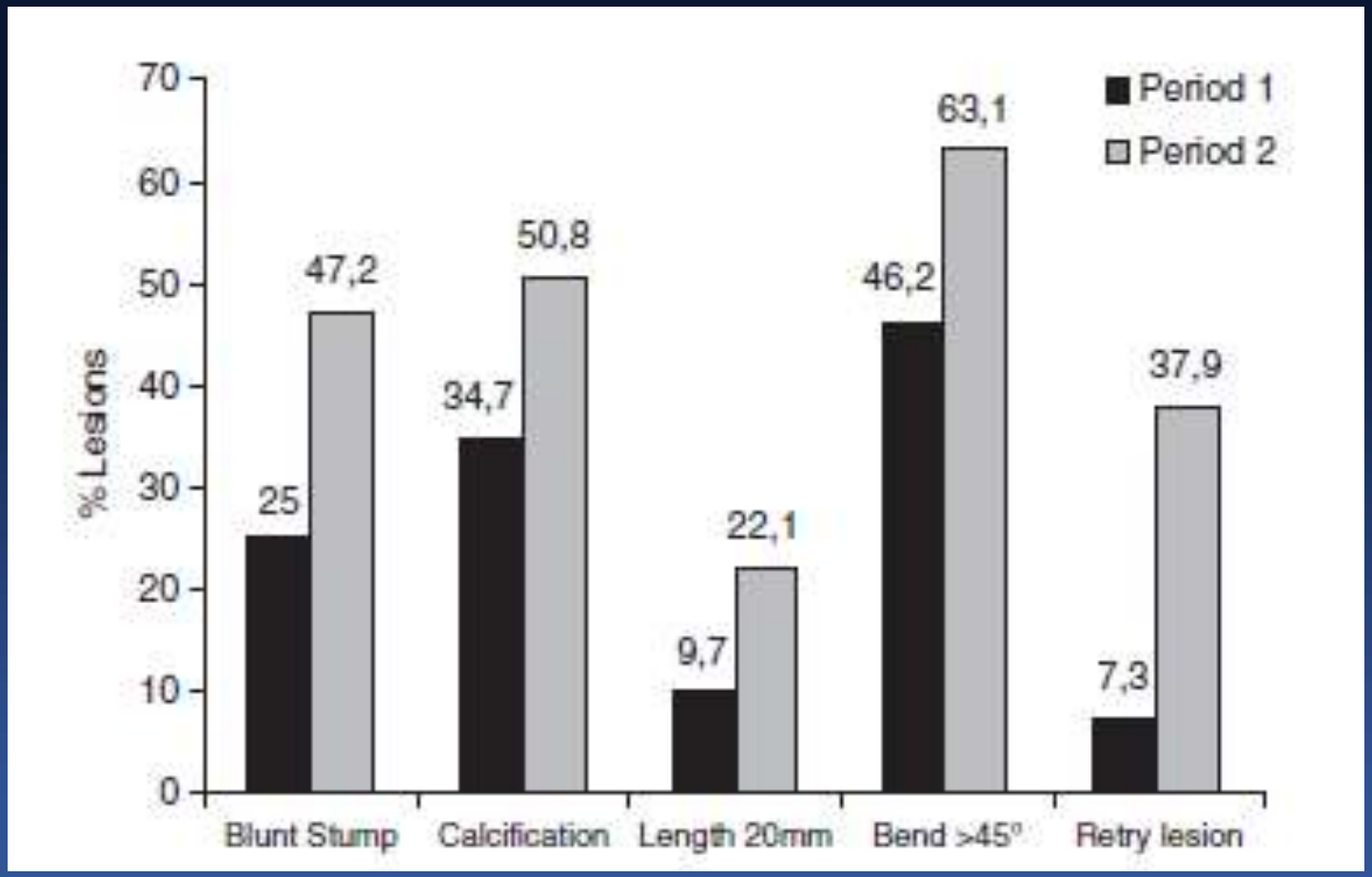
The simpler the better: Simple Approach has Evidence ?

Seung-Whan Lee, MD

Asan Medical Center,
University of Ulsan College of Medicine, Seoul, Korea

Increased CTO lesions complexity Attempted over years



Heart 2013;99:474–479

Higher J-CTO score, Higher events

EuroIntervention. 2016 Jan 22;11(9):981-8. doi: 10.4244/EIJV11I9A202.

Impact of J-CTO score on procedural outcome and target lesion revascularisation after percutaneous coronary intervention for chronic total occlusion: a substudy of the J-CTO Registry (Multicentre CTO Registry in Japan).

Tanaka H[1], Morino Y, Abe M, Kimura T, Hayashi Y, Muramatsu T, Ochiai M, Noguchi Y, Kato K, Shibata Y, Hiasa Y, Doi O, Yamashita T, Morimoto T, Hinohara T, Fujii T, Mitsudo K.

⊕ **Author information**

Abstract

AIMS: We investigated the impact of the J-CTO score, a pre-procedural risk score for successful guidewire crossing within 30 minutes through chronic total occlusion (CTO) lesions, on procedural and midterm clinical outcomes in terms of target lesion revascularisation (TLR) after CTO recanalisation.

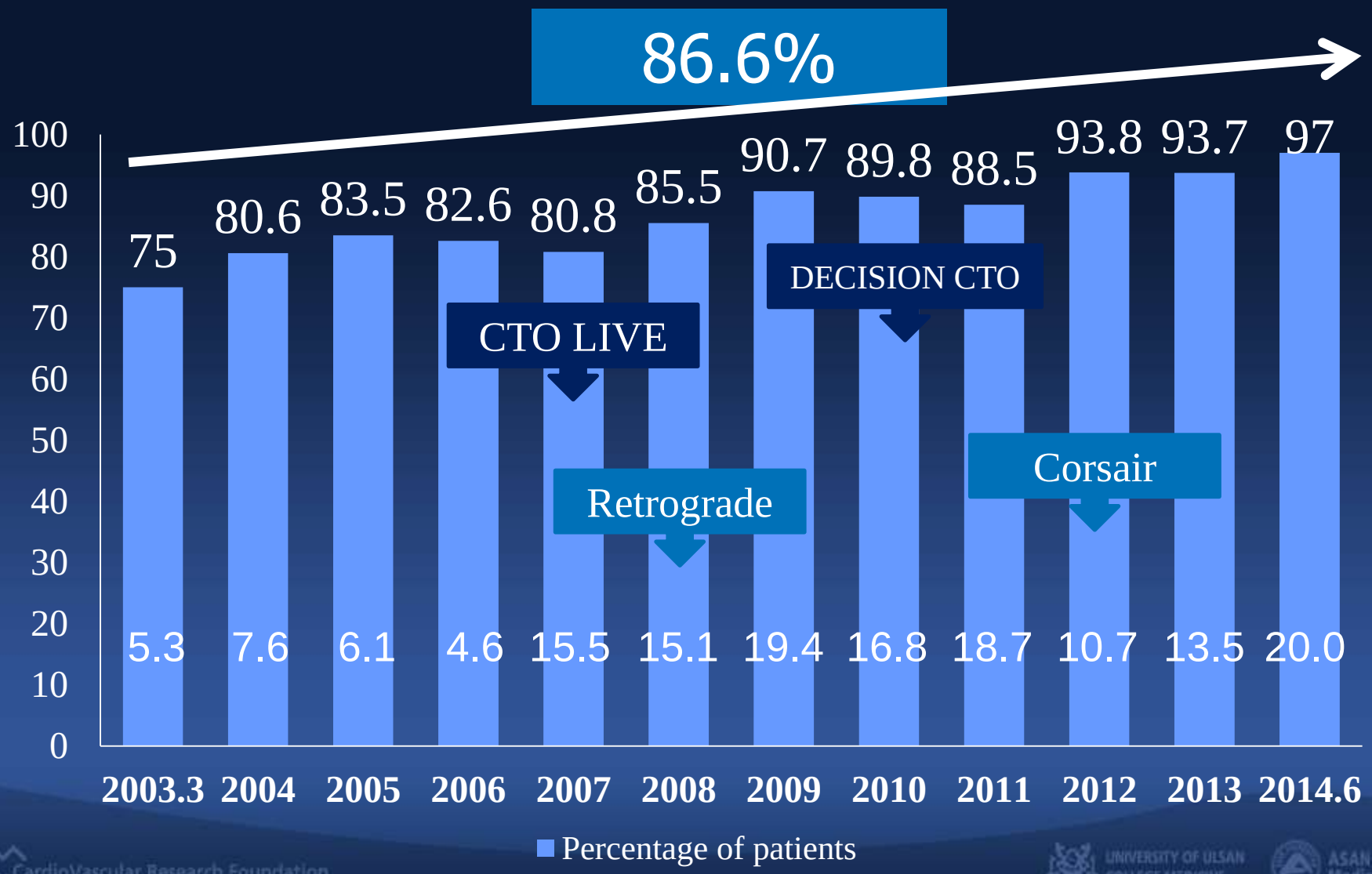
METHODS AND RESULTS: The primary endpoint of this substudy was midterm TLR. The net midterm success rate was calculated by multiplying the lesion success rate by the TLR-free survival rate. The initial lesion success rates according to the J-CTO score categories of 0, 1, 2, and ≥3 were 97.0%, 92.1%, 86.5%, and 73.6%, respectively ($p<0.001$). The TLR rates at one year according to the J-CTO score categories of 0, 1, 2, and ≥3 were 5.3%, 11.1%, 16.7%, and 13.4%, respectively ($p=0.082$). The net midterm success rates according to the J-CTO score categories of 0, 1, 2, and ≥3 were 91.9%, 81.9%, 72.1%, and 63.7%, respectively ($p<0.001$).

CONCLUSIONS: Patients with CTO lesions with lower J-CTO scores are expected to achieve a high procedural success rate and an increased TLR-free survival rate. Patients with high J-CTO scores still remain an issue.

Eurointervention 2016;11:981-8

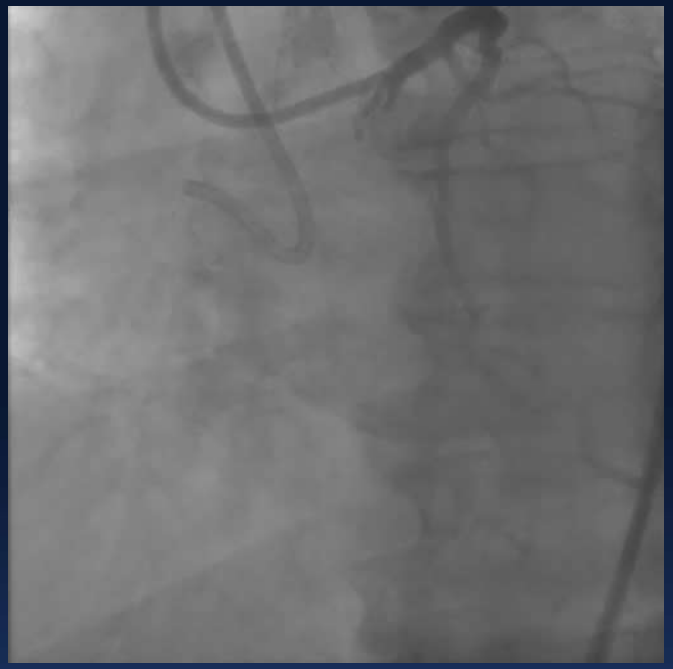
Procedural success rate

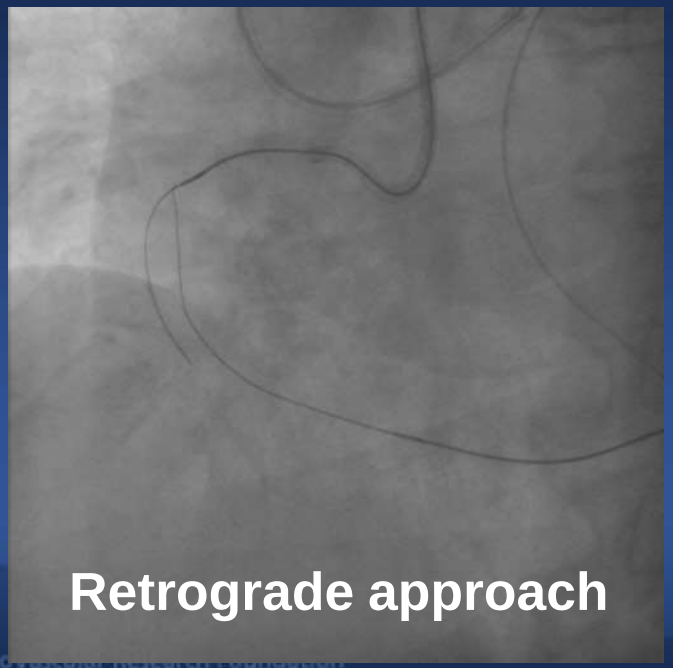
CTO PCI at AMC



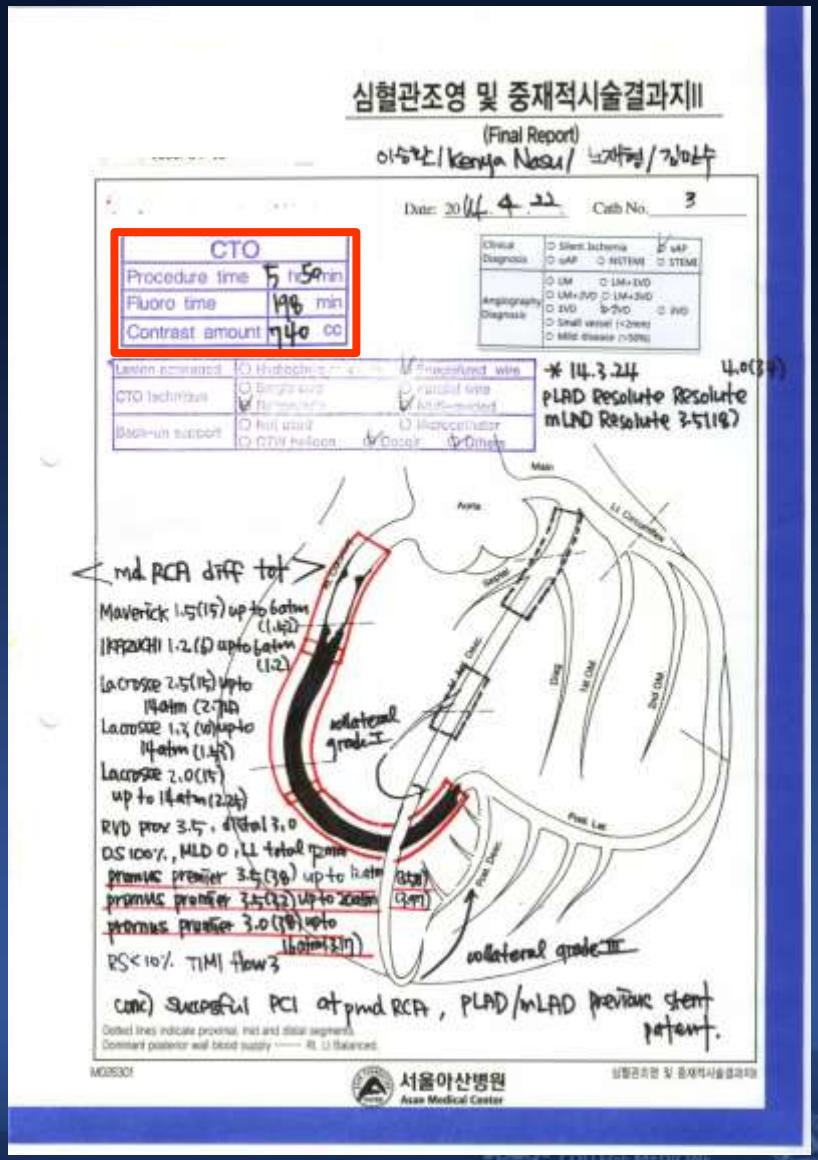
Complex CTO

Complex approach





Retrograde approach



심혈관조영 및 중재적시술결과지III

(Final Report)

이승찬 / Kenya Nasu / 노재형 / 김미나

Date: 2014. 4. 22 Cath No. 3

CTO	
Procedure time	5 hr 59 min
Fluoro time	198 min
Contrast amount	740 cc

* 14.3.24 4.0(3.9)
pLAD Resolute Resolute
mLAD Resolute 3.5(18)

Maverick 1.5(15) up to 6atm (1.42)
KAPPAKHI 1.2(8) up to 6atm (1.2)
LACROSSE 2.5(15) up to 14atm (2.74)
LACROSSE 1.7(10) up to 14atm (1.43)
LACROSSE 2.0(15) up to 14atm (2.26)
RVD prox 3.5, distal 3.0
DS 100%, MLD 0, LL total 17mm
promus premier 3.5(38) up to 14atm (3.38)
promus premier 3.5(32) up to 20atm (3.47)
promus premier 3.0(38) up to 16atm (3.17)
RS<10% TIMI flow 3

CONC) successful PCI at pmd RCA, pLAD/mLAD previous stent patent.

Dotted lines indicate proximal, mid and distal segments.
Dominant posterior wall blood supply ------ Rt. U Balanced

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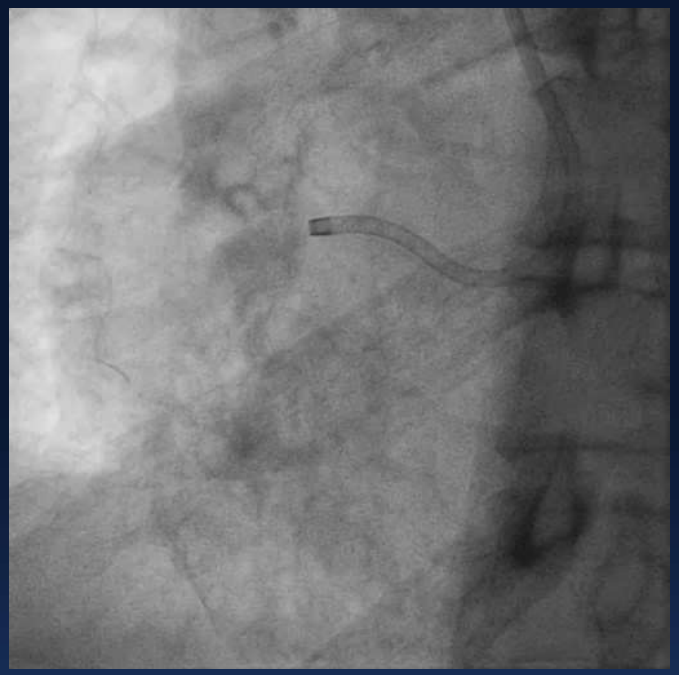
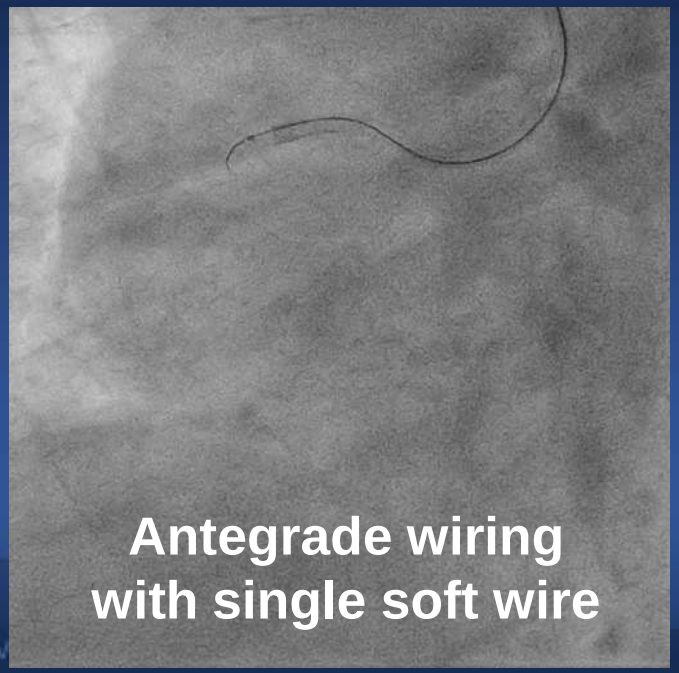
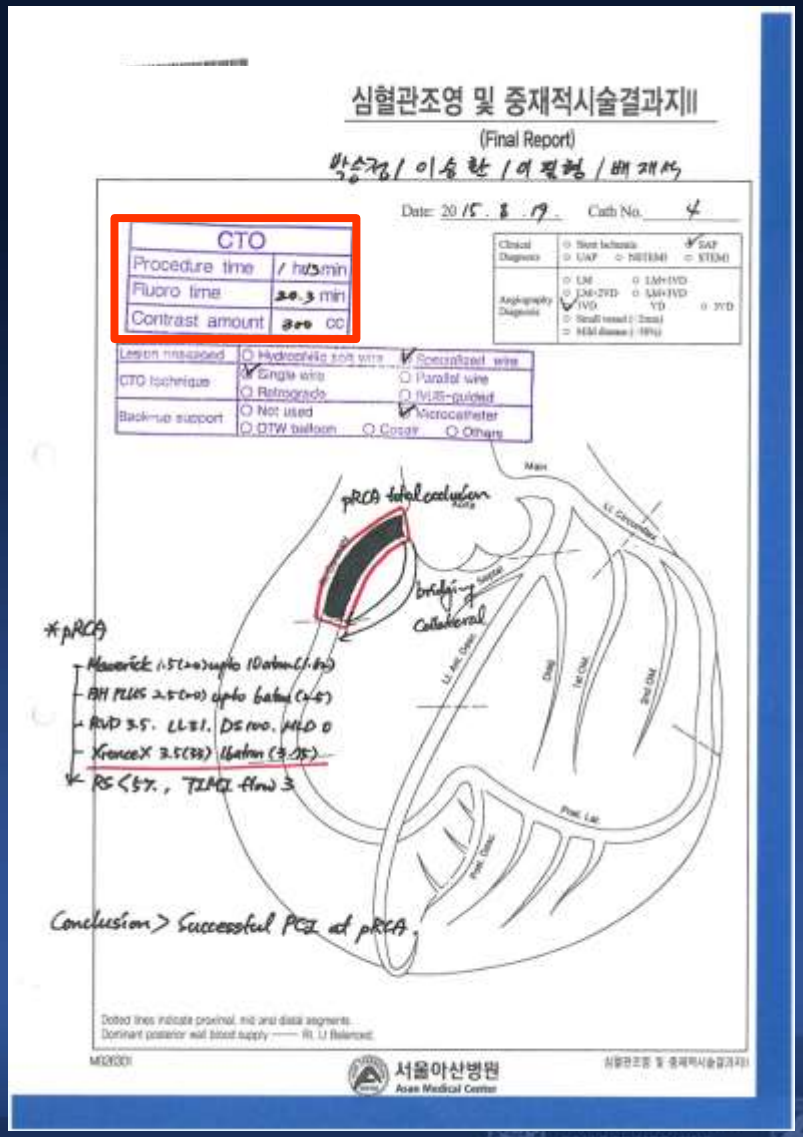
Complex CTO

Simple approach





Antegrade wiring
with single soft wire



심혈관조영 및 중재적시술결과지III

(Final Report)

Date: 20 15 . 8 . 19 . Cath No. 4

CTO	
Procedure time	1 hr 13 min
Fluoro time	30.3 min
Contrast amount	300 cc

Lesion crossed	○ Hydrophilic soft wire	✓ Specialized wire
CTO technique	✓ Single wire	○ Parallel wire
	○ Retrograde	○ IVUS-guided
Backup support	○ Not used	✓ Microcatheter
	○ OTW balloon ○ Cosair	○ Others

Clinical Diagnosis: ○ Stent ischemia ✓ SAP ○ UAP ○ NSTEMI ○ STEMI

Angiography Diagnosis: ○ LM ○ LM+1VD ○ LM+2VD ○ LM+3VD ✓ 1VD ○ 2VD ○ 3VD

Main

pRCA total occlusion

bridging collateral

*pRCA

- Maverick (1.5(2.0)) upto 10atm (1.8)
- BH PLUS 2.5(2.0) upto 6atm (2.5)
- RVD 3.5. LL 81. DS 100. MLD 0
- XtenceX 3.5(32) 16atm (3.75)

* RS < 57., TIMI flow 3

Conclusion > Successful PCI at pRCA.

Dotted lines indicate proximal, mid and distal segments.
Dominant posterior wall blood supply —— Rt. Lt Balanced.

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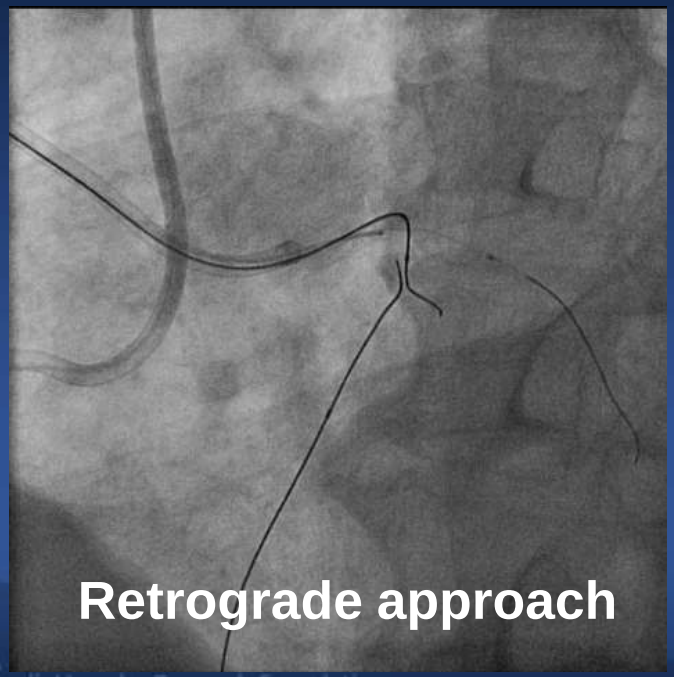
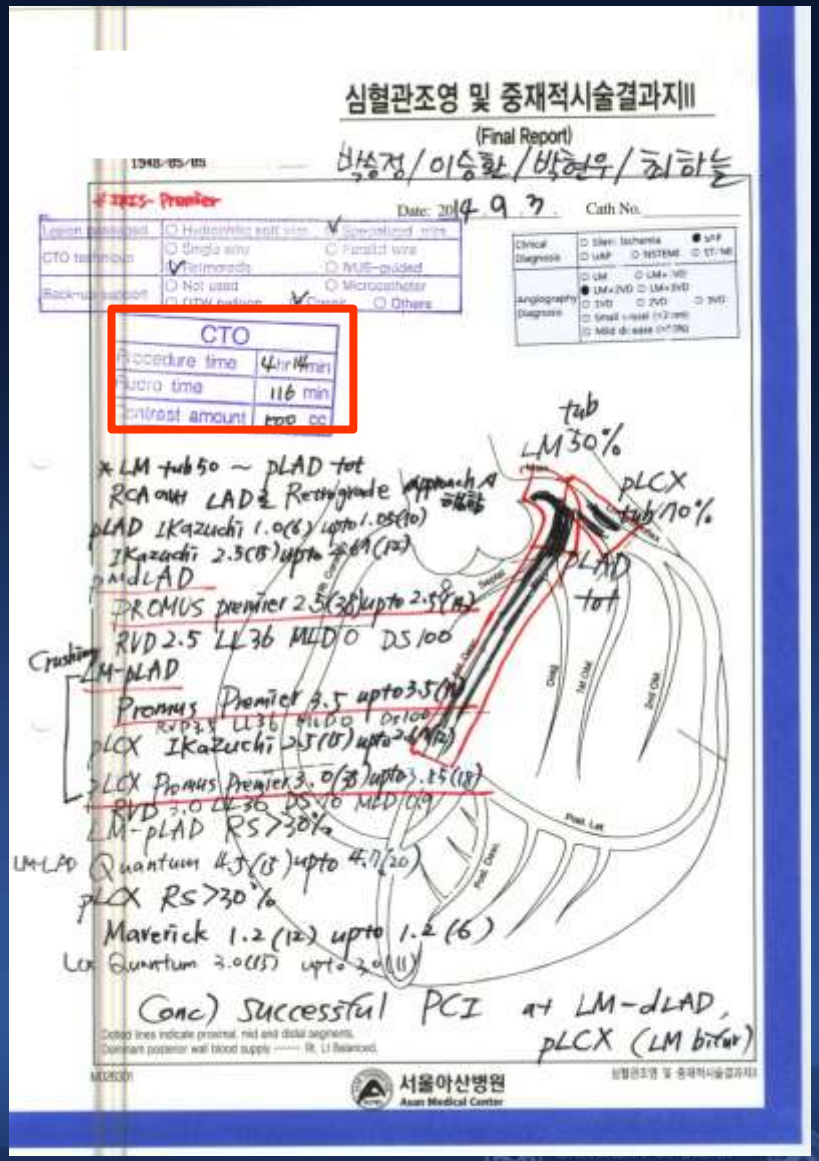
Complex CTO

Complex approach

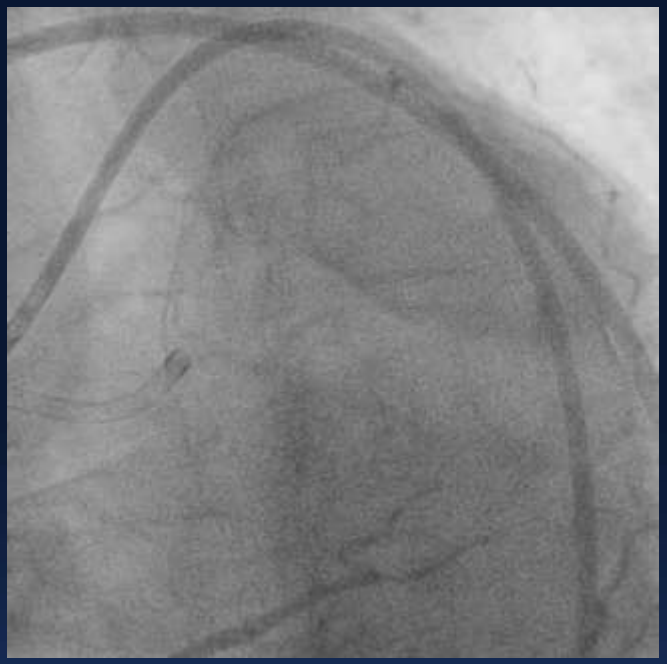


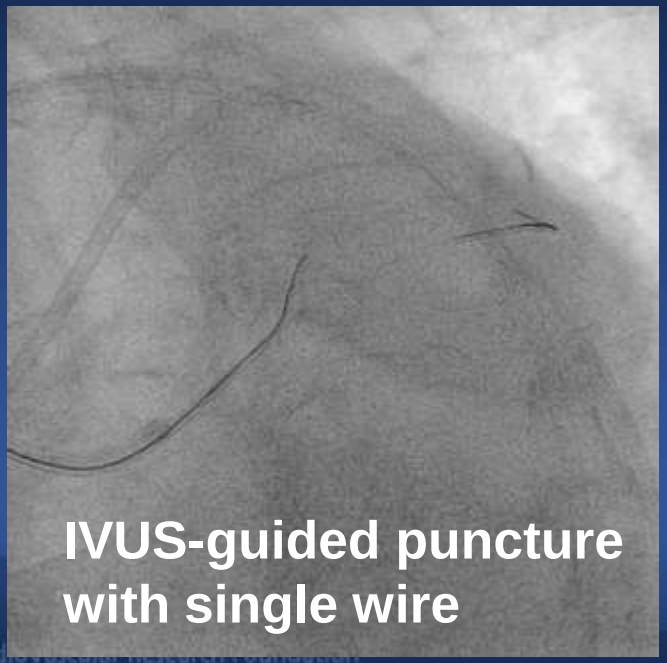
Retrograde approach



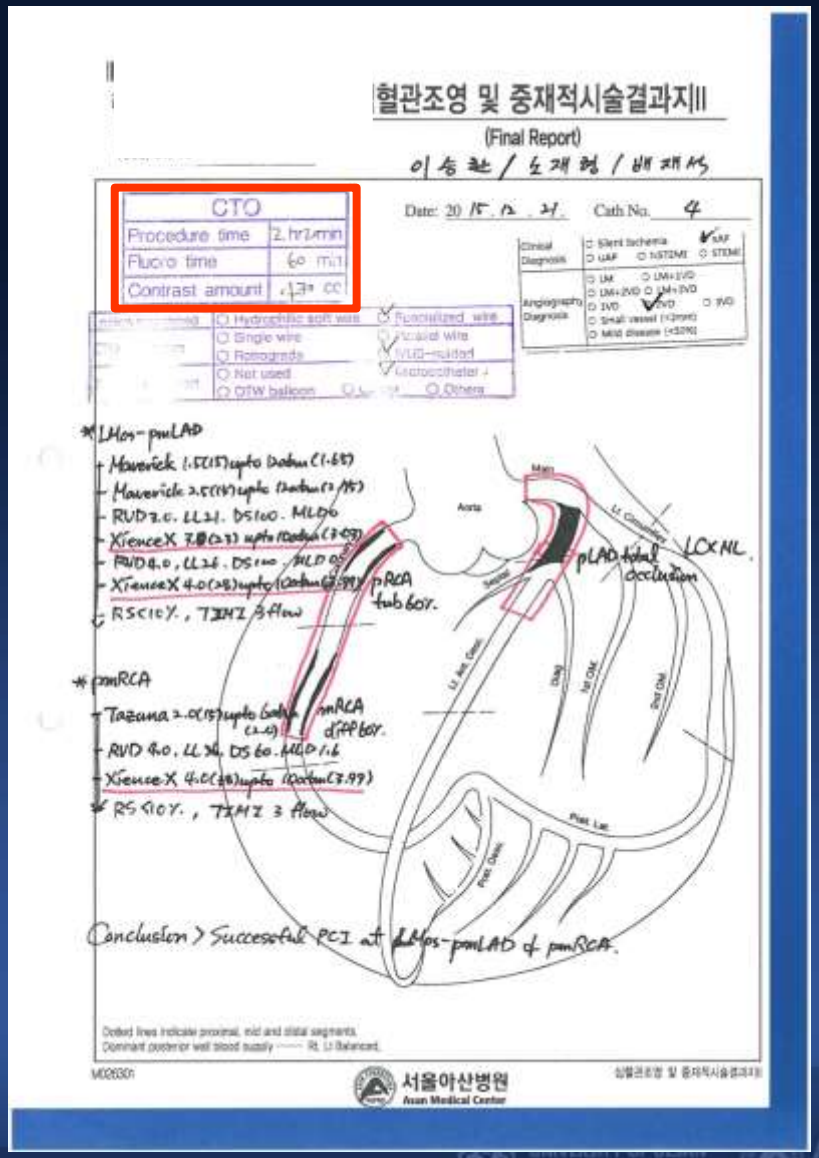
Complex CTO

Simple approach





IVUS-guided puncture with single wire



혈관조영 및 중재적시술결과지

(Final Report)

CTO	
Procedure time	2 hr 2 min
Fluoro time	60 min
Contrast amount	437 cc

Date: 20 15 12 21 Cath No. 4

Clinical Diagnosis: ○ Silent Ischemia ✓ SAP ○ UAP ○ NSTEMI ○ STEMI

Angiographic Diagnosis: ○ LM ○ LM+1VD ○ LM+2VD ○ LM+3VD ○ 1VD ✓ 2VD ○ 3VD ○ Small vessel (<2mm) ○ Mild disease (<50%)

○ Hydrophilic soft wire ✓ Fluoroplized wire
○ Single wire ○ Coated wire
○ Retrograde ✓ IVUS-guided
○ Not used ✓ Microcatheter
○ OTW balloon ○ Others

*LMos-pmLAD
- Maverick 1.5(15) upto Dobu(1.65)
- Maverick 2.5(15) upto Dobu(2.75)
- RVD 2.0, LL 21, DS 100, MLD 0
- XienceX 2.5(23) upto Dobu(2.97)
- RVD 4.0, LL 26, DS 100, MLD 0
- XienceX 4.0(28) upto Dobu(3.99) pRCA tub 60%
- RS(10)%, TIMI 3 flow

*pmRCA
- Tazuna 2.0(15) upto Dobu(2.2) pmRCA diff 60%
- RVD 4.0, LL 34, DS 60, MLD 1.6
- XienceX 4.0(28) upto Dobu(3.99)
- RS 40%, TIMI 3 flow

Conclusion > Successful PCI at LMos-pmLAD & pmRCA.

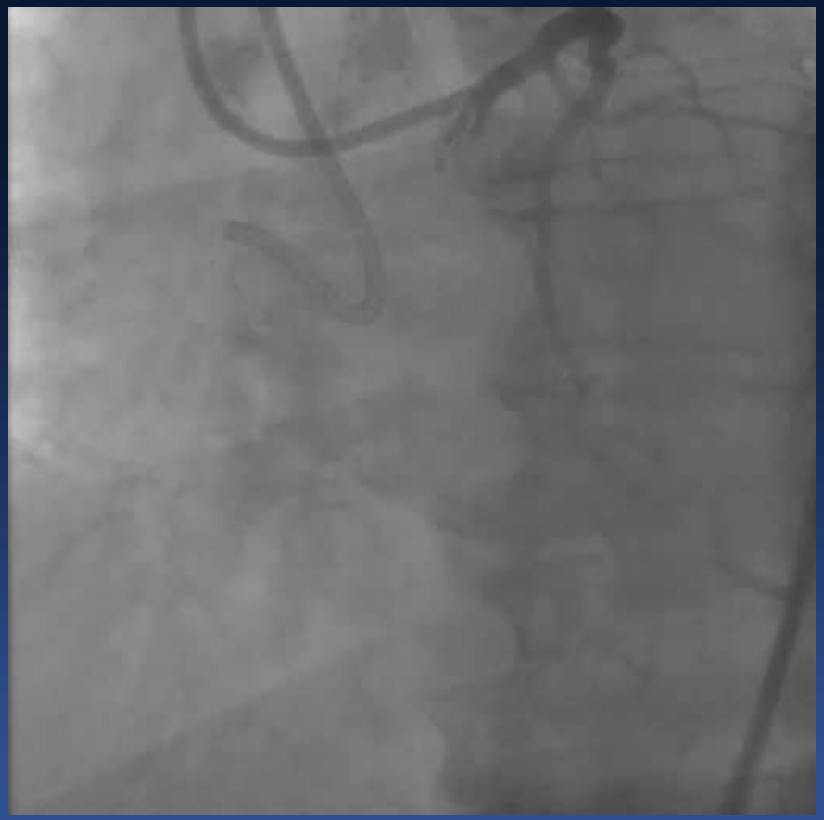
Aorta, Main, Lt Circumflex, pLAD total occlusion, LCX NL, Septal, Lt Ant Desc, Diag, 1st OM, 2nd OM, Post Lat, Post Desc

Dotted lines indicate proximal, mid and distal segments.
Dominant posterior wall blood supply ——— Rt, Lt Balanced.

M02630r

서울아산병원 Asan Medical Center

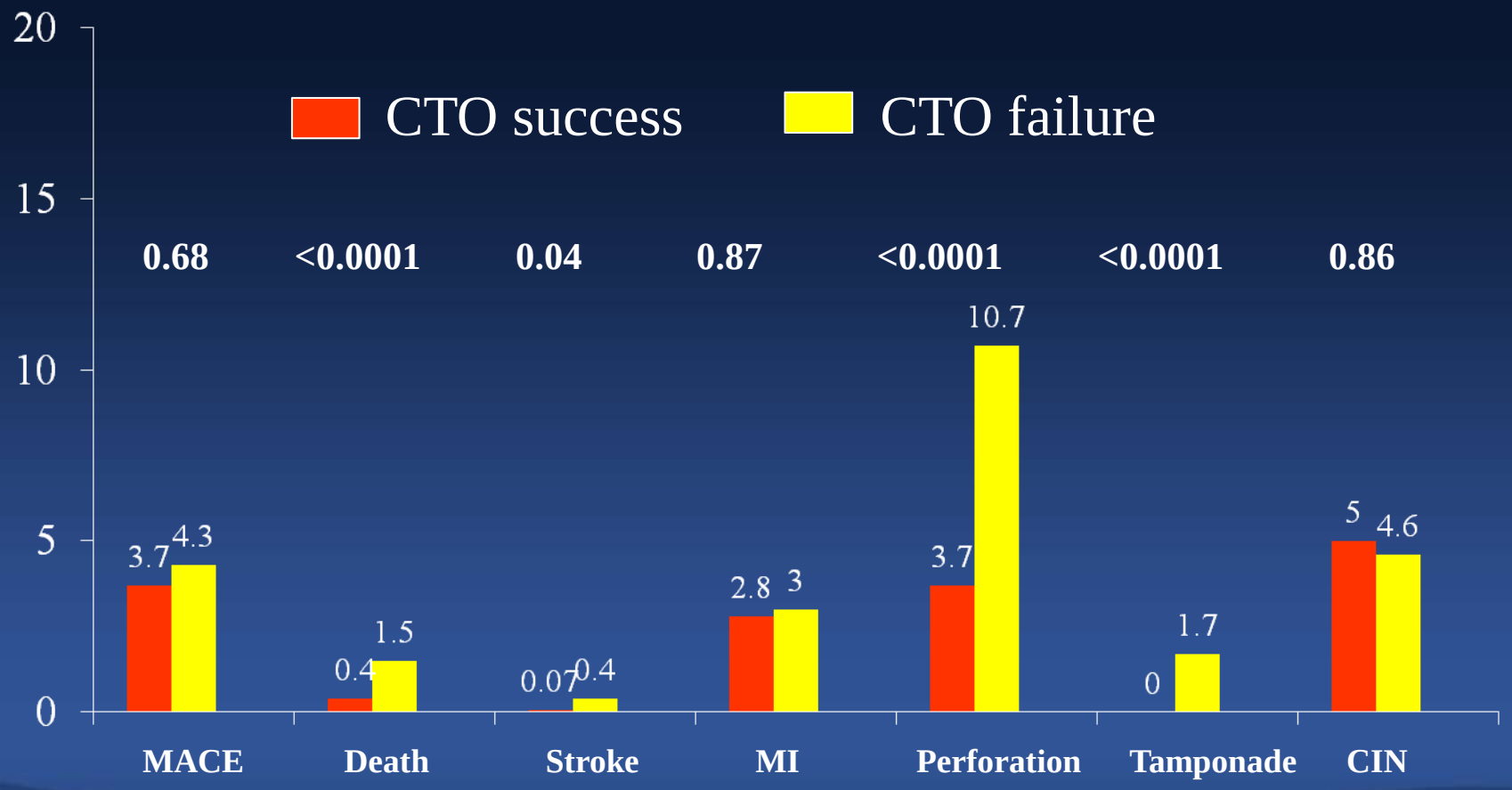
Do you really want to do PCI ?



- Retrograde approach
- Complication
- Periprocedural MI
- Full metal Jacket

CTO-PCI Complications

Meta Analysis of 18,061 Patients



Patel VG et al. J Am Coll Cardiol Intv 2013;6:128–36

Complications During Retrograde Approach for Chronic Coronary Total Occlusion: Sub-Analysis of Japanese Multicenter Registry

Atsunori Okamura,[1*] MD, Masahisa Yamane,[2] MD, Makoto Muto,[3] MD, Tetsuo Matsubara,[4] MD, Yasumi Igarashi,[5] MD, Shigeru Nakamura,[6] MD, Toshiya Muramatsu,[7] MD, Tsutomu Fujita,[8] MD, Akitsugu Oida,[9] MD, and Etsuo Tsuchikane,[4] MD

Retrograde approach relevant	11.3 (132)
Channel injury	9.5 (111)
Treatment required	2.1 (24)
Tamponade	0.3 (4)
Donor artery trouble	0.9 (10)
Dissection requiring stent	0.7 (8)
Thrombus formation	0 (0)
Spasm	0.2 (2)
Other events	0.9 (11)
At CTO site	2.6 (31)
Vessel perforation	2.2 (26)
Treatment required	1.1 (13)
Tamponade	0.2 (2)
Dissection	0.3 (3)
Hematoma	0.2 (2)
Other	1.6 (19)
Contrast induced nephropathy	0.5 (6)
Contrast allergy	0.1 (1)
Radiation dermatitis	0.2 (2)
Hematoma at access site	0.7 (8)
Hematoma in left ventricle	0.1 (1)
Blood transfusion	0.1 (1)

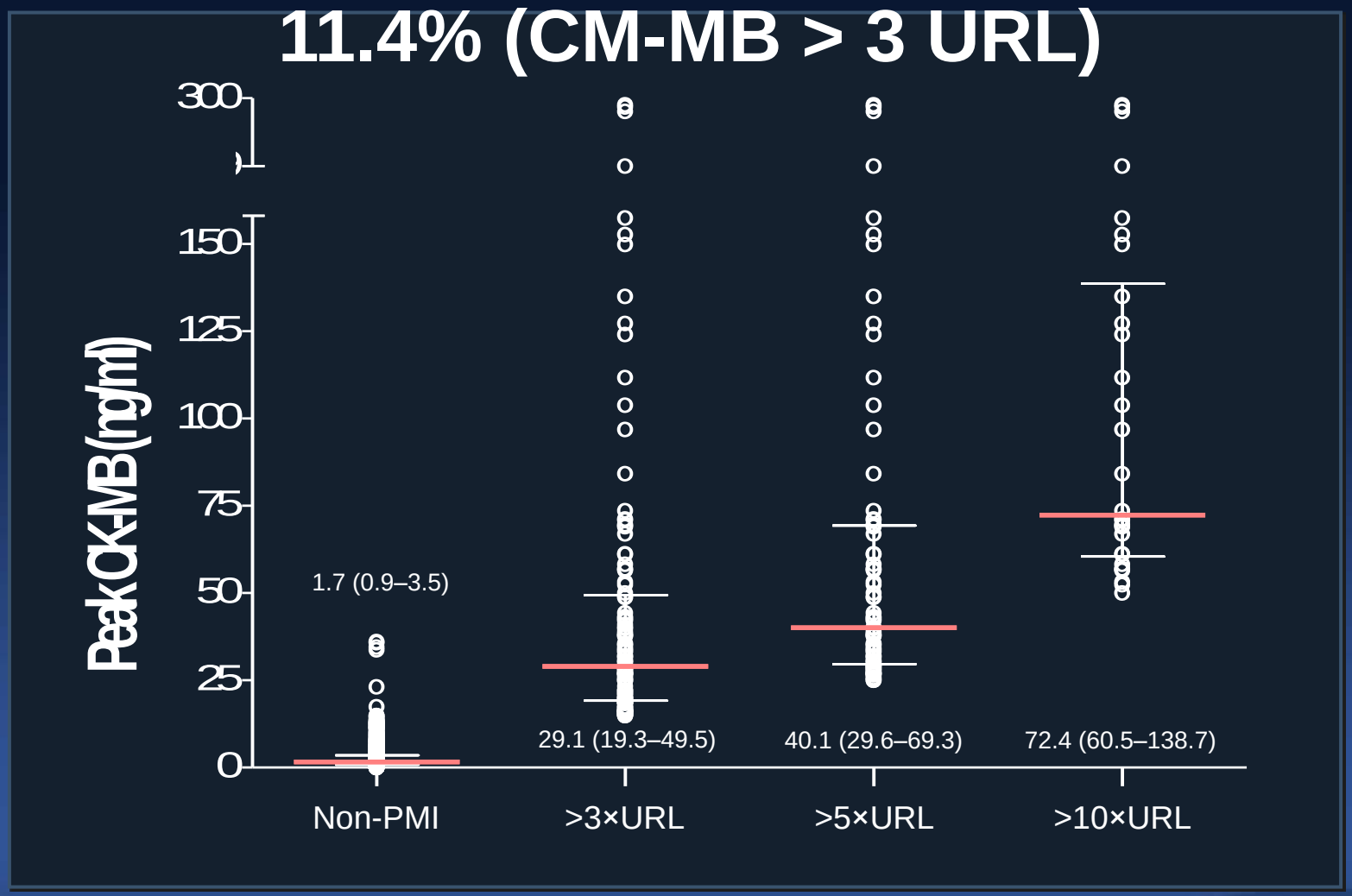
The MACCE rate during retrograde PCI for CTO determined from the Retrograde Summit registry was low and the frequency of complications related to the retrograde approach was acceptable, *inevitable complications*

CCI 2016 (in press)

CTO-PCI
Complex procedure

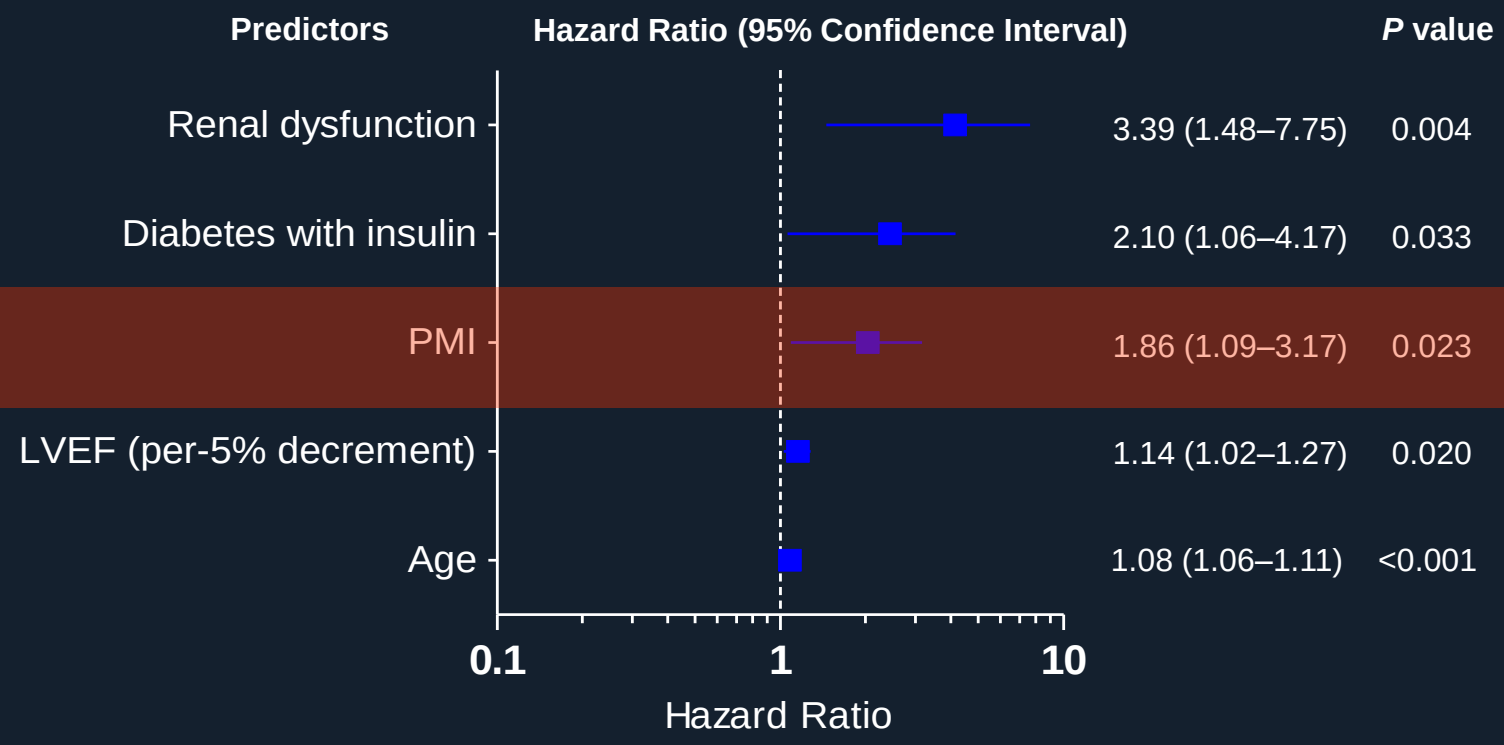
Determinants and Prognostic Significance of Periprocedural Myocardial Injury in CTO-PCI

Distribution of the Post-PCI Peak CK-MB values



Lee SW et al. J Am Coll Cardiol Intv (in press)

Predictors of Cumulative Death



PMI 5 (peak CK-MB >5×URL): HR 1.959 (1.040 – 3.690) P = 0.037
PMI 10 (peak CK-MB >10×URL): HR 2.458 (1.044 – 5.784) P = 0.040

Lee SW et al. J Am Coll Cardiol Intv (in press)

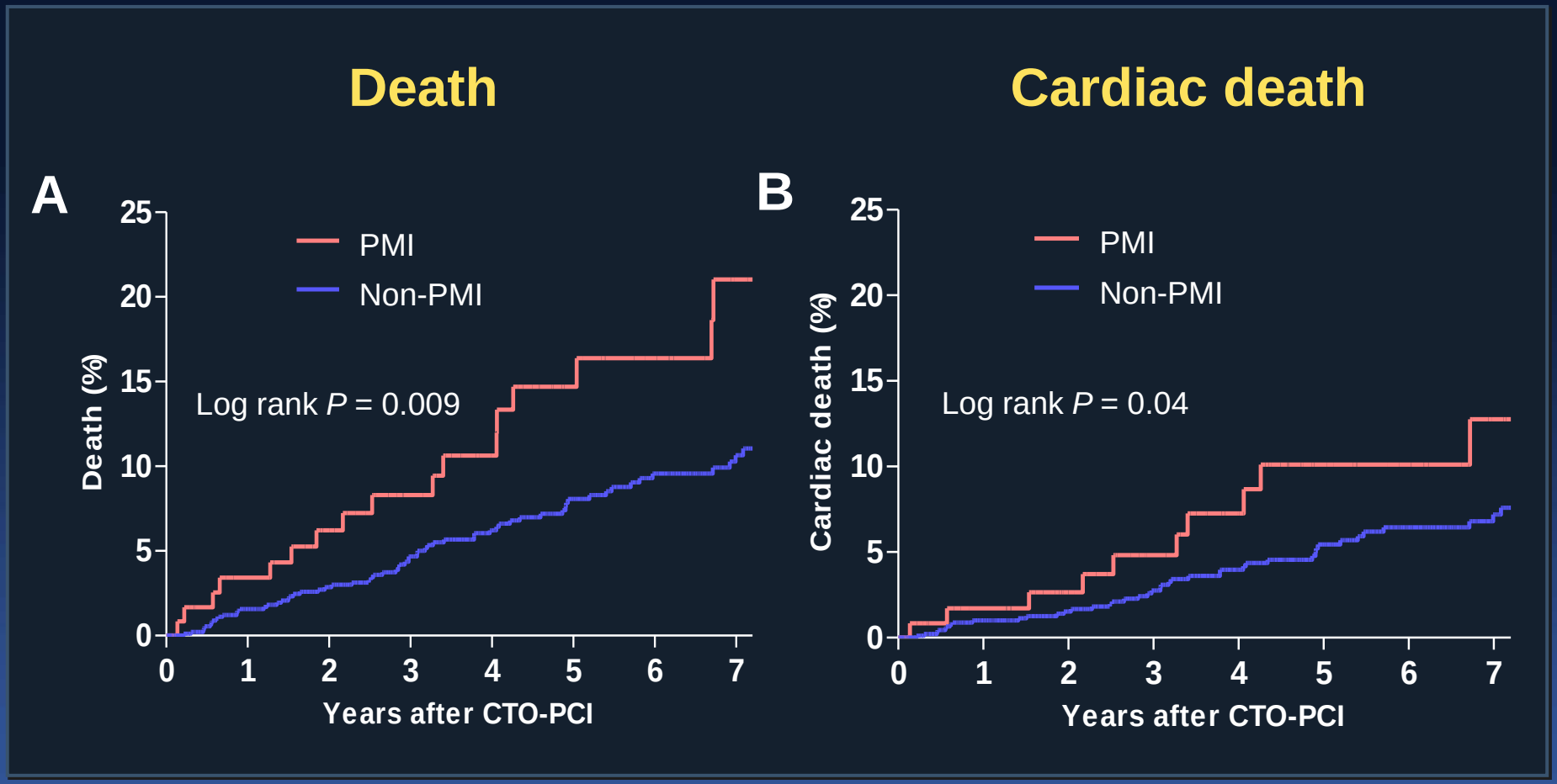
Key Predictors
of Periprocedural Myocardial Injury

Variables	Univariate	*P*	Multivariate	*P*
Age (per-year increment)	1.013 (0.995–1.032)	0.16		
Female gender	1.123 (0.692–1.823)	0.64		
Diabetes Mellitus	0.922 (0.608–1.398)	0.70		
Renal dysfunction*	4.364 (1.706–11.164)	0.002	4.251 (1.592–11.348)	0.004
Clinical presentation of ACS†	2.105 (1.420–3.122)	<0.001	2.181 (1.447–3.286)	<0.001
Collateral flow (per-1 Rentrop scale)	0.927 (0.724–1.188)	0.55		
Double coronary injection	1.115 (0.750–1.657)	0.59		
Stent length of the target vessel (per-1mm increment)	1.010 (1.002–1.018)	0.011		
Stent number of the target vessel	1.409 (1.117–1.777)	0.004	1.379 (1.075–1.769)	0.011
Retrograde attempt	2.229 (1.370–3.629)	0.001	2.267 (1.338–3.840)	0.002
Non-target lesion intervention	1.678 (1.144–2.463)	0.008	1.741 (1.171–2.587)	0.006

Lee SW et al. J Am Coll Cardiol Intv (in press)

Unadjusted Kaplan-Meier Curve

Median 4.4 years (IQR 2.1 – 7.0)



Lee SW et al. J Am Coll Cardiol Intv (in press)

Unadjusted Kaplan-Meier Curve

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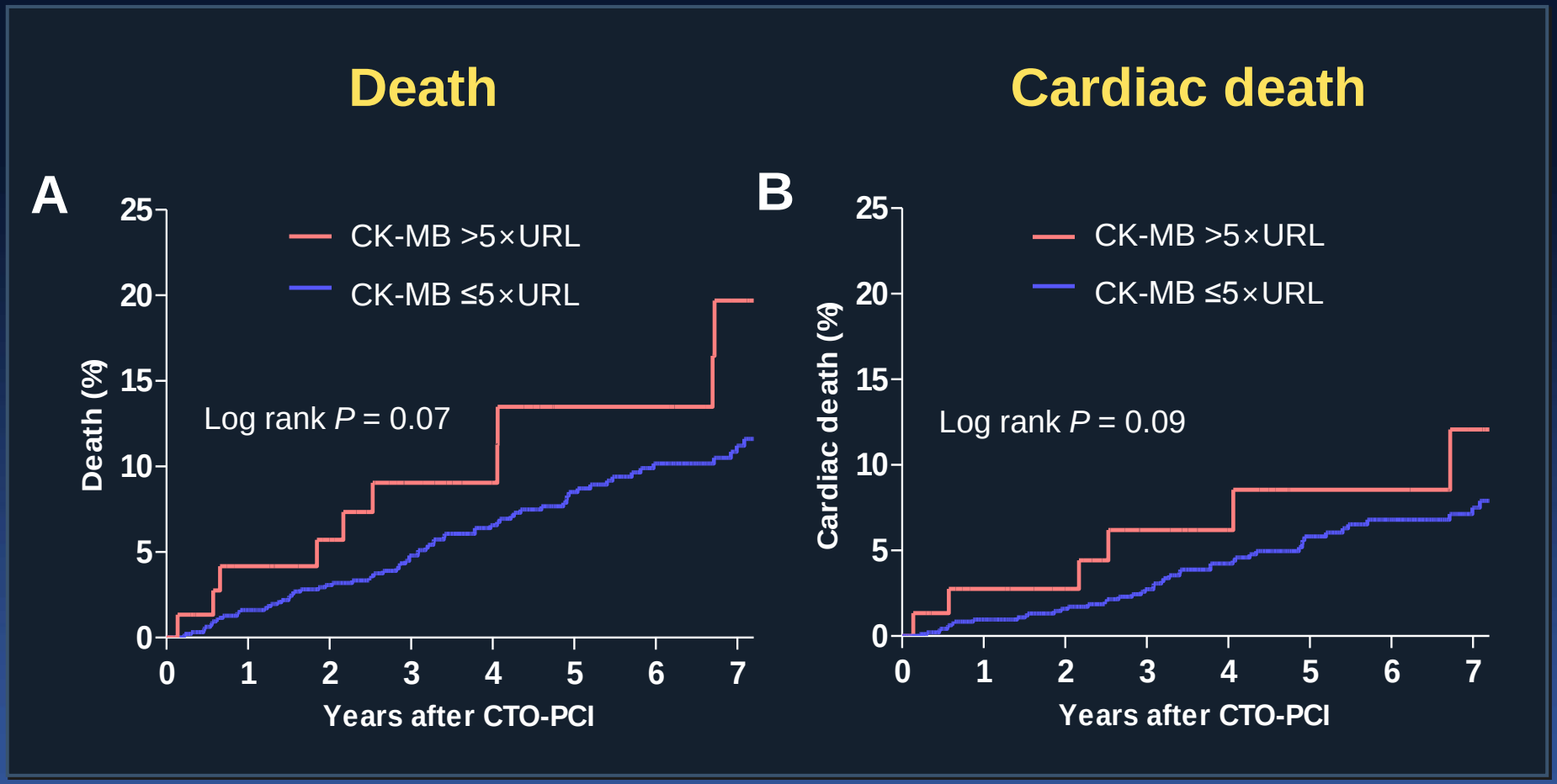

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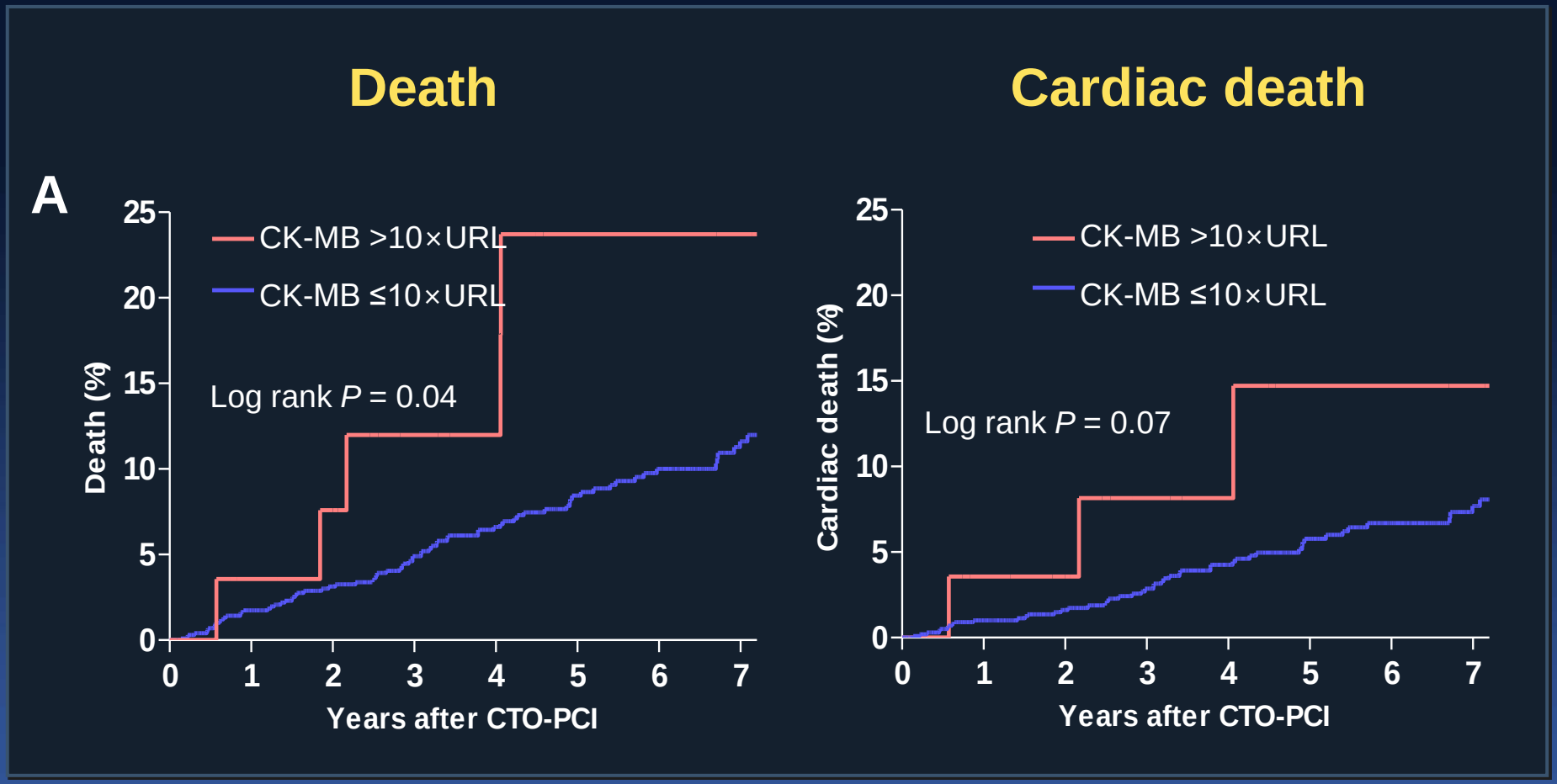
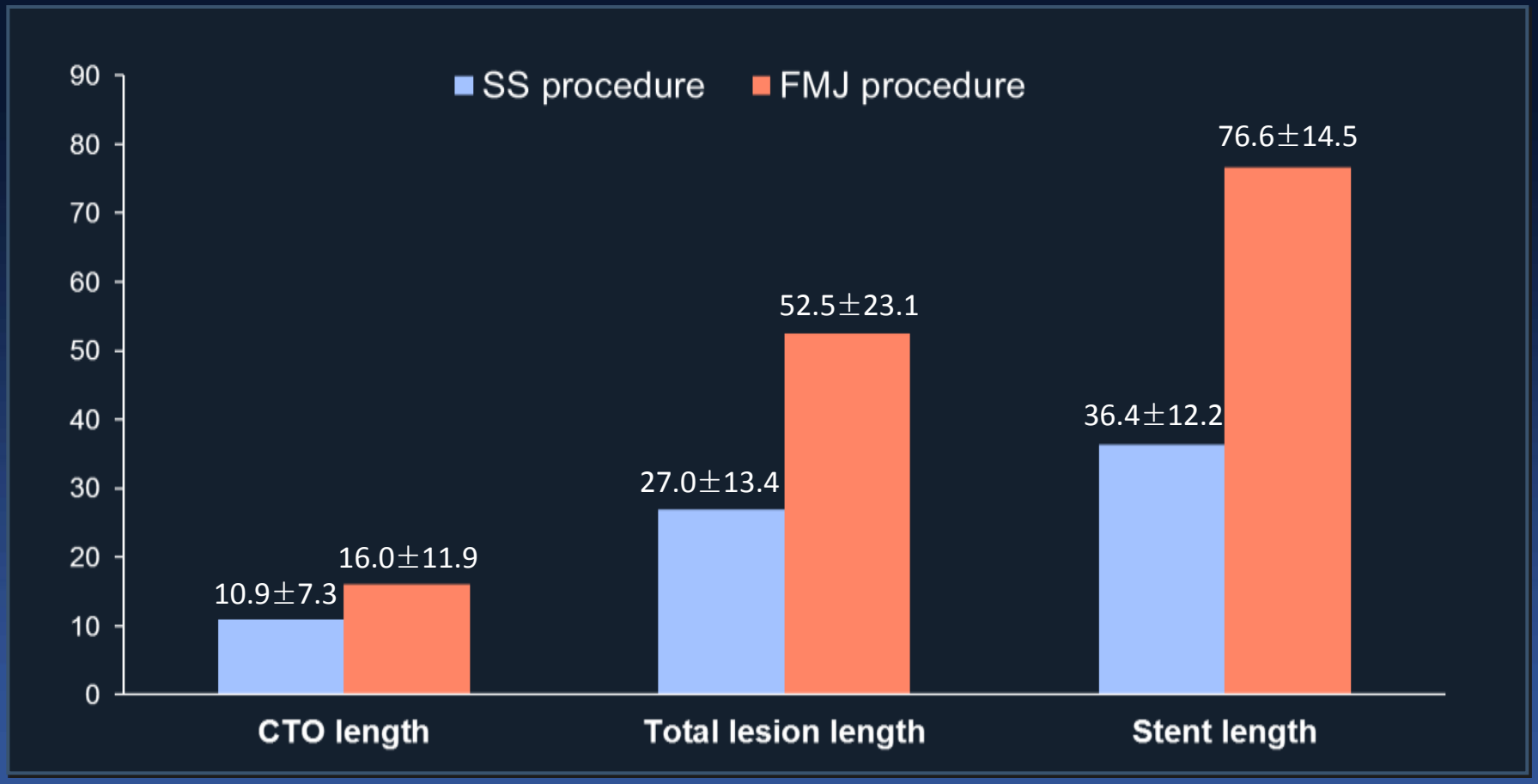


Lee SW et al. J Am Coll Cardiol Intv (in press)

CTO-PCI
Complex procedure

Full metal Jacket

Relationship between *CTO length, Total lesion length, and final stent length* after CTO-PCI



FMJ: *total stent length ≥ 60mm without gaps*

Baseline Clinical Characteristics

	SS group (N=679)	FMJ group (N=383)	P value
Age, years	60 (52, 68)	60 (53, 66)	0.57
Gender, male	542 (79.8)	335 (87.5)	0.002
Body mass index, kg/m^2	25.4 (23.4, 27.2)	25.2 (23.6, 27.2)	0.88
Current smoker	170 (25.0)	106 (27.7)	0.39
Hypertension	405 (59.6)	234 (61.1)	0.69
Hypercholesterolemia	426 (62.7)	262 (68.4)	0.07
Diabetes mellitus	189 (27.8)	135 (35.2)	0.014
Renal dysfunction*	14 (2.1)	6 (1.6)	0.74
Prior PCI	140 (20.6)	131 (34.2)	<0.001
Prior CABG	16 (2.4)	15 (3.9)	0.21
History of myocardial infarction	62 (9.1)	45 (11.7)	0.21
History of heart failure	62 (9.1)	43 (11.2)	0.32

Baseline Clinical Characteristics

	SS group (N=679)	FMJ group (N=383)	P value
History of stroke	38 (5.6)	28 (7.3)	0.33
Peripheral vascular disease	11 (1.6)	9 (2.3)	0.55
Chronic lung disease	18 (2.7)	9 (2.3)	0.92
Clinical indication			0.012
Stable angina	488 (71.9)	303 (79.1)	
Acute coronary syndrome	191 (28.1)	80 (20.9)	
Atrial fibrillation	12 (1.8)	7 (1.8)	1.00
Left ventricular ejection fraction, %	60 (55, 63)	60 (55, 64)	0.92
Drugs at discharge			
Aspirin	677 (99.7)	383 (100)	0.74
Clopidogrel	676 (99.6)	381 (99.5)	1.00
Cilostazol	145 (21.4)	129 (33.7)	<0.001
Statin	546 (80.4)	330 (86.2)	0.02

Lesion and Procedural Characteristics

	SS group (N=679)	FMJ group (N=383)	P value
Multi-vessel disease	347 (51.1)	231 (60.3)	0.005
Left main disease	22 (3.2)	21 (5.5)	0.11
Multiple CTOs	48 (7.1)	36 (9.4)	0.22
CTO located in*			<0.001
Left anterior descending artery	326 (48.0)	152 (39.7)	
Left circumflex artery	136 (20.0)	11 (2.9)	
Right coronary artery	213 (31.4)	220 (57.4)	
Left main	2 (0.3)	0	
Saphenous vein graft	2 (0.3)	0	
Stent type*			0.001
1st generation DES	337 (49.6)	150 (39.2)	
2nd generation DES	342 (50.4)	233 (60.8)	

*Information associated with the target CTO vessel

Lesion and Procedural Characteristics

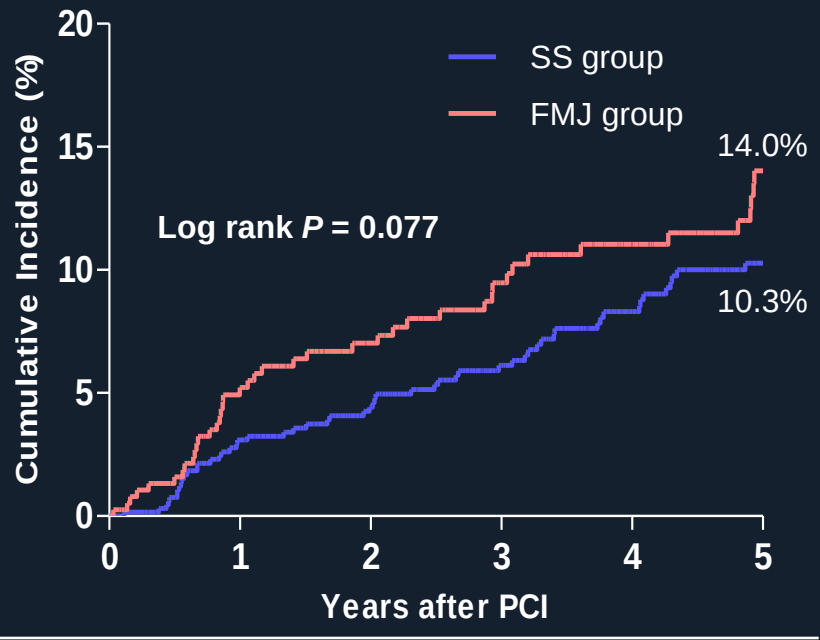
	SS group (N=679)	FMJ group (N=383)	P value
Number of stent per lesion*	1 (1, 2)	2 (2, 3)	<0.001
Length of stent per lesion, mm*	33 (28, 48)	74 (66, 84)	<0.001
Average stent diameter, mm*	3.0 (3.0, 3.5)	3.2 (3.0, 3.3)	0.06
Intravascular ultrasound use*	588 (86.6)	347 (90.6)	0.07
Retrograde attempt*	47 (6.9)	82 (21.4)	<0.001
Retrograde success*	33 (4.9)	59 (15.4)	<0.001
Double coronary injection*	173 (25.5)	184 (48.0)	<0.001
Contrast media amount, ml	360 (260, 500)	500 (350, 610)	<0.001
Total fluoroscopy time, min	25 (15, 40)	49 (29, 73)	<0.001
Non-target lesion intervention	234 (34.5)	125 (32.6)	0.59

*Information associated with the target CTO vessel

Unadjusted Kaplan-Meier Curve

Target Lesion Failure

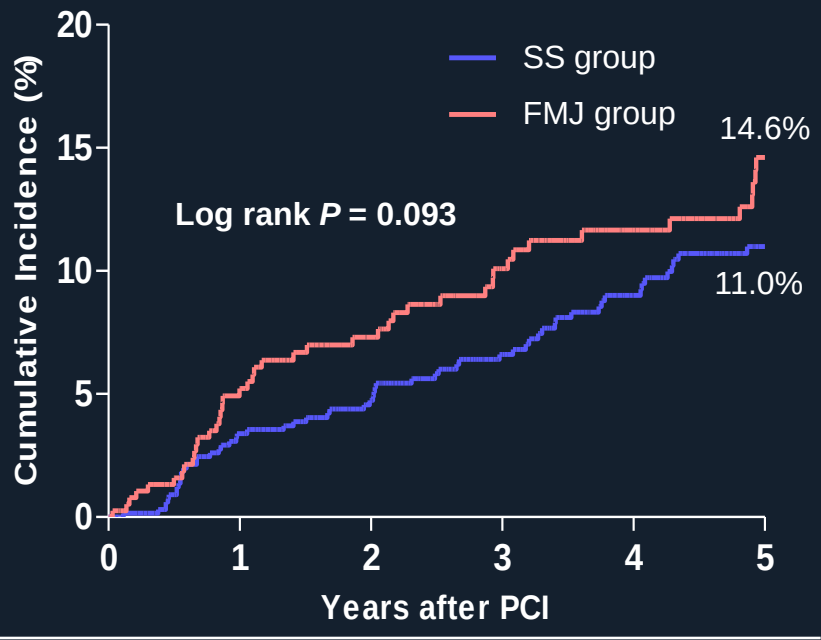
: composite of cardiac death, MI related to target vessel, clinically driven TLR



No. of patients at risk						
SS	679	614	542	455	388	326
FMJ	383	332	287	240	200	172

Target Vessel Failure

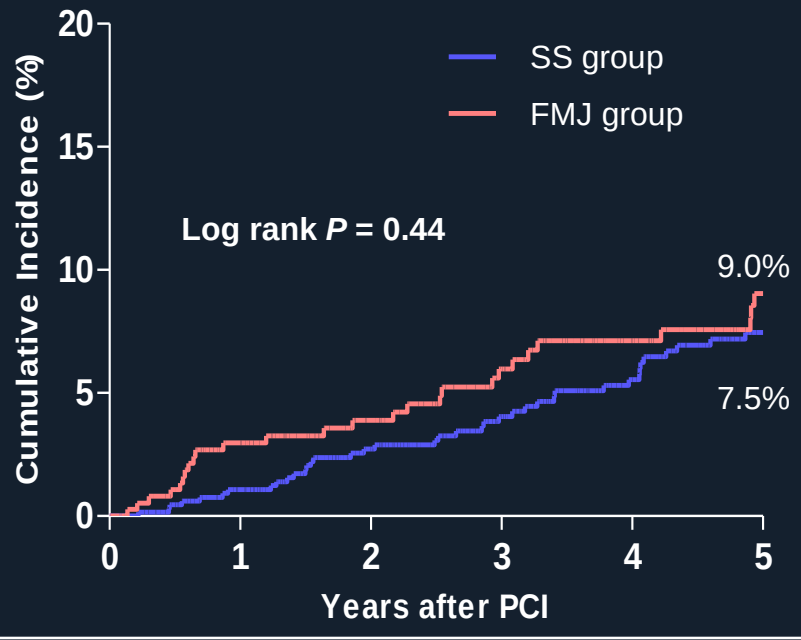
: composite of cardiac death, MI related to target vessel, clinically driven TVR



No. of patients at risk						
SS	679	612	540	452	385	323
FMJ	383	332	287	239	200	172

Unadjusted Kaplan-Meier Curve

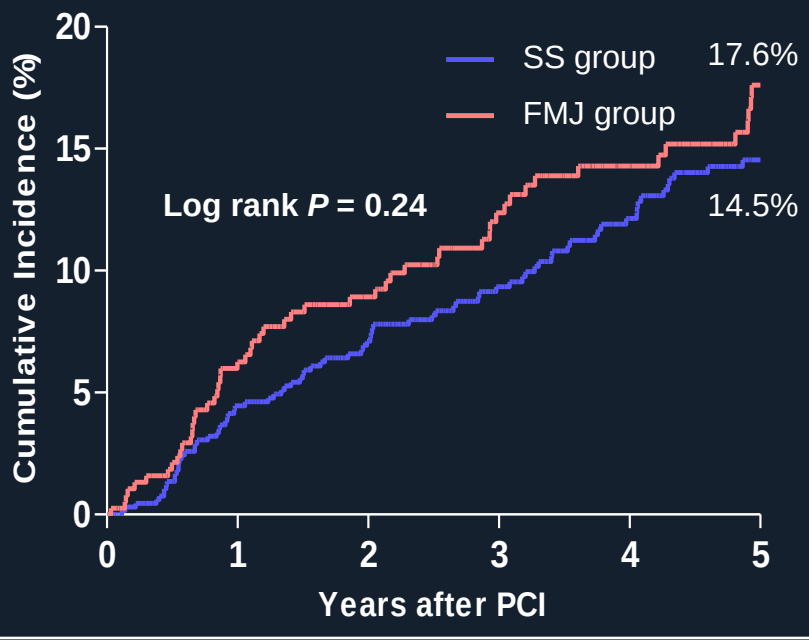
Death



No. of patients at risk						
SS	679	630	563	478	412	349
FMJ	383	342	300	255	215	186

MACE

: composite of all-cause death, MI, clinically driven TVR



No. of patients at risk						
SS	679	609	536	448	381	320
FMJ	383	331	286	238	199	171

Hazard Ratios of Clinical Outcomes

Medium Follow-up Time: 5.0 years

Outcome	SS group (N=679)	FMJ group (N=383)	HR (95% CI)	*P* value	Multivariable adjusted HR (95% CI)	*P* value
Target lesion failure	55 (10.3)	42 (14.0)	1.37 (0.97–1.93)	0.078	1.43 (1.01–2.02)	0.047
Target vessel failure	59 (11.0)	44 (14.6)	1.34 (0.95–1.87)	0.095	1.39 (0.99–1.95)	0.06
Death	39 (7.5)	27 (9.0)	1.18 (0.77–1.82)	0.44	1.24 (0.80–1.93)	0.33
Death or MI	50 (9.3)	32 (10.8)	1.09 (0.74–1.61)	0.67	1.10 (0.74–1.63)	0.65
MACE	80 (14.5)	54 (17.6)	1.20 (0.89–1.63)	0.24	1.24 (0.92–1.69)	0.16
TLR	30 (5.3)	22 (7.4)	1.42 (0.89–2.28)	0.15	1.47 (0.92–2.37)	0.11
TVR	34 (6.1)	24 (8.0)	1.37 (0.87–2.16)	0.18	1.42 (0.90–2.24)	0.13

Event rates are shown as Kaplan–Meier estimates (number and percentage of events).
Hazard ratios are for patients who received FMJ procedure compared with patients with SS procedure.

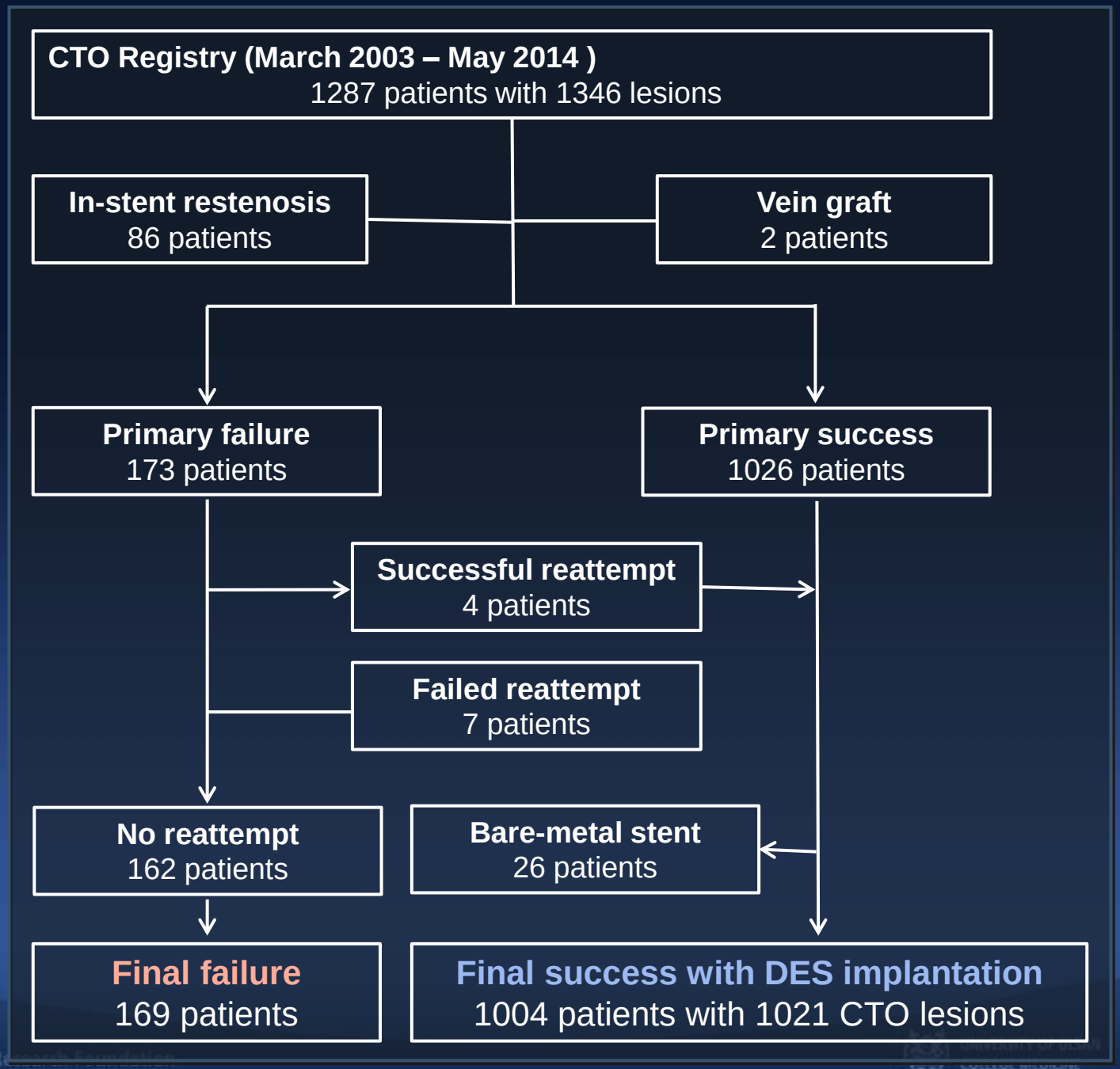
Fate of failed PCI in the current Era ?

AMC CTO-PCI registry

SUCCESS (N=1004) VS. Failure (n=169)

4.6-year follow-up

Lee et al. JACC Cardiovasc Interv. 2016;9:530-8



Baseline clinical characteristics

	Successful PCI (N=1004)	Failed PCI (N=169)	P value
Age, years	59.4 ± 10.6	60.5 ± 9.3	0.16
Sex, male	829 (82.6)	141 (83.4)	0.87
Body mass index, kg/m^2	25.5 ± 3.1	25.2 ± 2.7	0.28
Hypertension	600 (59.8)	109 (64.5)	0.28
Diabetes mellitus	311 (31.0)	54 (32.0)	0.87
Hypercholesterolemia	644 (64.1)	100 (59.2)	0.25
Current smoker	271 (27.0)	39 (23.1)	0.33
Previous PCI	205 (20.4)	35 (20.7)	1.00
Previous myocardial infarction	82 (8.2)	23 (13.6)	0.03
Previous CABG	26 (2.6)	7 (4.1)	0.38
Previous heart failure	100 (10.0)	18 (10.7)	0.89
Previous stroke	63 (6.3)	11 (6.5)	1.00
Peripheral vascular disease	18 (1.8)	1 (0.6)	0.42
Chronic lung disease	28 (2.8)	4 (2.4)	0.96
Renal dysfunction*	19 (1.9)	8 (4.7)	0.05
Clinical diagnosis at presentation			0.20
Stable angina	730 (72.7)	134 (79.3)	
Unstable angina	184 (18.3)	24 (14.2)	
Acute myocardial infarction	90 (9.0)	11 (6.5)	
Atrial fibrillation	18 (1.8)	2 (1.2)	0.81
Left ventricular ejection fraction, %	57.6 ± 8.6	57.5 ± 8.5	0.88
Left ventricular ejection fraction <40%	41 (4.1)	3 (1.8)	0.21

*Renal dysfunction was defined as creatinine ≥2.0 mg/dL or requiring dialysis.

Angiographic characteristics

*N=1190 CTO lesions (1021 vs. 169)	Successful PCI (N=1008)	Failed PCI (N=169)	P value
CTO located in*			0.02
Left anterior descending artery	460 (45.1)	55 (32.5)	
Left circumflex artery	151 (14.8)	28 (16.6)	
Right coronary artery	407 (39.9)	86 (50.9)	
Left main coronary artery	3 (0.3)	0	
Multiple (≥2) CTO	76 (7.6)	17 (10.1)	0.34
Multivessel disease	558 (55.6)	117 (69.2)	0.001
Triple-vessel disease	190 (18.9)	47 (27.8)	0.01
Left main disease	42 (4.2)	9 (5.3)	0.64
CTO length, mm*	13.7 ± 9.1	18.8 ± 11.7	<0.001
Lesion length, mm*	39.0 ± 19.4	45.0 ± 21.5	<0.001
Collateral flow, Rentrop scale*			0.19
0/1	228 (22.3)	38 (22.5)	
2	374 (36.6)	73 (43.2)	
3	419 (41.0)	58 (34.3)	

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Procedural characteristics

TABLE 3: PROCEDURAL CHARACTERISTICS

*N=1190 CTO lesions (1021 vs. 169)	Successful PCI (N=1008)	Failed PCI (N=169)	P value
Stent type			NA
1st generation DES	463 (46.1)	NA	
2nd generation DES	541 (53.9)	NA	
Number of stents per lesion*	1.77 ± 0.78	NA	NA
Length of stent per lesion, mm*	46.2 ± 21.0	NA	NA
Average stent diameter, mm*	3.15 ± 0.32	NA	NA
Double coronary injection*	331 (32.4)	45 (26.6)	0.16
Success by retrograde approach*	87 (8.5)	NA	NA
Intravascular ultrasound use*	894 (87.6)	NA	NA
Contrast media amount, ml	426 ± 200	514 ± 233	<0.001
Non-target lesion intervention	349 (34.8)	70 (41.4)	0.11

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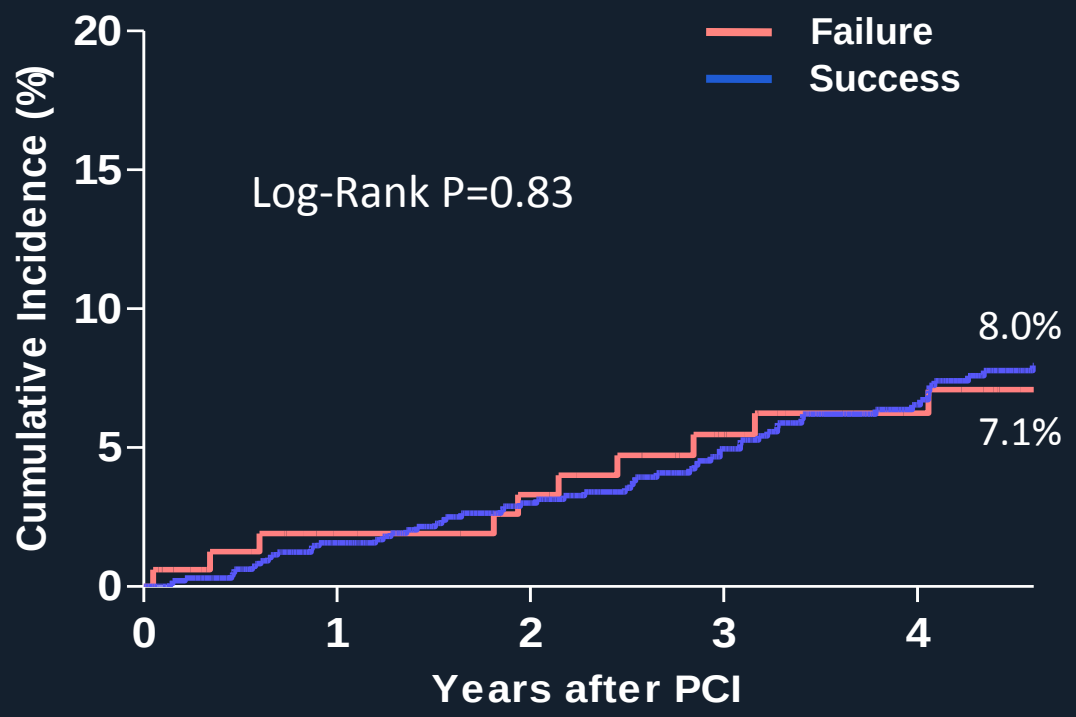
Unadjusted Kaplan-Meier Curve

Death



No. at Risk					
Success	1004	891	763	638	543
Failure	169	147	139	126	111

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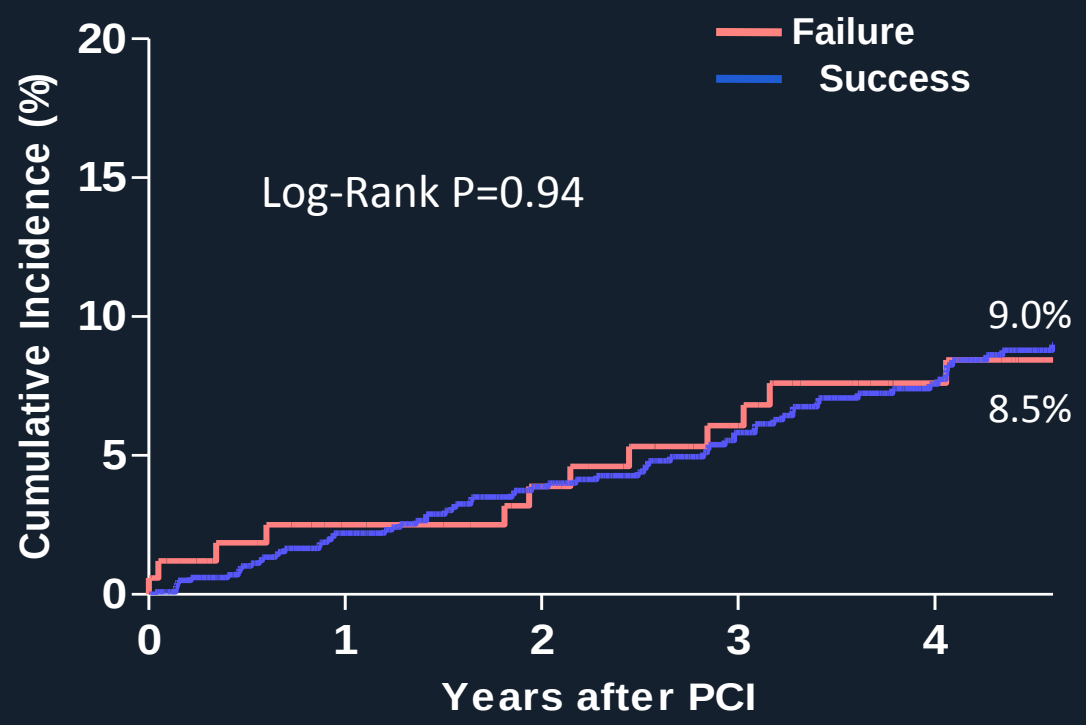
Unadjusted Kaplan-Meier Curve

Death or Q-wave MI



No. at Risk					
Success	1004	885	756	632	538
Failure	169	146	138	126	110

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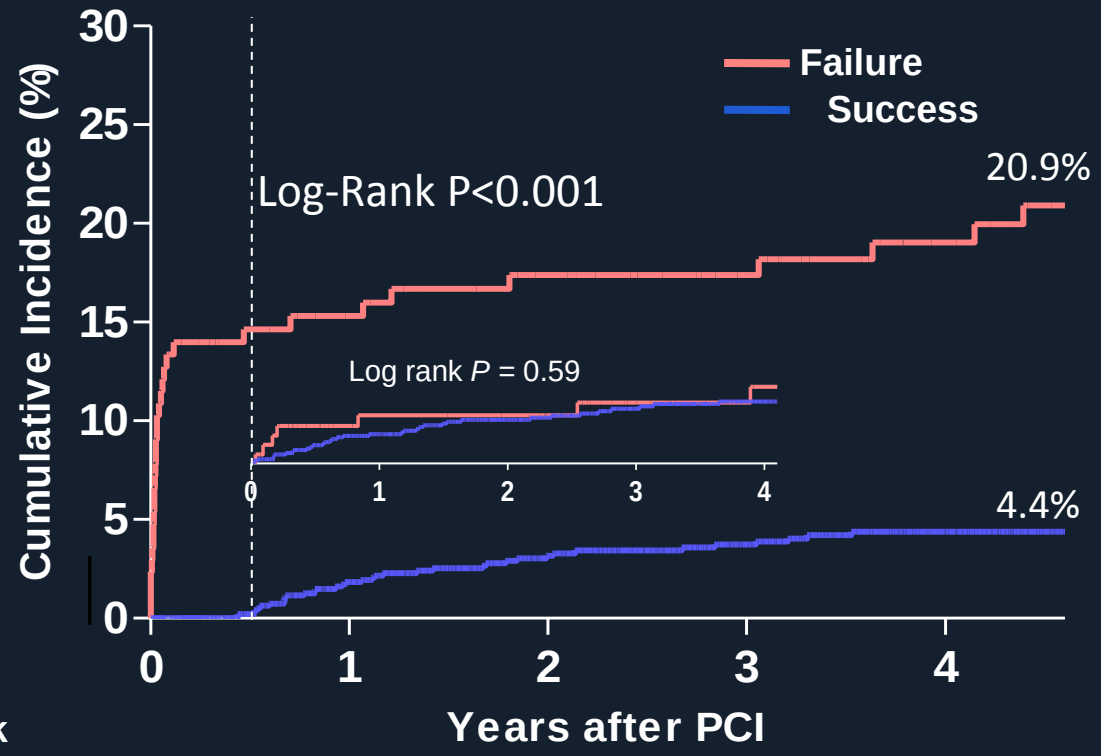
Unadjusted Kaplan-Meier Curve

Target vessel revascularization



No. at Risk					
Success	1004	875	738	613	519
Failure	169	125	115	104	90

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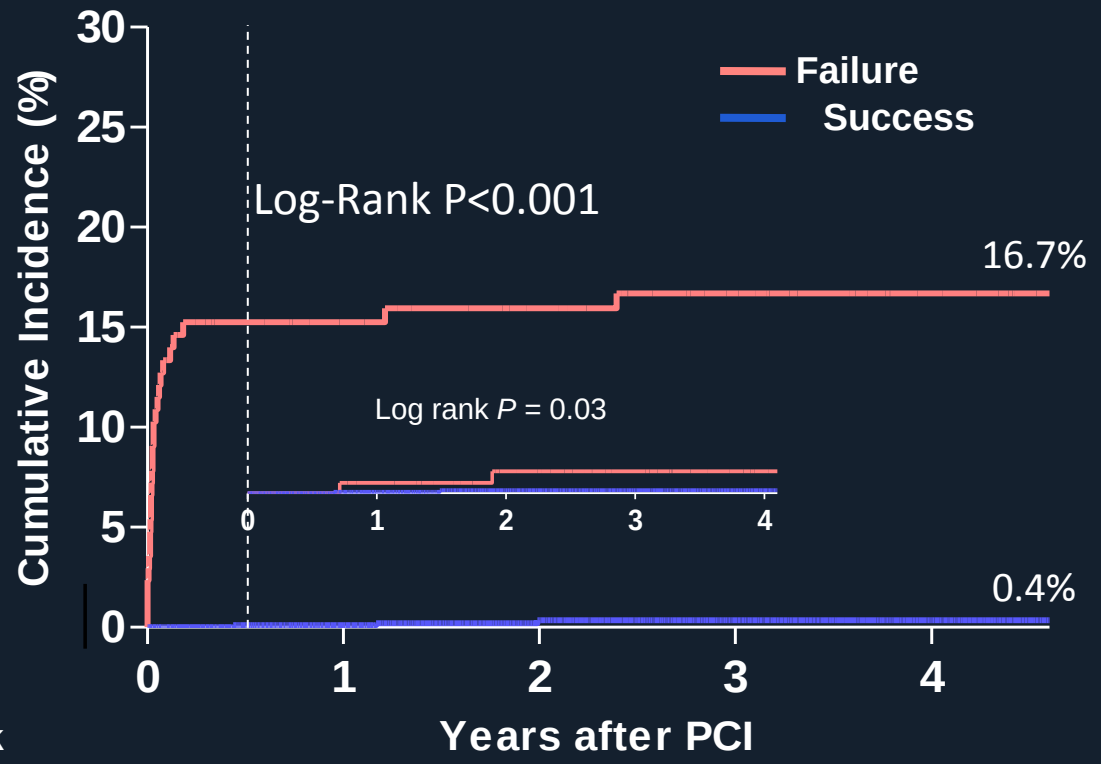
Unadjusted Kaplan-Meier Curve

CABG



No. at Risk					
Success	1004	890	760	635	540
Failure	169	125	117	105	92

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Hazard Ratios of Clinical Outcomes

Outcome rates at 4.6 years

Outcome	Successful PCI (n = 1004)	Failed PCI (n = 169)	HR (95% CI)	*P* value	Multivariable adjusted HR (95% CI)	*P* value
All-cause mortality	59 (8.0)	10 (7.1)	1.08 (0.55–2.10)	0.83	1.04 (0.53–2.04)	0.92
Cardiac death	38 (5.3)	7 (5.1)	1.00 (0.45–2.24)	1.00	1.00 (0.45–2.26)	0.99
Death or Q-wave MI	68 (9.0)	12 (8.5)	1.02 (0.55–1.89)	0.94	1.05 (0.56–1.94)	0.89
Q-wave MI	11 (1.3)	3 (2.1)	0.63 (0.18–2.28)	0.49	0.57 (0.16–2.06)	0.39
TVR	36 (4.4)	32 (20.9)	0.17 (0.11–0.27)	<0.001	0.15 (0.10–0.25)	<0.001
Death, Q-wave MI, or TVR	100 (12.8)	41 (27.1)	0.38 (0.26–0.54)	<0.001	0.42 (0.29–0.60)	<0.001
CABG	3 (0.4)	27 (16.7)	0.02 (0.01–0.06)	<0.001	0.02 (0.01–0.06)	<0.001
Any coronary revascularization	65 (8.6)	41 (28.1)	0.24 (0.16–0.35)	<0.001	0.23 (0.16–0.34)	<0.001
Stroke	3 (0.5)	2 (1.5)	0.28 (0.05–1.68)	0.16	0.29 (0.05–1.72)	0.17

Event rates are shown as Kaplan–Meier estimates (number and percentage of events).
Hazard ratios are for patients who received successful PCI compared with patients with failed PCI.

Conclusions

- CTO-PCI success rate improved dramatically, but complications still were inevitable.
- We can try to open all CTO lesions despite lesion complexity, but keep in mind that complex approach have chance to make immediate and long-term adverse outcomes.
- Don’t be afraid of CTO-PCI failure. If you achieve complete revascularization except CTO, It might be best for the patients
- Simple touch might be the good alternatives for patients

Thank you for your attention