Multi-center Registry for LAD Ostial CTO: Technical and Clinical Outcomes

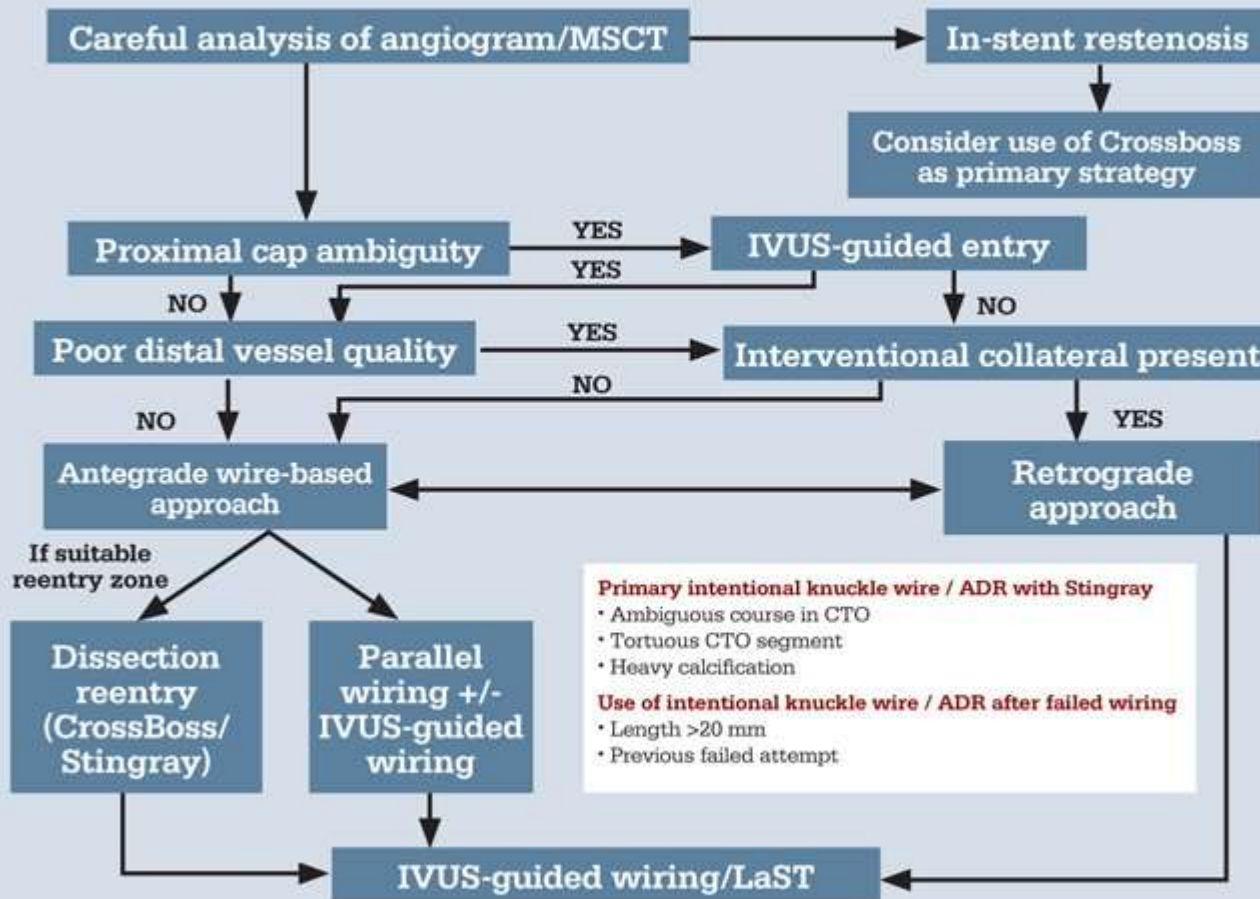Jong-Young Lee, MD, PhD. / Seung-Whan Lee, MD, PhD.

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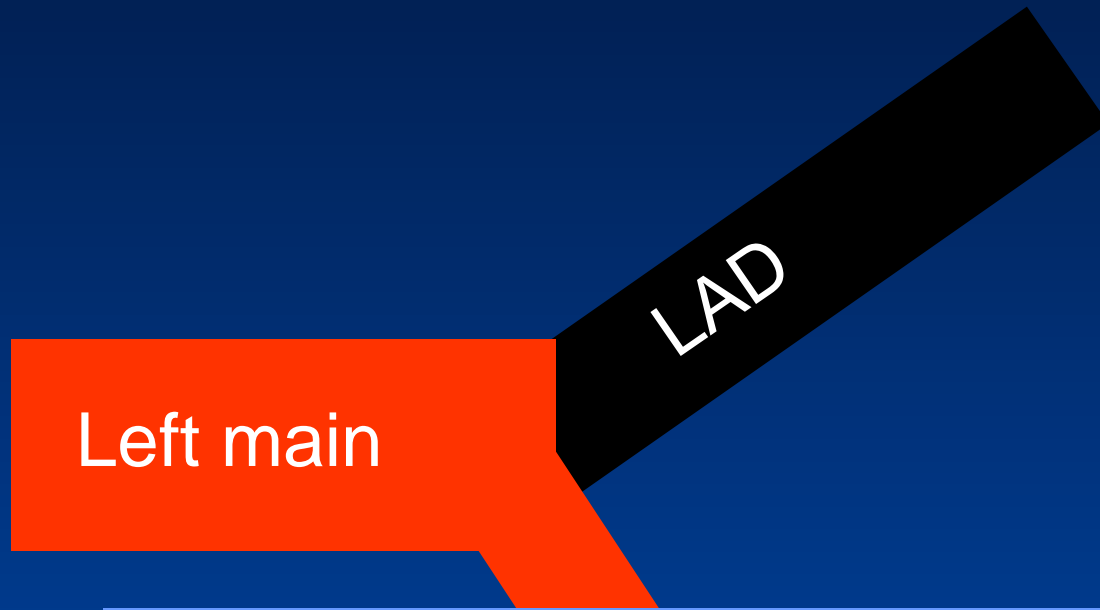
On behalf of Strike CTO Registry

AP CTO Club Algorithm

The Asia Pacific Algorithm for CTO Crossing

Careful analysis of angiogram/MSCT → In-stent restenosis

In-stent restenosis → Consider use of Crossboss as primary strategy

Careful analysis of angiogram/MSCT → Proximal cap ambiguity

Proximal cap ambiguity — YES → IVUS-guided entry
Proximal cap ambiguity — YES
Proximal cap ambiguity — NO ↓

Poor distal vessel quality — YES → Interventional collateral present
Poor distal vessel quality — NO ↓

IVUS-guided entry — NO ↓

Interventional collateral present — NO → Antegrade wire-based approach
Interventional collateral present — YES → Retrograde approach

Antegrade wire-based approach ↔ Retrograde approach

If suitable reentry zone:
- Dissection reentry (CrossBoss/Stingray)
- Parallel wiring +/- IVUS-guided wiring

Primary intentional knuckle wire / ADR with Stingray
· Ambiguous course in CTO
· Tortuous CTO segment
· Heavy calcification

Use of intentional knuckle wire / ADR after failed wiring
· Length >20 mm
· Previous failed attempt

Dissection reentry / Parallel wiring → IVUS-guided wiring/LaST ← Retrograde approach

Consider stopping if >3 hr; 3.7x eGFR ml contrast; Air Kerma > 5Gy unless procedure well advanced

Source: Figure courtesy of Dr. Etsuo Tsuchikane; printed with permission

LAD ostial CTO

LAD

Left main

Ostial CTO, especially LAD os
- complex
- dangerous
- specifically not fully elucidated

Backgrounds

- Success rates for treatment of CTO have dramatically improved in recent years with the development of new CTO guidewires, advances in microcatheters, development of new techniques such as the retrograde approach, ADR and systematic algorithm.

- But, LADos is one of the most difficult and challenging lesion subset for CTO revascularization, because of wide angle, coexistent left main or left circumflex artery lesion, ambiguous stump and the higher risk of periprocedural complication causing catastrophic hazard.

- Moreover, an algorithmic approach for the management of LADos CTO was not fully described.

Backgrounds

- Nevertheless, through the successful recanalization through LADos CTO intervention, substantial reduction of ischemic burden presumably might be associated with significant improvement of symptom, quality of life, and long-term clinical outcomes.

- Therefore, this study tried to investigate lesion characteristics, procedural techniques using contemporary devices and clinical (in-hospital and long-term) outcomes of PCI for CTO, through multicenter registry.

Methods

- Total 13 centers in Korea between February 2004 and August 2018.

- LADos CTO was defined as the proximal cap of CTO is within 1 mm from LM bifurcation carina tip.

- ISR CTO was excluded in this study population.

- The use of specialized devices and techniques and the choice of strategy in PCI were at the operator's discretion and all procedures were done in standard manners.

Methods

- The primary endpoint of interest was TVF, defined as the composite of cardiac death, target vessel myocardial infarction (MI), or target vessel revascularization (TVR).

- Peri-procedural MI was considered as peak elevations of the creatine kinase–myocardial band (CK-MB) >10 times the upper reference limit within 48 h post-procedure.

- In-hospital major adverse cardiac or cerebrovascular event (MACCE) included any of the following adverse events prior to hospital discharge: death from any cause; periprocedural MI; in-hospital TVR with PCI or bypass surgery; tamponade requiring intervention; and stroke.

Baseline Demographics

	(N=270)
Age	62.7 ±11.4
Men	220 (81.5)
Hypertension	143 (53.0)
Diabetes	94 (34.8)
Current smoker	87 (32.2)
Dyslipidemia	102 (37.8)
Prior CABG	3 (1.1)
Prior myocardial infarction	38 (14.1)
Prior PCI	43 (15.9)
Peripheral vascular disease	9 (3.3)
Chronic kidney disease (estimated glomerular filtration rate < 60 mL/min/1.73 m^2)	29 (10.7)
Stable angina	155 (57.4)
Left ventricle ejection fraction	53.8 ±12.3
Regional wall motion abnormality	135 (53.1%)
Single-photon emission computed tomography	52 (19.3)
Coronary computed tomography angiography	76 (28.1)

Angiographic Features

	(N=270)
Stumpless	117 (43.3)
Visible interventional collateral	192 (71.1)
LM disease	33 (12.2)
LCXos disease	24 (8.9)
J-CTO score	1.8 ±0.1
Blunted stump	152 (56.3)
Calcification, moderate to severe	117 (43.3)
Tortuous	39 (14.4)
Length > 20mm	156 (57.8)
Retrial	24 (8.9)
Collateral grade, Rentrop grade	
0-1	45 (16.7)
2-3	225 (83.3)
Bridge collateral	42 (15.6)
Multivessel disease	155 (57.4)
SYNTAX score	27.6 ± 6.9
CTO length	20.7 ± 10.5
Lesion length	42.1 ± 17.2

Procedural Features

	(N=270)
Technical success	**232 (85.9)**
Reason of failed procedure	**38 (14.1)**
- Wiring failure	27
- Perforation	4
- LM or LCX dissection	3
- No reflow	2
- Hemodynamically unstable during procedure	2
Wiring approach	
- Antegrade only	204 (75.6)
- Retrograde only or rescue retrograde	52 (19.3)
- Rescue antegrade	14 (5.2)
LM dissection in procedure	**13 (4.8)**
- During antegrade wiring	4
- During retrograde wiring	3
- After balloon angioplasty at LADos	4
- After stenting at LADos	2
LM dissection treatment	
- Immediate stenting at LM	5

Procedural Features

	(N=270)
Final technique	
- Antegrade	218 (80.7)
- Retrograde	52 (19.3)
Final Antegrade technique	
- Wire escalation	185
- Parallel wire	22
- IVUS guided rewiring	11
Final Retrograde technique	
- Reverse CART	10
- Regtrograde direct wiring	34
- Kissing wire	8
IVUS use	
- IVUS guided entry	71 (26.3)
- IVUS guided rewiring	36 (13.3)
- Stent optimization	159 (58.9)
Procedure time	137.4 ± 63.3
Fluorotime	58.8 ± 34.2
Radiocontrast amount	353.5 ± 182.4

Successful PCI	(N=232)
Stent generation	
- Bare metal stent	2 (0.9)
- 1st generation DES	45 (19.4)
- 2nd generation DES	182 (78.4)
- Bioresorbable vascular scaffold	3 (1.3)
Stent number	1.7 ± 0.1
Stent size	3.0 ± 0.3
Stent length	50.1 ± 19.7
Target vessel DCB	3 (1.3)
Target vessel POBA	41 (17.7)
Final stent strategy	
- Precise LAD stenting	137 (59.1)
- LM-LAD crossover	72 (31.0)
- LM bifurcation stenting	23 (9.9)
Reason for LM-LAD crossover	
- LM dissection	5
- Complete LADos coverage	54
- Baseline LM disease	13
Reason for LM bifurcation	
- LM dissection	6

Subgroup Analysis

(A) Left main disease — P=0.59
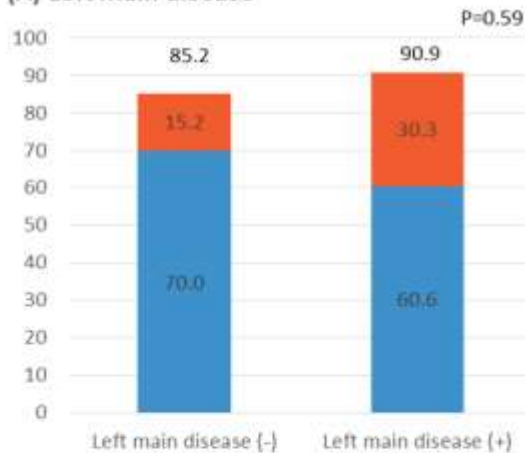
(B) LADos stump — P=0.72
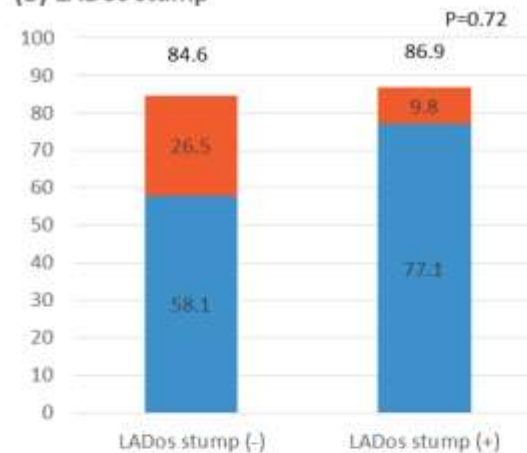
(C) Visible interventional collateral — P=0.33
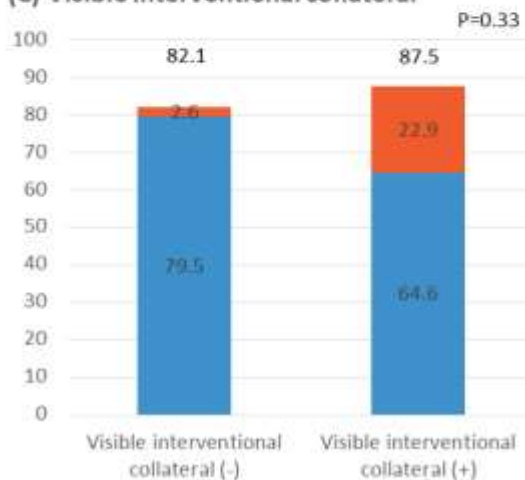
(D) J-CTO score — P=0.92
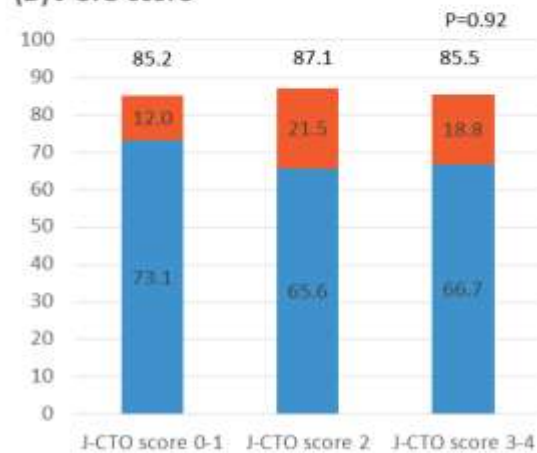
Antegrade success / Retrograde success

Predictors of successful PCI

	Unadjusted		Adjusted	
	OR (95% CI)	P	OR (95% CI)	P
Stumpless	0.95 (0.85-1.07)	0.391		
Visible interventional collateral	0.99 (0.88-1.11)	0.862		
J-CTO score 2	1.07 (0.91-1.26)	0.389		
J-CTO score 3-4	1.11 (0.86-1.43)	0.416		
Blunt	1.05 (0.91-1.20)	0.527		
Calcification	0.99 (0.87-1.12)	0.867		
Tortuous	1.03 (0.89-1.19)	0.723		
Length > 20mm	0.88 (0.77-1.00)	0.044	0.92 (0.85-1.00)	0.065
Retrial	1.05 (0.89-1.24)	0.528		
Collateral Rentrop grade 2 or 3	1.17 (1.02-1.33)	0.023	1.17 (1.04-1.30)	0.007
Bridge collateral	0.98 (0.87-1.10)	0.770		
LM disease	1.06 (0.92-1.21)	0.439		
LCXos disease	1.02 (0.87-1.19)	0.847		
Multivessel disease	1.00 (0.92-1.09)	0.978		
IVUS guided entry	0.99 (0.89-1.10)	0.854		
IVUS guided rewiring	1.03 (0.90-1.18)	0.661		
Retrograde only or rescue retrograde	0.76 (0.63-0.93)	0.008		
Rescue antegrade	0.99 (0.88-1.12)	0.877	0.79 (0.66-0.95)	0.014
LM dissection during intervention	0.99 (0.80-1.22)	0.926		

In-hospital MACE

	(N=270)
In-hospital MACCE	**15 (5.6)**
In-hospital death	3 (1.1)
Cardiac death	2
Non-cardidiac death	1
Periprocedural MI	6 (2.2)
Stroke	0
In-hospital TVR	5 (1.9)
- Emergent CABG	2
- Elective CABG	2
- Elective re-PCI	1
Cardiac tamponade requiring intervention	3 (1.1)

Long-term Clinical Outcomes

	Event number (Kaplan-Meier estimate)
TVF	15 (11.2)
MACE	20 (14.1)
Death	10 (6.6)
Cardiac death	5 (3.5)
MI	2 (1.3)
TVMI	1 (0.8)
TVR	12 (9.1)

KM curve in success cases
TVF & MACE
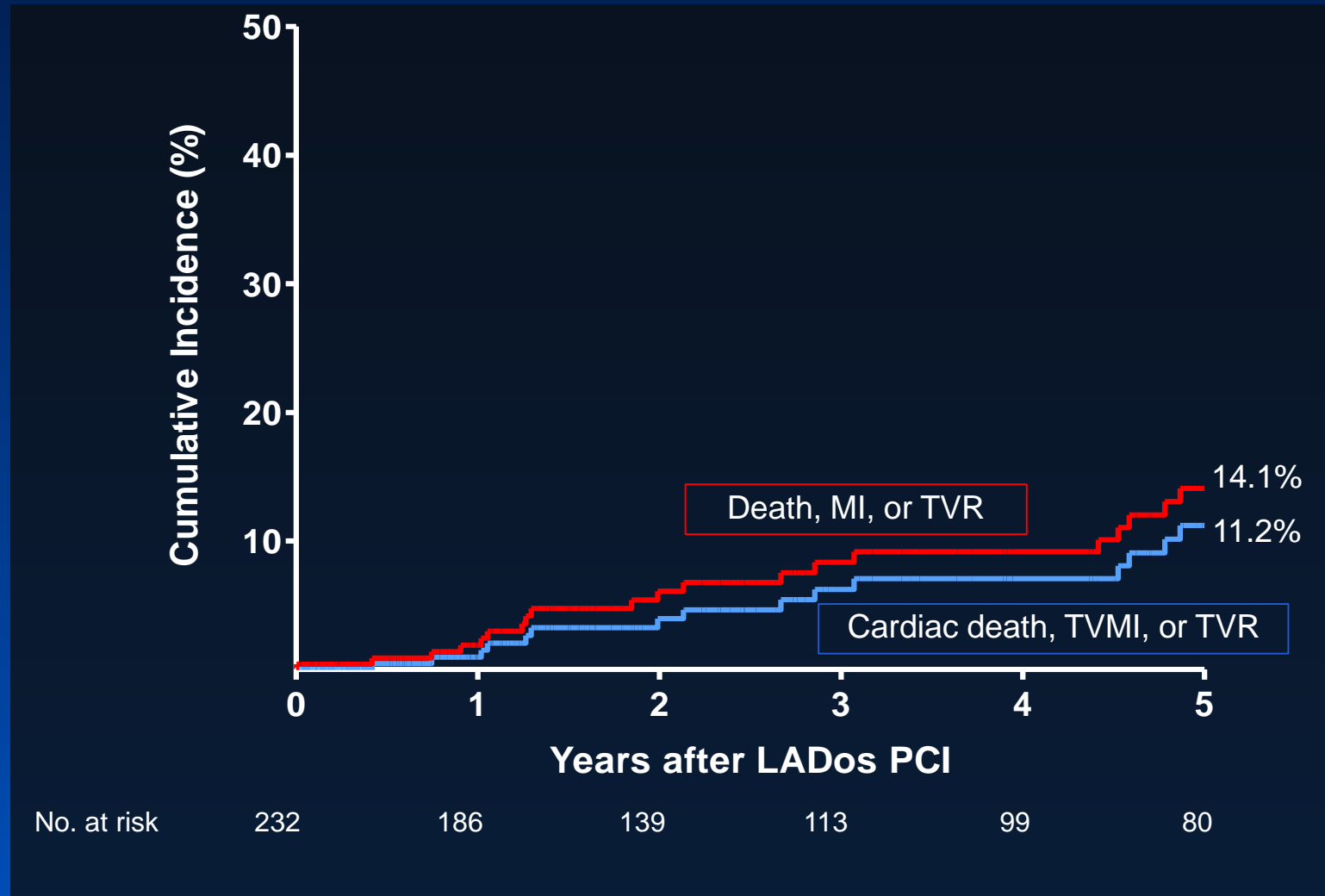
KM curve in success and failed cases TVF
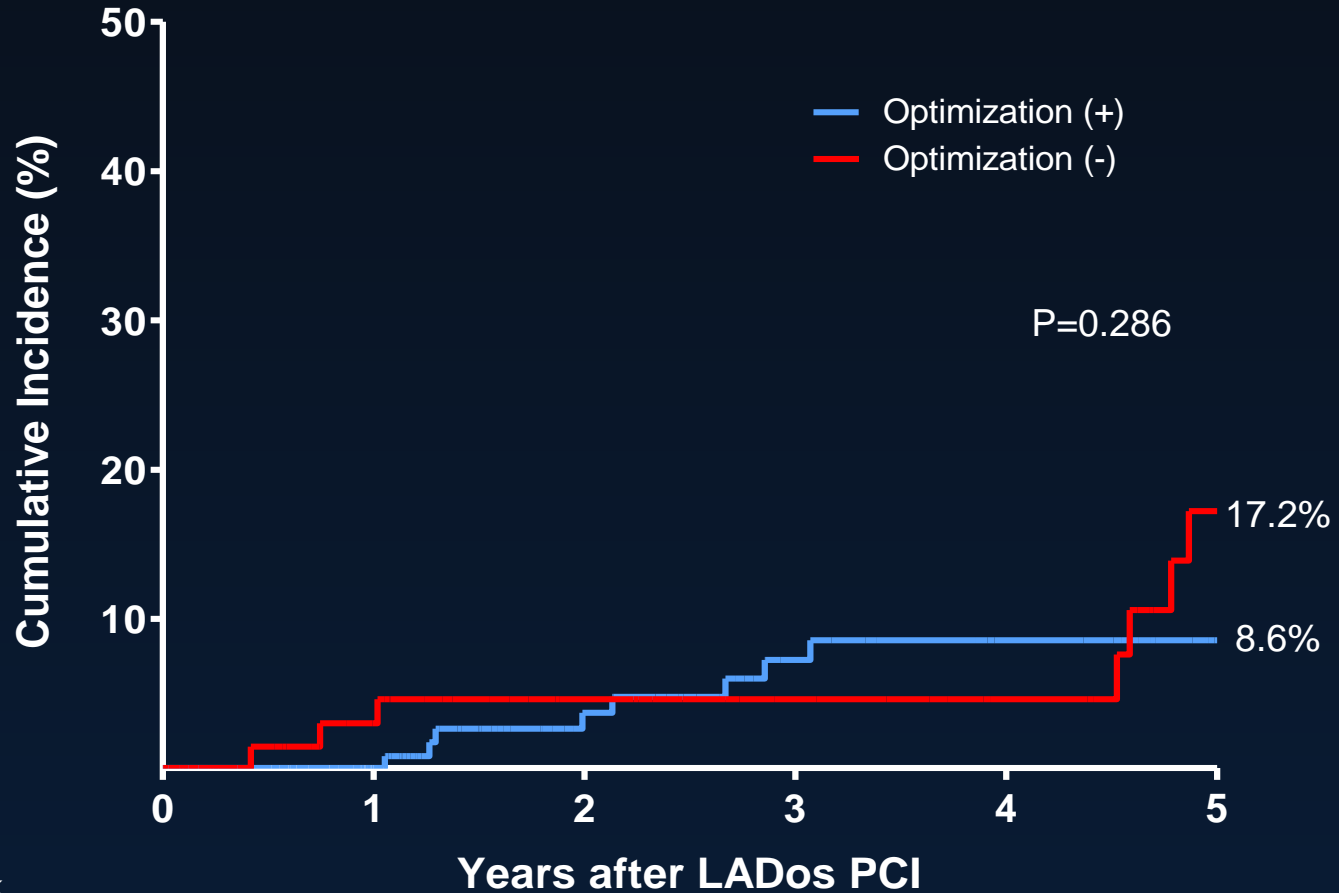
KM curve in success and failed cases MACE

No. at risk

Success	232	186	139	113	99	80
Fail	38	30	25	22	19	18

Chart: Cumulative Incidence (%) vs Years after LADos PCI. Success (blue) reaching 14.1%, Fail (red) reaching 20.2%. P=0.239
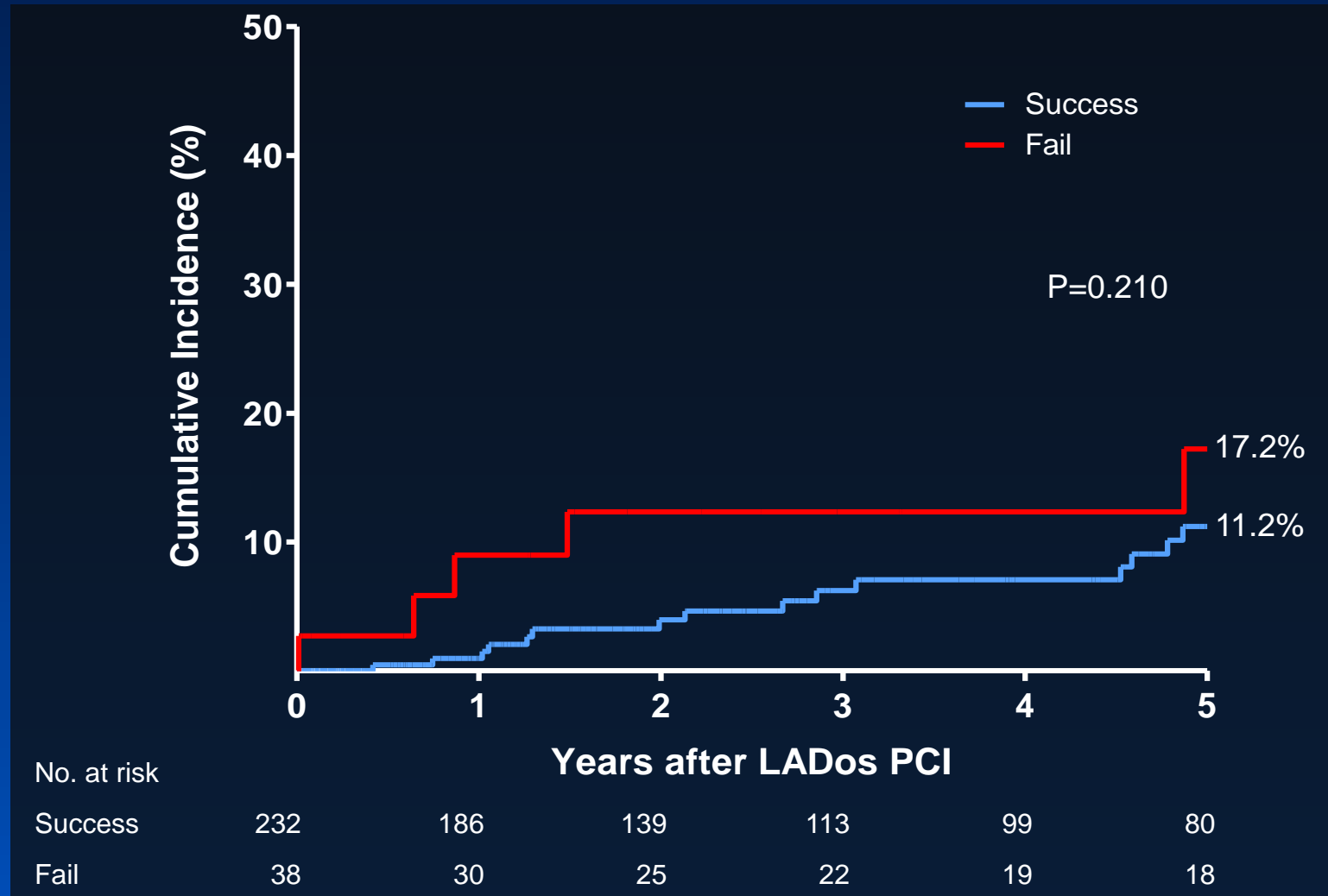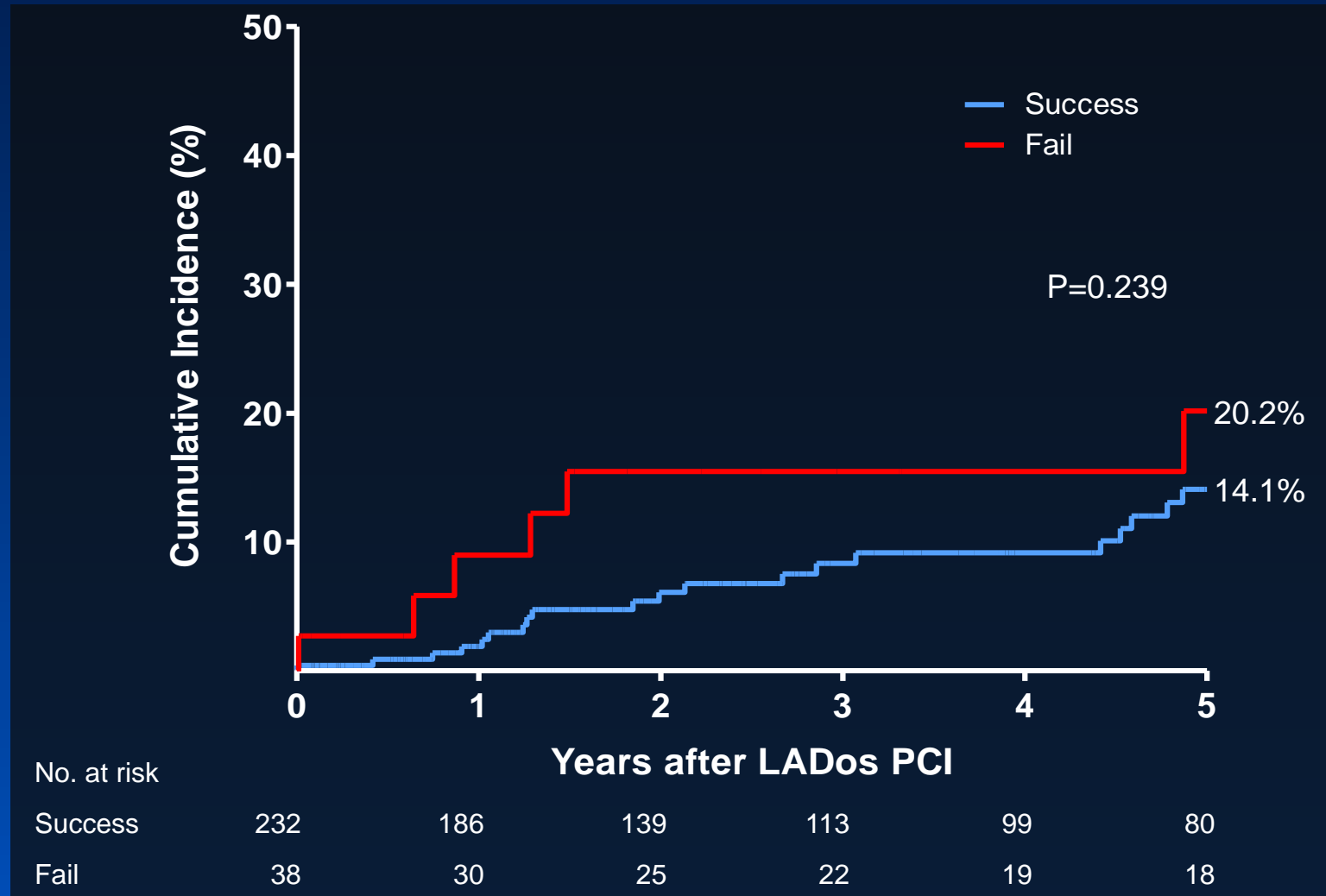
TVF in success cases
LAD only vs cross-over or bifurcation

Cumulative Incidence (%)

- LAD only
- LM-LAD cross-over or LM bifurcation stenting

P=0.610

12.5%

8.6%

Years after LADos PCI

No. at risk						
LAD only	137	115	91	76	66	52
Cross or Bifur	95	72	49	38	34	29
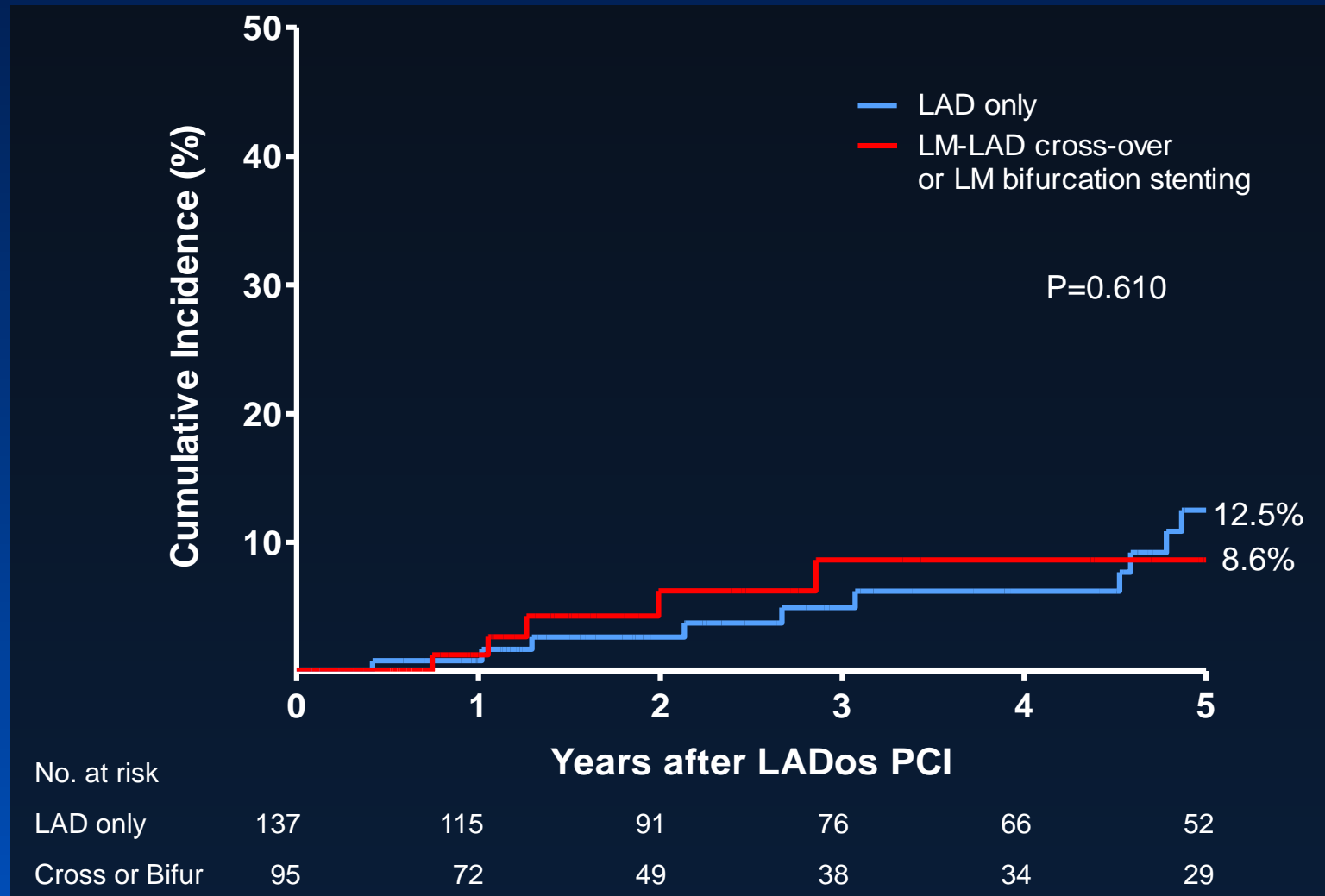
TVF in success cases
IVUS-guided optimization
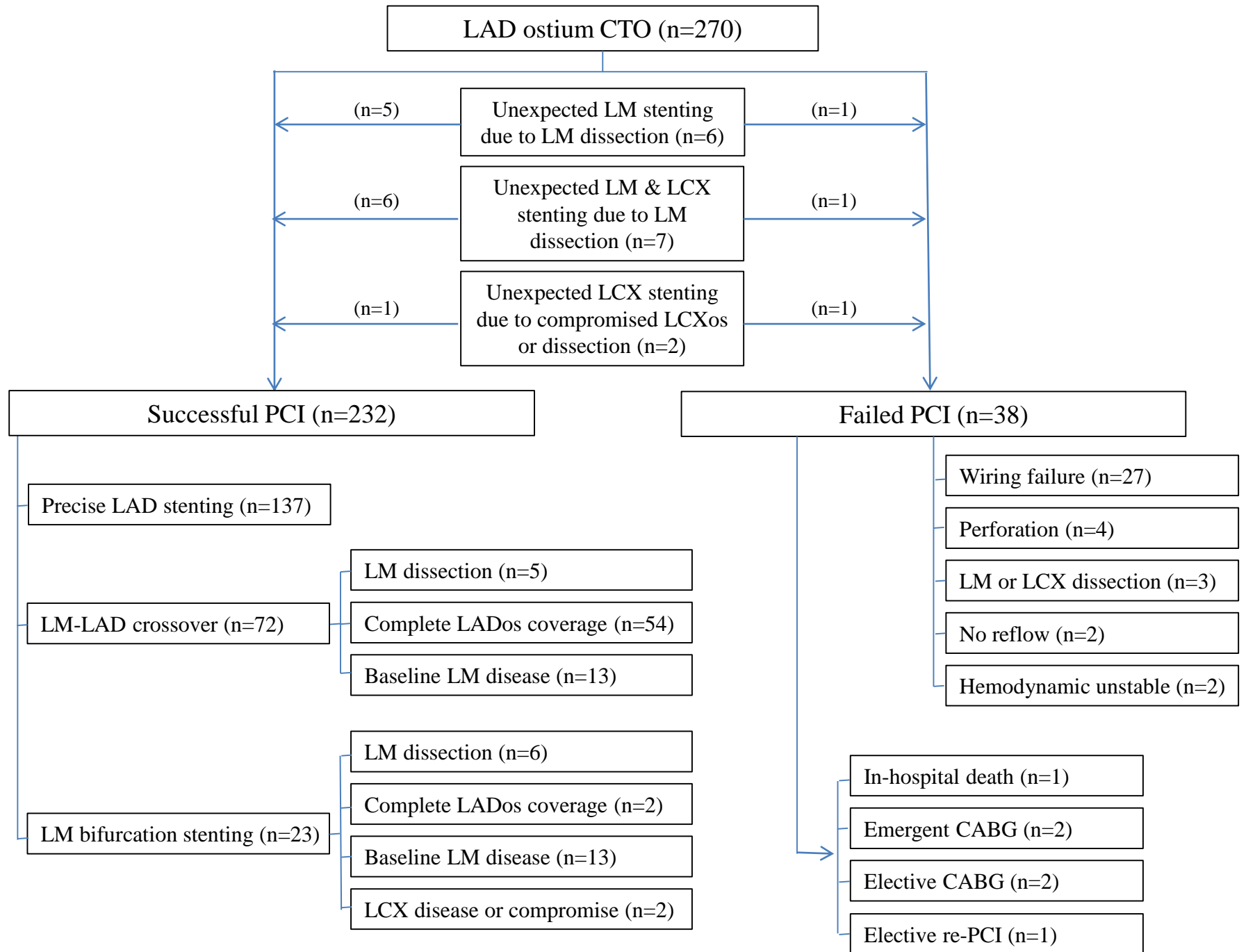
Conclusion

- CTO-PCI for LADos showed feasible success rate (85.9%) with acceptable incidence of peri-procedural complication (5.6%) and favorable long-term outcomes (11.2% of 5-year TVF).

- Especially, the ostial LAD CTO was a specific site with high chances of angiographic difficulties which may not be a suitable predictor for its success.

- Our study concluded that several scoring systems may be not a good predictor for ostial LAD CTO PCI due to its specific in coronary arteries. Only, CTO length, presence of sufficient collateral and rescue antegrade approach were identified as significant predictor of LADos CTO PCI.

- Therefore, dedicated specific LADos CTO algorithm might be necessary according to the several factors.