

11° CONGRESSO NAZIONALE



*Quello che le Linee
Guida Non Dicono*

Napoli
5-6 aprile 2024

KNOWLEDGE HUB

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Trattamento delle CTO: scelta ragionata tra terapia medica, PCI e CABG

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Dipartimento PROMISE, Università degli Studi di Palermo

CTO: Why and How to Revascularize

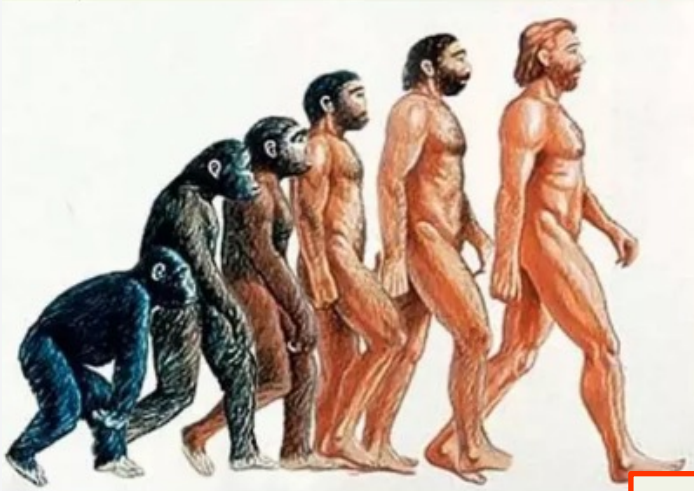
- ✓ **The advance in CTO PCI**
- ✓ **The importance on Health Outcomes**
- ✓ **The importance on Prognosis**

CTO: Why and How to Revascularize

- ✓ **The advance in CTO PCI**
- ✓ The importance on Health Outcomes
- ✓ The importance on Prognosis

Evolution of CTO-PCI

Increasing success rates related to technique evolution



2004

Antegrade
Wires and
IVUS

2007

Rudimentay
Retrograde

2012

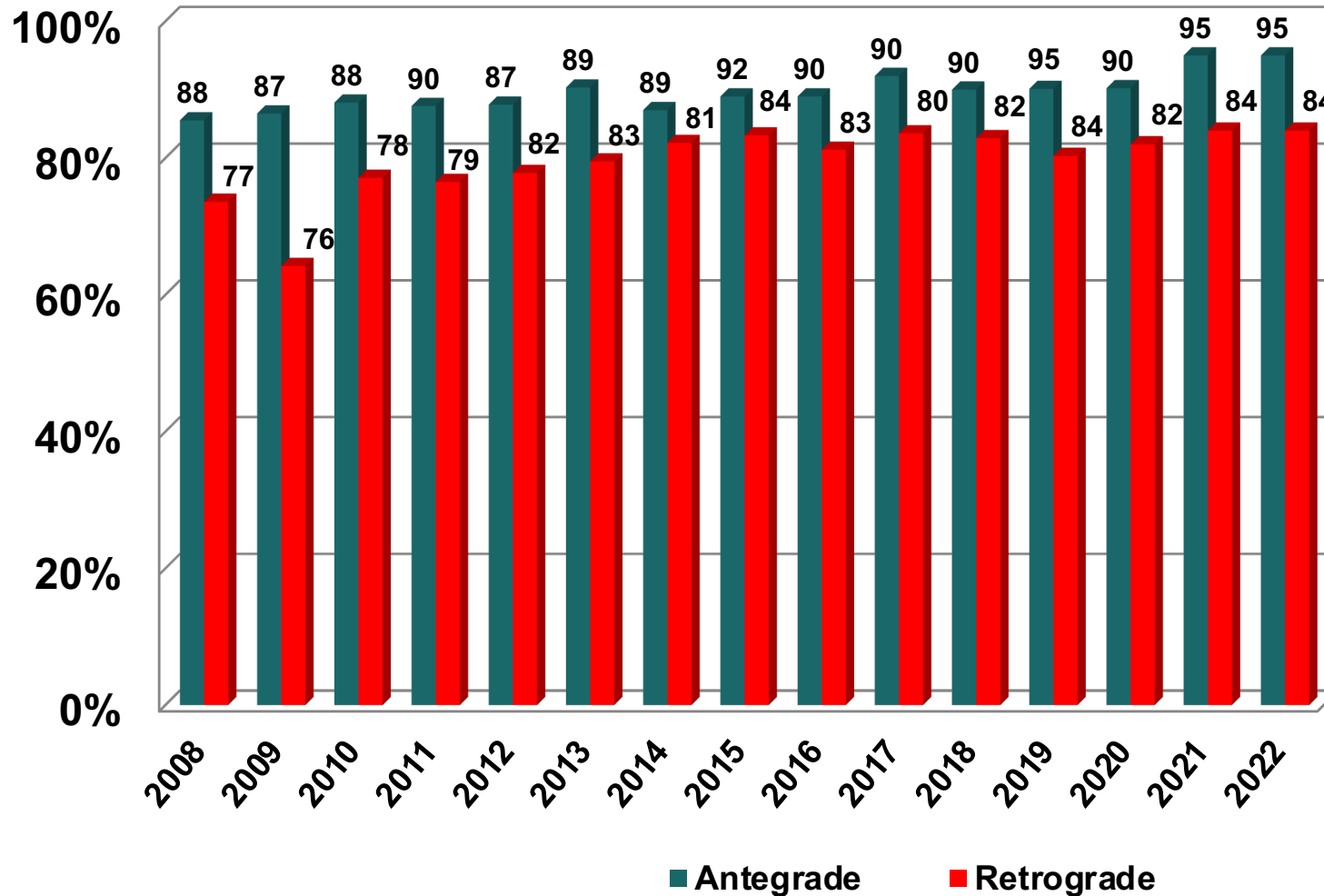
Early
Antegrade
Dissection
Re-Entry

2021

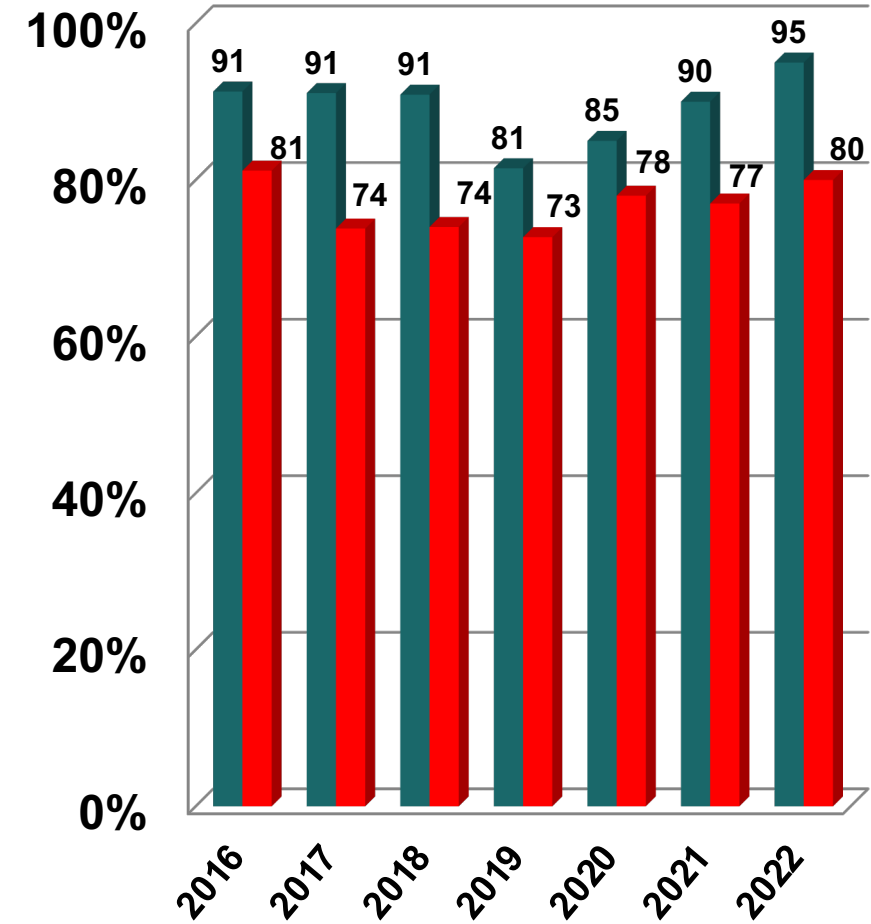
Hybrid

Angiographic success

Members



Candidate Members



Contemporary outcomes of chronic total occlusion percutaneous coronary intervention in Europe: the ERCTO registry

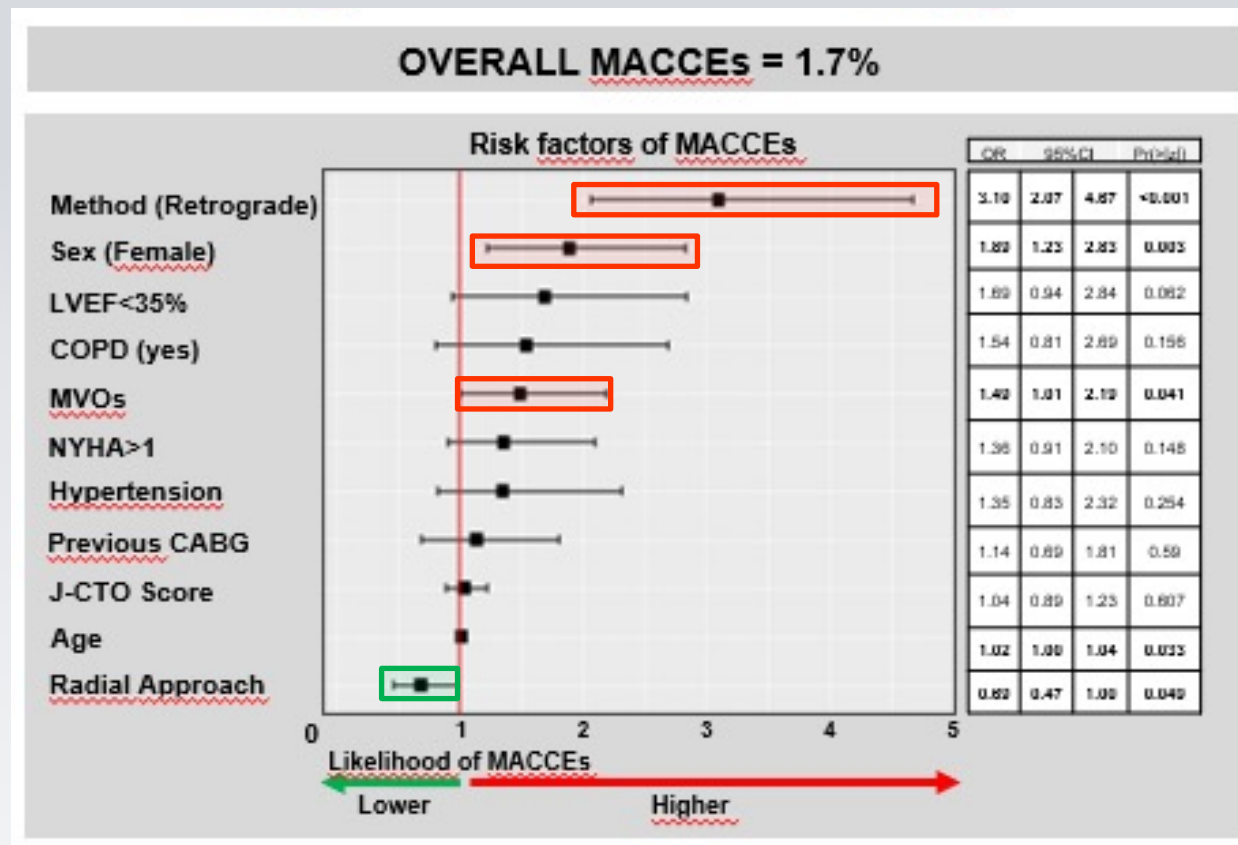
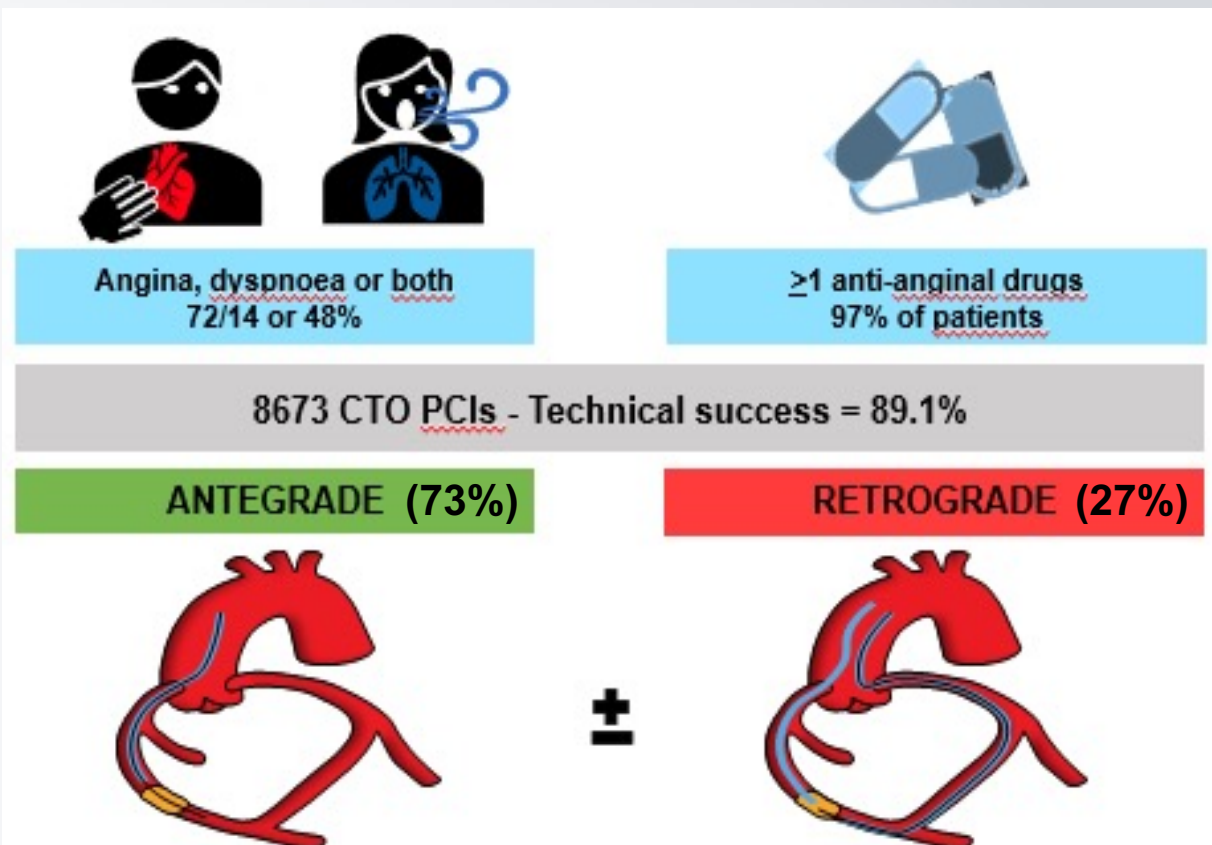
Giuseppe Vadalà¹, MD; Alfredo R. Galassi^{2*}, MD, PhD; Gerald S. Werner³, MD, PhD; George Sianos⁴, MD; Nicolaus Boudou⁵, MD; Roberto Garbo⁶, MD; Laura Maniscalco¹, PhD; Alexander Bufe⁷, MD; Alexander Avran⁸, MD; Gabriele L. Gasparini⁹, MD; Eugenio La Scala¹⁰, MD; Andrew Ladwiniec¹¹, MD; Meruzhan Saghatelyan¹², MD; Omer Goktekin¹³, MD, PhD; Sevket Gorgulu¹⁴, MD; Nicolaus Reifart¹⁵, MD, PhD; Pierfrancesco Agostoni¹⁶, MD; Sudhir Rathore¹⁷, MD; Mohamed Ayoub¹⁸, MD; Michael Behnes¹⁹, MD; Iskander Atmowihardjo²⁰, MD; Mario Iannaccone²¹, MD; Roberto Diletti²², MD; Carlo di Mario²³, MD, PhD; Kambis Mashayekhi^{24,25}, MD, PhD; on behalf of the EURO CTO investigators

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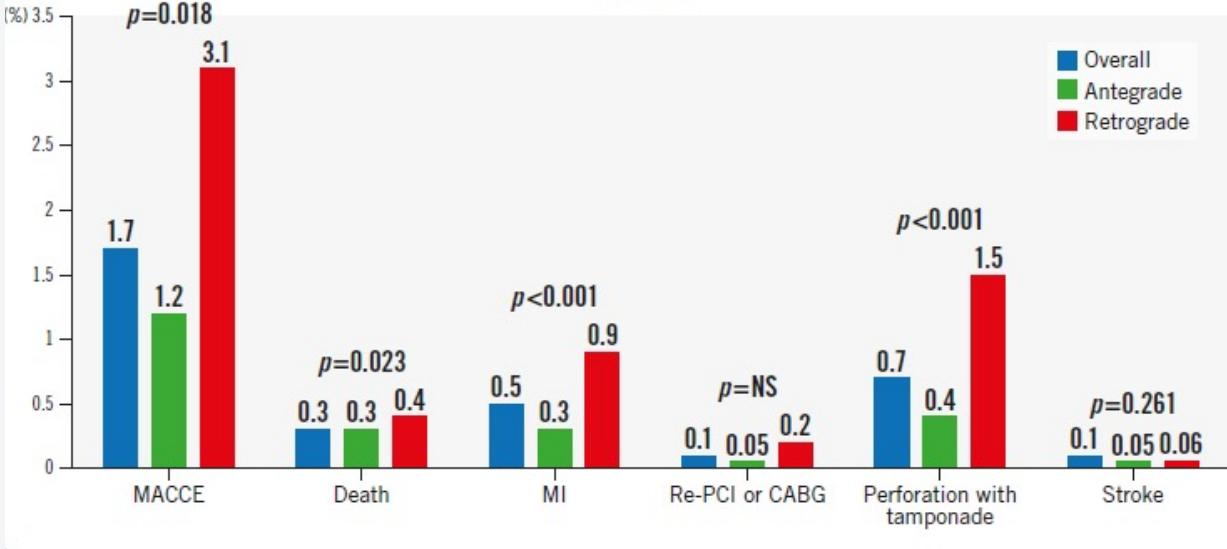
This paper also includes supplementary data published online at: <https://eurointervention.pcronline.com/doi/10.4244/EIJ-D-23-00490>

Contemporary Outcomes of CTO PCI in Europe: the ERCTO Registry (2021-2022)

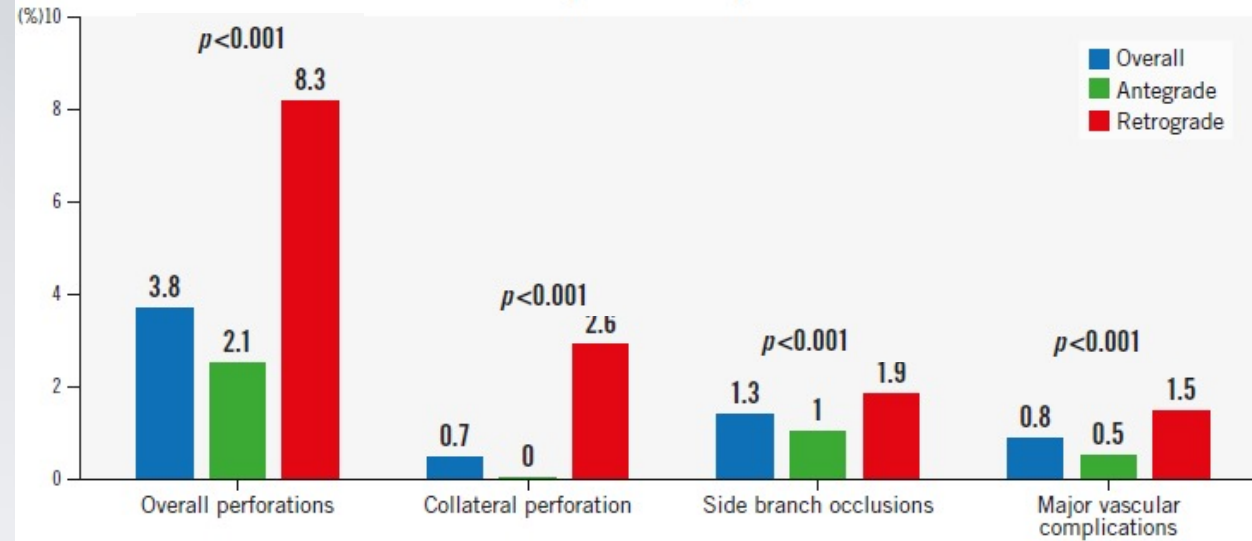


Procedural and in-hospital complications

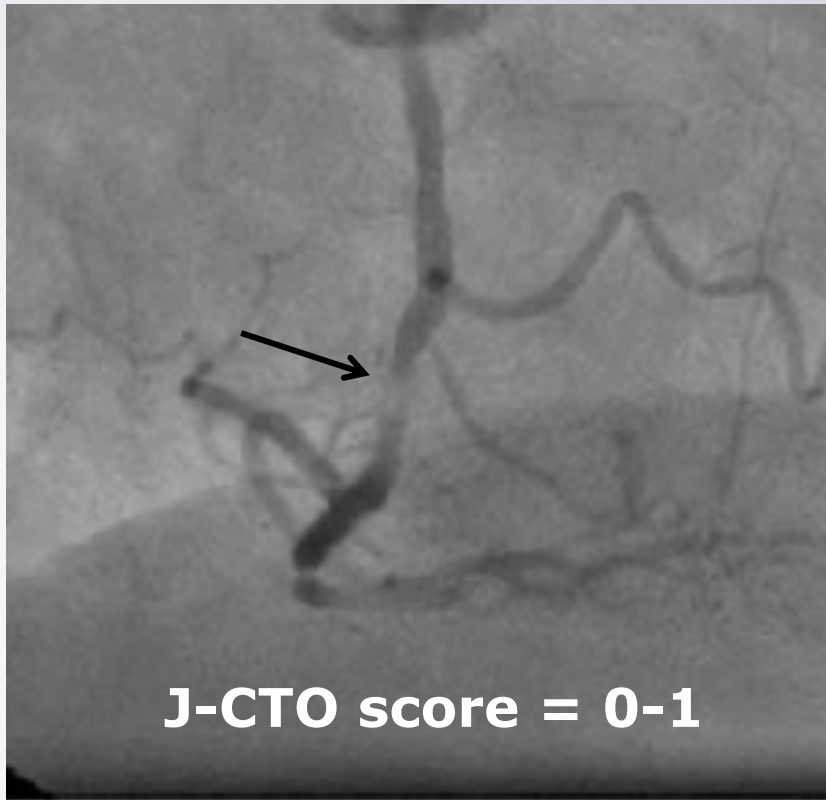
MACCE



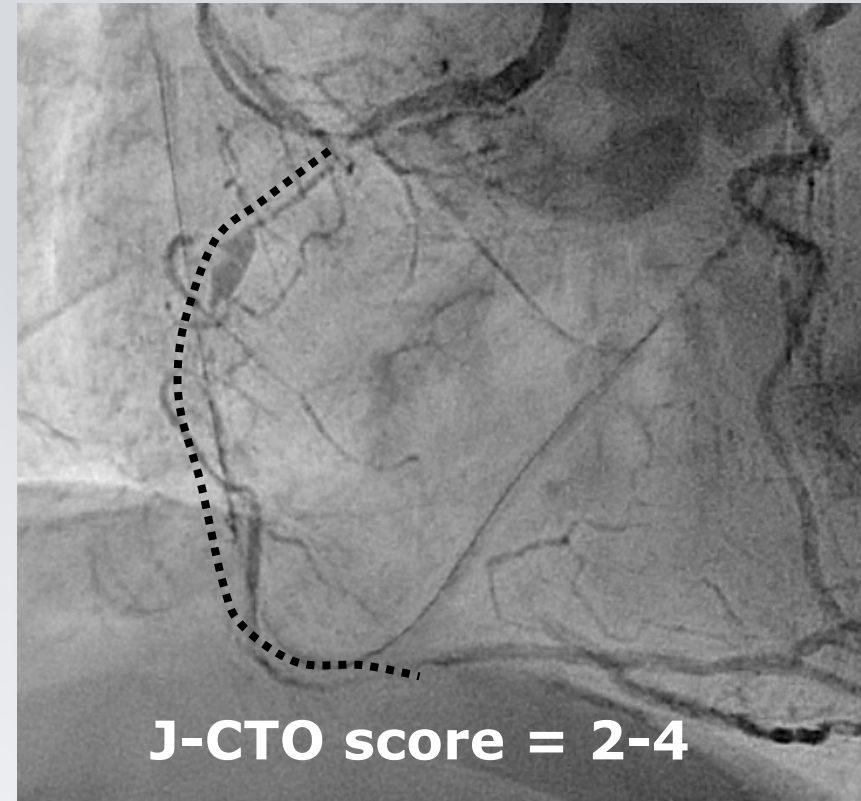
Other procedural complications



There are CTO's and CTO's



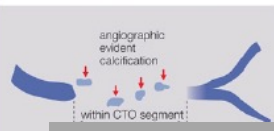
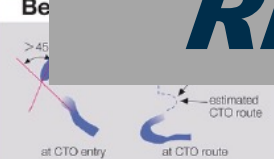
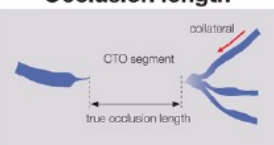


**can be attempted by
a low-medium
volume CTO operator**



**Should be attempted
by high volume CTO
operator**

J-CTO score sheet: predicting complexity

Variables and definitions		Entry shape
<p>Tapered</p> 	<p>Blunt</p> 	<p>Entry with any tapered tip or dimple indicating direction of true lumen is categorized as "tapered".</p> <p><input type="checkbox"/> Tapered (0)</p> <p><input type="checkbox"/> Blunt (1)</p>
		point
<p>Calcification</p> 		<p>Regardless of severity, 1 point is assigned if any evident calcification is detected within the CTO segment.</p> <p>Calcification</p> <p><input type="checkbox"/> Absence (0)</p> <p><input type="checkbox"/> Presence (1)</p>
		point
<p>Bent</p> 		<p>RECALL</p> <p>>45°</p> <p>CTO segment. Any tortuosity separated from the CTO segment is excluded from this assessment.</p> <p><input type="checkbox"/> Presence (1)</p>
		point
<p>Occlusion length</p> 		<p>Using good collateral images, try to measure "true" distance of occlusion, which tends to be shorter than the first impression.</p> <p>Occl.Length</p> <p><input type="checkbox"/> <20mm (0)</p> <p><input type="checkbox"/> ≥20mm (1)</p>
		point
<p>Re-try lesion</p> <p>Is this Re-try (2nd attempt) lesion? (previously attempted but failed)</p>		<p>Re-try lesion</p> <p><input type="checkbox"/> No (0)</p> <p><input type="checkbox"/> Yes (1)</p>
		point
<p>Category of difficulty (total point)</p> <p><input type="checkbox"/> easy (0) <input type="checkbox"/> Intermediate (1)</p> <p><input type="checkbox"/> difficult (2) <input type="checkbox"/> very difficult (≥3)</p>		<p>Total</p> <p><input type="checkbox"/> points</p>

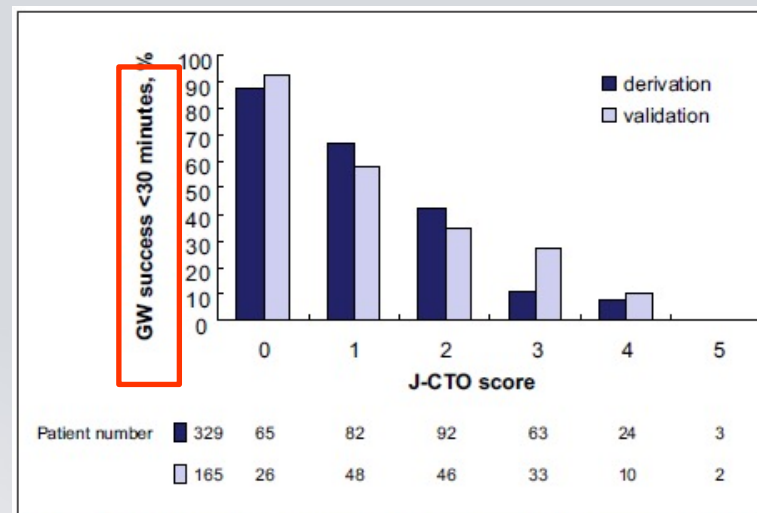


Figure 1. Relationship Between J-CTO Score and GW Success <30 Min

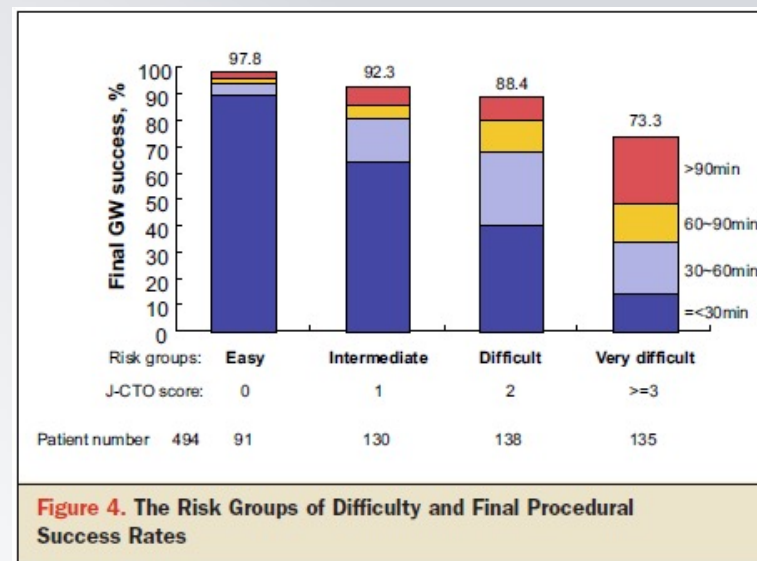
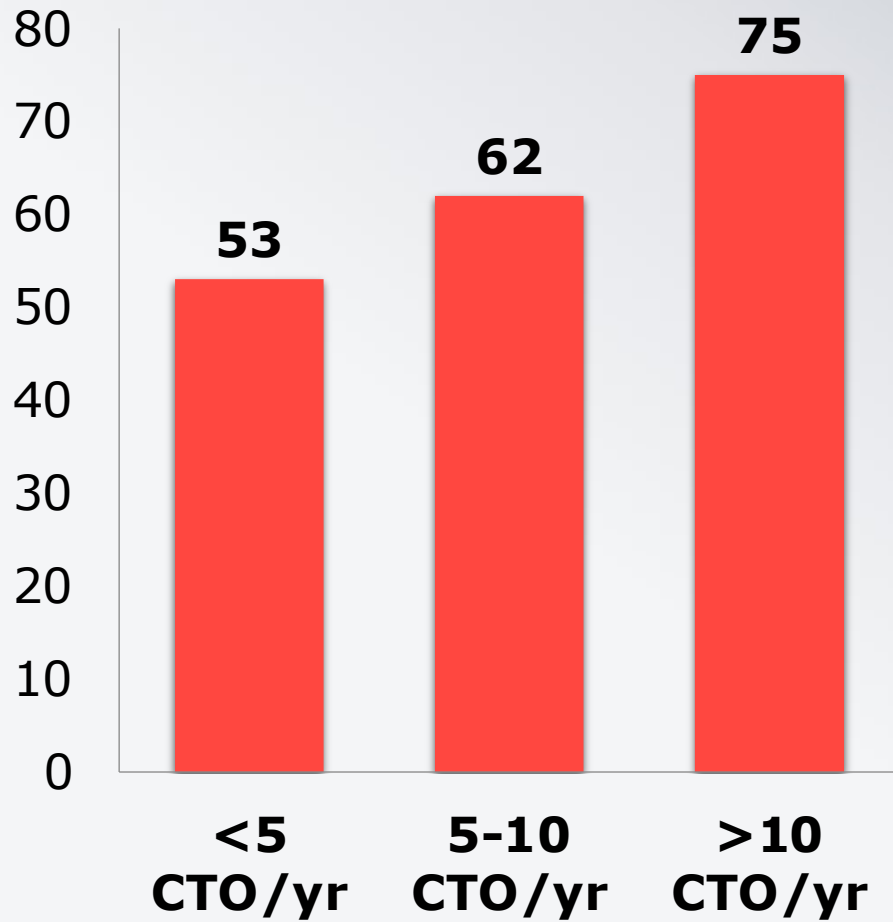


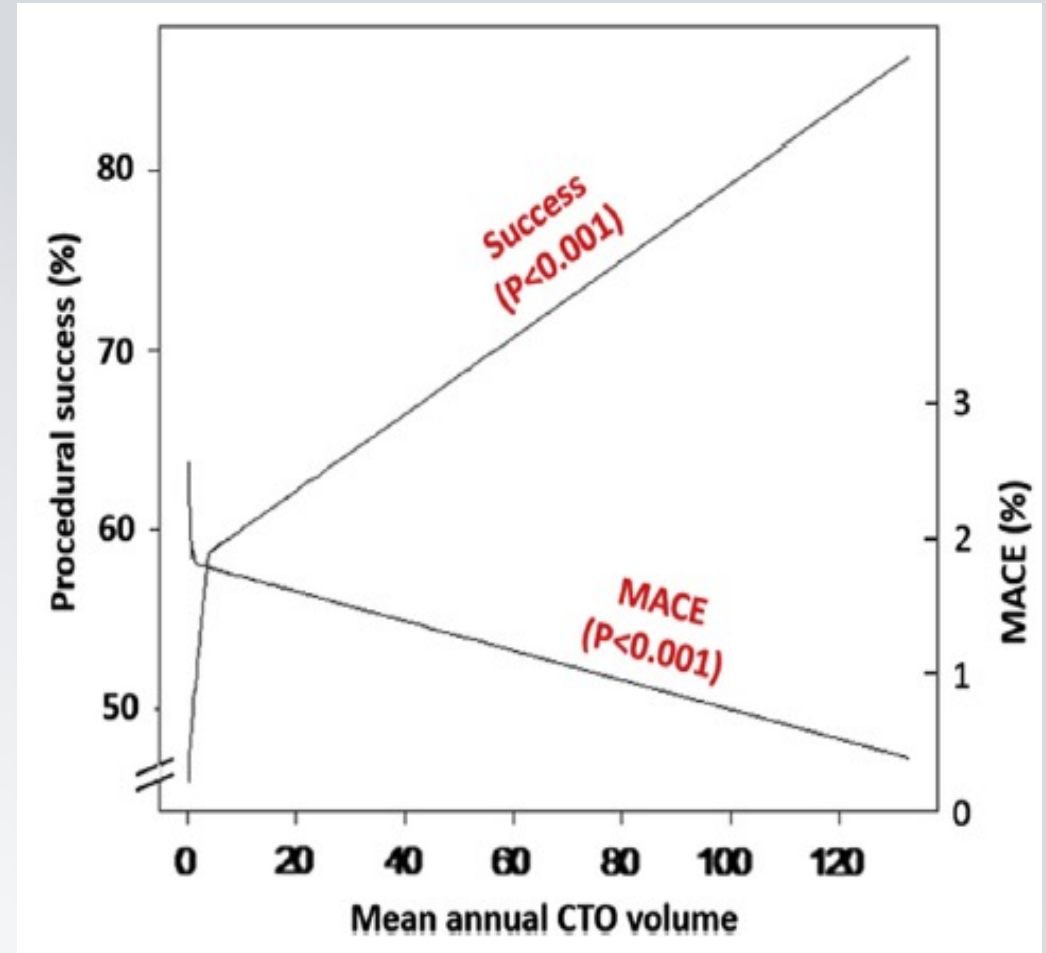
Figure 4. The Risk Groups of Difficulty and Final Procedural Success Rates

Success rates and operator volumes

Success rate and operator volume



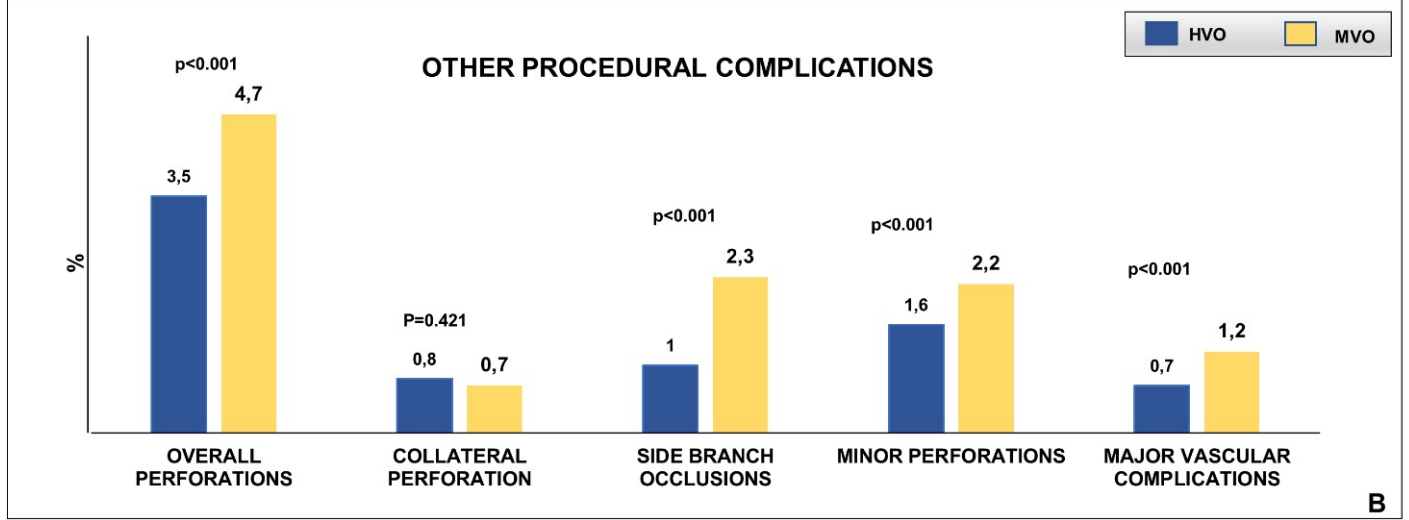
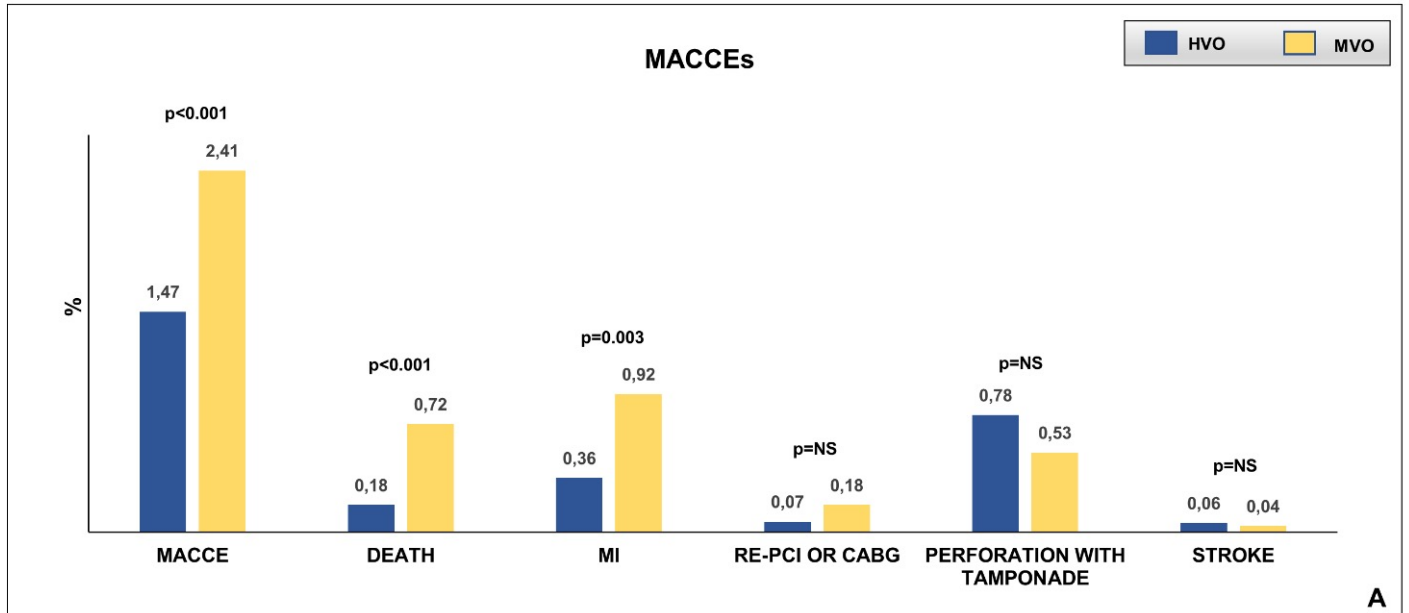
MACE rate and operator volume



Contemporary outcomes of CTO PCI in Europe: the ERCTO Registry

High-volume operator (HVO)
 >300 certified entries in the ERCTO

Low-volume operator (LVO)
 <300 certified entries in the ERCTO



In-hospital complications in patients undergoing PCI in non-CTO and CTO Vessels

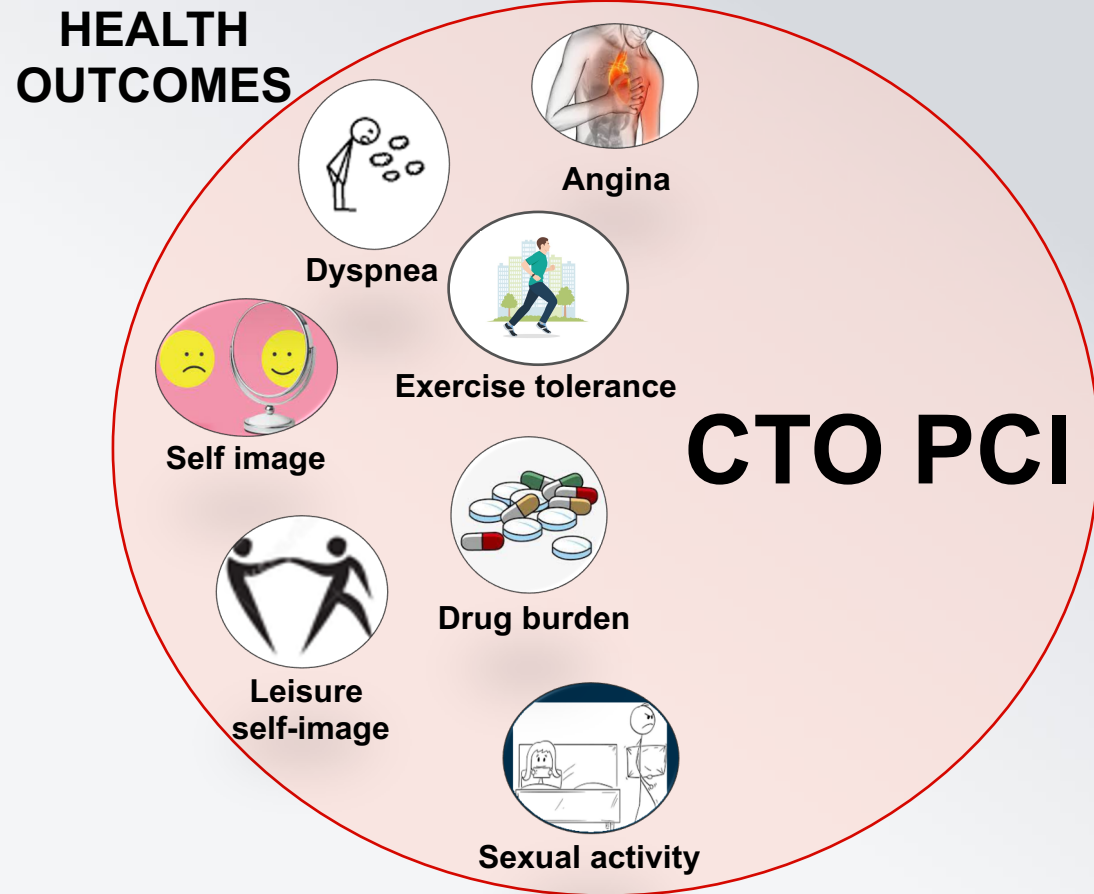
In-Hospital Complications	PCI	CTO PCI
Q-wave myocardial infarction	0.02 %	2.5 %
Emergency CABG	0.03 %	0.1 %
Stroke	0.04 %	0.01 %
Mortality	0.14 %	0.2–0.9 %
Perforation	0.38 %	2–4.8 %

Source: Ludman and British Cardiovascular Intervention Society, 2017;² Prasad et al., 2007;⁹ Patel et al., 2013;¹⁰ El Sabbagh et al., 2014¹¹

CTO: Why and How to Revascularize

- ✓ The advance in CTO PCI
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CTO Revascularization – Body of Evidences



Quality of Life Changes After Chronic Total Occlusion Angioplasty in Patients With Baseline Refractory Angina

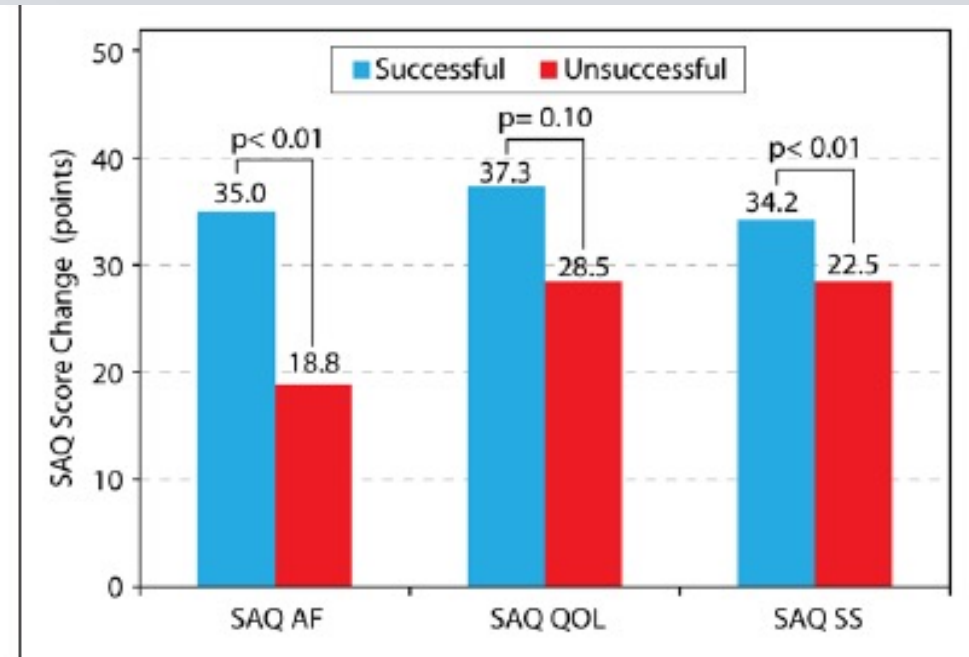
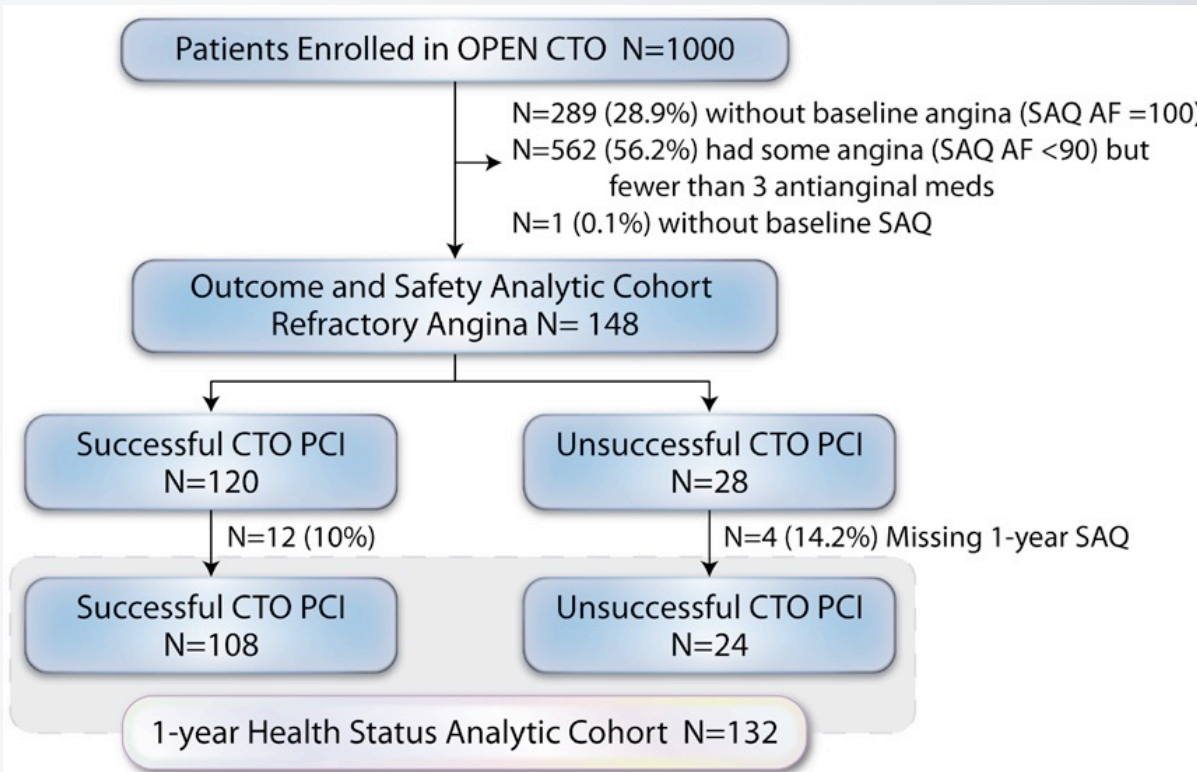
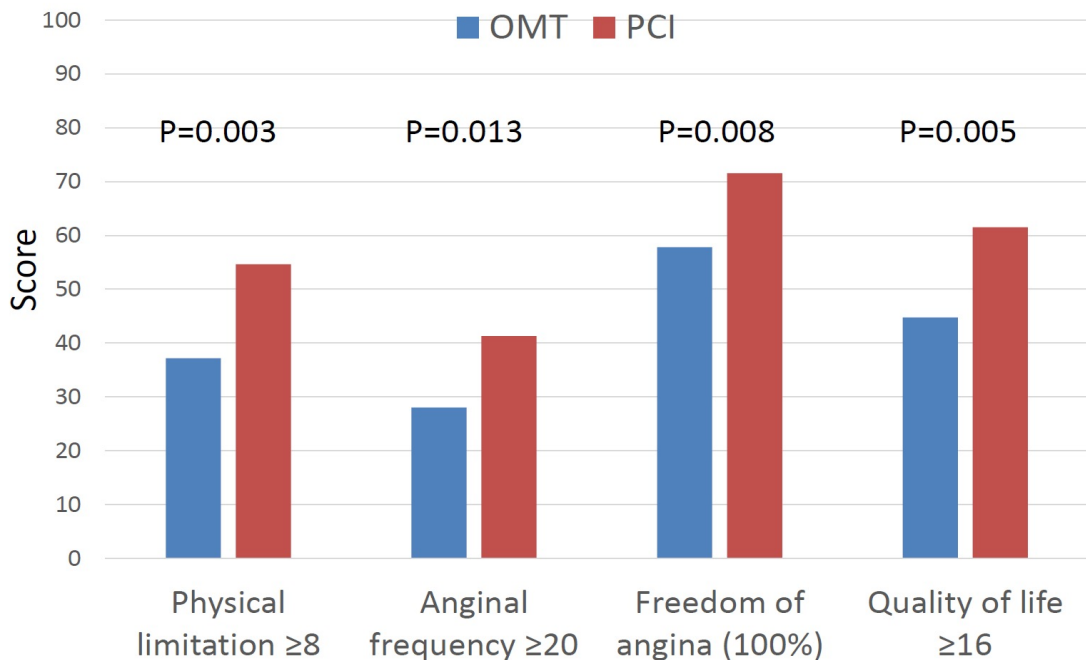


Figure 3. Improvement of Seattle Angina Questionnaire (SAQ) scores after chronic total occlusion (CTO) percutaneous coronary intervention (PCI) stratified by success of the CTO PCI attempt in patients with refractory angina.

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

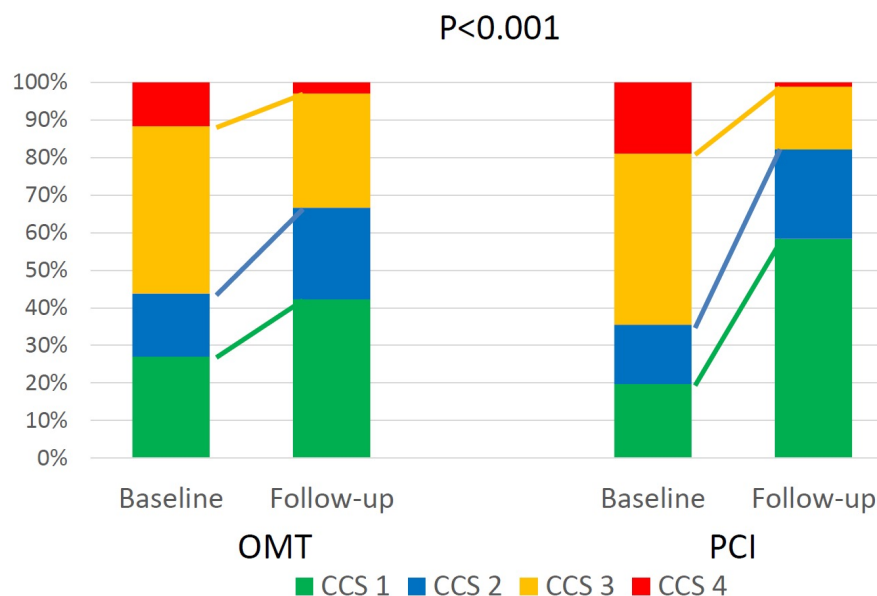
euro PCR

Significant change in SAQ subscale scores *



euro PCR

Changes in CCS class during follow-up



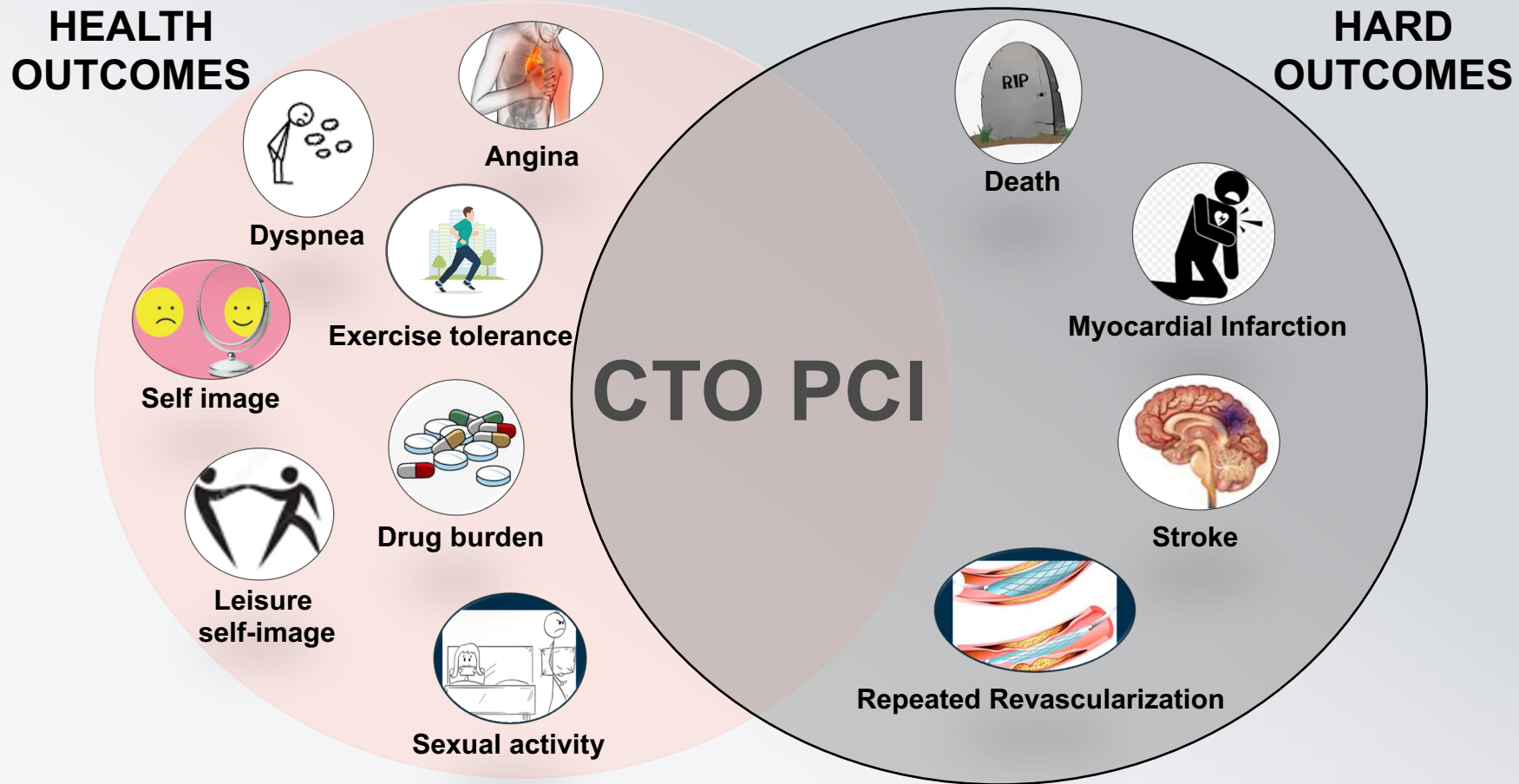
Higher score, better health status

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

CTO: Why and How to Revascularize

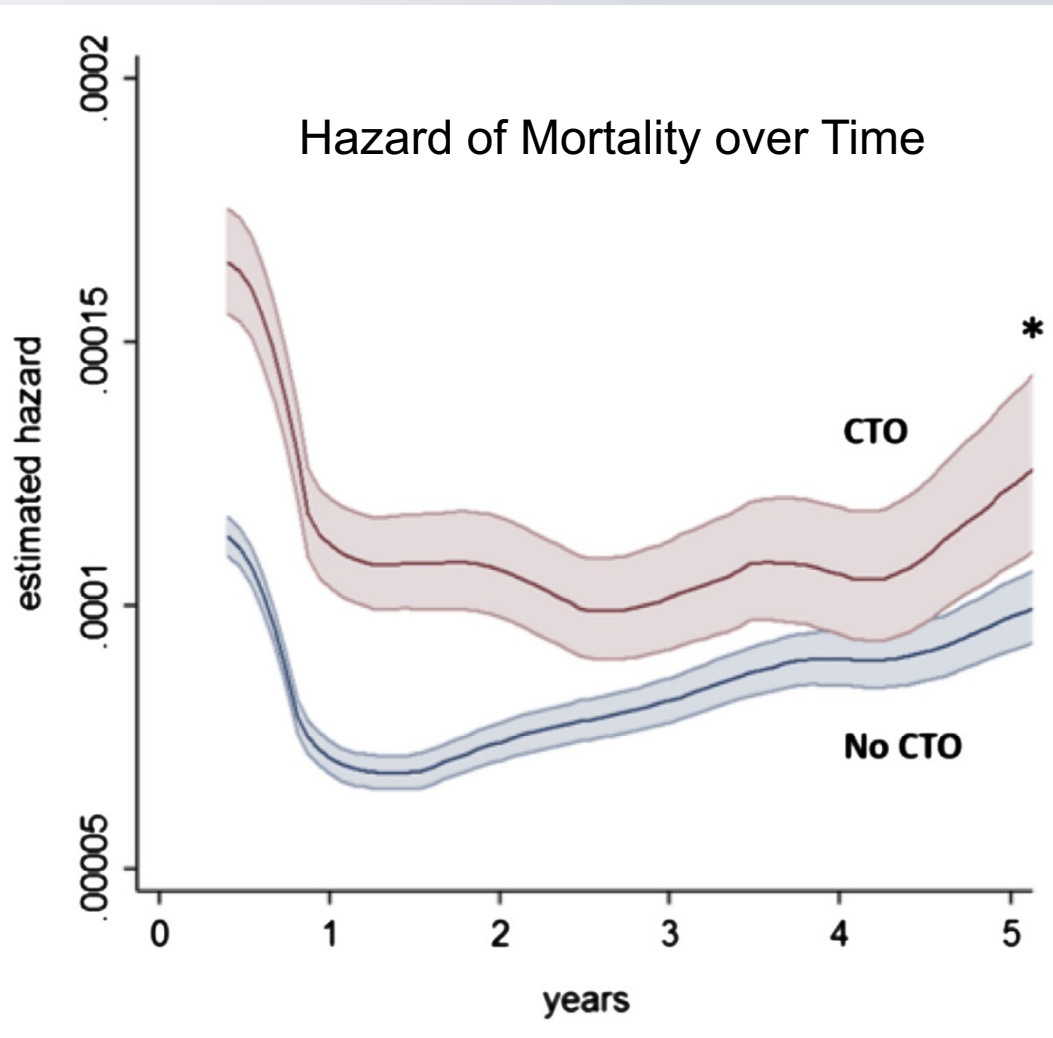
- ✓ The advance in CTO PCI
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CTO Revascularization – Body of Evidences



SCAAR: Prognostic Importance of CTO

14,441 patients with CTO and 75,431 patients without CTO from 2005-2012

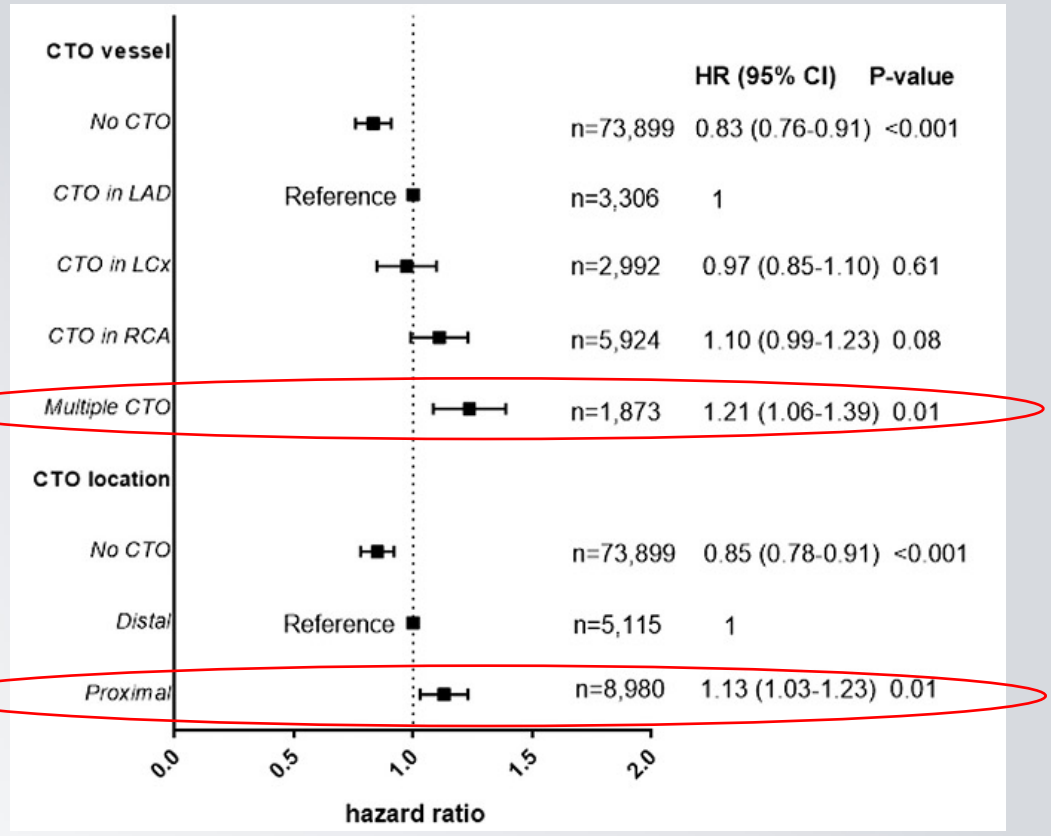


CTO was associated with higher mortality
HR: 1.29 (1.22-1.37), $p < 0.001$

Risk attributable to CTO was greatest in patients with STEMI and younger patients



TABLE 2 Multivariate Cox Proportional Hazards Regression Analysis

	HR	95% CI	p Value
CTO	1.29	1.22-1.37	<0.001
Age	1.08	1.07-1.08	<0.001
Male	0.99	0.95-1.04	0.733
Smoking			
Never	Reference		
Previous	1.19	1.13-1.25	<0.001
Current	1.83	1.72-1.94	<0.001
Hypertension	1.07	1.02-1.11	0.003
Hyperlipidemia	0.91	0.87-0.96	<0.001
Diabetes mellitus	1.69	1.62-1.77	<0.001
Previous MI	1.49	1.42-1.57	<0.001
Previous PCI	0.94	0.89-1.01	0.078
Indication			
Stable angina	Reference		
Other	2.65	2.43-2.83	<0.001
Unstable angina/non-STEMI	1.65	1.55-1.76	<0.001
STEMI	2.34	2.17-2.52	<0.001
Severity of CAD			
1-vessel	Reference		
2-vessel	1.16	1.10-1.22	<0.001
3-vessel	1.45	1.37-1.53	<0.001
Left main	1.86	1.73-1.99	<0.001
Hospital volume			
Low	Reference		
Middle	1.07	0.95-1.20	0.261
High	1.08	0.95-1.22	0.245
Year of procedure (2005-2012)	0.98	0.97-0.99	0.023*
CTO × year†	1.06	1.03-1.08	<0.001
Puncture site			
Femoral	1.27	1.21-1.34	<0.001
Any complication	1.45	1.33-1.58	<0.001
Primary decision‡			
No intervention	Reference		
PCI	0.63	0.59-0.67	<0.001
CABG	0.64	0.60-0.66	<0.001



CTO Revascularization – body of evidences 2022

Study or Author	Study Type	Comparators	Study Population	Outcome of Interest	Results
EXPLORE (n=304) ⁹	RCT	CTO PCI vs no CTO PCI	Post-PCI STEMI patients with concurrent CTO	4 mo LVEF and LVEDV assessed on cMRI	No difference between groups
DECISION-CTO (n=834) ⁵	RCT	CTO PCI+OMT vs OMT alone	Stable angina, nonsymptomatic ischemia, or ACS with CTO	3 y death, MI, stroke, or repeated revascularization	No difference between groups
EURO-CTO (n=396) ⁶	RCT	CTO PCI+OMT vs OMT alone	Stable angina or equivalent with CTO in viable territory	QOL by SAQ score (primary) 1 y death or nonfatal MI (secondary)	Improved QOL in CTO PCI arm (primary) No difference between groups (secondary)
Galassi et al 2017 (n=839) ⁴	Observational	CTO PCI in patients with LVEF ≥50%, 35%–50%, and ≤35%	Symptomatic patients undergoing elective CTO PCI with inducible ischemia in CTO territory	2 y cardiac death, MI, stroke, or revascularization-free survival	No difference among groups; highest benefit in LVEF ≤35% group
Jang et al 2014 (n=738) ¹⁴	Observational	CTO treated with OMT alone vs OMT+CABG or PCI	CTO on angiogram with Rentrop 3 collateral circulation	42 mo cardiac death, MACE (cardiovascular death, MI, repeated revascularization)	Significant lower incidence of cardiac death and MACEs in revascularization compared with OMT group
George et al 2014 (n=13 443) ¹¹	Observational	Successful vs unsuccessful CTO PCI	At least 1 CTO intervention	Procedural success (primary) 5 y mortality (secondary)	Procedural success of 70.6%; decreased mortality in those with successful revascularization compared with failed revascularization
Yang et al 2016 (n=1547) ¹³	Observational	CTO PCI vs OMT	Symptomatic angina or +functional ischemia study with CTO	Cardiac death at follow-up (median follow-up, 45.8 mo)	No difference in rate of cardiac death between OMT and PCI groups
Goel et al 2018 (n=632) ¹²	Observational	CTO PCI success vs failure	Consecutive cases with at least 1 CTO	Survival free of all adverse outcomes (death, MI, repeated PCI or CABG, recurrent angina) (median follow-up, 2.9 y)	Significantly higher event-free survival in successful vs unsuccessful CTO PCI No difference in death or MI individually (subgroup analysis)
Tomasello et al 2015 (n=1777) ¹⁵	Observational	CTO PCI vs OMT or CABG	At least 1 CTO	1 y MACE, cardiac death	Significant lower incidence of MACEs and cardiac death in PCI compared with OMT or CABG group

 No differences between CTO-PCI and OMT
 CTO-PCI better than OMT


Comparative Analysis of Patient Characteristics in Chronic Total Occlusion Revascularization Studies



Trials vs Real-World Registries

Comparative Analysis of Chronic Total Occlusion Patients in Randomized Trials and Real-World Registries

6 RCTs (n = 1,047) vs. 10 dedicated CTO registries (n = 76,467), 5 national registries (n = 110,349)

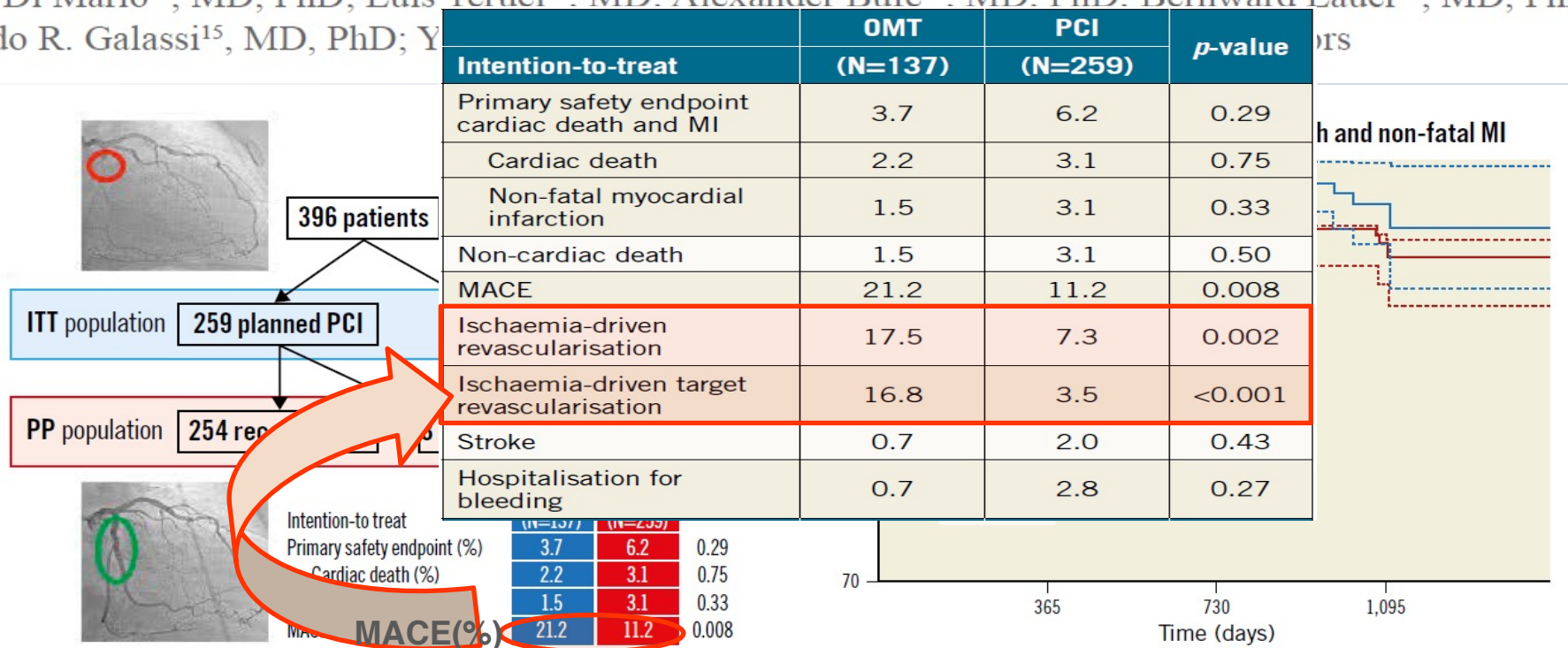
RCT Patient	Compared With Real-World Registries
	Similar procedure success as dedicated CTO registries (84.5% vs. 81.4%)

Current evidence from RCTs may not be representative of real-world patients and should be interpreted within its limitation

Less complex CTO features (shorter, lower J-CTO scores)	and adverse events
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Three-year outcomes of A Randomized Multicentre Trial Comparing Revascularization and Optimal Medical Therapy for Chronic Total Coronary Occlusions (EuroCTO)

Gerald S. Werner^{1*}, MD, PhD; David Hildick-Smith², MD, PhD; Victoria Martin Yuste³, MD, PhD; Nicolas Boudou⁴, MD; Georgios Sianos⁵, MD, PhD; Valery Gelev⁶, MD, PhD; Jose Ramon Rumoroso⁷, MD; Andrejs Erglis⁸, MD, PhD; Evald Høj Christiansen⁹, MD, PhD; Javier Escaned¹⁰, MD, PhD; Carlo Di Mario¹¹, MD, PhD; Luis Teruel¹², MD; Alexander Bufe¹³, MD, PhD; Bernward Lauer¹⁴, MD, PhD; Alfredo R. Galassi¹⁵, MD, PhD; Y

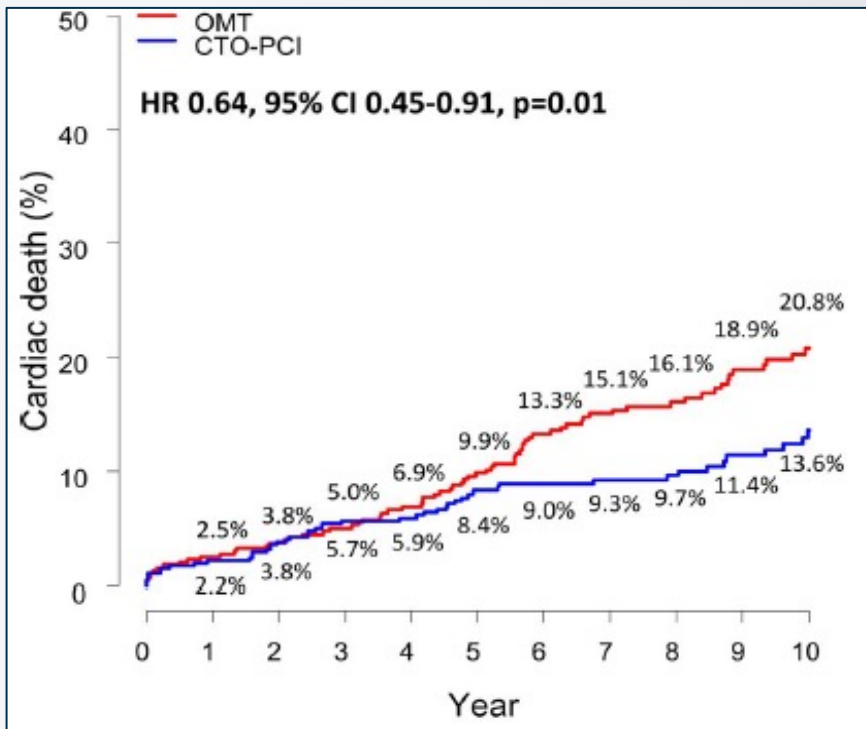


CTO Revascularization – body of evidences

Journal of the American Heart Association

ORIGINAL RESEARCH

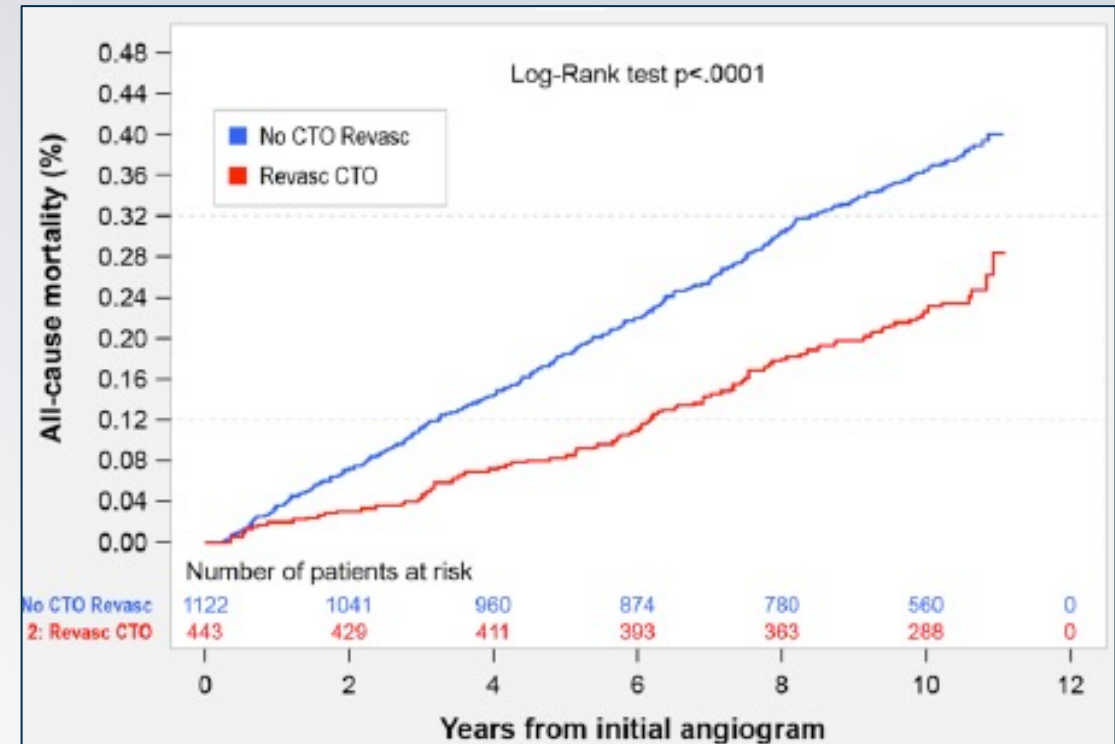
Late Survival Benefit of Percutaneous Coronary Intervention Compared With Medical Therapy in Patients With Coronary Chronic Total Occlusion: A 10-Year Follow-Up Study



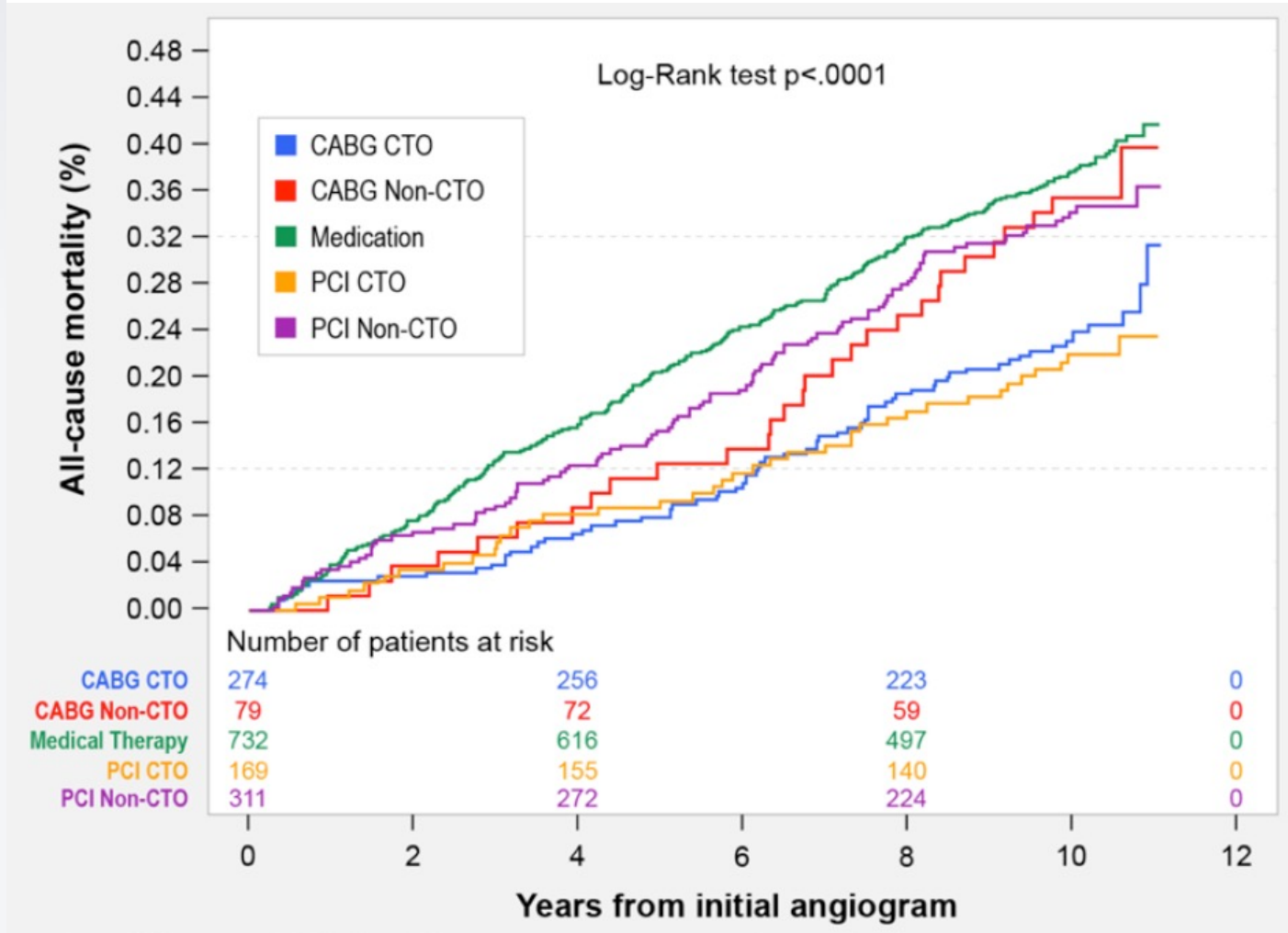
Circulation: Cardiovascular Interventions

ORIGINAL ARTICLE

Canadian Multicenter Chronic Total Occlusion Registry: Ten-Year Follow-Up Results of Chronic Total Occlusion Revascularization

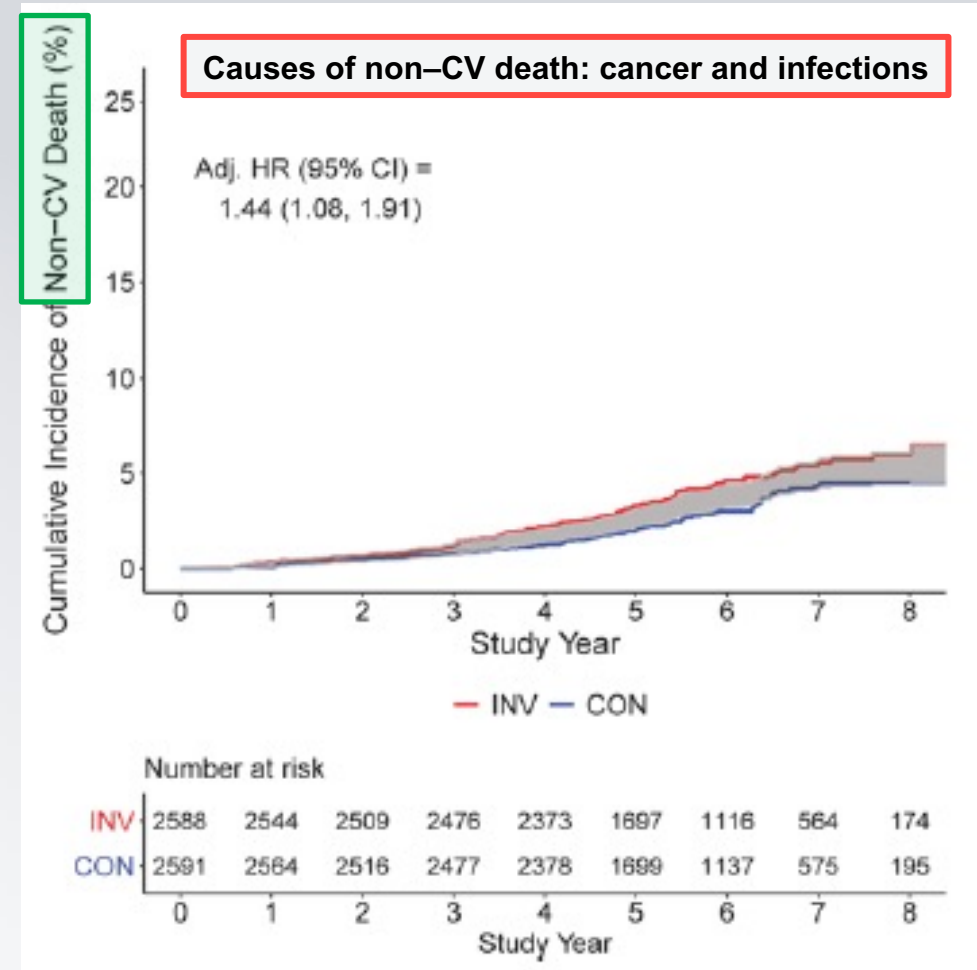
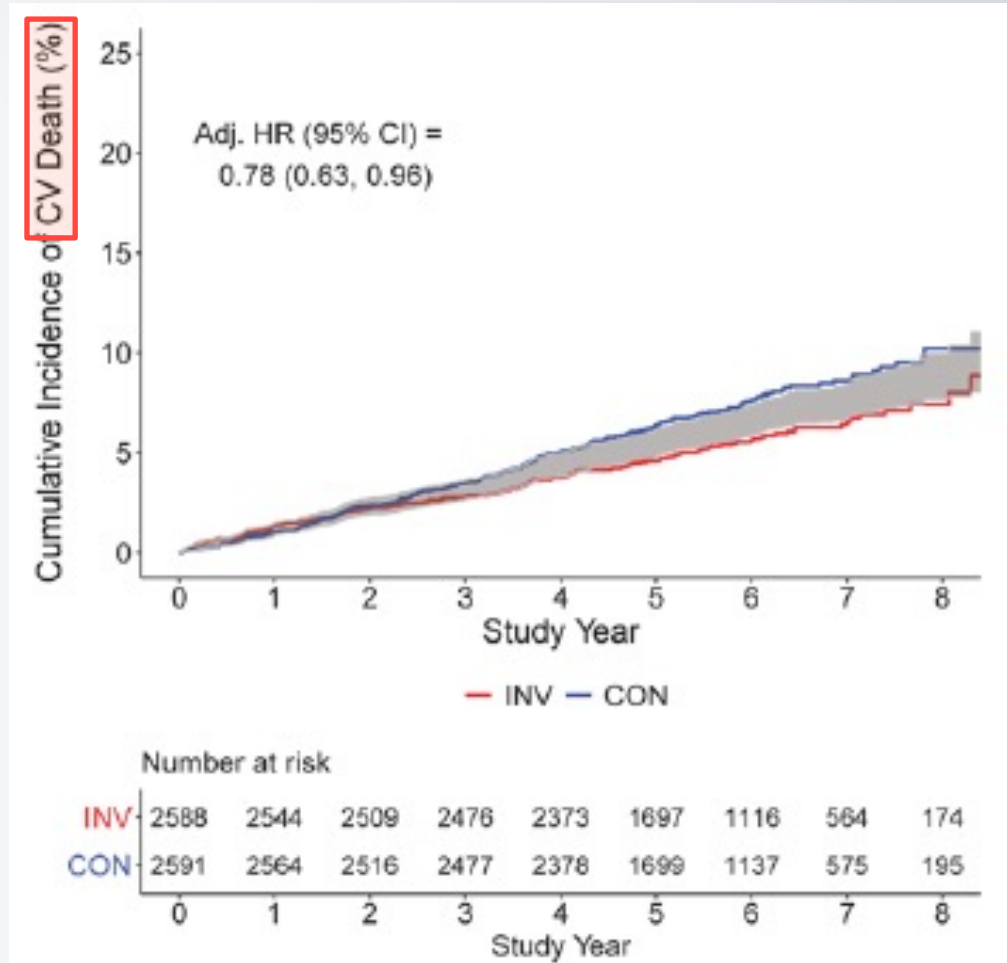


Canadian Multicenter Chronic Total Occlusion Registry: Ten-Year Follow-Up Results of Chronic Total Occlusion Revascularization



Strauss et al. *Circ Cardiovasc Interv* 2021

Ischemia-Extended Trial (median 5.7 yrs)



Percutaneous Coronary Intervention of Chronic Total Occlusions in Patients With Low Left Ventricular Ejection Fraction

Alfredo R. Galassi, MD,
Oliver Gaemperli, MD,
Kambis Mashayekhi, MD

Lobna Laroussi, MD,^c
Inz J. Neumann, MD,^d

Patients CTO Patients with EF<35% successfully revascularized Improvement in LVEF

ABSTRACT

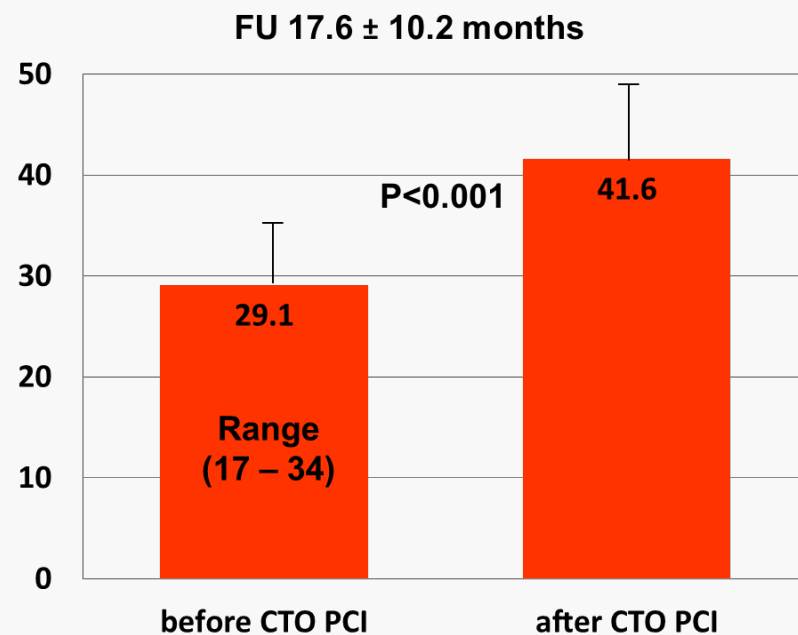
OBJECTIVES The s
occlusions (CTOs) in

BACKGROUND Dat

METHODS The auth
undergoing elective I
to 50%), and group :

RESULTS A total of
LVEF ≤35% was pre
the 3 groups (93.5%
CTO PCI were observ
including those with
in the 3 groups (86%
presence of a succes

CONCLUSIONS In CTO patients with low LVEF, PCI could represent a safe and effective revascularization strategy achieving good midterm outcome and LVEF improvement. (J Am Coll Cardiol Intv 2017; ■: ■-■) © 2017 by the American College of Cardiology Foundation.



of chronic total

scarcely reported.

ve patients
oup 2 (LVEF 35%


attempts. Baseline
and similar among
omplikations of
(93.1%) patients
survival was similar
significantly in the



Initial Invasive Versus Conservative Management of Stable Ischemic Heart Disease in Patients With a History of Heart Failure or Left Ventricular Dysfunction

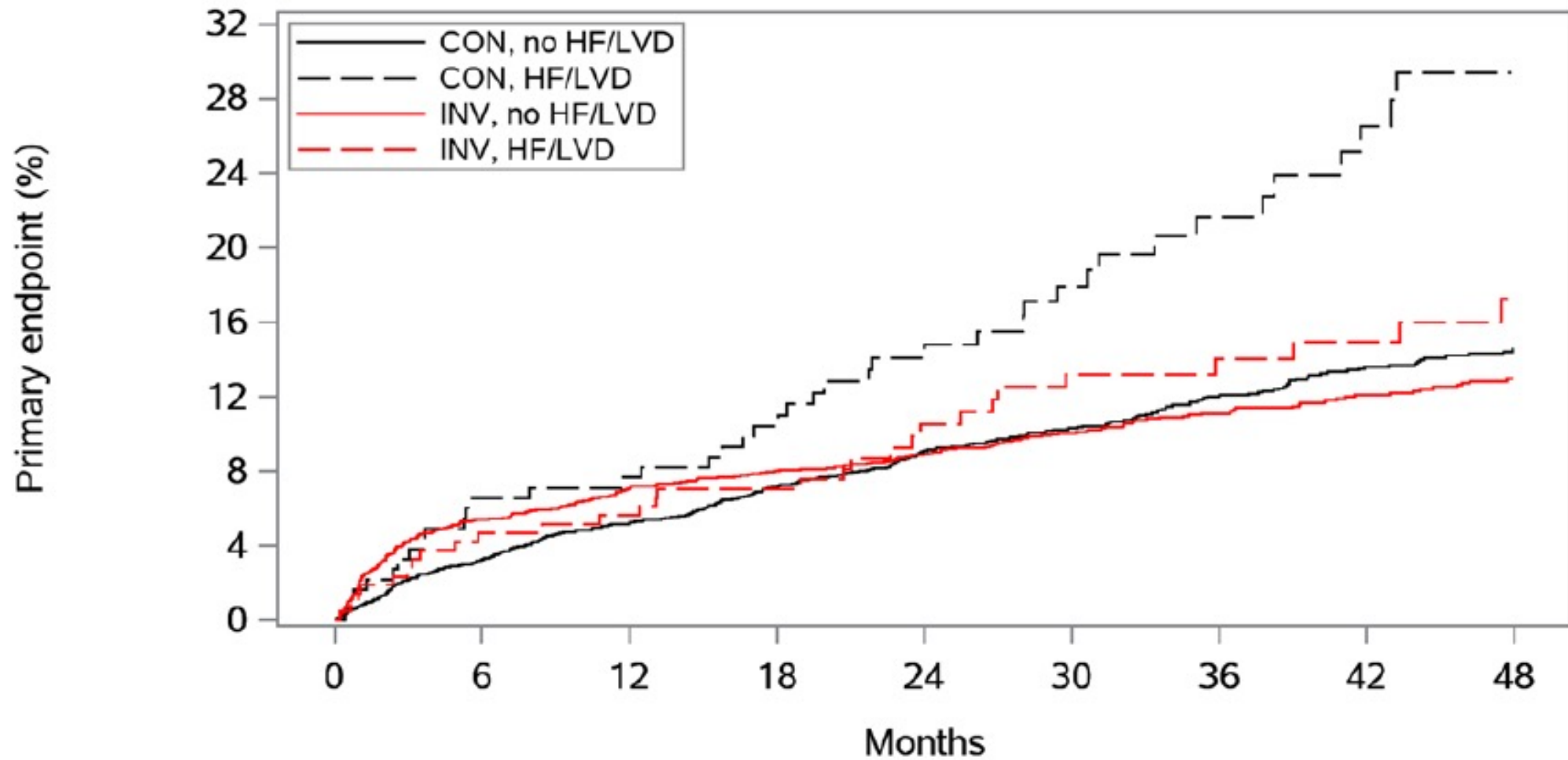
Insights From the ISCHEMIA Trial

CONCLUSIONS: ISCHEMIA participants with stable ischemic heart disease and at least moderate ischemia with a history of HF or LVD were at increased risk for the primary outcome. In the small, high-risk subgroup with HF and LVEF 35% to 45%, an initial invasive approach was associated with better event-free survival. This result should be considered hypothesis-generating.

Renato D. Lopes , MD

:

David J. Maron, MD



	Subjects at Risk								
	0	6	12	18	24	30	36	42	48
CON, no HF/LVD	2404	2311	2260	2114	1781	1469	1222	947	690
CON, HF/LVD	184	172	169	156	124	98	77	56	43
INV, no HF/LVD	2372	2218	2164	2040	1764	1455	1189	913	670
INV, HF/LVD	214	203	199	185	143	121	103	84	63

Lopes RD et al, Circulation 2020

LATEST GUIDELINES



European Heart Journal (2019) 40, 87–165
doi:10.1093/eurheartj/ehy394



ESC/EACTS GUIDELINES

2018 ESC/EACTS Guidelines on myocardial revascularization

Percutaneous revascularization of CTOs should be considered in patients with angina resistant to medical therapy or with a large area of documented ischaemia in the territory of the occluded vessel.^{629,659–663}

IIa

B

CLINICAL PRACTICE GUIDELINE: FULL TEXT

2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization

Recommendation for Treatment of CTO

Referenced studies that support the recommendation are summarized in [Online Data Supplement 29](#).



COR	LOE	RECOMMENDATION
2b	B-R	1. 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 (1-4).

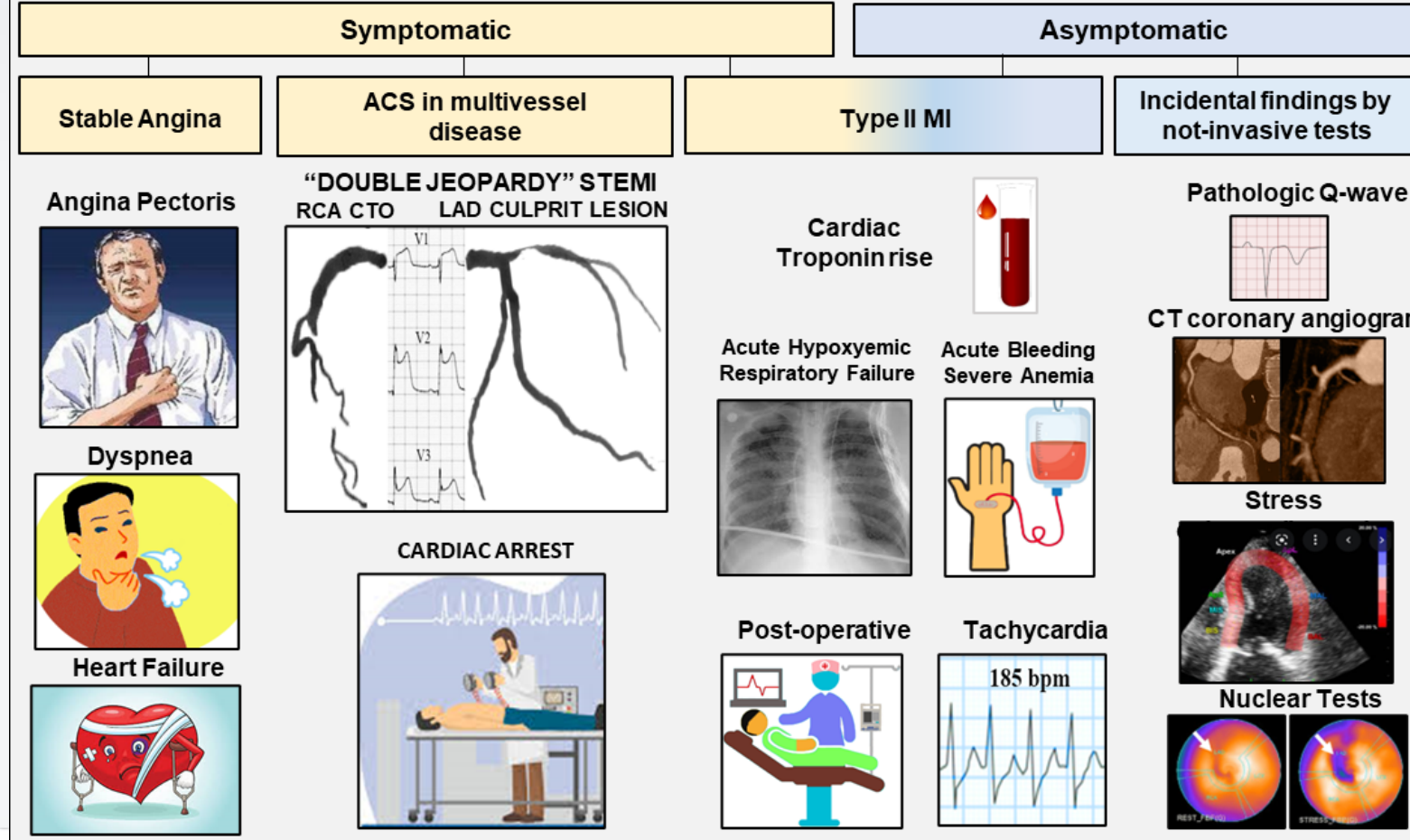
Evaluation and management of patients with coronary chronic total occlusions considered for revascularisation. A clinical consensus statement of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) of the ESC, the European Association of Cardiovascular Imaging (EACVI) of the ESC, and the ESC Working Group on Cardiovascular Surgery

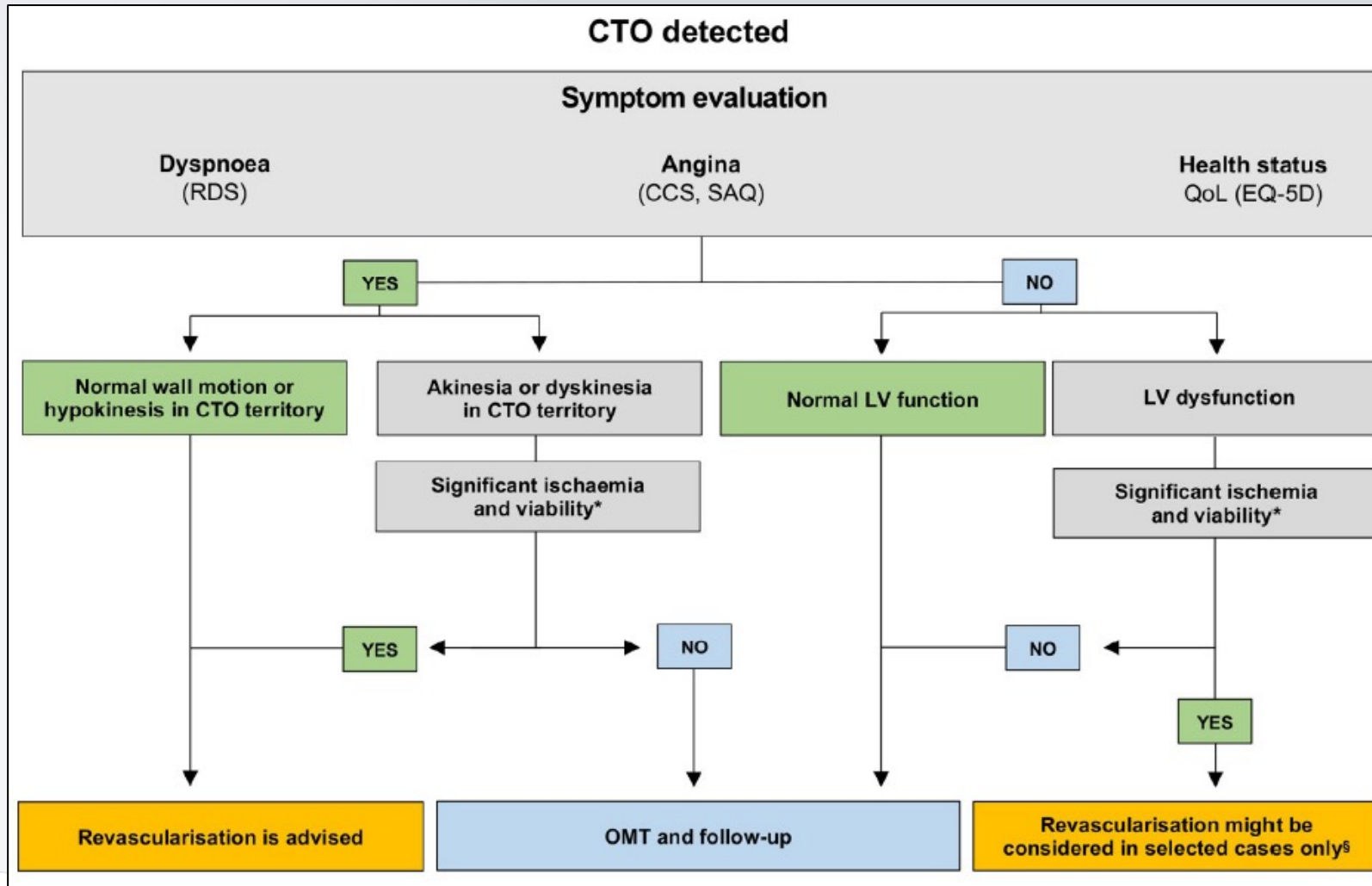
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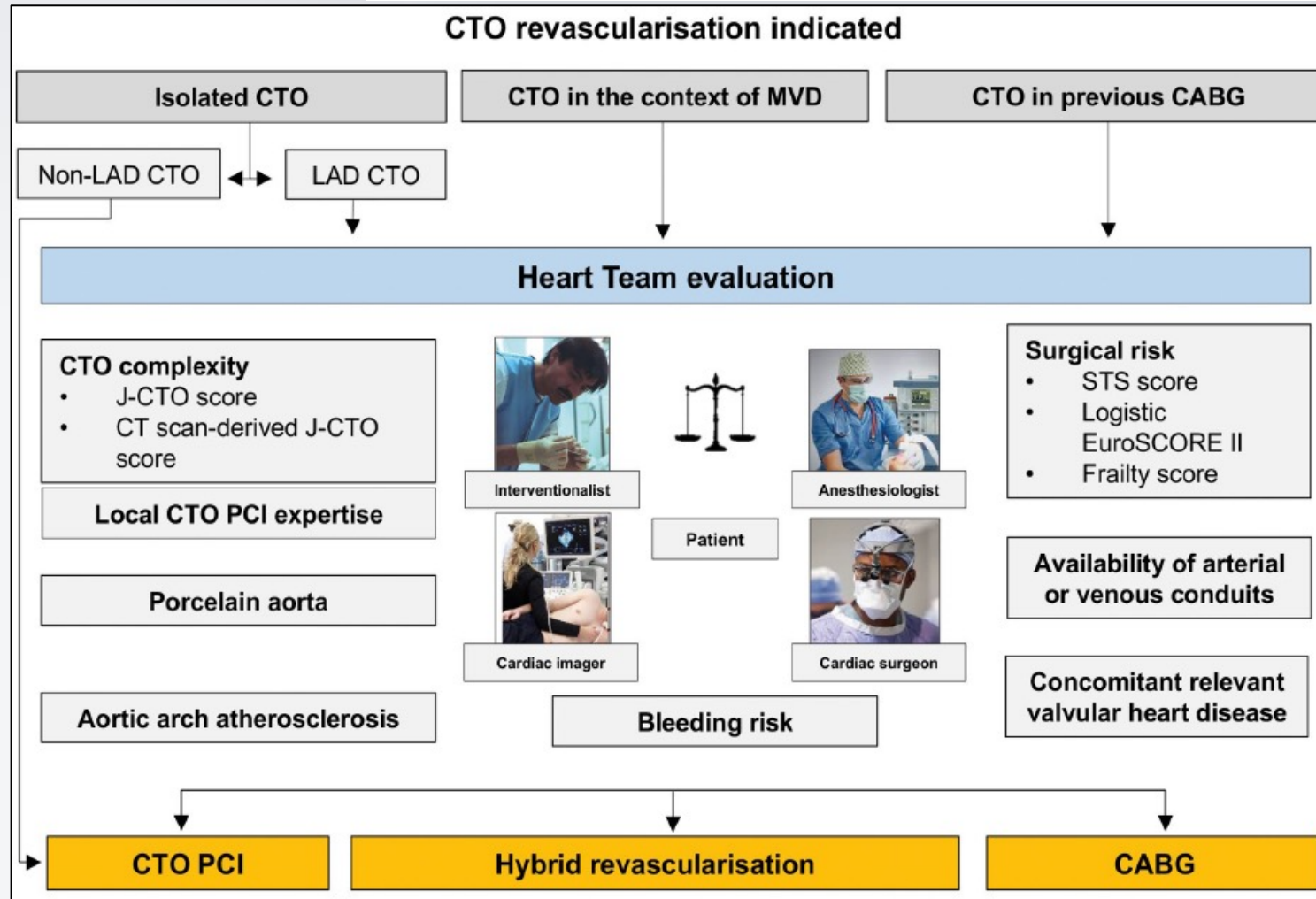
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CTO is found in 20% of coronary angiography

Different presentation modalities of CTO patients







Grazie
per la vostra attenzione

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