ACC.26

OCT and CMR to determine underlying causes of MINOCA in women and men

Harmony Reynolds, MD

NYU Langone Health

On behalf of: Akiko Maehara, Bobby Heydari, Nathaniel Smilowitz, Tara Sedlak, Yader Sandoval, Hayder Hashim, Kevin Bainey, Akl Fahed, Natalia Pinilla Echeverri, Mitsuaki Matsumura, Mobeen Ahmed, Jacqueline Saw, Aun Yeong Chong, Atul Sharma, Anais Hausvater, Yuhe Xia, Jennifer Tremmel, Shuangbo Liu, Puja Mehta, Bryan Har, Sripal Bangalore, Michael Attubato, Lori Vales Lay, Alair Holden, Chang Yu, Judith Hochman and the HARP Research Group

AMERICAN COLLEGE of CARDIOLOGY

What is MINOCA?

- MI meeting Universal Definition, with 0-49% stenosis on coronary angiography
  - 6% of MI overall; 15% of women with NSTEMI
  - MINOCA is 3x more common among women than men with MI
- ***If you see MI patients, you are seeing MINOCA***
- Prognosis:
  - 1-year major adverse cardiovascular events: **10%**
  - 4-year major adverse cardiovascular events: **24%**

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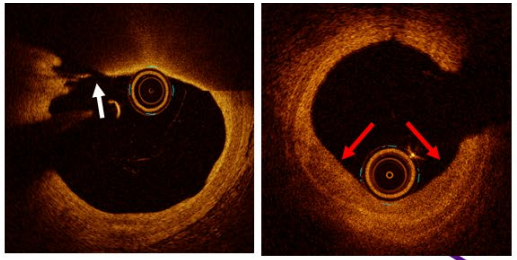
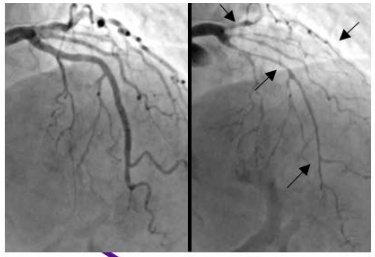
Tamis-Holland, Jneid, Reynolds…Beltrame et al Circ 2019; Smilowitz NR et al Circ Quality and Outcomes 2017; Pasupathy et al Circ Cardiovasc Qual Lindahl B et al Circ 2017

Vascular Phenomena (Myocardial Infarction)

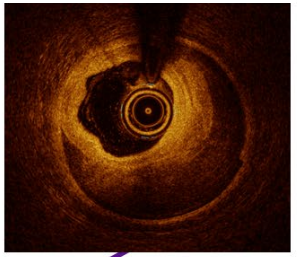
Atherosclerotic Culprit Lesions



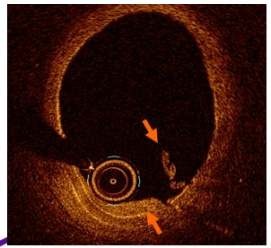
Coronary Spasm

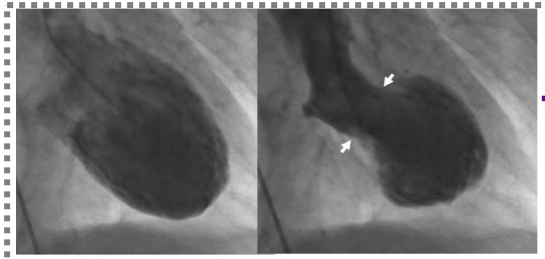


Dissection

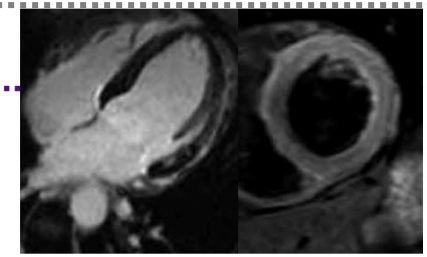


Thrombosis & Thromboembolism





MINOCA



Takotsubo Syndrome, Non-ischemic Cardiomyopathy, Hypertrophic Cardiomyopathy, Myocarditis

Mimicking Conditions (not MI → not MINOCA once found): CMR is diagnostic

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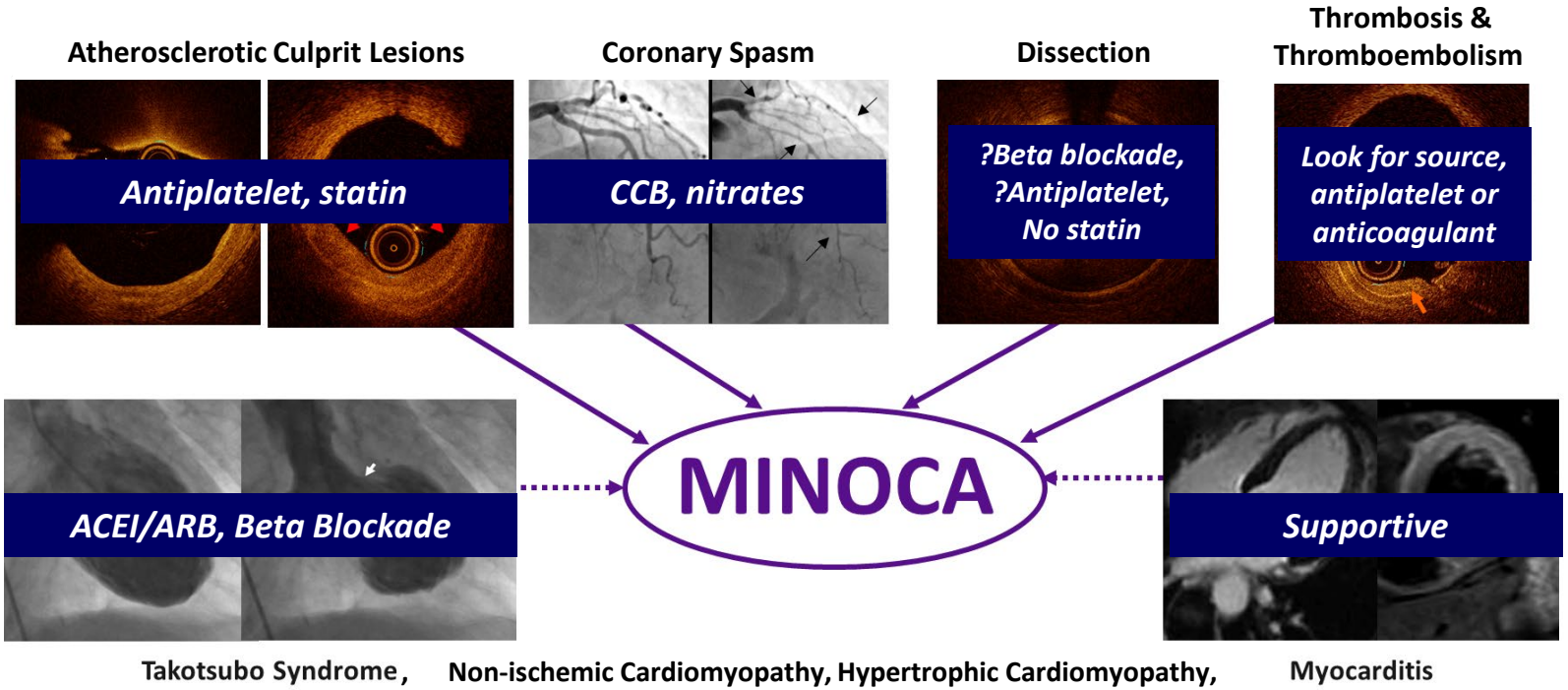
MI guidelines: Treat according to underlying diagnosis



Diagnosis based on multi-modality imaging – reported experience to date:
231 MINOCA patients with OCT and CMR in **5 published prospective studies**

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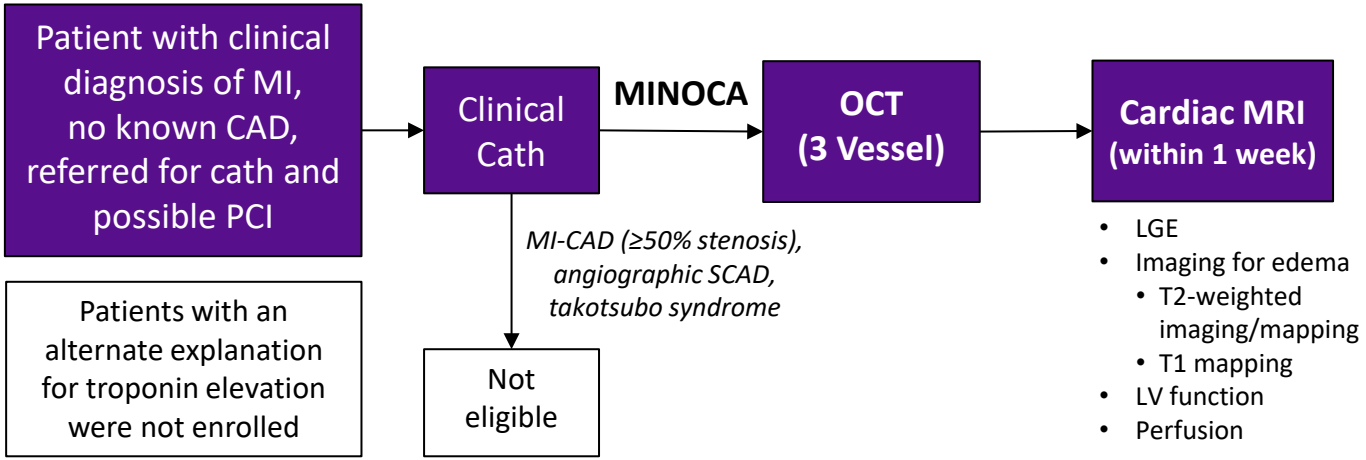
Reynolds et al Circ 2021; Montone et al EHJ 2026; Gerbaud et al iJACC 2020; Opolski et al iJACC 2019; Fluder-Wlodarczyk et al J Clin Med 2022

Heart Attack Research Program (HARP)

AHA Go Red for Women Strategically Focused Research Network

Objectives - to determine frequency and clinical predictors of:

- Vascular causes of MINOCA on coronary optical coherence tomography (OCT)
- Myocardial abnormalities on cardiac MRI (CMR) - ischemic or non-ischemic
- Various underlying etiologies identified based on OCT + CMR



Initial Phase: Women only (n=145, reported 2020)

Extension: Both sexes, enrolled through 2025

Enrolled before or after clinical cardiac cath with OCT performed

Core laboratories were blinded to detailed clinical information, sex, results of other imaging tests

OCT Core Lab
Dr. Akiko Maehara, Cardiovascular Research Foundation

CMR Core Lab
Dr. Bobby Heydari, Brigham and Women's Hospital

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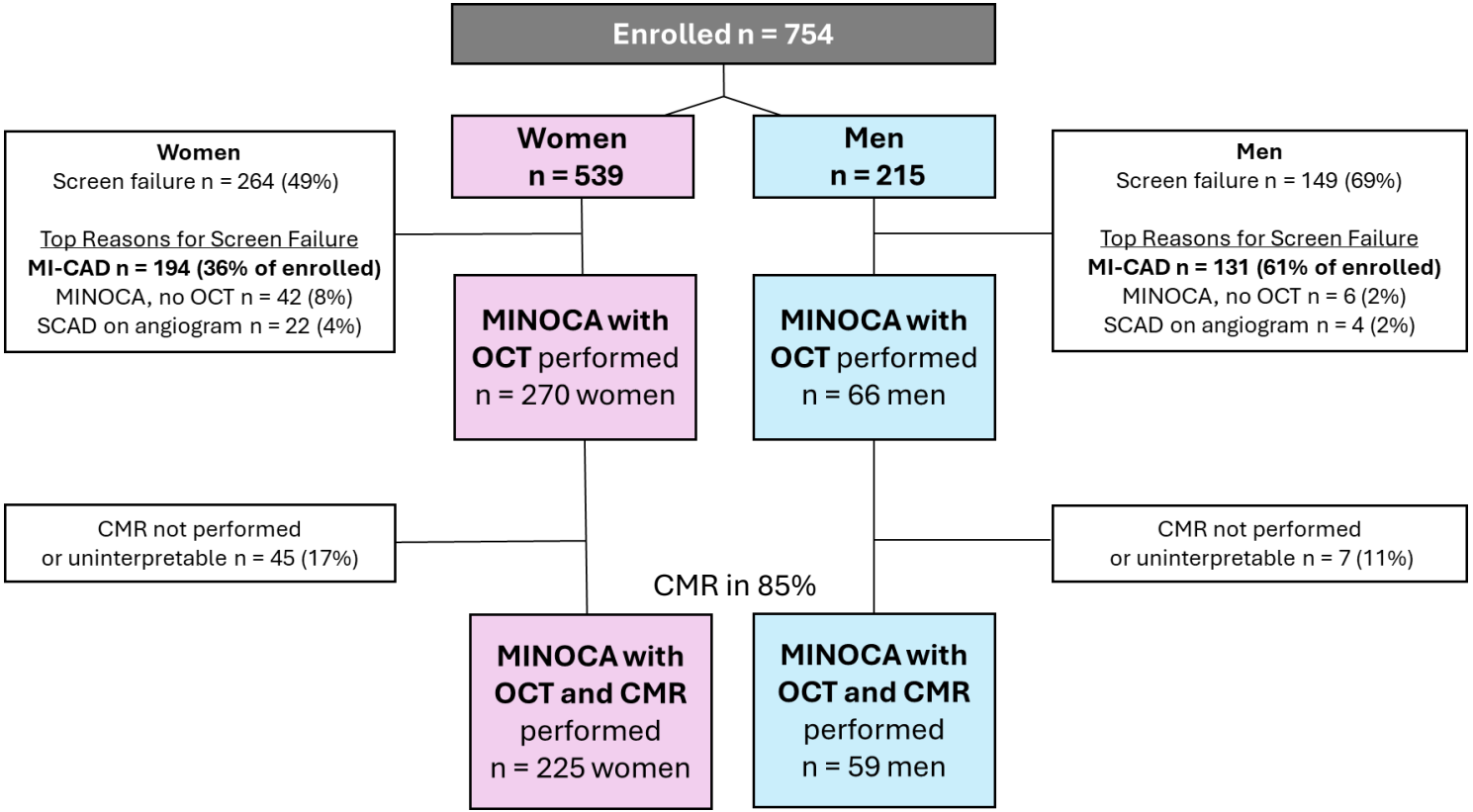
American Heart Association. Funded Research



28 sites in US, Canada and UK

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American Heart Association. Funded Research

HARP: Demographics, Presentation, OCT Imaging

Demographics and History	Fully Eligible MINOCA (n=336)
Age, years (median, IQR)	58 [50, 67]
Race/ethnicity other than white, non-Hispanic	46%
Hypertension	48%
Diabetes mellitus	18%

MI Presentation	Fully Eligible MINOCA (n=336)
Peak troponin as multiple of upper reference limit, median (IQR)	32 x URL [11 x, 111 x]
STEMI presentation	5%
Segmental wall motion abnormality on echocardiogram (N=270)	35%
Coronary angiogram normal per site	46%

- **Multivessel OCT imaging in 93%:**
  - 3-vessel OCT in 64%, 2-vessel OCT in 29%, 1-vessel OCT in 7%
- **Median 2 days from MI** to cath with OCT (IQR 1-3)
- Complications of OCT imaging: **3 coronary dissections (0.9%),** all requiring PCI

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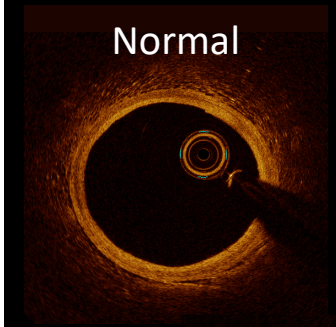
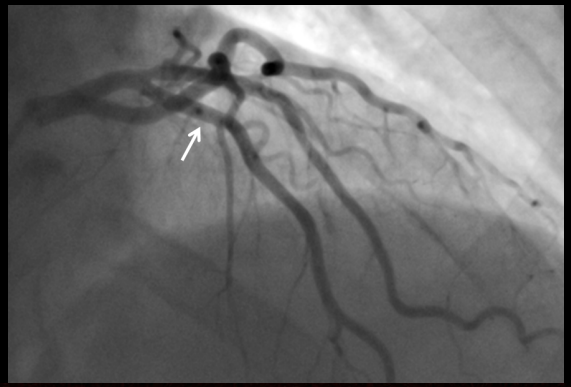
OCT findings

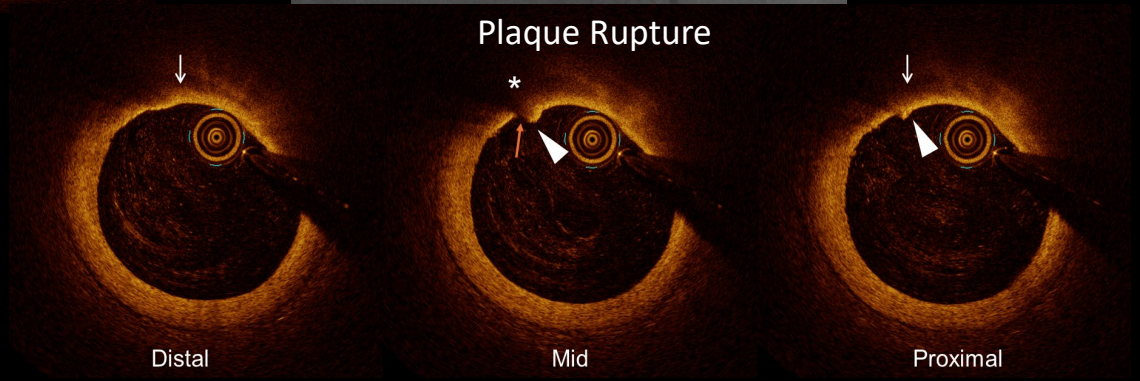
OCT N=336

Culprit Lesion n=151 (45%)

Plaque Rupture	n=24 (7%)
Intra-Plaque Hemorrhage	n=58 (17%)
Healed Plaque	n=40 (12%)
Plaque Erosion	n=17 (5%)
Calcified Nodule	n= 6 (2%)
Thrombus without Plaque	n= 4 (1%)
SCAD	n= 2 (0.6%)







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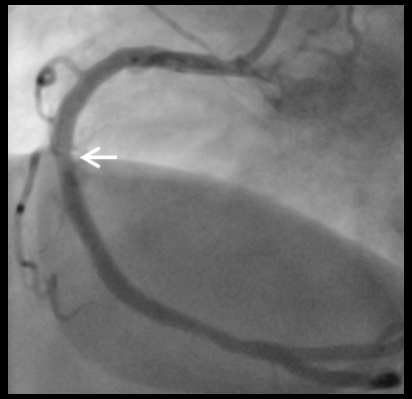
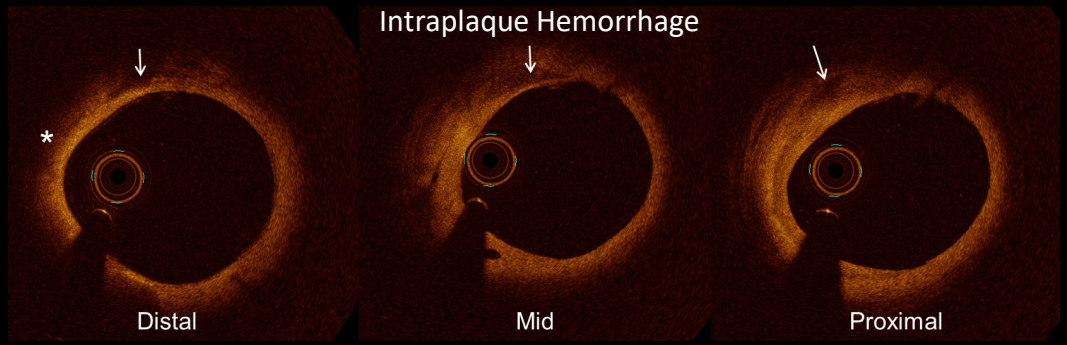


Intraplaque Hemorrhage



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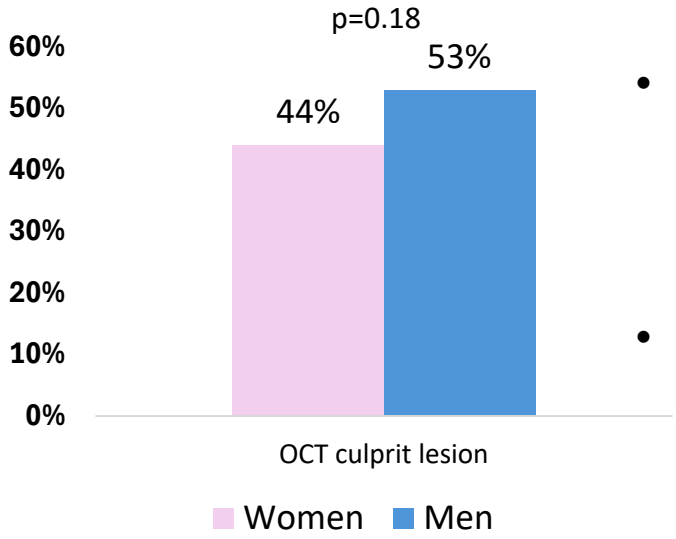
OCT culprit lesion 45%, not different by sex



- Culprit lesion on OCT in 61% with any angiographic stenosis vs. 27% with normal coronary angiography, p=0.003

- <u>Multivariable predictors of culprit lesion:</u>
  - Older age (OR 1.63 per 10 years, 95% CI 1.29-2.08)
  - Abnormal angiogram (OR 3.69, 95% CI 2.25-6.14)
  - 3-vessel OCT imaging (OR 2.07, 95% CI 1.23- 3.53)

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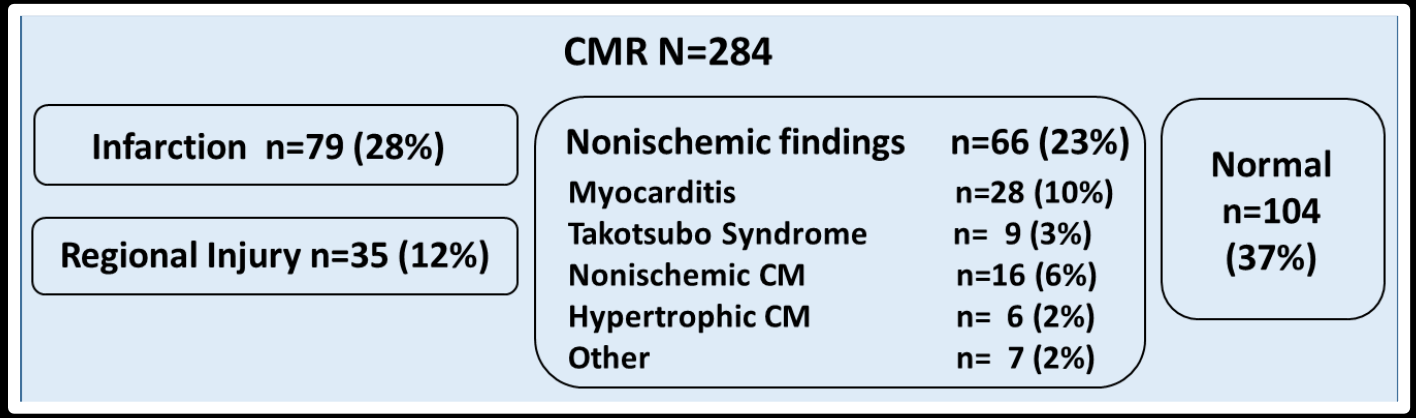
CMR abnormal in 63% → 40% ischemic + 23% non-ischemic



- Median 6 days from MI to CMR (IQR 3-10)
- Most common reasons CMR not done: refusal after consent 49% (e.g., unable to return due to need to work, unable to get childcare, lived too far from CMR location), no show 21%

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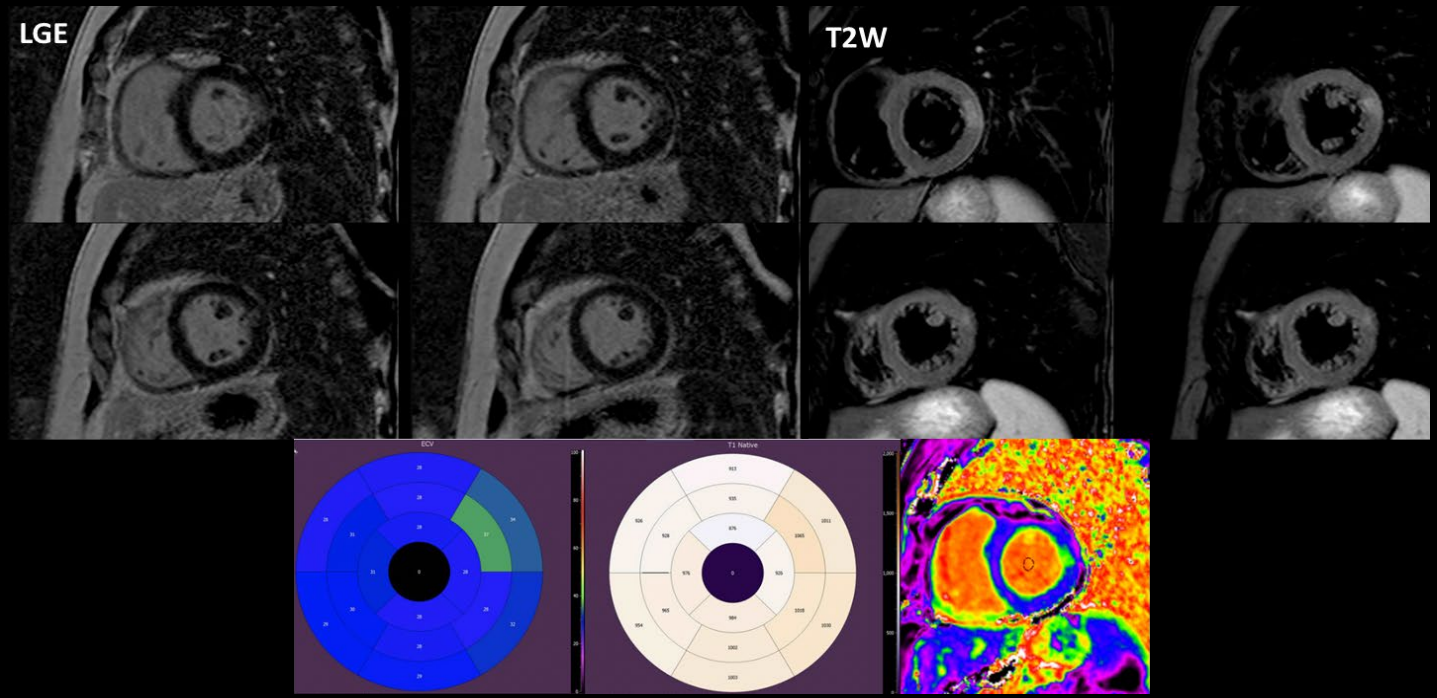
Small myocardial infarction



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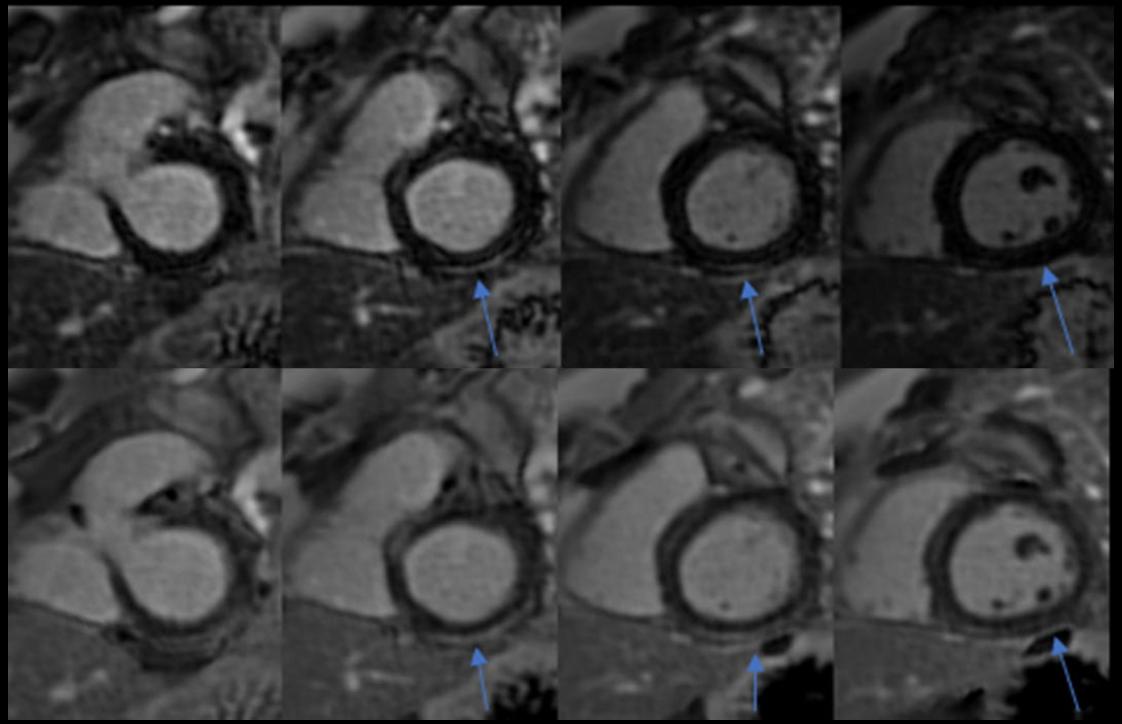
Myocarditis



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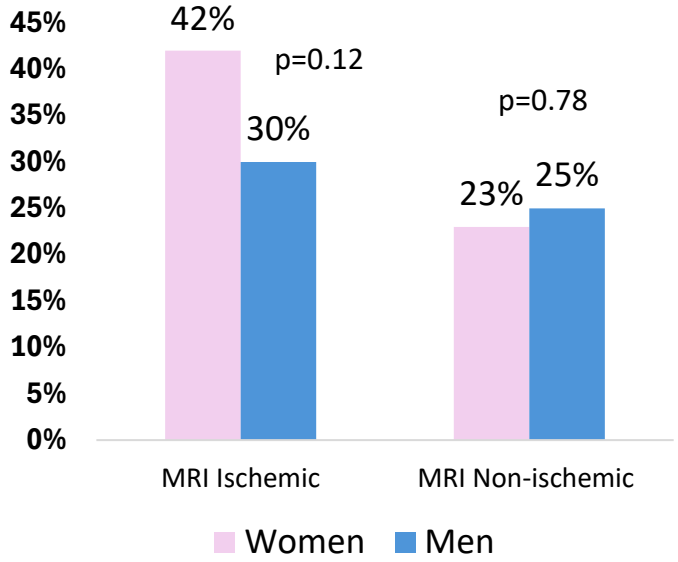
CMR findings did not differ by sex



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Ischemic CMR more likely with an OCT culprit lesion

OCT and CMR performed (n=284)	**OCT culprit lesion present** (n=124)	**No culprit lesion on OCT** (n=160)	**P value**
Abnormal CMR (n=180)	81 (65.3%)	99 (61.9%)	0.111 *
Ischemic CMR findings *(n=114)*	64 (51.6%)	50 (31.3%)	*<0.001 †*
Non-ischemic CMR findings *(n=66)*	17 (13.7%)	49 (30.6%)	
Normal CMR (n=104)	43 (34.7%)	61 (38.1%)	

* P value for abnormal vs normal CMR;
† P value for Ischemic CMR vs. non-ischemic CMR vs. normal CMR

- Ischemic CMR findings (LGE or regional injury) without culprit lesion → Suspect coronary artery spasm, thromboembolism (or missed culprit lesion)

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Predictors of abnormal CMR

- CMR more likely to be normal with normal echo
  - 43% vs. 25% with low EF or wall motion abnormal
  - CMR abnormal in 57% when echo was normal
- Multivariable predictors of abnormal CMR:
  - Higher peak troponin (OR 1.47, log transformed, 95% CI 1.20-1.83)
  - Non-Asian race (OR 0.14, 95% CI 0.03-0.54 for Asian vs. White race)
  - Shorter time from MI to CMR (OR 0.95 per day longer, 95% CI 0.91-0.99)
- …but even with troponin <4 times the URL, 38% had abnormal CMR

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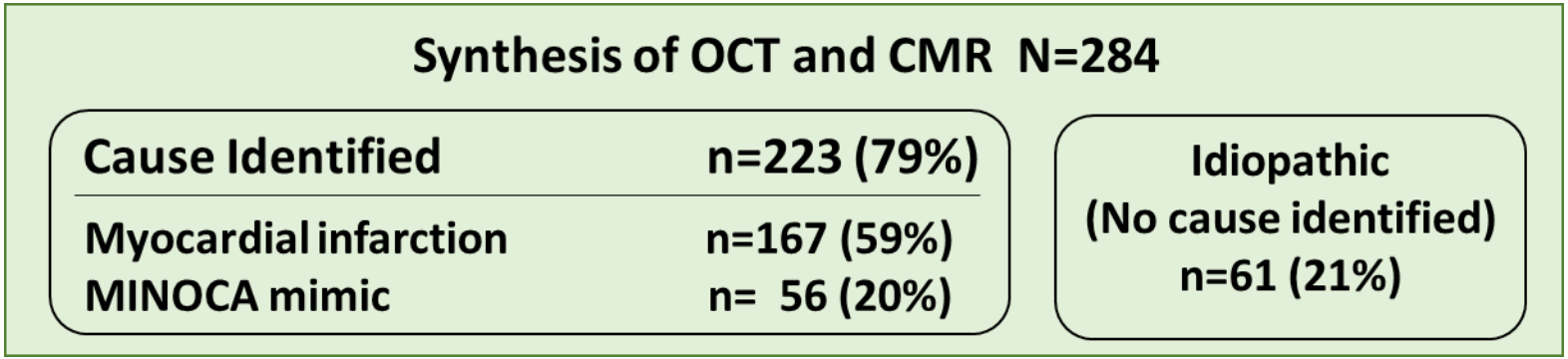

- Multi-modality imaging (OCT + CMR) better than either modality alone
  - **OCT + CMR: 79%**
  - **CMR alone: 69%** ($p<0.001$)
  - **OCT alone: 44%** ($p<0.001$)

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Limitations

- Sample size, particularly for men and STEMI
- No spasm testing
- No control group
- Not all patients had 3-vessel OCT
- Not all patients had CMR

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OCT + CMR → Causal diagnosis in 79% of MINOCA

- Final diagnosis: MI in 59%, MINOCA mimic in 20%
- Clinical factors had limited utility to predict imaging abnormalities
- No sex differences in imaging results were detected
  - Sex differences in the prevalence of MINOCA are more prominent than sex differences in underlying mechanisms

- Our findings support current guidelines that recommend imaging to guide selection of treatment after a MINOCA presentation

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Thanks to the HARP participants and investigators, American Heart Association

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American Heart Association. Funded Research

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Circulation

DOI: 10.1161/CIRCULATIONAHA.126.080234

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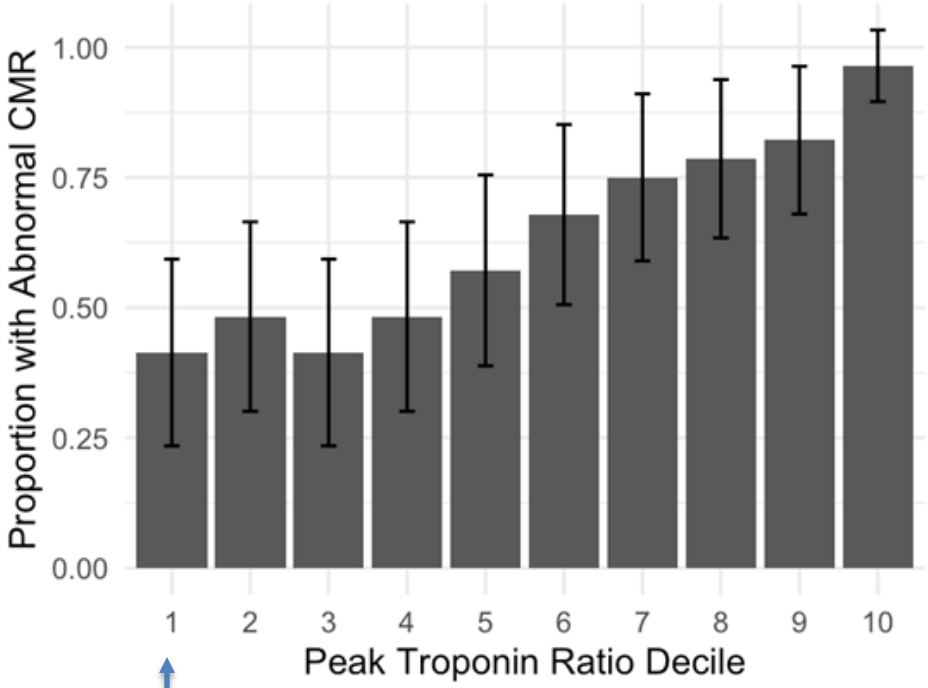
CMR commonly abnormal even with lower peak troponin



Lowest decile of peak troponin <4 fold the upper reference limit: 38% abnormal CMR

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OCT findings: healed plaque

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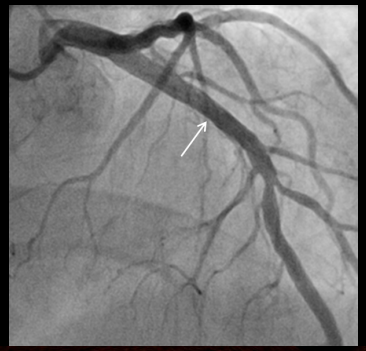

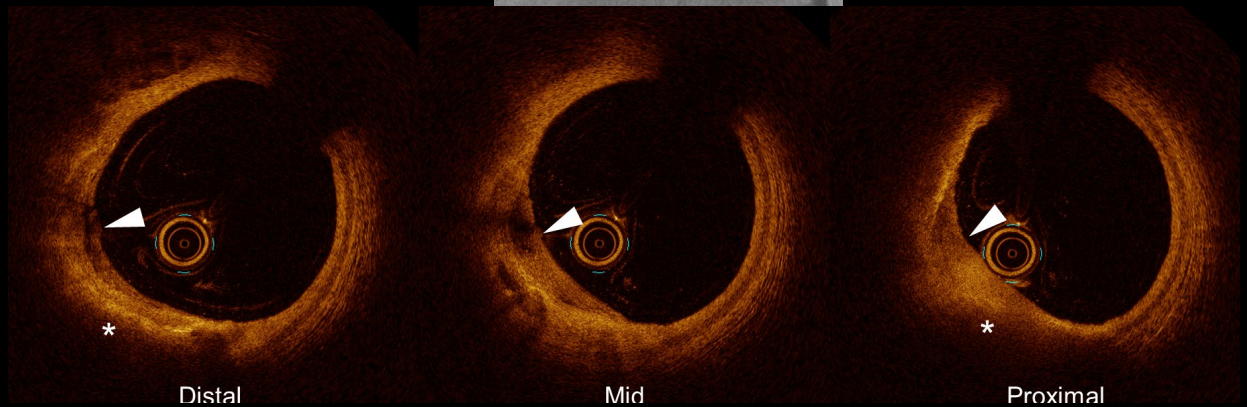

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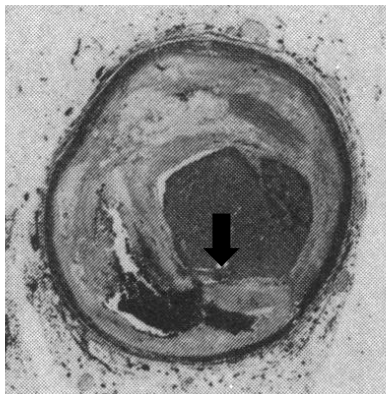
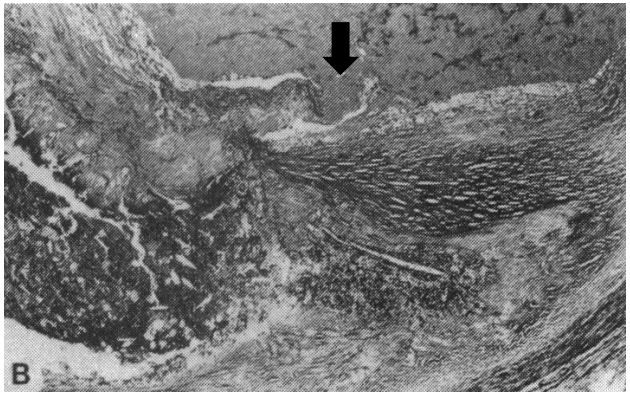
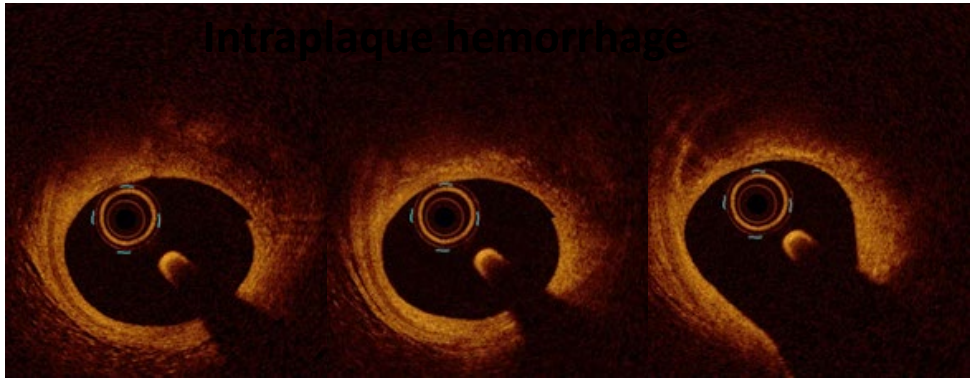
Autopsy findings in sudden death include intraplaque hemorrhage





49 pts with fatal IHD
76% men, age 42-87

63 of 103 ruptured plaques had IPH without luminal thrombus



In HARP, 89% of intraplaque hemorrhage cases were associated with CMR findings of ischemic injury

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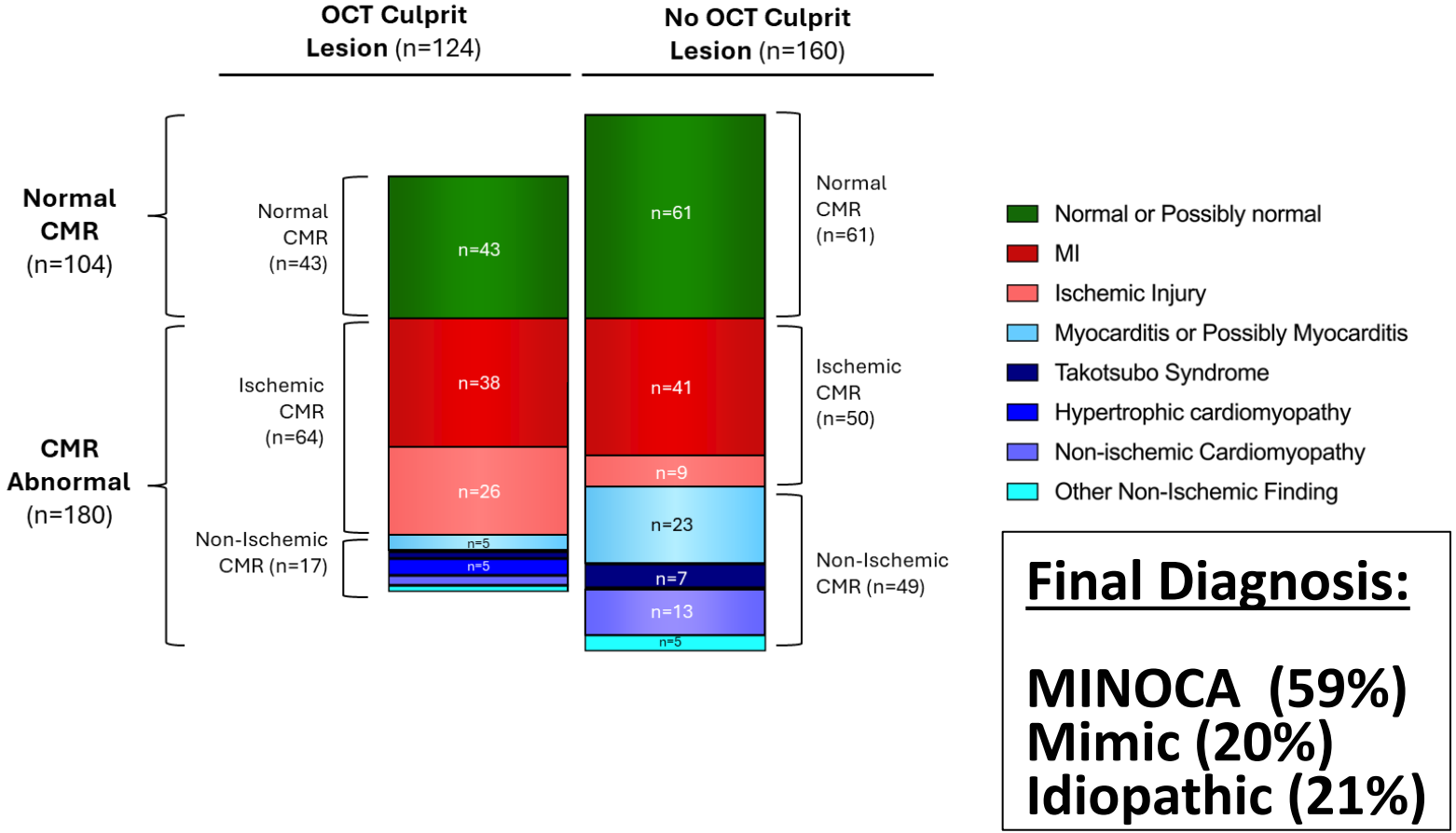
Falk E. Br Heart J 1983; 50:127-134; OCT from Reynolds HR, Maehara A et al Circ 2021. Slide courtesy of Akiko Maehara MD

OCT and CMR: complementary information (HARP n=284)



Final Diagnosis:

MINOCA (59%)
Mimic (20%)
Idiopathic (21%)

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HARP: Demographics, Presentation, OCT Imaging

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