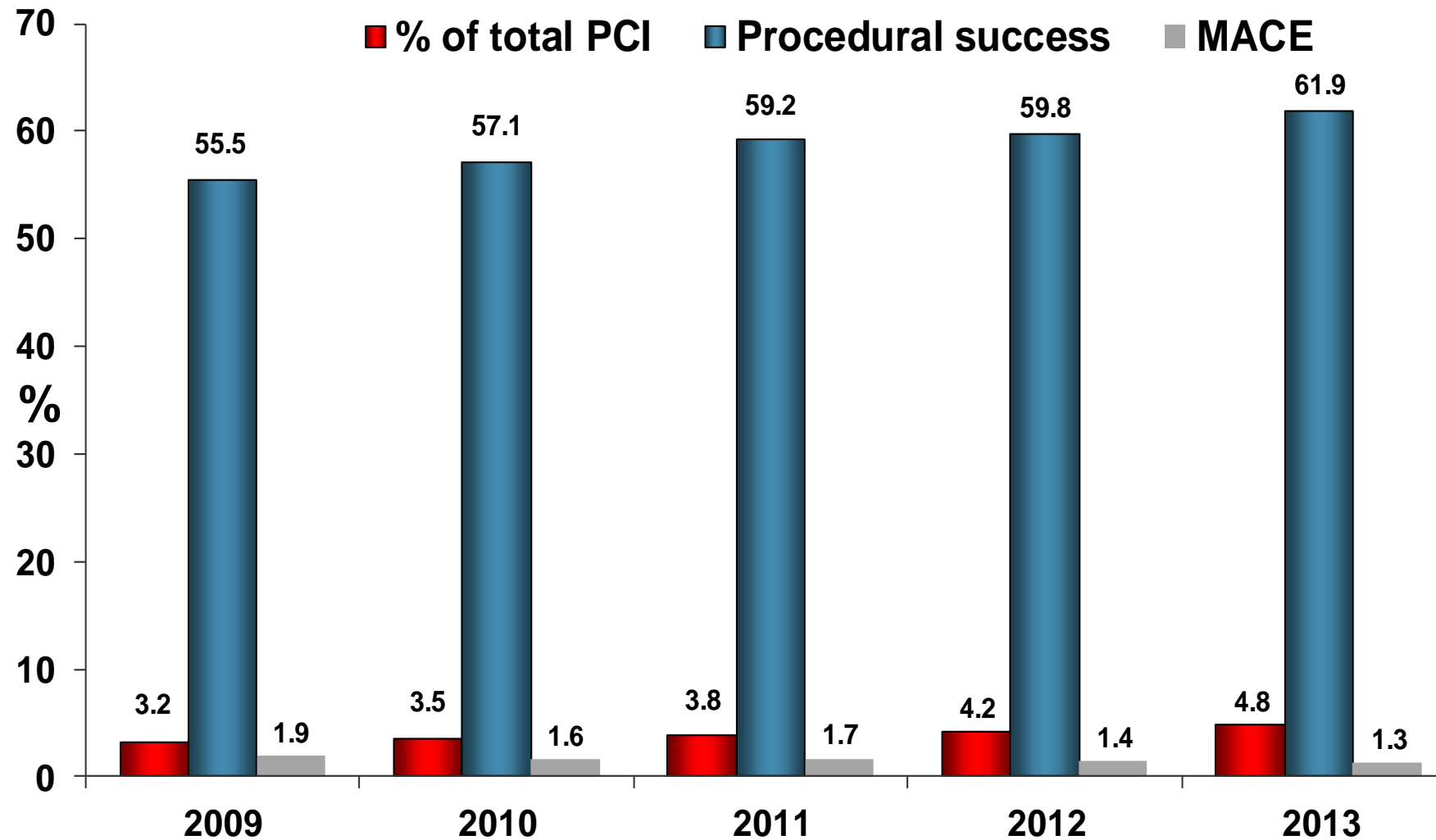
# Do We Need to Revascularize Everyone?

Dear Dr Kirrane,  
Thank you so much for taking the  
time to meet with me on  
THURSDAY, March 16. You and your  
STAFF WERE VERY KIND, WELCOMING  
AND OFFERED EXCELLENT PROFESSIONAL  
CARE.  
IT WAS A GREAT VISIT AND ONE  
THAT WAS VERY IMPORTANT TO ME  
AND MY FAMILY.  
THANK YOU AGAIN AND I WILL  
CERTAINLY STAY IN TOUCH WITH ANY  
CHANGES IN MY HEALTH.

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- CTO PCI is not straightforward
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# CTO PCI in the United States: NCDR CathPCI Analysis



Operators %CTO PCI IQR: 0.3% to 4.9%

Operator volume associated with greater success and decreased MACE  
234 of 1,387 sites (17%) never performed CTO PCI

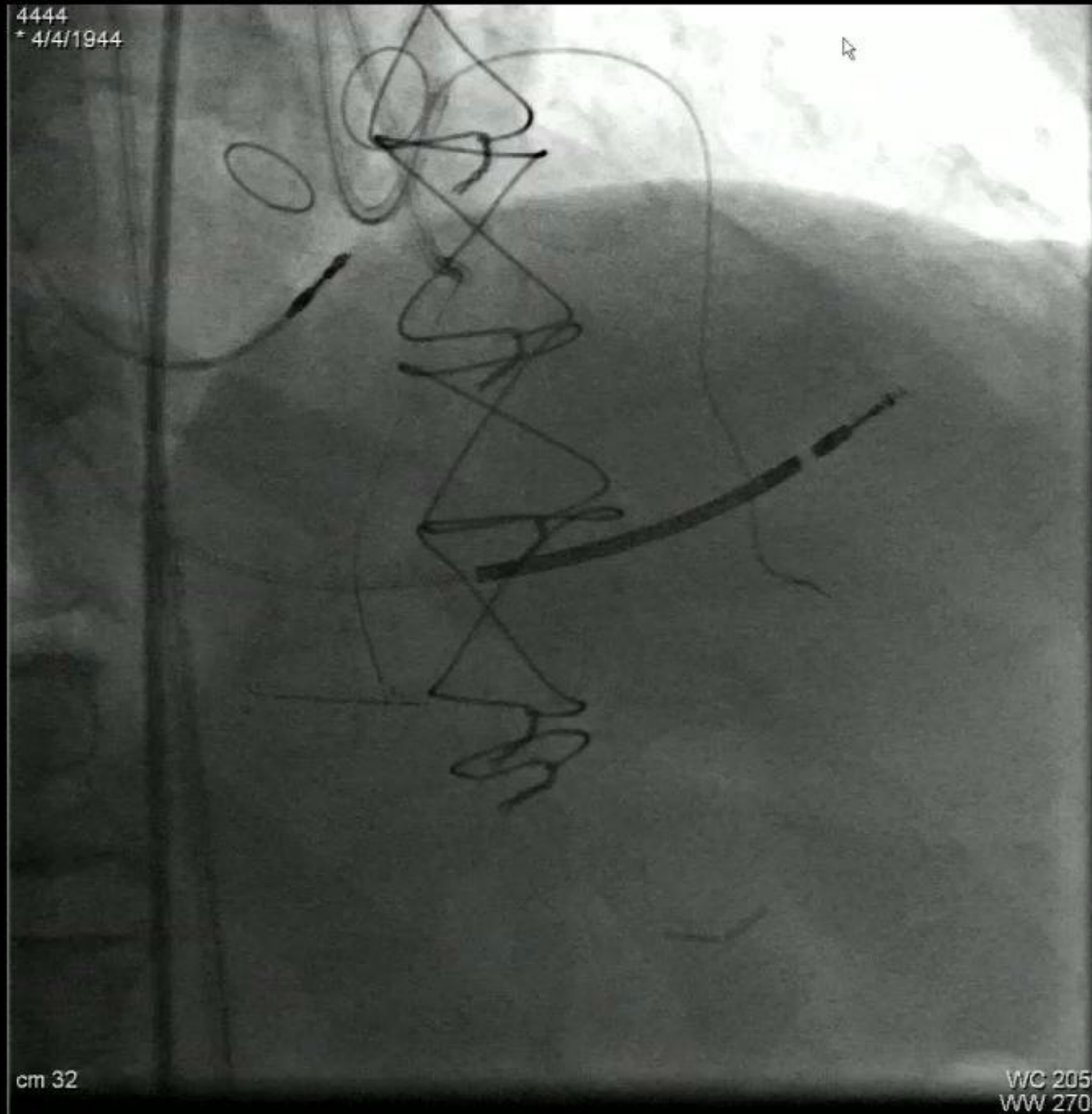
# New York State Database: CTO PCI

7/2009 – 6/2012: 4030 (3.1%) CTO PCI procedures with 61.3% success

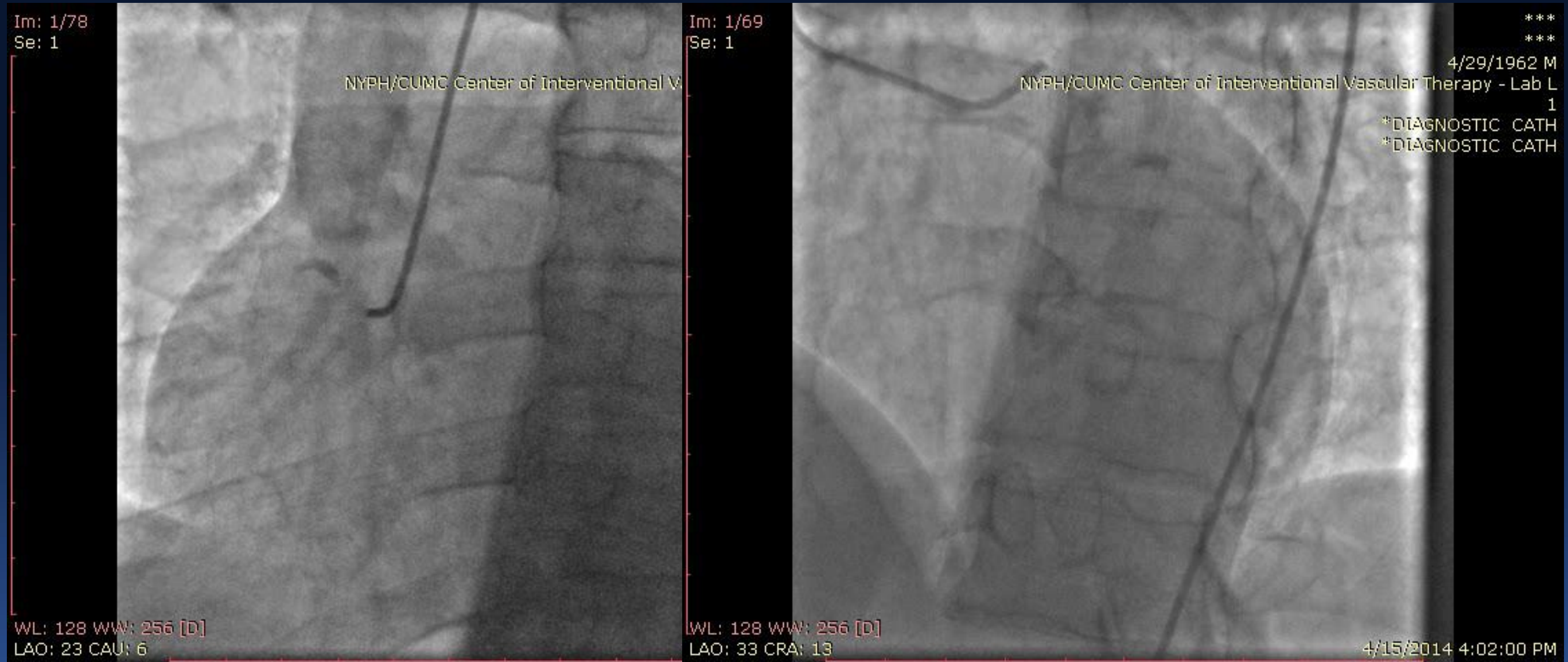
	Estimate	Standard Error	Adjusted Odds Ratio (95% CI)	P Value
Intercept	2.5109	0.3317		<0.0001
Age by 10	-0.1098	0.0307	0.90 (0.84, 0.95)	0.0003
Ejection fraction <20%	-0.9714	0.3051	0.38 (0.21, 0.69)	0.0015
Previous PCIs	-0.2606	0.0712	0.77 (0.67, 0.89)	0.0003
Previous CABG surgery	-0.4488	0.0920	0.64 (0.53, 0.76)	<0.0001
Carotid/cerebrovascular disease	-0.2987	0.1215	0.74 (0.58, 0.94)	0.0140
CTO lesion location				
Right coronary artery	-0.4057	0.0814	0.67 (0.57, 0.78)	<0.0001
Left circumflex artery	-0.3480	0.0924	0.71 (0.59, 0.85)	0.0002
LAD artery and others*	...	...	Reference	...
CTO PCIs only	-0.5192	0.0707	0.59 (0.52, 0.68)	<0.0001
Operator CTO PCI volume per year (quartiles)				
Q1: <4	-0.8875	0.2657	0.41 (0.24, 0.69)	0.0008
Q2: 4-8	-0.6958	0.2720	0.50 (0.29, 0.85)	0.0106
Q3: 9-47	-0.4204	0.2852	0.66 (0.38, 1.15)	0.1405
Q4: ≥48	...	...	Reference	...

Highest volume quartile operators (48+) had >2X higher success than lowest 2 quartiles

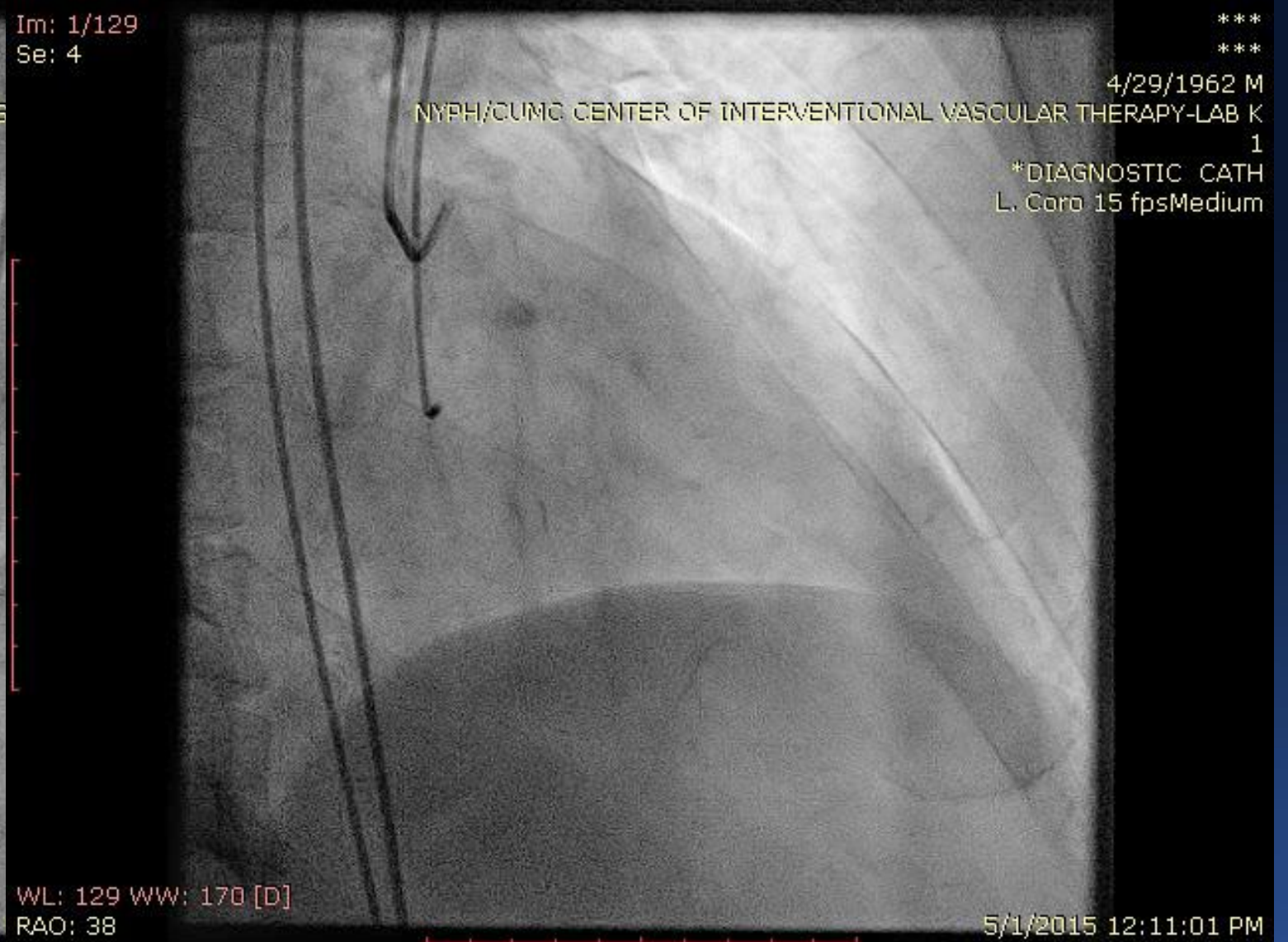
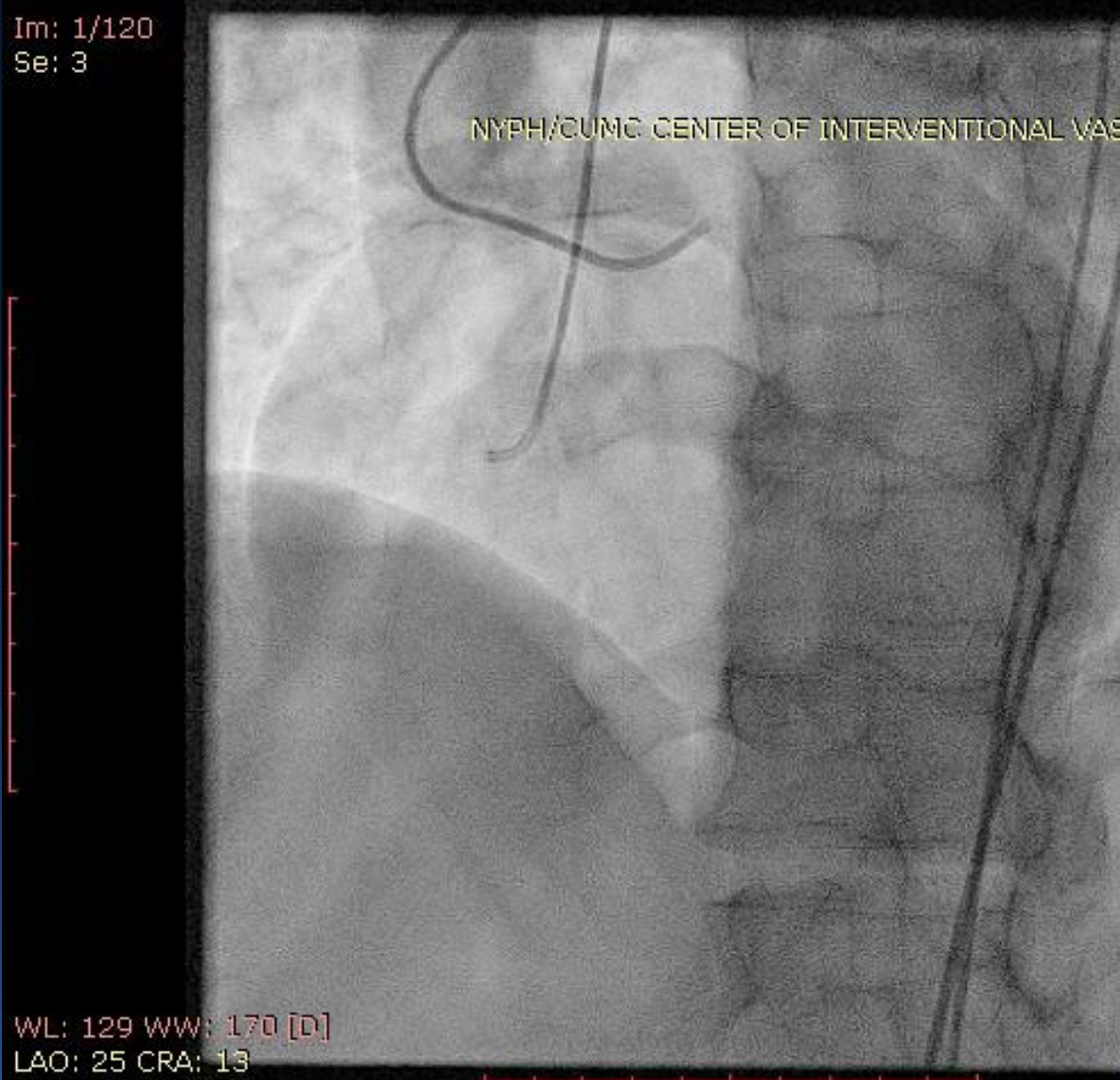
# Microcatheter Advancement



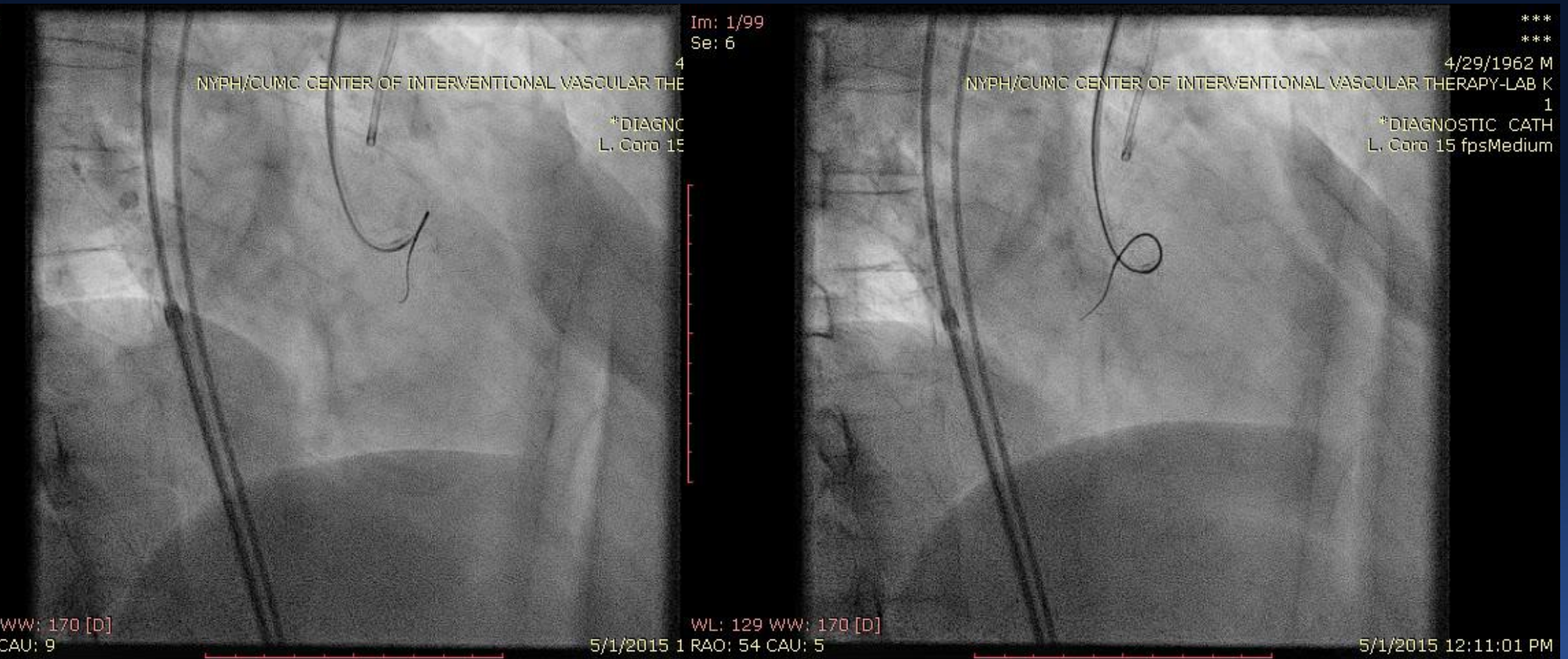
# What Should Be Treated?



# Return for RCA PCI



# Loss of Antegrade Perfusion



# Importance of Dual Injection

Im: 1/128  
Se: 7

NYPH/CUMC CENTER OF INTERVENTIONAL VA

WL: 129 WW: 170 [D]  
LAO: 31 CRA: 8

Im: 1/75  
Se: 8

NYPH/CUMC CENTER OF INTERVENTIONAL VASCULAR THERAPY-LAB K

WL: 127 WW: 171 [D]  
LAO: 31 CRA: 8

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4/29/1962 M

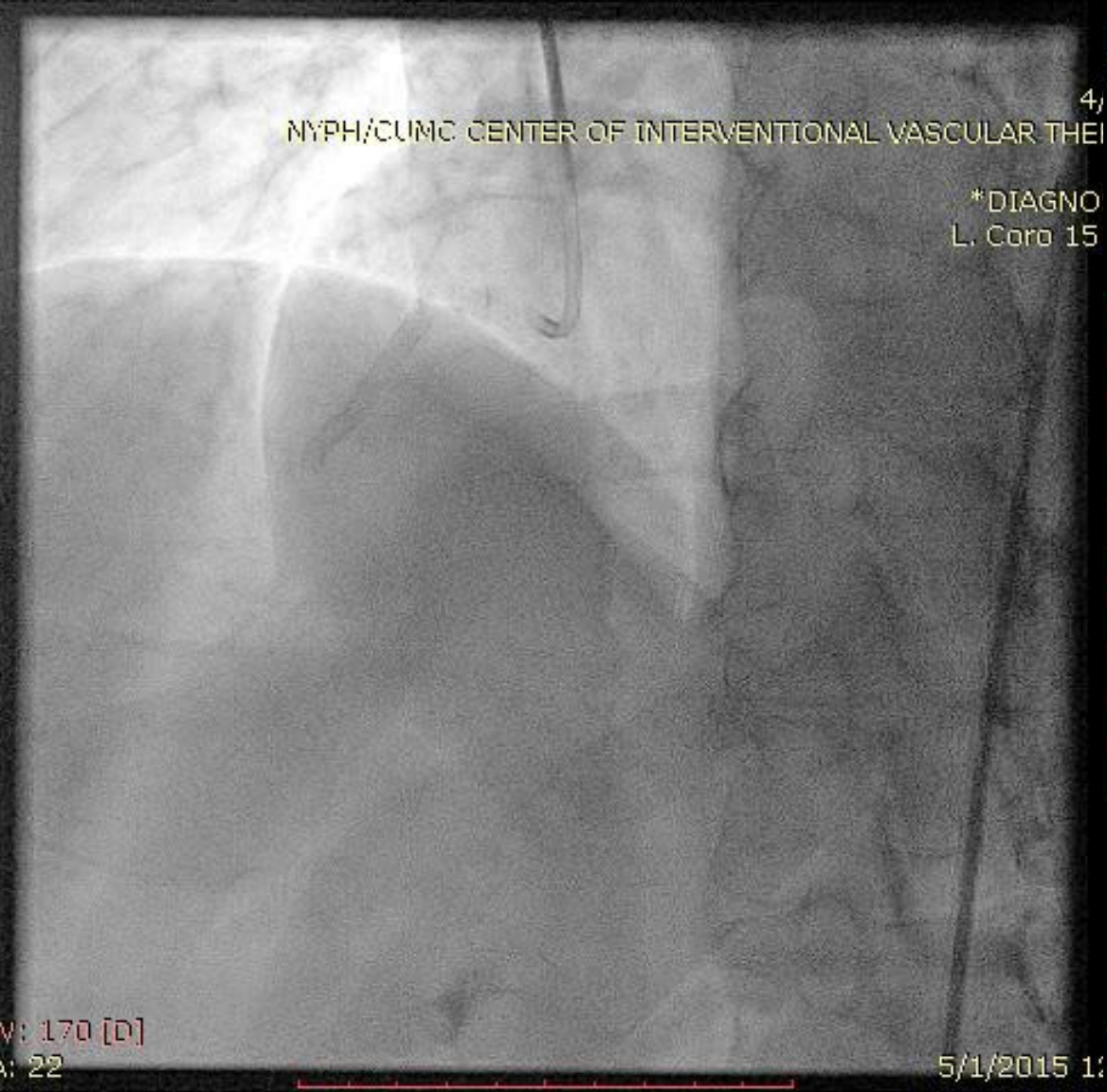
1

\*DIAGNOSTIC CATH  
Fluoroscopy

5/1/2015 12:11:01 PM

# Final Angiogram

Im: 1/82  
Se: 25



Im: 1/71  
Se: 26



\*\*\*  
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4/29/1962 M  
1  
\*DIAGNOSTIC CATH  
L. Coro 15 fpsMedium

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- CTO PCI is not straightforward
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- The risks of CTO PCI are significantly higher, and need higher end skills to treat successfully

# Treatment of CTO

COR	LOE	Recommendation
2b	B-R	<p><b>In patients with suitable anatomy who have refractory angina on medical therapy, after treatment of non-CTO lesions, the benefit of PCI of a CTO to improve symptoms is uncertain.</b></p>

*“Enthusiasm for treating these lesions was fueled by retrospective data suggesting improved outcomes for those patients who underwent successful recanalization compared with those who had failed. However, RCTs have not demonstrated improved function and have been equivocal w/regard to symptoms. For this reason, shared decision-making should inform treatment of patients with refractory angina despite GDMT w/remaining CTO coronary lesion, with careful discussions of the limitations of treating these lesions, as well as the potential benefits.”*

# OPEN CTO Registry



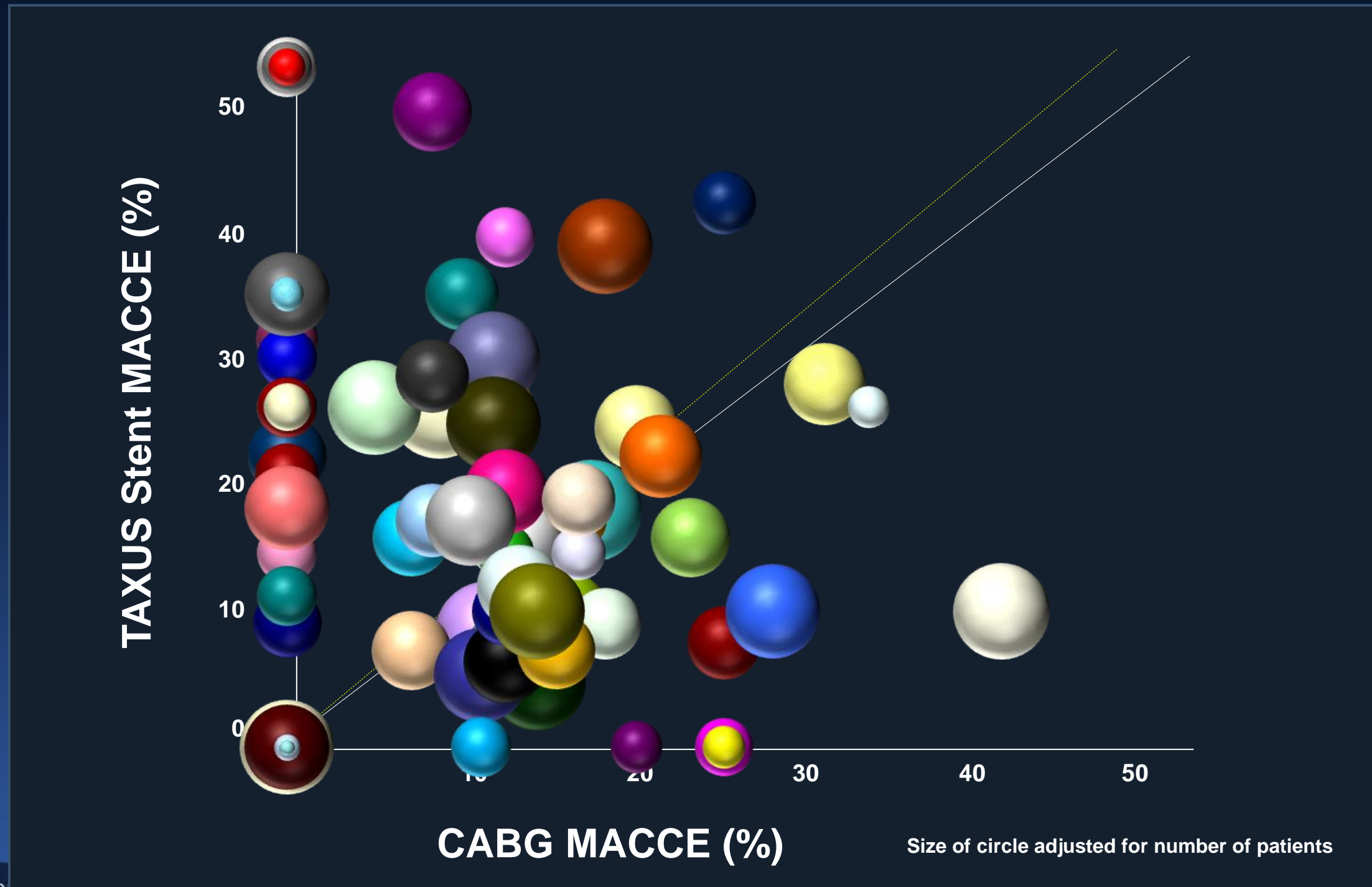
1000 consecutive patients enrolled between  
Feb 2014 and July 2015 at 12 clinical sites in the US

Overall success: 89%; Success of 1<sup>st</sup> approach: 58%

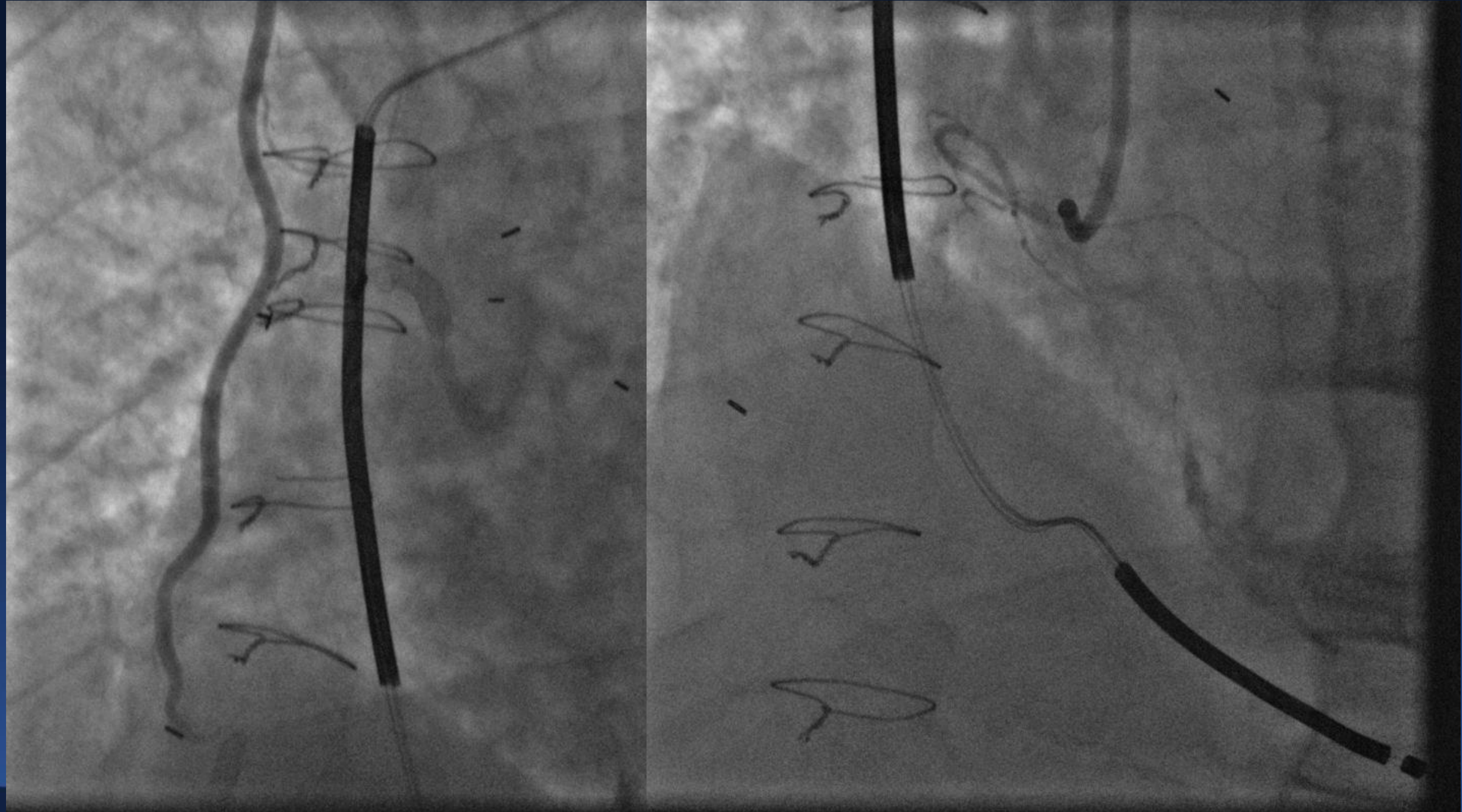
In Hospital	Frequency
Death	0.9%
MI	2.4%
Emergent surgery	0.6%
Perforation	6.0%
Clinical perforation	4.9% (82%)
Bleeding Access	4.0%
Radiation injury	0.1%

30 Day	Frequency
Death	1.3%
Rehospitalization	14.7%
Unplanned	12.1%
Revascularization	2.6%
Planned	2.6%
PCI	2.3%
CABG	0.3%
Skin change	3.1%

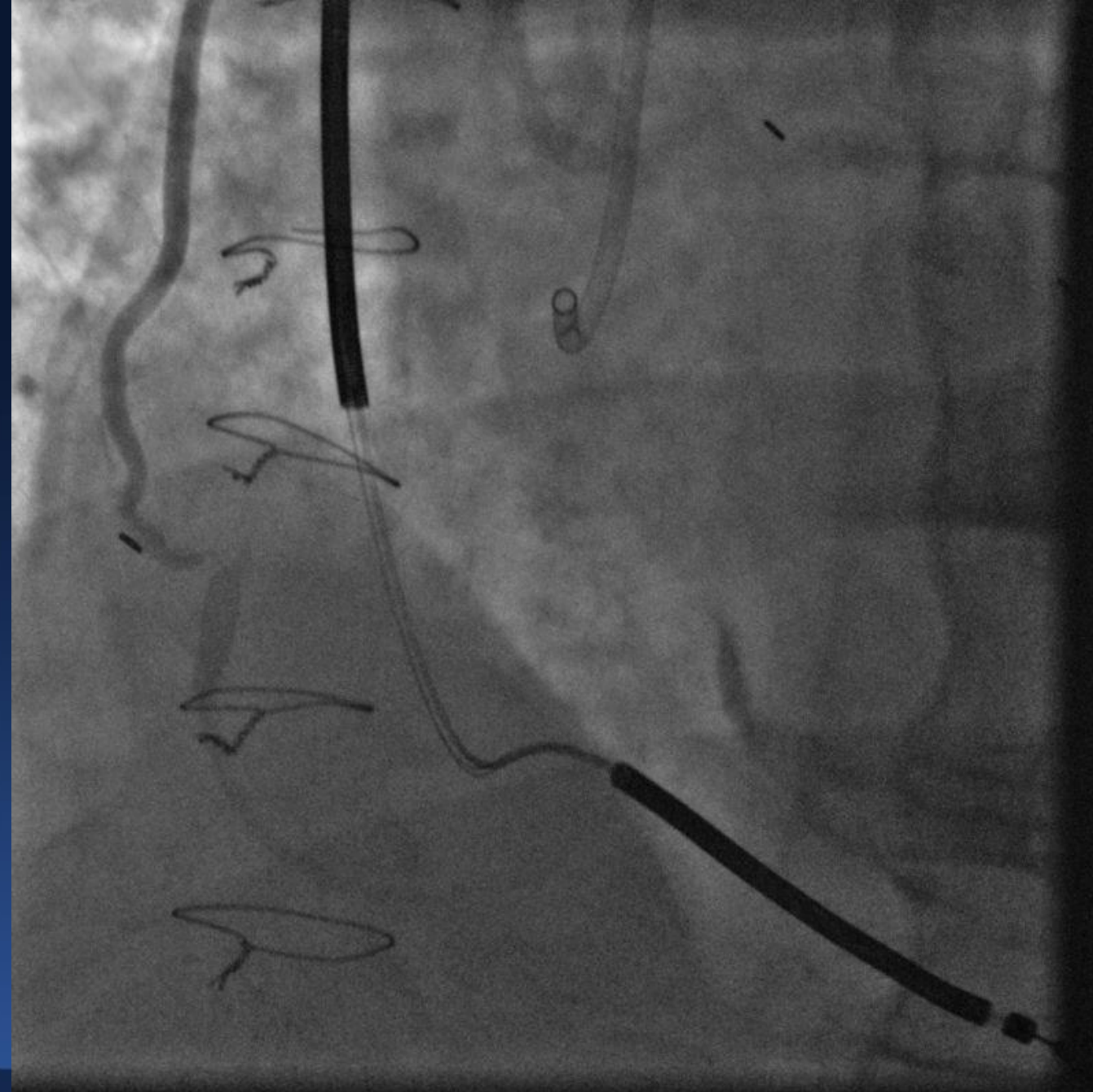
# Variability in Practice Should be Taken into Account: The SYNTAX Trial



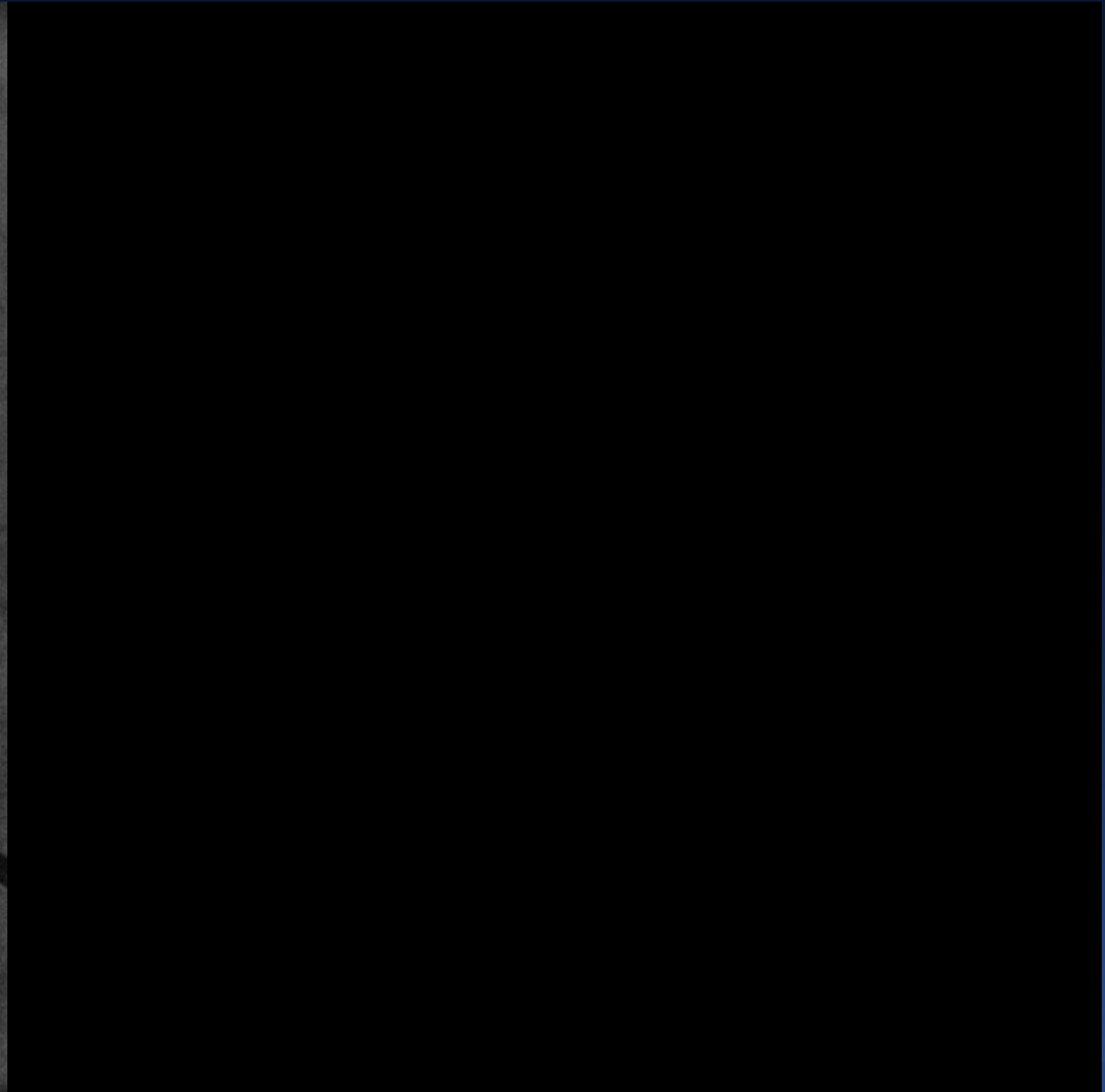
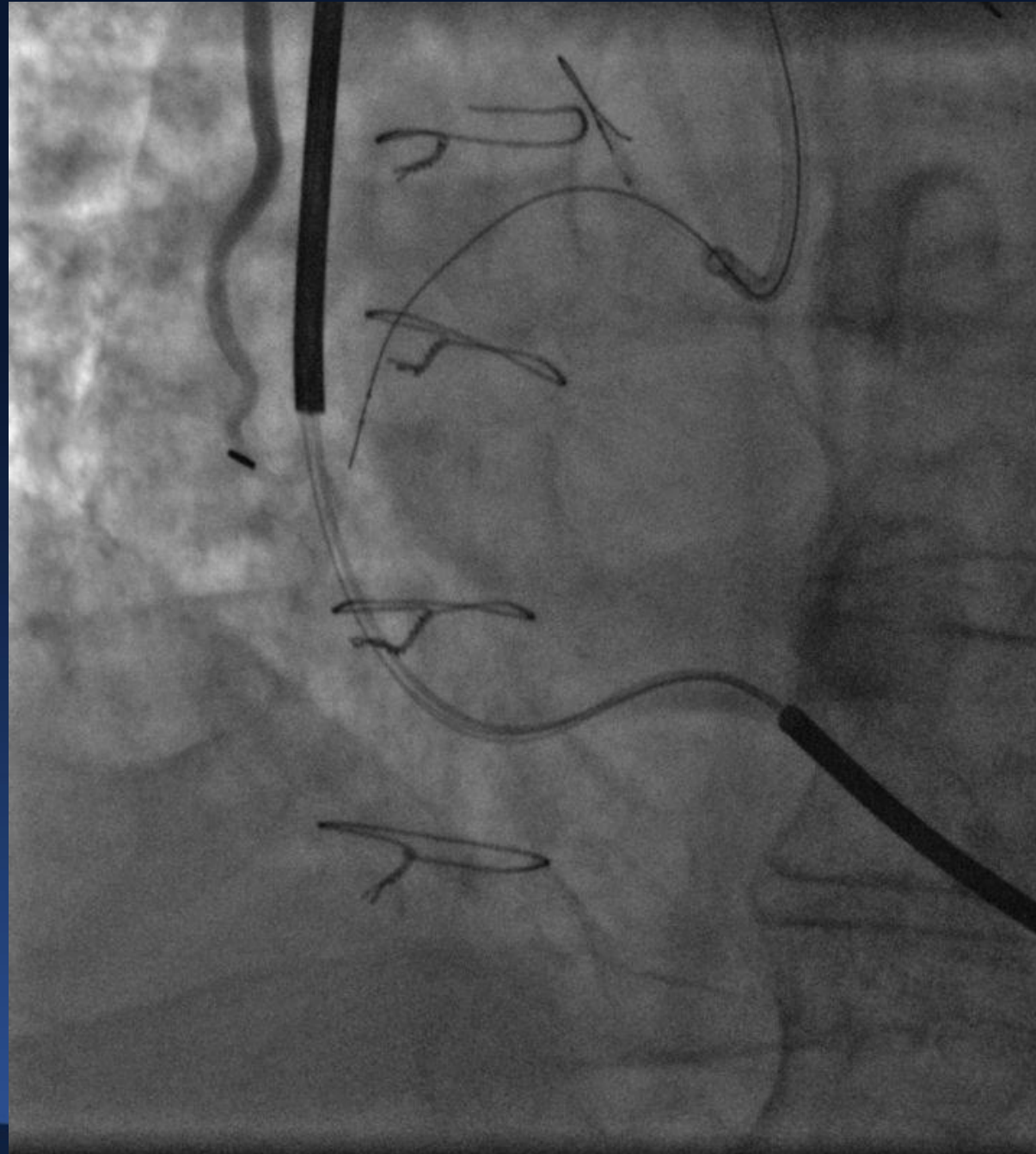
# RIMA-RCA Anastomosis Restenosis



# Dual Injections



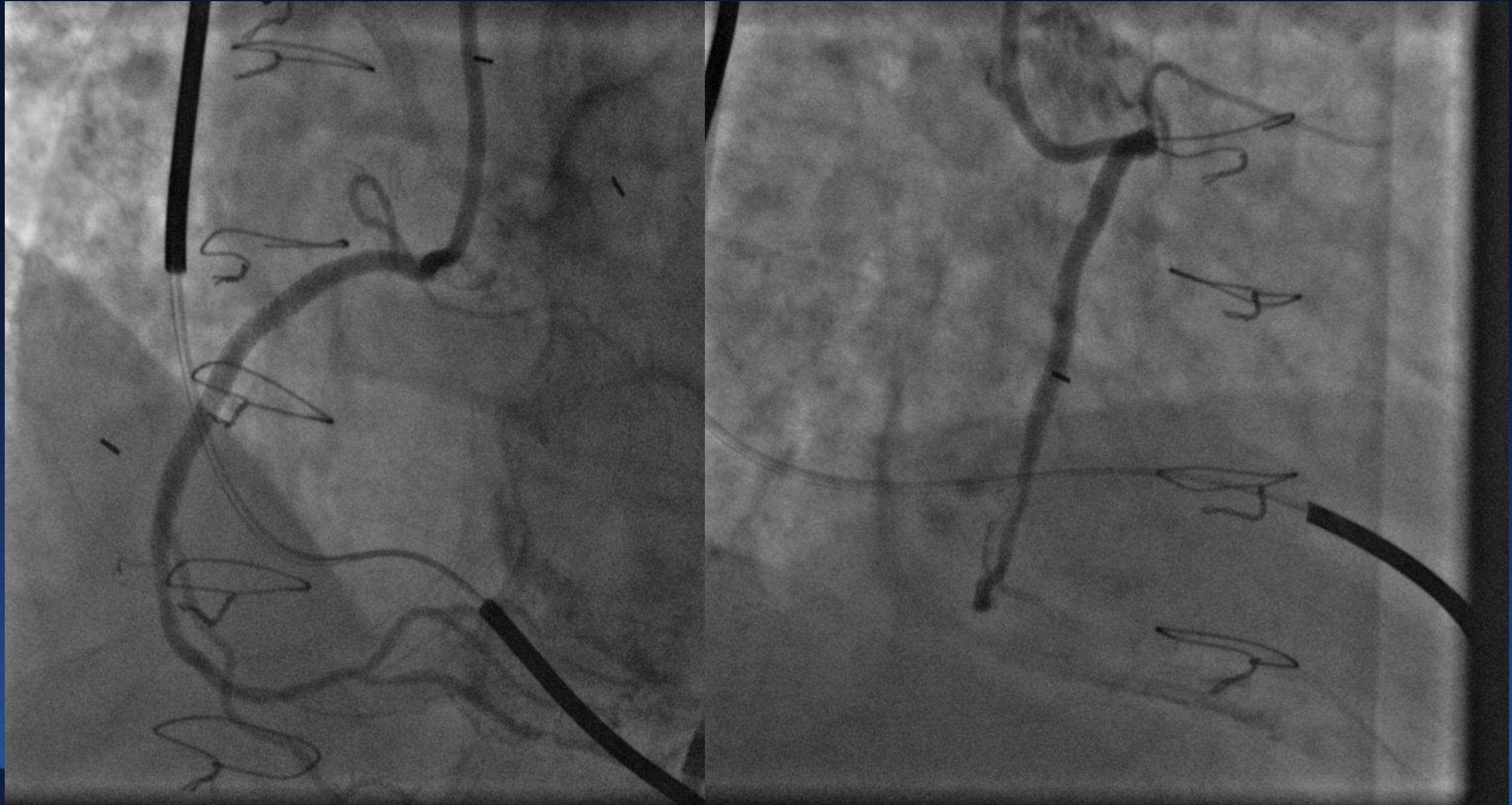
# Stingray Stick and Swap w/Anchor Balloon



# Stenting



# Final Angiograms



# Ideal Components of the Informed Consent Process

Spend sufficient time to engage in shared decision-making; allow for a second opinion
Use plain language, avoiding jargon, and adopt the patient's words; integrate pictures to teach
Document teach-back of patient's knowledge and understanding
Conduct conversations with a trained interpreter, as needed
Provide patient-specific short- and long-term risks, benefits, and alternative treatments
Provide unbiased, evidence-based, reliable, accessible, and relevant information to patient
Discuss specific risks and benefits with regard to survival, relief of angina, quality of life, and potential additional intervention, as well as uncertainties associated with different treatment strategies
Provide patient time to reflect on the trade-offs imposed by the outcome estimates
Provide information on the level of operator expertise, volume of the facility, and local results in the performance of coronary revascularization options
Clearly inform of the need for continued medical therapy and lifestyle modifications

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# What's the Solution?

- Select patients *carefully* with the luxury of time to manage them and understand how symptomatic they are
- Don't be complacent though, because many really symptomatic patients will just stop complaining if we just say “there is nothing to do” or “it's too risky”
- **For those patients who remain symptomatic, either make sure you have the skills to treat these patients or partner with CTO operators/sites that you trust will do the right thing for the patient before, during, and after a possible procedure**