The case against CTO-PCI

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Director, Structural heart interventions

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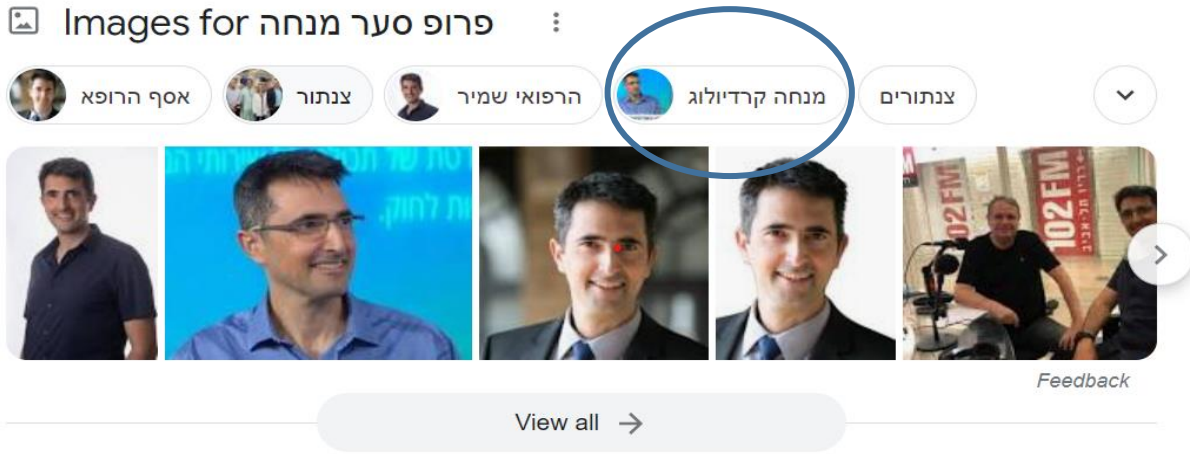
Disclosures

- I may (or may not) believe everything I say today
- Everything I say will be the truth

Know your enemy

- Prof Saar Mincha
- Professor of Cardiology
- Professional charmer
- Terribly good looking
- Cross country runner
- All round “celeb”

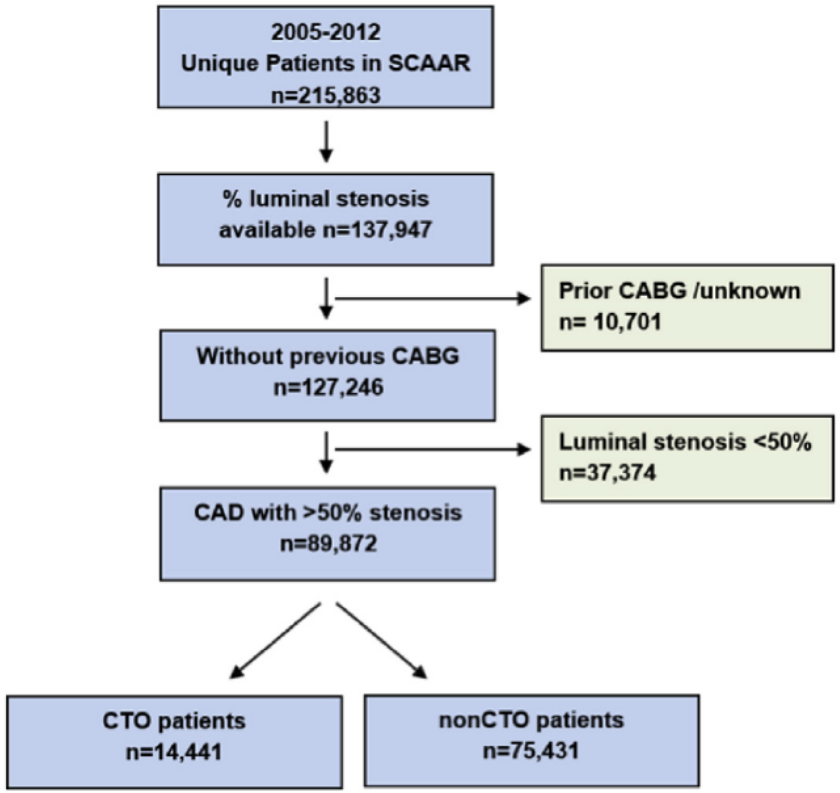


What Prof. Mincha will tell you 3 things:

- CTO is associated with adverse outcomes
- CTO-PCI:
  - Reduces angina severity
  - Increases QOL
  - Relieves ischemia
  - Improves LV function
  - Improves survival
- Is underutilized

SCAAR Registry

FIGURE 1 Flowchart for Patient Inclusion



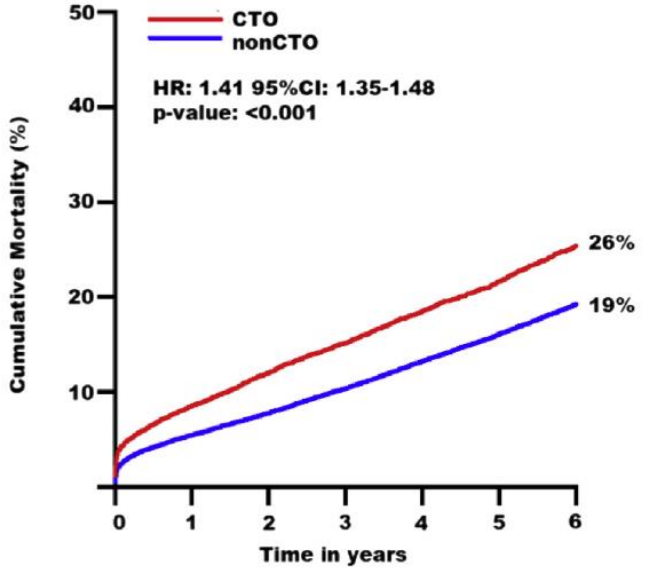
CABG = coronary artery bypass grafting; CAD = coronary artery disease; CTO = chronic total occlusion; SCAAR = Swedish Coronary Angiography and Angioplasty Registry.

TABLE 1 Baseline Characteristics of Patients With and Those Without Chronic Total Occlusion

	CTO		Non-CTO		
	(n = 14,441)	Missing	(n = 75,431)	Missing	p Value
Male	77.7	0	70.7	0	<0.01
Age, yrs	68 (61-76)	289 (0.02%)	68 (60-75)	150 (0.2%)	<0.01
Age, yrs					<0.01
0-59	21.7		24.3		
60-79	63.7		62.1		
≥80	14.6		13.6		
Diabetes	23.7	144 (1%)	18.4	603 (0.8%)	<0.01
Hypertension	60.4	361 (2.5%)	51.4	1,509 (2%)	<0.01
Hyperlipidemia	60.2	404 (2.8%)	43.3	1,886 (2.5%)	<0.01
Smoking status		838 (5.8%)		4,149 (5.8%)	<0.01
Current	18.8		20.5		
Previous	37.6		33.1		
Previous MI	35.5	549 (3.8%)	16.1	1,735 (2.3%)	<0.01
Previous PCI	17.4	12 (0.08%)	10.6	38 (0.05%)	<0.01
Indication		0		0	<0.01
Stable CAD	44.6		17.1		
Unstable CAD*	26.4		49.7		
STEMI	15.1		26.0		
Other	14.0		7.2		
Extent of CAD		3 (0.02%)		53 (0.07%)	<0.01
1-vessel	17.4		48.6		
2-vessel	35.1		26.0		
3-vessel	38.3		17.2		
Left main†	9.2		8.2		
Puncture site		4 (0.03%)		15 (0.02%)	<0.01
Femoral	46.7		48.8		
Radial	53.3		51.2		
Any complication	3.9	0	4.2	8 (0.01%)	0.14
Primary decision		4 (0.03%)		8 (0.01%)	<0.01
Conservative	15.9		12.0		
PCI	62.3		72.3		
CABG surgery	21.9		15.9		
CTO vessel		0		0	
RCA	42.1		NA		
LAD	23.4		NA		
LCx	21.1		NA		
Multiple vessels	13.5		NA		
CTO location		0		0	
Proximal	64.2				
Distal	35.8				

Outcome

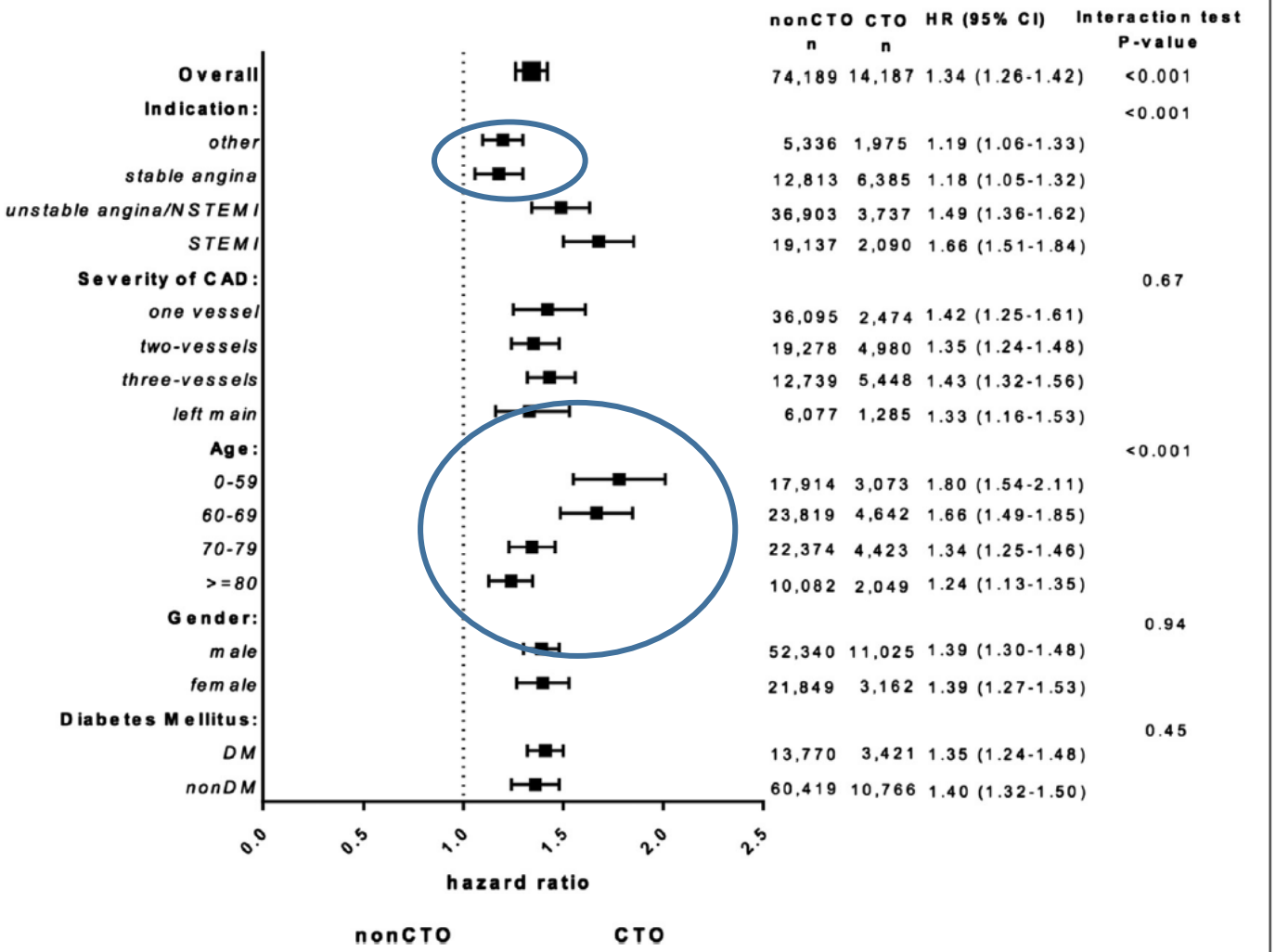
FIGURE 2 Crude Kaplan-Meier Curves for Long-Term Mortality in Patients With and Those Without Chronic Total Occlusion in the Swedish Coronary Angiography and Angioplasty Registry

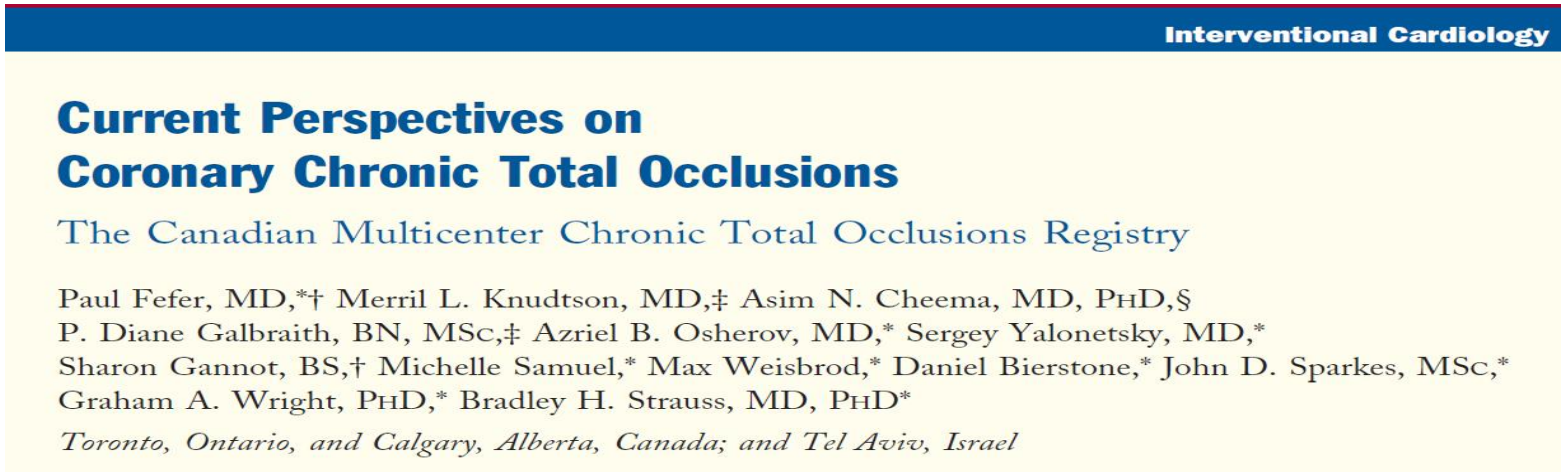


Number at Risk	0	1	2	3	4	5	6
CTO	14,269	11,009	9,015	7,163	5,447	3,797	1,773
non CTO	74,373	58,408	47,639	37,365	28,218	19,270	9,204

CI = confidence interval; CTO = chronic total occlusion; HR = hazard ratio.

FIGURE 6 Forest Plot Showing Interactions Between Chronic Total Occlusion and Different Patient Characteristics





Interventional Cardiology

Current Perspectives on Coronary Chronic Total Occlusions

The Canadian Multicenter Chronic Total Occlusions Registry

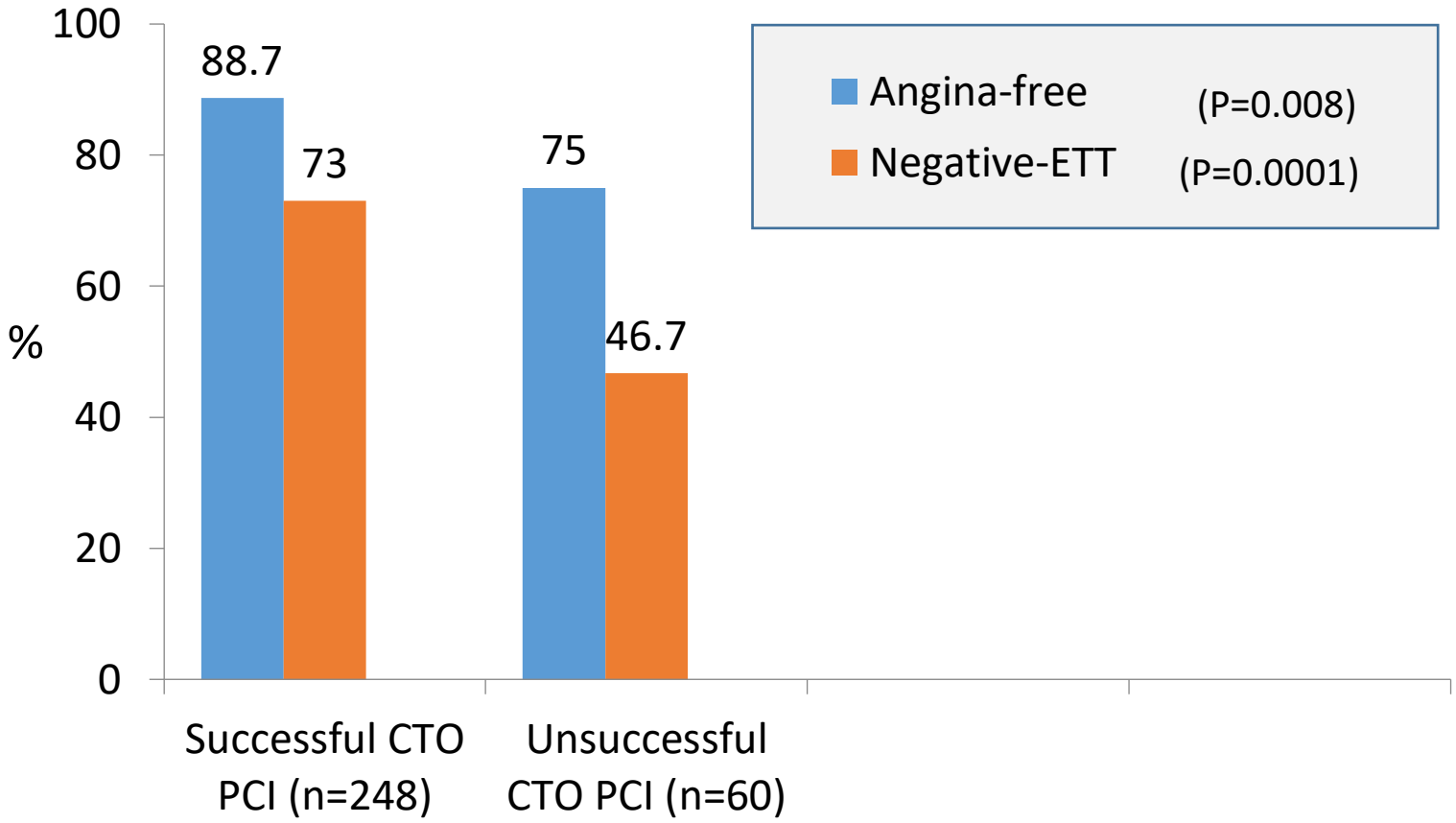
Paul Fefer, MD,*† Merril L. Knudtson, MD,‡ Asim N. Cheema, MD, PhD,§
P. Diane Galbraith, BN, MSc,‡ Azriel B. Osherov, MD,* Sergey Yalonetsky, MD,*
Sharon Gannot, BS,† Michelle Samuel,* Max Weisbrod,* Daniel Bierstone,* John D. Sparkes, MSc,*
Graham A. Wright, PhD,* Bradley H. Strauss, MD, PhD*

Toronto, Ontario, and Calgary, Alberta, Canada; and Tel Aviv, Israel

- 1,697 CAD patients in Canadian Multicenter CTO Registry who had at least 1 CTO identified during diagnostic angiography, 4.2008-7.2009
  - Prevalence of CTO in CAD patients undergoing CA was 18.4%
  - Almost all patients were symptomatic, and the majority had well preserved LV function
  - Nonetheless, only 10% had attempted PCI (with 70% success) and 23% underwent CABG.

Fefer P, Strauss BH, et al. JACC 2012:991

Multicenter CTO Prospective Observational Registry in Italy: TOAST-GISE



Olivari Z, Rubartelli P, et al; TOAST-GISE Investigators JACC 2003;41:1672

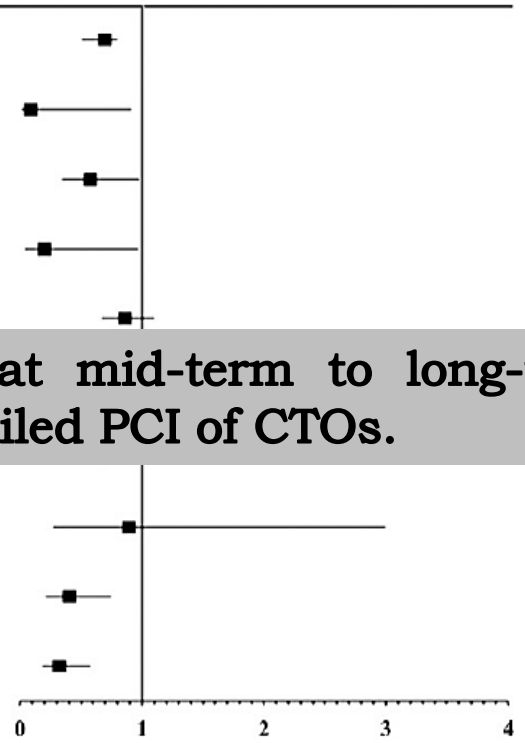
Results of Early Health Status Benefits of Successful CTO Recanalization

- **The FACTOR trial assessed 125 patients, 64 (55%) had procedural success.**
- **Successful CTO was independently associated with:**
  - Angina relief
  - Improved physical function
  - Enhanced QOL
  - Clinical benefit was evident only among symptomatic pts

Grantham JA, et al; Circ Cardiovasc Qual Outcomes 2010;3:284-90

CTO Meta-Analysis (I)

Author (Enrolment period)	Patients N	Cumulative Follow-up	Stent used (%)	Survival rates in successful vs. failed
Suero et al.[6] (1980-1999)	2005	10-yr	BMS (7.0)	73.5% vs. 65%, $P = .001$
Olivari et al.[7*] 1999-2000	369	1-yr	BMS (89.7)	99.7% vs. 96.4%, $P = .04$
Hoye et al.[8] 1992-2002	871	5-yr	BMS (81.0)	93.5% vs. 88.0%, $P = .02$
Aziz et al.[9] 2000-2004	543	2-yr	BMS (97.7)	98.0% vs. 94.2%, $P = .05$
Prasad et al.[10]	1262	10-yr	DES (29)	72% vs. 77%, $P = .03$
2003-2006				
Lee et al.[20] 2003-2006	333	3-yr	DES (100)	96.7 vs. 94.7%, $P = .28$
Mehran et al.[19°] 1998-2007	1791	5-yr	BMS (34.0) DES (66.0)	97.0% vs. 94.2%, $P < .01$
Jones et al.[18] 2003-2010	836	5-yr	DES (76.1)	95.5% vs. 82.8%

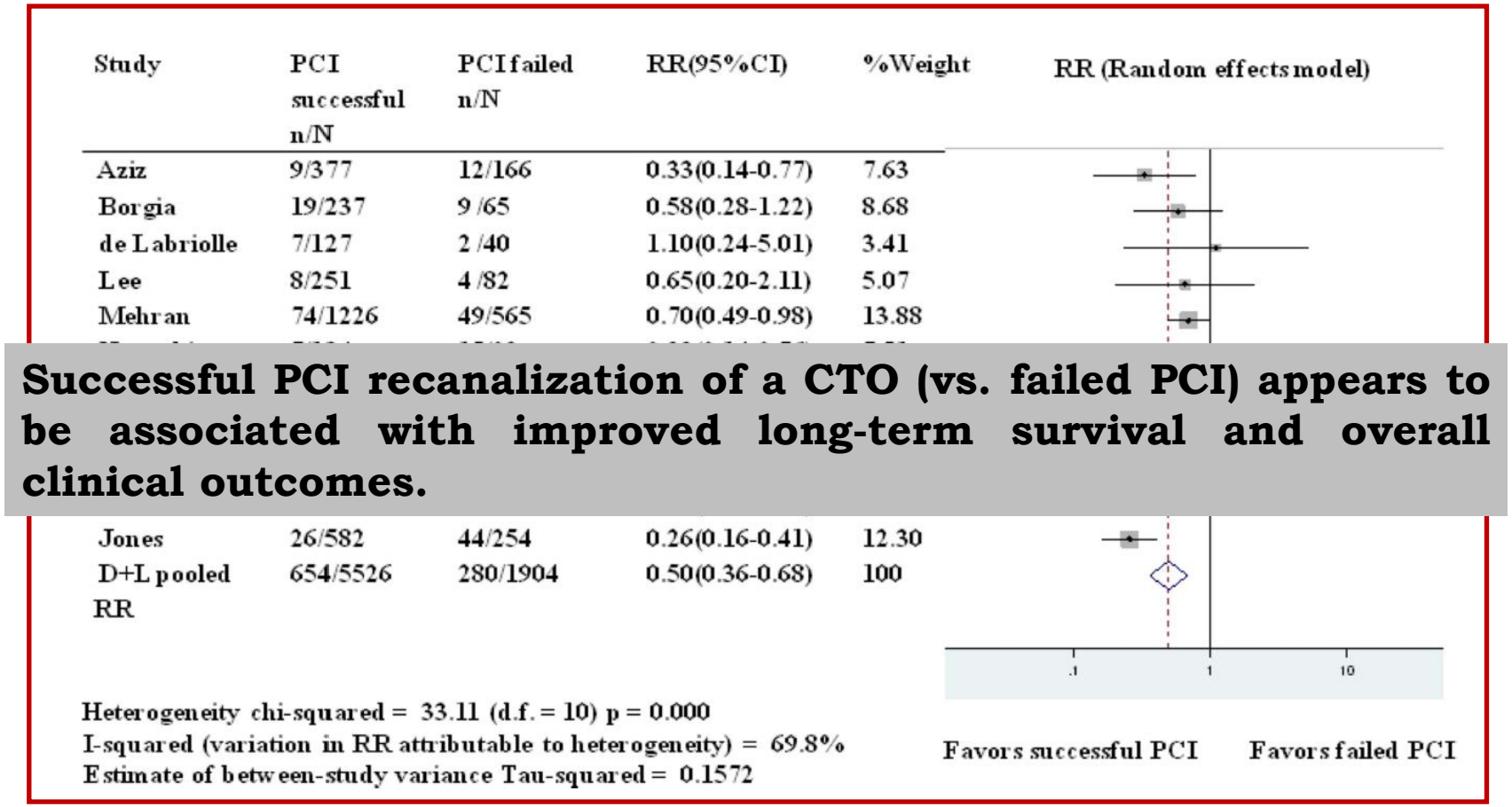


Higher rates of survival were observed at mid-term to long-term follow-up after successful compared with failed PCI of CTOs.

Long-term survival rates and relative risk estimates of successful vs failed CTOs PCI in observational studies, including patients treated with stents. In the graph, black squares represent hazard ratios (except for one study in which odds ratio is represented), and bars indicate 95% CI. *Unadjusted hazard ratio. °Cardiac survival. §Odds ratio. HR, hazard ratios.

Tamburino C, et al. Am Heart J. 2013;165:133

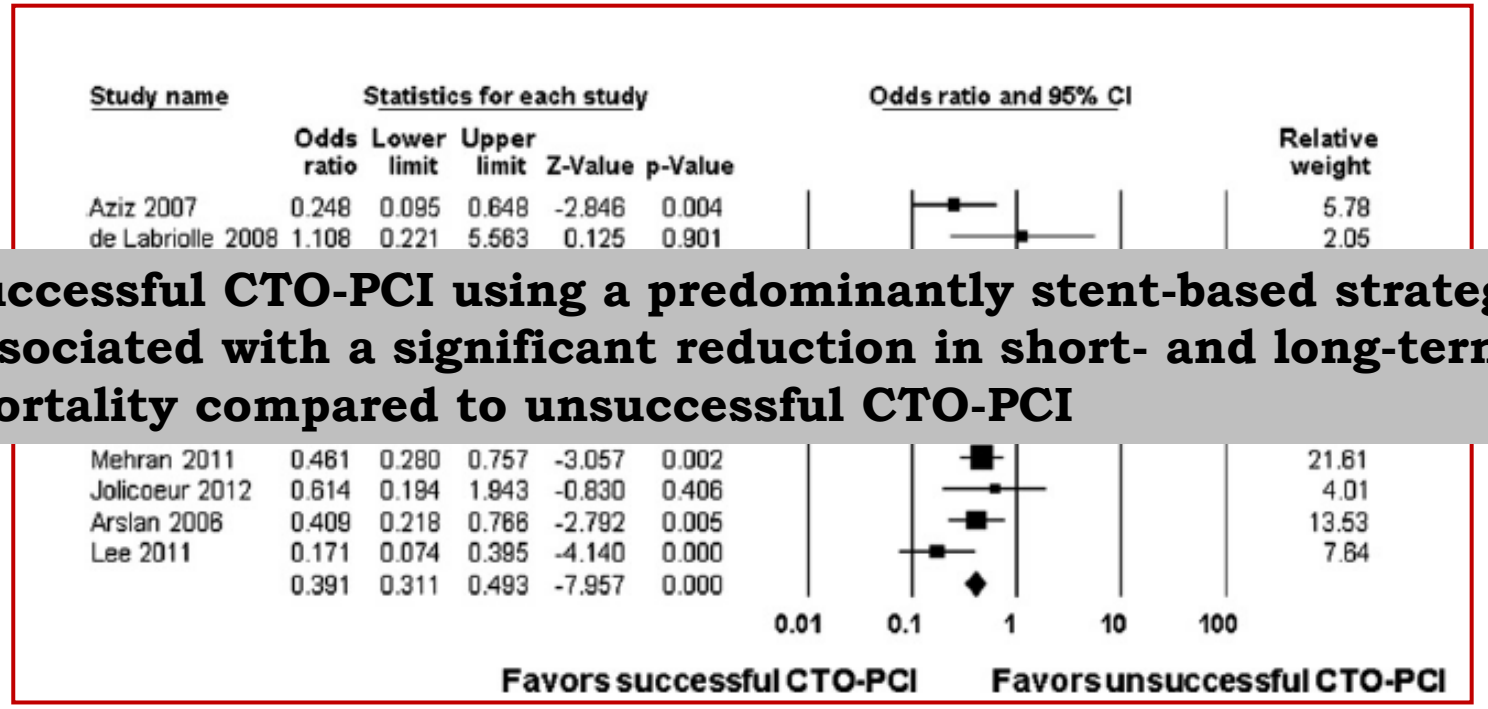
CTO Meta-Analysis (II)



Successful PCI recanalization of a CTO (vs. failed PCI) appears to be associated with improved long-term survival and overall clinical outcomes.

Khan MF, et al. CCI:2013;82:95

CTO Meta-Analysis (III)



Successful CTO-PCI using a predominantly stent-based strategy is associated with a significant reduction in short- and long-term mortality compared to unsuccessful CTO-PCI

Pancholy SB, et al. Am J Cardiol 2013;111:521

Claim #1:

- CTO is a form of stable coronary disease

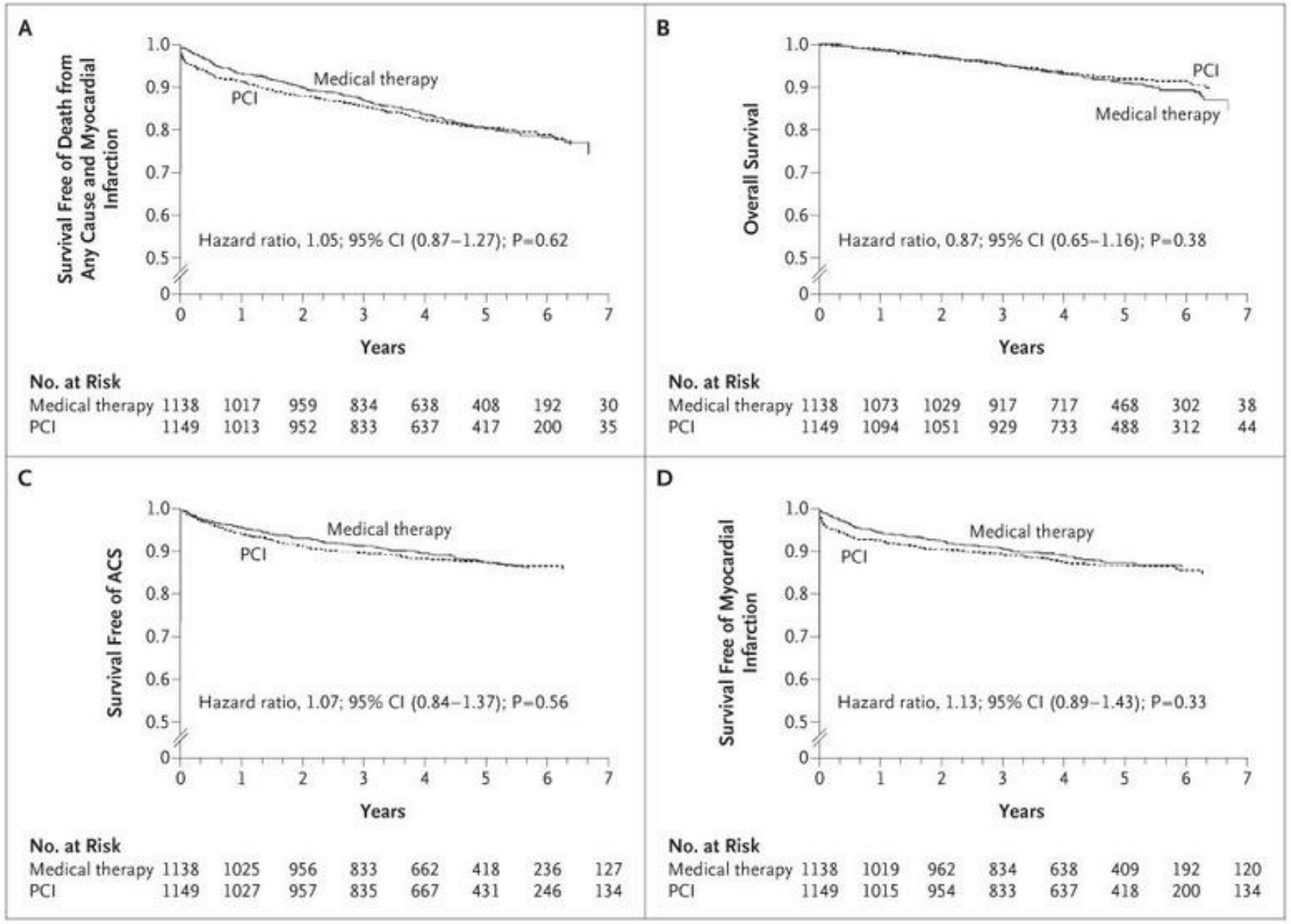
COURAGE Trial

Patients Enrolled: 2,287
Mean Follow-Up: Median, 4.6 years (range 2.5-7.0 years); and 15 years
Mean Patient Age: 62 years
Female: 15%

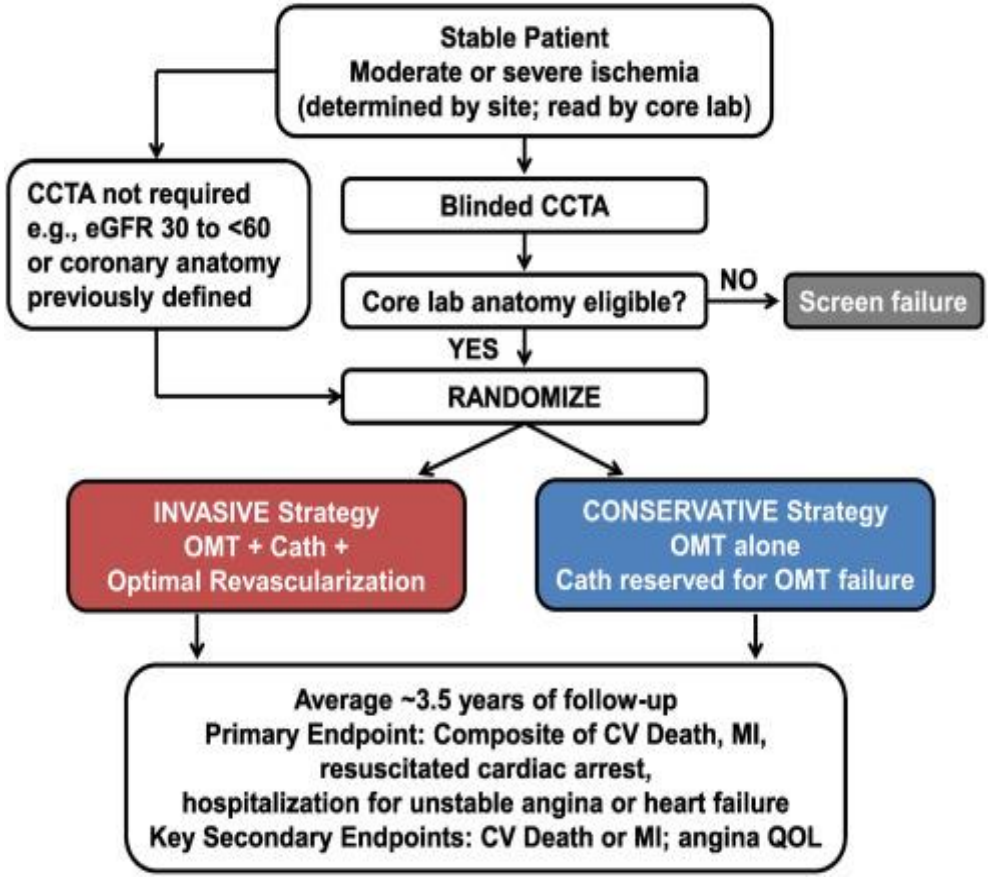
INCLUSION:

in ≥1 stenosis ≥70% in proximal artery with objective evidence of myocardial ischemia or 2) ≥1 coronary stenosis of ≥80% and classic angina without provocative testing

1ry endpoint: death/MI



ISCHEMIA TRIAL



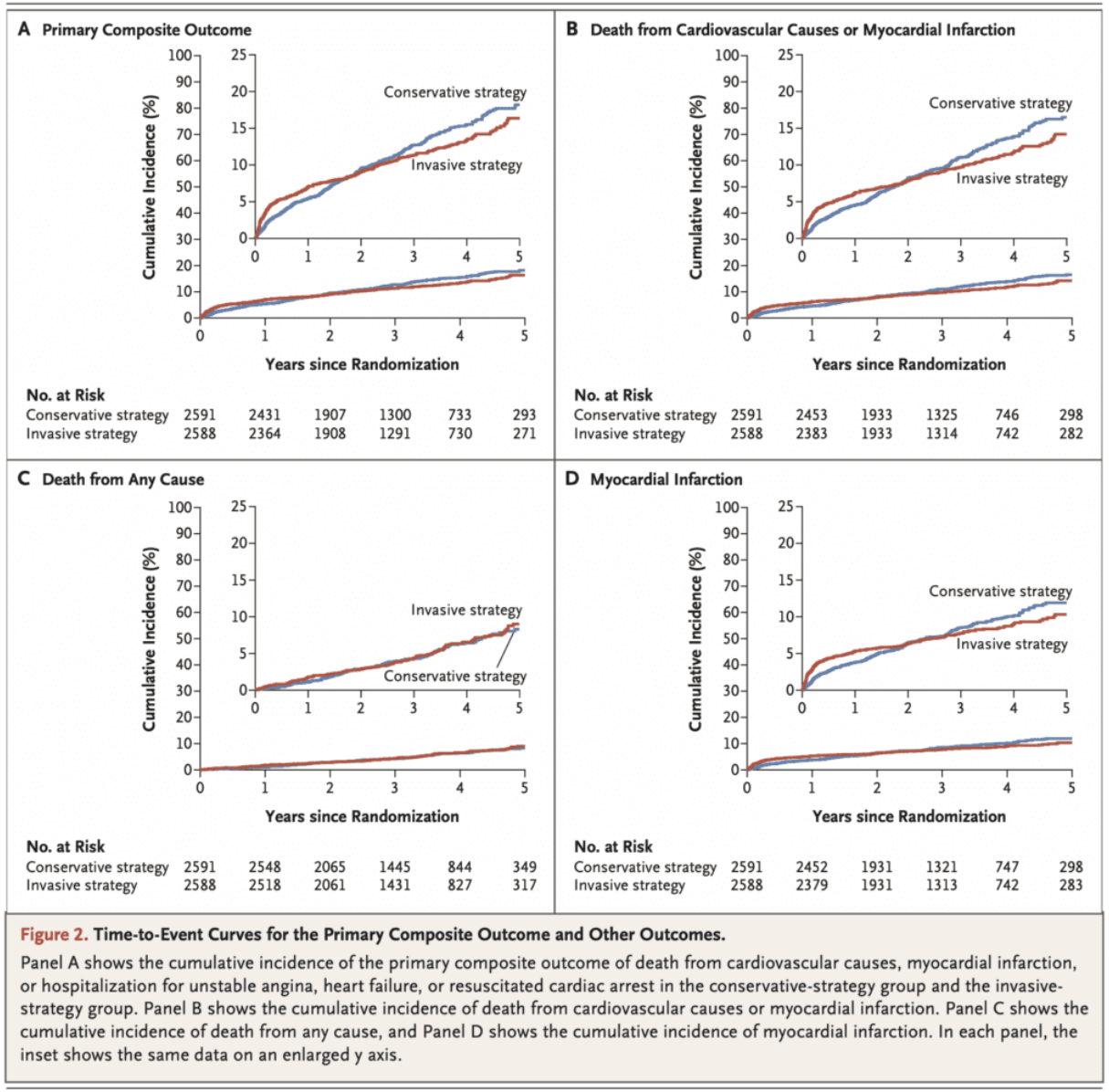
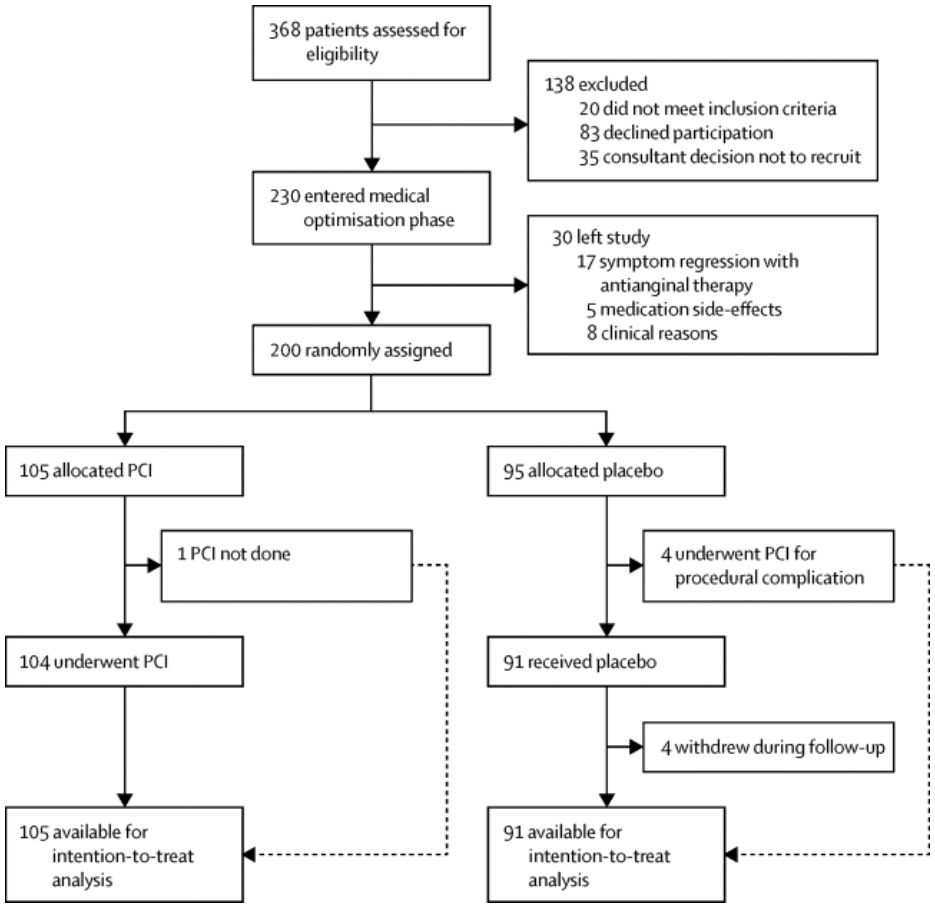


Figure 2. Time-to-Event Curves for the Primary Composite Outcome and Other Outcomes.

Panel A shows the cumulative incidence of the primary composite outcome of death from cardiovascular causes, myocardial infarction, or hospitalization for unstable angina, heart failure, or resuscitated cardiac arrest in the conservative-strategy group and the invasive-strategy group. Panel B shows the cumulative incidence of death from cardiovascular causes or myocardial infarction. Panel C shows the cumulative incidence of death from any cause, and Panel D shows the cumulative incidence of myocardial infarction. In each panel, the inset shows the same data on an enlarged y axis.

ORBITA Trial



ORBITA Trial: Secondary Endpoint Results

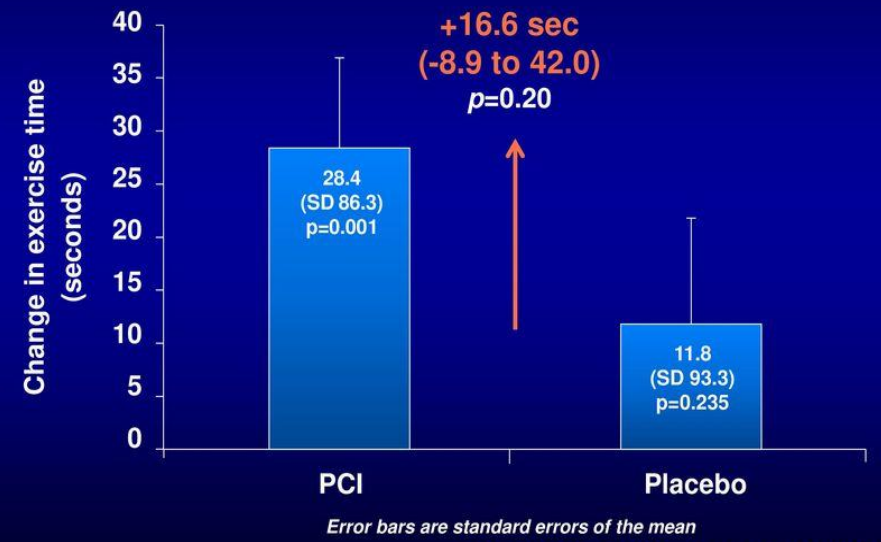
Blinded Evaluation of Ischemia Reduction

Peak Stress Wall Motion Index Score	PCI (n=80)	Placebo (n=57)
Pre-randomization	0.18	0.18
Follow-up	0.06	0.19
Δ (Pre-randomization to follow-up)	-0.08 (0.17) p=<0.0001	0.02 (0.16) p=0.43
Difference in Δ between arms	-0.09 (-0.15 to -0.04) p=0.001	

Al-Lamee, et al., Lancet Nov. 2, 2017 Epub

ORBITA Trial: Primary Endpoint

Change in Total Exercise Time

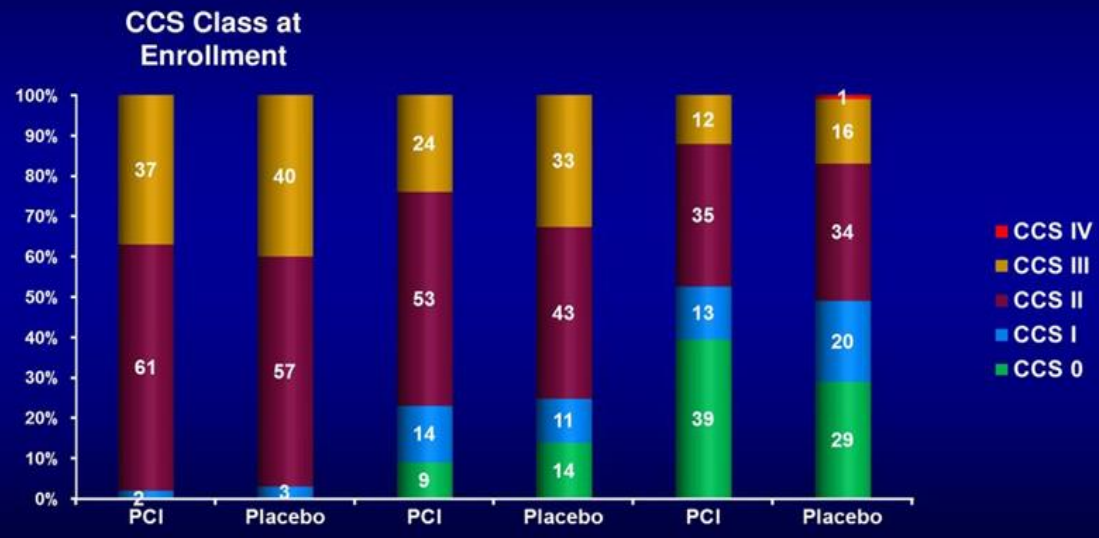


Error bars are standard errors of the mean

Al-Lamee, et al., Lancet Nov. 2, 2017 Epub

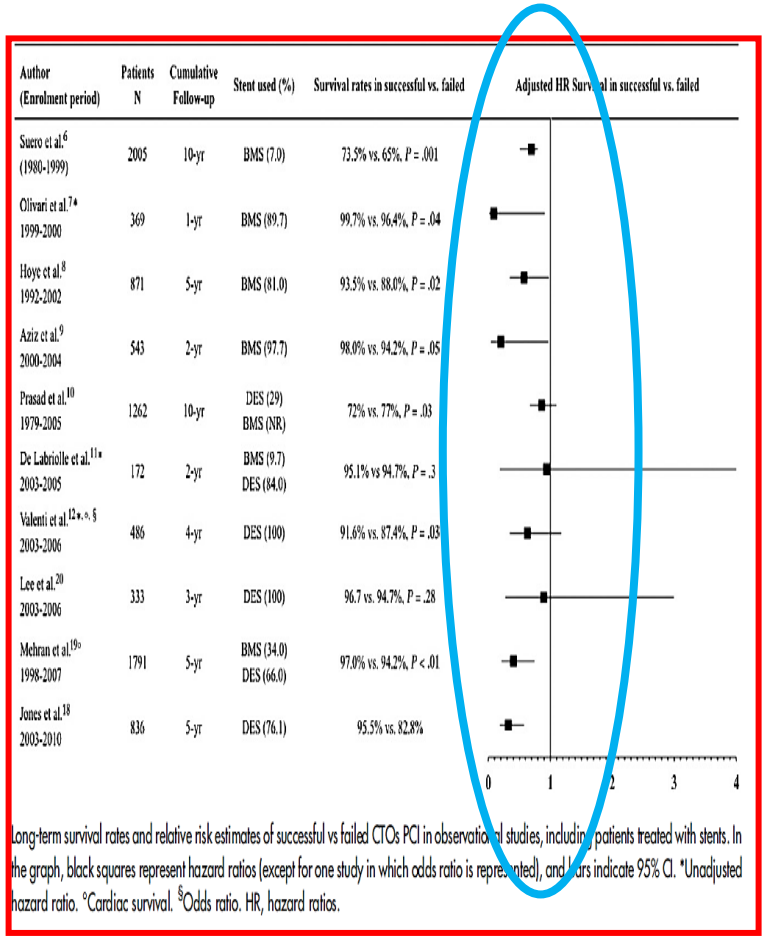
ORBITA Trial: Secondary Endpoint Results

CCS Class Improved in Both Groups



Al-Lamee, et al., Lancet Nov. 2, 2017 Epub

But…..CTOs are different



Author (Enrolment period)	Patients N	Cumulative Follow-up	Stent used (%)	Survival rates in successful vs. failed	Adjusted HR Survival in successful vs. failed
Suero et al.[6] (1980-1999)	2005	10-yr	BMS (7.0)	73.5% vs. 65%, P = .001	
Olivari et al.[7*] 1999-2000	369	1-yr	BMS (89.7)	99.7% vs. 96.4%, P = .04	
Hoye et al.[8] 1992-2002	871	5-yr	BMS (81.0)	93.5% vs. 88.0%, P = .02	
Aziz et al.[9] 2000-2004	543	2-yr	BMS (97.7)	98.0% vs. 94.2%, P = .05	
Prasad et al.[10] 1979-2005	1262	10-yr	DES (29) BMS (NR)	72% vs. 77%, P = .03	
De Labriolle et al.[11*] 2003-2005	172	2-yr	BMS (9.7) DES (84.0)	95.1% vs 94.7%, P = .3	
Valenti et al.[12*,§] 2003-2006	486	4-yr	DES (100)	91.6% vs. 87.4%, P = .03	
Lee et al.[20] 2003-2006	333	3-yr	DES (100)	96.7 vs. 94.7%, P = .28	
Mehran et al.[19§] 1998-2007	1791	5-yr	BMS (34.0) DES (66.0)	97.0% vs. 94.2%, P < .01	
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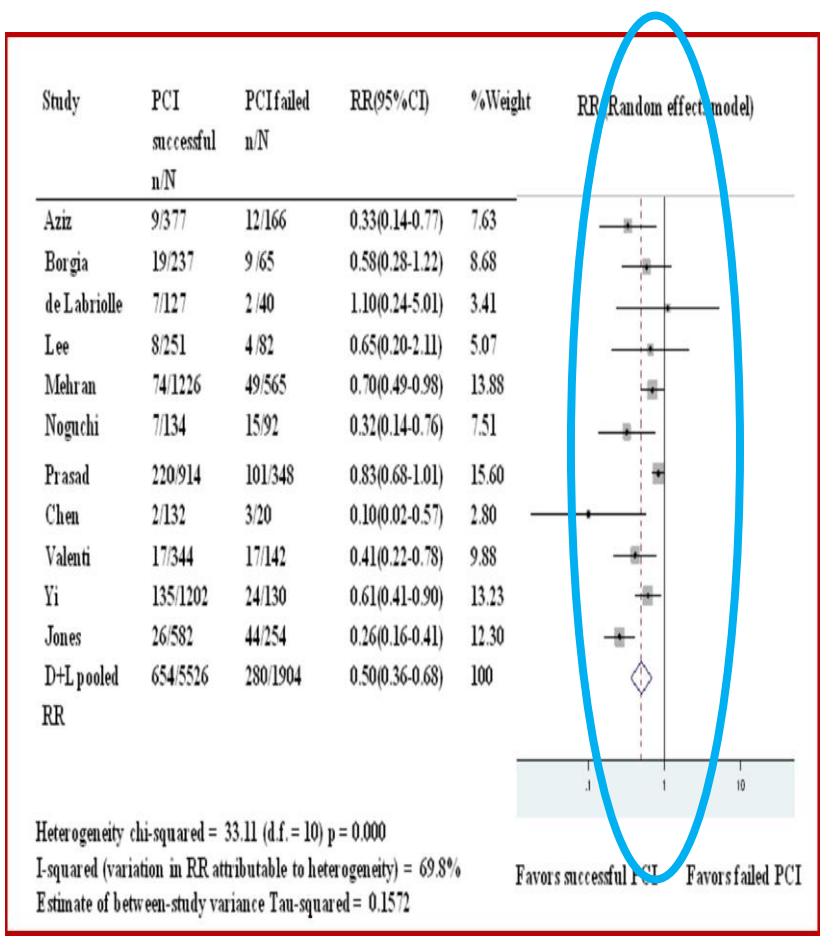
0 1 2 3 4

Long-term survival rates and relative risk estimates of successful vs failed CTOs PCI in observational studies, including patients treated with stents. In the graph, black squares represent hazard ratios (except for one study in which odds ratio is represented), and bars indicate 95% CI. *Unadjusted hazard ratio. †Cardiac survival. §Odds ratio. HR, hazard ratios.

Tamburino C, et al. Am Heart J. 2013;165:133



Study	PCI successful n/N	PCI failed n/N	RR(95%CI)	%Weight
Aziz	9/377	12/166	0.33(0.14-0.77)	7.63
Borgia	19/237	9/65	0.58(0.28-1.22)	8.68
de Labriolle	7/127	2/40	1.10(0.24-5.01)	3.41
Lee	8/251	4/82	0.65(0.20-2.11)	5.07
Mehran	74/1226	49/565	0.70(0.49-0.98)	13.88
Noguchi	7/134	15/92	0.32(0.14-0.76)	7.51
Prasad	220/914	101/348	0.83(0.68-1.01)	15.60
Chen	2/132	3/20	0.10(0.02-0.57)	2.80
Valenti	17/344	17/142	0.41(0.22-0.78)	9.88
Yi	135/1202	24/130	0.61(0.41-0.90)	13.23
Jones	26/582	44/254	0.26(0.16-0.41)	12.30
D+L pooled RR	654/5526	280/1904	0.50(0.36-0.68)	100

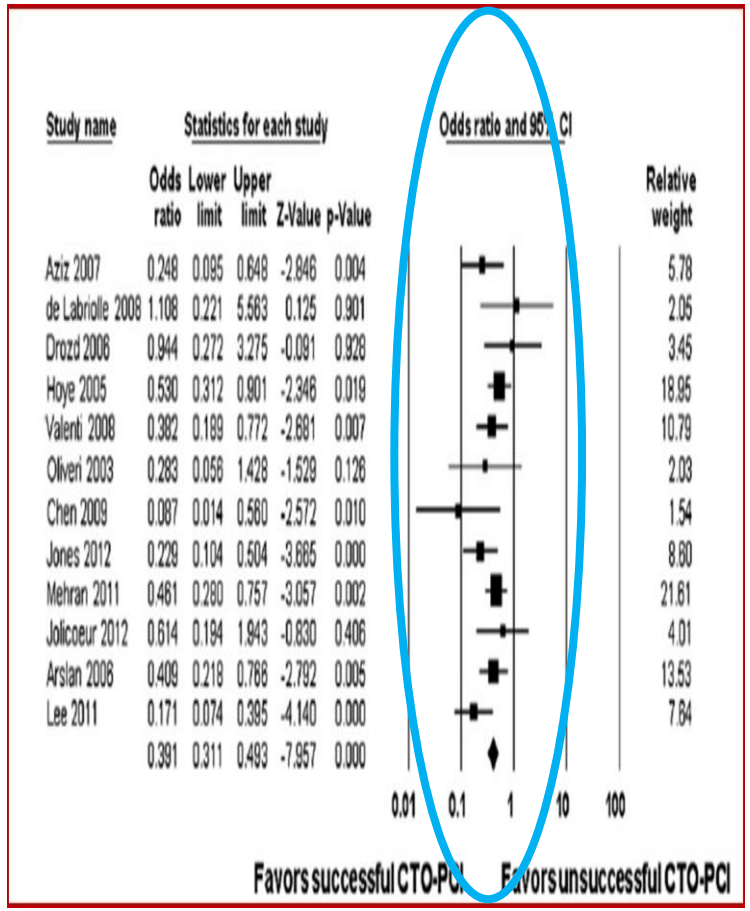
RR (Random effect model)

.1 1 10

Heterogeneity chi-squared = 33.11 (d.f. = 10) p = 0.000
I-squared (variation in RR attributable to heterogeneity) = 69.8%
Estimate of between-study variance Tau-squared = 0.1572

Favors successful PCI Favors failed PCI

Khan MF, et al. CCI:2013;82:95



Study name	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value	Relative weight
Aziz 2007	0.248	0.095	0.648	-2.846	0.004	5.78
de Labriolle 2008	1.108	0.221	5.563	0.125	0.901	2.05
Drozd 2006	0.944	0.272	3.275	-0.091	0.928	3.45
Hoye 2005	0.530	0.312	0.901	-2.346	0.019	18.95
Valenti 2008	0.382	0.189	0.772	-2.681	0.007	10.79
Oliveri 2003	0.283	0.056	1.428	-1.529	0.126	2.03
Chen 2009	0.087	0.014	0.560	-2.572	0.010	1.54
Jones 2012	0.229	0.104	0.504	-3.685	0.000	8.80
Mehran 2011	0.481	0.280	0.757	-3.057	0.002	21.81
Jolicoeur 2012	0.614	0.194	1.943	-0.830	0.406	4.01
Arslan 2008	0.409	0.218	0.768	-2.792	0.005	13.53
Lee 2011	0.171	0.074	0.395	-4.140	0.000	7.84
	0.391	0.311	0.493	-7.957	0.000	

Odds ratio and 95% CI

0.01 0.1 1 10 100

Favors successful CTO-PCI Favors unsuccessful CTO-PCI

Pancholy SB, et al. Am J Cardiol 2013;111:521

But….as compared to what?

- Compared to unsuccessful CTO-PCI

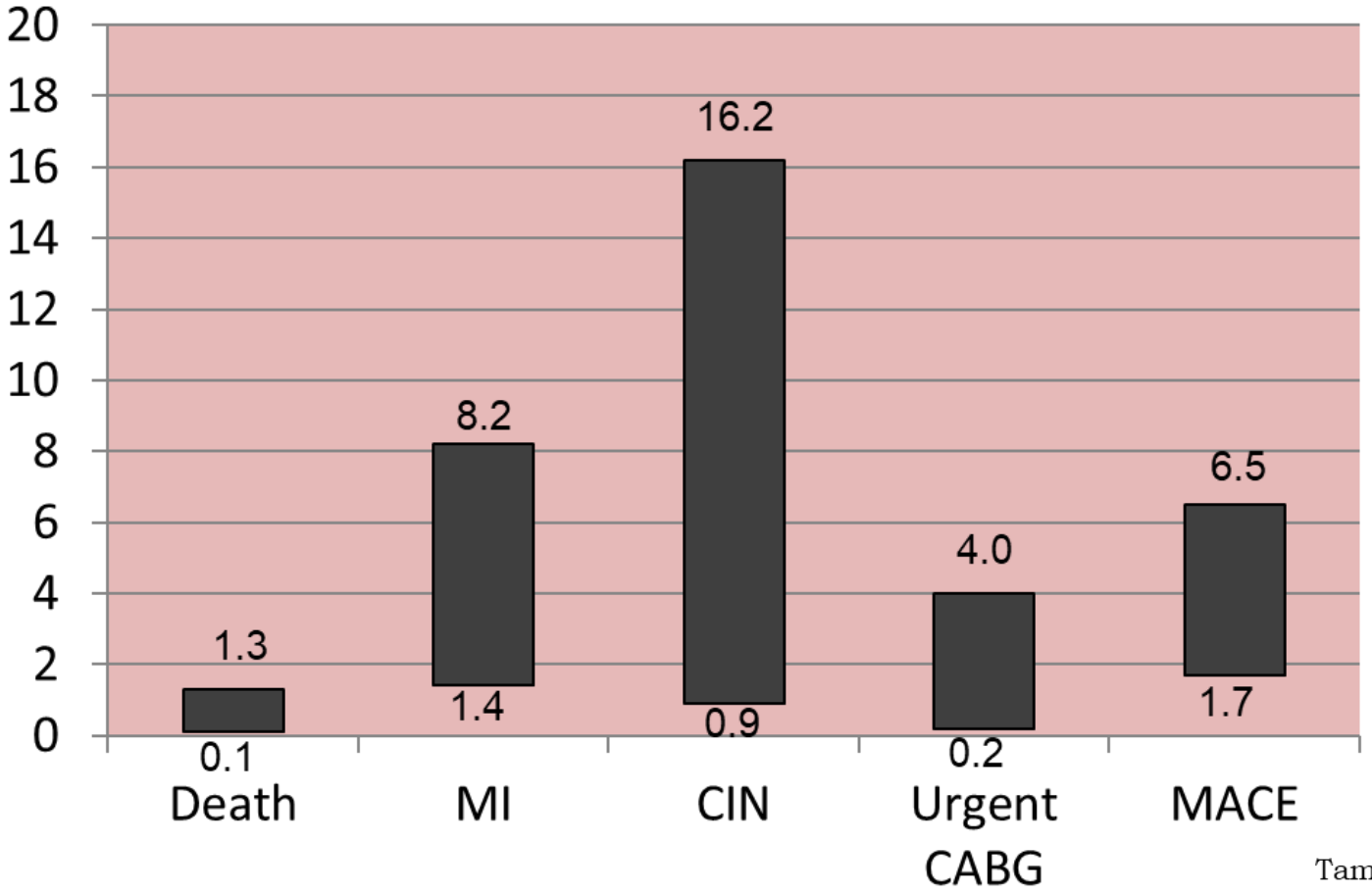
AND

- Comparing successful CTO-PCI to unsuccessful CTO-PCI is
  - Scientifically unsound
  - Simply ABSURD

Bit like comparing….

For a start….Complications

	Suero et al[6]	Olivari et al[7]	Hoye et al[8]	Aziz et al[9]	Prasad et al[10]	de Labriolle et al[11]	Valenti et al[12]	ERCTO[13]	J-CTO[14]	Rathore et al[15]	ALKK[16]	SECTOR[17]	Jones et al[18]
Patients (n)	2005	376	871	543	1262	172	486	1914	498	904	674	172	836



Tamburino C, et al. Am Heart J. 2013:133

Comparison of Procedural Complications and In-Hospital Clinical Outcomes Between Patients with Successful and Failed Percutaneous Intervention of Coronary Chronic Total Occlusions: A Meta-Analysis of Observational Studies

Muhammad F. Khan,[1,2*] MD, FACP, Emmanouil S. Brilakis,[3,4] MD, PhD, FACC, FSCAI, Christopher S. Wendel,[1] MS, and Hoang Thai,[5,6] MD, FACC, FSCAI

a

Study	MI(S n/N
Angioi	3/93
Aziz	24/
Borgia	3/23
Drozd	1/29
Hoye	1/56
Ivanhoe	8/33
Prasad	74/
Chen	3/13
Dong	4/21
Suero	28/1
Yi	15/1
Jones	7/58
Rathore	24/
Yamamoto	10/1
de Labriolle	0/1
D+L pooled RR	205/

Heterogeneity chi-squ
I-squared (variation in
Estimate of between-s
Test of RR=1 : z= 2.15

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Study
Aziz
de Labriol
Drozd
Hoye
Ivanhoe
Prasad
Chen
Suero
Yi
Jones
Rathore
Yamamot
D+L poole RR

Heteroge
I-squared
Estimate
Test of RI

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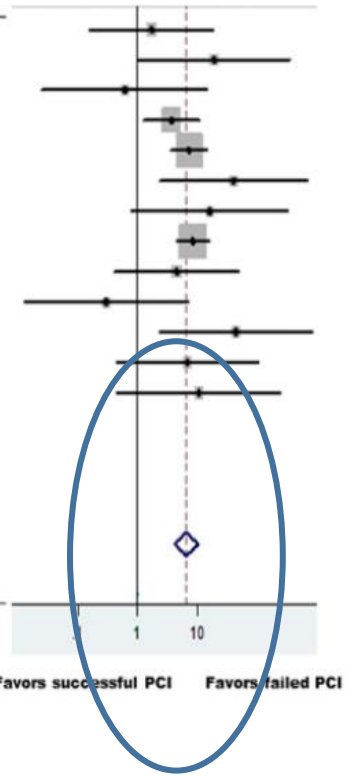
Study	CABG (S) n/N	CABG (F) n/N	RR (95% CI)	% Weight
Angioi	1/93	2/108	1.72(0.16-18.69)	3.38
de Labriolle	0/127	3/45	19.48(1.03-369.91)	2.25
Drozd	1/298	0/161	0.61(0.02-15.02)	1.92
Hoye	5/567	10/304	3.73(1.29-10.82)	14.76
Ivanhoe	10/332	33/148	7.40(3.75-14.62)	29.20
Lee	0/251	7/89	42.0(2.42-727.96)	2.39
Olivari	0/289	2/87	16.48(0.79-340.0)	2.13
Prasad	12/914	39/348	8.54(4.52-16.11)	31.99
Jones	1/582	2/254	4.58(0.42-50.31)	3.35
Stewart	1/47	0/53	0.29(0.01-7.10)	1.94
Sheiban	0/81	2/8	45.56(2.37-876.79)	2.23
Rathore	1/791	1/113	7.0(0.44-111.13)	2.54
Yamamoto	0/1192	1/332	10.75(0.44-263.22)	1.91
Aziz	0/377	0/166	(Excluded)	
Noguchi	0/134	0/92	(Excluded)	
Valenti	0/344	0/142	(Excluded)	
Yang	0/87	0/49	(Excluded)	
D+L pooled RR	32/6506	102/2499	6.67(4.26-10.43)	100.00

Heterogeneity chi-squared = 13.11 (d.f. = 12) p = 0.361
I-squared (variation in RR attributable to heterogeneity) = 8.5%
Estimate of between-study variance Tau-squared = 0.0577
Test of RR=1 : z= 8.32 p = 0.000

RR (Random effects model)



Urgent CABG

- These complications would never had occurred with OMT

Baseline characteristics worse in unsuccessful PCI

TABLE I Patient Characteristics of the Included Studies

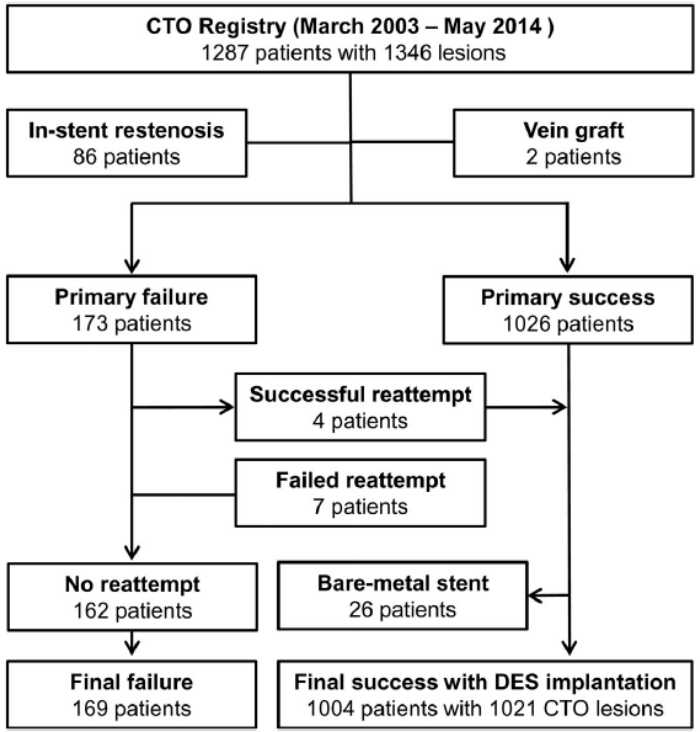
Study	Year	Follow up (mean ± SD)	Age (S) (mean ± SD)	Age (F) (mean ± SD)	Male (S) %	Male (F)%	DM (S)%	DM (F)%	Prior MI (S)(%)	Prior MI (F)(%)	EF(S) (% ± SD)	EF(F) (% ± SD)	MVD% (S)	MVD% (F)
Angioi	1995	3.6 ± 1.8	55 ± 10	56 ± 11	52	88	10	11	54	66	59 ± 14	59 ± 14	37	45
Arslan	2006	2.6 ± 1	61 ± 10	60 ± 11	75	75	25.6	24	40	45	50 ± 14	50 ± 14	67	70
Aziz	2007	1.7 ± 0.5	59	59	76	81	14	9	58	58	53	53	50	60
Borgia	2011	4	64 ± 10	65 ± 11	82	82	26	31	58	60	53 ± 9	53 ± 10	73	83
de Labriolle	2008	2	61 ± 12	64 ± 10	72	87	19	40.5	21	22	50 ± 12	48 ± 15	45	66
Drozd	2006	2.5 ± 1.5	57 ± 10	58 ± 10	81	80	11	11	73	66	NA	NA	46	53
Jolicoeur	2011	5.6	58(51–67)	61(55–70)	70	79	33	26	21	29	56(46–61)	55(45–60)	60	69
Finci	1990	2	55 ± 11	55 ± 12	93	88	NA	NA	NA	NA	NA	NA	24	23
Hoye	2005	4.5 ± 2.7	60 ± 11	61 ± 10	74	72	12	9	56	49	NA	NA	54	67
Ivanhoe	1992	4	55 ± 10	56 ± 11	81	82	10	15	56	53	55 ± 10	56 ± 11	30	54
Lee	2011	3.6	59 ± 10	64 ± 9	77	23	31	30	18	29	56 ± 10	55.0 ± 11	51	55
Mehran	2011	2.9	61 ± 11	62 ± 10	85	89	23	22	47	56	54 ± 10	53 ± 11	65	75
Noguchi	2000	4.3 ± 3.1	61 ± 9	61 ± 11	78	80	26	32	36	51	56 ± 12	54 ± 9	47	67
Olivari	2003	1	58 ± 10	59 ± 11	86	85	17	20	69	69	56 ± 10	56 ± 10	45	60
Prasad	2007	10	63 ± 11	64 ± 11	76	75	NA	NA	33	42	NA	NA	70	70
Sathe	1994	2.8	55	57	66	70	NA	NA	NA	NA	NA	NA	NA	NA
Chen	2009	3	64 ± 15	68 ± 7	74	80	26	25	46	65	45 ± 11	42 ± 16	85	95
Suero	2001	7.6 ± 4.6	60 ± 11	61 ± 12	78	80	21	20	56	52	51 ± 14	52 ± 14	73	82
Valenti	2008	2	67 ± 11	70 ± 11	81	83	24	21	45	54	42 ± 13	41 ± 14	85	87
Warren	1990	2.6 ± 1	54	55	53	47	NA	NA	60	40	NA	NA	38	61
Yang	2011	2	66 ± 11	69 ± 10	82	82	36	37	26	33	46 ± 7	47 ± 5	100	100
Yi X	2009	6.3 ± 2.5	58 ± 10	58 ± 11	82	84	18	20	54	57	NA	NA	42	48
Jones	2012	3.8	62 ± 12	64 ± 11	76	79	27	29	32	36	56 ± 9	54 ± 1.4	45	49

Follow-up times and ages are in years.
All the comorbidities are expressed in percentage fraction of total numbers.
SD, standard deviation; MI, myocardial infarction; DM, diabetes mellitus; MVD, multi-vessel disease; EF, ejection fraction; S, successful intervention group; F, failed intervention group; NA, not available.

Successful Recanalization of Native Coronary Chronic Total Occlusion Is Not Associated With Improved Long-Term Survival

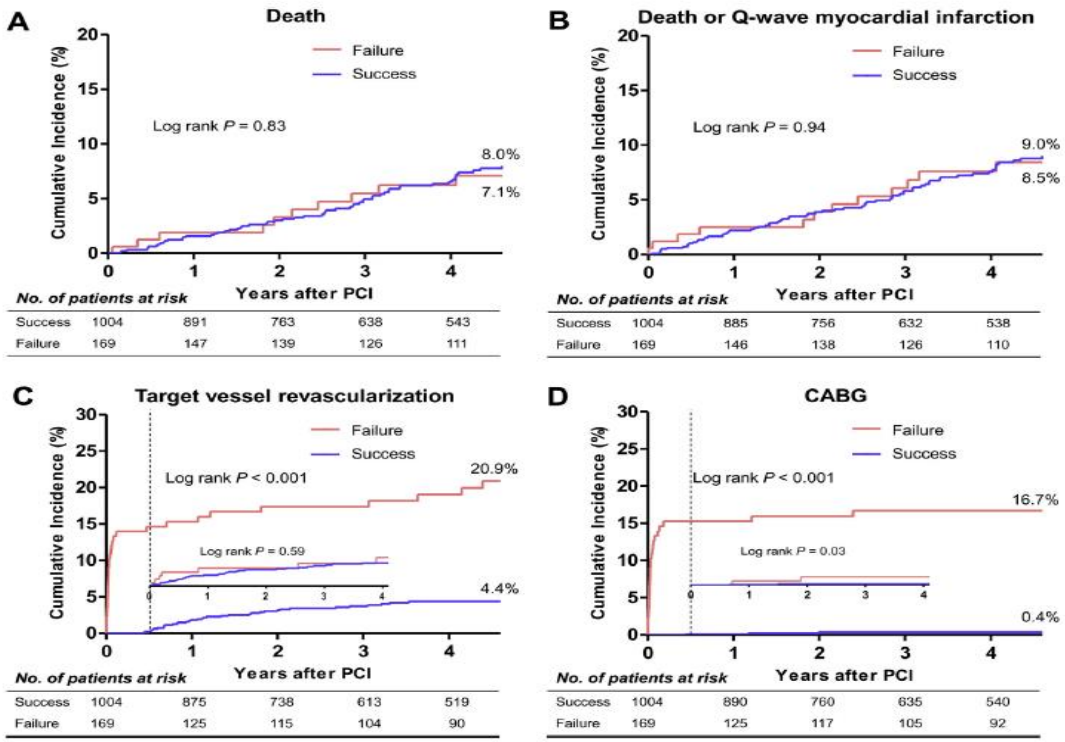
Pil Hyung Lee, MD, Seung-Whan Lee, MD, PhD, Hee-Soon Park, MD, Se Hun Kang, MD, Byeong Joo Bae, MD, Mineok Chang, MD, Jae-Hyung Roh, MD, Sung-Han Yoon, MD, Jung-Min Ahn, MD, Duk-Woo Park, MD, PhD, Soo-Jin Kang, MD, PhD, Young-Hak Kim, MD, PhD, Cheol Whan Lee, MD, PhD, Seong-Wook Park, MD, PhD, Seung-Jung Park, MD, PhD

FIGURE 1 Study Flowchart



CTO = chronic total occlusion; DES = drug-eluting stent(s).

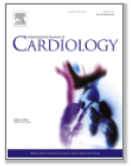
FIGURE 3 Kaplan-Meier Curves for Clinical Endpoints



Kaplan-Meier curves of cumulative incidence of **(A)** all-cause mortality, **(B)** composite of death and myocardial infarction, **(C)** target vessel revascularization, and **(D)** coronary artery bypass grafting (CABG). PCI = percutaneous coronary intervention.

Improvement in LV function

International Journal of Cardiology
Volume 187, 6 May 2015, Pages 90-96



Meta-analysis on the impact of percutaneous coronary intervention of chronic total occlusions on left ventricular function and clinical outcome ☆

Loes P. Hoebers [a], Bimmer E. Claessen [a], Joelle Elias [a], George D. Dangas [b], Roxana Mehran [b], José P.S. Henriques [a]

- 27 studies, 1990–2013
- 11,085 successful CTO-PCI
- 4347 failed CTO PCI
- After successful CTO PCI, LVEF increased with 4.44% (95% CI: 3.52–5.35, $p < 0.01$) compared to baseline.

Improvement in LV function

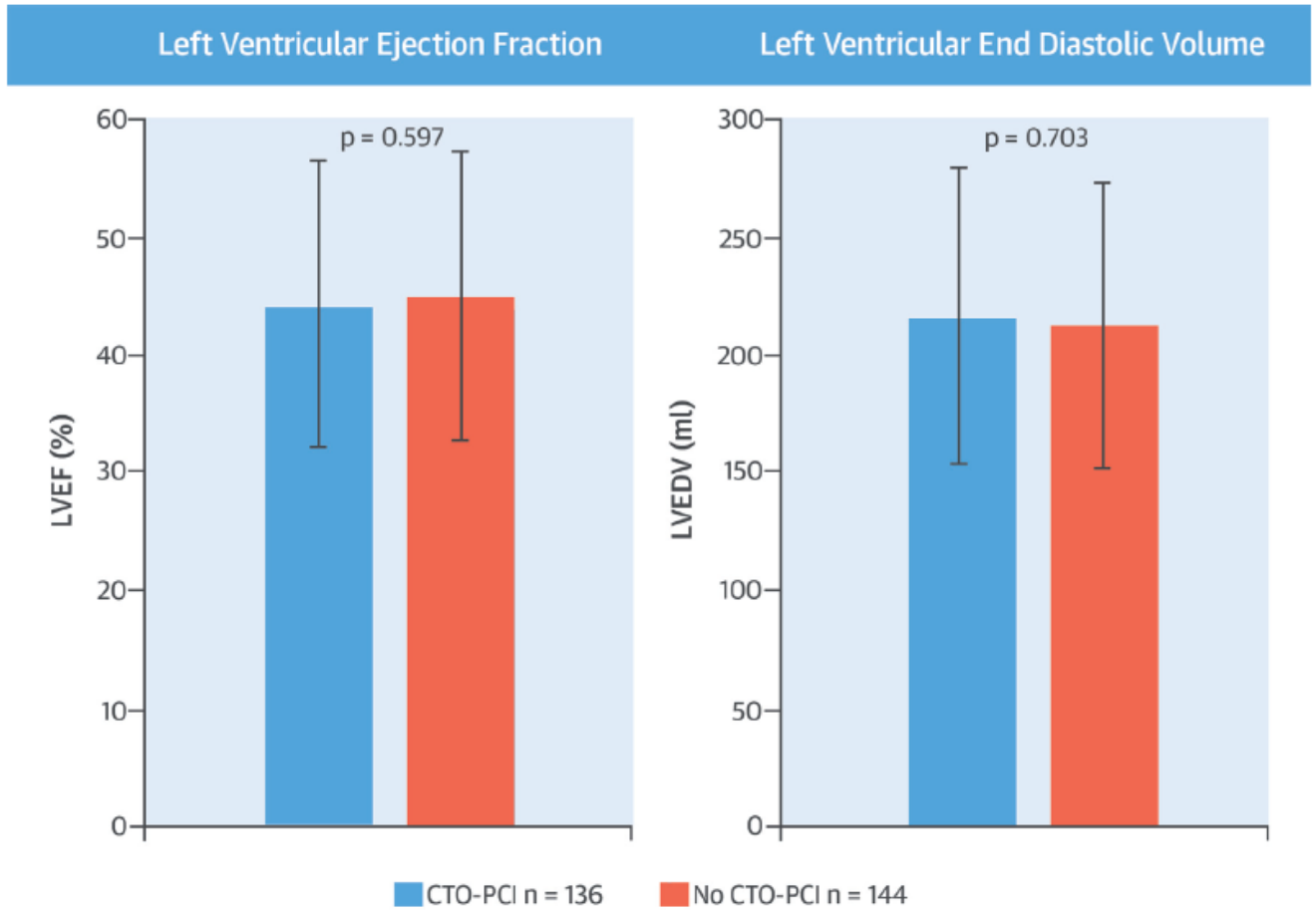
Percutaneous Intervention for Concurrent Chronic Total Occlusions in Patients With STEMI

The EXPLORE Trial

José P.S. Henriques, MD, PhD,[a] Loes P. Hoebers, MD,[a] Truls Råmunddal, MD, PhD,[b] Peep Laanmets, MD,[c] Erlend Eriksen, MD,[d] Matthijs Bax, MD,[e] Dan Ioanes, MD,[b] Maarten J. Suttorp, MD, PhD,[f] Bradley H. Strauss, MD, PhD,[g] Emanuele Barbato, MD, PhD,[h] Robin Nijveldt, MD, PhD,[i] Albert C. van Rossum, MD, PhD,[i] Koen M. Marques, MD, PhD,[i] Joëlle Elias, MD,[a] Ivo M. van Dongen, MD,[a] Bimmer E.P.M. Claessen, MD, PhD,[a] Jan G. Tijssen, PhD,[a] René J. van der Schaaf, MD, PhD,[j] for the EXPLORE Trial Investigators

- 304 pts with STEMI and concurrent CTO randomized to CTO-PCI (< 1 week) and OMT
- Multicentre 2007-2015
- 1ry outcomes were LVEF and LVEDV

CENTRAL ILLUSTRATION **Left Ventricular Function at 4-Month Follow-Up in STEMI Patients Undergoing CTO PCI Versus no CTO PCI**



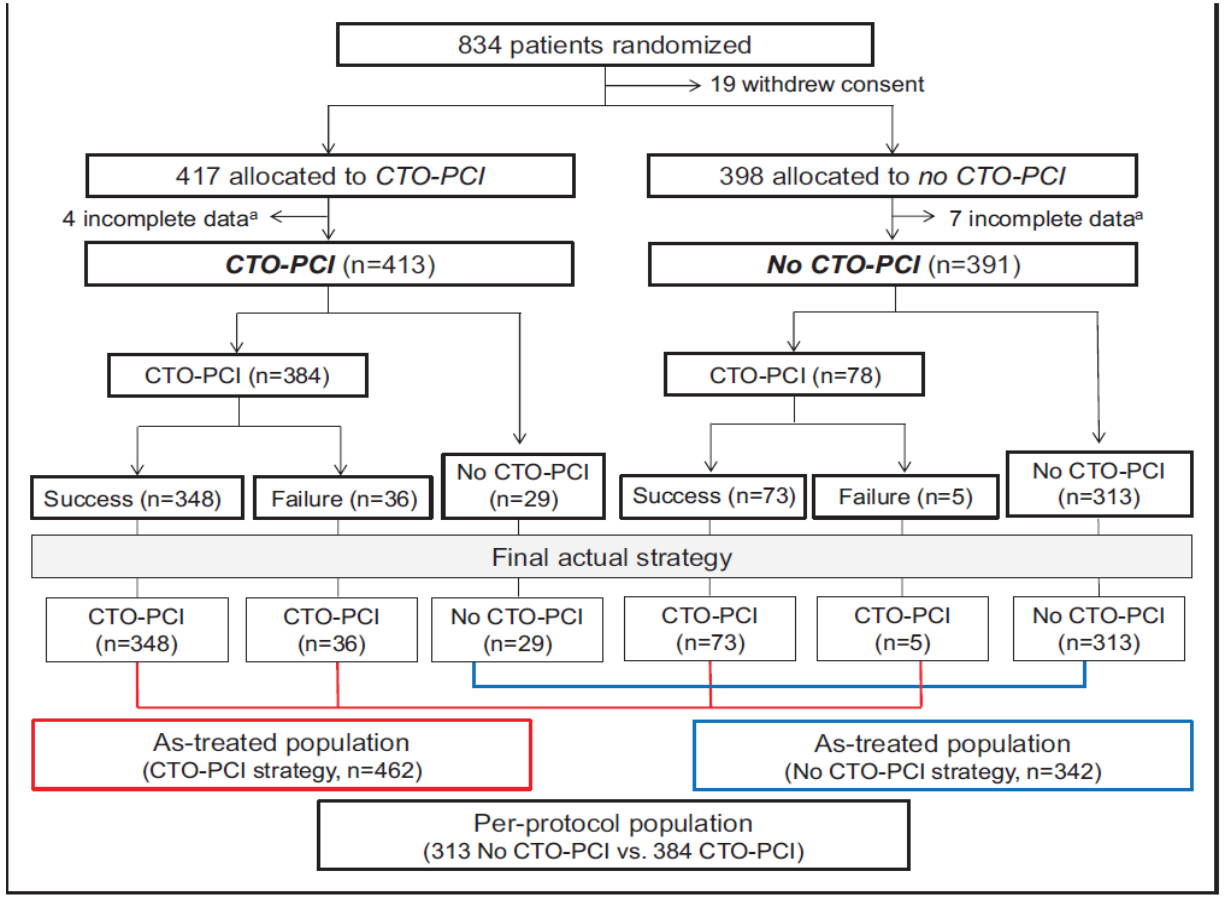
Henriques, J.P.S. et al. J Am Coll Cardiol. 2016;68(15):1622-32.

Left ventricular ejection fraction (LVEF) **(left)** and left ventricular end-diastolic volume (LVEDV) **(right)** at 4-month follow-up. All analyses were performed on an intention-to-treat basis: core-laboratory-reported success rates of chronic total occlusion percutaneous coronary intervention were 73%; and operator-reported success rates were 77%. **Whiskers** indicate standard deviation. CTO = chronic total occlusion; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

Do we have any RCTs?

Randomized Trial Evaluating Percutaneous Coronary Intervention for the Treatment of Chronic Total Occlusion

The DECISION-CTO Trial

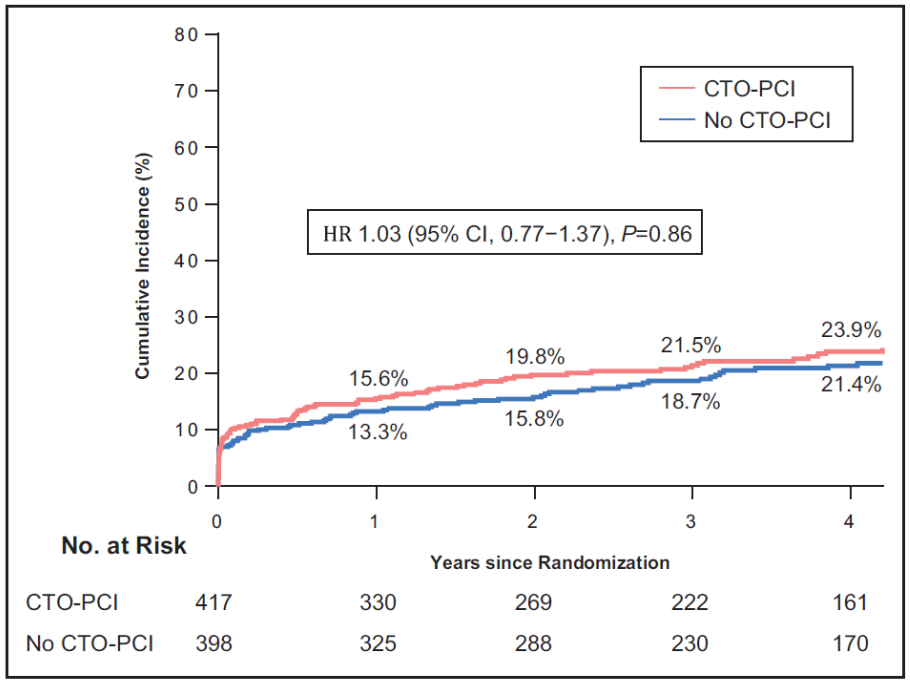


Circulation. 2019;139:1674–1683.

Null outcomes

Table 2. **Primary and Secondary Clinical End Points in the Intention-to-Treat Analysis**

	CTO-PCI (n=417)	No CTO-PCI (n=398)	Crude HR (95% CI)	*P* Value
Primary end point: death, MI, stroke, or any revascularization	93 (22.3)	89 (22.4)*	1.03 (0.77–1.37)	0.86
Secondary end points				
Death	15 (3.6)	21 (5.3)	0.70 (0.36–1.37)	0.30
Cardiac cause	8 (1.9)	14 (3.5)	0.56 (0.24–1.34)	0.19
Noncardiac cause	7 (1.7)	7 (1.8)	0.99 (0.35–2.82)	0.99
Myocardial infarction	47 (11.3)	34 (8.5)	1.39 (0.90–2.15)	0.14
Periprocedural MI	41 (9.8)	30 (7.5)	1.37 (0.816–2.18)	0.19
Spontaneous MI	7 (1.7)	7 (1.8)	0.88 (0.30–2.57)	0.82
Stroke	6 (1.4)	10 (2.5)	0.61 (0.23–1.65)	0.33
Any revascularization	46 (11.0)	42 (10.6)	1.14 (0.75–1.73)	0.55
CTO vessel	33 (7.9)	30 (7.5)	1.13 (0.69–1.84)	0.63
Non-CTO vessel	29 (7.0)	23 (5.8)	1.34 (0.77–2.31)	0.30
Death, MI, or stroke	66 (15.8)	61 (15.3)	1.07 (0.75–1.51)	0.72
Cardiac death, MI, stroke, or any revascularization	86 (20.6)	82 (20.6)	1.02 (0.76–1.39)	0.88
Death, spontaneous MI, stroke, or any revascularization	64 (15.3)	69 (17.3)	0.91 (0.65–1.30)	0.59



- 1ry endpoint: death, MI, stroke, revascularisation

A randomized multicentre trial to compare revascularization with optimal medical therapy for the treatment of chronic total coronary occlusions

Gerald S. Werner[1]*, Victoria Martin-Yuste[2], David Hildick-Smith[3], Nicolas Boudou[4], Georgios Sianos[5], Valery Gelev[6], Jose Ramon Rumoroso[7], Andrejs Erglis[8], Evald Høj Christiansen[9], Javier Escaned[10], Carlo di Mario[11], Thomas Hovasse[12], Luis Teruel[13], Alexander Bufe[14], Bernward Lauer[15], Kris Bogaerts[16], Javier Goicolea[17], James C. Spratt[18], Anthony H. Gershlick[19], Alfredo R. Galassi[20], and Yves Louvard[12]; for the EUROCTO trial investigators†

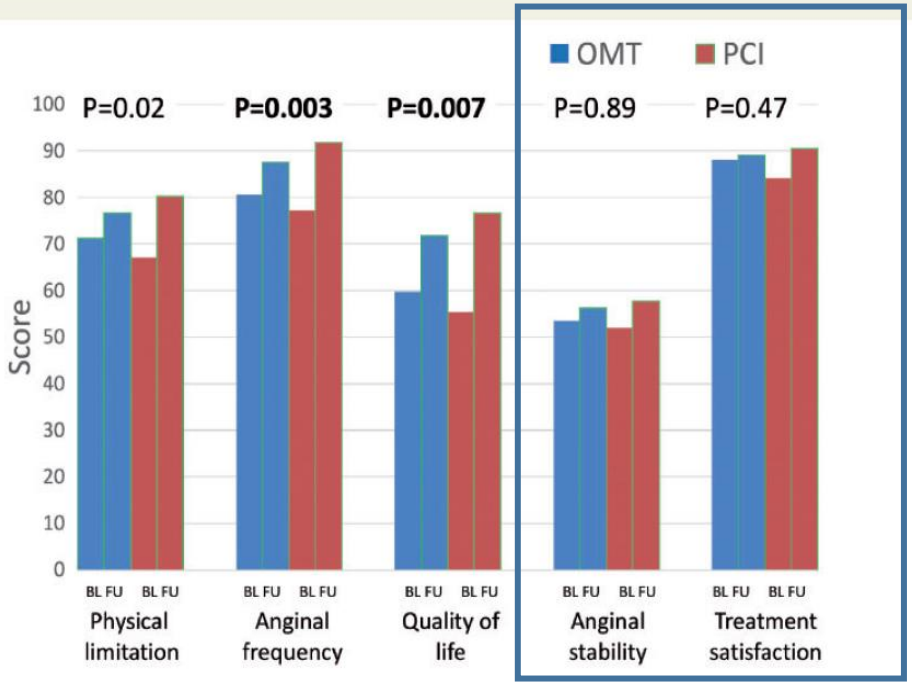


Figure 3 Comparison of Seattle angina questionnaire subscale changes between optimal medical therapy and percutaneous coronary intervention.

- 396 pts randomized 2:1
- 12 month FU
- 1ry endpoint: Change in SAQ at 12 months

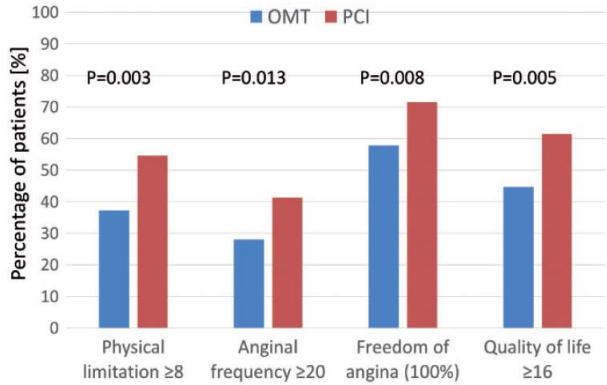


Figure 4 Comparison of significant changes in the Seattle angina questionnaire categories from baseline to follow-up between optimal medical therapy and percutaneous coronary intervention.

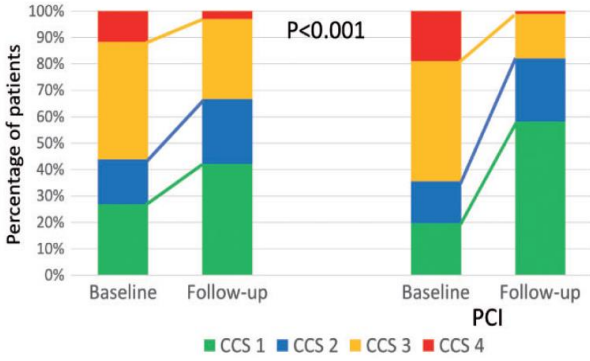


Figure 5 Comparison of changes in CCS classification from baseline to follow-up between optimal medical therapy and percutaneous coronary intervention. CCS: Canadian Cardiology Society.

But note:

- 86% success rate
- 36% retrograde PCI

} Highly proficient operators in centres of excellence

- ALL patients were symptomatic
- 192 pts with 1 vessel CAD (CTO only)
- 204 pts with multivessel CAD – 116 underwent pre-randomization PCI of non-CTO vessels
- Safety at 36 months – equivalent
- **Importantly, hard endpoints not different (angina stability, treatment satisfaction, mortality)**

Best available RCT data –meta-analysis

- 6 RCTs
- 1890 pts
- Median FU 12 months
- 63±9.8 yrs, 83% male
- LVEF 53±13%
- SYNTAX Score 21.6±10

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Hafeez Hassan Virk, MD[c]
Mohammed Mhanna, MD[d]
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26 July 2021
3 August 2021

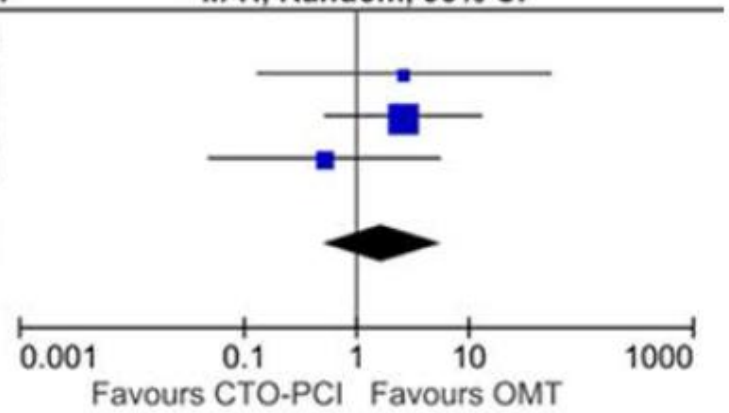
1. Jeroudi OM, Alomar ME, Michael TT, Sabbagh AE, Patel VG, Mogabgab O, Fuh E, Sherbet D, Lo N, Roesle M, Rangan BV,

Am J Cardiol 2021

All-cause mortality 1 year

Study or Subgroup	CTO-PCI Events	CTO-PCI Total	OMT Events	OMT Total	Weight	Risk Ratio M-H, Random, 95% CI
COMET-CTO	0	50	0	50		Not estimable
EUROCTO	2	259	0	137	16.4%	2.65 [0.13, 54.89]
EXPLORE	5	148	2	154	57.1%	2.60 [0.51, 13.20]
REVASC	1	101	2	104	26.5%	0.51 [0.05, 5.59]
Total (95% CI)		**558**		**445**	**100.0%**	**1.70 [0.50, 5.80]**
Total events	8		4			

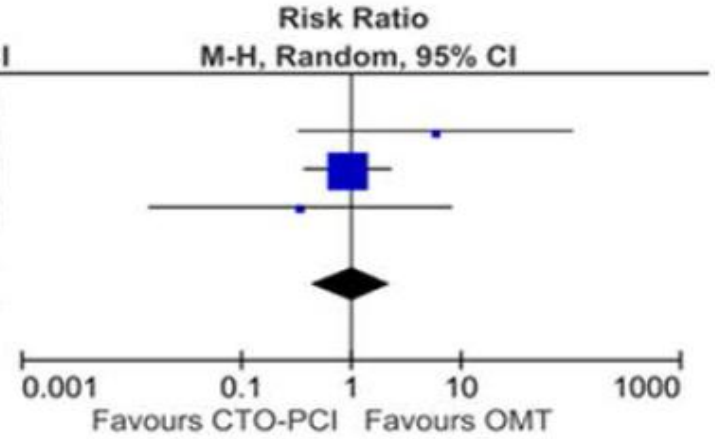
Heterogeneity: Tau² = 0.00; Chi² = 1.31, df = 2 (P = 0.52); I² = 0%
Test for overall effect: Z = 0.85 (P = 0.40)



Myocardial infarction 1 year

Study or Subgroup	CTO-PCI Events	CTO-PCI Total	OMT Events	OMT Total	Weight	Risk Ratio M-H, Random, 95% CI
COMET-CTO	0	50	0	50		Not estimable
EUROCTO	5	259	0	137	8.7%	5.84 [0.33, 104.81]
EXPLORE	8	148	9	154	84.3%	0.92 [0.37, 2.33]
REVASC	0	101	1	104	7.1%	0.34 [0.01, 8.33]
Total (95% CI)		**558**		**445**	**100.0%**	**1.01 [0.43, 2.36]**
Total events	13		10			

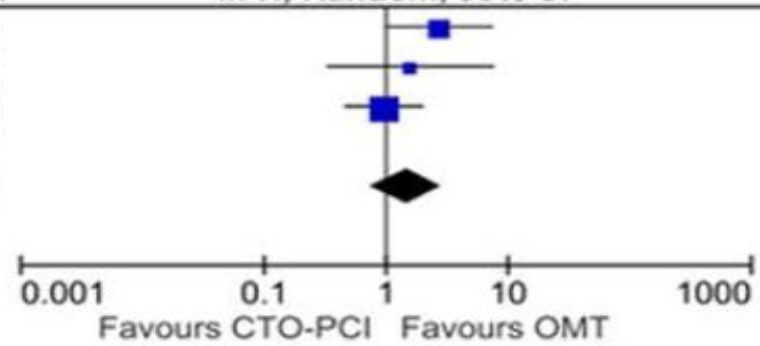
Heterogeneity: Tau² = 0.00; Chi² = 1.97, df = 2 (P = 0.37); I² = 0%
Test for overall effect: Z = 0.03 (P = 0.98)



TLR 1 year

Study or Subgroup	CTO-PCI Events	CTO-PCI Total	OMT Events	OMT Total	Weight	Risk Ratio M-H, Random, 95% CI
DECISION-CTO	7	147	7	398	32.8%	2.71 [0.97, 7.59]
EUROCTO	6	259	2	137	16.0%	1.59 [0.32, 7.76]
EXPLORE	12	148	13	154	51.2%	0.96 [0.45, 2.04]
Total (95% CI)		**554**		**689**	**100.0%**	**1.46 [0.75, 2.87]**
Total events	25		22			

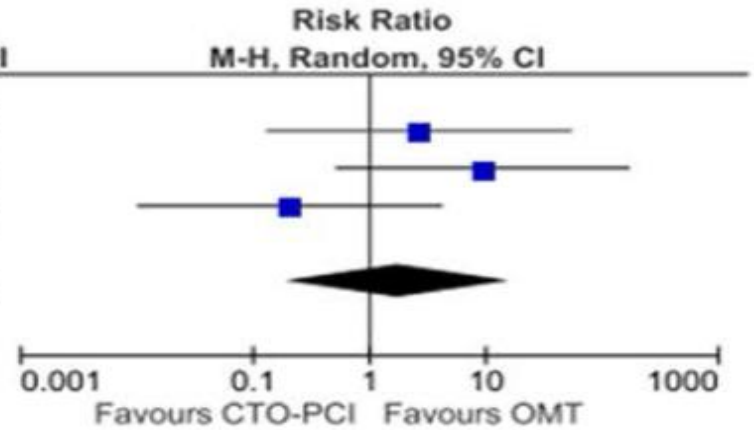
Heterogeneity: Tau² = 0.08; Chi² = 2.56, df = 2 (P = 0.28); I² = 22%
Test for overall effect: Z = 1.11 (P = 0.27)



Cardiac mortality 1 year

Study or Subgroup	CTO-PCI Events	CTO-PCI Total	OMT Events	OMT Total	Weight	Risk Ratio M-H, Random, 95% CI
COMET-CTO	0	50	0	50		Not estimable
EUROCTO	2	259	0	137	32.8%	2.65 [0.13, 54.89]
EXPLORE	4	148	0	154	34.4%	9.36 [0.51, 172.39]
REVASC	0	101	2	104	32.8%	0.21 [0.01, 4.24]
Total (95% CI)		**558**		**445**	**100.0%**	**1.77 [0.19, 16.06]**
Total events	6		2			

Heterogeneity: Tau² = 1.48; Chi² = 3.27, df = 2 (P = 0.19); I² = 39%
Test for overall effect: Z = 0.51 (P = 0.61)



Conclusions

- There is no convincing proof that CTO-PCI applied broadly has prognostic benefit regarding
  - angina relief
  - QOL
  - LV function
  - Mortality
- CTO-PCI may have benefit in selected patients
  - Limiting angina after PCI of non-CTO vessels
  - Undertaken in centres of excellence

So Saar....Good luck!