Should All CTOs Be Opened ?
PRO CTO – Revasvularisation

Gerald S. Werner, MD, FESC, FACC, FSCAI

Klinikum Darmstadt GmbH

Darmstadt

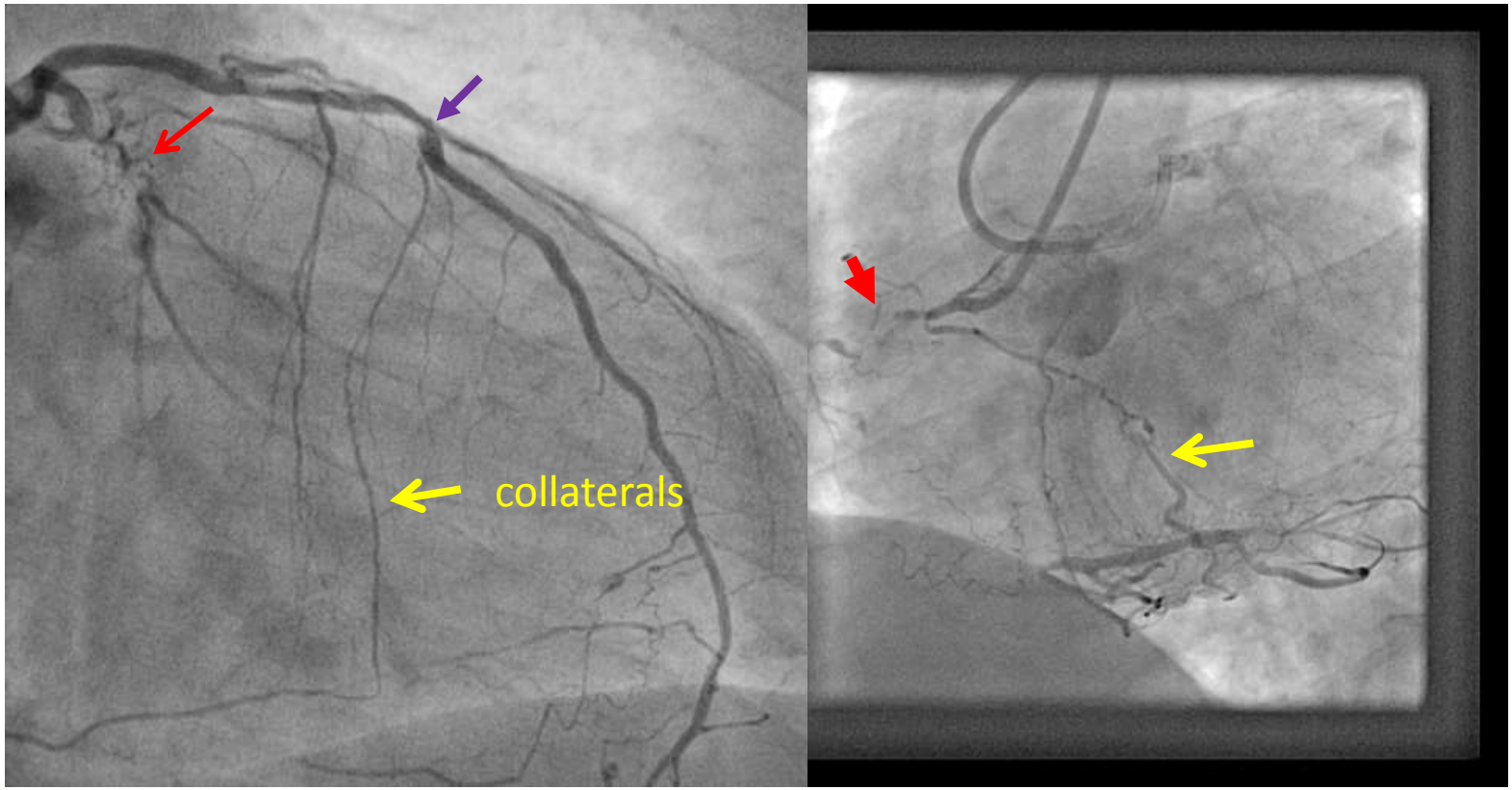
gerald.werner@mail.klinikum-darmstadt.de

Conflict of interest

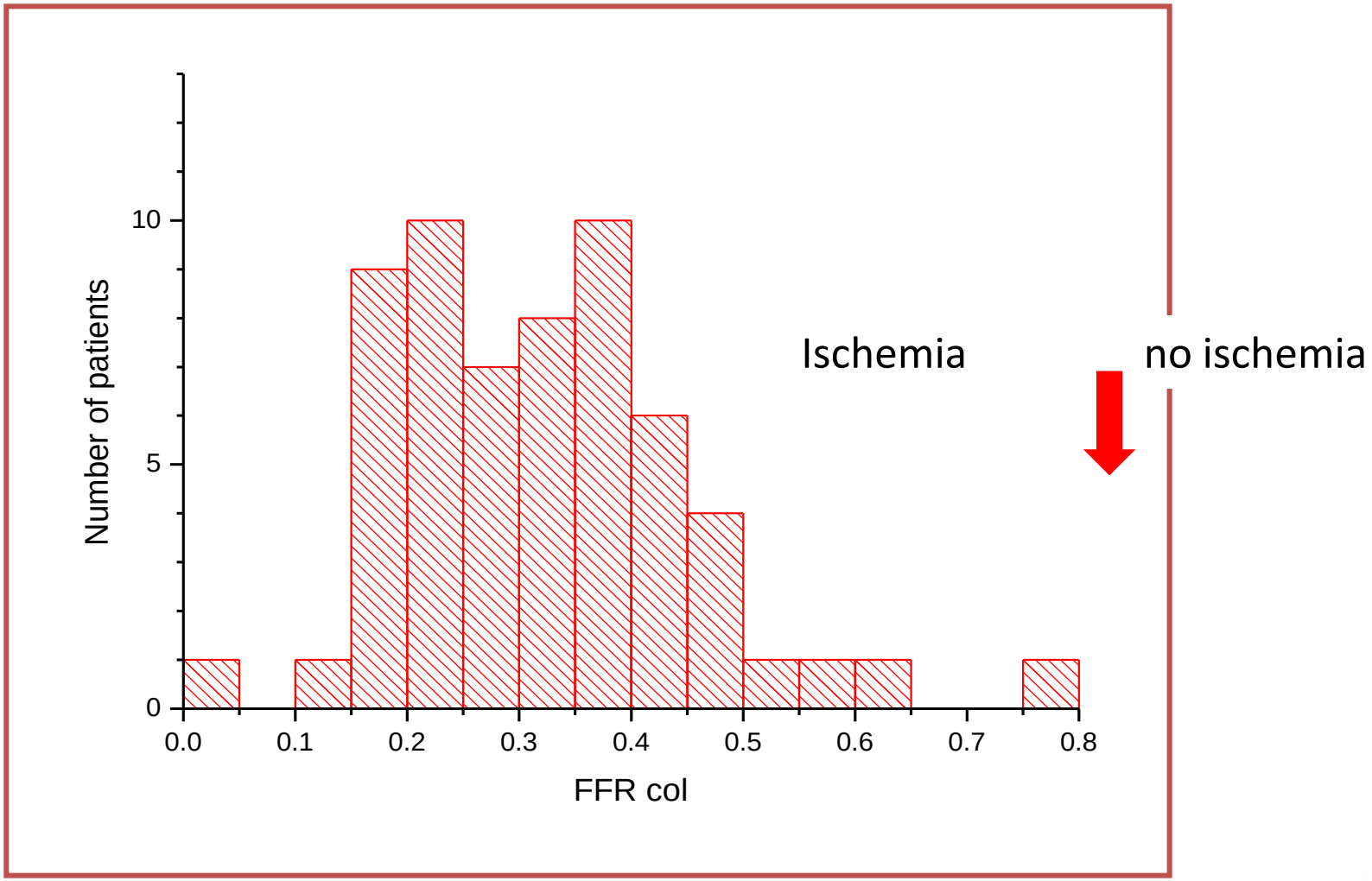
- I, Gerald S. Werner, MD, have no conflict of interest to declare with regard to the following presentation

Is a CTO harmless because there are collaterals?

- Stable symptoms in a 55 year old: limited physical ability, occasional tightness in his breast



Can collaterals prevent ischemia ?
FFR in CTOs

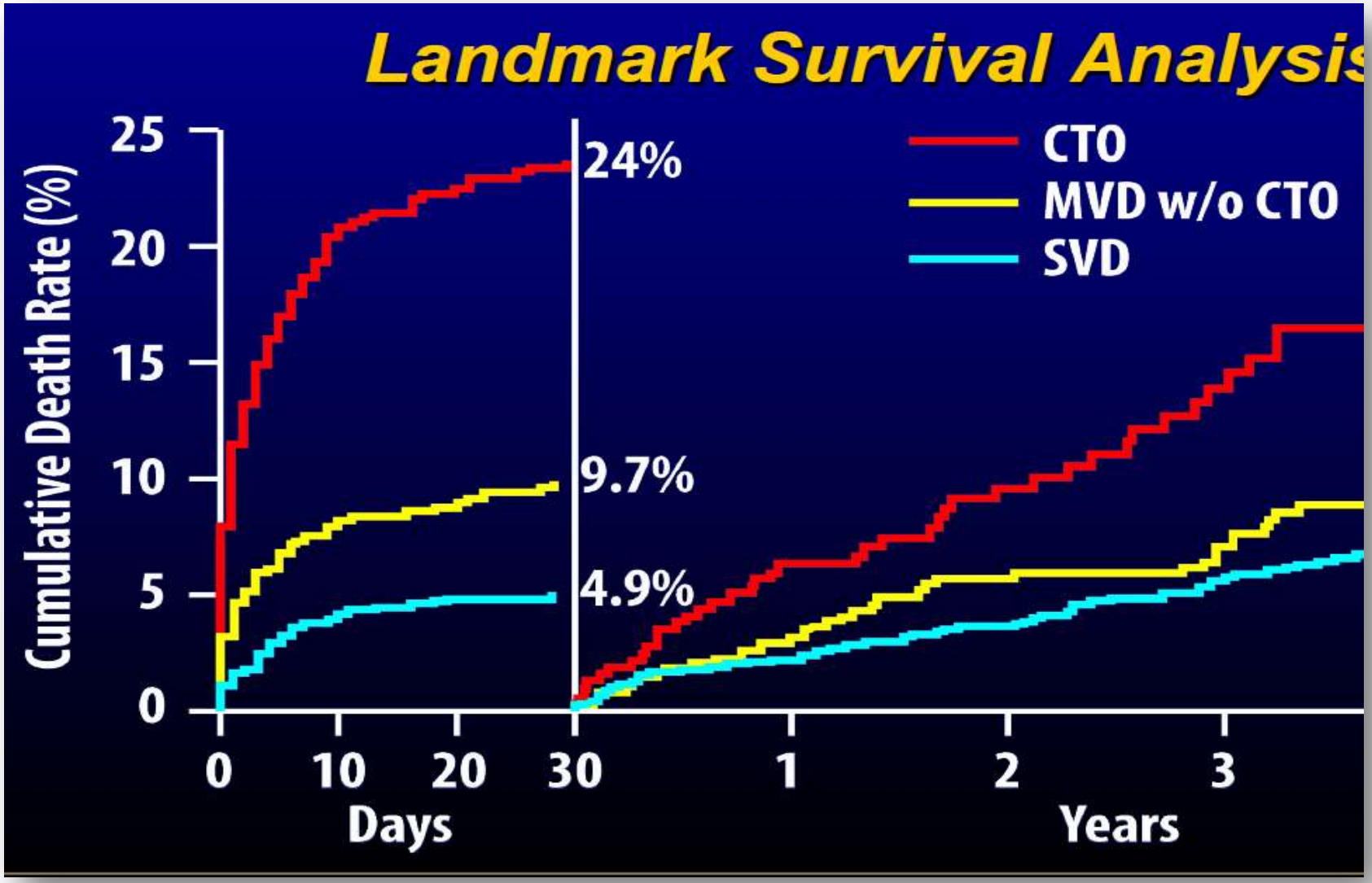


Modified from Werner et al. Eur Heart J 2006;27:2406-12

Why should we open a CTO

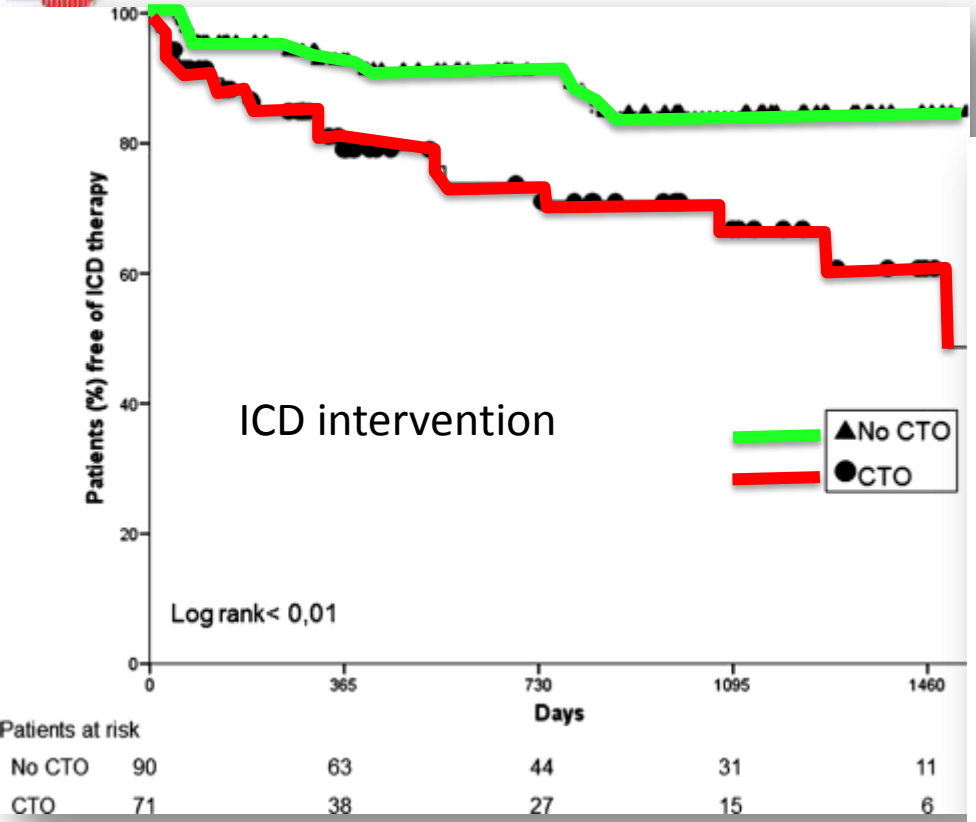
- **To improve prognosis and live longer ?!**
- **To let people lead a symptom-free and unaffected life ?!**

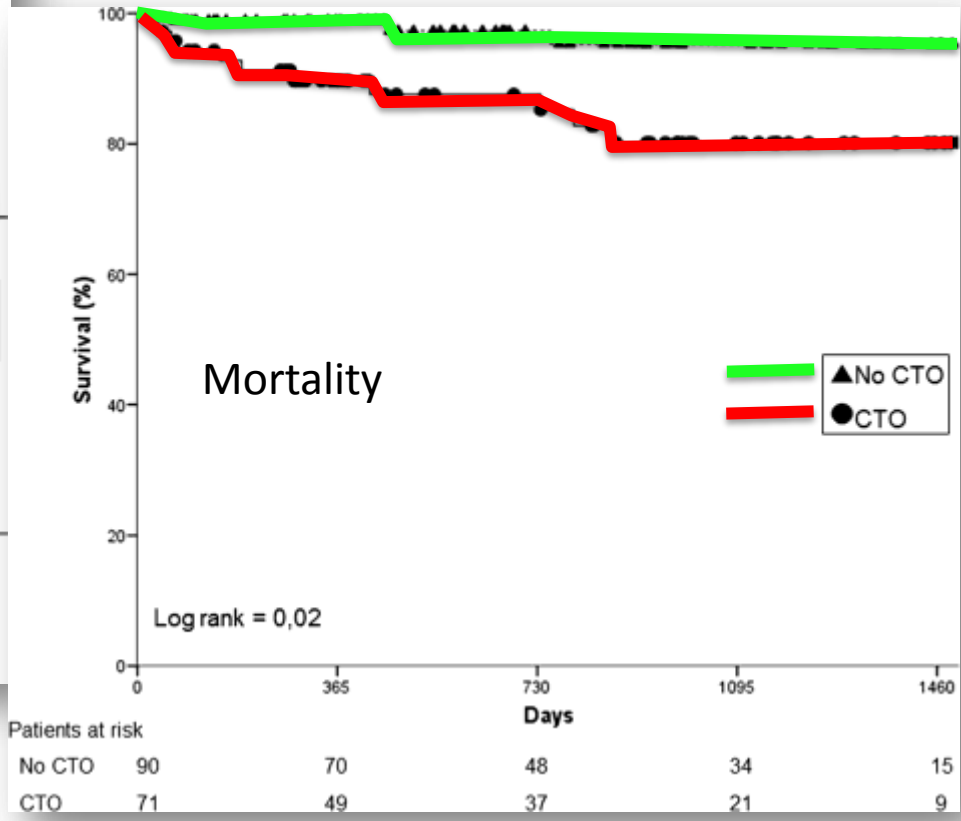
One out of four CTO patients with a future STEMI die



Claasen et al JACC Intervention 2009;2:1128

If a patient has severe LV dysfunction he is more likely to die even with an ICD





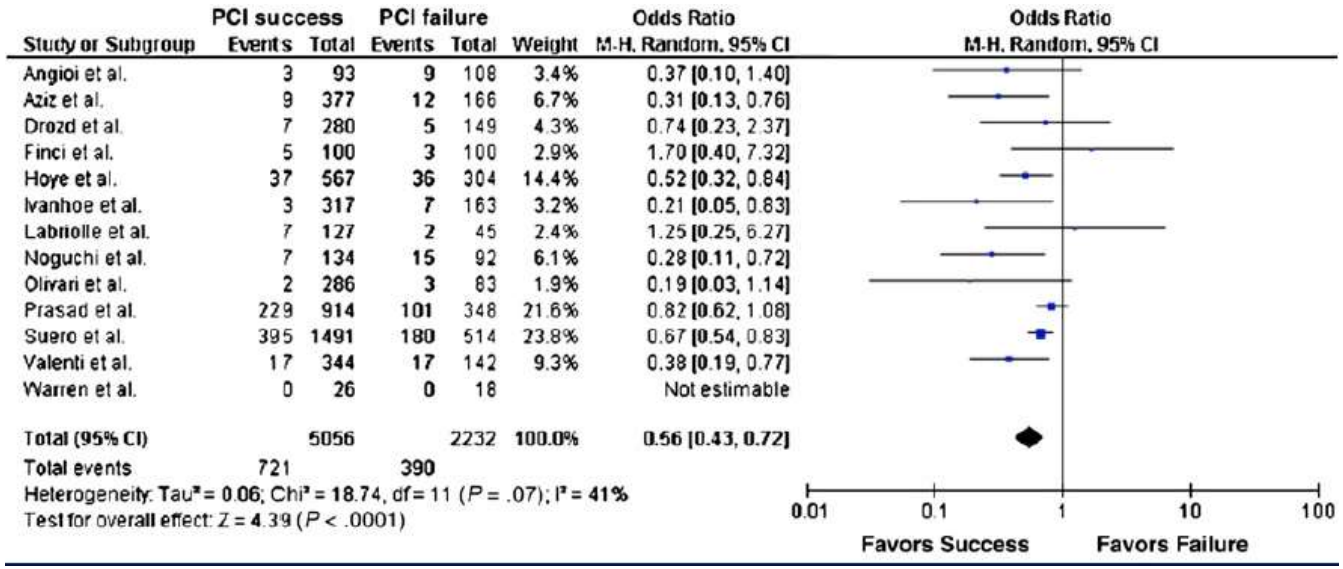
CTOs are found in 44% of pts receiving an ICD for primary prevention

Nombela –Franco L et al. Circulation: Arrythmia & Electrophysiology 2012;5:147-154

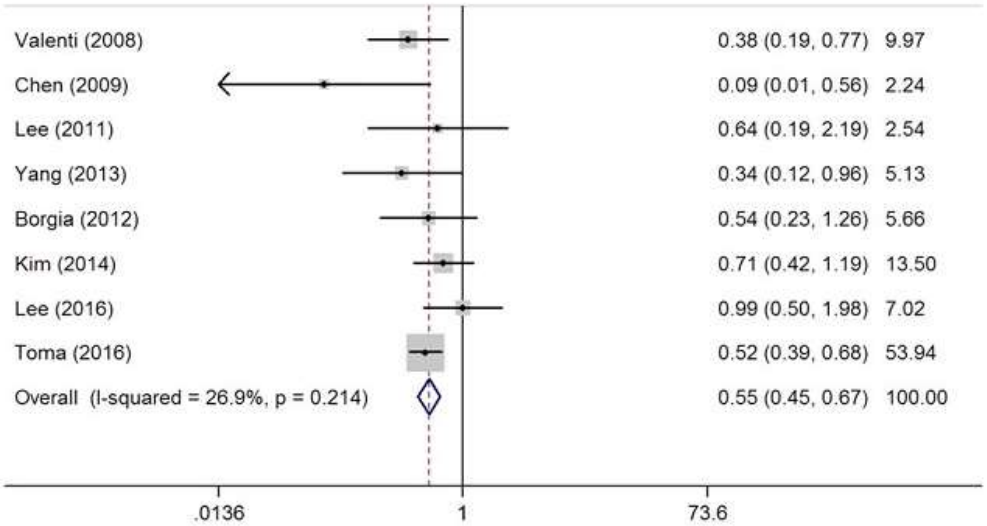
But can we change the fate with a successful PCI ?

Registries show better survival with successful CTO-PCI, but not compared to medical therapy

Classic technique



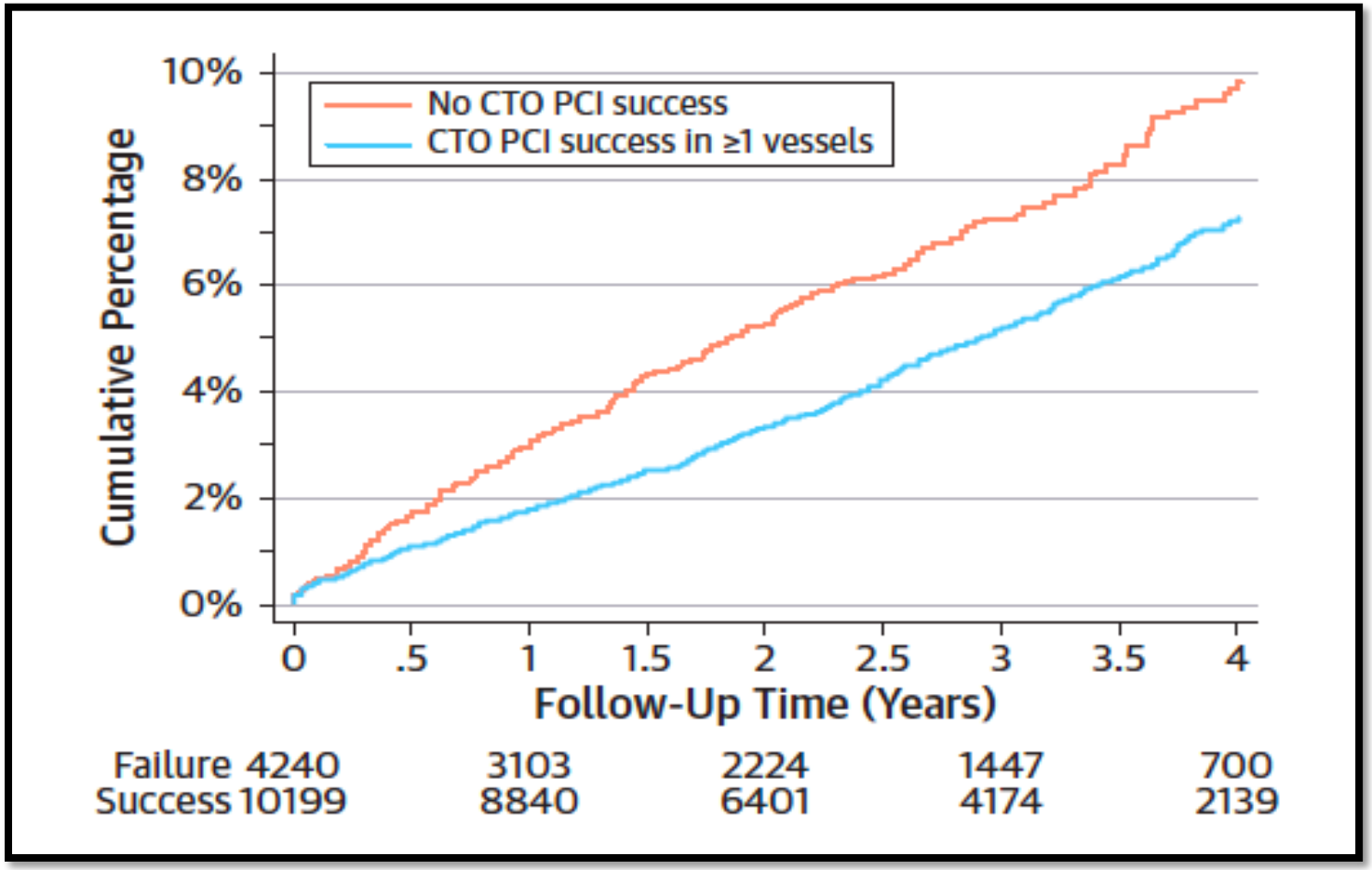
Joyal D, et al. Am Heart J. 2010; 160: 179-.-87



More recent technique

Gao L, Wang J et al, Catheterization and Cardiovascular Interventions 89:574–581 (2017)

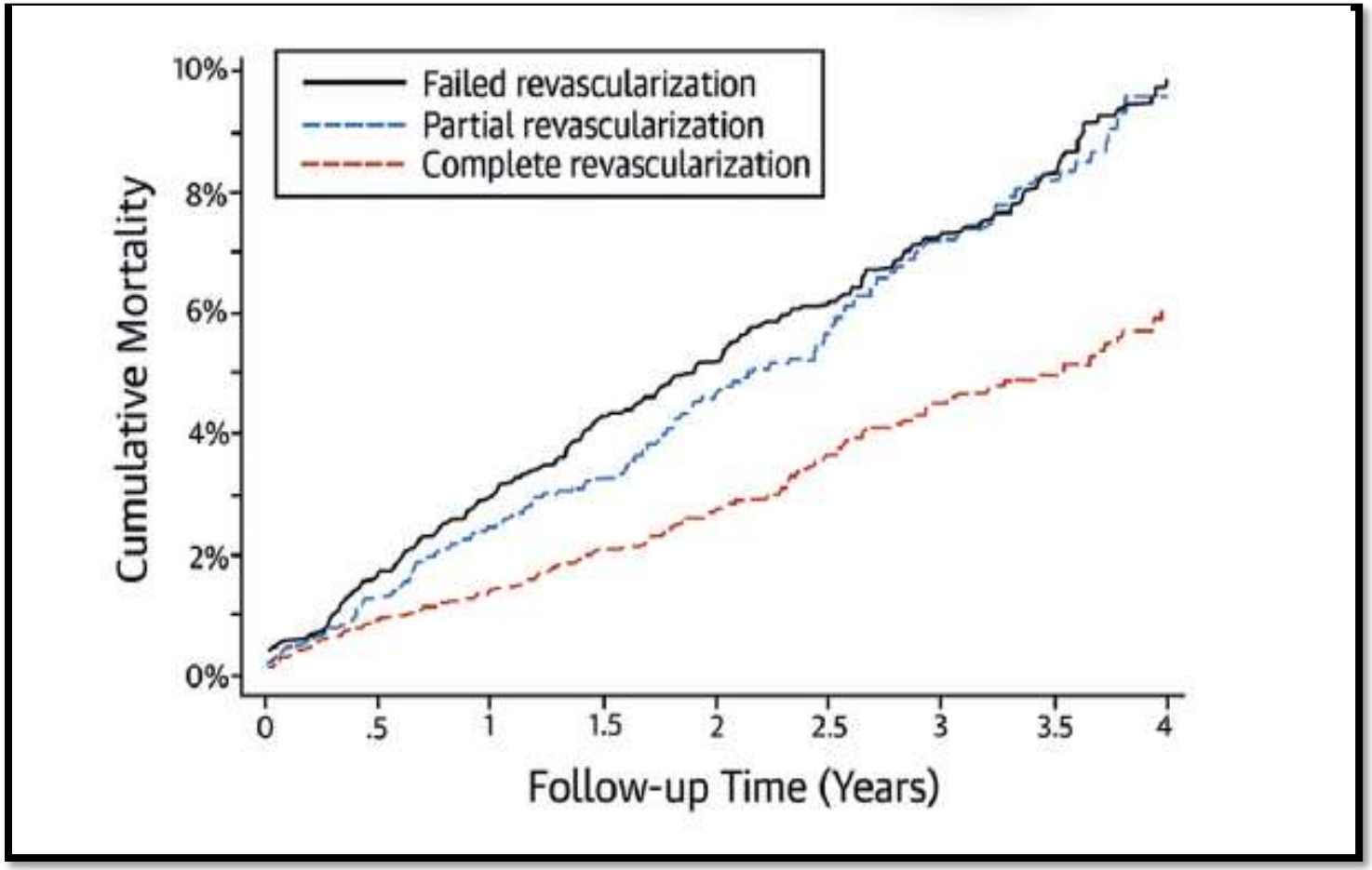
The latest from registries: successful vs unsuccessful CTO PCI



Successful PCI of at least 1 CTO was associated with improved survival
(hazard ratio [HR]: 0.72; 95% CI: 0.62 to 0.83; p < 0.001)

George S et al. *J Am Coll Cardiol.* 2014;64:235-243

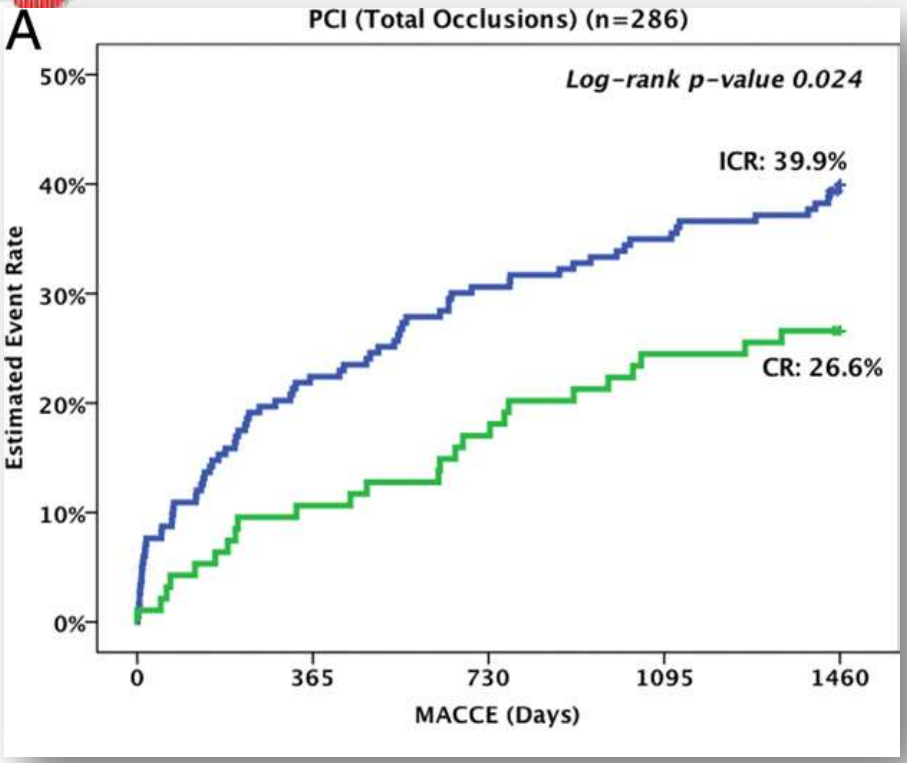
The latest from registries: successful vs unsuccessful CTO PCI



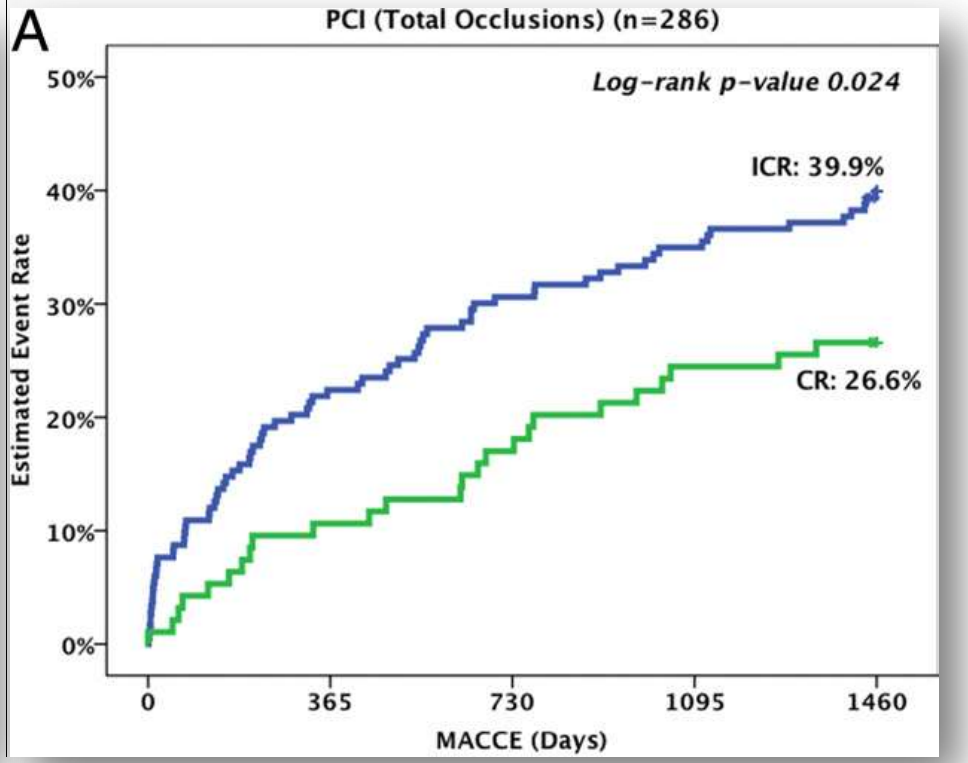
Successful PCI of at least 1 CTO was associated with improved survival
(hazard ratio [HR]: 0.72; 95% CI: 0.62 to 0.83; p < 0.001)

George S et al. *J Am Coll Cardiol.* 2014;64:235-243

Incomplete revascularization of CTO



PCI group

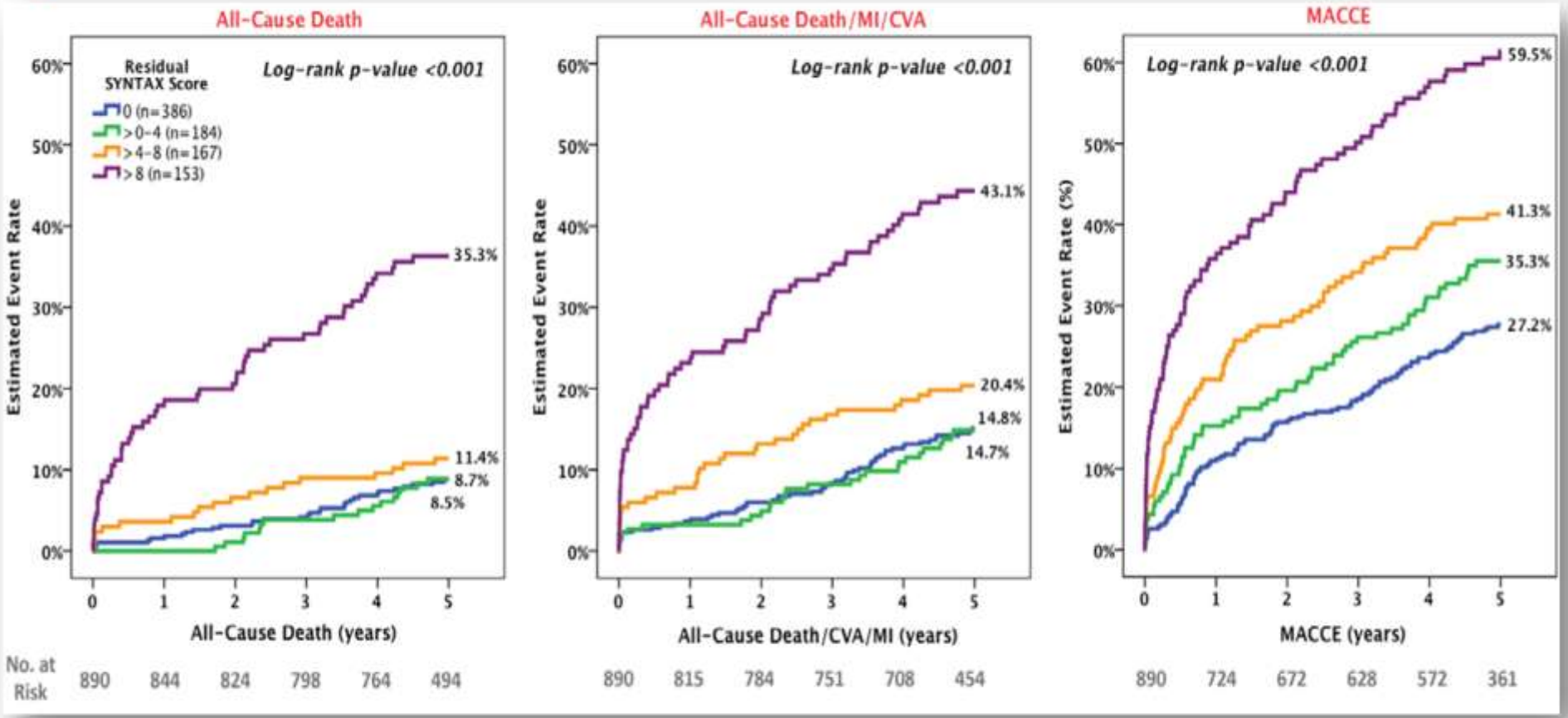


CABG group

Both RCT and registry arm of the SYNTAX trial

Farooq V et al. JACC 2013;61:282-94

rSS and outcome after PCI



Farooq V et al. Circulation 2013;128:141-51

Why should we open a CTO

- To improve prognosis and live longer ?!
- **To let people lead a symptom-free and unaffected life is the highest goal of any medical discipline ?!**

What would a medical approach achieve ?

EURO CTO CLUB

Table 2 Angina Frequency and Nitroglycerin Use (CARISA)

		Placebo	Ranexa 750 mg*	Ranexa 1000 mg*
Angina Frequency (attacks/week)	N	258	272	261
	Mean	3.3	2.5	2.1
	p-value vs placebo	—	*0.006*	*< 0.001*
Nitroglycerin Use (doses/week	N	252	262	244
				1.8
				< 0.001

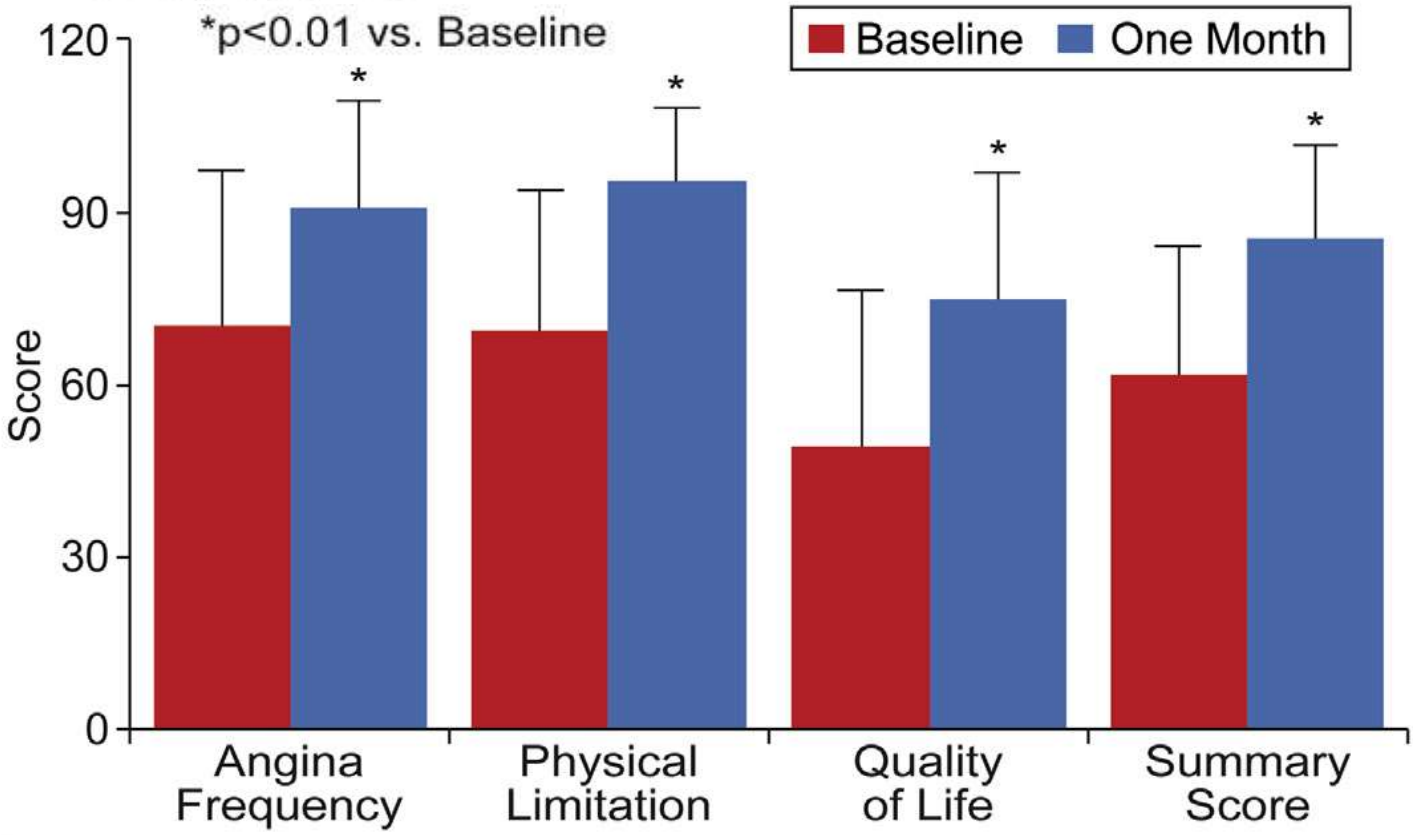
* Twice daily

Antianginal medication: Betablocker, Nitrates, Ca-Antagonists are not without side effects

And medication needs to go on forever....

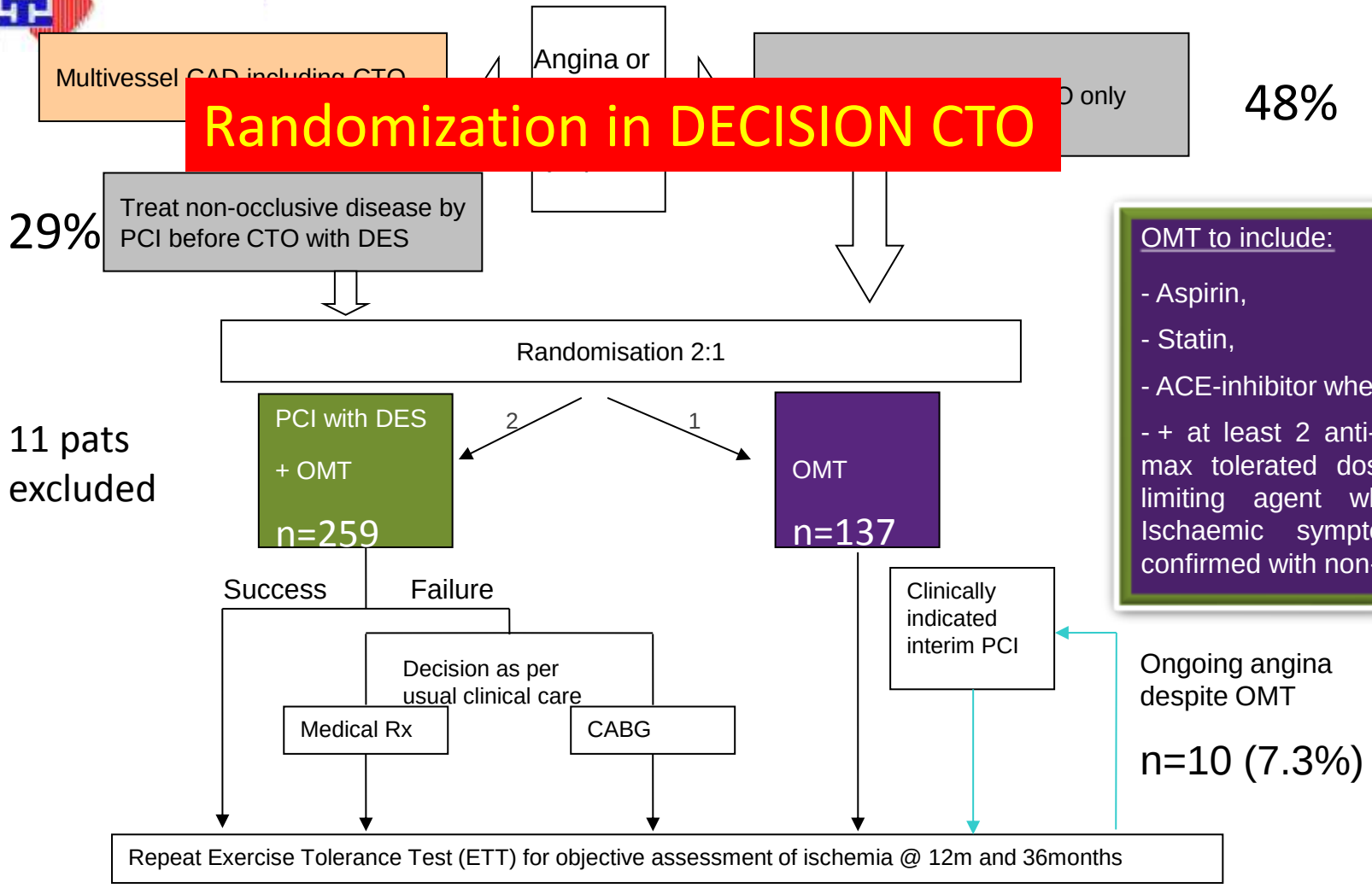
Quality of life-OPEN CTO registry

Seattle Angina Questionnaire



Sapontis J, …. Grantham J Am Coll Cardiol Intv 2017;10:1523–34

EURO-CTO Trial: Study flow chart

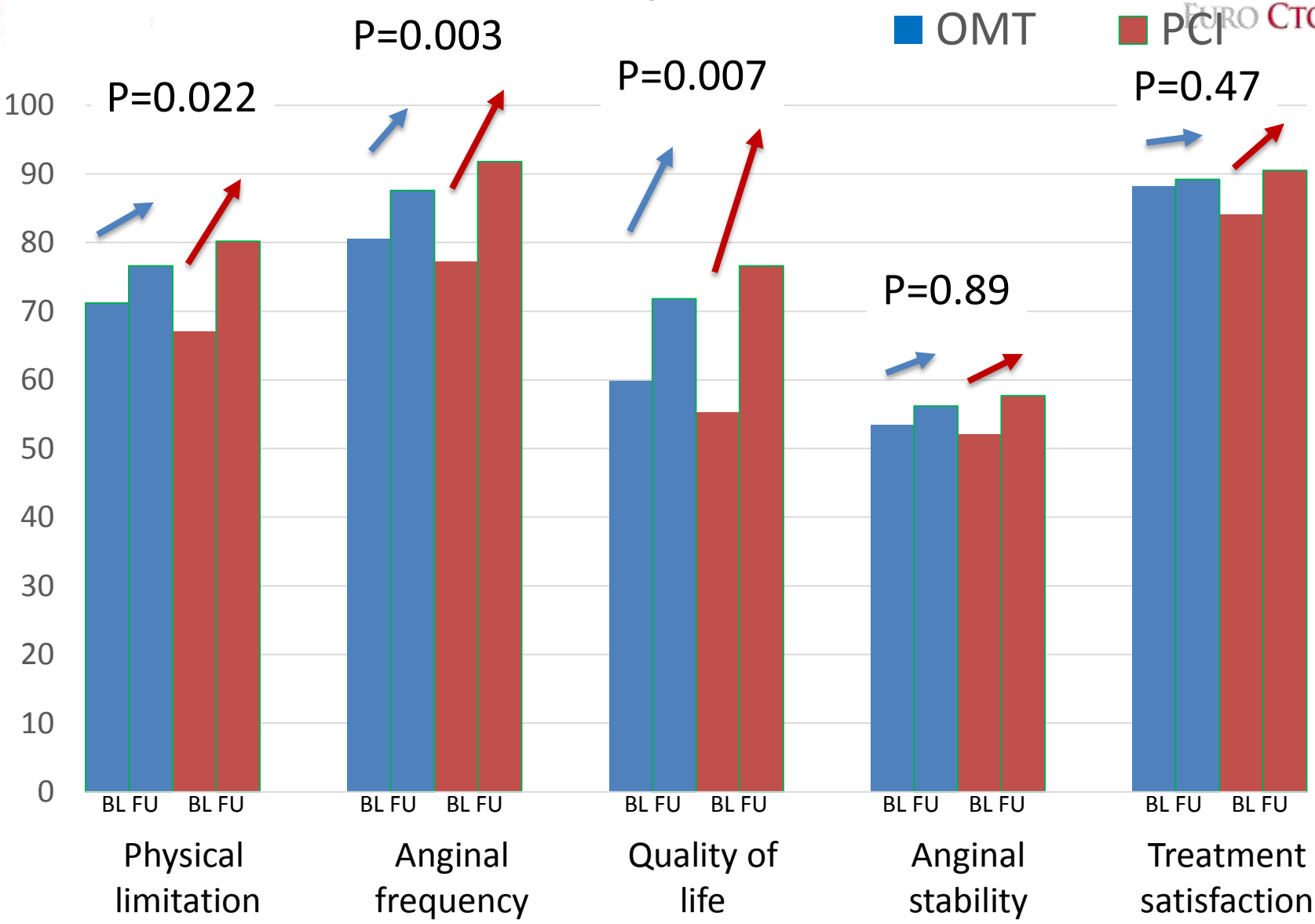


OMT to include:

- Aspirin,
- Statin,
- ACE-inhibitor where tolerated
- + at least 2 anti-anginal agents at max tolerated dose including rate-limiting agent where appropriate. Ischaemic symptoms should be confirmed with non-invasive test.

Efficacy: Health status @ 12 and 36 months
Safety: Death, non-fatal myocardial infarction (ITT, PP) @ 36 months

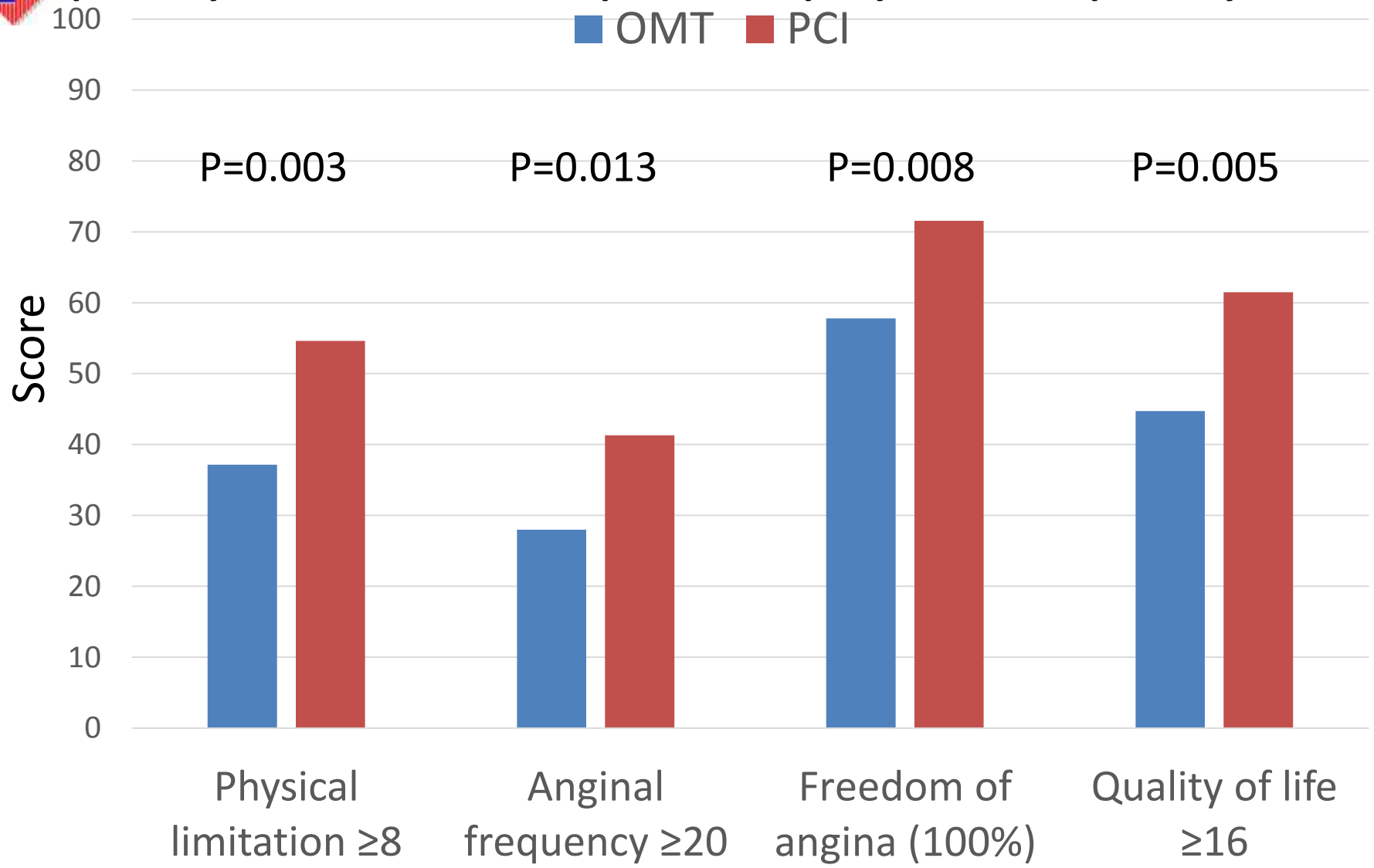
Primary Endpoint reached (ITT)



For multiple testing the significance level is 0.01

Eur Heart J 2018 in press

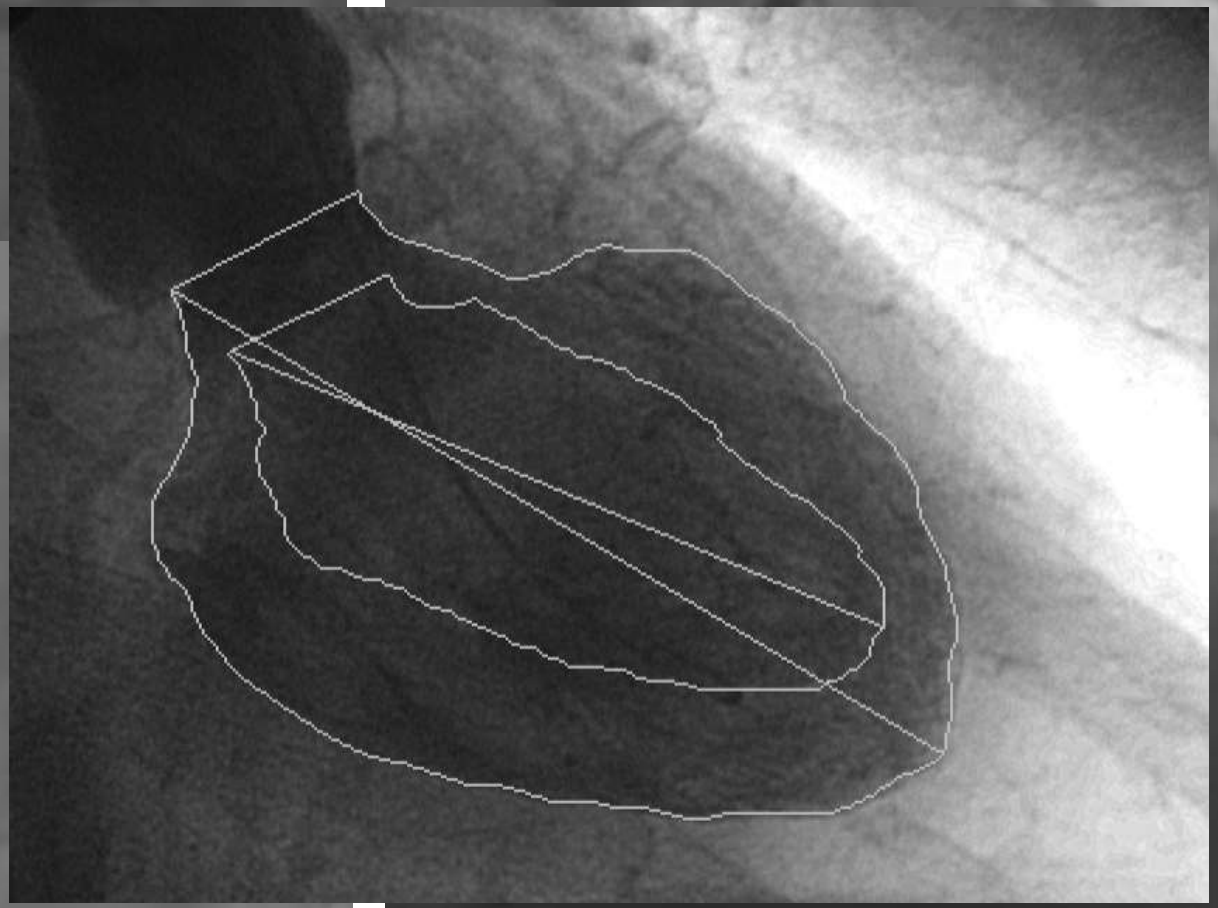
More patients were free of angina, had better quality of life and improved physical capacity



*) Spertus et al. JACC 1995;25:333-41

Eur Heart J 2018 in press

The “asymptomatic” patient



Patient with no angina

	Baseline
Maximum exercise	**125** W
Maximum heart rate	**80** bpm
Maximum oxygen uptake	**20.8** ml/min/kg

Exercise capacity improves after CTO PCI

TABLE 1 Changes of Parameters of CPET Before and at Midterm Follow-Up After Successful CTO-PCI

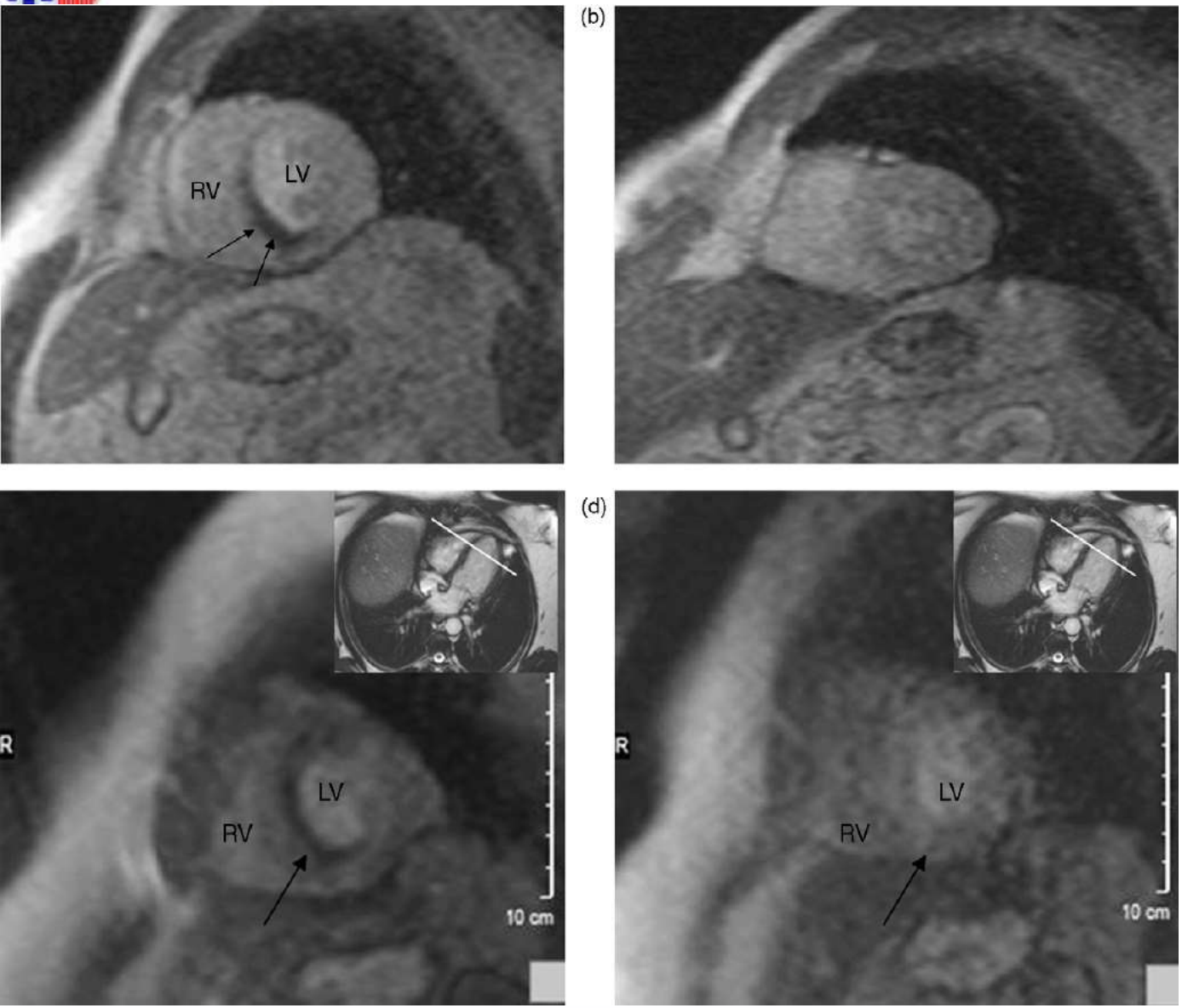
Parameter	Baseline	Change From Baseline to 7 Months		p Value
		Absolute	Change in % (95% Confidence Interval)	
Cardiopulmonary exercise testing				
V'_{O_2}max, ml/min	1,458.06 ± 449.99	1,629.34 ± 487.09	12.25 (8.32-16.18)	0.001
V_{O_2}max, ml/min/kg	16.59 ± 5.10	18.42 ± 5.25	12.40 (8.53-16.28)	0.001
Work rate, W	106.36 ± 37.95	117.54 ± 41.47	13.62 (6.25-20.99)	0.001
Anaerobic threshold, ml/min	1,009.78 ± 329.69	1,267.3 ± 417.34	27.87 (20.19-35.55)	0.001
O2-pulse, ml/beat	12.65 ± 3.14	13.56 ± 3.29	8.75 (3.83-13.66)	0.003
Maximal exercise ventilation, l/min	57.90 ± 20.52	60.15 ± 18.19	6.12 (1.86-14.11)	0.204
Echocardiography				
Ejection fraction, %	52.08 ± 12.57	54.48 ± 11.15	6.79 (2.18-11.40)	0.007
Symptoms				
NYHA functional class	2.26 ± 0.10	1.56 ± 0.10	-	0.0001
CCS	1.88 ± 0.12	1.14 ± 0.08	-	0.0001

Values are mean ± SEM unless otherwise indicated.

CCS = Canadian Cardiovascular Society; CPET = cardiopulmonary exercise testing; CTO-PCI = chronic total occlusion percutaneous coronary intervention; NYHA = New York Heart Association; V_{O_2}max = peak oxygen consumption; V'_{O_2}max = maximal oxygen consumption.

Mashayekhi et al. JACC 2017;69:1095-6

Reversal of perfusion defects after CTO Rx

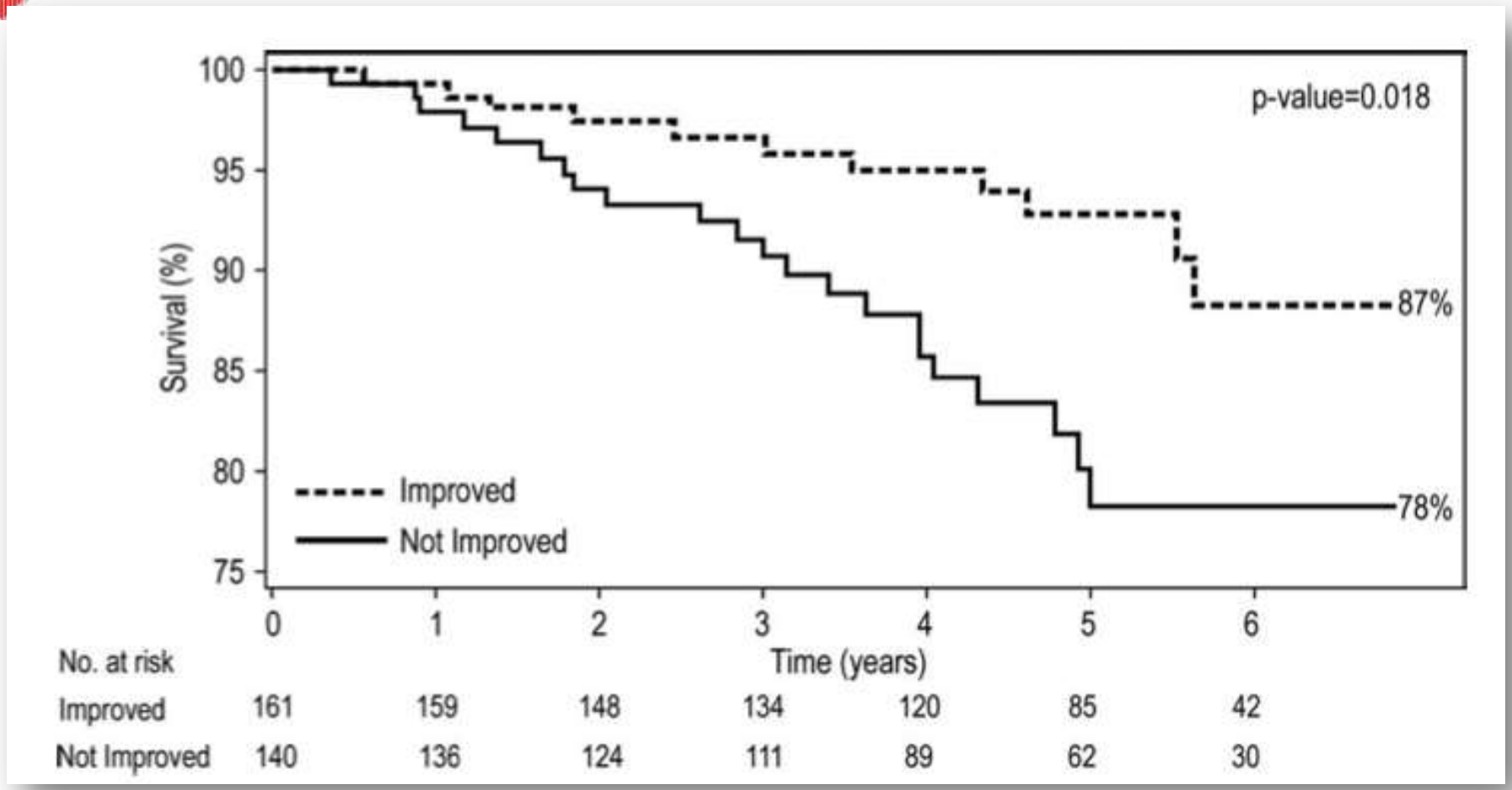


RCA CTO
LAD 90%

LAD CTO

Heyne …. Werner et al. Eur J Radiol 2007;63:384-90

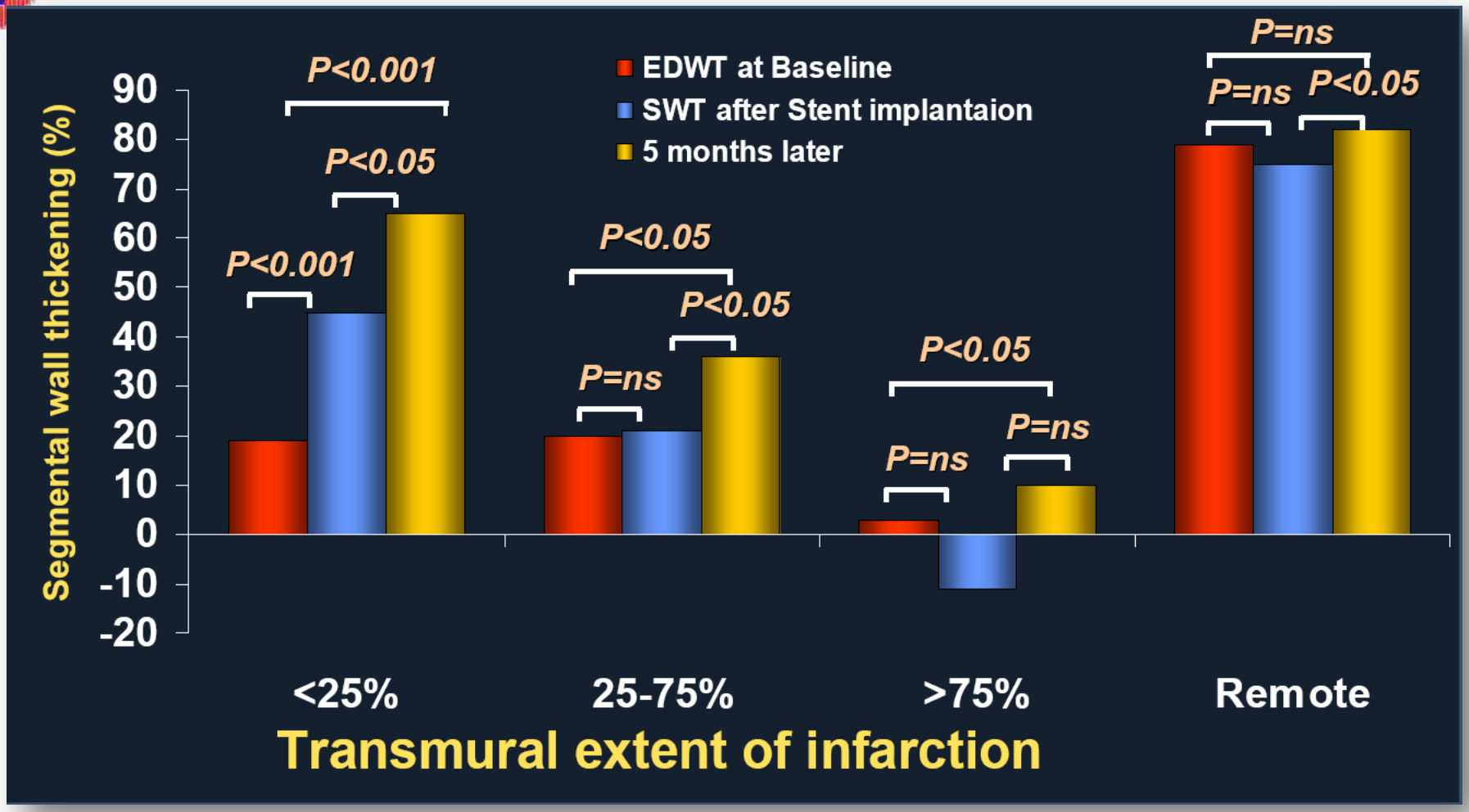
Patient selection based on ischemic burden



Select patients with <6% ischemic burden to prevent worsening, and >12%, to achieve certain benefit

Safley DM et al. CCI 2011; 78: 337-43

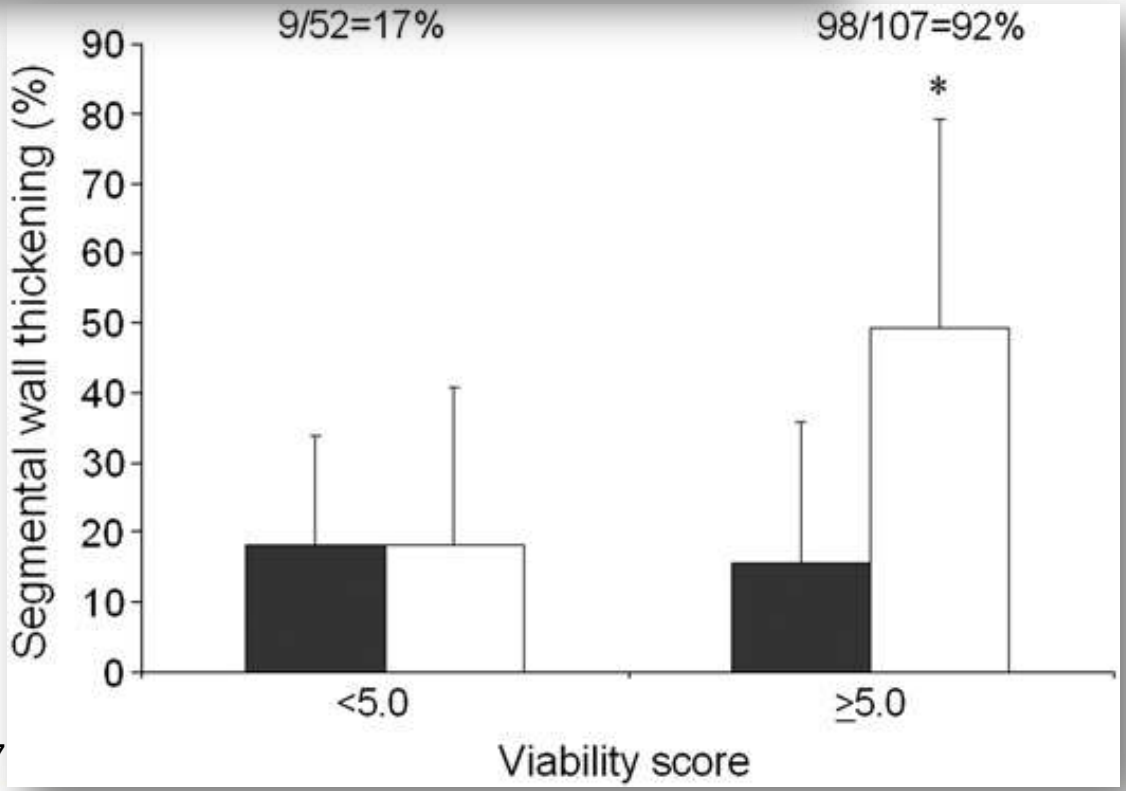
Recovery of LV function according to MRI



Kirschbaum et al. Am J Cardiol 2008;101:179

Predicting LV recovery in CTOs

LDD (>7%)	4	46(17–123)
TEI (<50%)	2	8(4–18)
EDWT (>6 mm)	1	4(2–10)
Unenhanced rim thickness (>3 mm)	3	15(6–42)
SWTUR (<45%)	1	4(2–8)



Kirschbaum et al. Int J Cardiol 2012; 159:192-7

The question is when not to open a CTO?

- CTO post MI without viable myocardium
- CTO in a small territory of ischemia without related symptoms
- CTO in a patient with severe comorbidity and limited life expectancy