Minneapolis Heart Institute Foundation

Spring Conference Showcase

April 1, 2024

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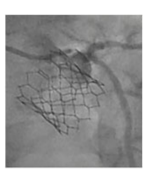
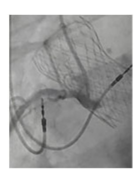
Unplanned Coronary Angiography After Transcatheter Aortic Valve Replacement

(Incidence, Predictors, and Outcome)

Asa Phichaphop
Research Scholar, Valve Science Center, Minneapolis Heart Institute Foundation

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Background

- Coronary artery disease and aortic stenosis are frequently found together
- TAVR prostheses may cause difficulties in coronary cannulation and exacerbated when revascularization is needed urgently

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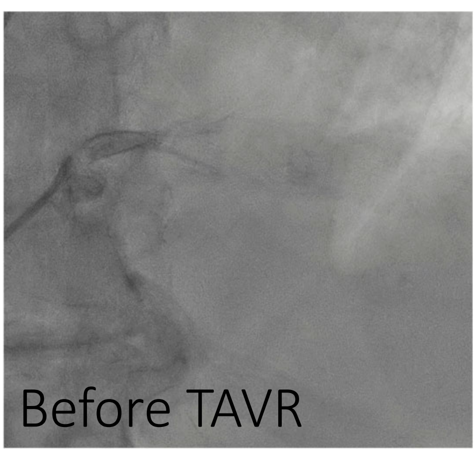

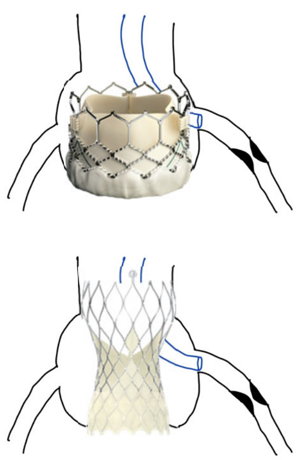

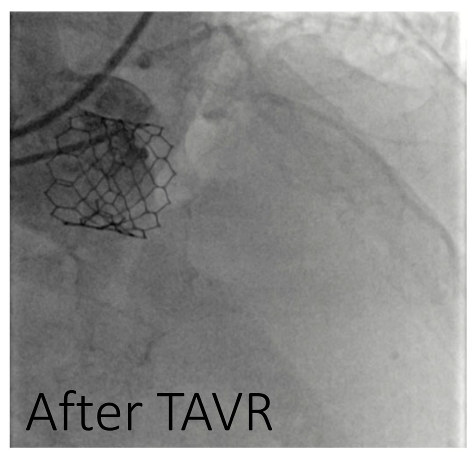

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Objectives

- Incidence of unplanned coronary angiography after TAVR
- 5-year Prediction model of the need for coronary angiography

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Method

All patients underwent TAVR between
July 2015 - December 2021

Excluded
- Aborted procedure
- Patient without device success according to VARC-2 criteria

Outcome: Incidence of unplanned coronary angiography

Excluded: planned angiography/PCI decided prior to TAVR

Angiography performed at the same procedure as TAVR

Retrospective, single center study

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Result

- *1,444* patients, median time follow up 26 months

  Mean age of 81 years old, STS-PROM 3.40, 64% of balloon-expandable use

Incidence of unplanned coronary angiography

Indication of coronary angiography	Total n = 97
STEMI	7 (7.2%)
UA/ NSTEMI	41 (42.3%)
Chronic coronary disease	41 (42.3%)
Others	8 (8.2%)

49.5% ACS (STEMI + UA/ NSTEMI)

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Baseline characteristics

	Without unplanned CAG (n=1,347)	With unplanned CAG (n=97)	p-value
Age, yrs	81 (76.0 – 86.5)	↓ 78.0 (72.0 – 83.0)	0.001
Men - no. (%)	777 (57.5)	↑ 69 (71.1)	0.010
Hypertension - no. (%)	1154 (85.7)	85 (87.6)	0.654
Diabetes - no. (%)	447 (33.2)	↑ 42 (43.3)	0.045
Dialysis - no. (%)	29 (2.2)	5 (5.2)	0.084
Permanent pacemaker - no. (%)	179 (13.3)	12 (12.4)	0.878
Coronary artery disease - no. (%)	648 (48.1)	↑ 76 (78.4)	<0.001
Prior CABG - no. (%)	223 (16.6)	↑ 37 (38.1)	<0.001
Prior PCI, no. (%)	413 (30.7)	↑ 56 (57.7)	<0.001
STS-PROM, (%)	3.40 (2.19 - 5.40)	3.35 (2.20 - 5.26)	0.989

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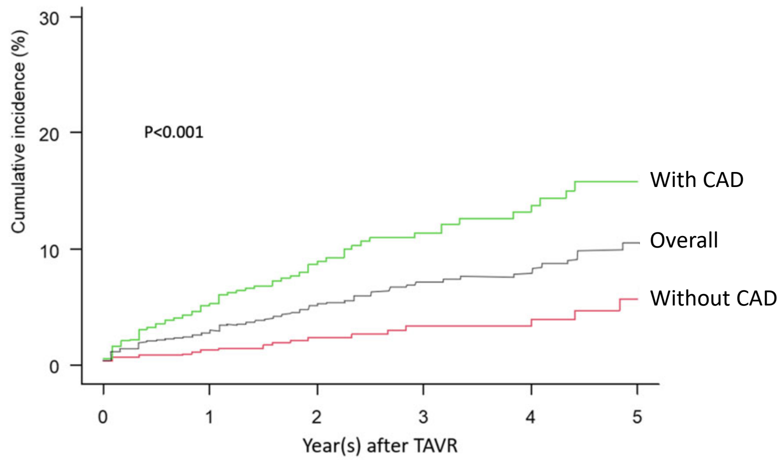
Patient with CAD had a higher rate of unplanned CAG



Number at risk

	0	1	2	3	4	5
With CAD	720	613	375	250	163	91
Without CAD	724	587	361	227	153	73

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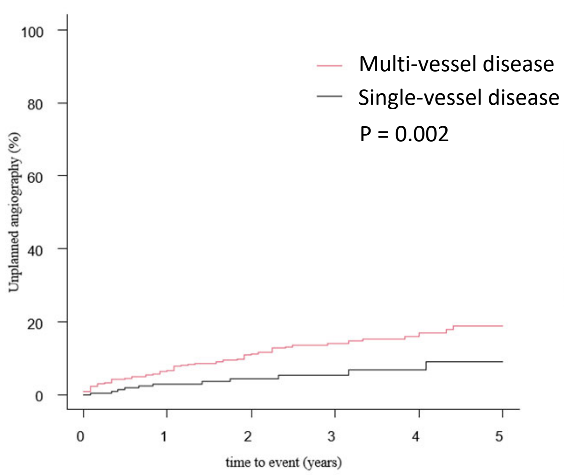
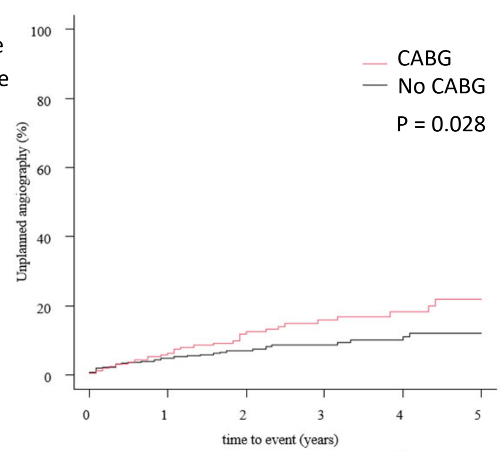
In CAD group: higher CAG in Multivessel and CABG



	0	1	2	3	4	5
MVD	498	401	248	155	109	48
SVD	224	184	112	71	44	25



	0	1	2	3	4	5
CABG	260	210	133	81	56	30
no CABG	464	377	228	146	97	43

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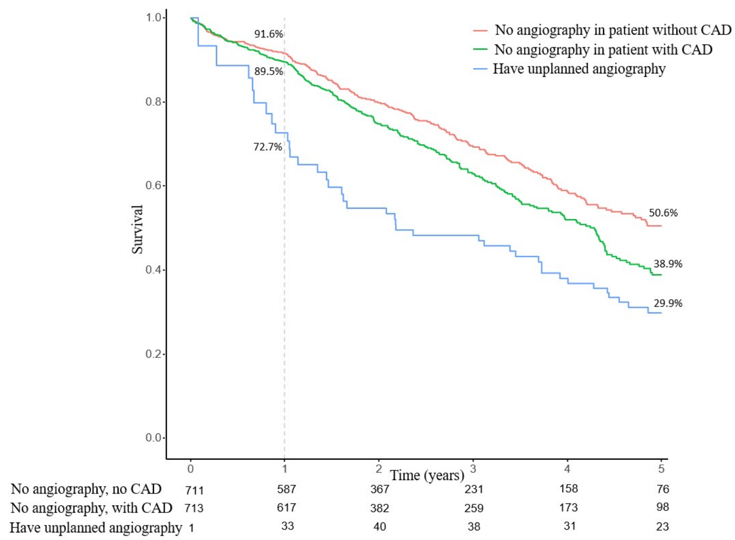
5-year survival



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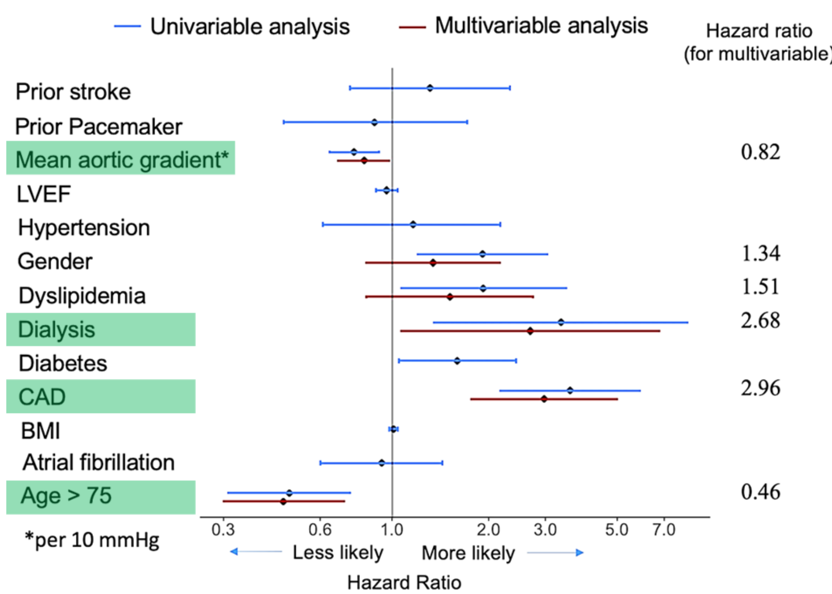
Factors association with the unplanned CAG



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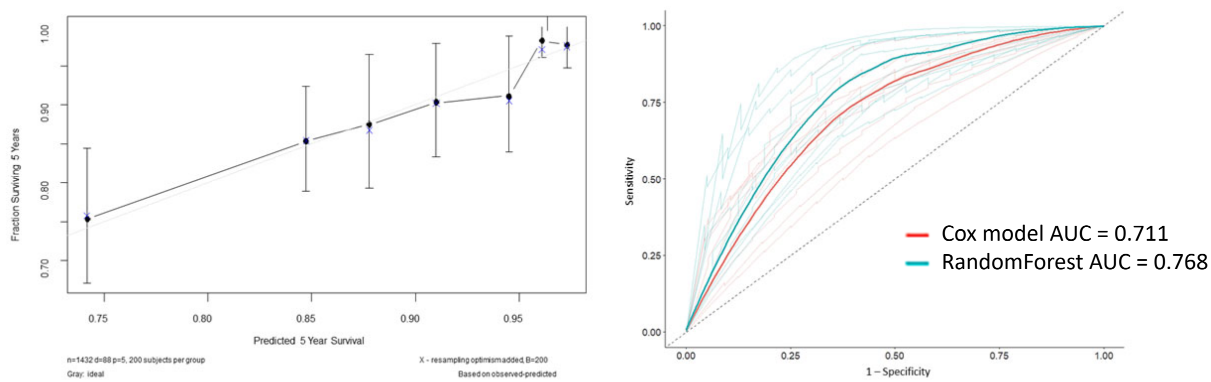
5 –year prediction model

(cause-specific cox regression)

a) calibration plot and b) receiver operating characteristic (ROC) curve



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Clinical application

- Considering the challenges and risk of unplanned coronary angiography, those patients with risk factors for subsequent unplanned coronary angiography need to be carefully evaluated and attempted to minimize the occurrence of the event.

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Take home message

Unplanned coronary angiography

- **Occurrence was 6.6%** of patients after TAVR
- **Acute coronary syndrome** was the most common indication in 50%
- **Patient with significant CAD has 3 fold higher needed**
- Younger age, dialysis, and low mean aortic gradient associated with higher needed
- A comprehensive strategy for lifetime care in those patients is needed.

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April 2024

In-vivo CT sizing for redo-transcatheter aortic valve replacement in Evolut valves

Atsushi Okada, Miho Fukui, Kiahltone R. Thao, Evan Walser-Kuntz, Larissa I. Stanberry, Marcus R. Burns, Hideki Koike, Cheng Wang, Asa Phichaphop, John R. Lesser, João L. Cavalcante, Paul Sorajja, Vinayak N. Bapat

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Background

Transcatheter aortic valve (TAV) designs

- SAPIEN3 / SAPIEN3Ultra (S3)
  - Balloon expandable valves
  - Short valves
- Evolut PRO+ / Evolut FX (Evolut)
  - Self expandable valves
  - Tall valves

TAV-in-TAV (Redo TAV)

2 x 2 combination

How should we plan?

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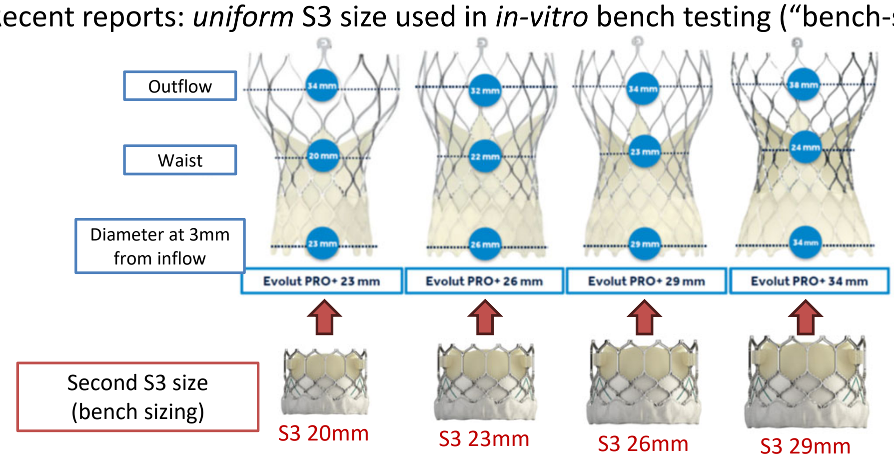
Background

S3-in-Evolut: a common combination

- How to decide the <u>second TAV size</u> is not fully understood
- Recent reports: *uniform* S3 size used in *in-vitro* bench testing ("bench-sizing")



Is there a better way to decide the S3 size?

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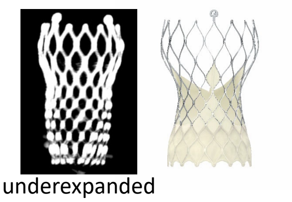
Background

Hypothesis / Aims

- Using a *uniform* bench sizing may be inappropriate since
  1. Evolut valves have a "waist"
  2. Evolut is often underexpanded *in-vivo*

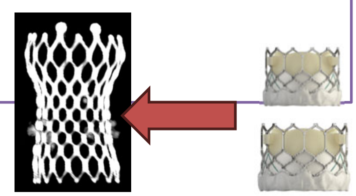
- Second TAV (S3) size impacts
  - risk to coronaries (i.e. feasibility of Redo-TAV)
  - may cause harm if oversized: possible annulus rupture

Post TAVR CT



underexpanded
in-vivo

- Aim: evaluate the usefulness of applying *in-vivo* CT sizing using post TAVR CTs on
  1. second TAV size
  2. risk to coronaries (redo-TAV feasibility)
  3. estimated risk of prosthesis-patient mismatch (PPM)



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Methods

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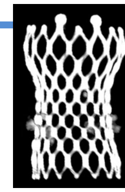
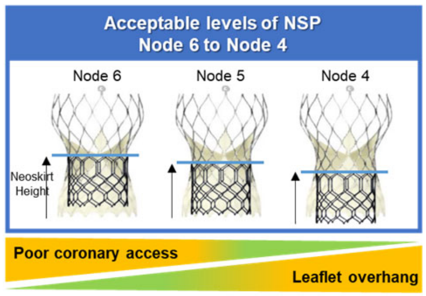
Methods

Study population



- Study population
  - Post TAVR CTs of 290 patients treated with Evolut R/PRO/PRO+
- CT simulation: S3-in-Evolut in 3 implant positions
  - *i.e.* neoskirt plane: NSP



*Node 5/4 for Evolut 23 mm

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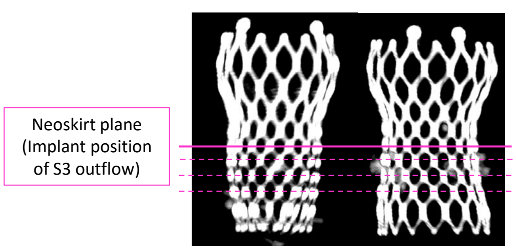
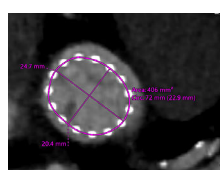
Methods

Method of CT sizing for S3-in-Evolut

- average of 4 areas of Evolut stent frame on post TAVR CT
  - at the Neoskirt plane (NSP) and 3 nodes below



Tapered shape   Flared shape



Edwards SAPIEN 3 valve size (mm)	3-D Area-derived Diameter (mm)	3-D Annular Area (mm2)
20	18.6-21.0	273-345
23	20.7-23.4	338-430
26	23.4-26.4	430-546
29	26.2-29.5	540-683

- then averaged area was referenced to S3 sizing tables

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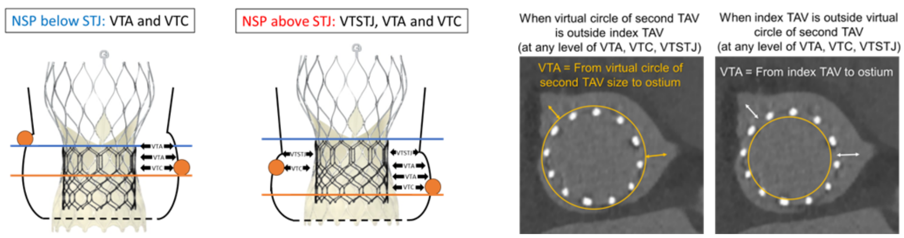
Methods

Evaluation of coronary obstruction risk (Redo-TAV feasibility)

- Evaluated by narrowest valve-to-aorta (VTA) distance below NSP
  - >4 mm low-risk, 2-4 mm intermediate-risk, <2 mm high-risk



- Predicted PPM risk
  - estimated using reported EOA values of S3 (Hahn RT, et al. JACC Img 2019;12:25-34.)

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Results

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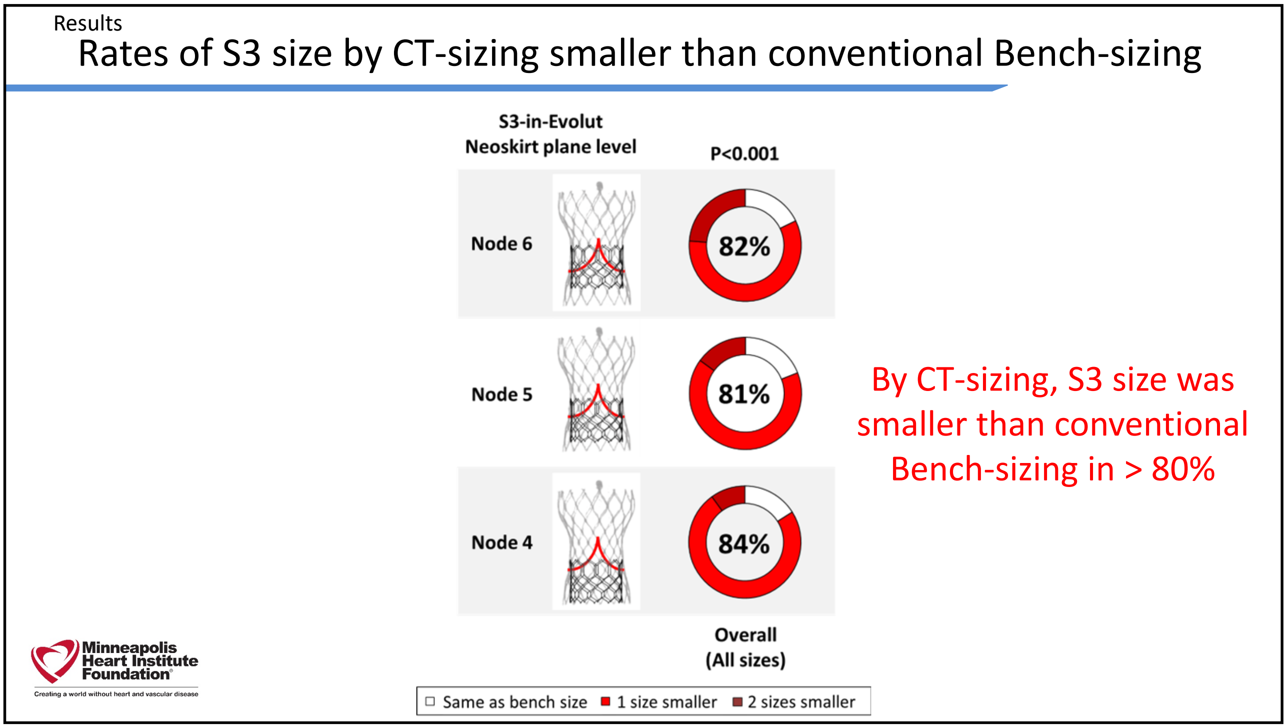
Results
Rates of S3 size by CT-sizing smaller than conventional Bench-sizing
S3-in-Evolut
Neoskirt plane level
P<0.001
Node 6
82%
Node 5
81%
Node 4
84%
Overall
(All sizes)
By CT-sizing, S3 size was smaller than conventional Bench-sizing in > 80%
Same as bench size
1 size smaller
2 sizes smaller
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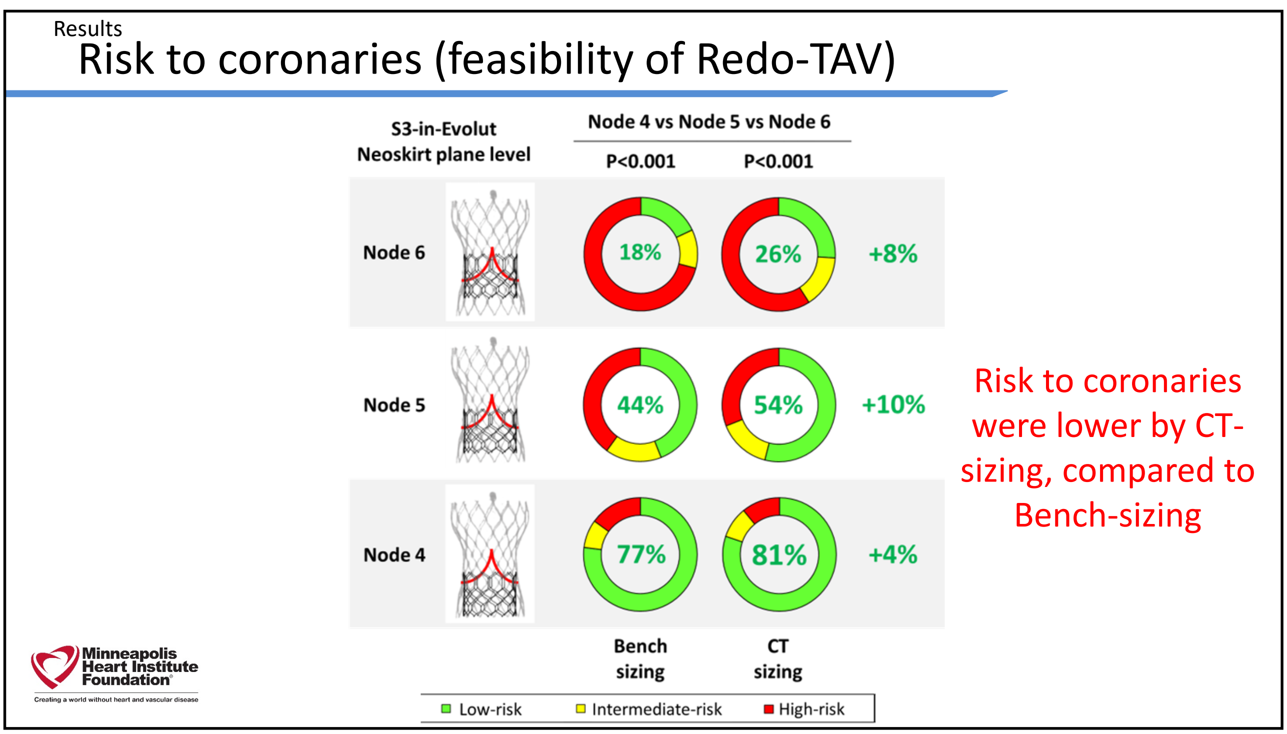
Results
Risk to coronaries (feasibility of Redo-TAV)
S3-in-Evolut
Neoskirt plane level
Node 4 vs Node 5 vs Node 6
P<0.001
P<0.001
Node 6
18%
26%
+8%
Node 5
44%
54%
+10%
Node 4
77%
81%
+4%
Bench
sizing
CT
sizing
Risk to coronaries were lower by CT-sizing, compared to Bench-sizing
Low-risk
Intermediate-risk
High-risk
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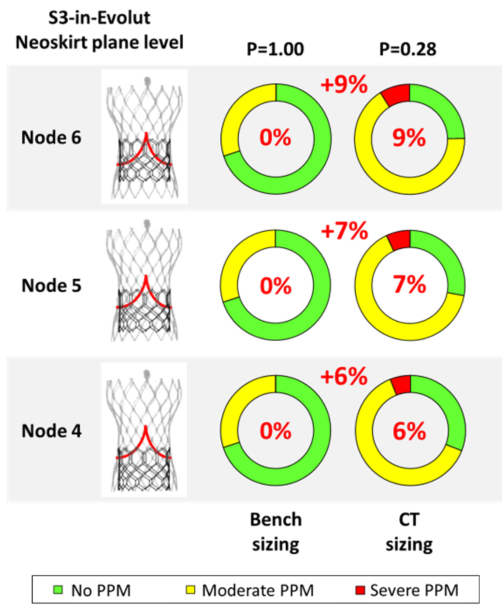
Results

Predicted risk of prosthesis-patient mismatch (PPM)



Rates of severe PPM were <10% by CT-sizing

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Results

Summary of Results

- Applying CT-sizing for S3-in-Evolut resulted in
  - smaller S3 size compared to Bench-sizing in *>80%* of cases
  - possible consequence of under-expansion and the “waist” shape of Evolut
- Risk to coronaries by CT-sizing were
  - Lower by CT-sizing (higher feasibility for S3-in-Evolut)
    - %Low-risk: 26% at node 6, 55% at node 5, and 80% at node 4
- Predicted risk of PPM after S3-in-Evolut
  - less than 10% by CT-sizing

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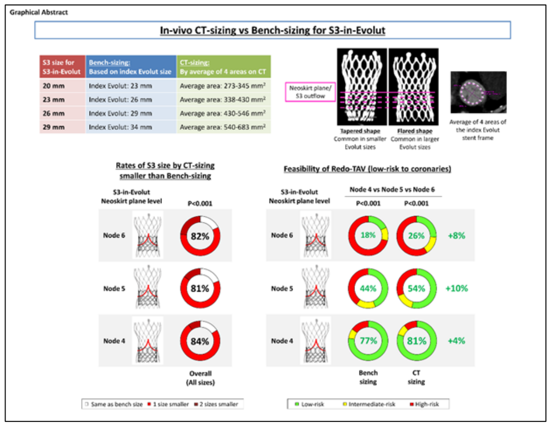
Conclusions

- Applying CT sizing for S3-in-Evolut
  - Increase the feasibility of Redo-TAV (TAV-in-TAV)
  - Lower the risk of excessive oversizing and subsequent complications



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Thank you for your attention

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Direct current cardioversion post-LAAC with Watchman devices

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Disclosures

- None

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Background

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Left atrial appendage closure

- LAA is the source of 90% of systemic emboli in AF patients
- LAA clos
- It can be

- Patients follow recommended OAC regimen post implantation

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Direct current cardioversion in atrial fibrillation

- DCCV carries a risk for thromboembolism in AF patients
- Guidelines from Cardiology societies provide a clear roadmap
- Safety and effectiveness of DCCV for AF are well documented
- No clear guidelines on best approach for DCCV after LAAC

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Direct current cardioversion after LAAC

Direct Current Cardioversion of Atrial Fibrillation in Patients With Left Atrial Appendage Occlusion Devices

Sharan Prakash Sharma, MD,[a] Mohit K. Turagam, MD,[b] Rakesh Gopinathannair, MD,[a] Vivek Reddy, MD,[b] Saibal Kar, MD,[c] Sangamitra Mohanty, MD,[d] Jie Cheng, MD,[e] David R. Holmes, Jr, MD,[f] Lars Sondergaard, MD,[g] Andrea Natale, MD,[d] Dhanunjaya Lakkireddy, MD[a]

- Include
- All pati
- DCCV
- DRT w

TABLE 2 Device-Related Thrombus

	Timing From LAAO Implantation	Anticoagulation Prior to DCCV	Treated With	Repeat TEE	DCCV	Post-DCCV OAC
Patient #1	3 months	Aspirin and clopidogrel	Apixaban × 8 weeks	Resolution	Success	Apixaban × 12 weeks
Patient #2	8.5 months	Aspirin only	Apixaban × 4 weeks	Resolution	Success	Apixaban × 12 weeks
Patient #3	11 months	Aspirin only	Rivaroxaban × 24 weeks	Resolution	Success	Rivaroxaban × 6 weeks
Patient #4	14 months	Aspirin only	Apixaban × 4 weeks	Resolution	Success	Apixaban × 6 weeks

DCCV = direct current cardioversion; LAAO = left atrial appendage occlusion; OAC = oral anticoagulants; TEE = transesophageal echocardiography.

Sharma et al., JACC. 2019

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Methods

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Objectives

- Assessment of safety and effectiveness of DCCV on SAPT regimen
  -Safety endpoint was freedom from post-DCCV complications
  -Systemic embolism/Death/Device embolism within 30 days
- Feasibility of DCCV without pre-procedural imaging
- Capturing the incidence of DRT/PDL in cases who had imaging

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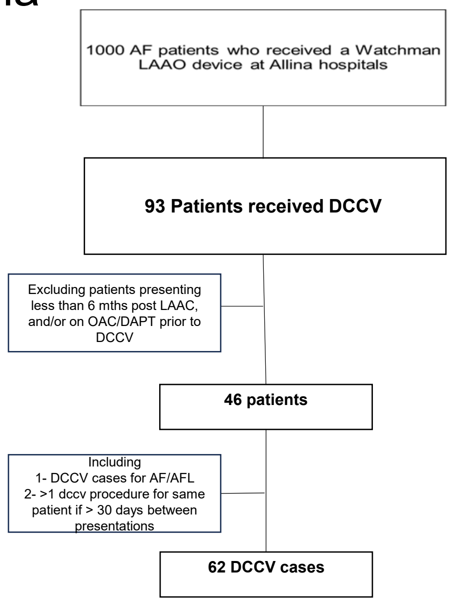
Selection criteria



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Results

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Baseline characteristics

- More than half were females 26(56%), 75 years, BMI 32.2 Kg/m²
- CHA2DS2-VASc score 4.6, with 18 patients(39%) having stroke history
- Comorbidities were abundant
- Median time from implantation to DCCV was 20 (12.4-26.9) months

Baseline Characteristics N=46		
Gender (Female)	26	56.5
Race (White)	45	97.8
LVEF	57	7
Age at implantation	75.5	5.7
BMI	32.2	6.5
CHADSVASC at implantation	4.5	1.3
History of stroke	18	39
COPD	9	19.6
Diabetes mellitus	17	37.0
Smoking	28	60.9
Chronic kidney disease	13	28.3
Heart failure	25	54.3
Hypertension	45	97.8
MI	6	13.0
Device implanted (Watchman)	32	69.5

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Results

- 54 (87%) cases were on Aspirin 81.mg
- 8 cases were on Clopidogrel 75.mg
- 48 cases (77%) did not get pre-procedural imaging
- No DRT was noticed on imaging
- PDL incidence was high 4 (28%) among those who had TEE/CCT
- Safety endpoint was achieved in all cases

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Conclusions

- DCCV could be considered safe while being on SAPT regimen
- Performing DCCV without pre-imaging is still under question
- More studies are needed to optimize DCCV approach post LAAC

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PROGRESS

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Allina Health
ABBOTT NORTHWESTERN HOSPITAL

Retrograde CTO PCI via Ipsilateral Collaterals

Ahmed Al-Ogaili
CHIP-CTO Fellow

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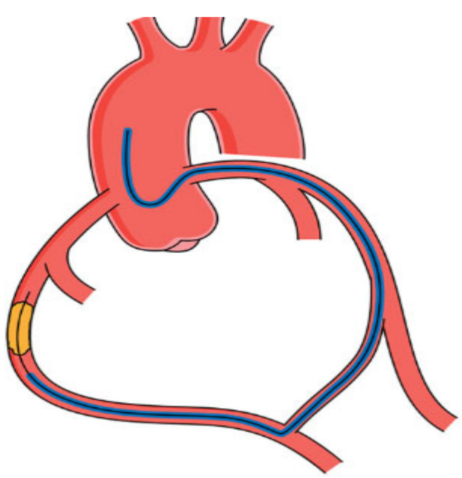
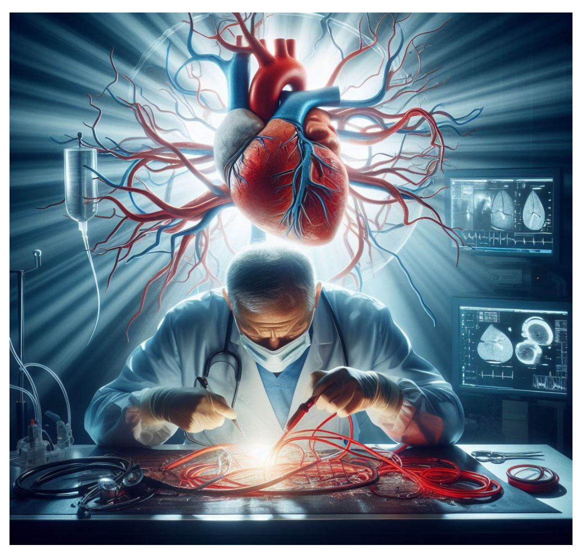
Background





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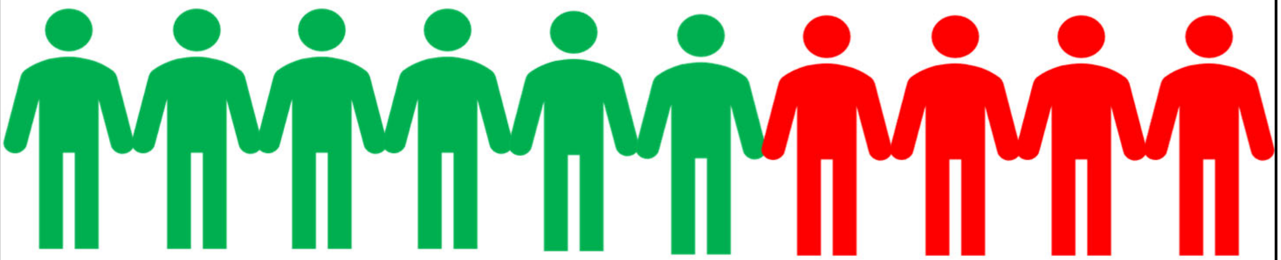
Background



Brilakis ES, et al. JACC Cardiovasc Interv. 2015 Feb;8(2):245-253.

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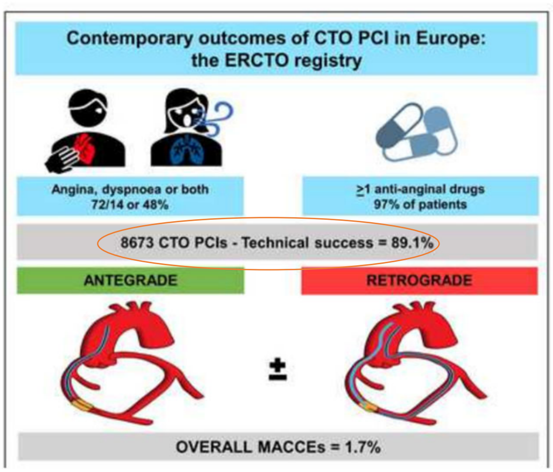
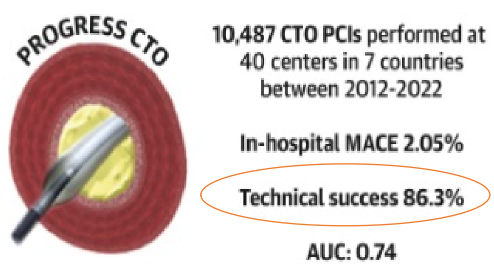
Background



Vadala G, et al. Eurointervention 2024 Feb 5;20(3):e185-e197



Simsek B, et al. J Am Coll Cardiol Intv. 2022;15(14):1413-1422

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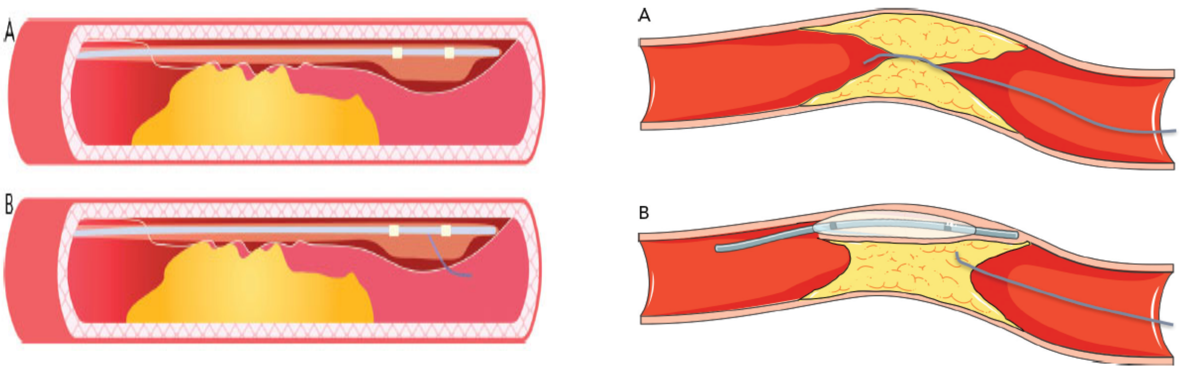
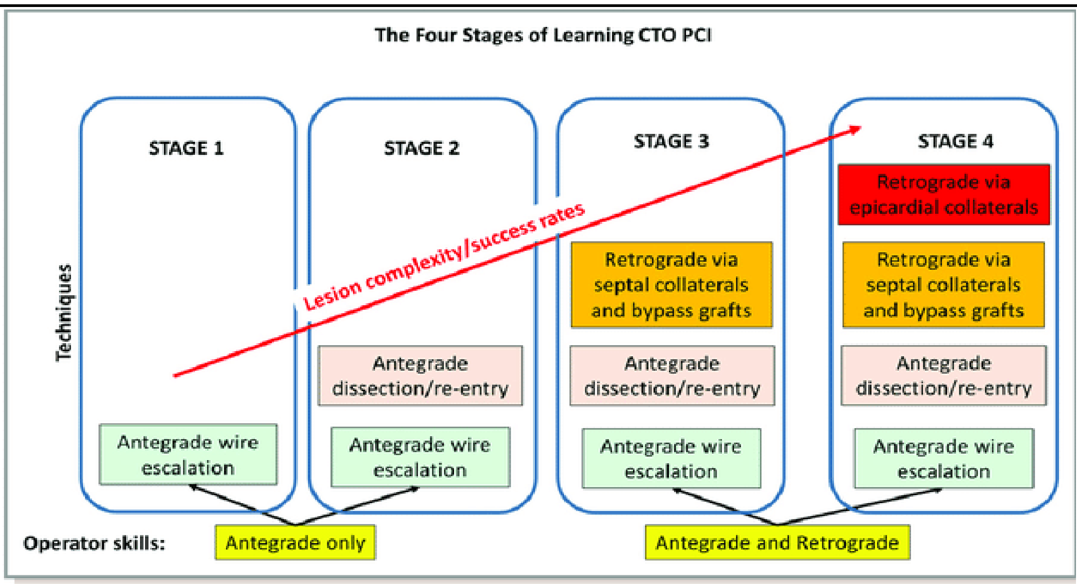
Background





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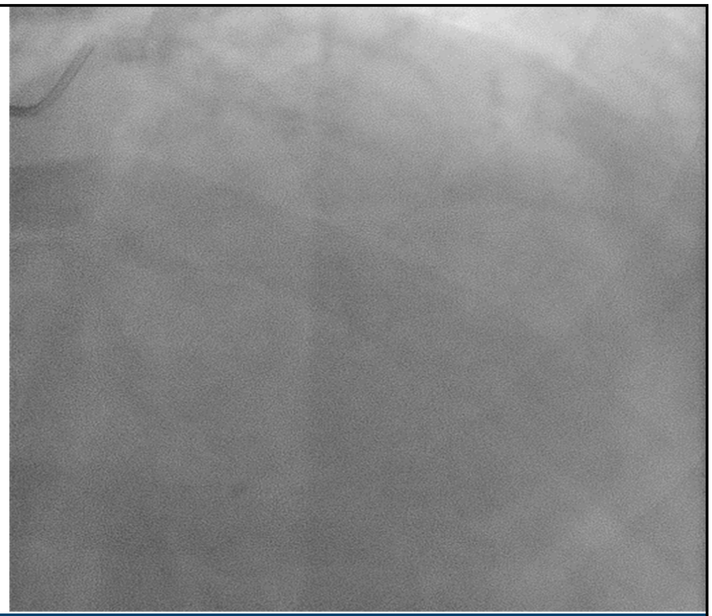
Case



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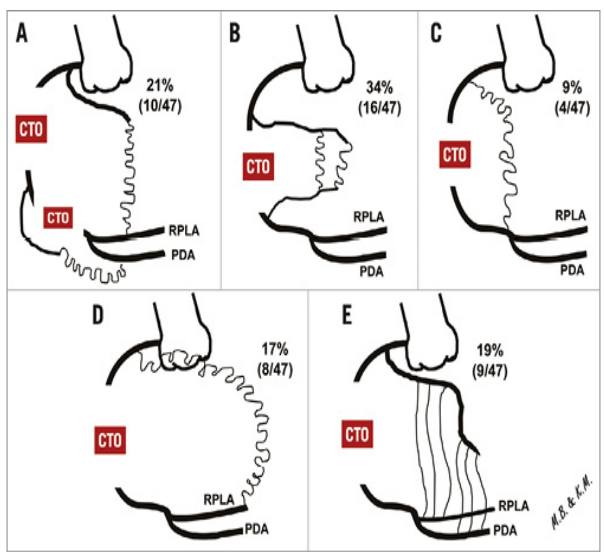
Background

There is limited data on retrograde chronic total occlusion (CTO) percutaneous coronary intervention (PCI) via ipsilateral epicardial collaterals (IEC)



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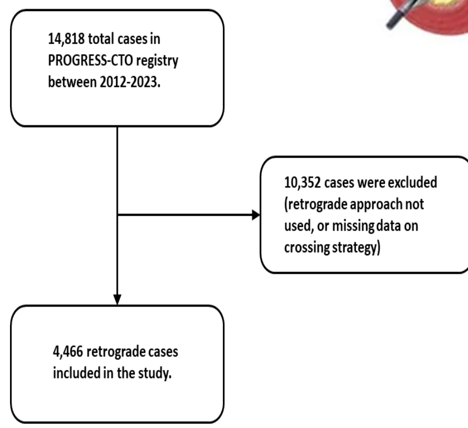
Methods

Ipsilateral collaterals VS **All other collaterals**

- Baseline clinical and angiographic characteristics
- Procedural outcomes



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Statistical analysis

- Categorical variables were expressed as percentages and compared using the Pearson's chi-square test.
- Continuous variables are presented as mean ± standard deviation or as median (interquartile range) unless otherwise specified and were compared using the independent-samples t-test for normally distributed variables and the Mann-Whitney U test for non-parametric variables.
- Multivariable logistic regression was used to examine the association between the use of IEC vs other collaterals and procedural complications.
- All statistical analyses were performed using JMP version 14.0 (SAS Institute, Cary, North Carolina). A p-value of <0.05 was considered statistically significant.

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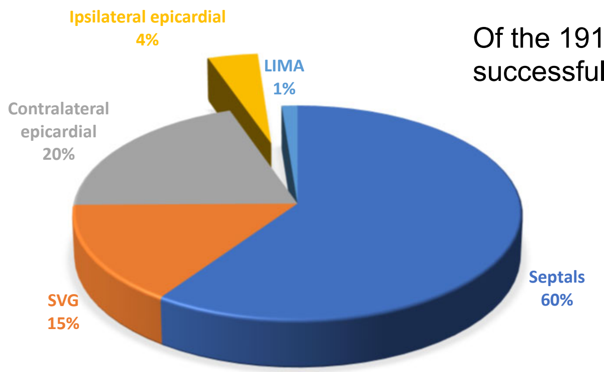
Results



Of the 191 IEC cases, the epicardial collateral was successfully wired in 50%.

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Baseline clinical characteristics

Clinical characteristics	IEC N = 191	Other retrograde conduits N= 4275	P-Value
Age	66 ± 10	65 ± 10	0.173
Men	82%	84%	0.739
Atrial fibrillation	89%	86%	0.276
Diabetes	49%	43%	0.125
Dyslipidemia	87%	89%	0.535
Hypertension	89%	89%	0.880
Smoking	44%	41%	0.053
Prior MI	52%	48%	0.280
Prior heart failure	39%	29%	0.003
Left ventricular EF %	47 ± 13	50 ± 13	0.006
Prior PCI	74%	69%	0.155
Prior CABG	42%	42%	0.909
Current dialysis	5%	2%	0.025
Cerebrovascular disease	8%	11%	0.234
Peripheral arterial disease	16%	17%	0.689
Chronic lung disease	20%	16%	0.204
Creatinine level, mg/dl	1.03 (0.87-1.23)	1.01 (0.87-1.2)	0.609

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Angiographic characteristics

	IEC N = 191	Other retrograde conduits N= 4275	P- value
Dual injection	66%	89%	<0.0001
Target Vessel			<0.0001
RCA	15%	70%	
LAD	30%	16%	
LCX	50%	13%	
Other	5%	1%	
Proximal cap ambiguity	66%	57%	0.012
Side branch at Proximal Cap	74%	63%	0.002
Good distal landing zone	47%	58%	0.003
Moderate or severe calcification	58%	60%	0.675
Moderate or severe tortuosity	42%	40%	0.500
In-stent restenosis	14%	13%	0.595
Prior attempt to open the CTO	23%	22%	0.902
Bifurcation at distal cap	44%	45%	0.655
Occlusion length, mm	34 ± 19	40 ± 25	0.0001
Vessel diameter	2.8 ± 0.5	3 ± 0.5	<0.0001
J-CTO score	3.13 ± 1.23	3.06 ± 1.06	0.456
Progress CTO score	1.95 ± 1.02	1.27 ± 0.92	<0.0001
Progress MACE score	5.06 ± 1.72	4.99 ± 1.73	0.568

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Procedural details

	IEC N = 191	Other retrograde conduits N= 4275	P-value
Crossing Strategies used			
AWE	75%	68%	0.031
ADR	37%	29%	0.018
Retrograde	100%	100%	N/A
First crossing strategy			0.007
AWE	67%	56%	
ADR	3%	3%	
Retrograde	30%	41%	
Successful crossing Strategy			0.004
AWE	12%	10%	
ADR	19%	12%	
Retrograde	49%	60%	
None	20%	19%	
Guide-extension assisted reverse CART	4%	13%	0.0001
IVUS use	70%	60%	0.007

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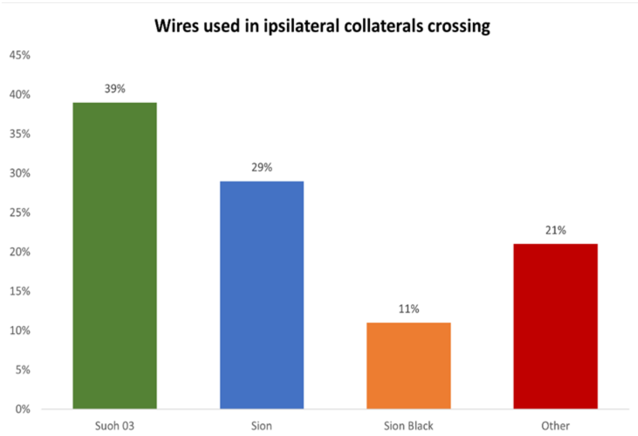
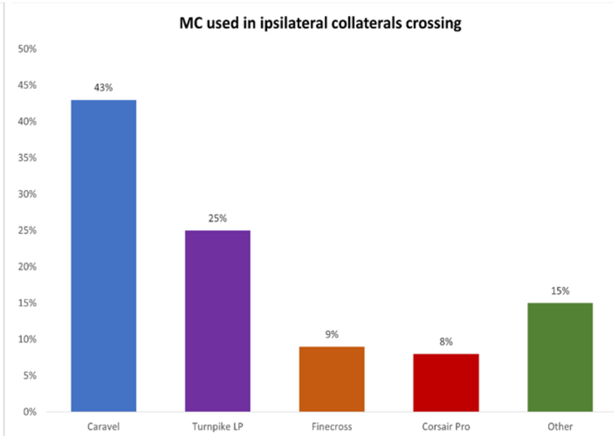
Results





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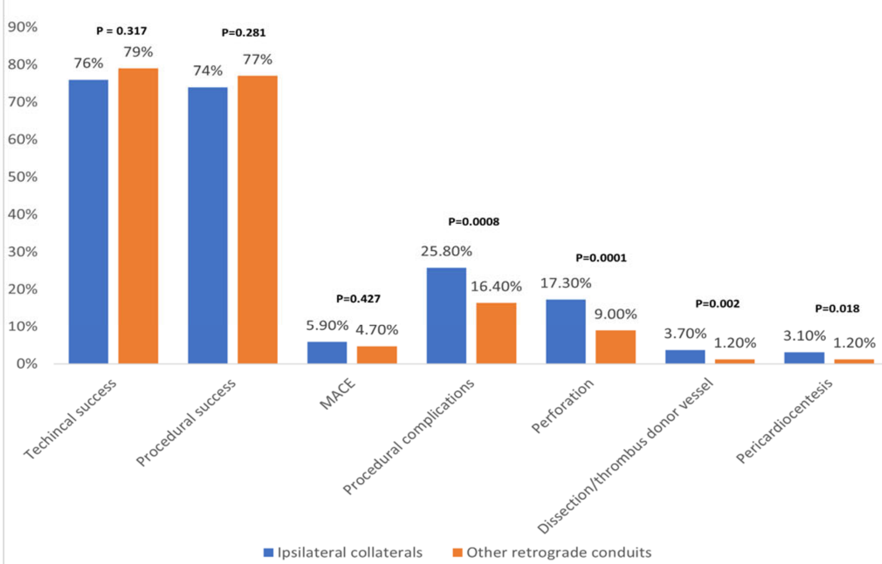
Outcomes



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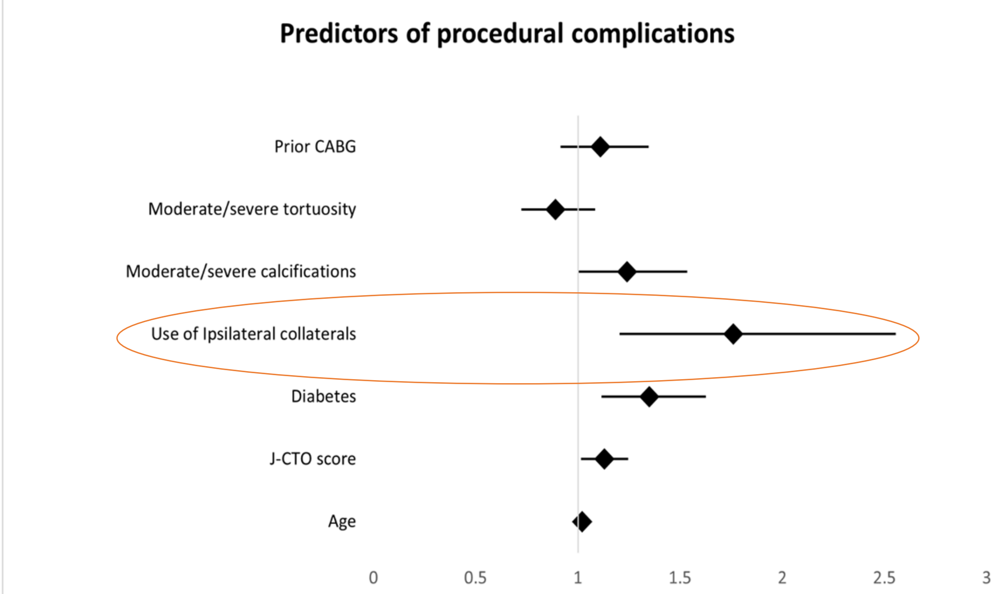

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Limitations

- **Observational study without adjudication of clinical events by an independent committee**

- **Core laboratory analysis of the study's angiograms was not performed**

- **The operators in the PROGRESS-CTO registry are more experienced in performing CTO PCI, potentially limiting the external validity of the study's results**

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Conclusions

- Retrograde CTO PCI through IEC is feasible , similar success rate to other retrograde conduits.
- Higher complication rates, especially perforations.
- Such procedures should be performed by experienced, high-volume CTO PCI operators.

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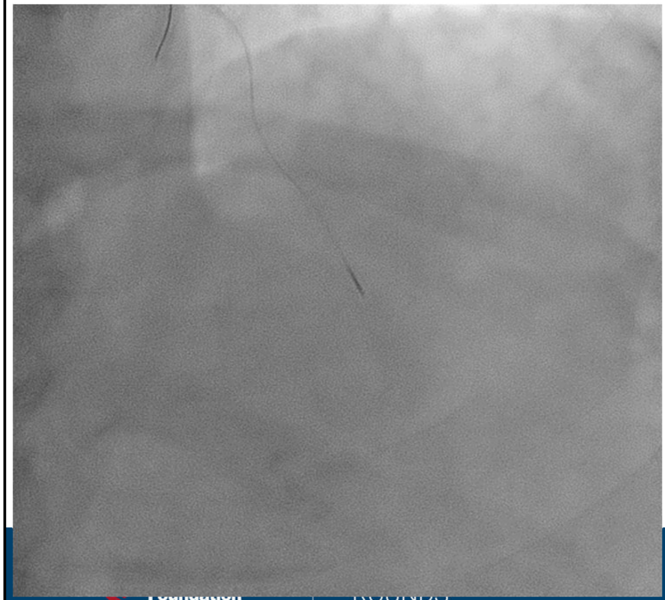
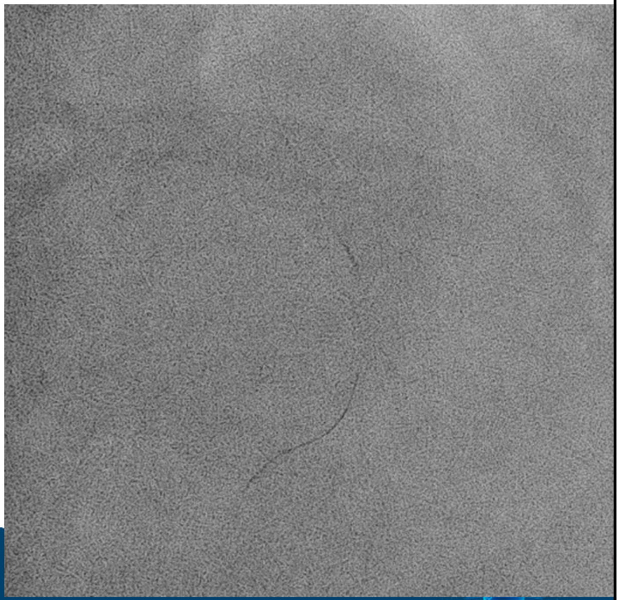
Case continued!





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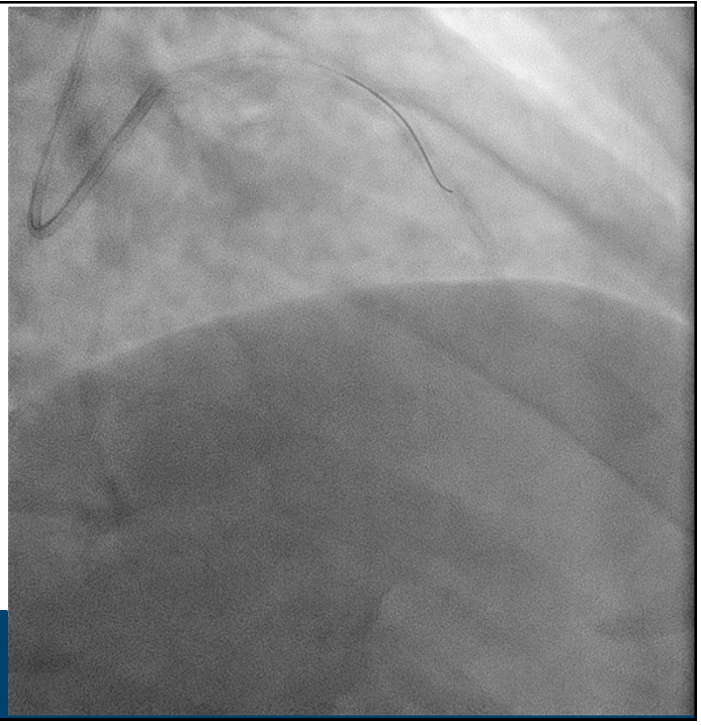
Result



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Thank you!

Ahmed Al-Ogaili, MD[1]; Michaella Alexandrou, MD[1]; Athanasios Rempakos, MD[1]; Deniz Mutlu, MD[1]; James W. Choi, MD[2]; Paul Poommipanit, MD[3]; Jaikirshan J. Khatri, MD[4]; Khaldoon Alaswad, MD[5]; Mir Babar Basir, DO[5]; Raj H. Chandwaney, MD[6]; Sevket Gorgulu, MD[7]; Ahmed M. ElGuindy, MD[8]; Basem Elbarouni, MD[9]; Wissam Jaber, MD[10]; Stephane Rinfret, MD[10]; William Nicholson, MD[10]; Farouc A Jaffer, MD, PhD[11]; Nazif Aygul, MD[12]; Lorenzo Azzalini, MD, PhD, MSc[13]; Kathleen E. Kearney, MD[13]; Jarrod Frizzell, MD[14]; Rhian Davies, MD[15]; Omer Goktekin, MD[16]; Bavana V. Rangan, BDS, MPH[1]; Olga C. Mastrodemos, BA[1]; Yader Sandoval, MD[1]; M. Nicholas Burke, MD[1]; Emmanouil S. Brilakis, MD, PhD[1]

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Acknowledgments

The authors are grateful for the philanthropic support of our generous anonymous donors(2), and the philanthropic support of Drs. Mary Ann and Donald A Sens; Mr. Raymond Ames and Ms. Barbara Thorndike; Frank J and Eleanor A. Maslowski Charitable Trust; Joseph F and Mary M Fleischhacker Family Foundation; Mrs. Diane and Dr. Cline Hickok; Mrs. Marilyn and Mr. William Ryerse; Mr. Greg and Mrs. Rhoda Olsen; Mrs. Wilma and Mr. Dale Johnson; Mrs. Charlotte and Mr. Jerry Golinvaux Family Fund; the Roehl Family Foundation; the Joseph Durda Foundation.

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Results

- 54 (87%) cases were on Aspirin 81.mg
- 8 cases were on Clopidogrel 75.mg
- 48 cases (77%) did not get pre-procedural imaging
- No DRT was noticed on imaging
- PDL incidence was high 4 (28%) among those who had TEE/CCT
- Safety endpoint was achieved in all cases

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Conclusions

- DCCV could be considered safe while being on SAPT regimen
- Performing DCCV without pre-imaging is still under question
- More studies are needed to optimize DCCV approach post LAAC

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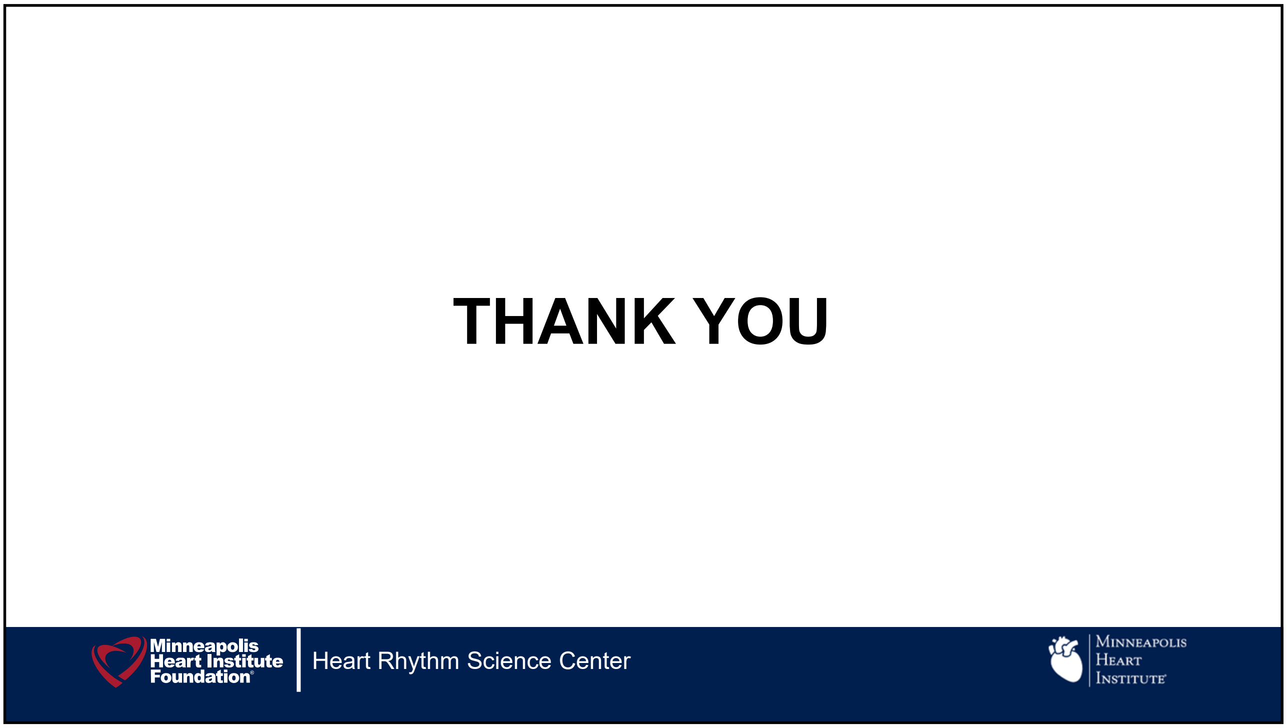
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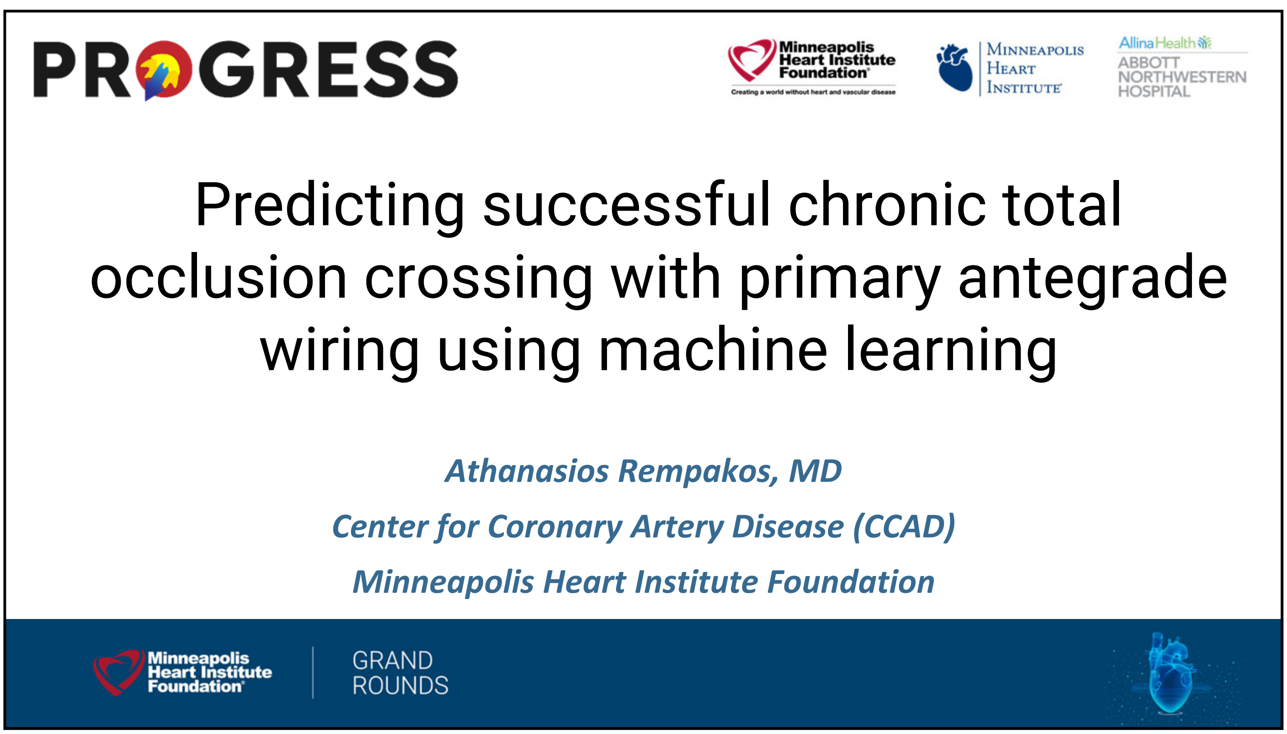
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Creating a world without heart and vascular disease
Minneapolis Heart Institute
Allina Health
ABBOTT NORTHWESTERN HOSPITAL
Predicting successful chronic total occlusion crossing with primary antegrade wiring using machine learning
Athanasios Rempakos, MD
Center for Coronary Artery Disease (CCAD)
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Disclosure of Relevant Financial Relationships

I, Athanasios Rempakos DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

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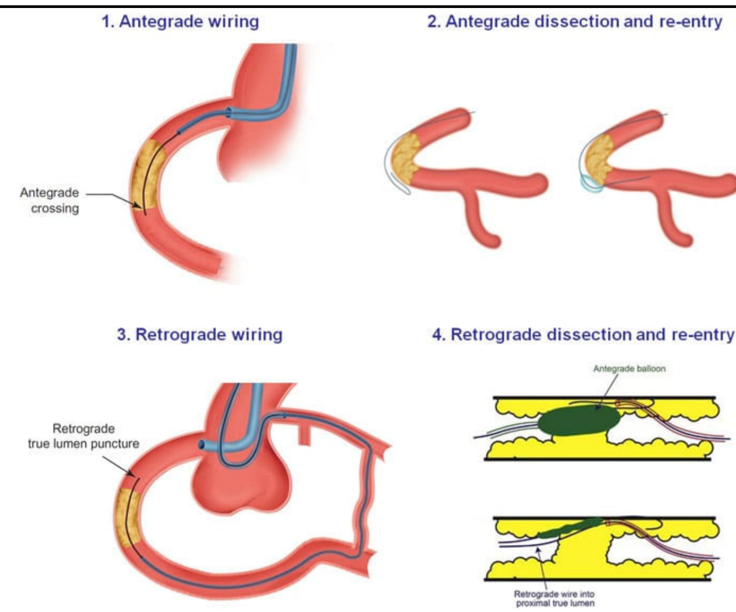
Crossing strategies for CTO PCI



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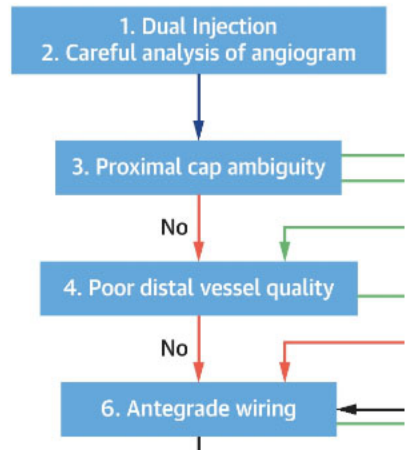
When should we use primary antegrade wiring?

- Antegrade wiring (AW) → most used strategy in CTO PCI
- Crossing algorithms → rely on limited angiographic features & expert opinions
- **Aim:** Develop a machine learning model for predicting successful lesion crossing using primary AW during CTO PCI



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Wu, E.B. et al. J Am Coll Cardiol. 2021;78(8):840:853.

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Global Coordinating Center: Chairman/PI: E. S. Brilakis **Global Director:** B.V. Rangan
Database Managers: A. Rempakos, M. Alexandrou, D. Mutlu
Operational Support: O. Mastrodemos
Project Impact: Data from 15,958 cases at 67 participating centers, 10 countries
Resulting in 131 publications, 188 conference presentations

NCT02061436

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Data preparation

12,136 primary antegrade cases → Imputed 15,355 values (8%) using missForest → Z-score normalization → Training set: ***9,708 (80%)*** / Test set: ***2,4***28 (20%)

14 variables: blunt/no stump, occlusion length, vessel diameter, aorto-ostial lesion, proximal cap ambiguity, in-stent restenosis, side branch at proximal cap, bifurcation at distal cap, poor distal landing zone, interventional collaterals, calcification, tortuosity, target vessel, prior attempt to open CTO

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Five machine learning models

- Logistic regression with L2 regularization
- Gaussian Naive Bayes
- Support vector machine
- Multilayer perceptron neural networks
- Extreme gradient boosting (XGBoost)

14 predictor variables → Outcome: Successful primary antegrade crossing

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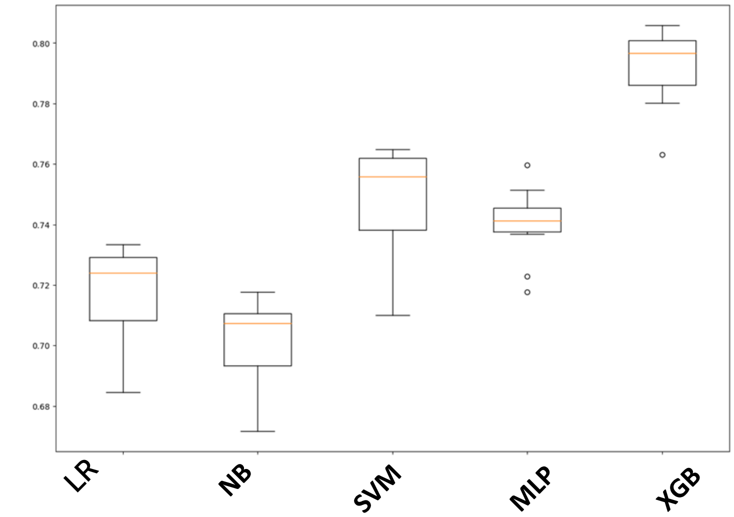
XGBoost had the best performance



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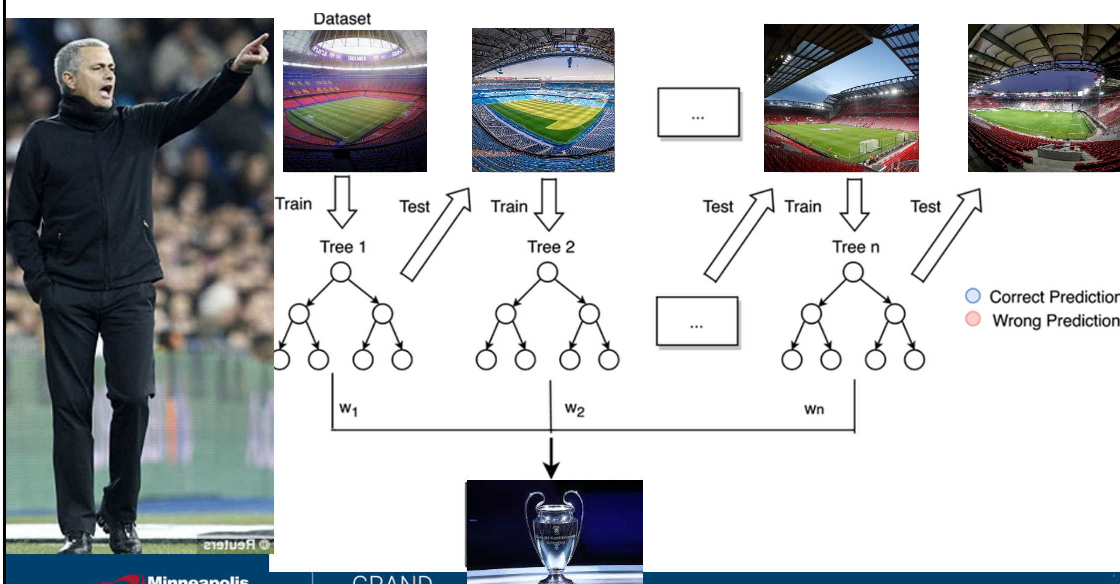

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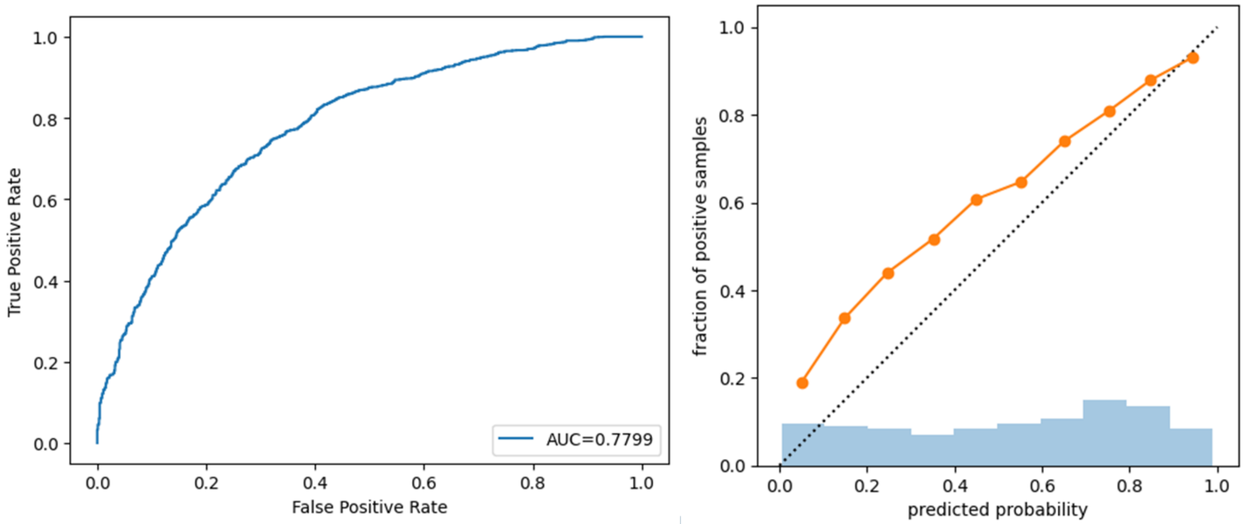
XGBoost performance after hyperparameter tuning



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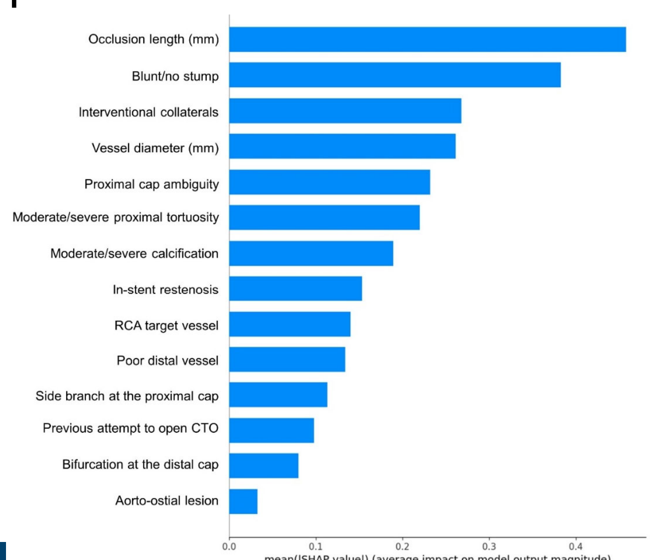
Variable importance



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How do we use the model?

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PROGRESS-CTO

Prospective Global Registry for the Study of Chronic Total Occlusion Intervention

Antegrade wiring success prediction

Aorto-ostial lesion:
Proximal cap ambiguity:
Side branch at proximal cap:
Blunt/no stump:
Vessel diameter:
Occlusion length:
In-stent lesion:
Moderate/severe calcification:
Moderate/severe proximal tortuosity:
Interventional collaterals:
RCA target vessel:
Poor distal landing zone:
Distal cap at bifurcation:
Prior attempt:

Predict primary antegrade success

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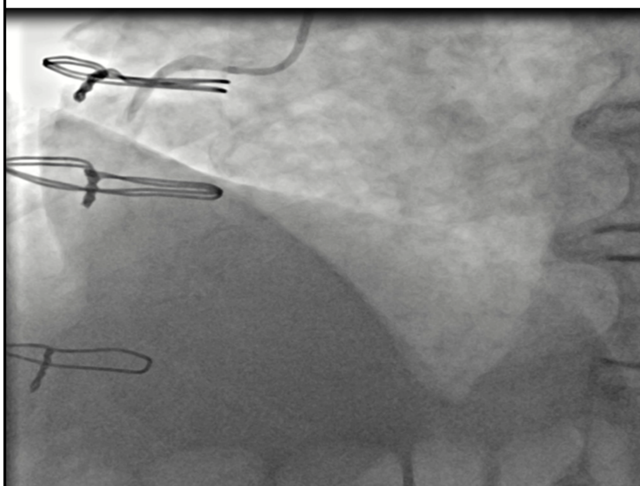
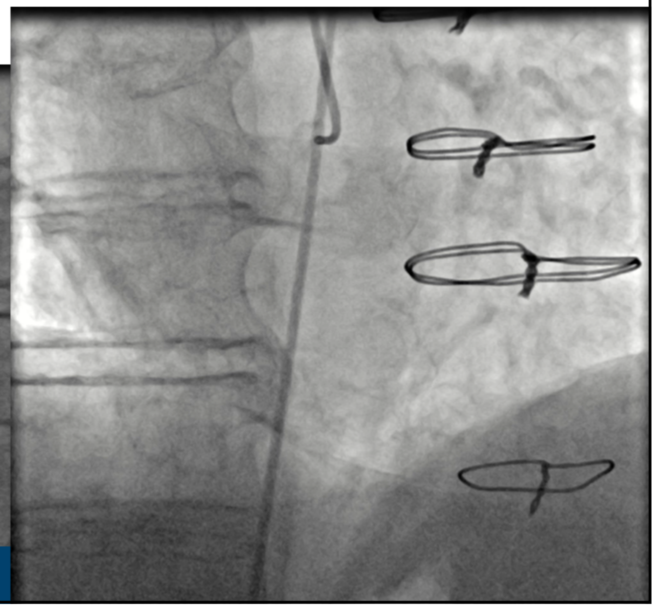
80-year-old man with medically refractory angina and 3 unsuccessful attempts for recanalizing RCA CTO





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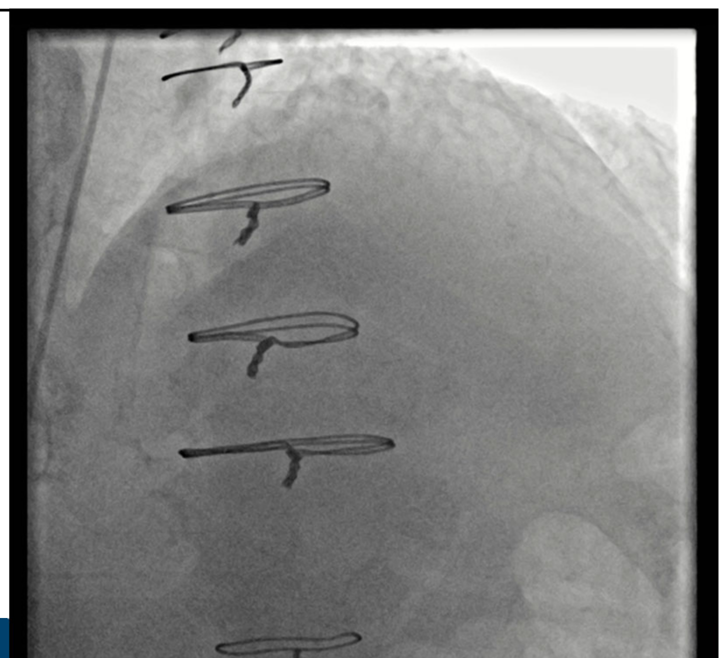
Epicardial collateral:

LIMA → Diagonal → RPL



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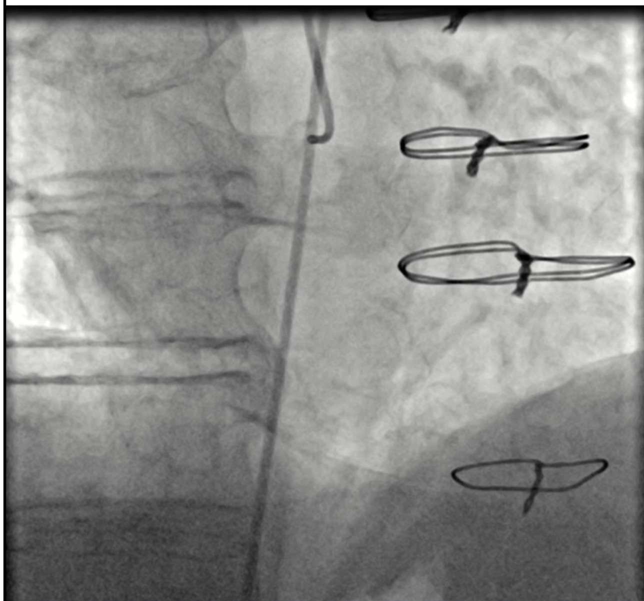

Target vessel: RCA

Assessment

Proximal cap:	**Blunt, side branch**
Length:	**~ 20 mm**
Calcification:	**Severe**
Collaterals:	**Epicardial from diagonal through LIMA graft**
J-CTO score:	**3**

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PROGRESS-CTO
Prospective Global Registry for the Study of Chronic Total Occlusion Intervention

Antegrade wiring success prediction

Aorto-ostial lesion: No
Proximal cap ambiguity: No
Side branch at proximal cap: Yes
Blunt/no stump: Yes
Vessel diameter: 3
Occlusion length: 20
In-stent lesion: No
Moderate/severe calcification: Yes
Moderate/severe proximal tortuosity: No
Interventional collaterals: Yes
RCA target vessel: Yes
Poor distal landing zone: No
Distal cap at bifurcation: No
Prior attempt: Yes
Predict primary antegrade success

Likelihood of successful crossing with primary antegrade [74.65] %
Primary antegrade likely to be successful

www.progresscto.org/predict-aw-success

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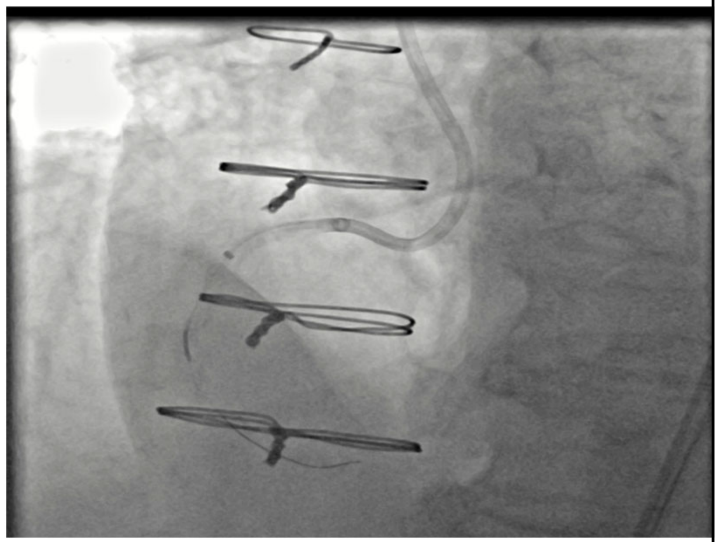
Gaia Next 2 → Gladius Mongo



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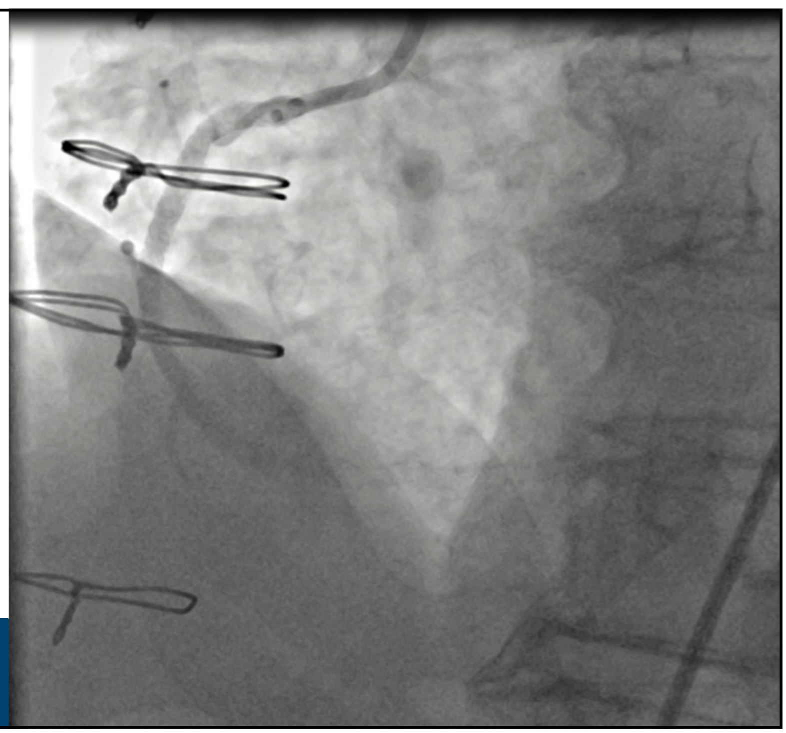
Final result



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In summary

- **XGBoost best ML model for predicting primary antegrade wiring success (AUC = 0.780)**
- **Most impactful predictors:**
  - **occlusion length**
  - **blunt/no stump**
  - **interventional collaterals**
  - **vessel diameter**
  - **proximal cap ambiguity**

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The PROGRESS-AW model accurately predicts primary antegrade wiring success

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Thank you!

Athanasios Rempakos, MD
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PROGRESS CTO

Rempakos A, Alexandrou M, Mutlu D, Kalyanasundaram A, Ybarra LF, Bagur R, Choi JW, Poommipanit P, Khatri JJ, Young L, Davies R, Benton S, Gorgulu S, Jaffer FA, Chandwaney R, Jaber W, Rinfret S, Nicholson W, Azzalini L, Kearney KE, Alaswad K, Basir MB, Krestyaninov O, Khelimskii D, Abi-Rafeh N, Elguindy A, Goktekin O, Aygul N, Rangan BV, Mastrodemos OC, Al-Ogaili A, Sandoval Y, Burke MN, Brilakis ES.

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