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Complex Coronary Interventions

C.A.S.E. SYMPOSIUM 2018

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Interventional Cardiology

BMG Cardiology

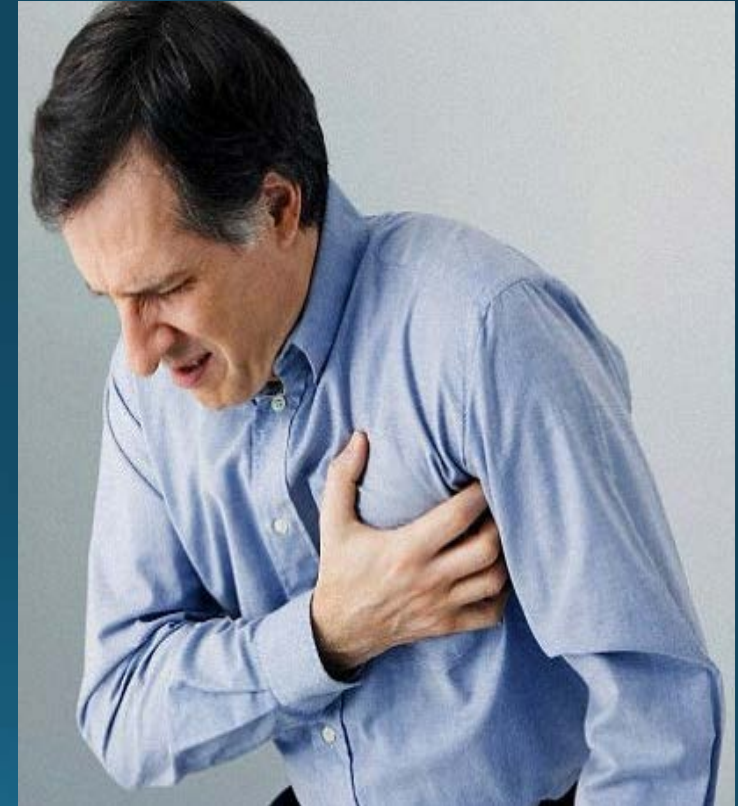
Director, Mease Countryside Cardiac Cath lab

Disclosures

- No Disclosures related to this presentation

Traditional High Risk PCI Patients

- STEMI / NSTEMI / Cardiac arrest
- High risk based on Presentation
- Anatomy / Lesions usually straightforward

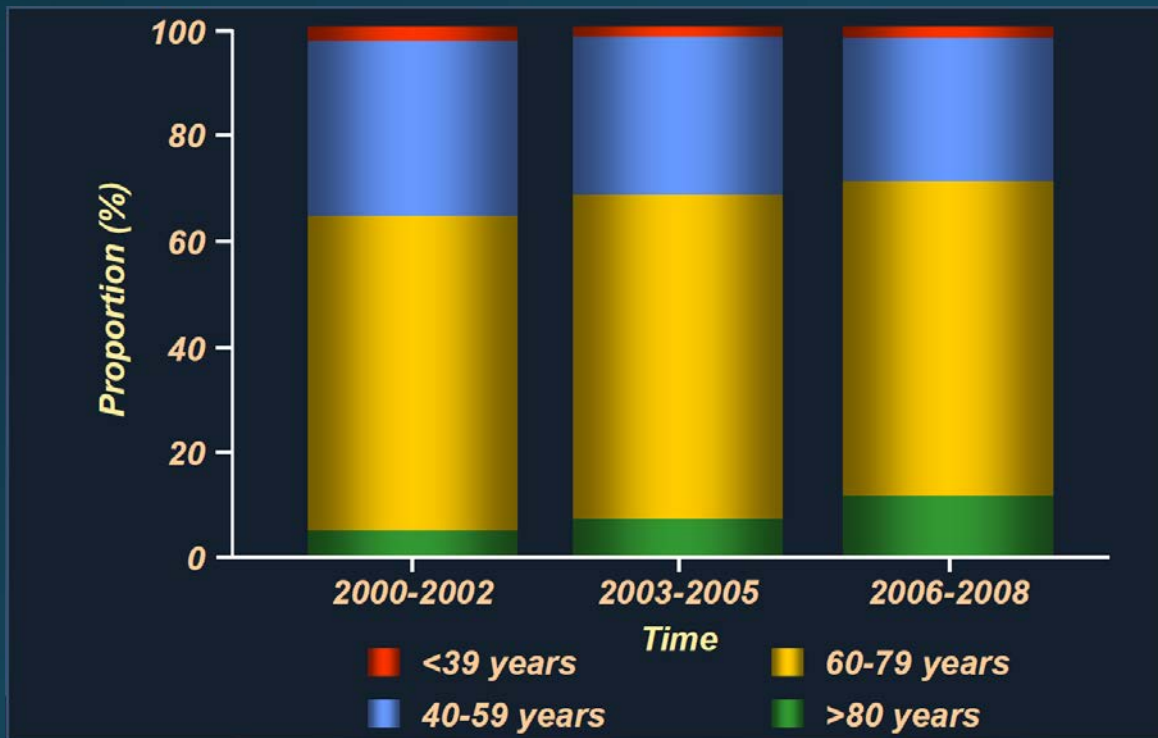


Emerging High Risk PCI Patients

- High Lesion Risk with Poor Patient substrate
- Less acute presentations: UA/NSTEMI, elective
- Complex disease: Multi-vessel disease, Left main, Calcified vessels, CTO
- Elderly, Diabetics, Renal insufficiency, Low EF
- Not Eligible for surgery



Aging of the PCI Population



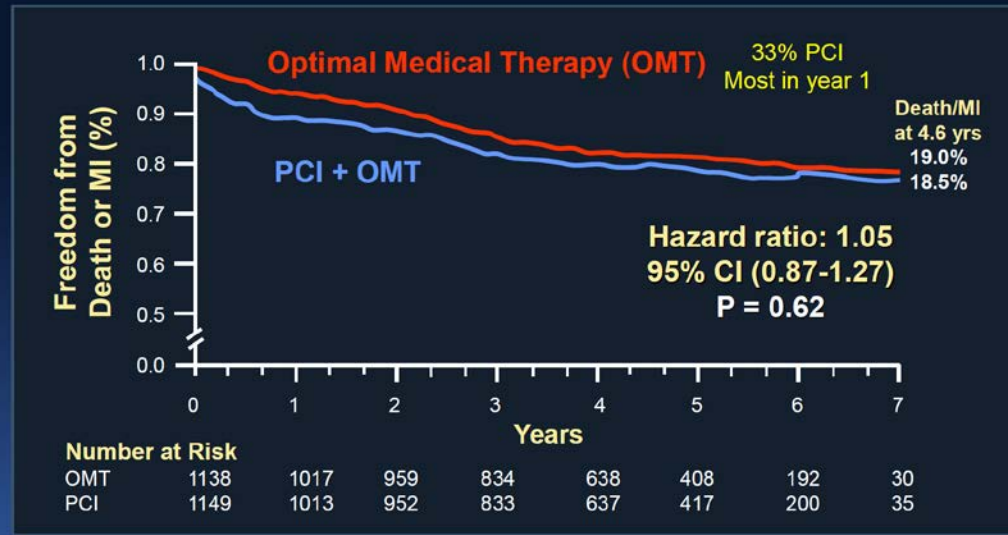
Rajani et al. *Br J Cardiol* 2011; 18:73-76.





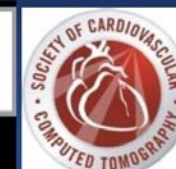
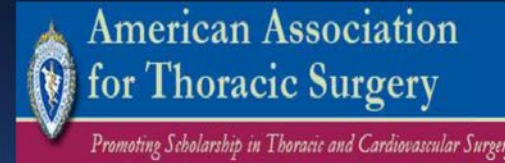
PCI in Stable CAD: **COURAGE**

Median FU 4.6 years (n=2,287)

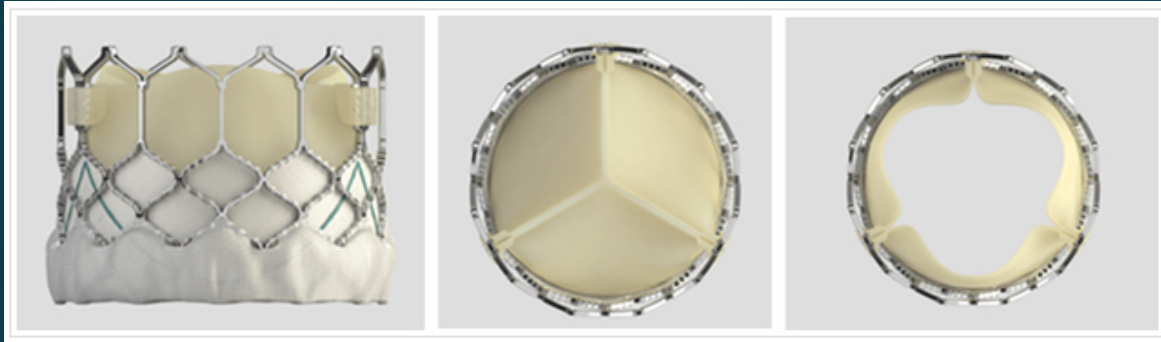


- Boden WE et al. NEJM 2007; 356:1503-16

Appropriate Use Criteria for Coronary Revascularization

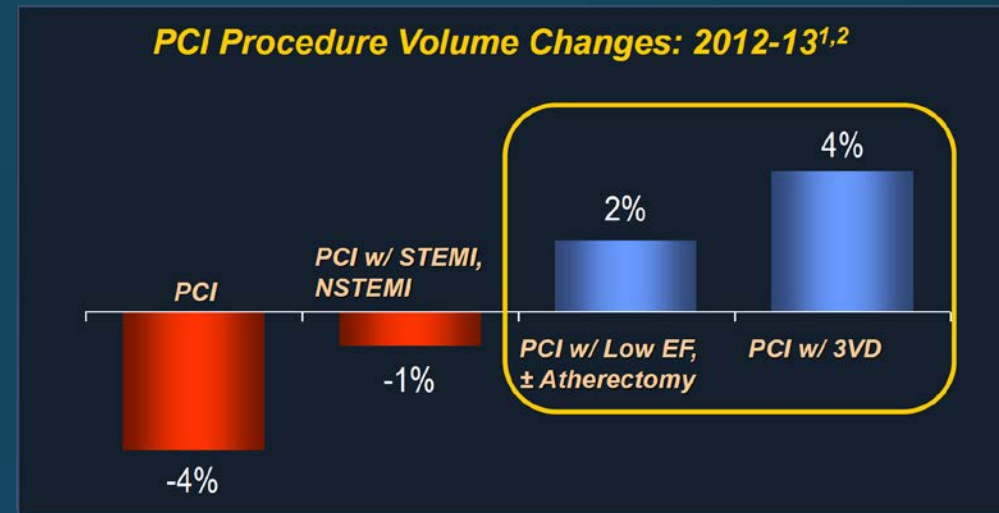
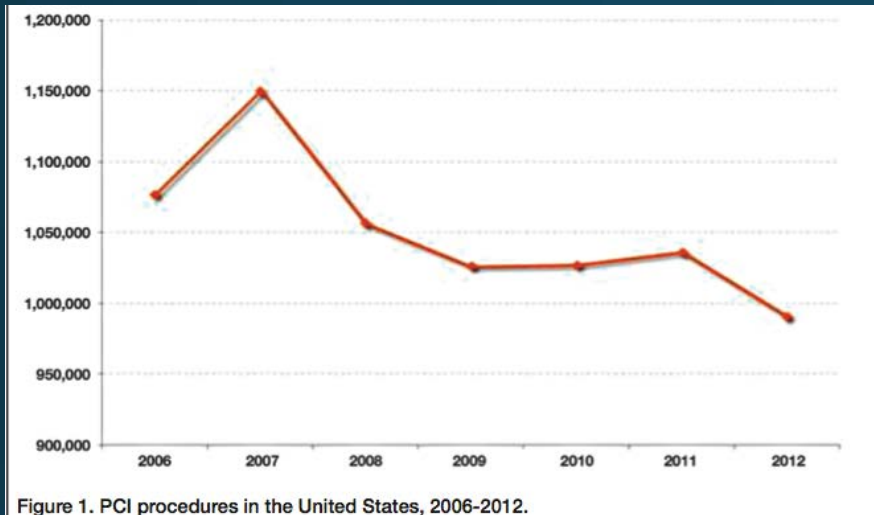


Transcatheter Valve Therapies



Appropriate Use Score (1-9)								
		Asymptomatic		Ischemic Symptoms				
		Not on AA Therapy or With AA Therapy	Not on AA Therapy	On 1 AA Drug (BB Preferred)		On ≥ 2 AA Drugs		
Patient Who Will Undergo a Percutaneous Valve Procedure (TAVR, MitraClip, Others)								
54.	■ One- or two-vessel CAD, no proximal LAD involvement, with low-risk noninvasive findings	M (4)		M (4)		M (6)		A (8)
55.	■ One- or two-vessel CAD, no proximal LAD involvement, with intermediate- or high-risk noninvasive findings	A (7)		A (7)		A (7)		A (8)
56.	■ One- or two-vessel CAD, including proximal LAD, with low-risk noninvasive findings	M (6)		M (6)		A (7)		A (8)
57.	■ One- or two-vessel CAD, including proximal LAD, with intermediate- or high-risk noninvasive findings	A (7)		A (7)		A (8)		A (9)
58.	■ Left main and/or three-vessel disease, with intermediate- or high-risk noninvasive findings (e.g., SYNTAX ≤ 22)	A (8)		A (8)		A (8)		A (9)
59.	■ Left main and/or three-vessel disease, with intermediate- or high-risk noninvasive findings (e.g., SYNTAX >22)	A (7)		A (7)		A (8)		A (8)

PCI Volumes



- Overall PCI volumes are expected to continue to decline about 10% in the coming years
- However those in the Higher risk, more complex subset are increasing and expected to continue to increase over the next 20 years
- As a result the case mix for PCI volumes is projected to have a major shift

High Risk Patients

CAD Prognostic Index

Extent of CAD	Prognostic Weight (0–100)	5-Year Survival Rate (%)*
1-vessel disease, 75%	23	93
1-vessel disease, 50% to 74%	23	93
1-vessel disease, $\geq 95\%$	32	91
2-vessel disease	37	88
2-vessel disease, both $\geq 95\%$	42	86
1-vessel disease, $\geq 95\%$ proximal LAD artery	48	83
2-vessel disease, $\geq 95\%$ LAD artery	48	83
2-vessel disease, $\geq 95\%$ proximal LAD artery	56	79
3-vessel disease	56	79
3-vessel disease, $\geq 95\%$ in ≥ 1 vessel	63	73
3-vessel disease, 75% proximal LAD artery	67	67
3-vessel disease, $\geq 95\%$ proximal LAD artery	74	59

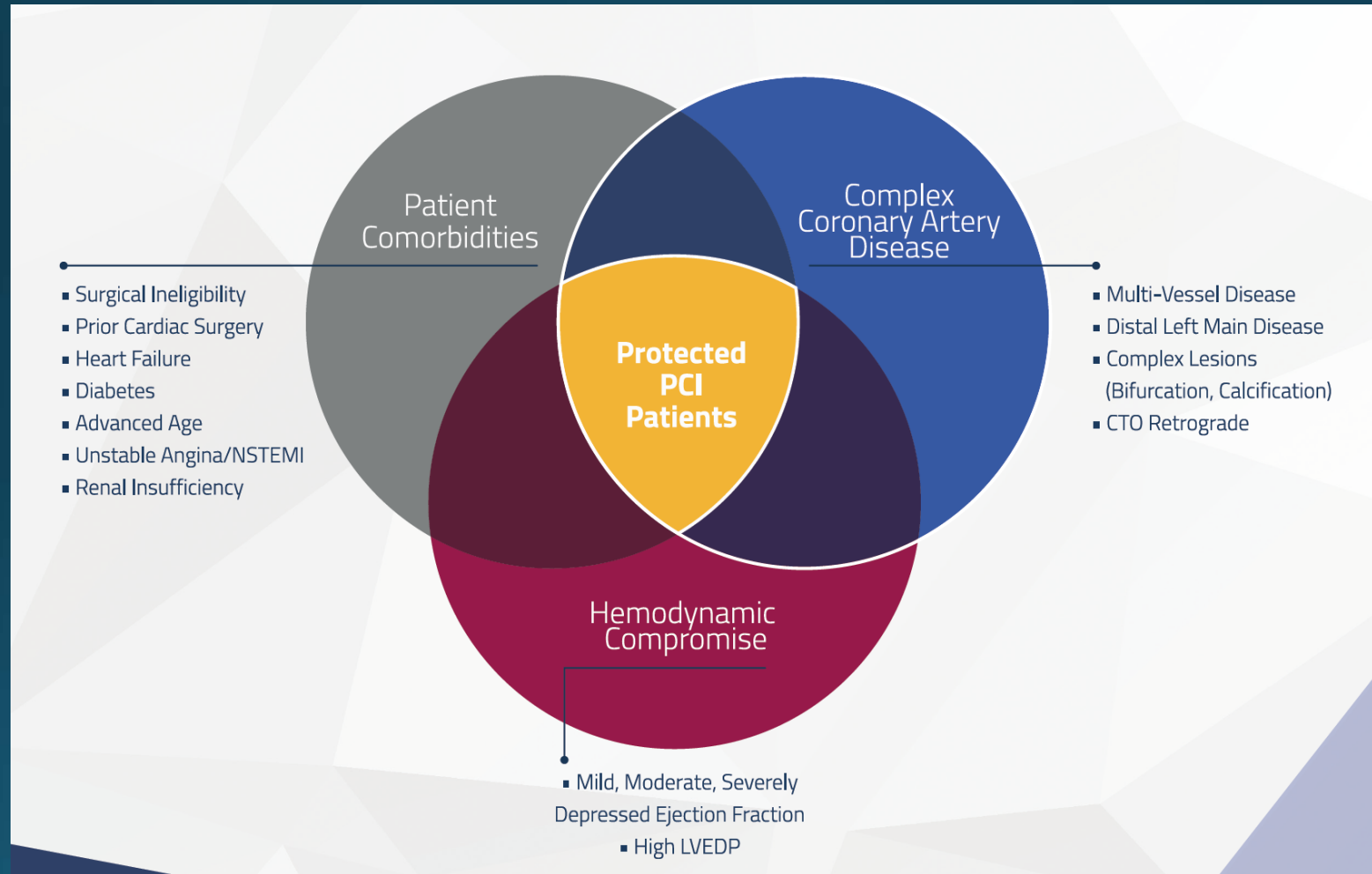
*Assuming medical treatment only.

- Previously patients deemed high surgical risk or inoperable were often relegated to medical therapy despite severe multi-vessel CAD
- Historically when PCI was offered it was often incomplete revascularization – High grade, low complexity lesions were “Cherry-picked” whereas more complex anatomy left behind

Complex Patients

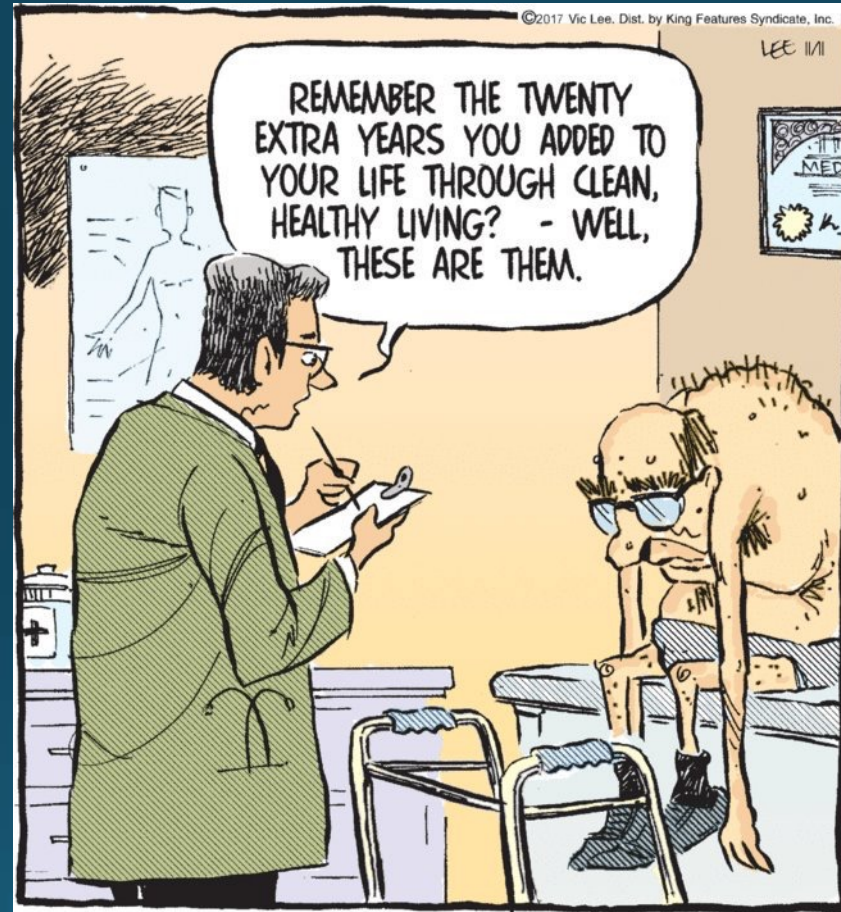
- There is a large underserved population that can benefit from revascularization
- Highest risk patients often have the greatest incremental benefit from treatment but simultaneously are the least desirable to treat based on elevated procedure risk (**Risk / Treatment Paradox**)
- The indications for the case do not change just because the lesion is “harder to treat”
- Rather than focusing just on low-risk patients who may be “easy to treat”, we need to focus more on higher risk patients that have the most to gain.

CHIP (Complex Higher-Risk & Indicated Patients)



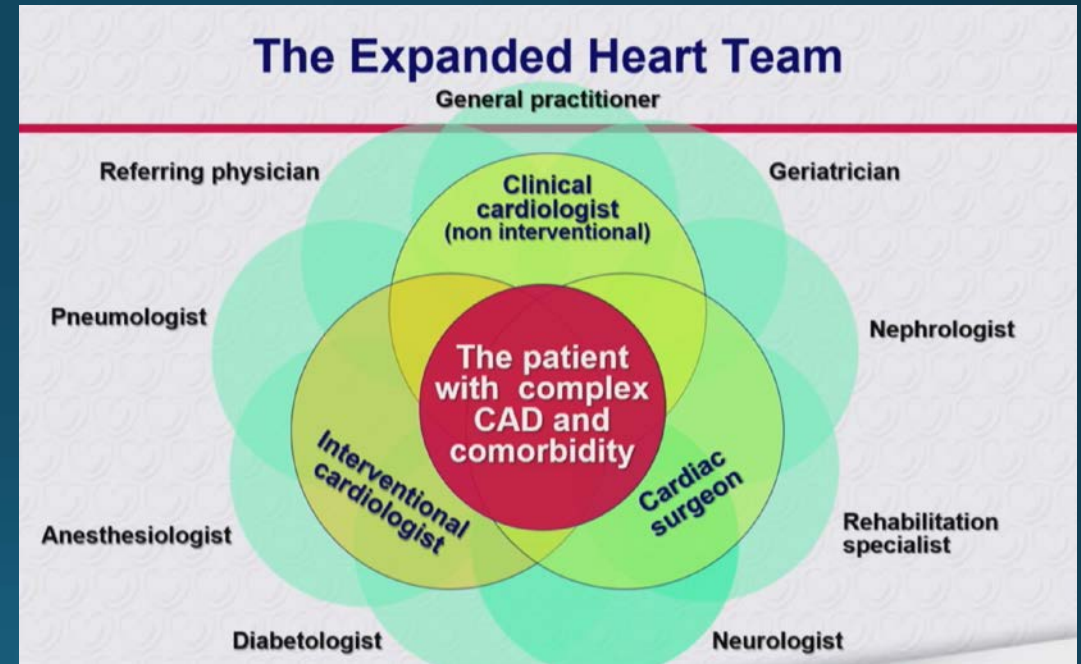
CHIP Patients

- “PCI certainly isn’t becoming easier”
 - Every Interventionalist I’ve ever met
- The risk/benefit equation can be modified with appropriate case selection, the correct training in advanced techniques, and use of appropriate devices/equipment



CHIP Program

- Heart team approach
- Specialized operator skills and training
- Institutional support and resources
- Given the high risk nature of these cases, anything short of such a comprehensive program will yield inadequate or suboptimal results.

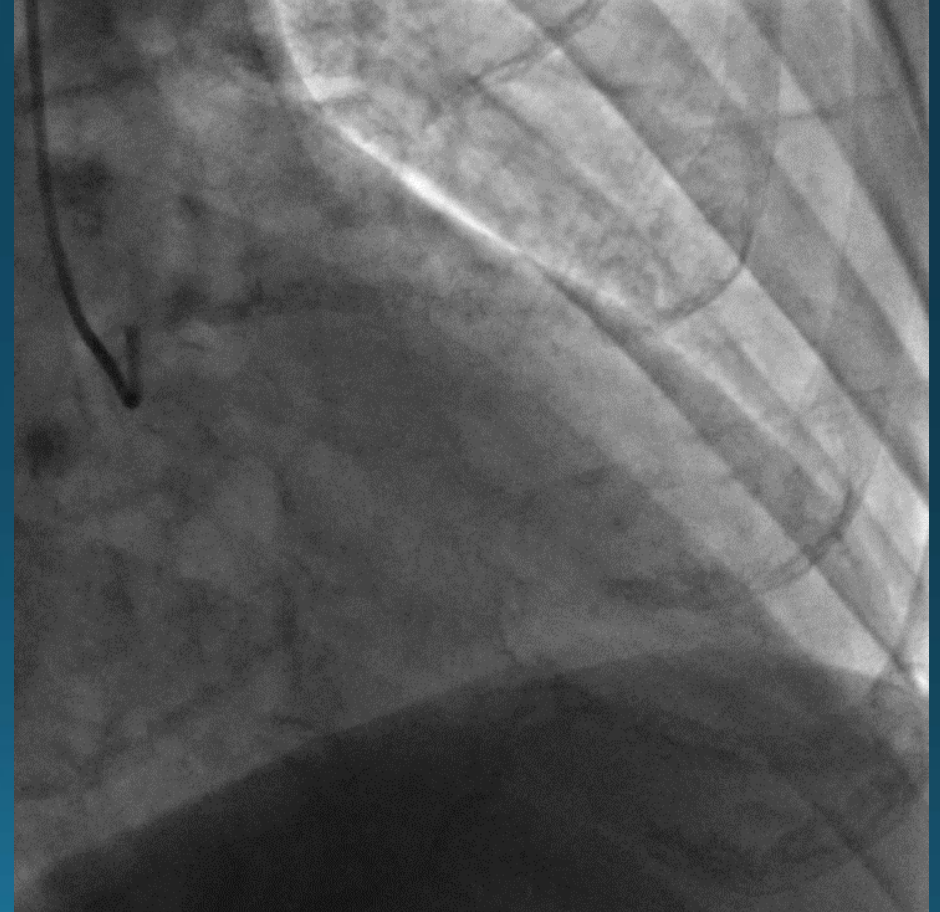


Left main/MVD Case

- 86 year old man with hx of HTN, HLD, PAD, Ex-smoker
- CAD with hx of PCI of LAD in early 90's
- Admitted to hospital with 3 day hx of increasing chest pain
- Normally active - plays tennis several times per week but has had decreased exercise tolerance over past month
- ECG without acute ischemic changes
- Troponin elevated to 3.5
- Referred for cardiac catheterization



Coronary angiogram



Coronary angiogram



Echocardiogram





Heart Team discussion

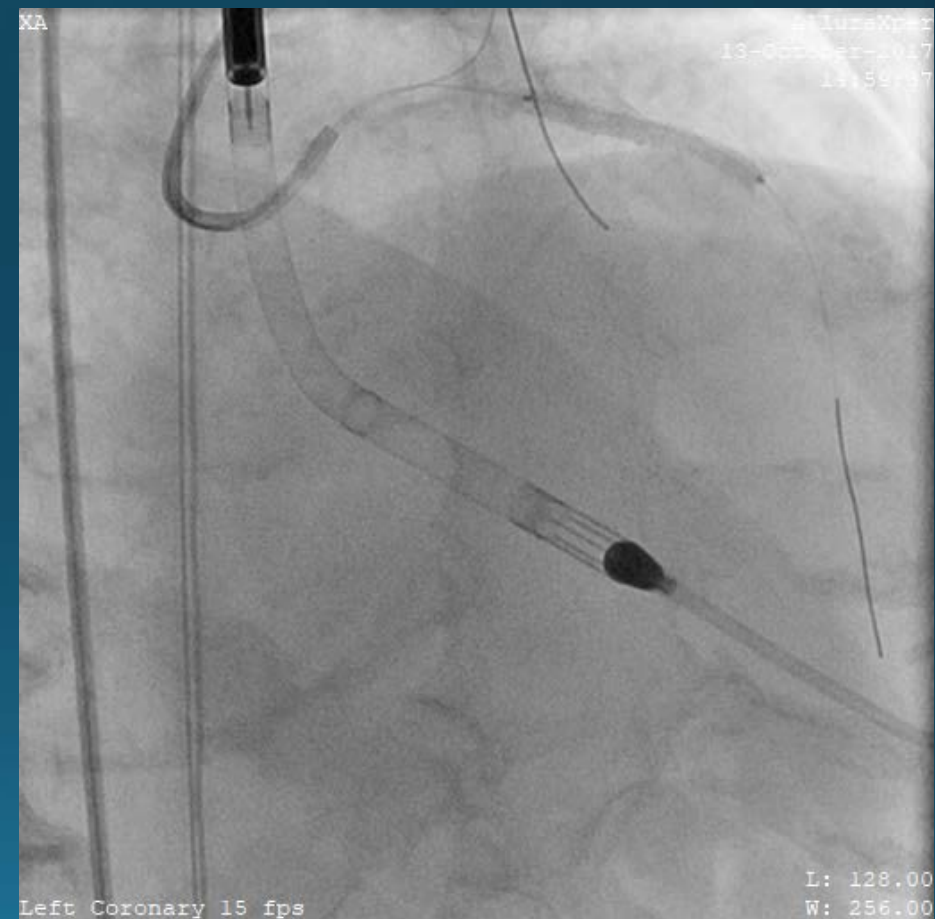
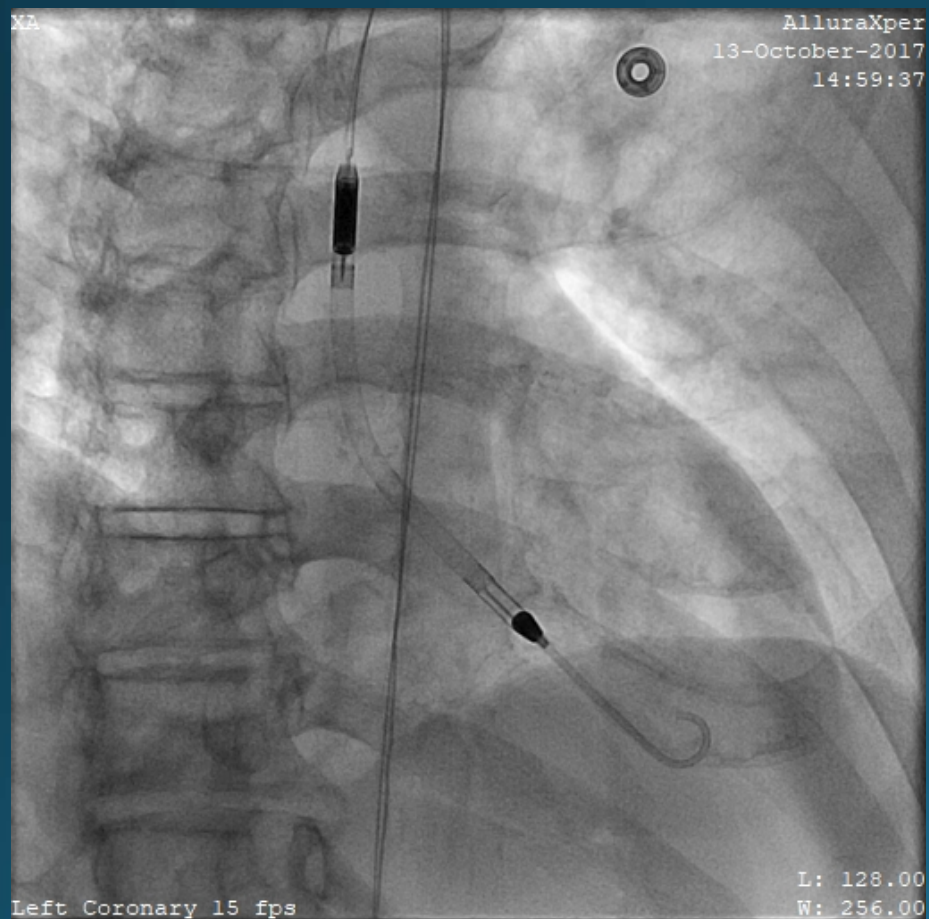


- CKD with baseline Cr 1.5
- Echo showed LVEF 35% with anterior hypokinesis
- Abnormal carotid US → CTA showed > 95% Right ICA stenosis

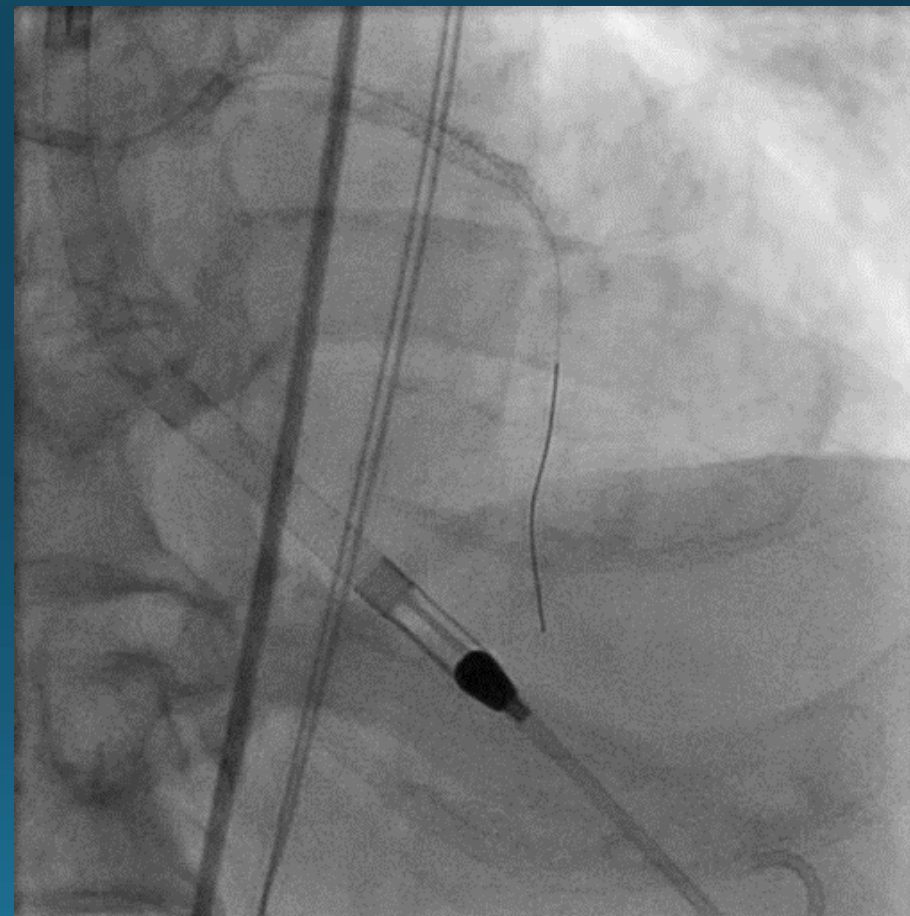
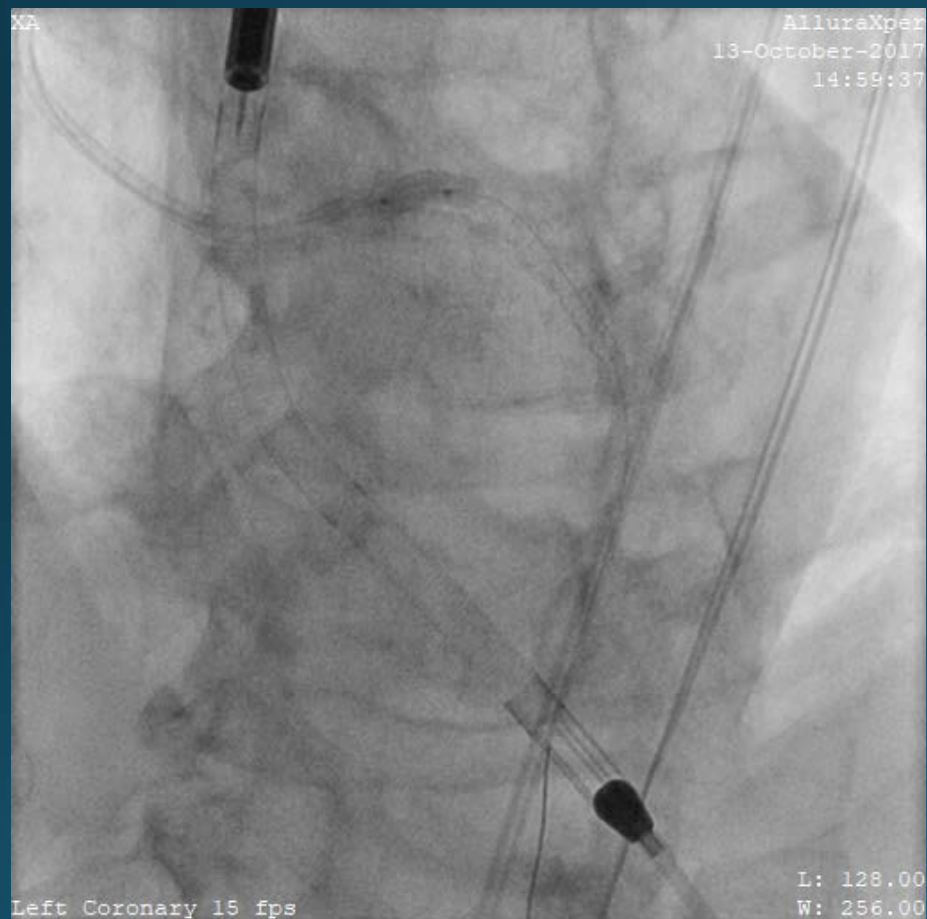
STS Score

- Risk of Mortality: 7.295%
- Morbidity or Mortality: 50.354%
- Long Length of Stay: 21.37%
- Short Length of Stay: 12.104%
- Permanent Stroke: 5.76%
- Prolonged Ventilation: 41.64%
- DSW Infection: 0.437%
- Renal Failure: 20.602%
- Reoperation: 12.13%

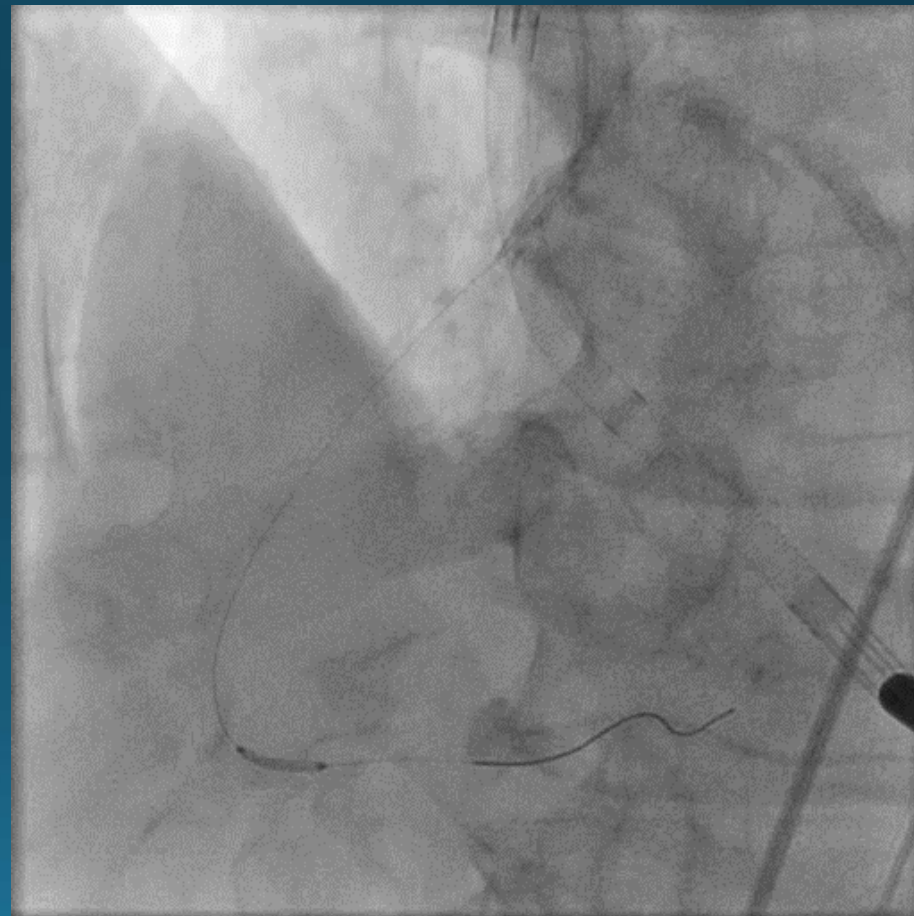
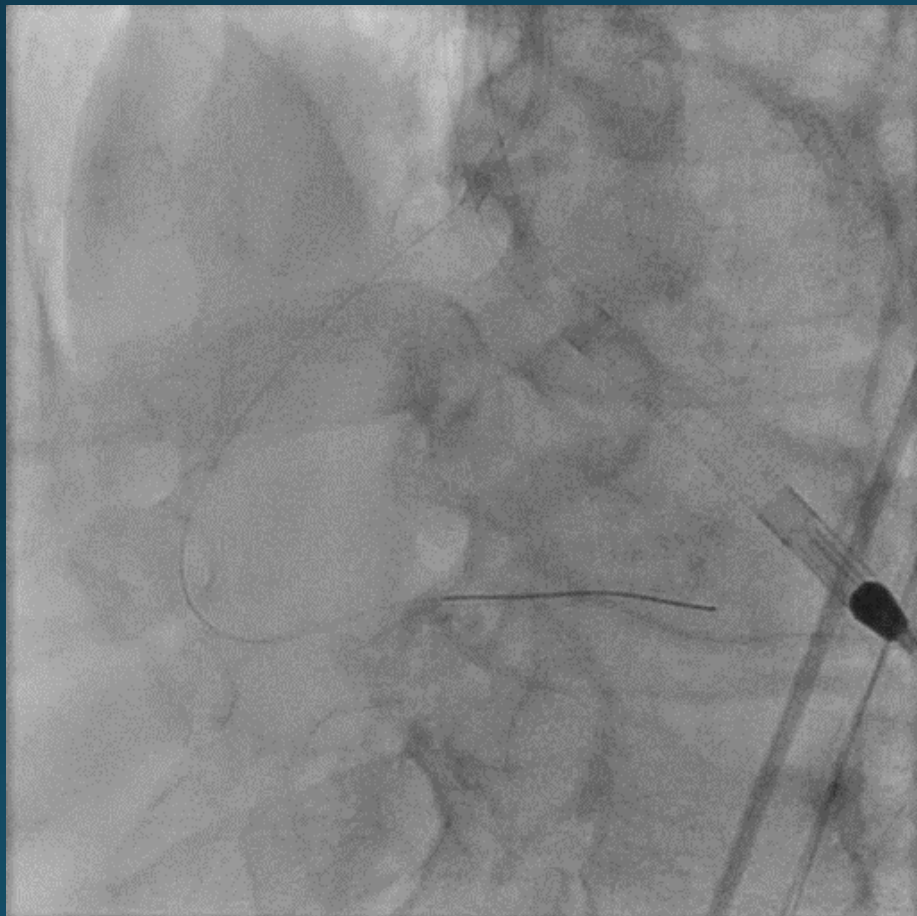
Coronary Intervention



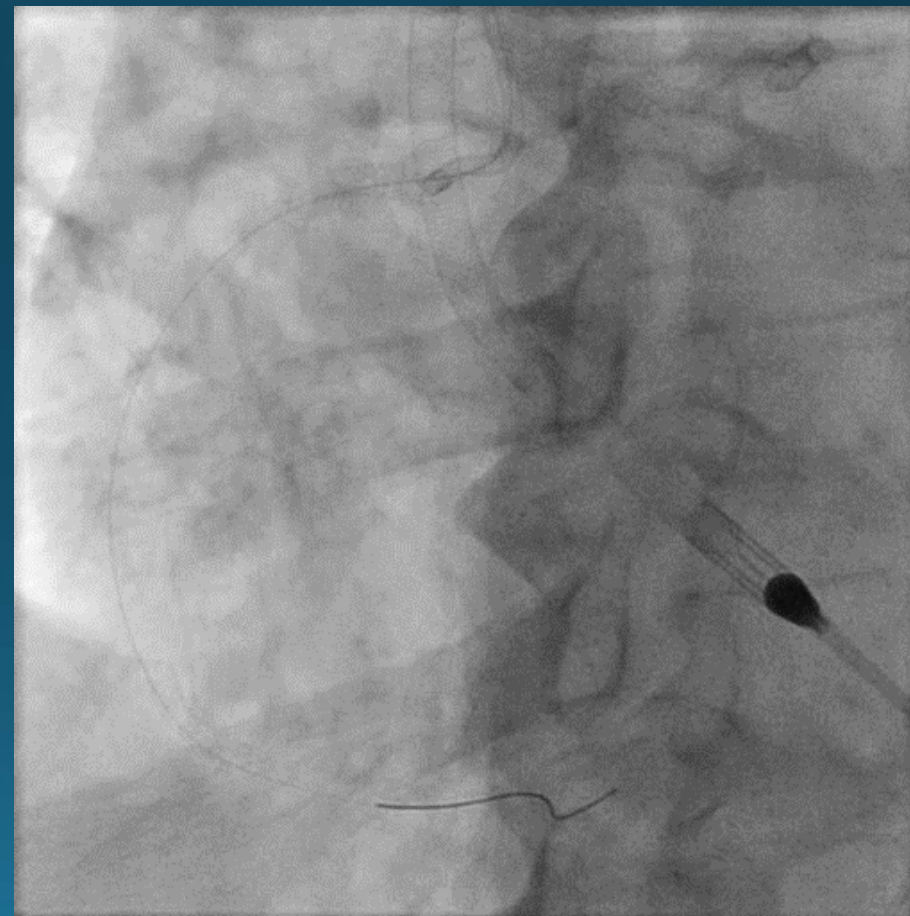
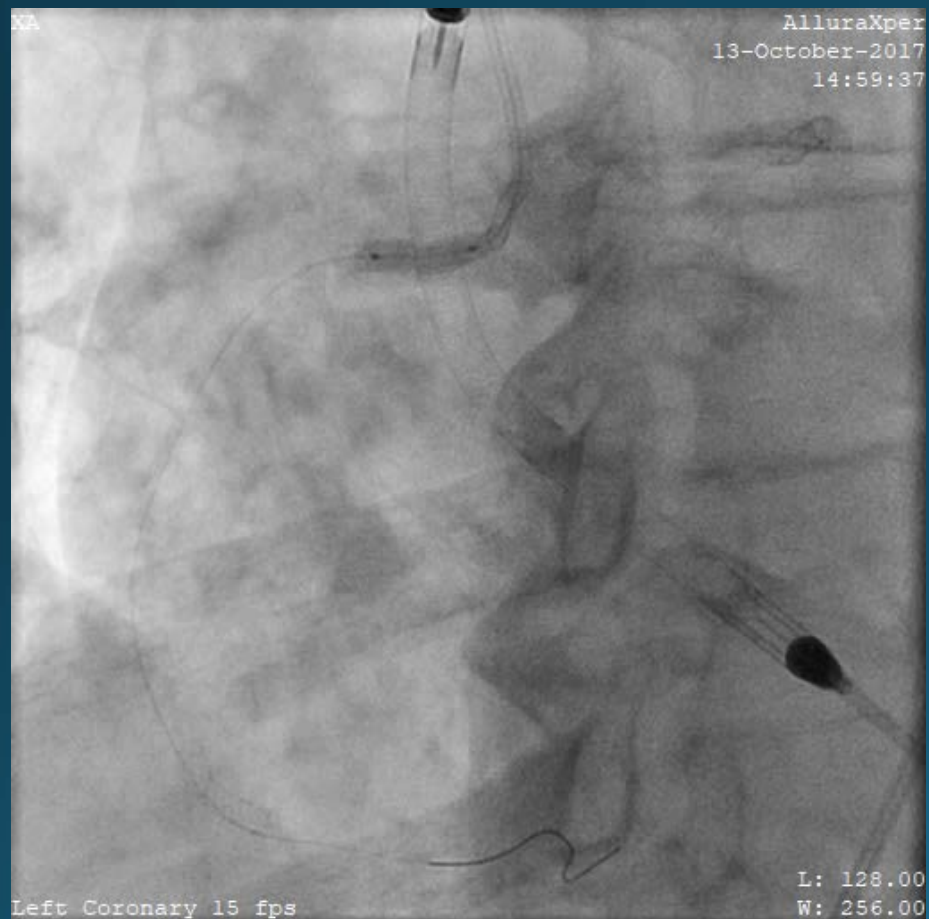
Coronary Intervention



Coronary Intervention

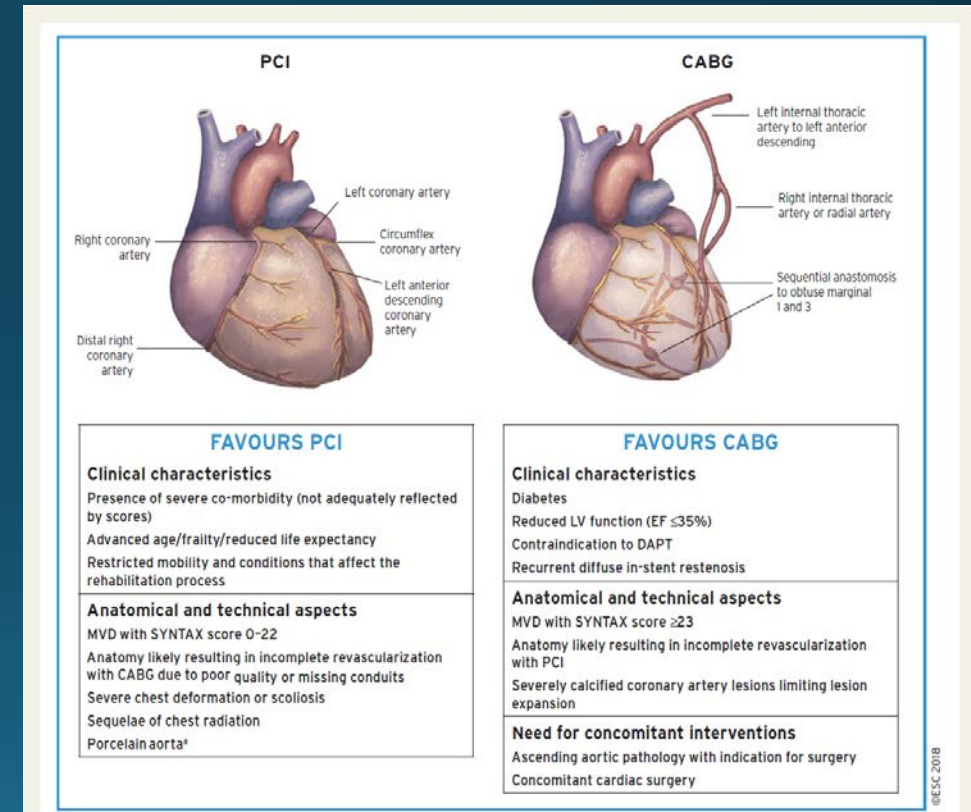


Coronary Intervention



Criteria for choosing PCI or CABG

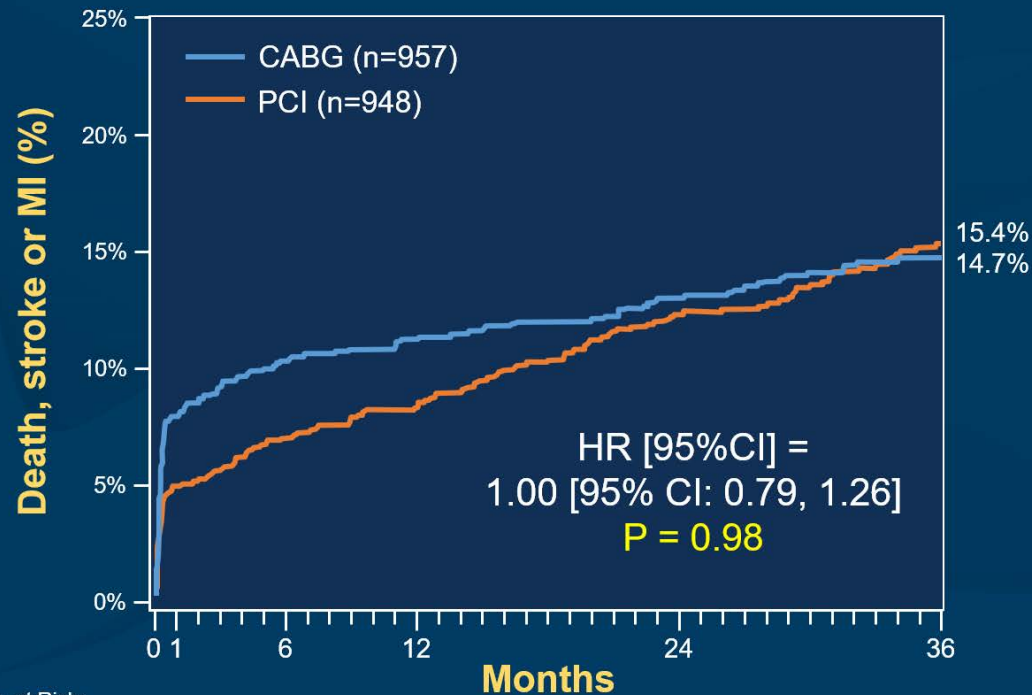
- 1) Surgical Risk (STS score)
- 2) Anatomical complexity of CAD (SYNTAX score, Left main disease)
- 3) Anticipated completeness of revascularization
- 4) Presence of Diabetes



Left main disease

EXCEL

Primary Endpoint Death, Stroke or MI at 3 Years



No. at Risk:

PCI	948	896	875	850	784	445
CABG	957	868	836	817	763	458

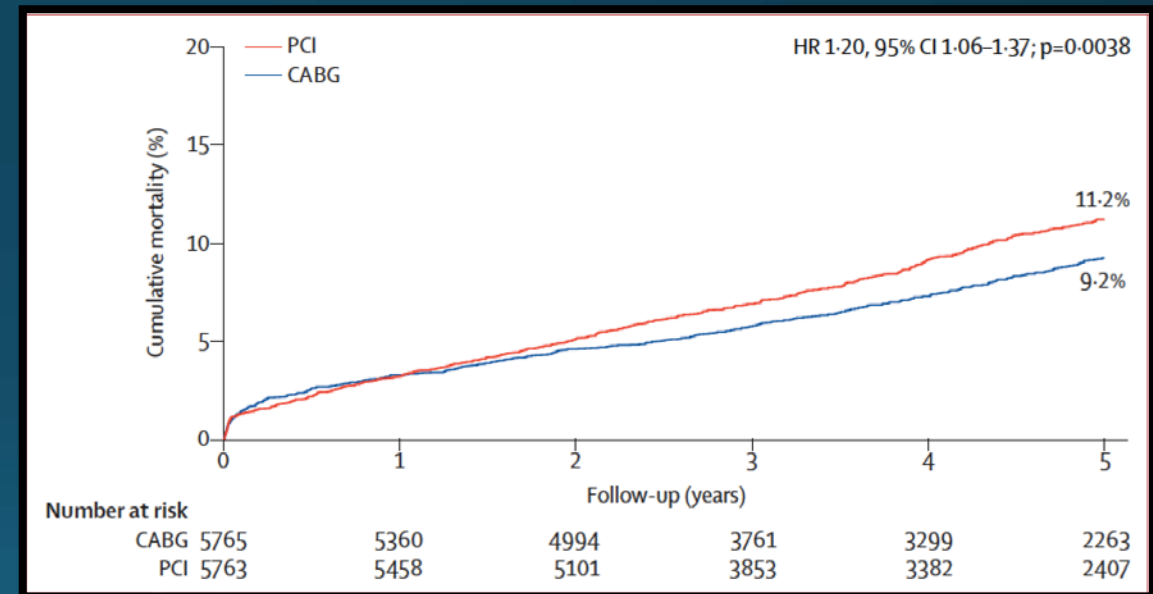
Revascularization for Three vessel disease

Death, myocardial infarction or stroke

3-Vessel Disease

SYNTAX	1.64 [1.22, 2.20]	15.5%
FREEDOM	1.36 [1.10, 1.68]	19.6%
BEST	1.26 [0.84, 1.89]	11.1%
		46.2%
Fixed effect model	1.42 [1.21, 1.66]	$p < 0.001$
Random effects model	1.42 [1.21, 1.66]	$p < 0.001$

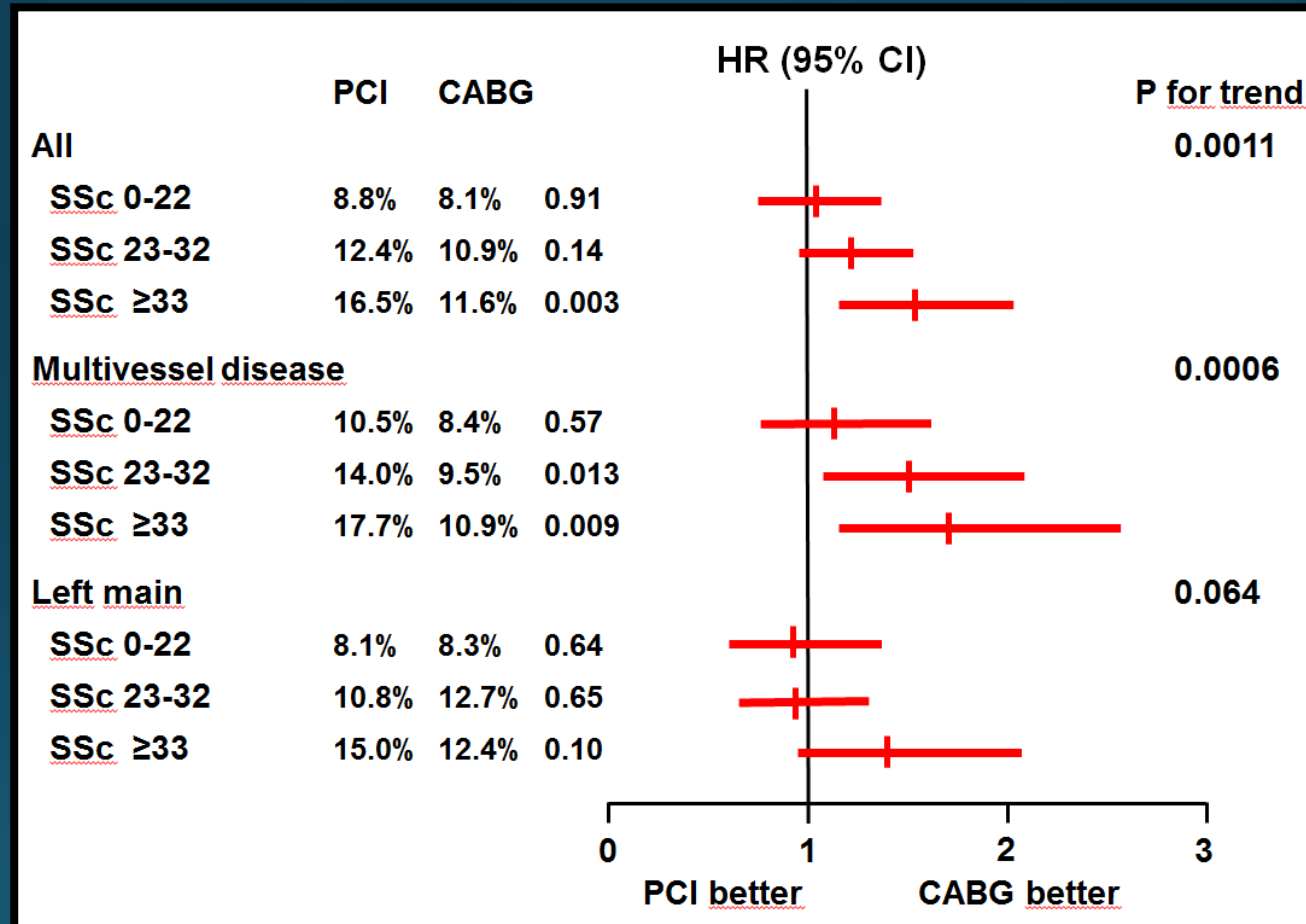
$Q=1.410$, $I^2=0\%$, $\tau^2=0$, $p=0.494$



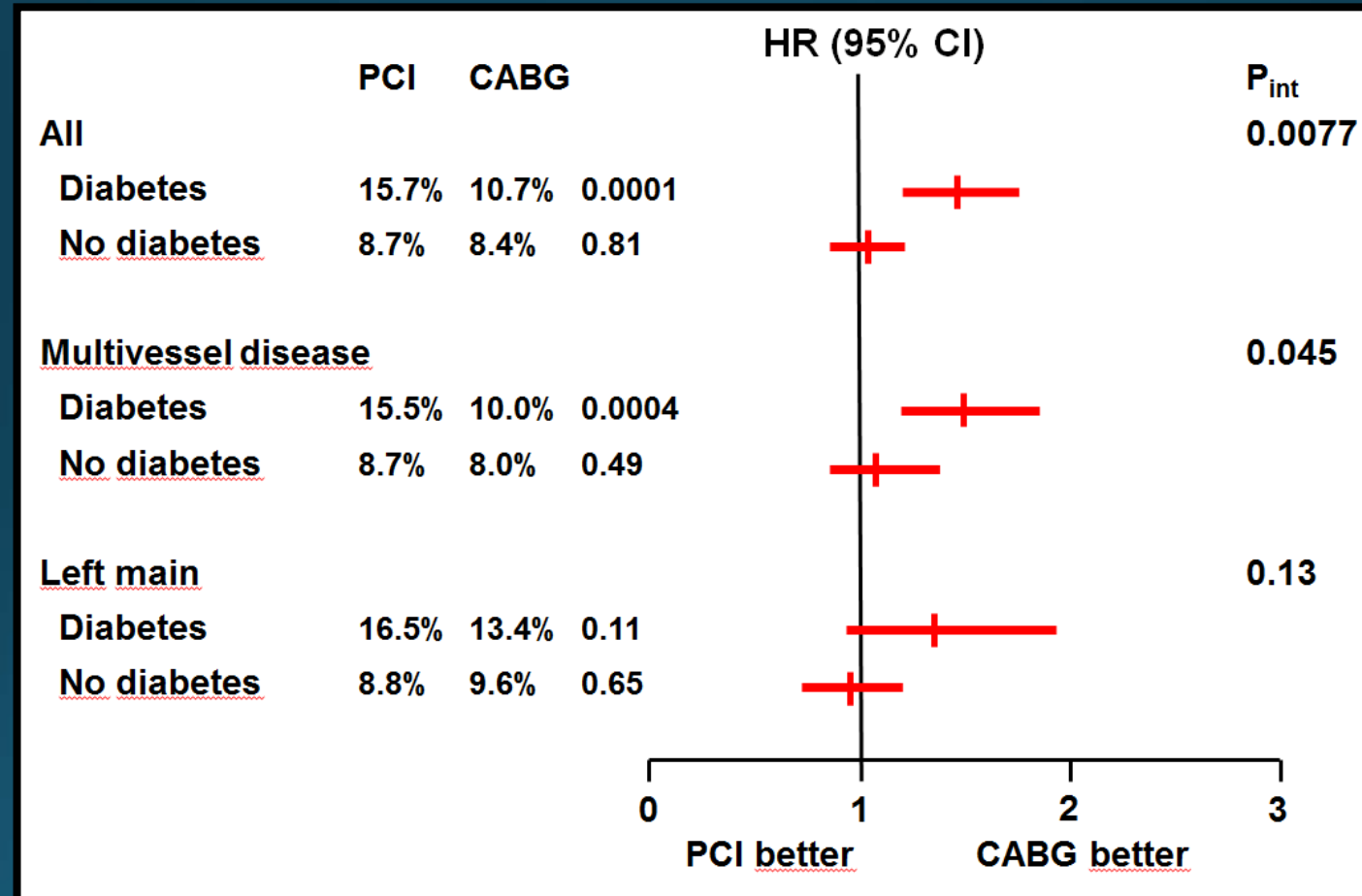
Giacoppo et al. JAMA Cardio 2017 Oct 1;2(10):1079-1088.

Head SJ et al., Lancet 2018; 391: 939-48

5-year all-cause mortality after PCI vs CABG according to coronary complexity



5-year all-cause mortality after PCI vs CABG according to diabetes



Guidelines

Multi-vessel CAD

Recommendations according to extent of CAD	CABG		PCI	
	Class	Level	Class	Level
Three-vessel CAD without diabetes mellitus				
Three-vessel disease with low SYNTAX score (0-22).	I	A	I	A
Three-vessel disease with intermediate or high SYNTAX score (>22). ^a	I	A	III	A
Three-vessel CAD with diabetes mellitus				
Three-vessel disease with low SYNTAX score (0-22).	I	A	IIb	A
Three-vessel disease with intermediate or high SYNTAX score (>22). ^a	I	A	III	A

^a PCI should be considered, if the Heart Team is concerned about the surgical risk or if the patient refuses CABG after adequate counselling by the Heart Team.

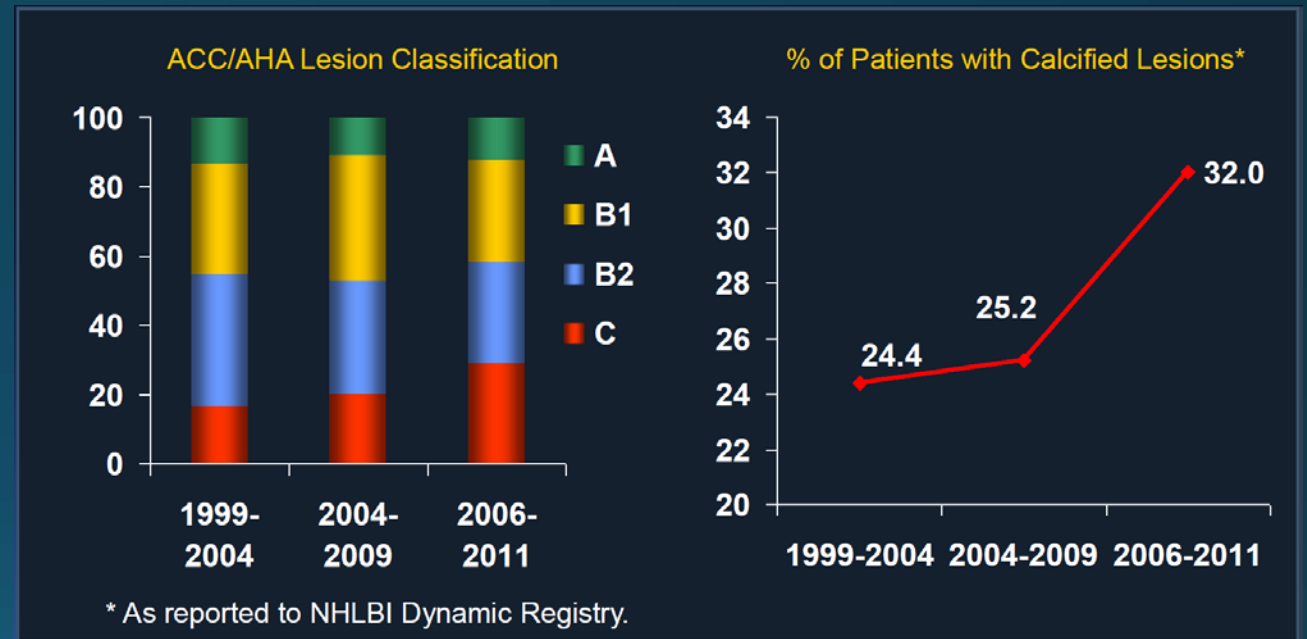
Left main

Recommendations according to extent of CAD	CABG		PCI	
	Class	Level	Class	Level
Left main CAD				
Left main disease with low SYNTAX score (0-22).	I	A	I	A
Left main disease with intermediate SYNTAX score (23-32).	I	A	IIa	A
Left main disease with high SYNTAX score (≥33). ^a	I	A	III	B

^a PCI should be considered, if the Heart Team is concerned about the surgical risk or if the patient refuses CABG after adequate counselling by the Heart Team.

Calcified Coronary artery disease

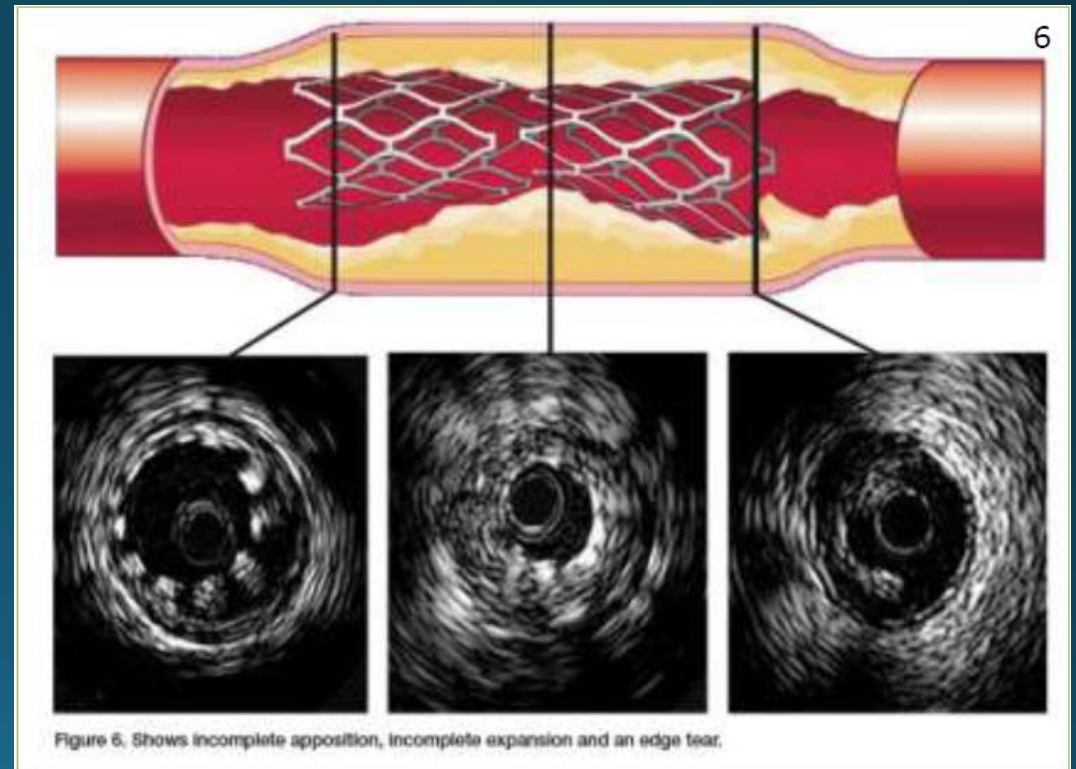
- Renal disease
- Diabetics
- Smokers
- Advanced age



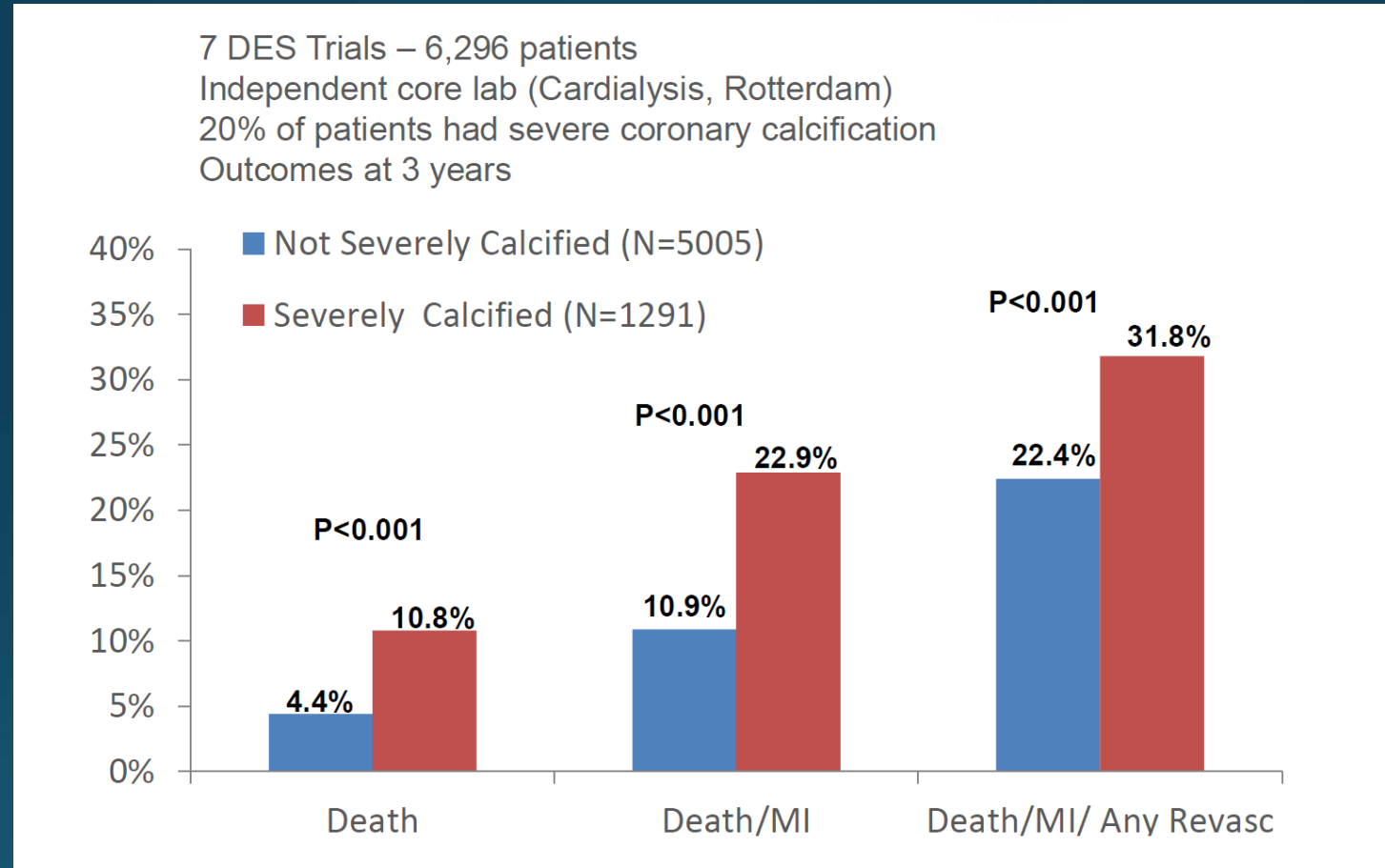
Bortnick, et. al. Am J Cardiol 2014;113:573-579.

Complications with Calcified coronary lesions

- Difficult to completely dilate
- Prone to dissection or even perforation during balloon
- Prevent stent delivery to the desired location
- May prevent adequate stent expansion
- Higher risk of procedural failure and more MACE during long term follow-up

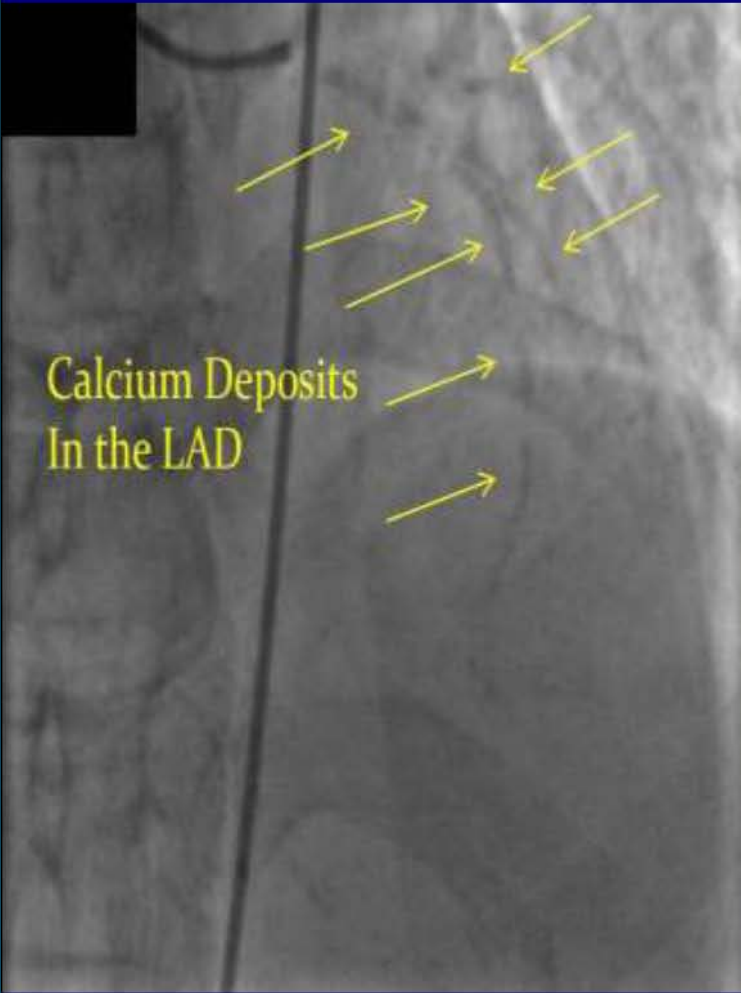


Coronary Calcium is a predictor for worse clinical outcomes after PCI



Imaging of Coronary Calcium

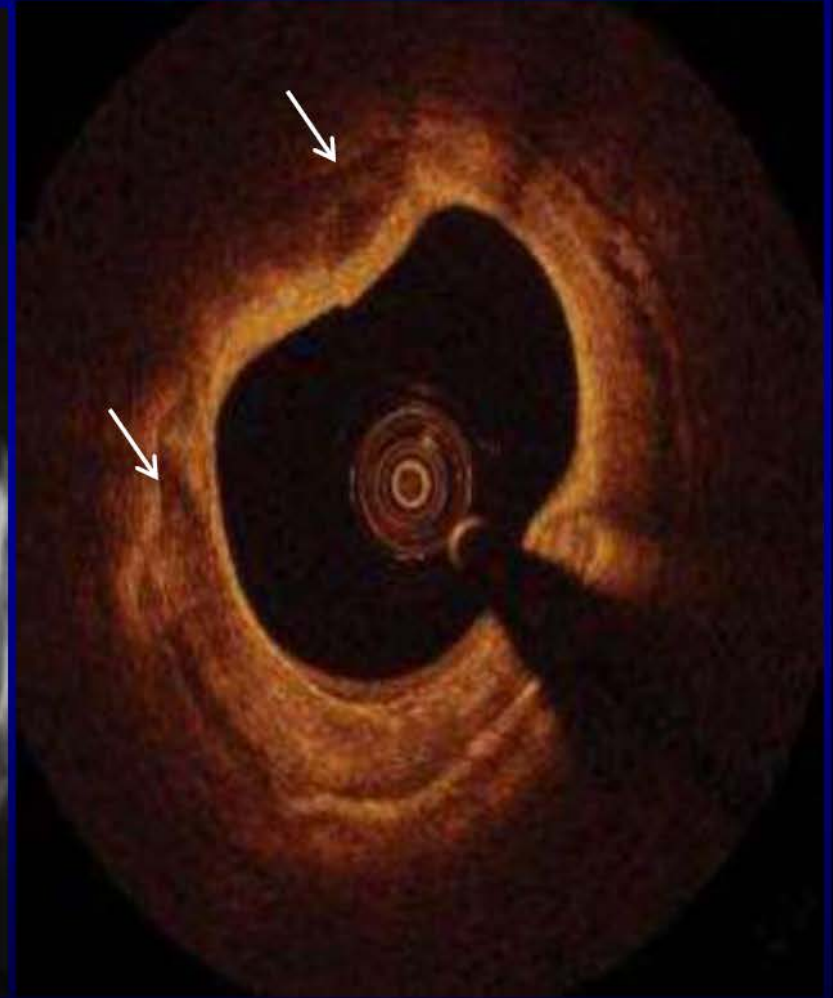
**“Tram-track” sign
on Angio X-ray**



**IVUS showing a highly
calcified lesion (>2Q)**



**OCT showing a highly
calcified lesion**

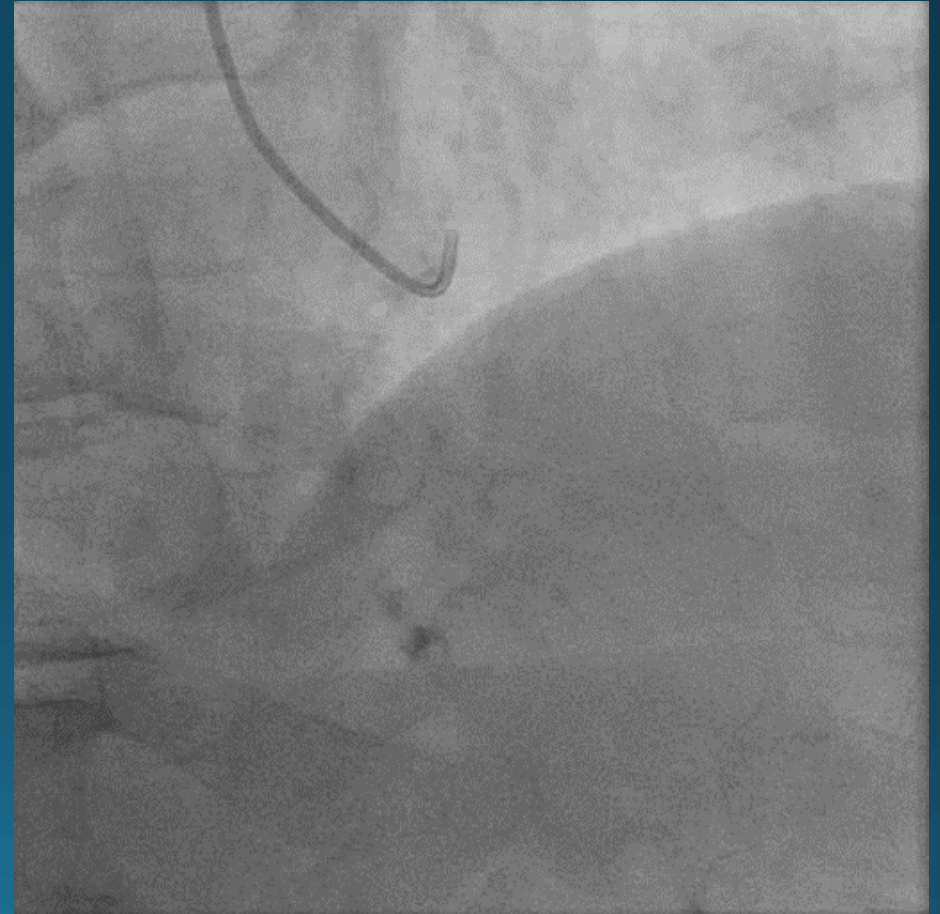
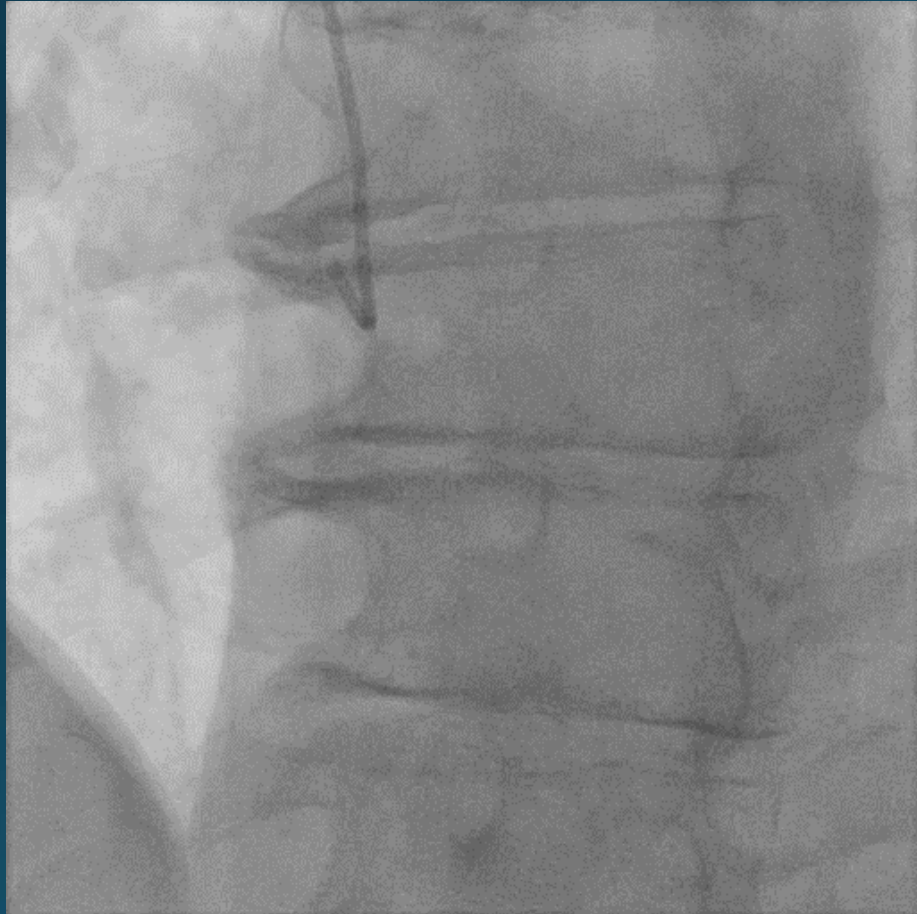


Case – Calcified disease

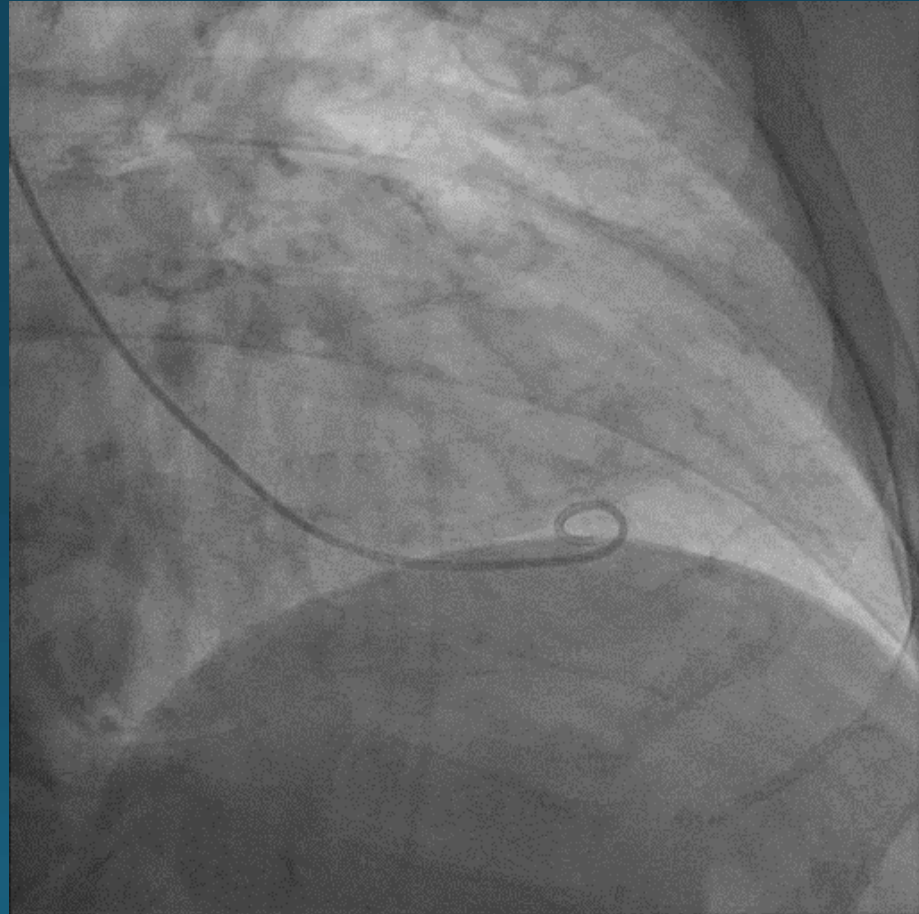


- 67 year old man with hx of HTN, HLD, DM2, Ex-smoker (quit 2 years ago)
- CAD with hx of LAD stenting several years ago
- PVD with hx of Aorto bifem bypass, bilateral SFA occlusions, and Left carotid occlusion
- Presents with chest pain and dyspnea with minimal activity (CCS III) despite GDMT with Toprol XL 50 mg, Imdur 30 mg, Ranexa 500 mg bid, ASA 81 mg, Plavix 75 mg, Simvastatin 40 mg
- Echo: LVEF 40% with severe inferior hypokinesis
- Nuclear stress test: Large inferior ischemia

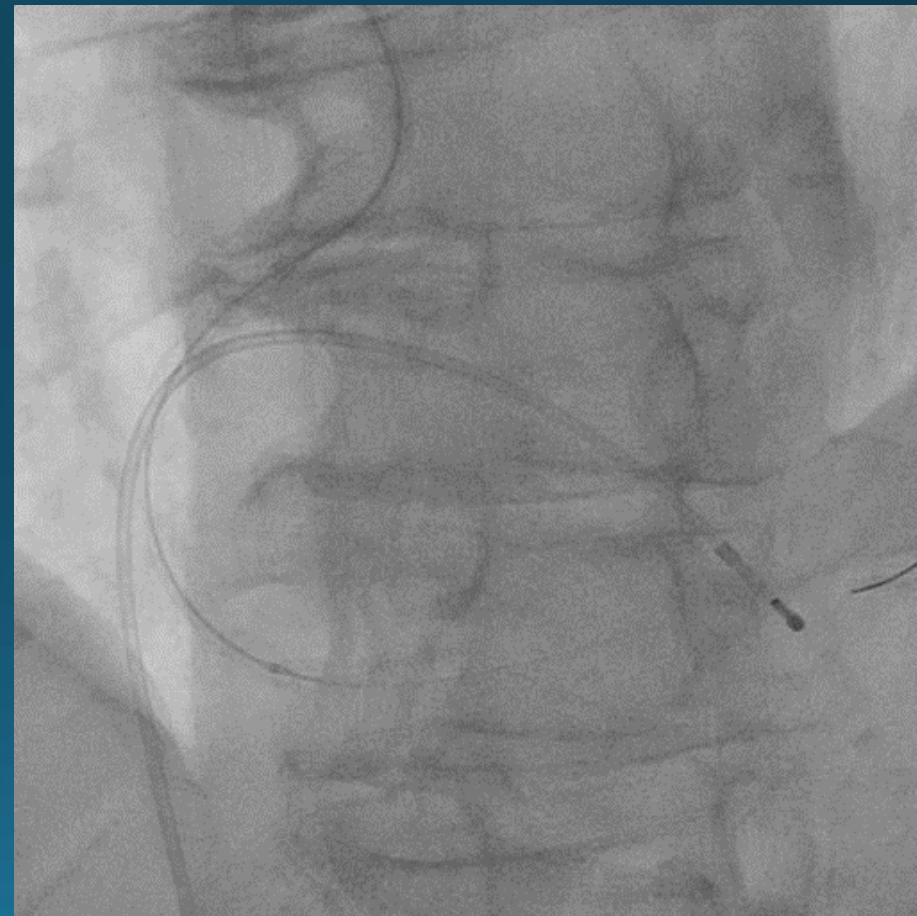
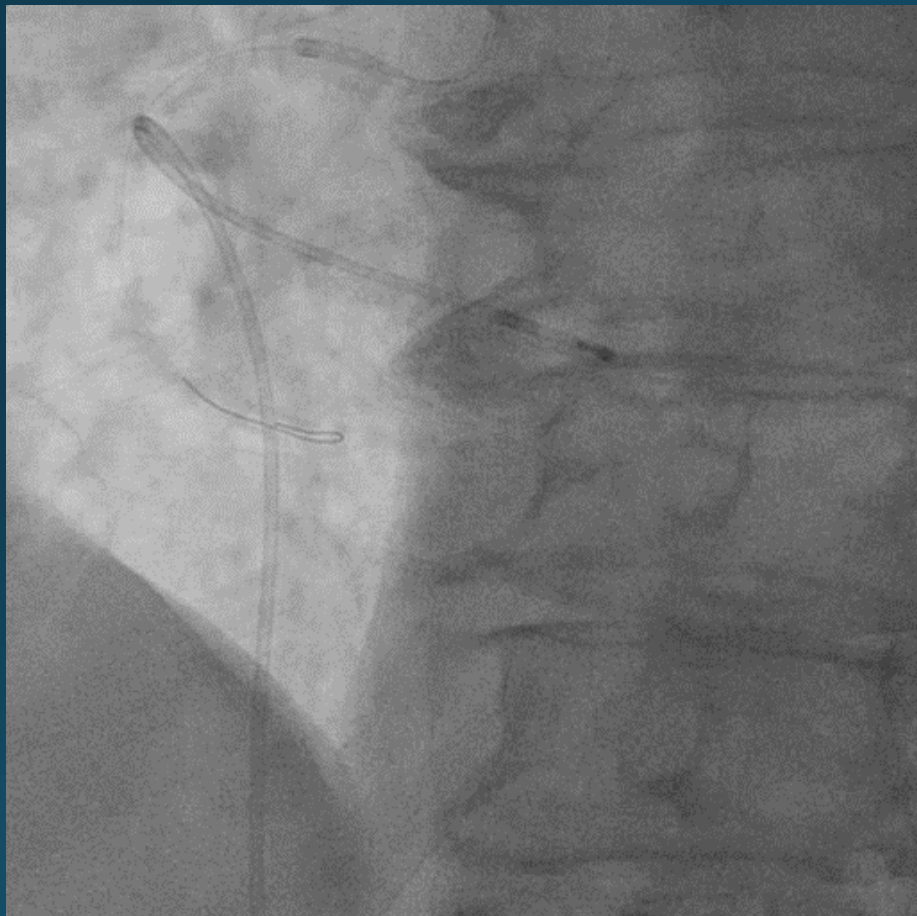
Coronary Angiogram



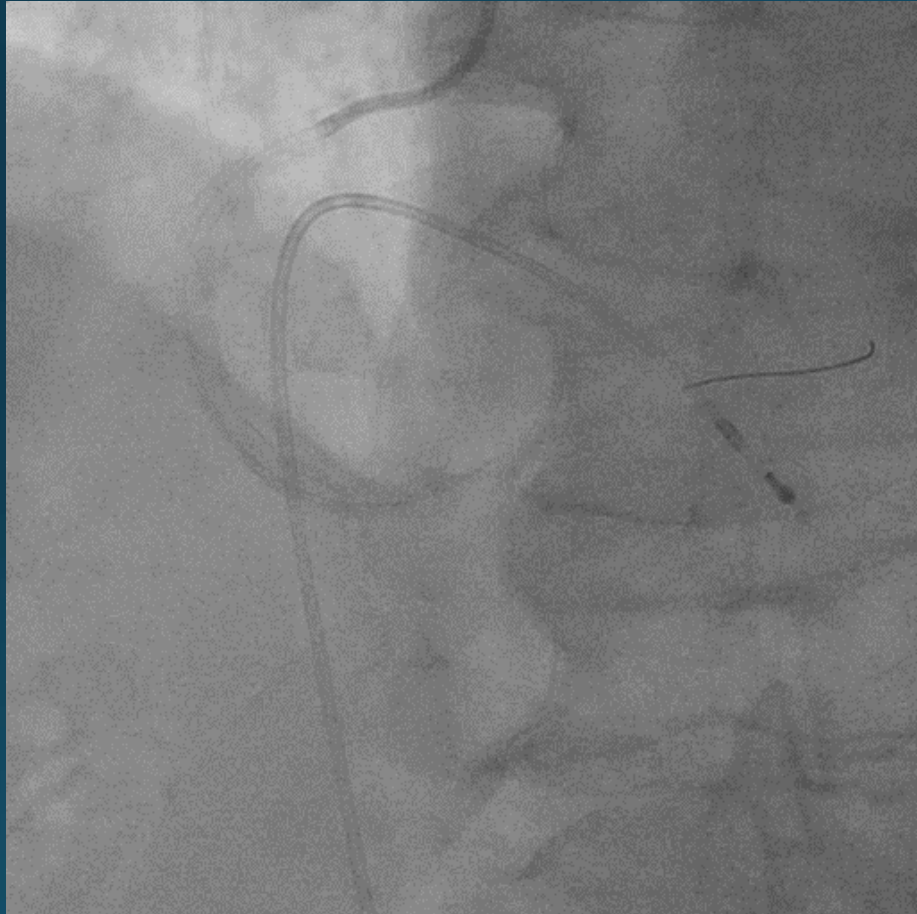
Coronary Angiogram



Coronary Intervention



Coronary Intervention

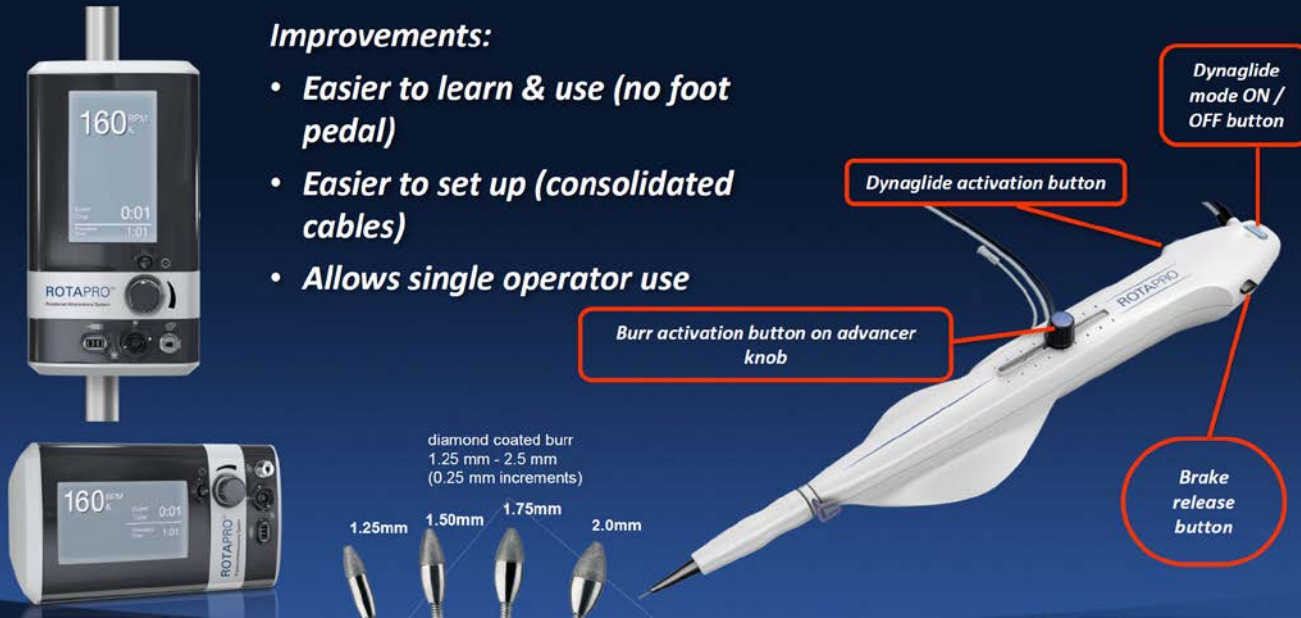


Treatment for Severely Calcified Lesions

Atherectomy: ROTAPRO Rotational Atherectomy System

Improvements:

- Easier to learn & use (no foot pedal)
- Easier to set up (consolidated cables)
- Allows single operator use



DIAMONDBACK 360: Coronary Orbital Atherectomy System

Device Features

- Simple device setup
- Microsecond feedback to changes in loading
- 135cm usable length



NC balloons

Cutting balloon

Angiosculpt



Orbital atherectomy system



Severe LV dysfunction

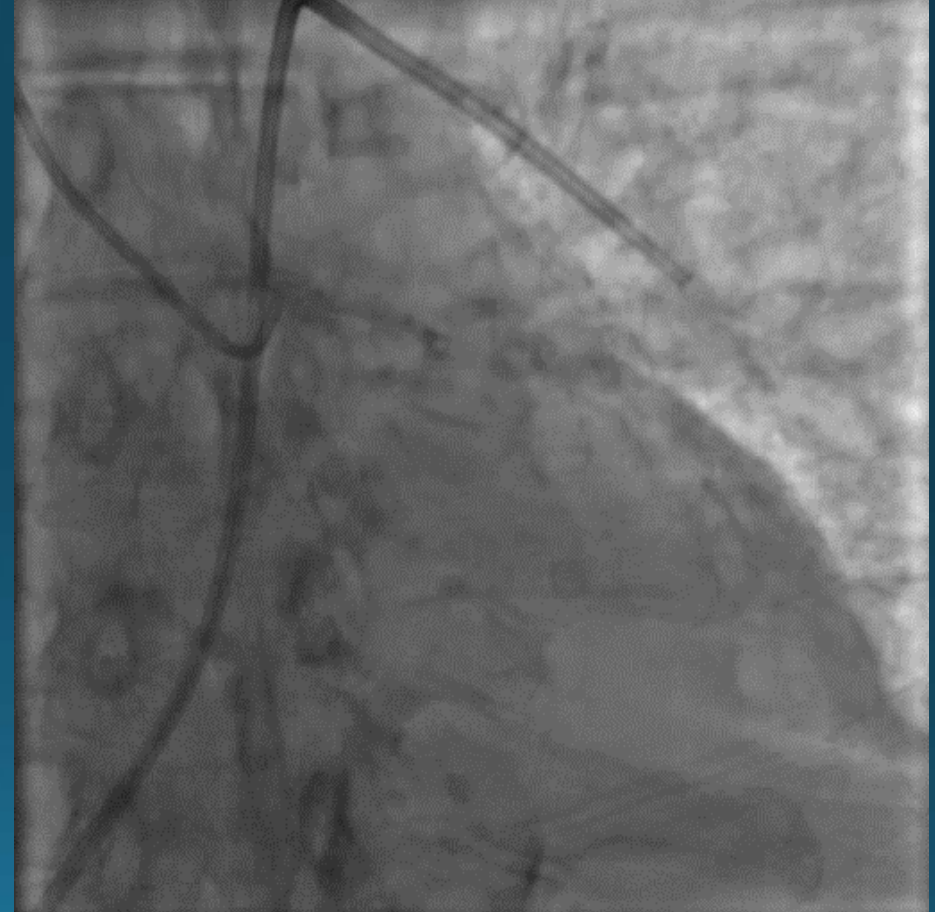
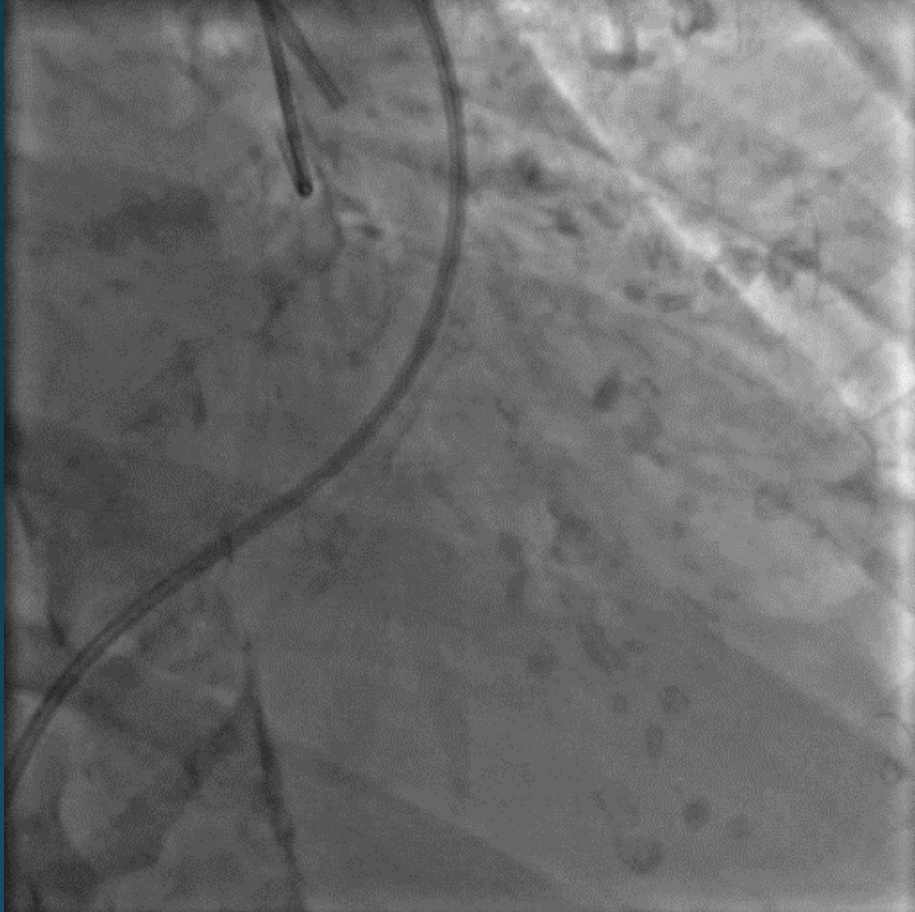
- Commonly seen in patients with Left main and/or Multi-vessel CAD
- One of the strongest predictors of morbidity and mortality
- Significant increases risk with surgical revascularization
- Also can significantly increase risk with PCI due to limited ability to tolerate any hemodynamic compromise
- Therefore, the prophylactic use of circulatory support should be considered when a high risk of hemodynamic compromise exists

Systolic dysfunction case

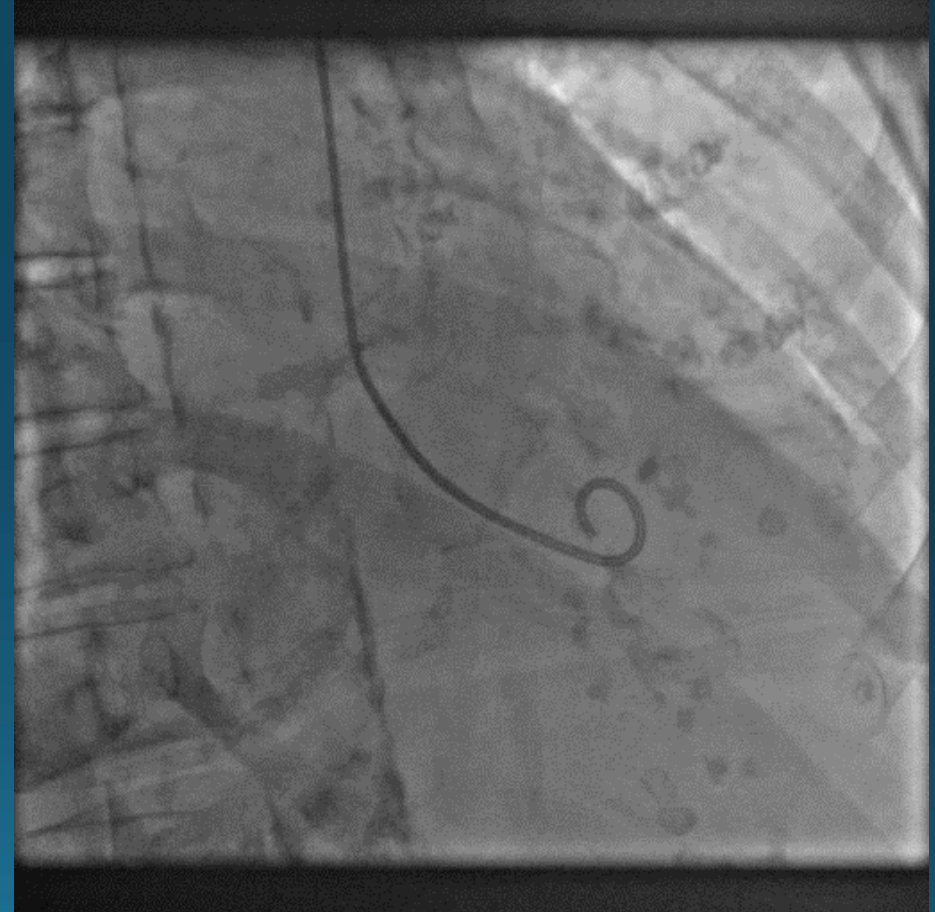
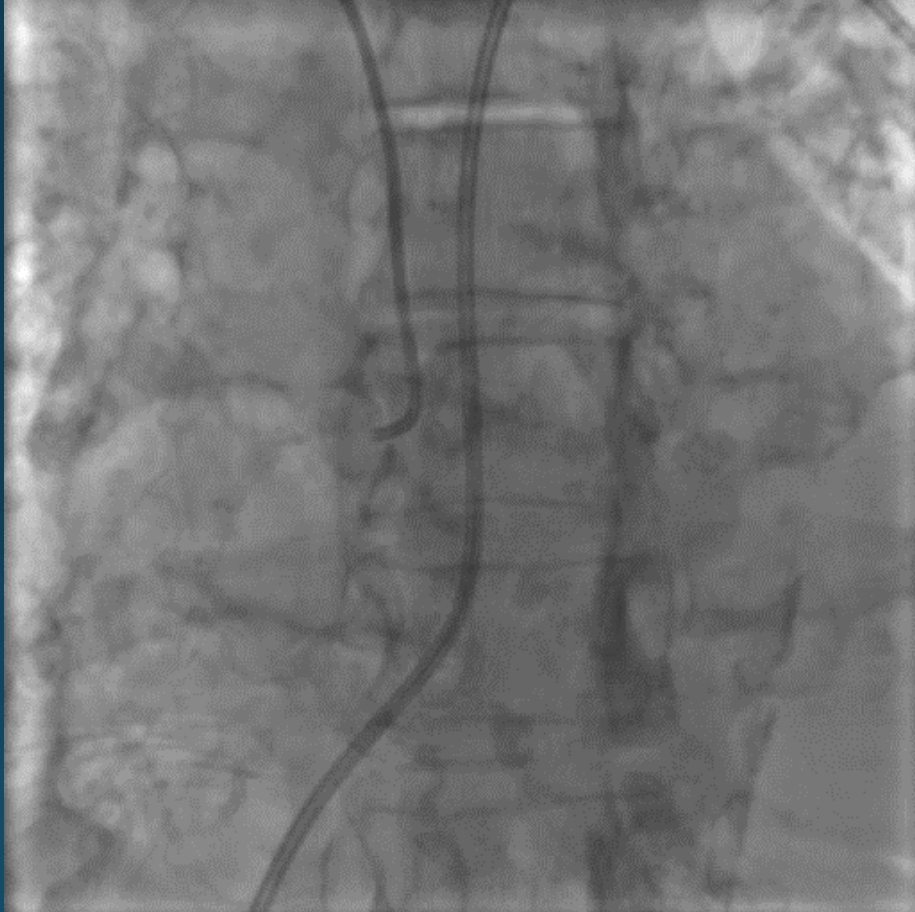
- 84 year old lady with hx of HTN, DM2 who presents with several week history of progressive chest pressure and dyspnea with minimal exertion.
- She lives in NJ and here visiting family. She lives independently, participates in community activities and last year took a trip to Europe without any difficulties
- Admitted to OSH: ECG antero-lateral ST depression. CXR pulmonary congestion
- Troponin = 2.1, BNP = 1670
- Echo: LVEF 30-35%, mild-moderate MR



Cardiac catheterization



Cardiac catheterization



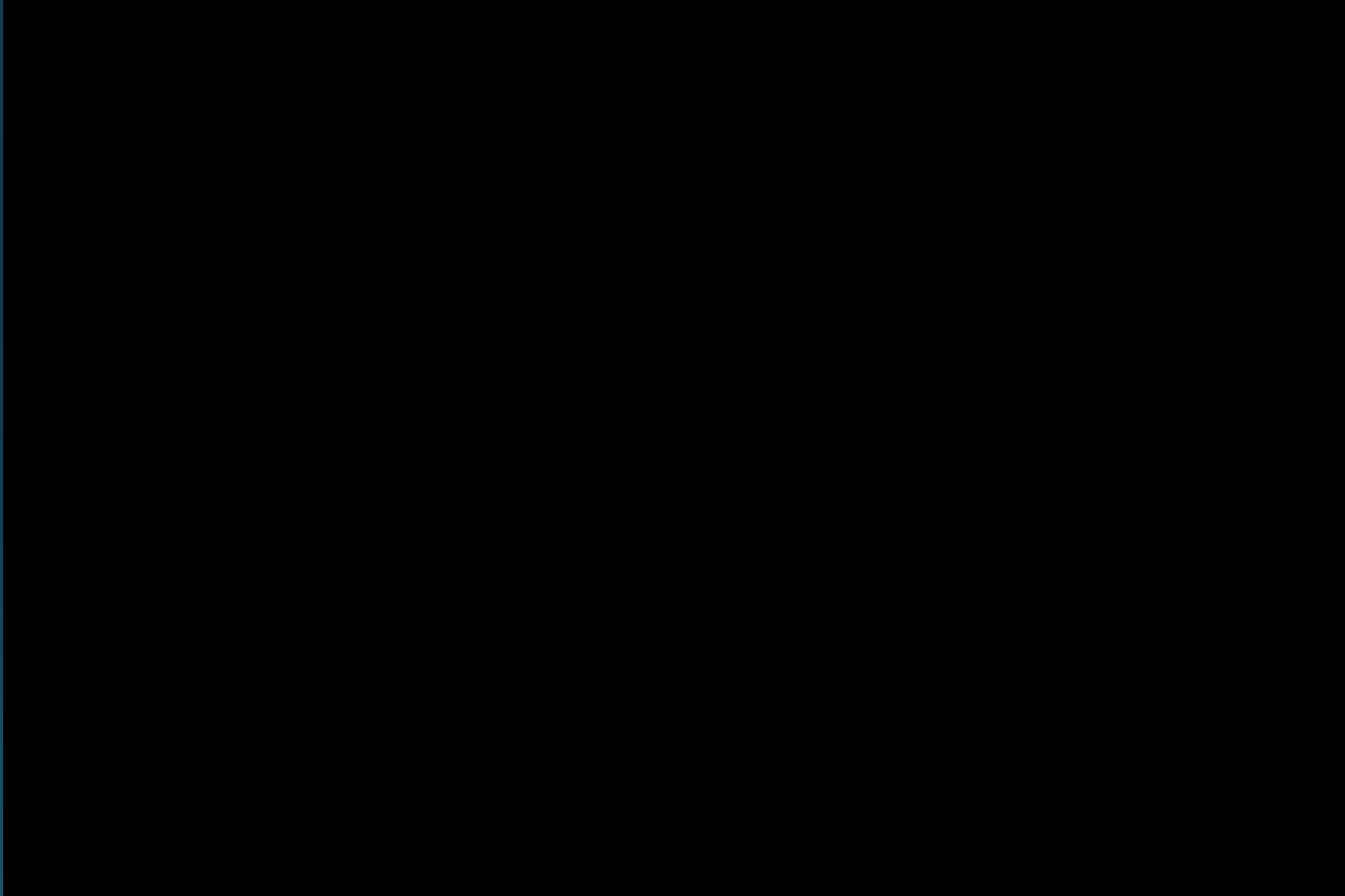


Heart team discussion

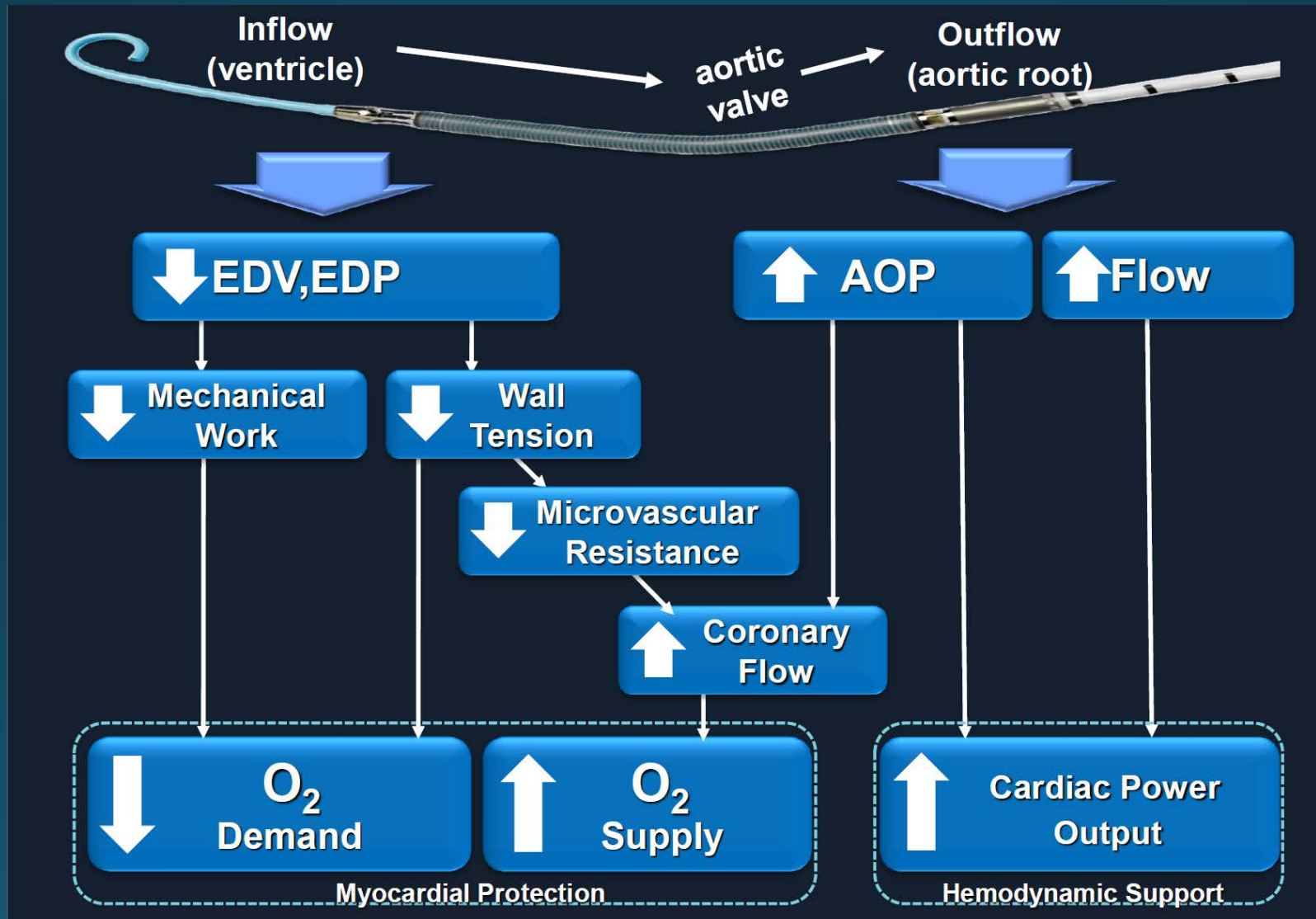


- **STS Risk:** CABG
- **Mortality:** 10.5%
- **M&M:** 38.8%
- **Permanent CVA:** 3.4%
- **Prolonged Vent:** 33%
- **Renal Failure:** 6.6%
- **Reoperation:** 11.1%
- Actual risk was thought to be higher after frailty testing
- Discussion with patient and family – decided to proceed with high risk PCI with percutaneous hemodynamic support

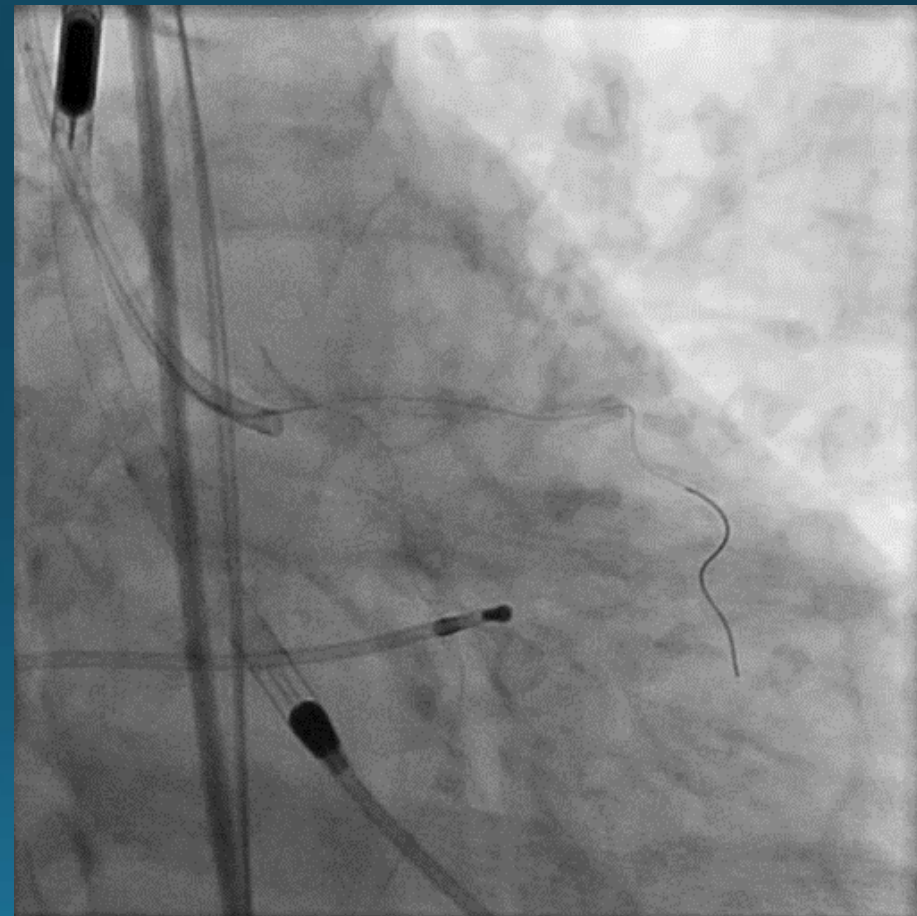
Percutaneous Hemodynamic Support



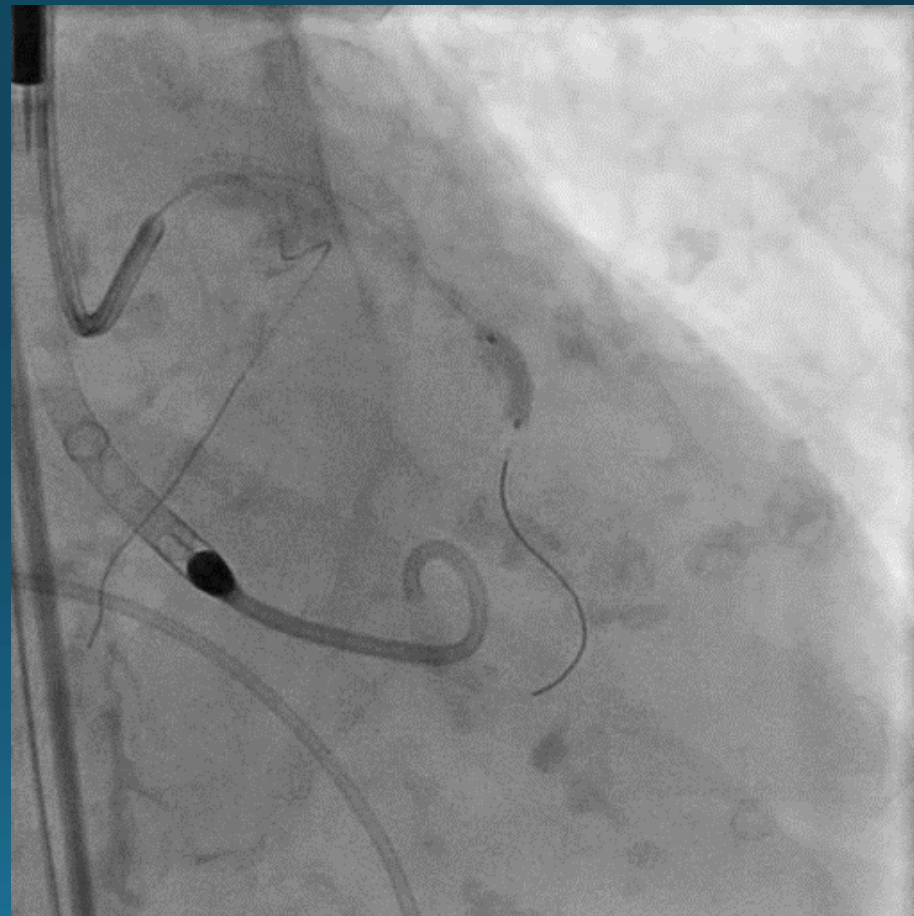
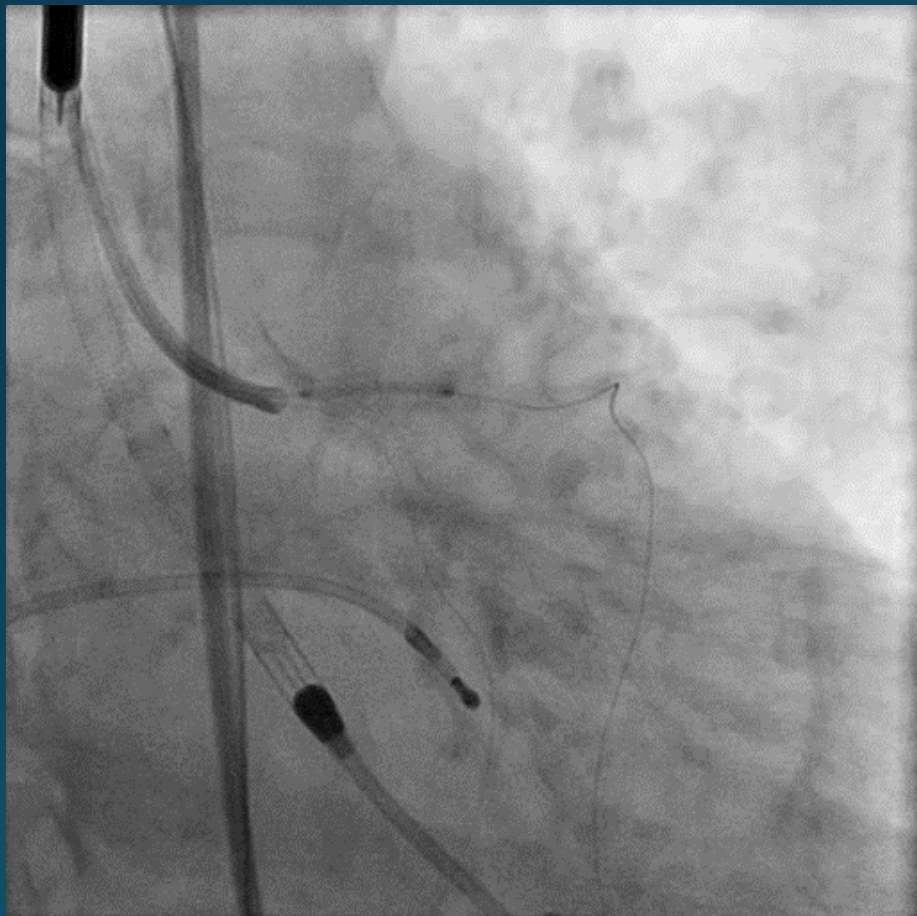
Impella Percutaneous Hemodynamic Support



Coronary intervention



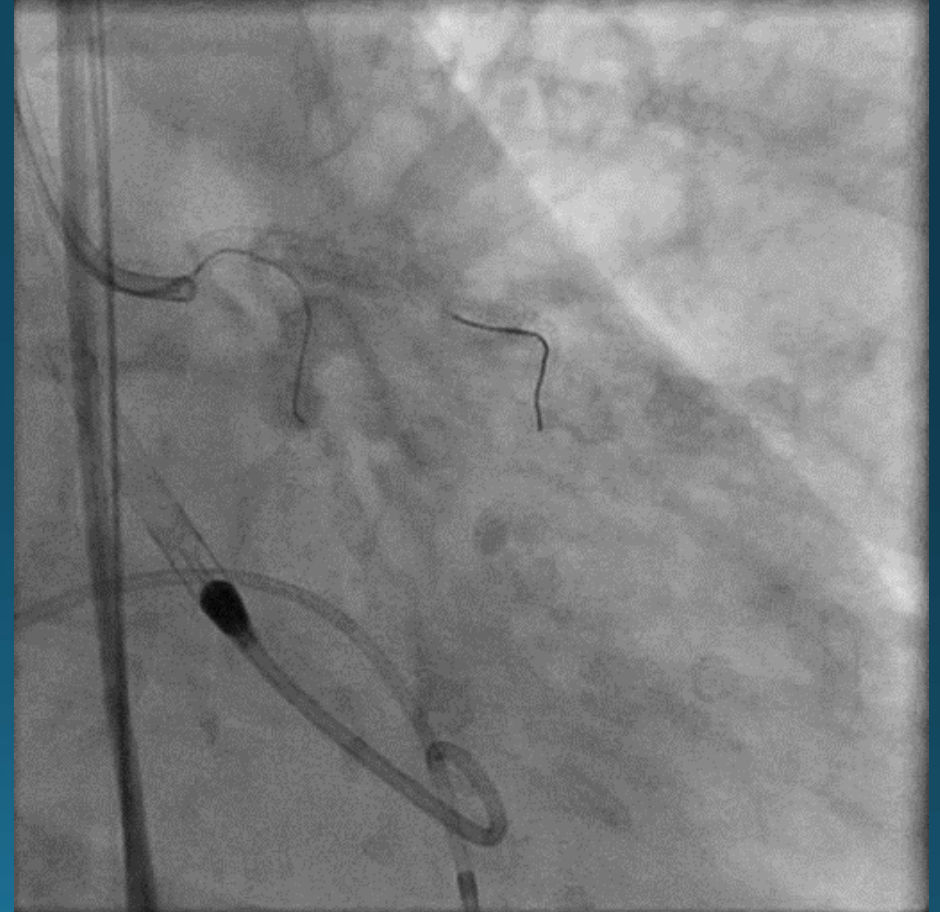
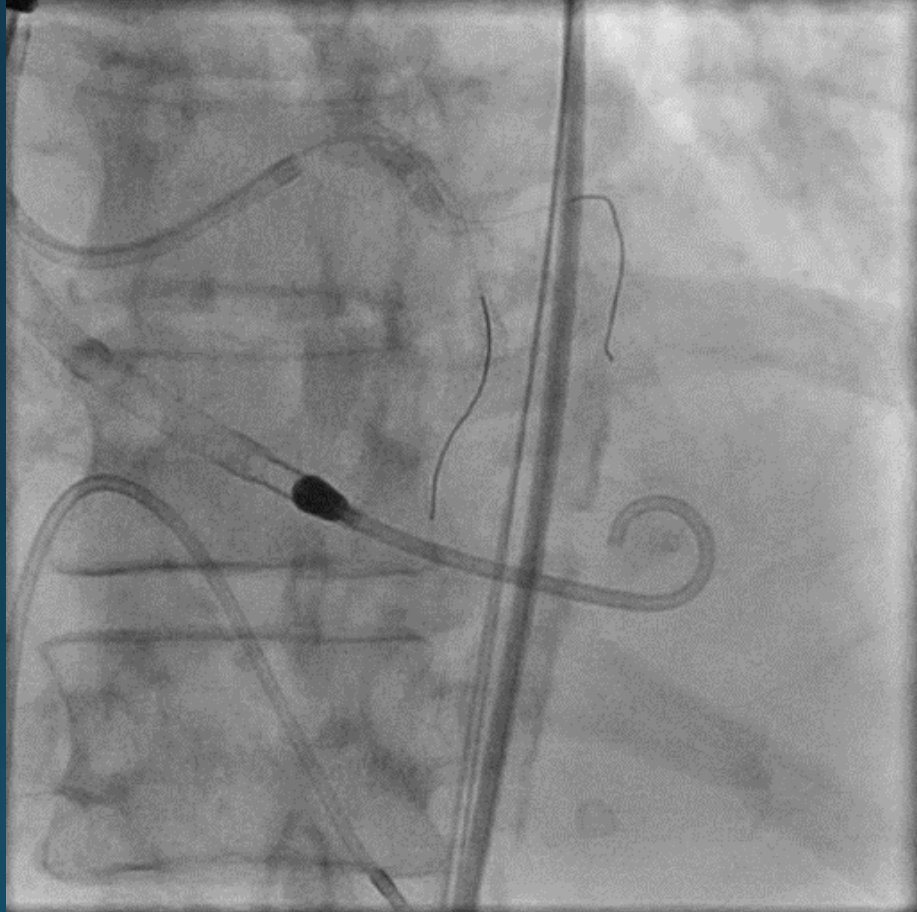
Coronary intervention



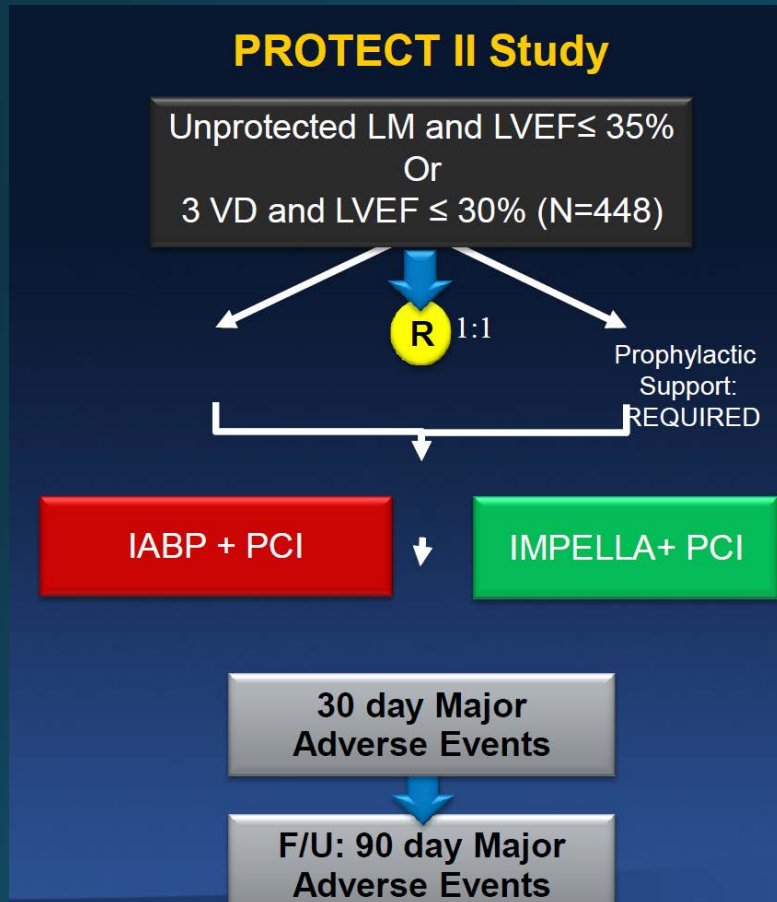
Coronary intervention



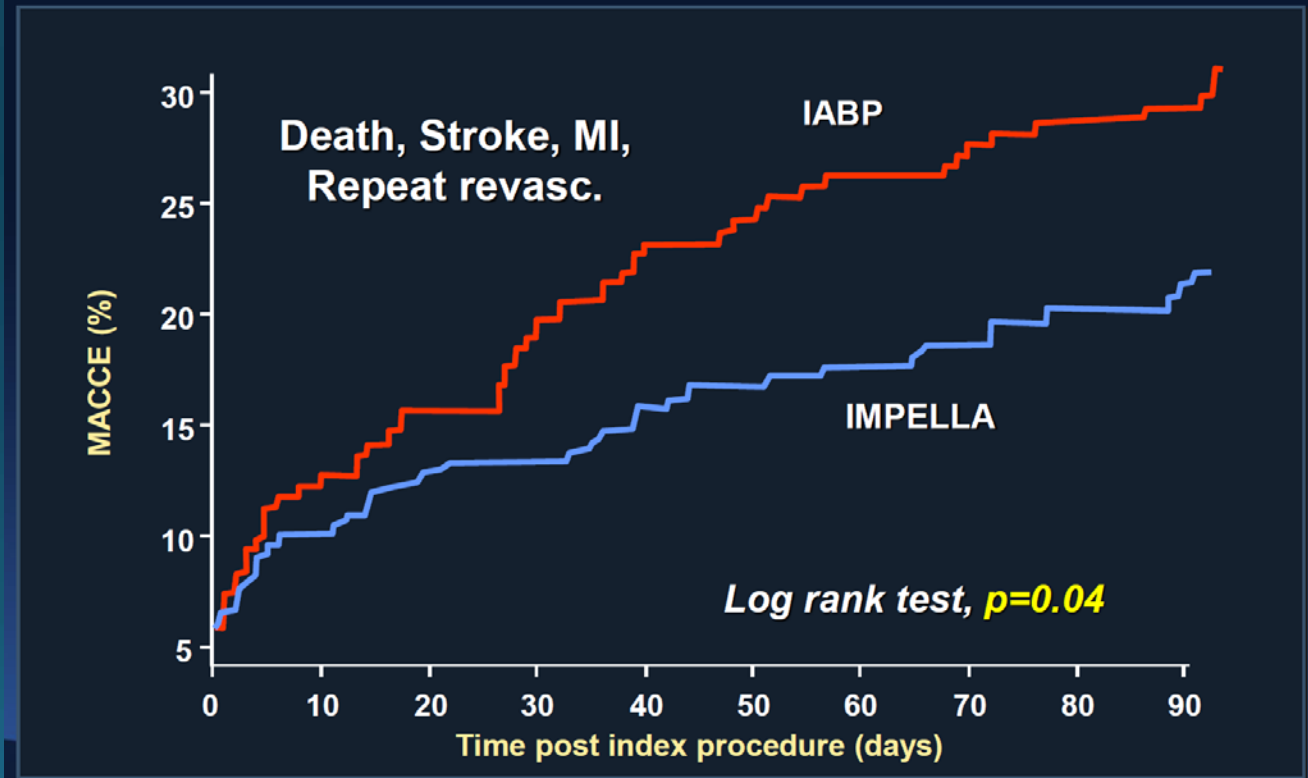
Coronary intervention



PROTECT II Study



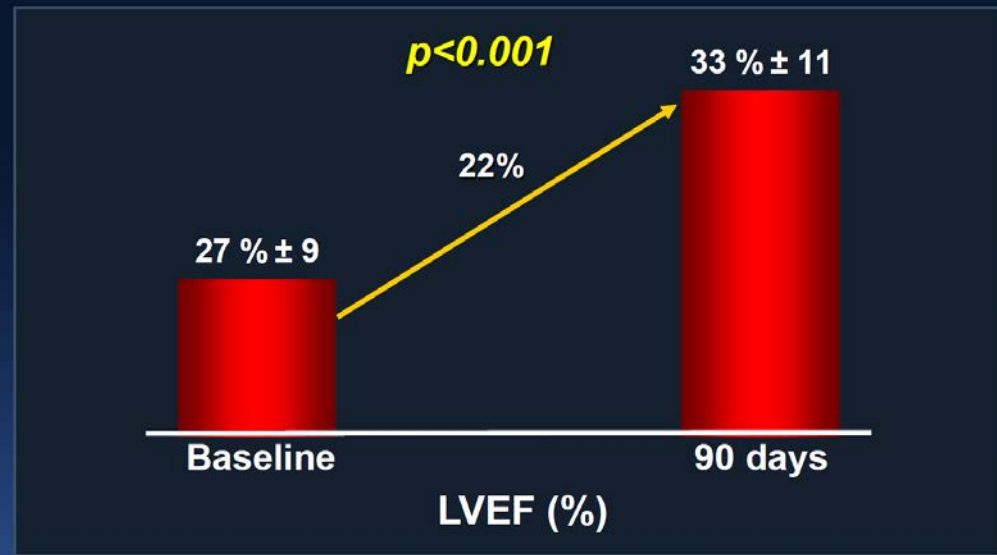
PROTECT II MACCE** Per Protocol Population, N=427



**Using x8ULN threshold for biomarkers or Q-wave for Peri-procedural MI (Stone et al Circulation 2001;104:642-647)

PROTECT II STUDY

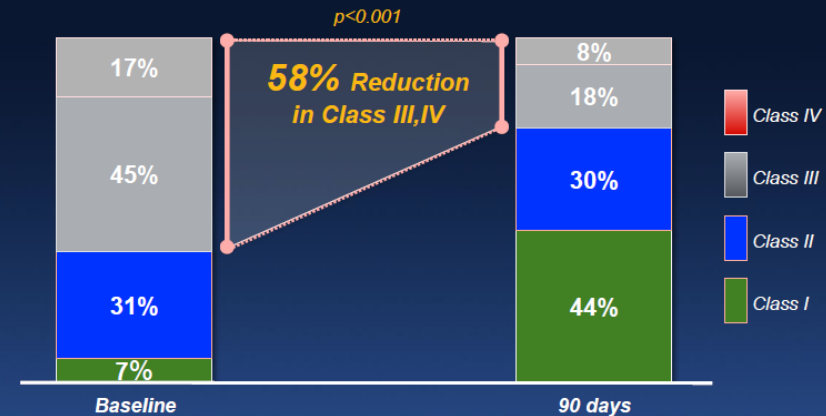
LVEF Improvement Post PCI



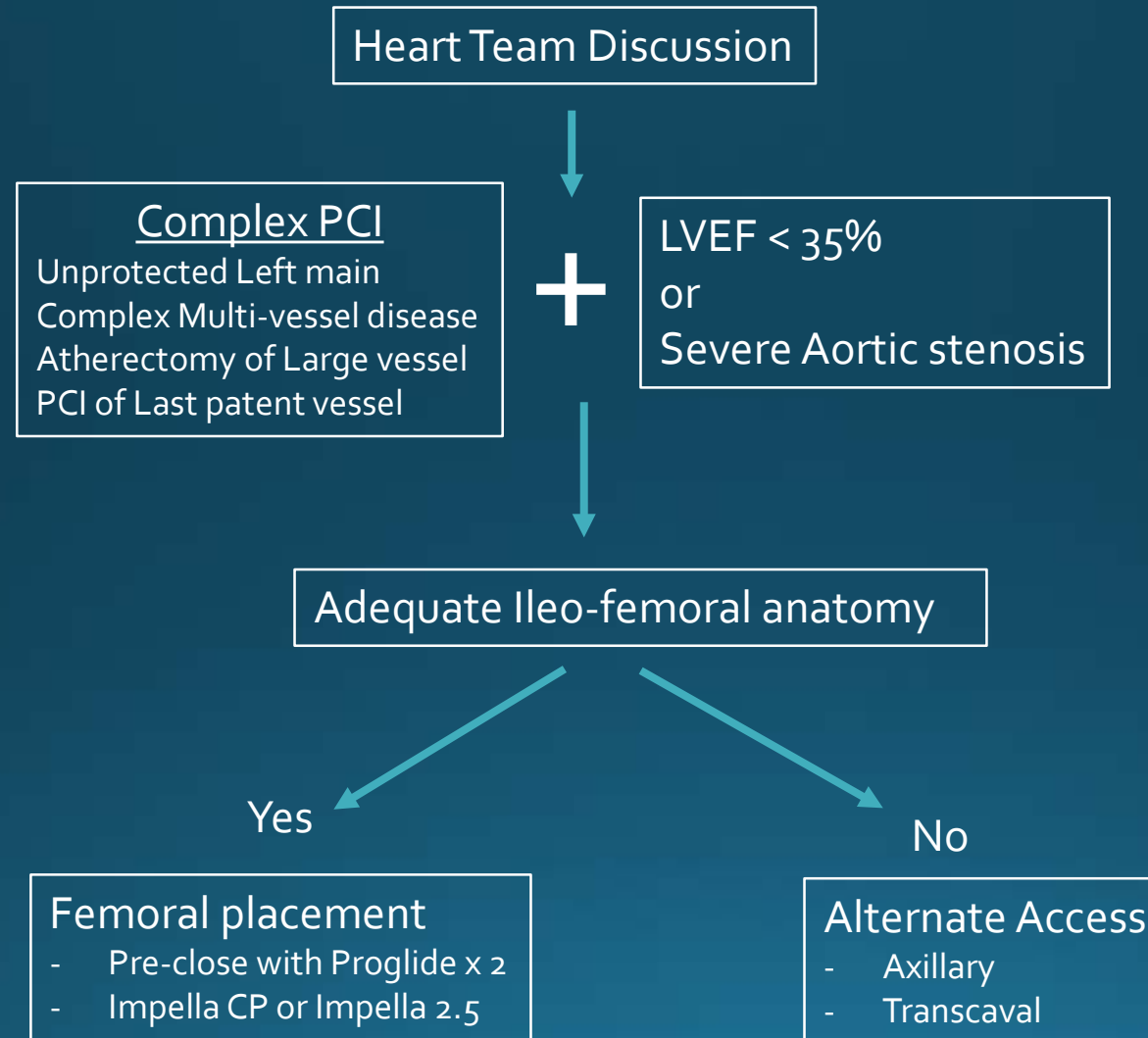
N=304 patients with LVEF measurements available at baseline and 90 days

Improvement in Quality of Life Post PCI

NYHA Class Improvement Post Procedure



Protected PCI Algorithm



Conclusions

- There is a growing population of higher risk patient with complex coronary artery disease – many of whom will benefit from revascularization, and many who are currently undertreated
- A collaborative Heart Team discussion is of paramount importance when devising a revascularization strategy
- For interventional cardiologists, training in specialized procedural and cognitive capabilities is necessary to achieve successful & high quality PCI in these complex subsets
- Advances in technology (eg. Percutaneous ventricular assist device) has allowed to us to perform these high risk procedures in a much more controlled and safer setting