
Minneapolis Heart Institute Foundation
GRAND ROUNDS

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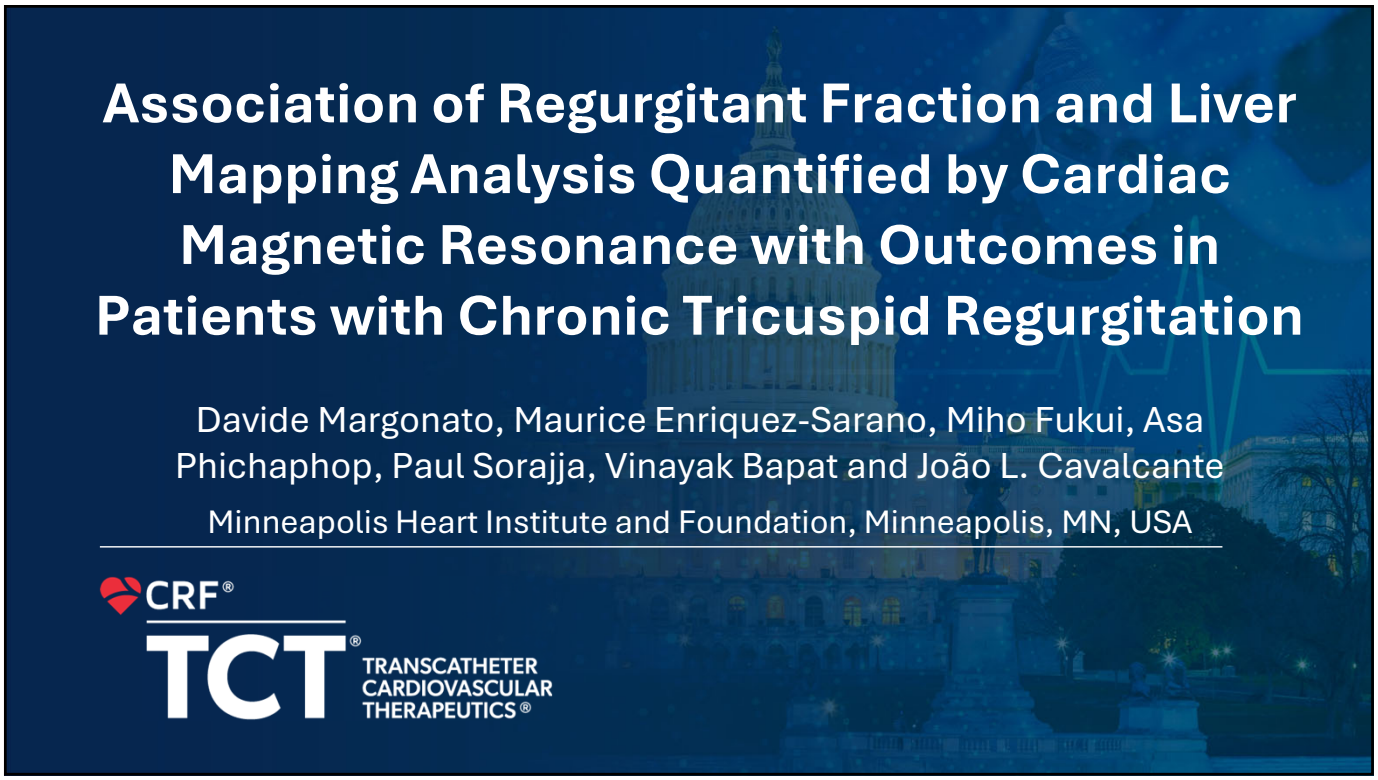
Association of Regurgitant Fraction and Liver Mapping Analysis Quantified by Cardiac Magnetic Resonance with Outcomes in Patients with Chronic Tricuspid Regurgitation
Davide Margonato, Maurice Enriquez-Sarano, Miho Fukui, Asa Phichaphop, Paul Sorajja, Vinayak Bapat and João L. Cavalcante
Minneapolis Heart Institute and Foundation, Minneapolis, MN, USA
CRF®
TCT®
TRANSCATHETER CARDIOVASCULAR THERAPEUTICS®

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Disclosure of Relevant Financial Relationships

I, Davide Margonato DO NOT have any relevant financial relationships to disclose.

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Faculty disclosure information can be found on the app.

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Introduction

- Chronic TR causes RV volume overload and systemic venous congestion, negatively affecting outcomes[1,2]
- Valvular heart disease guidelines[3] underscore the importance of accurate TR quantification and of right-sided HF diagnosis to determine the timing for invasive TR treatment
- CMR has emerged as a valuable method for the quantitative assessment of TR and of its pathophysiological cardiac and extracardiac consequences[4]

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1) Topilsky Y et al, JACC CV Imaging, 2014
2) Benfari G et al, Circulation, 2019
3) Otto CM et al, Circulation, 2021
4) Myerson SG. JACC CV Imaging, 2021

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Introduction

- While CMR quantifies Tricuspid Reg. Fraction and Reg. Volume without assumptions, *the thresholds associated with outcomes are poorly defined*[1,2].
- Beyond TR quantification, it is unknown whether novel CMR parameters of extracardiac involvement can help to objectively identify high-risk TR patients prompting earlier intervention.
- We aimed to assess:
  - CMR-based TR severity threshold associated with outcomes
  - Incremental risk stratification of parametric mapping analysis for liver extracellular volume, a marker of both fibrosis and systemic venous congestion

1) Zoghbi WA et al, JASE, 2017
2) Lancellotti P et al, EHJ CV Imaging, 2022

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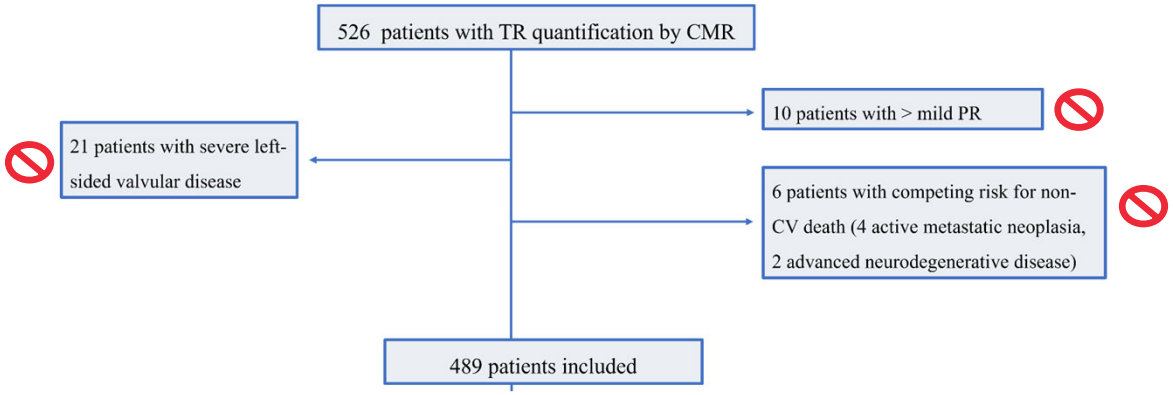
Methods

- Comprehensive clinical and imaging data were collected from consecutive patients evaluated by CMR from 2019 to 2023 who had quantitative evaluation of RV volumes and TR severity.



Primary outcome: All Cause Death+ HF hospitalization under medical management

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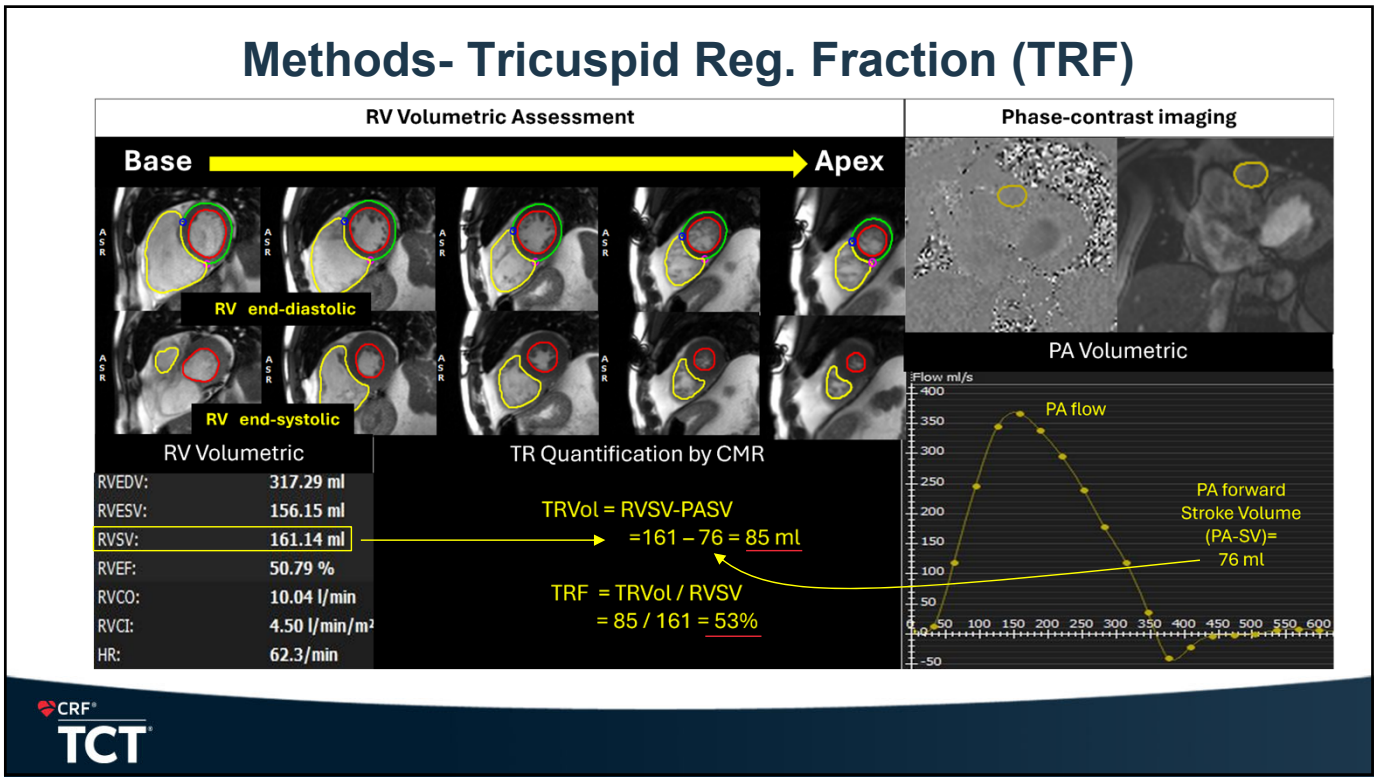
Methods- Tricuspid Reg. Fraction (TRF)
RV Volumetric Assessment
Phase-contrast imaging
Base
Apex
RV end-diastolic
RV end-systolic
PA Volumetric
Flow ml/s
PA flow
PA forward Stroke Volume (PA-SV)= 76 ml
RV Volumetric
RVEDV: 317.29 ml
RVESV: 156.15 ml
RVSV: 161.14 ml
RVEF: 50.79 %
RVCO: 10.04 l/min
RVCI: 4.50 l/min/m²
HR: 62.3/min
TR Quantification by CMR
TRVol = RVSV-PASV
=161 – 76 = 85 ml
TRF = TRVol / RVSV
= 85 / 161 = 53%
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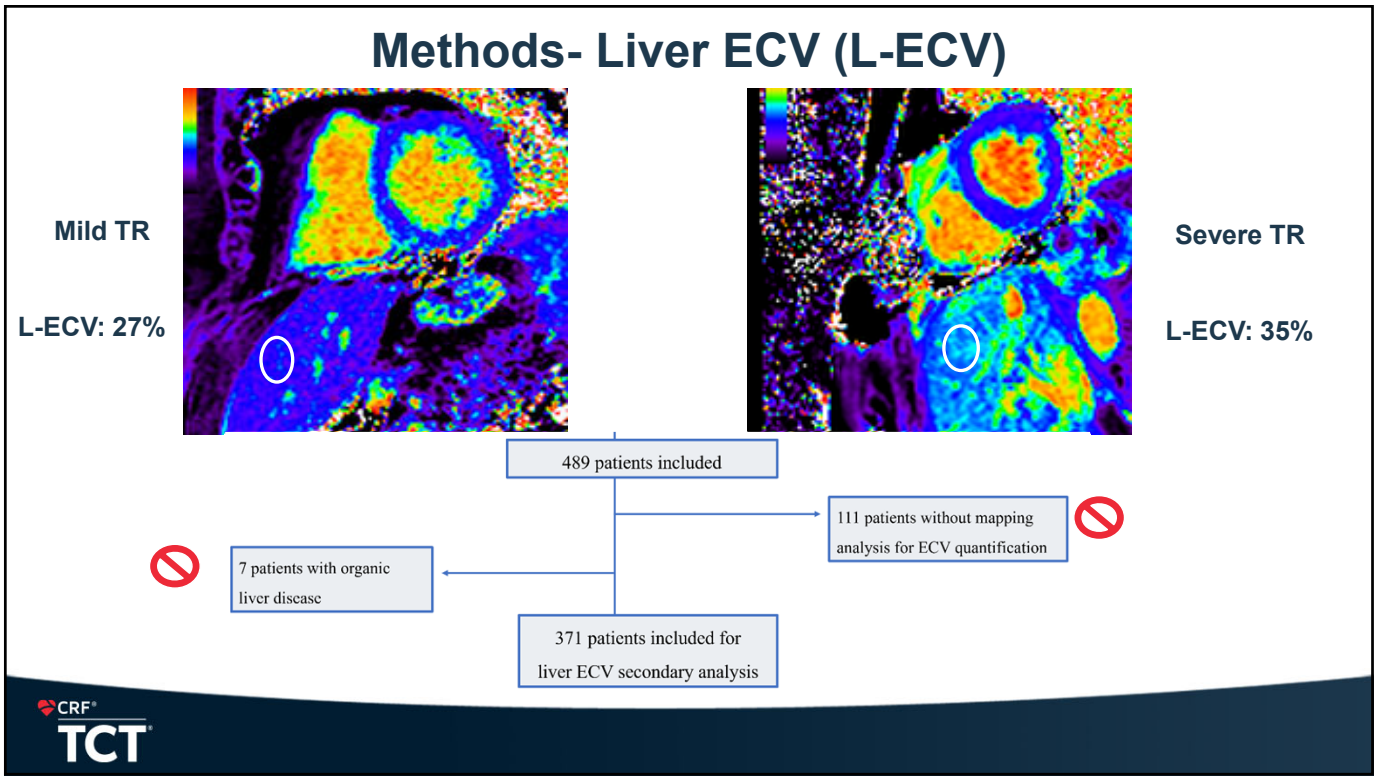
Methods- Liver ECV (L-ECV)
Mild TR
L-ECV: 27%
Severe TR
L-ECV: 35%
489 patients included
111 patients without mapping analysis for ECV quantification
7 patients with organic liver disease
371 patients included for liver ECV secondary analysis
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Results

Clinical and Echo parameters	N= 489
Age (years)	68 (55-76)
Gender (female)	201 (41%)
History of coronary artery disease	117 (24%)
Atrial Fibrillation	193 (39%)
Chronic Kidney Disease	127 (26%)
NYHA class III/IV	78 (16%)
TRISCORE	2 (1-3)
Diuretic therapy	201 (41%)
PASP (mmHg)	33 (28-44)
TADi (mm/m2)	19 (18-22)
IVC (mm)	17 (15-22)

CMR parameters	N= 489
RV EDVi (ml/m^2)	94 (77-117)
RV ESVi (ml/m^2)	43 (33-58)
RVEF (%)	52 (45-58)
RV SV (ml)	94 (78-112)
TV Reg. Volume (ml)	19 (12-31)
TV Reg. Fraction (%)	21 (14-33)
RV Free Wall Long Strain (%)	-20 (23-18)
RA ESVi (ml/m^2)	47 (33-65)
LVEF (%)	53 (43-61)
Myocardial ECV (n=385,%)	28 (25-32)
Liver ECV (n=371,%)	30 (27-35)

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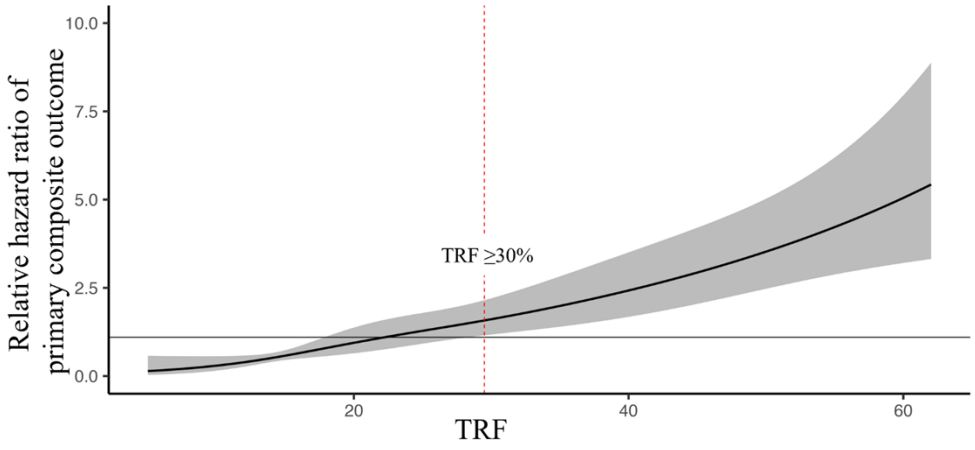
Results- primary analysis

- During a median follow-up of 2.3 years, 43 (9%) patients died, 65 (13%) were hospitalized because of HF

JC0



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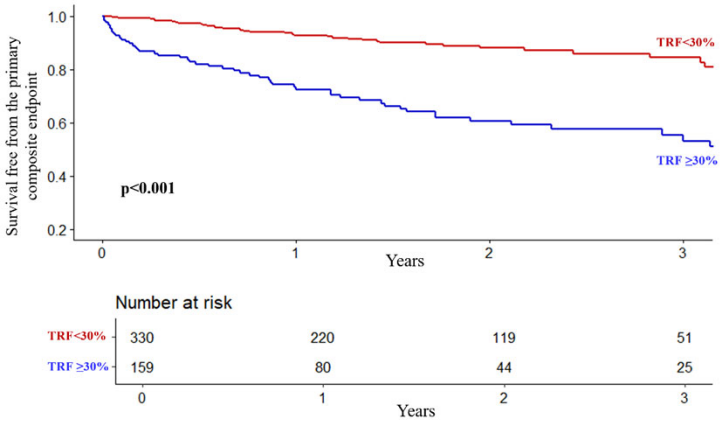
Slide 10

JC0 If the intent is to describe the natural history of TR severity by CMR under medical management - would not make more sense to remove from this slide the 53 who had TV intervention?

A question you might get:
- Significant TR undertreatment - 11% overall which is a reality. Even if you consider that all those that were treated have TRF> 30%, it's only 33% of that group. Have those numbers in mind.

Cavalcante, Joao L, 2024-10-19T20:39:26.381

Results- primary analysis



		Composite endpoint	
		HR (95% CI)	p-value
Univariate	TRF≥ 30%	4.31 (2.68-6.95)	**<0.001**
Model 1	TRF≥ 30%	3.66 (2.22-6.03)	**<0.001**
Model 2	TRF≥ 30%	3.20 (1.91-5.36)	**<0.001**
Model 3	TRF≥ 30%	1.87 (1.03-3.44)	**0.038**

Model 1: Adjusted on Age and Gender
Model 2: Model 1+ CKD, AF, CAD
Model 3: Model 2 + LVEF, RVEF, PASP

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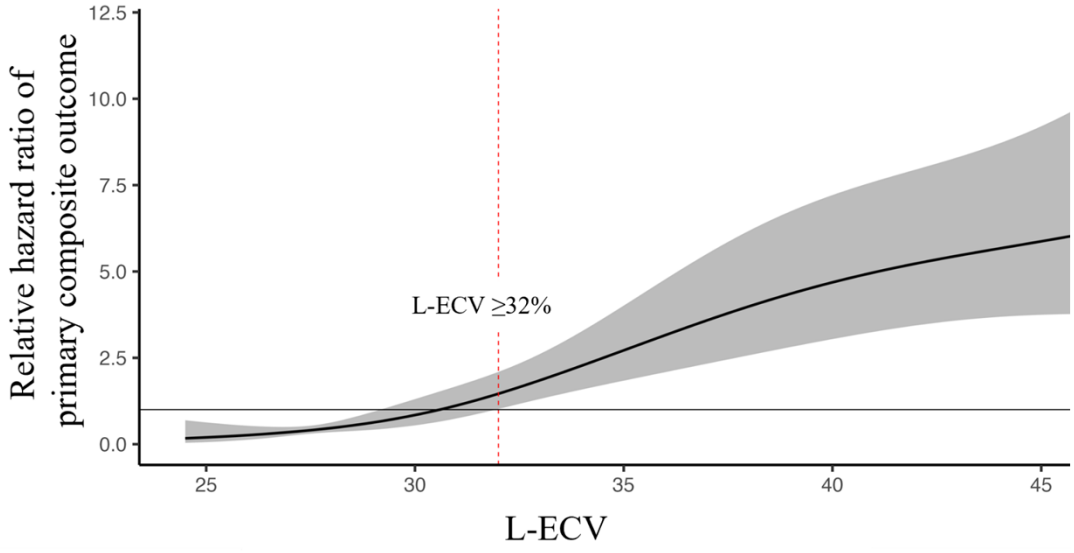
Results- secondary analysis on L-ECV



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Results- secondary analysis on L-ECV

Variables Associated with Right HF	L-ECV <32% (n= 222, 60%)	L-ECV ≥32% (n= 149, 40%)	p-value
NYHA Class III/IV	16 (7%)	53 (35%)	**<0.001**
Jugular Venous Distension	10 (5%)	42 (28%)	**<0.001**
Peripheral Edema	13 (6%)	43 (29%)	**<0.001**
TRISCORE	1 (1-2)	4 (2-6)	**<0.001**
PASP (mmHg)	30 (25-36)	41 (31-55)	**<0.001**
RV EDVi (ml/m2)	83 (71-102)	110 (87-131)	**<0.001**
RVEF (%)	54 (48-60)	46 (37-56)	**<0.001**
Forward RVSV (ml)	70 (53-88)	57 (43-78)	**<0.001**
TV Reg. Volume (ml)	15 (11-21)	33 (18-50)	**<0.001**
TV Reg. Fraction (%)	18 (13-24)	36 (22-48)	**<0.001**
RVFWLS (%)	22 (24-19)	18 (20-15)	**<0.001**
IVC (mm)	15 (14-18)	22 (17-26)	**<0.001**

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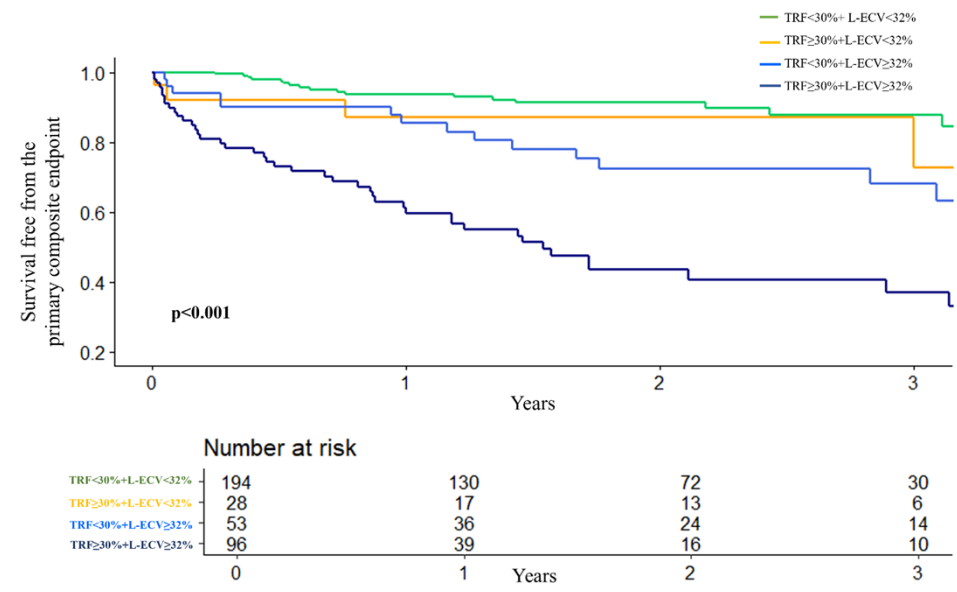
Results- secondary analysis on L-ECV



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Closing thoughts

- In a large cohort of all-comers patients with TR quantification by CMR, we identified a TR Fraction cut-off of ≥ 30% which associated with the composite outcome of all cause death+HF hospitalization.
- This TRF cut-off remained significantly associated with the outcomes after comprehensive adjustment models, and is lower than the one (≥ 50%) proposed by current guidelines to define severe TR.
- Right-sided HF signs and symptoms captured by elevation of L- ECV supports the extracardiac consequences from chronic TR. L-ECV yielded incremental prognostic value to CMR quantification of TR, highlighting the potential discriminatory role of this novel imaging biomarker.

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Coronary Computed Tomography Angiography For Percutaneous Coronary Intervention: Initial US Experience With FFR_{CT} Based Virtual PCI

Pedro E. P. Carvalho, Joao Cavalcante, John Lesser, Victor Cheng, Michaella Alexandrou, Dimitrios Strepkos, Deniz Mutlu, Sandeep Jalli, Ozgur Selim Ser, Bavana Rangan, Olga Mastrodemos, Emmanouil S. Brilakis, and Yader Sandoval.

[1] Center for Coronary Artery Disease, Minneapolis Heart Institute Foundation.

[2] Allina Health Minneapolis Heart Institute, Abbott Northwestern Hospital, Minneapolis, MN

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Disclosure of Relevant Financial Relationships

I, Pedro Carvalho DO NOT have any relevant financial relationships to disclose.

Background

- Coronary CT angiography (CCTA) and fractional flow reserve derived from CCTA (FFR_{CT}) are guideline-recommended, non-invasive methods to rule-in and rule-out obstructive coronary artery disease (CAD).
- It is increasingly recognized that these tools can be used to guide percutaneous coronary intervention, including with the use of FFR_{CT} based virtual PCI, and facilitate pre-procedural planning, however, there is limited data.

Sonck J et al. Clinical Validation of a Virtual Planner for Coronary Interventions Based on Coronary CT Angiography. JACC Cardiovasc Imaging 2022;15: 1242-1255.

Background

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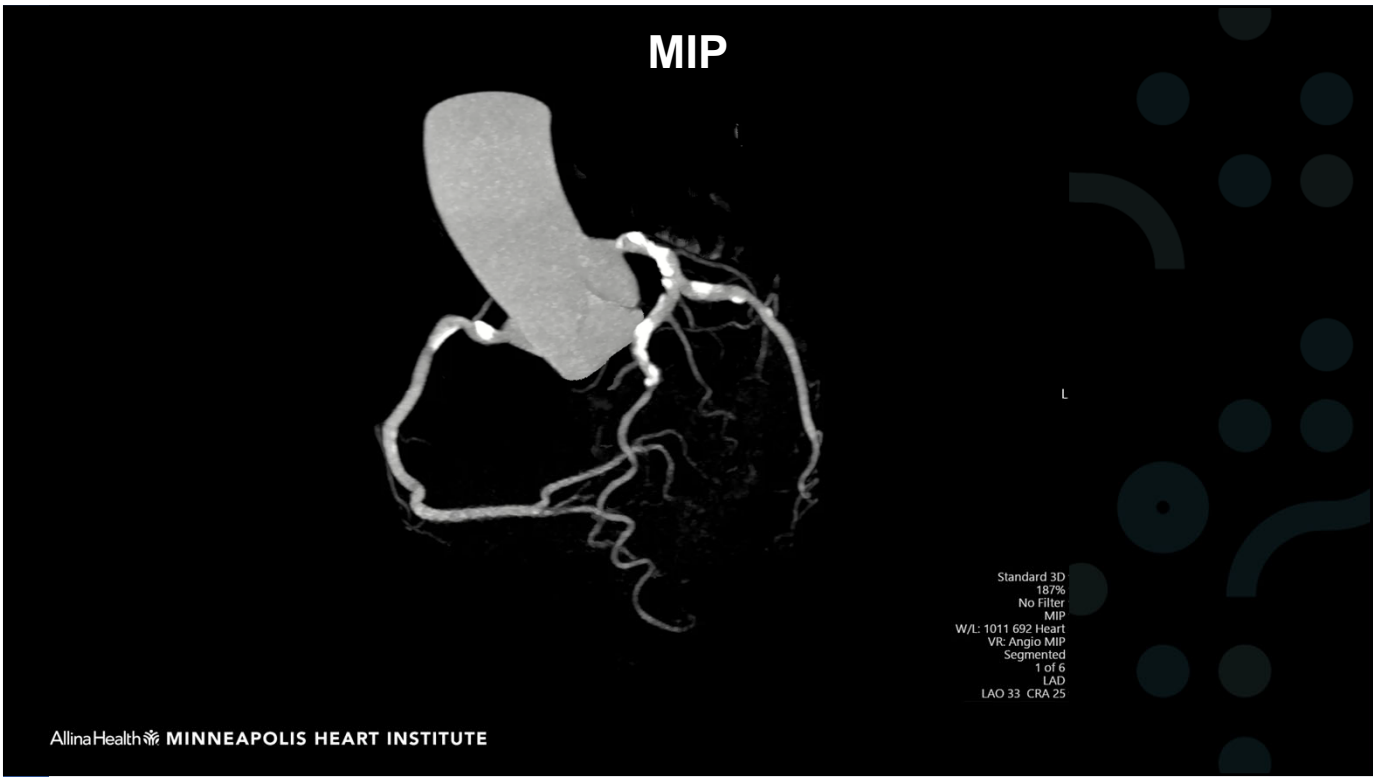
Live Case #1

- **81-year-old male with dyspnea on exertion and fatigue.**
- **PMH: dyslipidemia, paroxysmal AF**
- **Echocardiogram:** LVEF 57%, no significant VHD.
- **Scan info**:
  - Vitals: BP 102/68 mmHg, HR 99 BPM (AF), BMI 25 kg/m2
  - Scanner: Siemens SOMATOM Drive
  - Medications administered during scan:
    - SL Nitroglycerin: 0.8 mg
    - PO metoprolol tartrate 50 mg
  - Contrast: Isovue 370 - 90 mL
  - Radiation dose: DLP 305, KV 100
  - Calcium score 2291


MIP
L
Standard 3D
1879s
No Filter
MIP
W/L: 1011 692 Heart
VR: Angio MIP
Segmented
1 of 6
LAD
LAO 33 CRA 25
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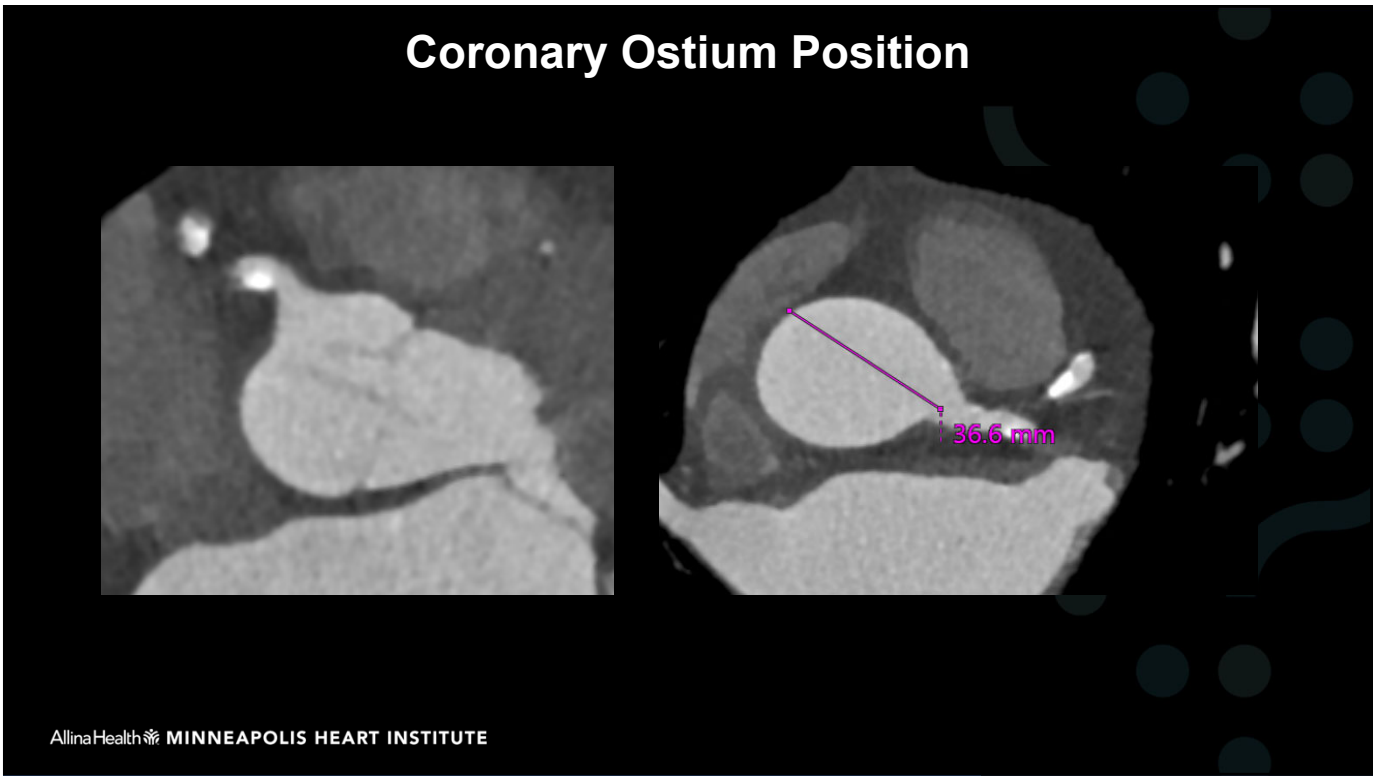
Coronary Ostium Position
36.6 mm
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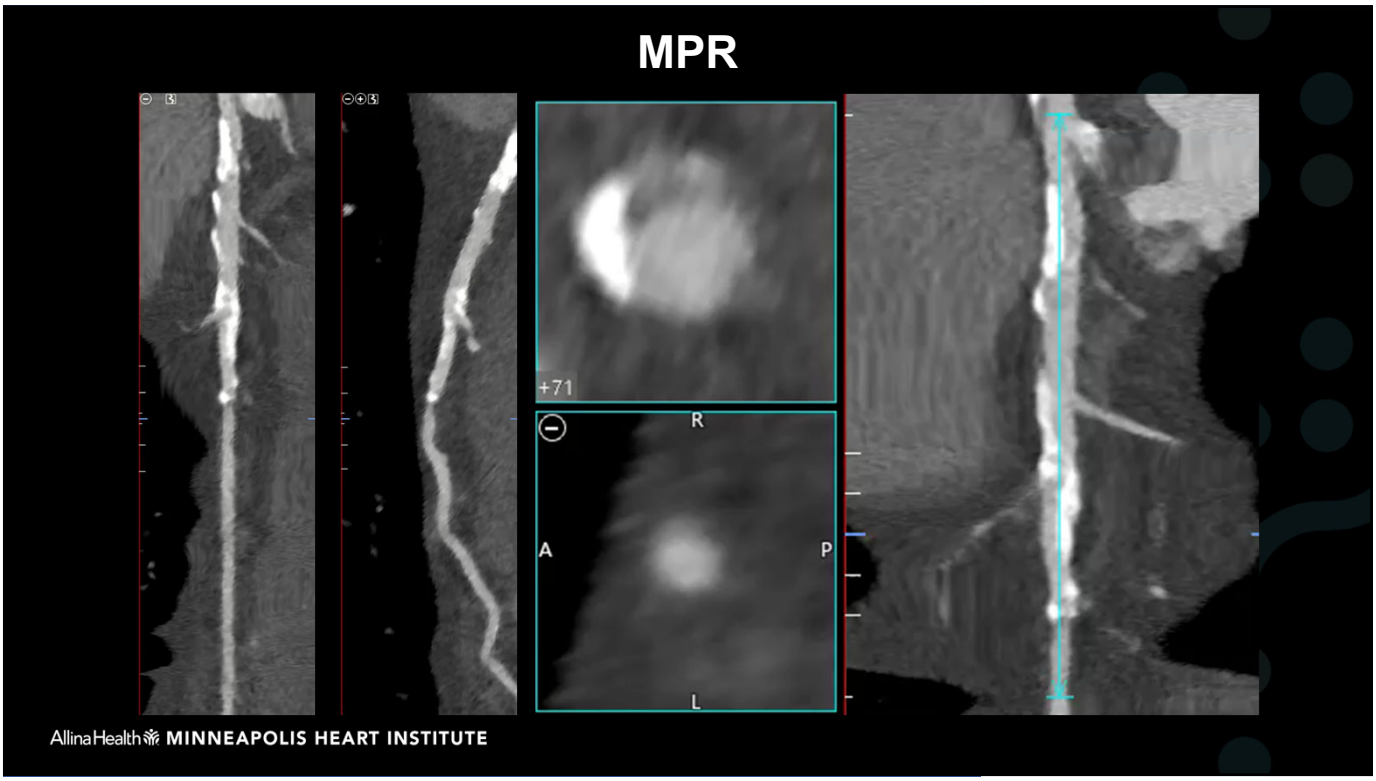
MPR
+71
R
A
P
L
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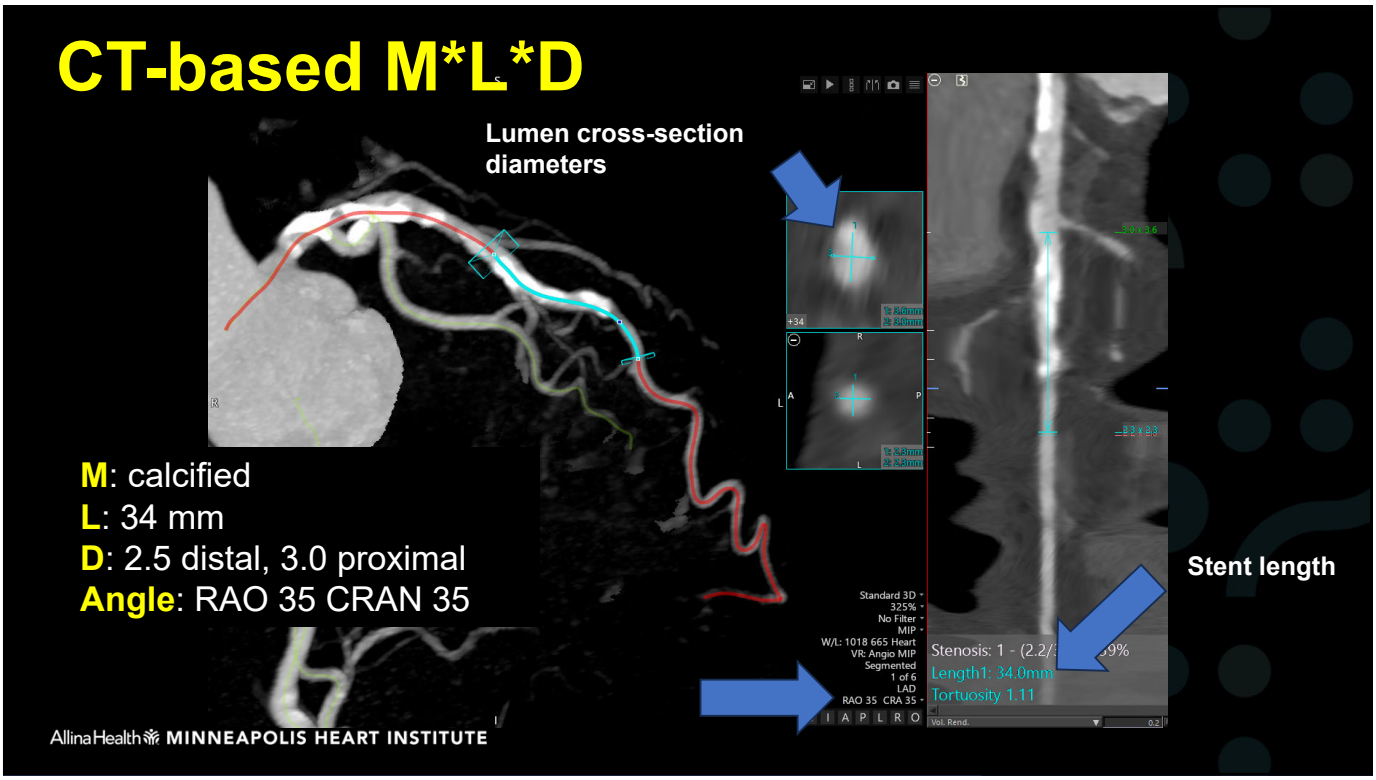
CT-based M*L*D
Lumen cross-section diameters
M: calcified
L: 34 mm
D: 2.5 distal, 3.0 proximal
Angle: RAO 35 CRAN 35
Stent length
Stenosis: 1 - (2.2/
Length1: 34.0mm
Tortuosity 1.11
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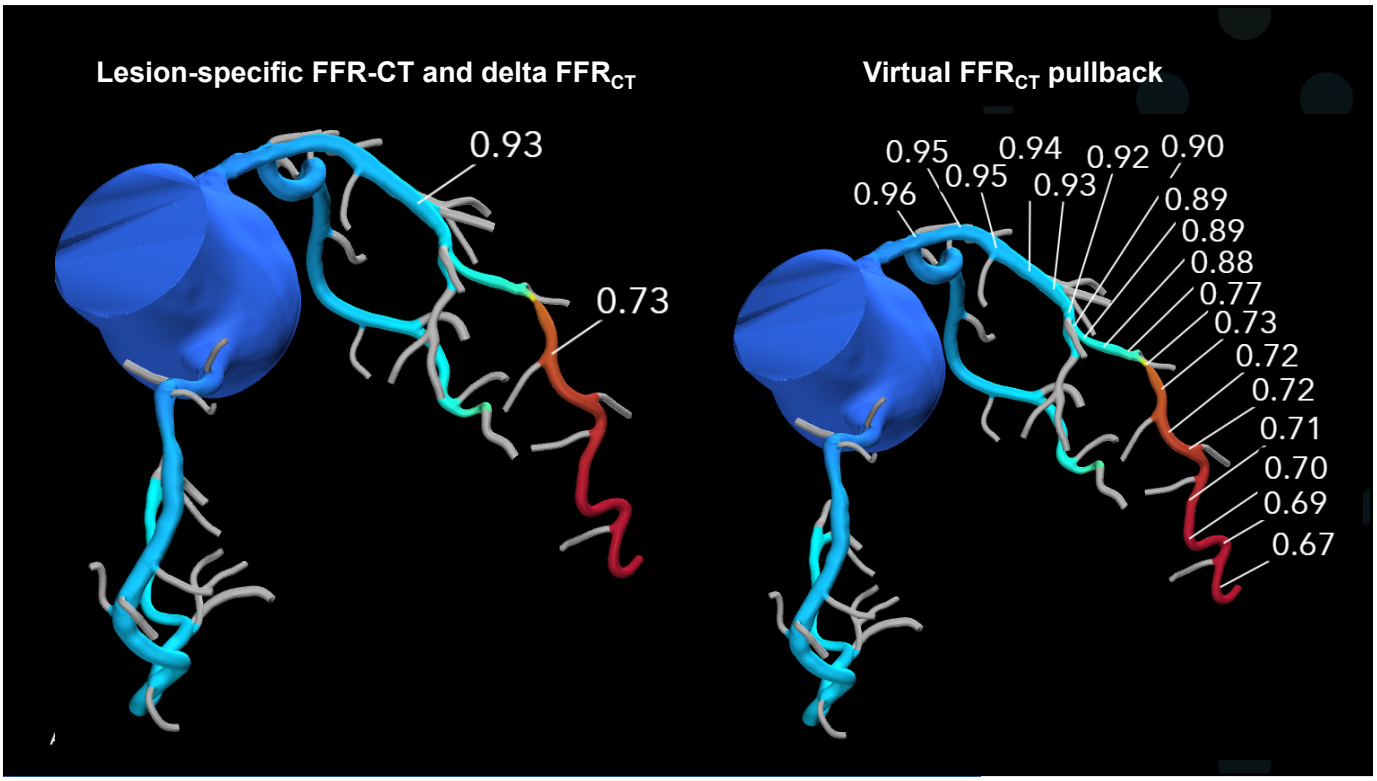
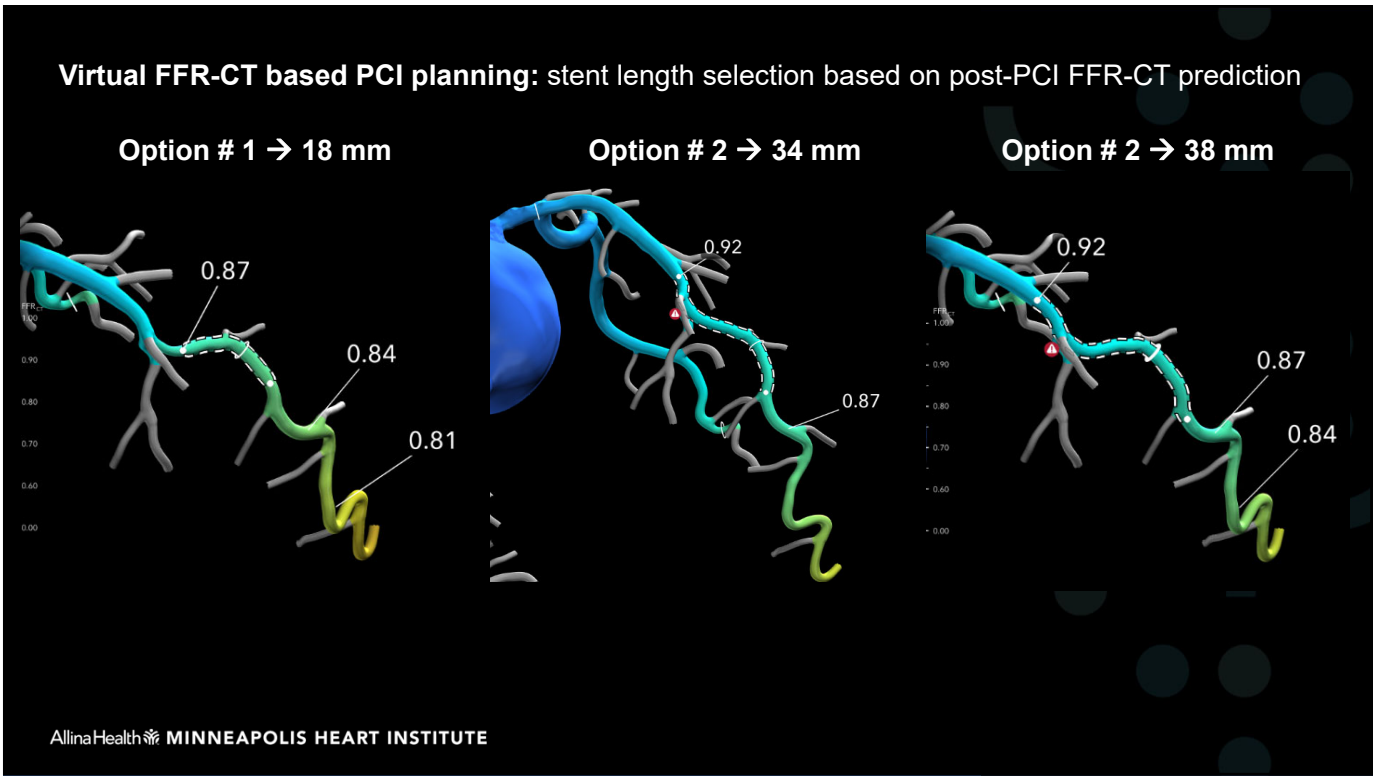

Lesion-specific FFR-CT and delta FFR$_{CT}$
0.93
0.73
Virtual FFR$_{CT}$ pullback
0.96
0.95
0.95
0.94
0.93
0.92
0.90
0.89
0.89
0.88
0.77
0.73
0.72
0.72
0.71
0.70
0.69
0.67

24


Virtual FFR-CT based PCI planning: stent length selection based on post-PCI FFR-CT prediction
Option # 1 → 18 mm
0.87
0.84
0.81
Option # 2 → 34 mm
0.92
0.87
Option # 2 → 38 mm
0.92
0.87
0.84
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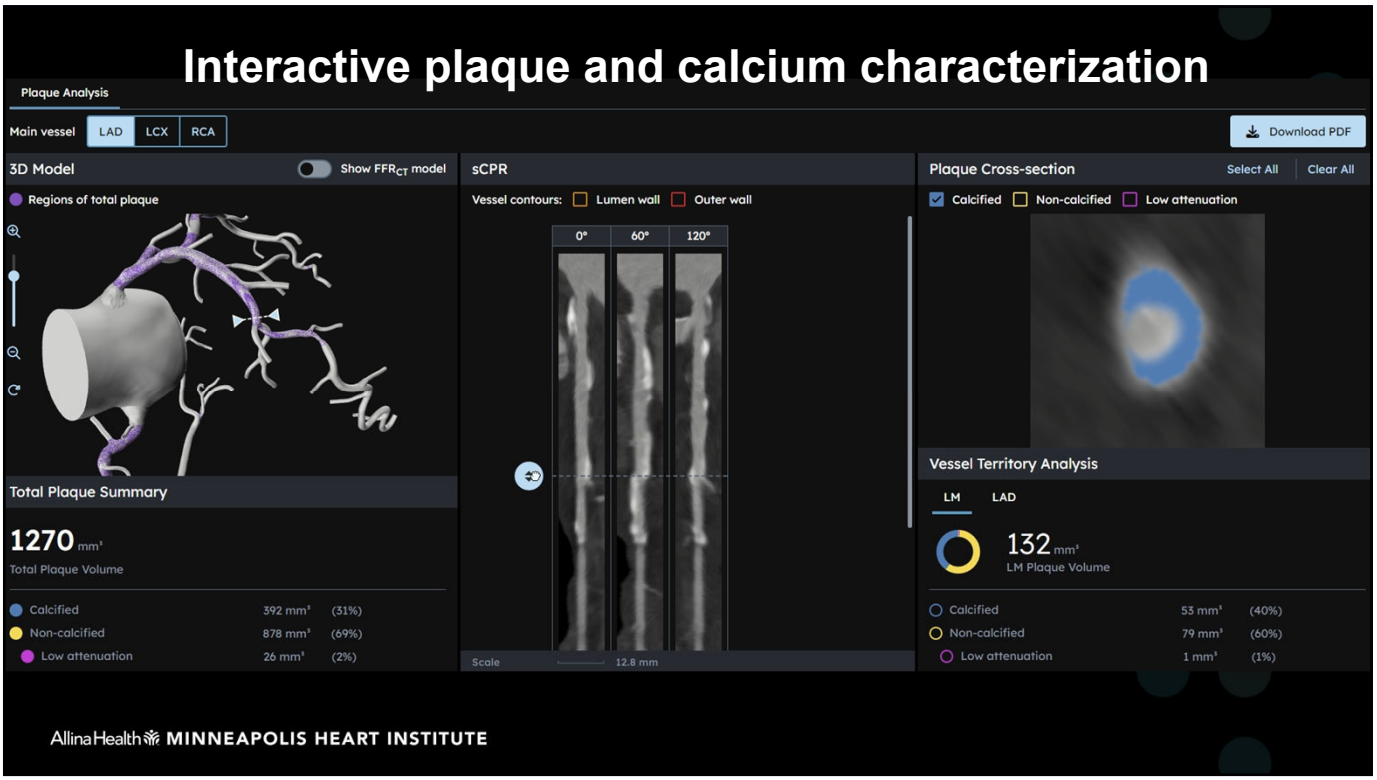

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Statistical Analysis

- Categorical variables are presented as percentages and compared using Pearson's chi-square test or Fisher's exact test
- Continuous variables are presented as mean ± SD or as median (interquartile range [IQR]) and compared using the Student's t-test and the Mann-Whitney U test
- A 2-sided p value of 0.05 was considered indicative of statistical significance
- A Pearson correlation analysis and the Bland Altman method were used to assess the agreement between FFR modalities and stent sizing pre-planned versus obtained values.

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Results

Baseline patient characteristics (n=48)	
Age, yrs	69.90 ± 8.31
Women	39.6% (19)
Clinical presentation	
Chronic CAD	81.3% (39)
Unstable angina	10.4% (5)
NSTEMI	8.3% (4)
Diabetes Mellitus	29.2% (14)
Hypertension	81.3% (39)
Dyslipidemia	83.3% (40)
BMI, kg/m^2	30.9 ± 7.1
LVEF, %	59.0 ± 7.8
Heart Failure	17.0% (8)
Prior PCI	10.4% (5)
Prior CABG	0% (0)
Prior MI	6.3% (3)
Atrial fibrillation or flutter	33.3% (16)
Current, smoker	6.3% (3)
CKD	10.6% (5)
Baseline eGFR (mL/min/1.73m^2)	73.8±14.7
Baseline creatinine, mg/dL	1.01 [0.83, 1.10]

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Results

Baseline patient characteristics (n=46)	
Pre-PCI FFR_{CT}	0.70 [0.62-0.74]
Calcium score	609.00 [207.5, 1,165.5]
Heart rate, bpm	65.4 ± 13.3
Sinus rhythm at the time of CCTA	83.0% (39)
Contrast, mL	105.5 [100.0, 121.3]
Radiation dose (DLP)	305.0 [170.0, 413.0]
kV	110 [100-120]
Beta blockers	69.6% (32)
Nitrate dose	
<0.8 mg	0 (0%)
≥0.8 mg	100.0% (48)
CAD-RADS	
3	25.0% (12)
4A	62.5% (30)
4B	4.2% (2)
5	6.3% (3)
Dominance	
Right	77.1% (37)
Left	22.9% (11)
Severe stenosis (≥70%) per CCTA	
LAD	63.6% (21)
D1	12.1% (4)
D2	0.0% (0)
Circumflex	3.1% (1)
OM1	0 (0%)
RCA	21.2% (7)

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Results

Procedural and in-hospital outcomes (n=48)	
Technical success	100% (48)
Procedural success	97.9% (47)
Length of hospital stay	1 (1-1)
Same day discharge	25.0% (12)
Procedure time, min	89.0 [70.5, 108.0]
Fluoroscopic time, min	18.4 [13.7, 26.5]
Contrast volume, ml	140.0 [125.0, 180.0]
Air kerma radiation, Gy	1.24 [0.81, 1.96]
Vessels treated with CT-guided PCI (n=55)	
Intravascular imaging	
IVUS	85.5% (47)
OCT	14.5% (8)
Calcium modification strategies	
IVL	20.0% (11)
Atherectomy	3.6% (2)
Target vessel	
LM	1.8% (1)
LAD	50.9% (28)
D1	5.5% (3)
Circumflex	3.6% (2)
OM1	1.8% (1)
OM2	0.0% (0)
RCA	32.7% (18)
Ramus	3.6% (2)

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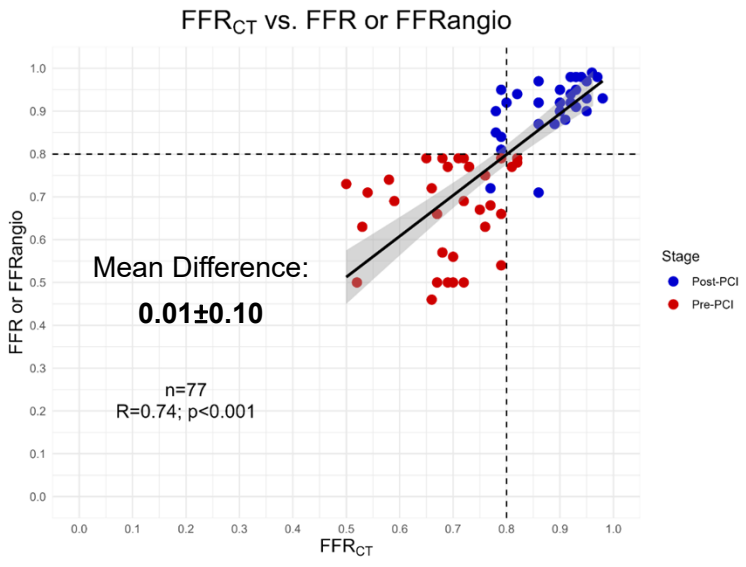
FFR_{CT} versus invasive FFR* correlation n=77

* Invasive FFR include both pressure-wire and angiographic FFR (FFRangio, CathWorks)



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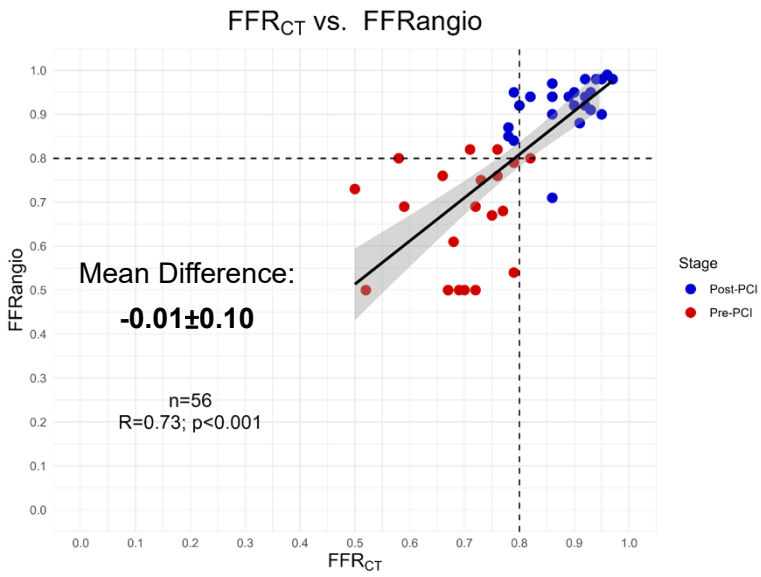
FFR_{CT} versus FFR_{angio} correlation n=56



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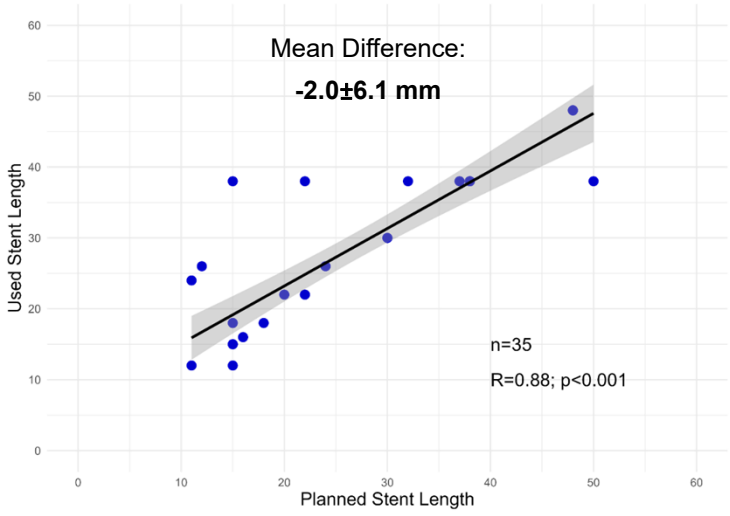
Stent Length

Planned vs. Used Stent



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Limitations

- Observational, single-center study.
- Statistical limitations due to modest sample size.

Conclusions

- FFR_{CT}-based virtual PCI planning was associated with excellent **in-hospital and follow-up** clinical results.
- FFR_{CT} had a **good agreement** with invasive FFR methods
- Pre-procedural planning with plaque characterization, demonstrates that almost **1 in 4** patients required advanced **calcium modification**, which most often involved intravascular lithotripsy.
- Larger prospective multicenter studies and **RCTs are warranted** to evaluate the impact of CT-guided PCI, the role of wireless end-to-end PCI including FFR_{CT} followed by FFRangio and calcium modification strategies.

Thank you!

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Understanding the Peripartum Cardiomyopathy Care-Continuum within the Allina Health System

Hayley Turch, DO | PGY-3

Rahmah Jingo, BA | Dubes Family Intern

Maya Palmer, BA | Clinical Research Associate

Ellen Cravero, MS | Biostatistician

Sarah Schwager, RN | Staff Investigator

Gretchen Benson, RDN | Staff Investigator

Dr Peter Eckman, MD | Physician Investigator

Dr. Retu Saxena, MD | Physician Investigator

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Peripartum Cardiomyopathy (PPCM)

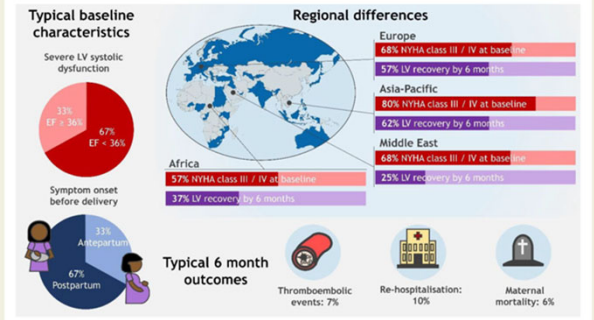


Figure 1 Baseline characteristics, 6-month outcomes, and regional differences observed in the peripartum cardiomyopathy (PPCM) EURObservational Research Programme (EORP). Analysis of 739 PPCM patients from 49 countries. In the map, countries in blue are those included in the EORP registry (countries not included in the illustration: Argentina, Canada, Honduras, Nicaragua, and the USA). EF, ejection fraction; LV, left ventricular; NYHA, New York Heart Association.

Sliwa K et al. European Heart Journal. August 2021

1. LVEF ≤45%
2. Onset within the last month of pregnancy or within (5) months following delivery
   - 60-90% develop after delivery
3. No other identifiable cause of heart failure

- Incidence: 1/2000 pregnancies worldwide
- Leading cause of maternal death
- 4x as likely to develop in Black women vs White women in the U.S.
- Black women 2x more likely vs White women to have persistently decreased LVEF

PPCM remains poorly understood

- **Pathogenesis**
  - Hormonal changes
    - prolactin, sFLT-1, activin A, progesterone
  - Genetic Contribution
    - 15% heterozygous loss-of-function genetic variant
  - Myocarditis? - not supported by myocardial biopsy or cMRI
- **Risk Factors**
  - Hypertensive diseases of pregnancy (e.g. preeclampsia)
  - Ethnicity: African American
  - Advanced maternal age
  - (>30)
  - Multiple gestations
  - Tobacco Use
  - Diabetes

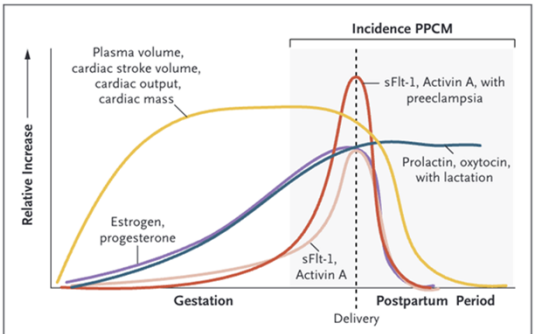
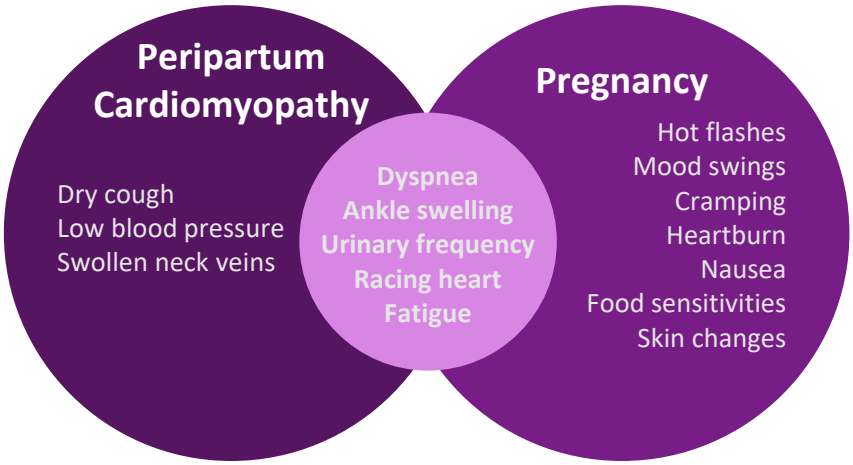


Figure 1. Temporal Hormonal and Hemodynamic Changes during Pregnancy in Relation to the Incidence of Peripartum Cardiomyopathy (PPCM).
Hemodynamic changes of pregnancy, including increases in plasma volume and cardiac stroke volume, cardiac output, and cardiac mass, occur during early gestation; these changes are temporally discordant with the typical postpartum presentation of PPCM. Late gestation and the postpartum period are also characterized by profound changes in hormones. The abbreviation sFlt-1 denotes soluble fms-like tyrosine kinase 1.

Arany Z. New England Journal of Medicine. January 2024

Symptoms of PPCM mirror symptoms of pregnancy itself



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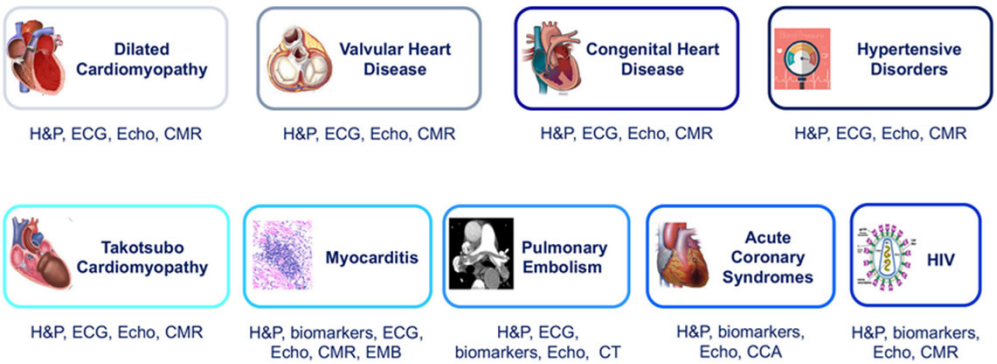
Many cardiac conditions mirror PPCM symptoms

Differential diagnosis of peripartum cardiomyopathy



Ricci et al. Frontiers in Cardiovascular Medicine 2020

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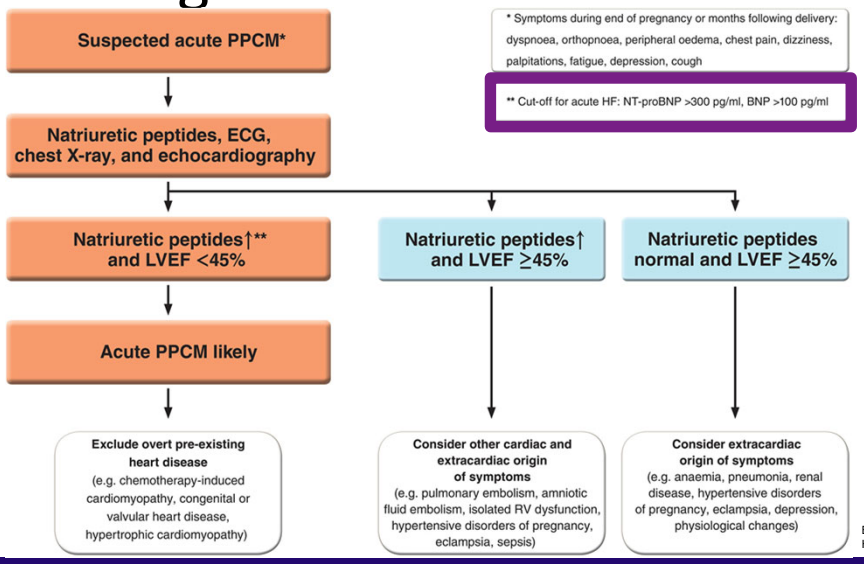
PPCM is a diagnosis of exclusion



Bauersachs et al. European Journal of Heart Failure 2019.

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GDMT is recommended for patients with PPCM

Table 4 Chronic drug treatment in peripartum cardiomyopathy patients after delivery

Drug	Persisting heart failure and absence of complete LV recovery	Complete and sustained recovery (LVEF > 55% and NYHA functional class I)
Beta-blocker	Essential for all patients in standard or maximally tolerated dosages	Continue all drugs (beta-blocker, ACEI/ARB/ARNI, MRA) for at least 12–24 months after full recovery, individual approach/discuss with patient. Discontinue stepwise and monitor symptoms and LV function: 1. MRA 2. ACEI/ARB/ARNI 3. Beta-blocker
ACEI	Essential for all patients in standard or maximally tolerated dosages	
ARB	Recommended in patients who do not tolerate ACEI	
ARNI	Recommended in patients with LVEF < 40% who are symptomatic despite maximal dosages of beta-blocker, ACEI/ARB and MRA	
MRA	Recommended in patients with LVEF < 40%, preferably eplerenone due to less hormonal side effects and less blood pressure reduction compared to spironolactone	
Ivabradine	Recommended in patients in sinus rhythm with a persisting heart rate > 70 b.p.m. at rest despite maximal tolerated beta-blocker up-titration	Discontinue if heart rate < 50 b.p.m. and/or in case of complete recovery
Diuretics	Recommended in patients with fluid overload	Taper dose/discontinue if no signs of fluid overload, maintain only if part of antihypertensive therapy

Please note that initiation of all heart failure drugs is only possible in patients who do not breastfeed (see also Table 3 and online supplementary *Table S1* for a more comprehensive summary of compatibilities with breastfeeding).
ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; ARNI, angiotensin receptor–neprilysin inhibitor; LV, left ventricular; LVEF, left ventricular ejection fraction; MRA, mineralocorticoid receptor antagonist; NYHA, New York Heart Association.

Bromocriptine: consider in LVEF <35% to suppress prolactin release

Anticoagulation (LMWH): consider in LVEF <35% to prevent LV thrombus

- Contraception and multidisciplinary management of subsequent pregnancies
- Risk of recurrent PPCM (10-50%)
- Lactation considerations

Bauersachset al. European Journal Heart Failure. July 2019.

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Study Aims

- **Evaluate the current state of PPCM diagnosis within Allina Health**
- **Adjudicate PPCM and Characterize Patients with an Accurate PPCM Diagnosis**
- **Assess GDMT Initiation and Maintenance within the Cohort**

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Methods: Retrospective Chart Review

Preconception	Pregnancy	Delivery	Post-partum (6 months)

• Demographics
  ○ Age
  ○ Race
  ○ # of pregnancies
• Pre-existing comorbidities
• Medications
	• Gestational age at presentation
	• # of appointments with OB, MFM, and cardiology
	• Medications
		• Mode
		• Gestational age
		• Delivery weight
		• CV complications
		• Follow-up arrangements
			• # of appointments with OB, MFM, and cardiology
			• ED visits & readmissions
			• CV complications
			• Medications

EKG, BNP/proBNP, troponin, Echo, MRI, CT, RHC data

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Patient Demographics and preconception History

Characteristic	N = 105[1]
Mother's Age at Delivery	30.0 (27.0, 35.0)
Unknown	6
Race	
White	65 (62%)
Asian	5 (4.8%)
Black/African American	29 (28%)
Multiracial	1 (1.0%)
American Indian or Alaska Native	3 (2.9%)
Patient Declined	2 (1.9%)

[1]Median (IQR); n (%)

History	N = 105[1]
Gestational Hx (prior pregnancies)	
0	29 (29%)
1	21 (21%)
2	9 (8.9%)
3	20 (20%)
4+	22 (22%)
Pre-existing Conditions	
Hypertension	20 (19%)
Diabetes Mellitus	8 (7.6%)
Tobacco Use (Current)	17 (16%)

n(%)

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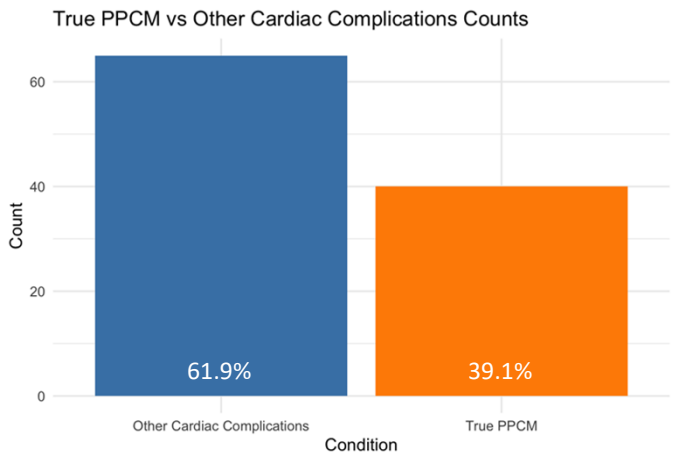
Proportion of PPCM misdiagnoses



Other Cardiac Complications	N=65
Preeclampsia	21 (31.3%)
HFpEF	10 (14.9%)
Myocardial Infarction	4 (6%)
Chronic Hypertension	3 (4.5%)
Kidney Failure	3 (4.5%)
Endocarditis	1 (1.5%)
Spontaneous coronary artery dissection	1 (1.5%)
Takotsubo syndrome	1 (1.5%)
Unknown	21 (32.3%)

n(%)

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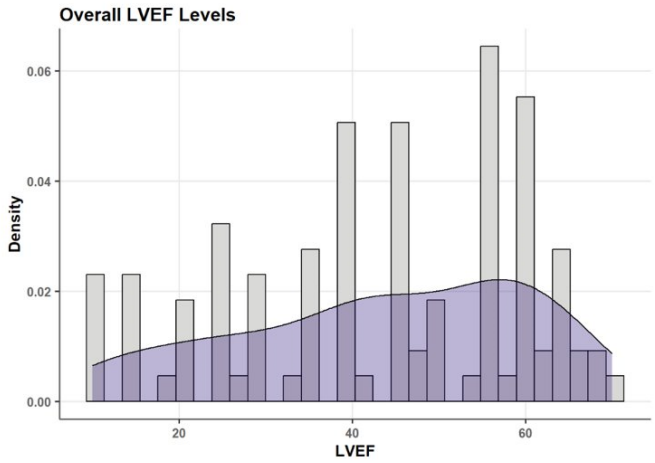
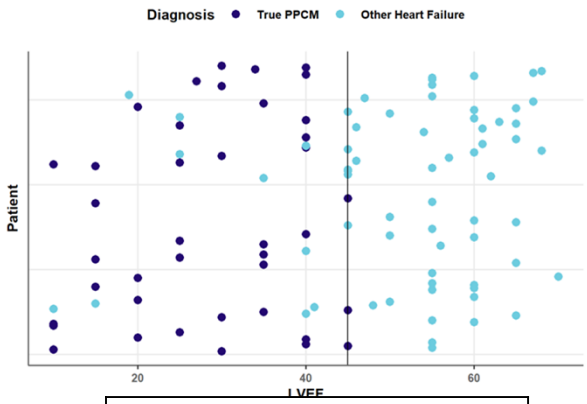
Most individuals with “Other Heart Failure” had LVEF >45%





LVEF by Adjudicated Diagnosis			
	Other Heart Failure (N=65)	True PPCM (N=40)	p-value
LVEF	55 (50, 61)	30 (25,40)	<0.001

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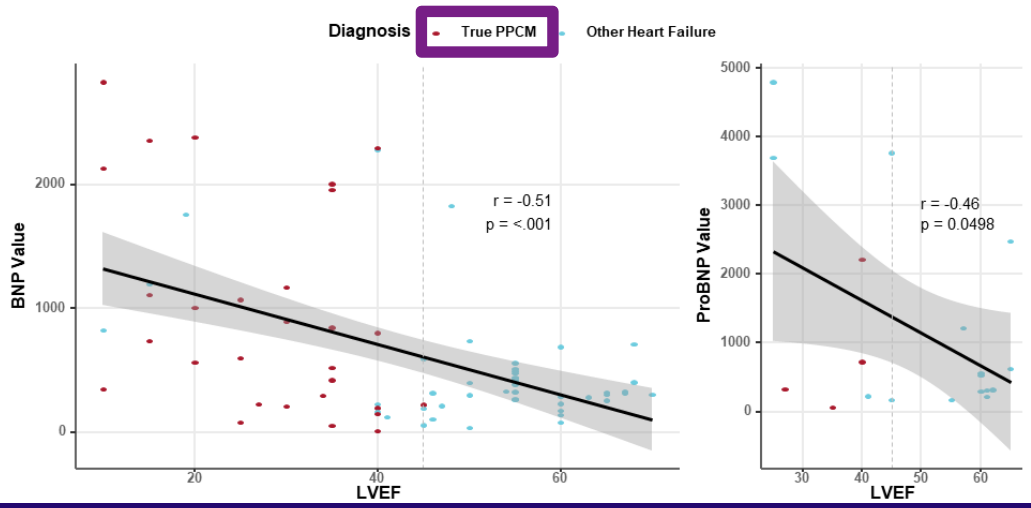
Median BNP values were higher in PPCM



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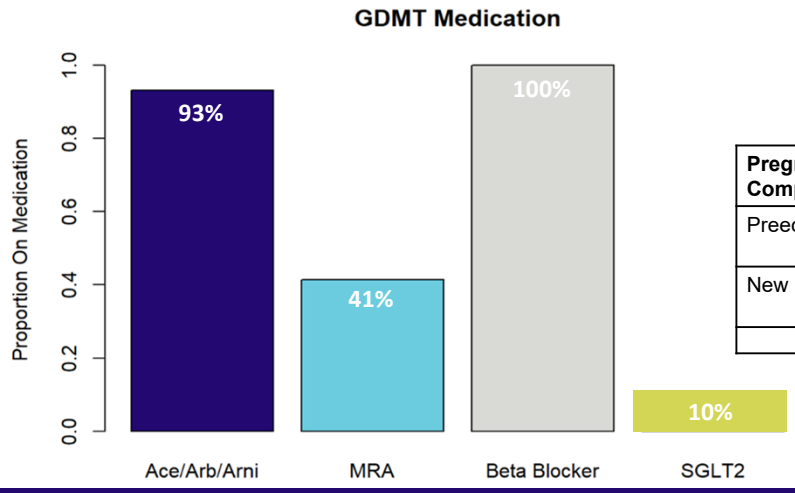
Antihypertensives were the primary line of treatment for patients with a true PPCM diagnosis



Pregnancy CV Complications	True PPCM	False PPCM	p-value
Preeclampsia	19 (50%)	12 (20%)	0.002
New hypertension	11 (29%)	5 (8.5%)	0.008

n(%); 2 Fisher's exact test; Pearson's Chi-squared test

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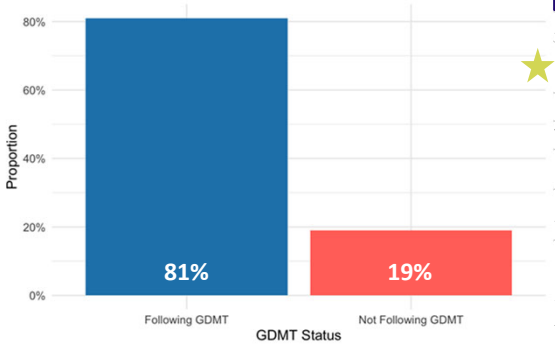
Increased follow-up visits with Cardiology correlate with GDMT status

Patients with True PPCM on GDMT



Outcomes for True PPCM by GDMT status

Outcome	No GDMT N = 7[1]	On GDMT N = 29[1]	p-value[2]
Any follow-up with Cardiology	7 (70%)	25 (89%)	0.3
Number of follow-up visits with cardiology	1 (0, 2)	3 (2, 5)	0.006
>=1 CV related hospitalization	7 (70%)	22 (79%)	0.7
Total CV related hospitalizations	1 (0, 1)	1 (1, 2)	0.3
>=1 obstetric related hospitalization	1 (11%)	0 (0%)	0.3
Advanced Heart Failure Management	0 (NA%)	3 (100%)	
Unknown	10	25	

[1] n (%); Median (IQR)

[2] Fisher's exact test; Wilcoxon rank sum test

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Discussion

Conclusions:

- PPCM is often misdiagnosed
  - LVEF ≤45% is part of diagnostic criteria
- Most patients with an accurate PPCM diagnosis received GDMT
  - Primarily with antihypertensives
- Follow-up with Cardiology is crucial for ensuring the initiation and maintenance of GDMT

Future Directions:

- Management of peripartum "Other Heart Failure"
- Genetic testing
- REBIRTH trial: bromocriptine and LVEF recovery
- HOPE Study for Mom and Baby

Limitations:

- Incomplete data from healthcare received outside of the Allina system

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Feasibility of Computed Tomography as a Gatekeeper for Invasive Angiography before TAVR

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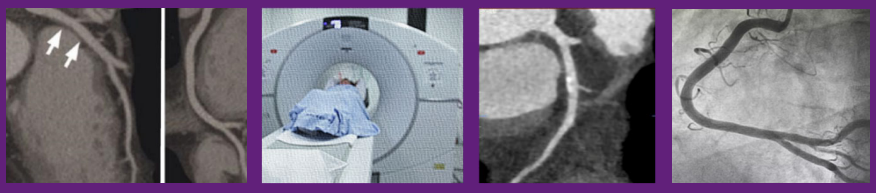

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Potential conflicts of interest

Speaker's name: Asa Phichaphop

☑ I do not have any potential conflicts of interest to report

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Severe Aortic Stenosis Patients

Work-up
Coronary artery

→ TAVR procedure
(Transcatheter Aortic Valve Replacement)

- Historically evaluated by invasive coronary angiography
- Can we use coronary CTA?
  - Has a high NPV
  - CCTA requires beta-blockers and SL nitroglycerin
- Diagnostic accuracy of TAVR-CTA is established
- *The safety and clinical application of this approach have not been demonstrated*

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CTA is Excellent for screening – Rule OUT

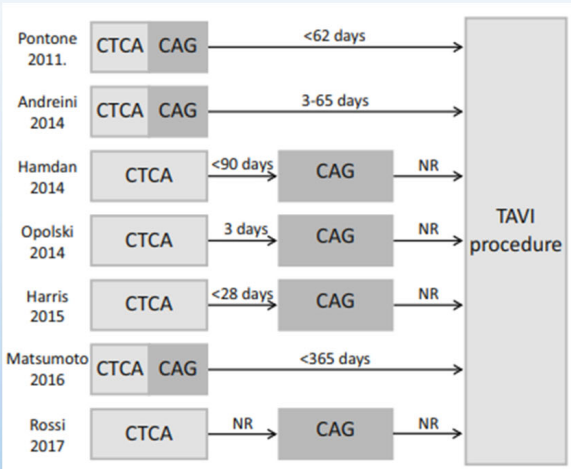

Fig. 4 Flow and timing. Scheme, depicting the timing of the pre-procedural CTCA and CAG before TAVI. (*CTCA* computed tomography coronary angiography, *CAG* coronary angiography, *NR* not reported, *TAVI* transcatheter aortic valve implantation procedure)

Gati M et al. Eur Radiol 2022 Aug;32(8):5189-5200.

Table 3 Diagnostic value of CTCA

	N	Prev (%)	TP (%)	TN (%)	FP (%)	FN (%)	Sensitivity	Specificity	PPV	NPV
Pontone et al. (2011) [13]	60	26 43.3%	23 38.3%	30 50.0%	4 6.7%	3 5.0%	88.5%	88.2%	85.2%	90.9%
Andreini et al. (2014) [18]	325	97 29.8%	87 26.8%	207 63.7%	21 6.5%	10 3.1%	89.7%	90.8%	80.6%	95.4%
Hamdan (2015) [19]	115	49 42.6%	47 40.9%	48 41.7%	18 15.7%	2 1.7%	95.9%	72.7%	72.3%	96.0%
Opolski (2015) [20]	475	270 56.8%	265 55.8%	76 16.0%	129 27.2%	5 1.1%	98.1%	37.1%	67.3%	93.8%
Harris et al. (2015) [21]	100	74 74.0%	73 73.0%	15 15.0%	11 11.0%	1 1.0%	98.6%	57.7%	86.9%	93.8%
Matsumoto (2017) [10]	60	24 40.0%	22 36.7%	21 35.0%	15 25.0%	2 3.3%	91.7%	58.3%	59.5%	91.3%
Rossi et al. (2017) [22]	140	58 41.4%	53 37.9%	45 32.1%	37 26.4%	5 3.6%	91.4%	54.9%	58.9%	90.0%
Total	*1,275*	*598* *46.9%*	*570* *44.7%*	*442* *34.7%*	*235* *18.4%*	*28* *2.2%*	*95.3%*	*65.3%*	*70.8%*	*94.0%*

Outcomes of individual studies and of the studies combined are listed as integers and as a percentage
FN false negatives, *FP* false positives, *N* number of studied subjects, *NPV* negative predictive value, *PPV* positive predictive value, *Prev* prevalence of coronary artery disease as reported, *TN* true negatives, *TP* true positives

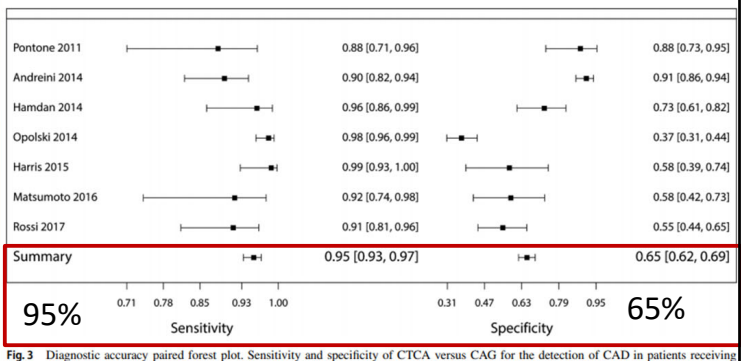

Fig. 3 Diagnostic accuracy paired forest plot. Sensitivity and specificity of CTCA versus CAG for the detection of CAD in patients receiving TAVI. Results are depicted in a paired forest plot, with resulting confidence intervals for each individual study and for the studies combined

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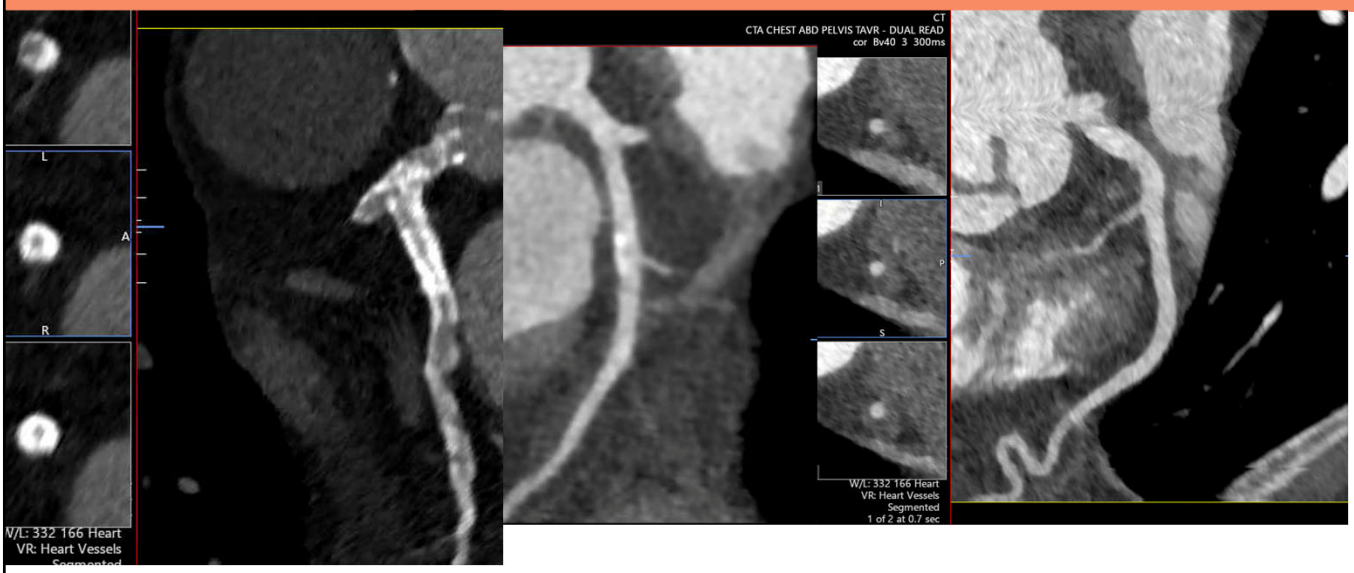
Coronary CTA evaluation on Pre-TAVR scan



TAVR CTA to exclude CAD can be attempted for most patients.
But there are patients and patients…

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Objectives

- *Ability* of standard pre-TAVR CTA protocol without medications, to serve as a *screening test* to rule out obstructive CAD
- *Outcomes* related to coronary events of both approaches.
- *Concordance* for obstructive CAD for both approaches
- *Factors* associated with the needed for ICA

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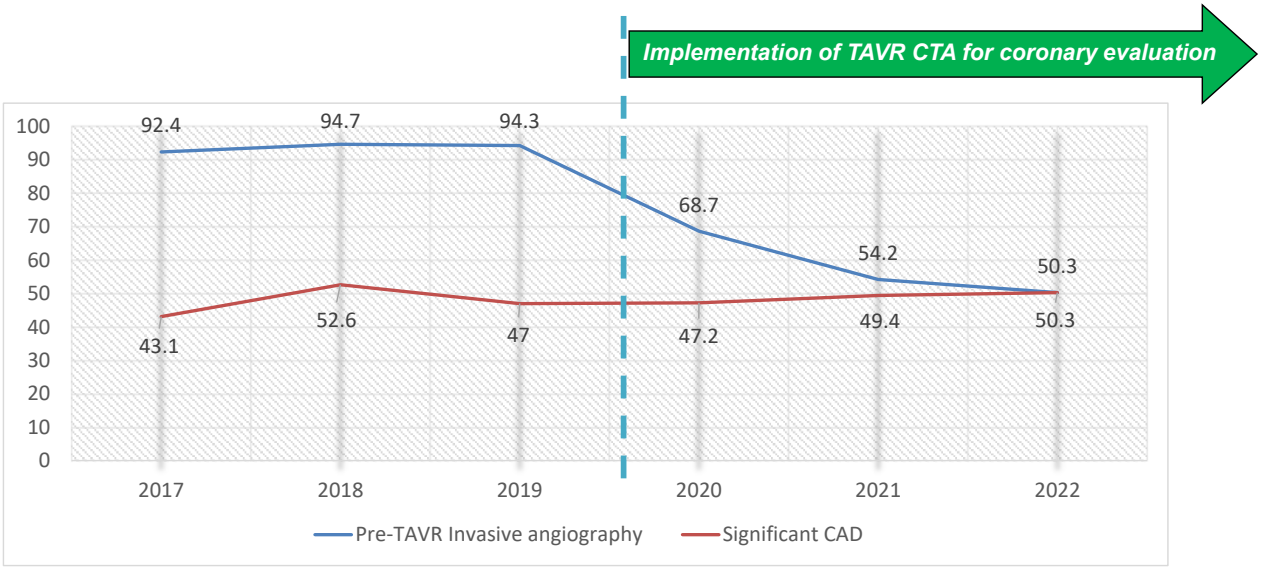
Pre-TAVR coronary angiography screening



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Methodology

Inclusion criteria

- consecutive TAVR patients with documented evaluation of CAD
  - By invasive angiography
  - By TAVR CTA (0.6 mm thickness, systolic recons, 512 matrix)
- TAVR procedure were performed afterward

Exclusion criteria

- CABG patients

Outcomes: coronary related events up to 1-year after TAVR

- Coronary revascularization
- Acute coronary syndrome
- Unplanned invasive angiography

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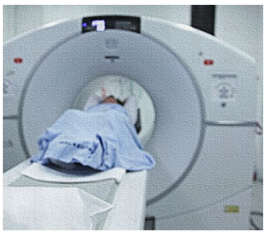
Methodology



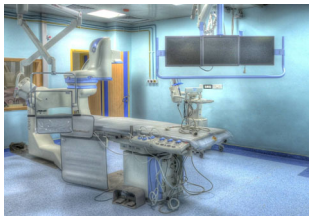
1,414 patients underwent TAVR

Exclude: 214 CABG patients
35 no CTA & no ICA before TAVR

1,165 patients

464 with coronary evaluation by TAVR-CTA

701 with coronary evaluation by invasive angiography



Outcome: symptom-driven revascularization at one-year after TAVR

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Result

Characteristic	TAVR-CTA N = 464[1]	ICA N = 701[1]	p-value[2]
Age, yrs	81 (76, 86)	81 (76, 87)	0.7
Male gender	246 (53%)	381 (54%)	0.7
Diabetes	126 (27%)	229 (33%)	0.045
Hypertension	382 (82%)	608 (87%)	0.039
Presence of pacemaker	58 (13%)	83 (12%)	0.7
History of PCI	90 (19%)	104 (15%)	0.041
Bicuspid valve	23 (5.0%)	45 (6.4%)	0.3
LVEF, %	63 (56, 65)	62 (55, 66)	0.2
Atrial fibrillation	162 (35%)	258 (37%)	0.5
Aortic valve area, cm²	0.8 (0.7, 0.9)	0.8 (0.7, 0.9)	0.086
STS-PROM, %	2.7 (1.8, 3.9)	3.1 (2.0, 4.7)	<0.001

[1] Median (IQR); n (%) [2] Wilcoxon rank sum test; Pearson's Chi-squared test.

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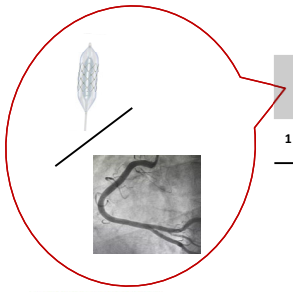
Baseline pre-TAVR evaluation



Characteristic	TAVR-CTA N = 464[1]	ICA N = 701[1]	p-value[2]
Obstructive CAD	173 (37%)	290 (41%)	0.2
Pre-TAVR angiography	217 (47%)	701 (100%)	<0.001
Pre-TAVR PCI	63 (14%)	134 (19%)	0.014
Complete revascularization	44 (70%)	100 (75%)	0.5
PCI / angiography ratio	0.29	0.19	0.003

[1] n (%) [2] Pearson's Chi-squared test.

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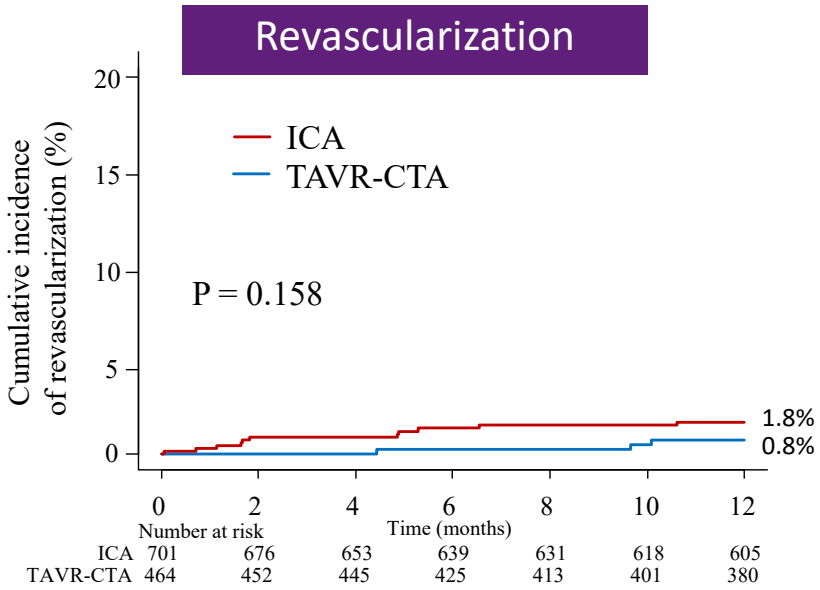
Result



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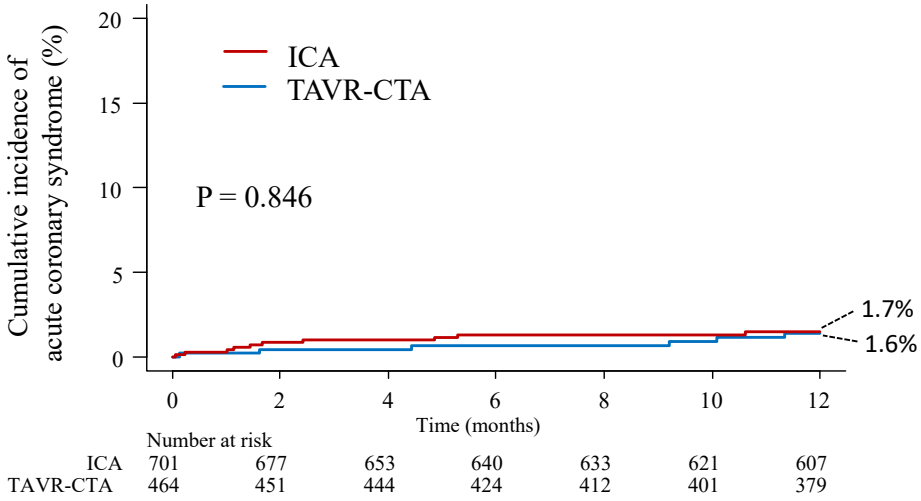
Result

Acute coronary syndrome



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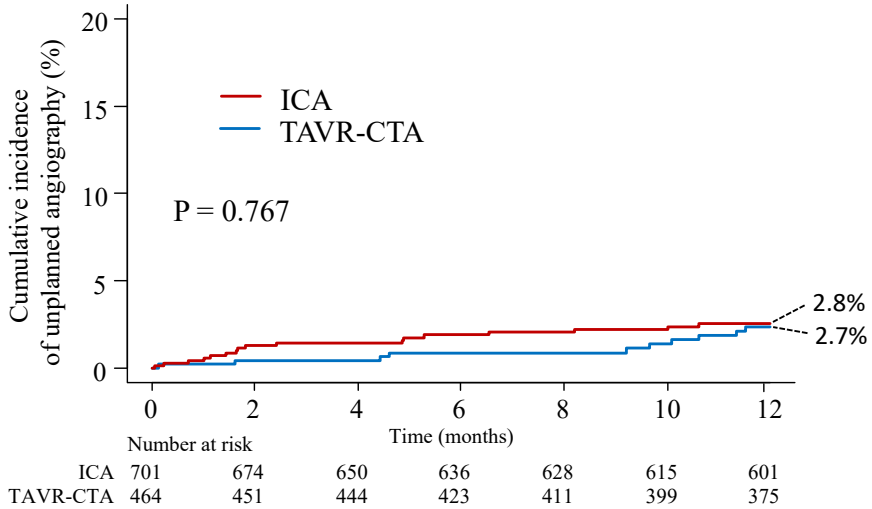
Result

Unplanned angiography



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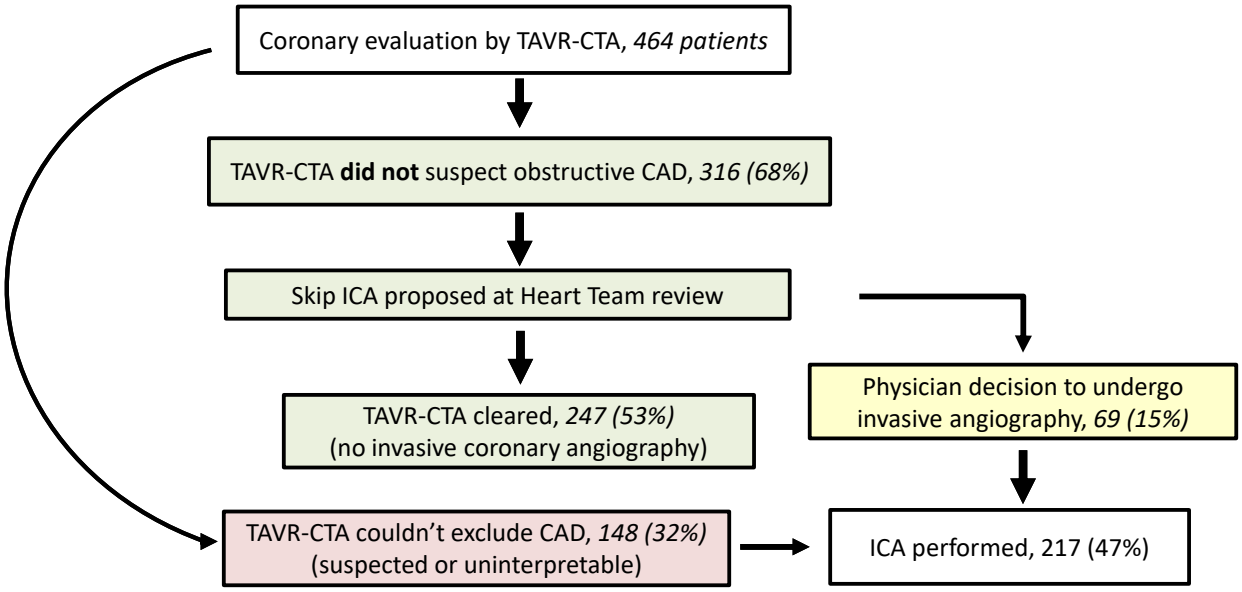
Patient subgroup with TAVR-CTA



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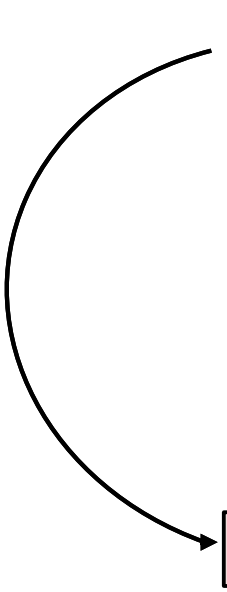
Factors related to requiring of ICA



Characteristic	IRR[1]	95% CI	p-value
Male gender	1.54	1.16, 2.07	0.004
Age, yrs	1	0.98, 1.02	>0.9
LVEF, %	1.01	0.99, 1.02	0.4
AF	1.01	0.76, 1.34	>0.9
Diabetes	1.3	0.97, 1.73	0.08
Hypertension	1.4	0.93, 2.21	0.12
History of PCI	2.07	1.55, 2.75	<0.001

1 IRR = Incidence Rate Ratio, CI = Confidence Interval. Abbreviation as in Table 1

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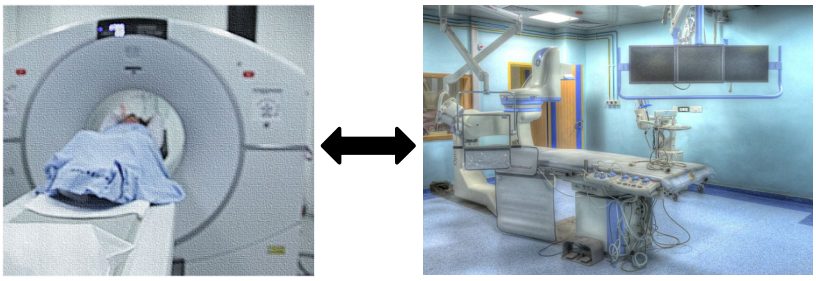
Matching the accuracy of TAVR-CTA



- Patients with TAVR-CTA (suspected or excluded CAD) and ICA
  Sensitivity = 88.5 % Specificity = 75 %
  PPV = 68.7 % *NPV = 91.3 %*
- TAVR-CTA did not miss any left main and/or proximal LAD stenosis
- Most common segment/vessel misinterpreted was proximal RCA

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Conclusion

When compared to routine invasive coronary angiography, use of routine pre-TAVR CTA evaluation of CAD, even without pre-medication can expedite TAVR work-up while:

- Safely excluding significant CAD up to **two-thirds** of patients without missing any severe left main or proximal LAD lesion.
- Maintaining comparable **low incidence of coronary events** at 1 year after TAVR – equal to routine invasive cath
- Providing reassuring high negative predictive value.

Male patients and history of PCI had increased need of invasive coronary angiography after TAVR-CTA evaluation.

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- CTA report grading

Table 1: Grading scale for stenosis severity, plaque burden and ischemia.

Degree of luminal diameter stenosis	Terminology
0%	No visible stenosis
1–24%	Minimal stenosis
25–49%	Mild stenosis
50–69%	Moderate stenosis
70–99%	Severe stenosis
100%	Occluded

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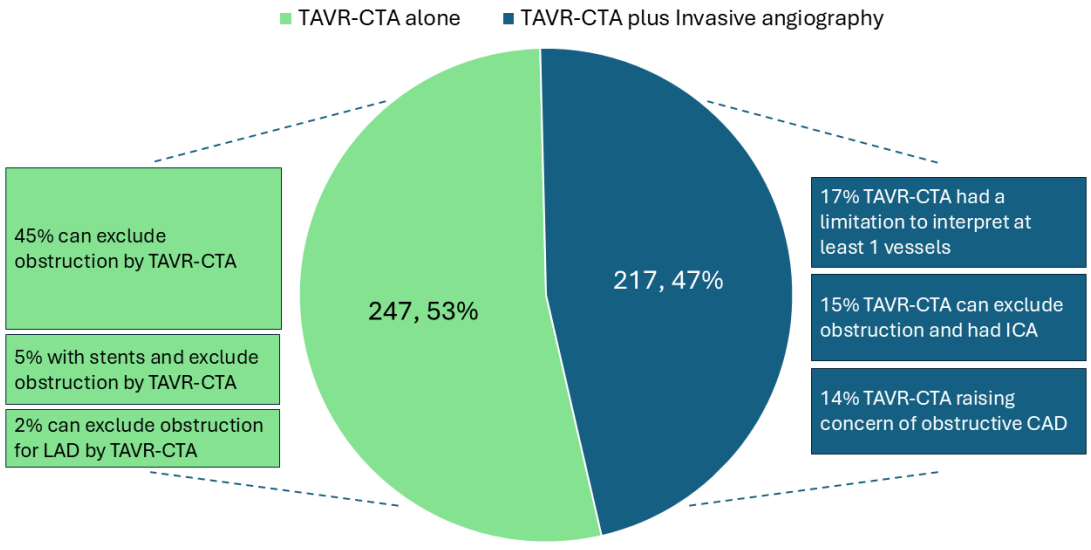
Result



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CAD-RADS System

Category	Degree of maximal coronary stenosis	Interpretation	Further Cardiac Investigation	Management considerations
CAD-RADS 0	0% (No plaque or stenosis)	Absence of CAD[a]	None	Reassurance. Consider non-atherosclerotic causes of symptoms
CAD-RADS 1	1–24% (Minimal stenosis or plaque with no stenosis[b]	Minimal non-obstructive CAD[b]	None	- Consider non-atherosclerotic causes of symptoms - P1: Consider risk factor modification and preventive pharmacotherapy - P2: Risk factor modification and preventive pharmacotherapy - P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy
CAD-RADS 2	25–49% (Mild stenosis)	Mild non-obstructive CAD	None	- Consider non-atherosclerotic causes of symptoms - P1 or P2: Risk factor modification and preventive pharmacotherapy - P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy
CAD-RADS 3	50–69% (Moderate stenosis)	Moderate stenosis	Consider functional assessment[c]	-P1, P2, P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy - Other treatments (including anti-anginal therapy) should be considered per guideline directed care[d] - When modifier I+, consider ICA, especially if frequent symptoms persist after guideline-directed medical therapy
CAD-RADS 4	A - 70–99% stenosis or B - Left main ≥50% or 3-vessel obstructive (≥70%) disease	Severe stenosis	A: Consider ICA[c] or functional assessment B: ICA is recommended	-P1, P2, P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy. - Other treatments (including anti-anginal therapy and options of revascularization) should be considered per guideline directed care[c]
CAD-RADS 5	100% (total occlusion)	Total coronary occlusion or sub-total occlusion	Consider ICA, functional and/or viability assessment	P1, P2, P3 or P4: Aggressive risk factor modification and preventive pharmacotherapy. - Other treatments (including anti-anginal therapy and options of revascularization) should be considered per guideline directed care[c]
CAD-RADS N	Non-diagnostic study	Obstructive CAD cannot be excluded	Additional/alternative evaluation	

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