



Muscoli papillari ed aritmie ventricolari: il ruolo della RM

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Left Ventricular Papillary Muscles: Clinical Relevance

1. Ischemic involvement

Papillary muscle ischemia or infarction may occur in ischemic heart disease.
Injury can be acute, chronic, or related to altered perfusion territories.

2. Ventricular Remodelling

Papillary muscle dysfunction can promote ischemic mitral regurgitation.
Valve–ventricle imbalance may contribute to adverse LV remodeling.

3. Non-ischemic disease

Involvement may occur in myocarditis and sarcoidosis.
Fatty metaplasia, calcification, and non-ischemic fibrosis can be observed.

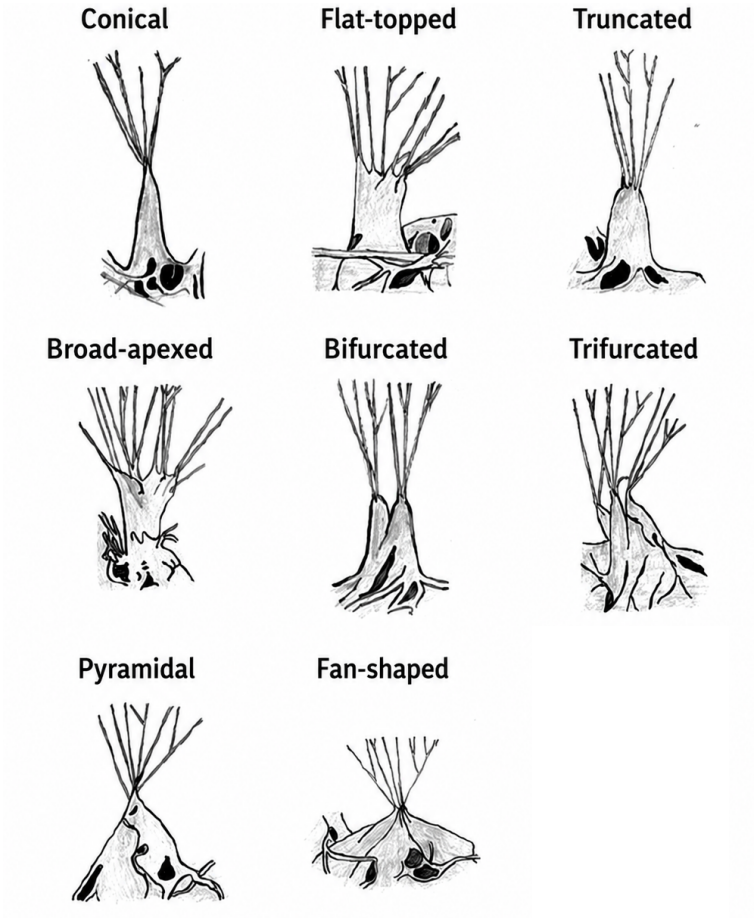
4. Arrhythmogenic substrate

Papillary muscles are often under-recognized in clinical cardiology.
Approximately 4–12% of ventricular tachycardias may arise from papillary muscles.

Shape of LV papillary muscles

	Papillary Muscle	Morphology	n	%
Papillary muscles of the left ventricle	Anterolateral papillary muscle (ALPM)	Conical	87	27.9%
		Flat-topped	11	3.5%
		Truncated	51	16.3%
		Bifurcated	11	3.5%
		Trifurcated	5	1.6%
		Broad-apexed	76	24.4%
		Pyramidal	46	14.7%
		Fan-shaped	25	8.0%
	Inferolateral papillary muscle (ILPM)	Conical	137	38.7%
		Flat-topped	9	2.5%
		Truncated	27	7.6%
		Bifurcated	26	7.3%
		Trifurcated	11	3.1%
		Broad-apexed	73	20.6%
		Pyramidal	37	10.5%
		Fan-shaped	34	9.6%

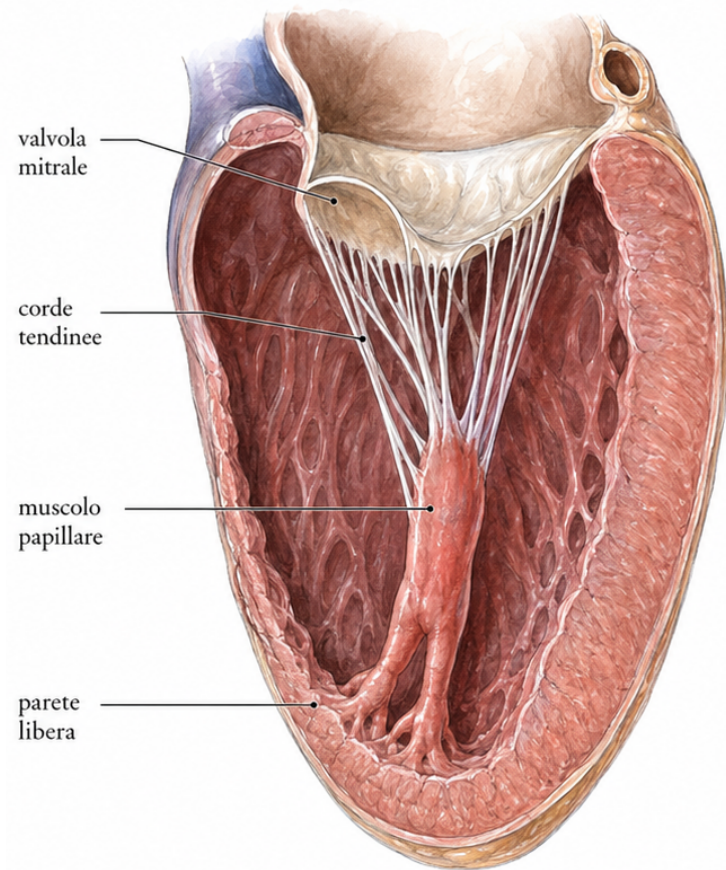
Series of unselected heart fixed in formalin



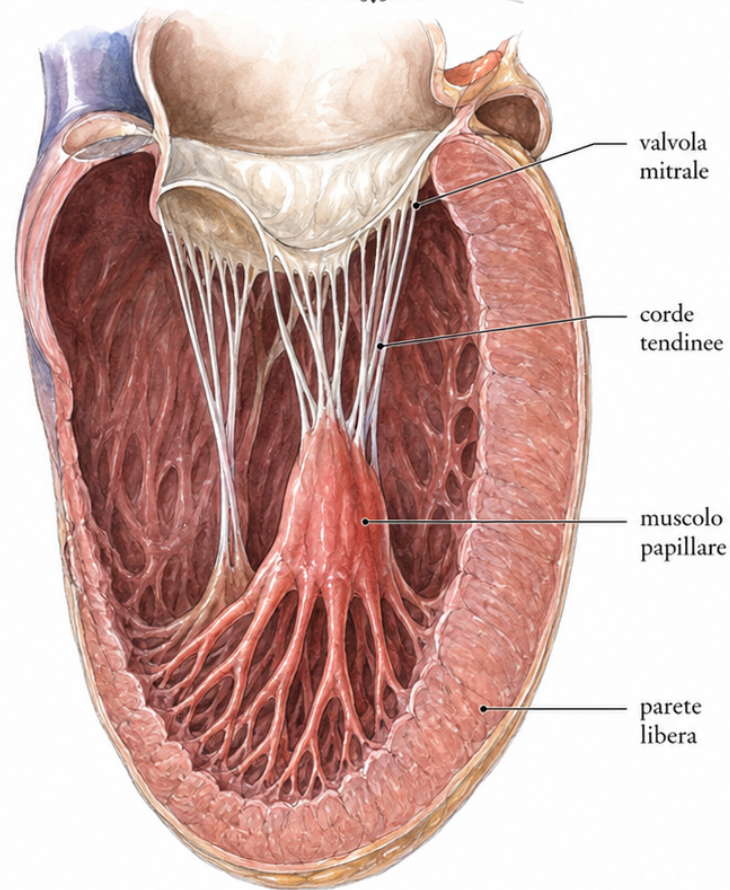
“finger”
or
“sequoia-like”



Attacco finger-like



Attacco mangrove-like



“tethered”
or
“mangroove-like”



Arterial supply of the left ventricular papillary muscles

AL papillary muscle (anterolateral)

Dual blood supply in 71%

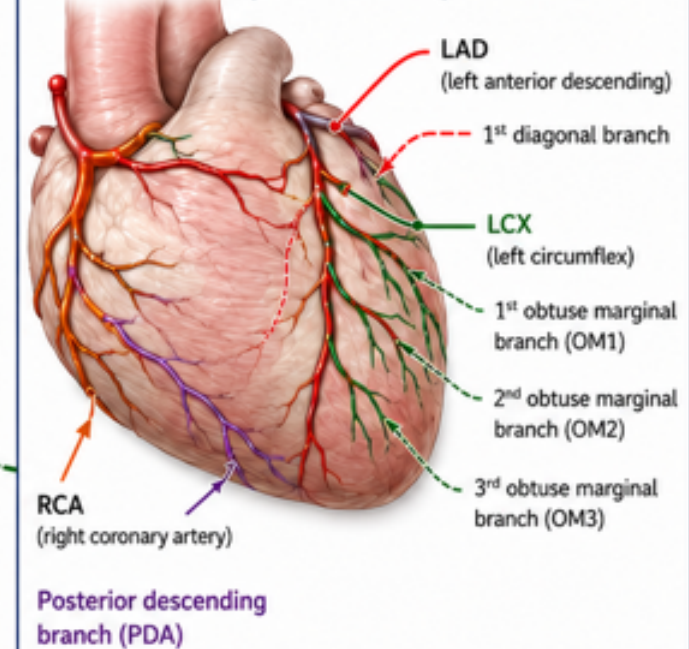
Receives blood supply from both the LCX (1st obtuse marginal branch) and the LAD (1st diagonal branch).

- From LCX via 1st obtuse marginal branch (OM1)
- From LAD via 1st diagonal branch

AL papillary muscle (anterolateral)

IL papillary muscle (inferolateral)

Epicardial coronary artery map (left ventricle)

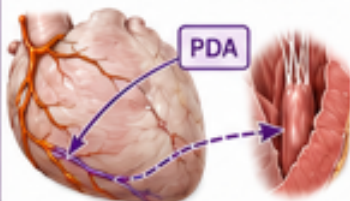


IL papillary muscle (inferolateral)

Single arterial supply in 63%

Right-dominant system

Supplied by the right coronary artery via the posterior descending branch (PDA).



OR

Left-dominant system

Supplied by the left circumflex artery (LCX), typically via the 2nd or 3rd obtuse marginal branch.



The papillary muscles are the last portion of the heart to be perfused and are therefore at high risk for ischemia

Separate branches are received for basal, mid-portion, and tips of the muscles

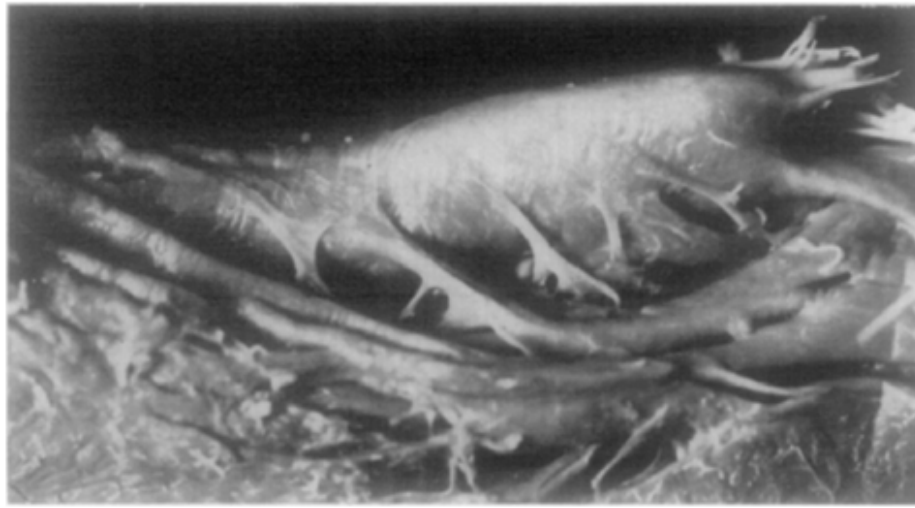


Fig. 1. Papillary muscle which is tightly bound to the ventricular wall by extensions of the trabeculae carneae. Most of the trabecular bridges contain vascular channels.

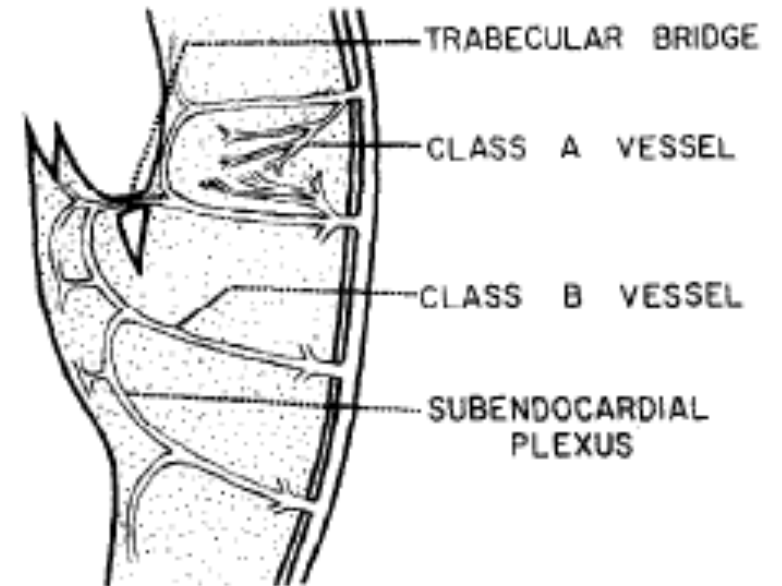
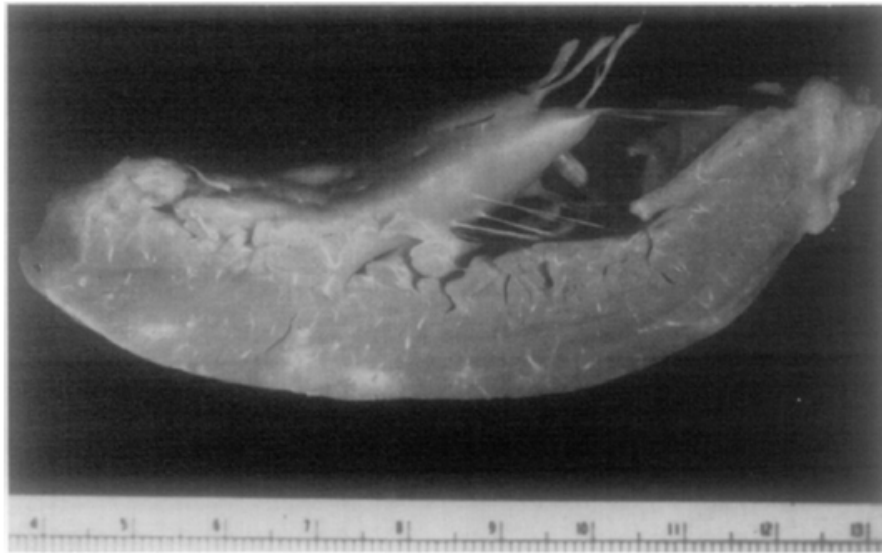


Fig. 2. Papillary muscle which is attached to the ventricular wall by muscular trabecular bridges and by fine thread-like bridges. The thin bridges may also contain vascular channels.

Papillary muscle disease

Morphological abnormalities:

Supernumerary papillaries

Apical insertion → associated with HCM

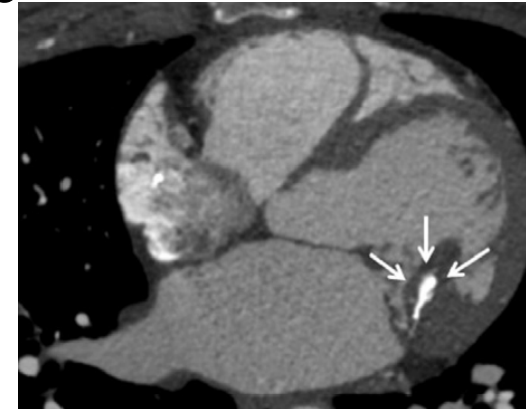
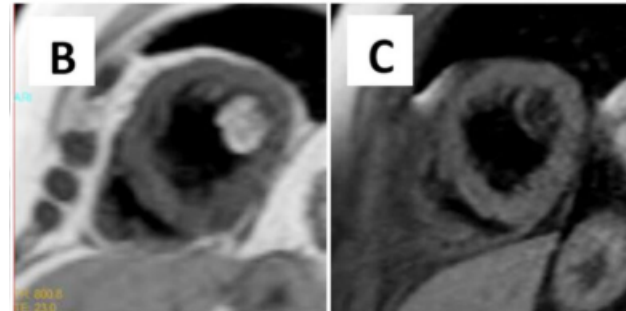
Dimensional abnormalities:

Papillary muscle hypertrophy → in HCM and Fabry disease

Tissue abnormalities:

LGE fibrosis, fat metaplasia edema and calcification

Papillary muscle tumors



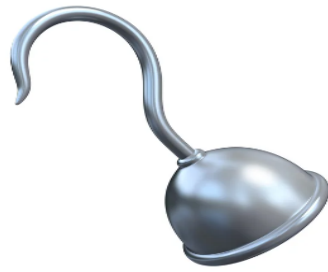
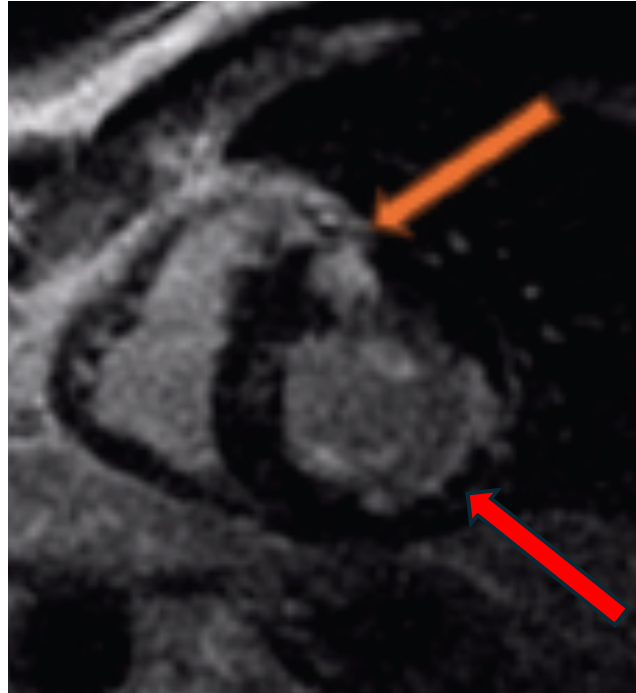
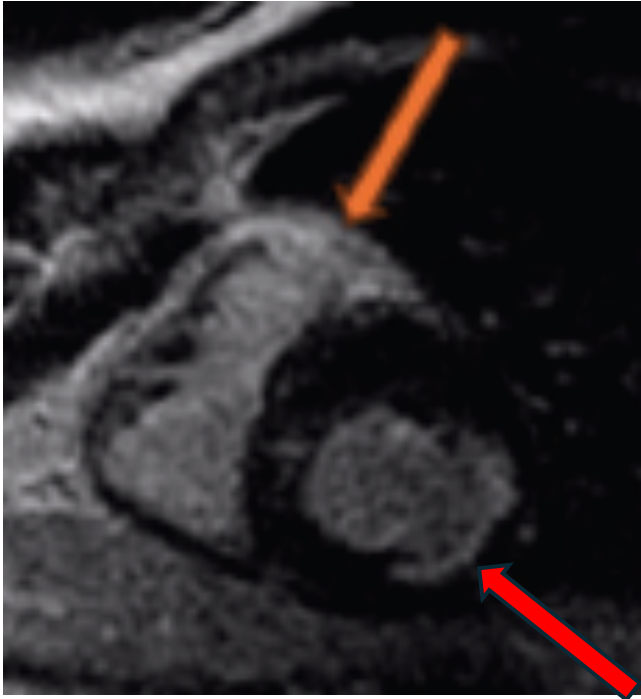
Cardiac Sarcoidosis

Different patterns of LGE:

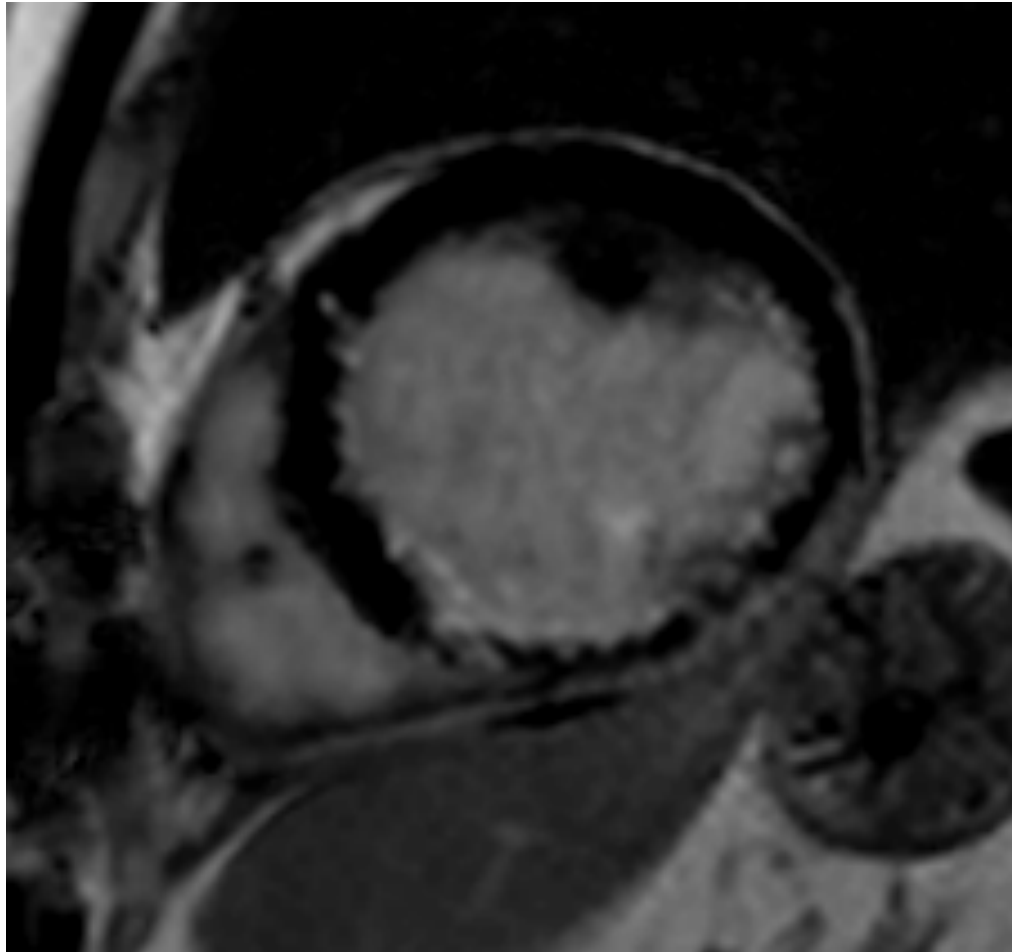
- Subendocardial lateral LGE
- Midwall anterior/septal
- RV involved in antero free wall
- Papillary muscles LGE



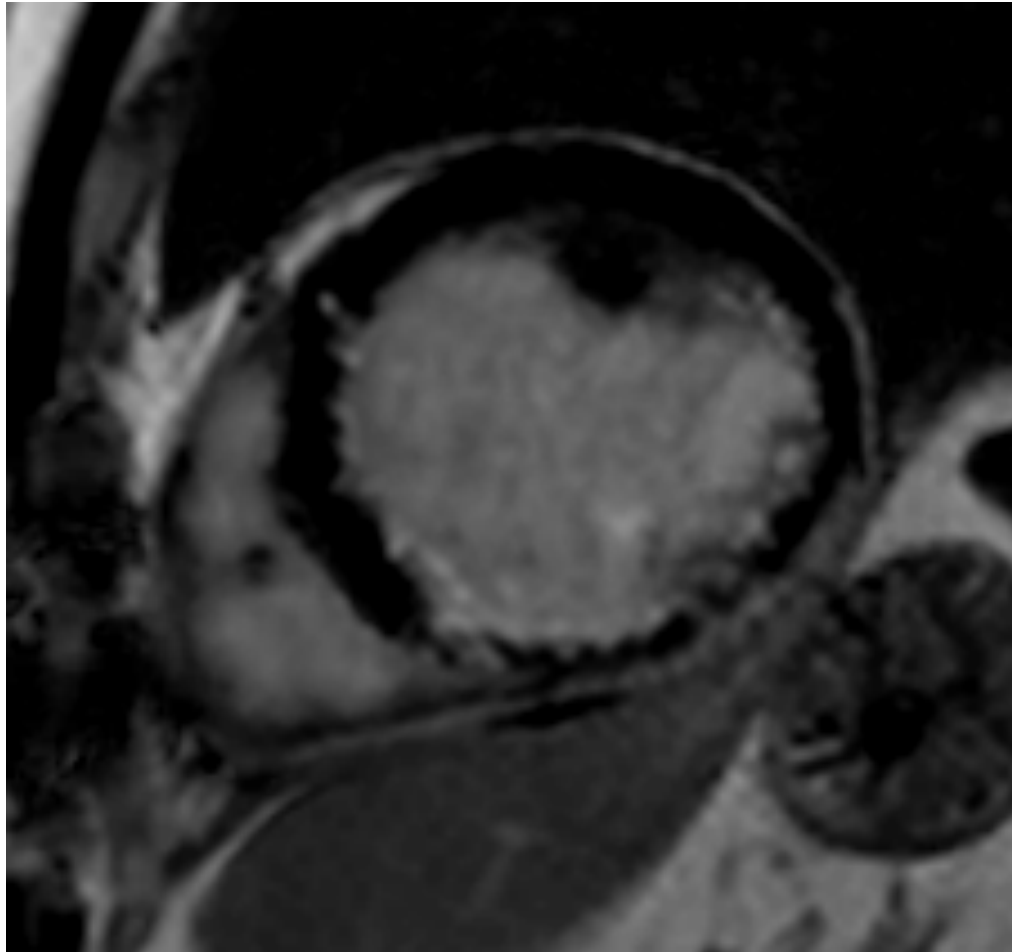
“The Great Mimicker”????



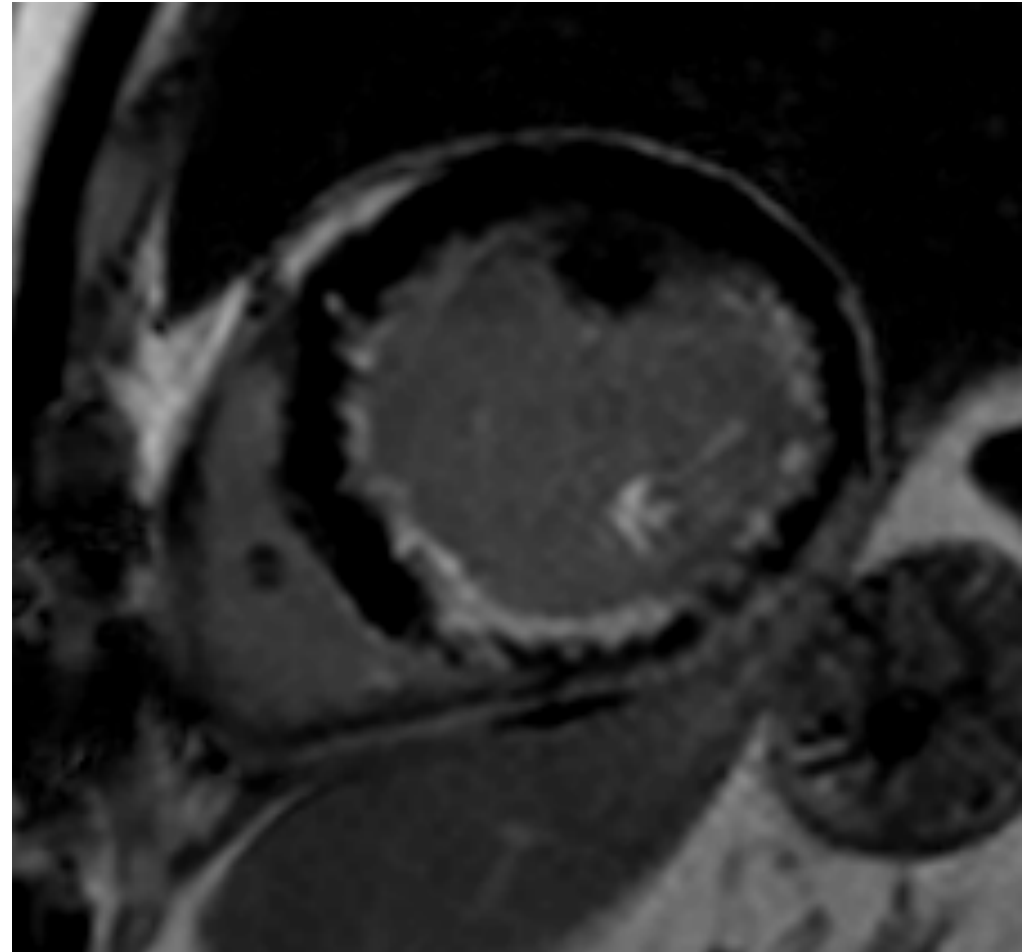
LGE at 10 minutes



LGE at 10 minutes

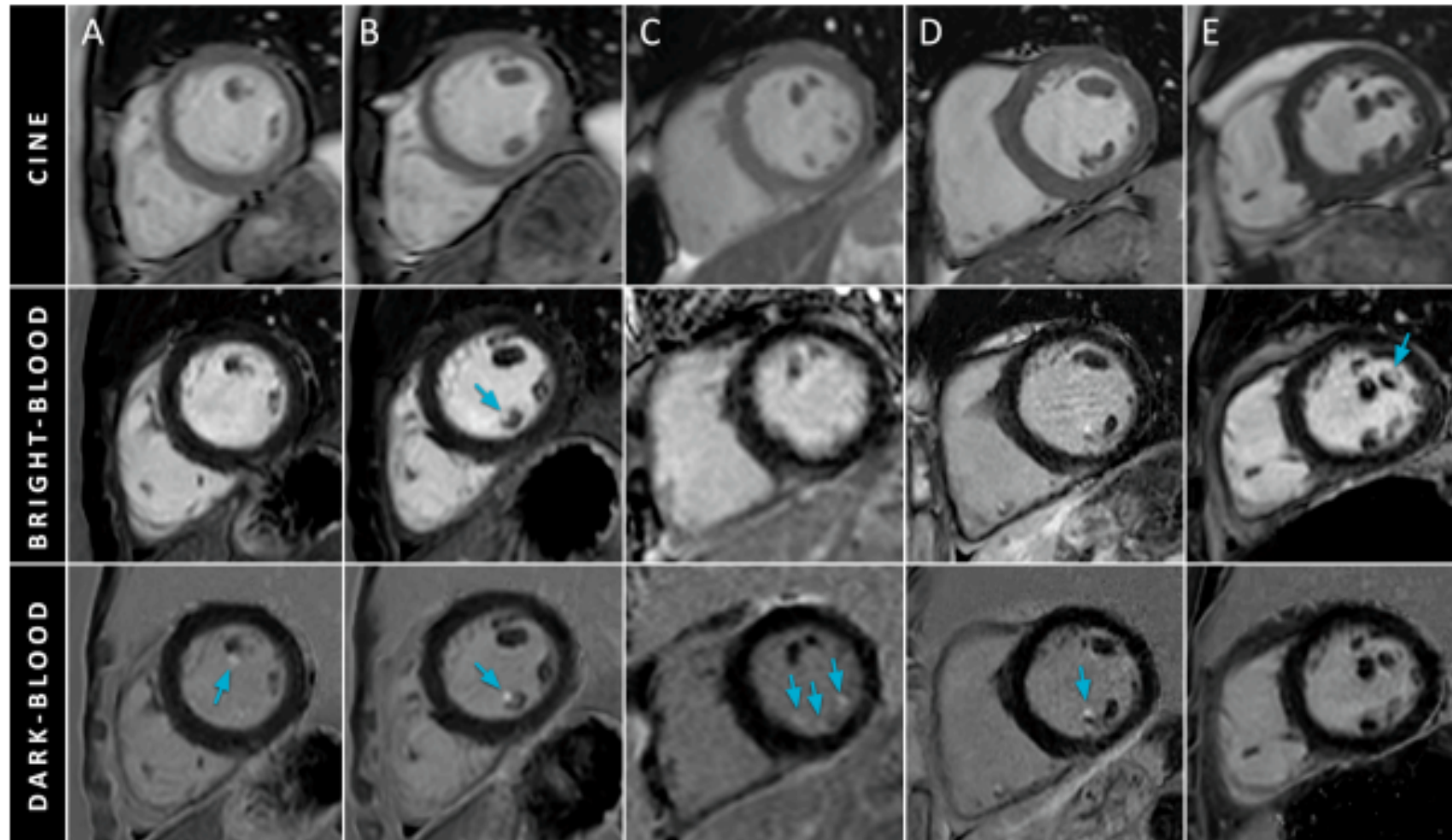


LGE at 20 minutes



Dark-blood late gadolinium enhancement CMR improves detection of papillary muscle fibrosis in patients with mitral valve prolapse

Caroline M. Van De Heyning^{a,b,*,1}, Robert J. Holtackers^{b,c,1}, Muhummad Sohaib Nazir^{b,d}, Julia Grapsa^d, Camelia Demetrescu^d, Lobke Pype^a, Amedeo Chiribiri^b



PSIR with TI to null blood pool

Prognostic Relevance of Papillary Muscle Infarction in Reperfused Infarction as Visualized by Cardiovascular Magnetic Resonance

738 patients with STEMI, CMR within 1 week from primary-PCI

LGE of papillary muscle in 104 patients (14%)

The presence of LGE of pap muscle was associated with:

- larger infarcts ($P<0.001$)
- less myocardial salvage ($P<0.001$)
- impaired left ventricular function ($P<0.001$)
- more pronounced reperfusion injury ($P=0.02$)

Patients with PapMI had a significantly higher mortality (8 [7.7%] versus 12 [1.9%]) and MACE (21 [20.2%] versus 31 [4.9%]) rate at 12-month follow-up ($P<0.001$, respectively)

PapMI was identified as a significant independent predictor of MACE (hazard ratio, 4.41 [95%CI 2.54-7.68] $P<0.001$).

BACKGROUND

DERIVATE-ICM International Registry

- Age ≥ 18 years
- Chronic HF & LVEF $< 50\%$
- Ischemic etiology

861 patients

Median follow up

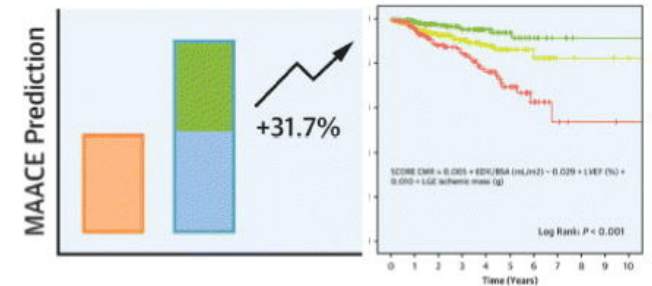
1,054 days

MAACE $\rightarrow$ 10.2%

DERIVATE-ICM Risk Score



LV EDV/BSA (mL/m²)
LVEF (%)
LGE scar mass (g)



POST-HOC ANALYSIS

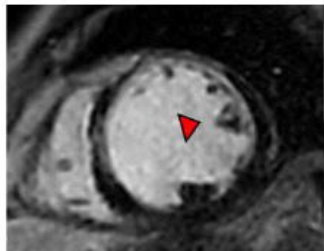
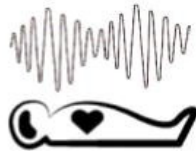
DERIVATE-ICM risk score : $0.005 + \text{EDV/BSA (mL/m}^2) - 0.029 + \text{LVEF (\%)} + 0.010 + \text{LGE scar mass (g)}$

Does the inclusion of papillary muscles LGE provide additional prognostic value for arrhythmic risk beyond the DERIVATE-ICM Risk Score?

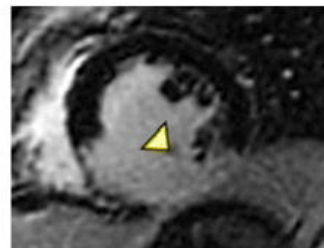
839 patients

1,054 days of follow up

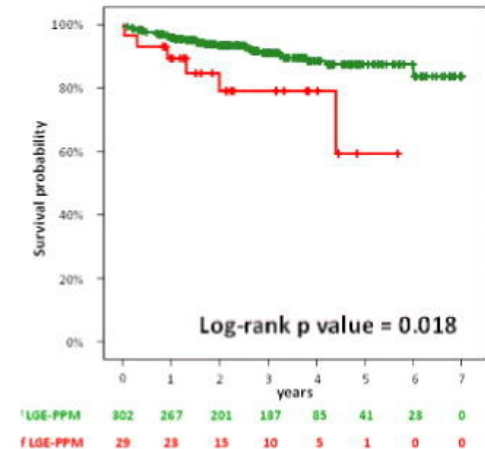
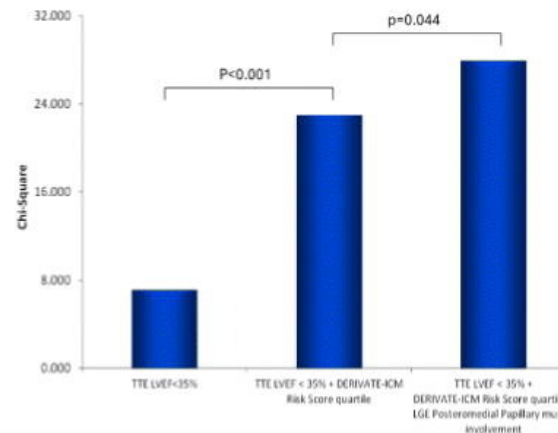
MAACE 9.7%



LGE – anterolateral
papillary muscle



LGE – posteromedial
papillary muscle (PPM)



In the intermediate quartiles of the DERIVATE-ICM Risk Score, the absence of LGE-PPM re-stratifies the arrhythmic risk downward

Importance of papillary muscle infarction detected by cardiac magnetic resonance imaging in predicting cardiovascular events

419 patients, mean age 62 years and 65% male.

CMR for:

- 1) assessment of myocardial viability (39%)
- 2) evaluation of cardiomyopathy (30%)
- 3) and valvular disease (12%).

232 (71%) had a diagnosis of ischemic cardiac disease

Characteristic	Papillary muscle infarct n = 204	No papillary muscle infarct n = 215	p value
Age (years)	64.7 ± 13	59.1 ± 17.6	<0.01
Male gender	143 (70%)	132 (61%)	0.06
<i>Past medical history</i>			
Diabetes	80 (39%)	57 (26%)	<0.01
Hypertension	152 (74%)	145 (67%)	0.11
Cigarette smoker	21 (10%)	22 (10%)	0.98
Hypercholesterolemia	130 (64%)	104 (48%)	<0.01
Renal disease	31 (15%)	27 (13%)	0.43
Myocardial infarction	93 (46%)	28 (13%)	<0.01
Congestive heart failure	110 (54%)	88 (41%)	<0.01
Cardiac valve disease	32 (16%)	38 (18%)	0.59
<i>CMR characteristics</i>			
Ischemic cardiomyopathy	165 (81%)	67 (31%)	<0.01
Non-ischemic cardiomyopathy	29 (14%)	120 (56%)	<0.01
Left ventricular ejection fraction (%)	36.2 ± 16.9	44.1 ± 15.6	<0.01
Presence of mitral regurgitation	138 (68%)	116 (54%)	<0.01

Multivariate cox regression analysis.

	HR (95% CI)	p value ^a
<i>Primary outcome</i>		
Postero-medial PMI	1.34 (0.92–1.95)	0.12
Antero-lateral PMI	0.82 (0.46–1.46)	0.5
Infarcts in both PMs	1.69 (1.01–2.86)	0.049
<i>All cause mortality</i>		
Postero-medial PMI	1.4 (0.79–2.48)	0.25
Antero-lateral PMI	1.34 (0.64–2.93)	0.42
Infarcts in both PMs	2.06 (1.01–4.2)	0.046
<i>Worsening heart failure</i>		
Postero-medial PMI	1.51 (0.96–2.37)	0.07
Antero-lateral PMI	0.56 (0.23–1.3)	0.19
Infarcts in both PMs	1.26 (0.6–2.66)	0.54

Papillary Muscle Delayed Hyperenhancement



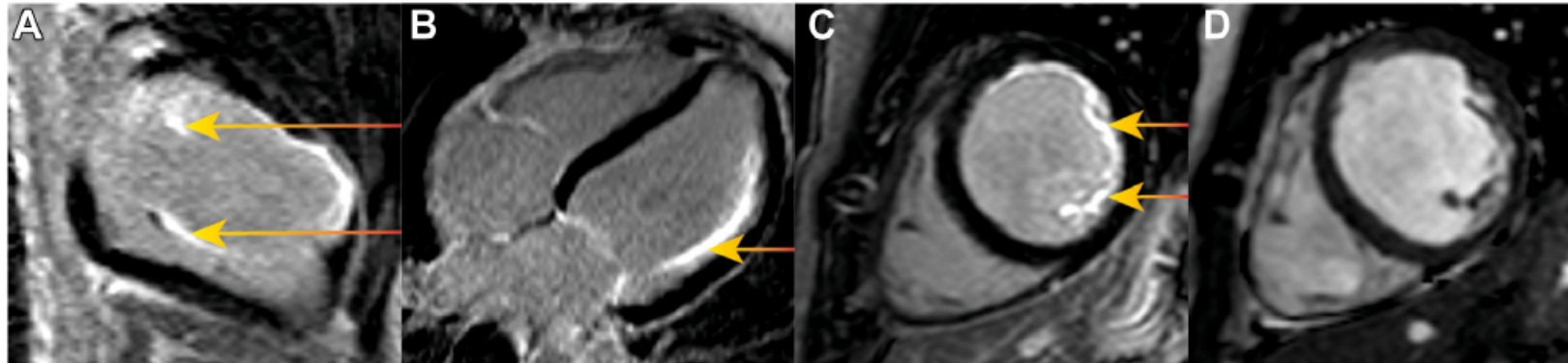
Prevalence and Clinical Implications in a Large Population With Dilated Cardiomyopathy

528 pts with non ischemic DCM

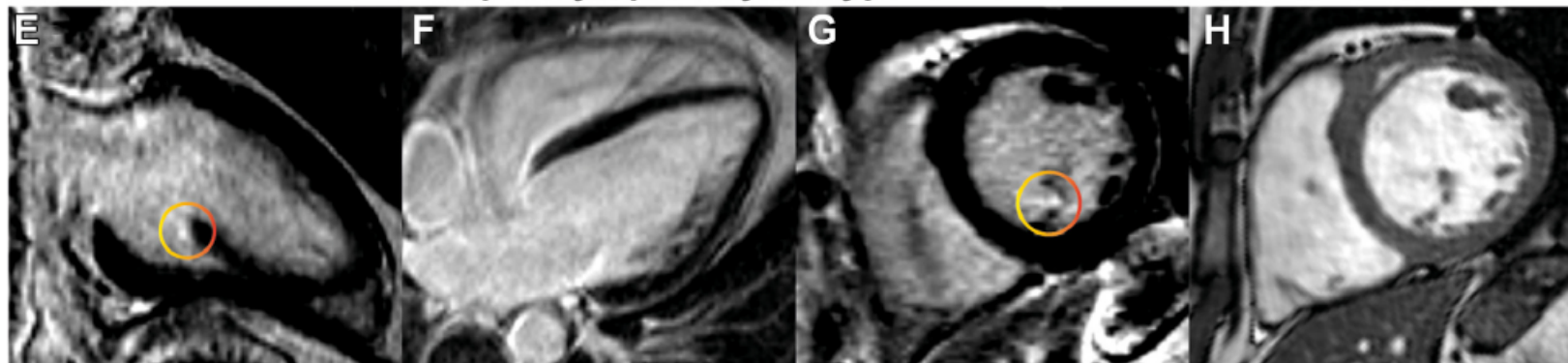
Papillary LGE was present in 131 patients (25%)

The median follow-up duration was 6.1 years (IQR: 3.7-9.7 years)

Complete papillary muscle delayed hyperenhancement



Papillary tip delayed hyperenhancement



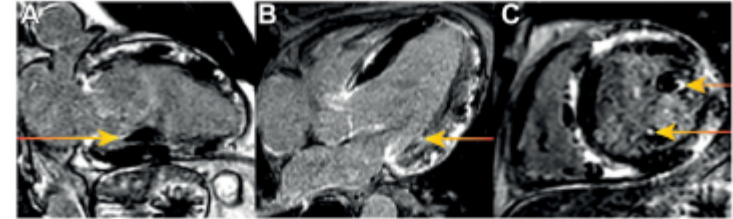
Papillary Muscle Delayed Hyperenhancement



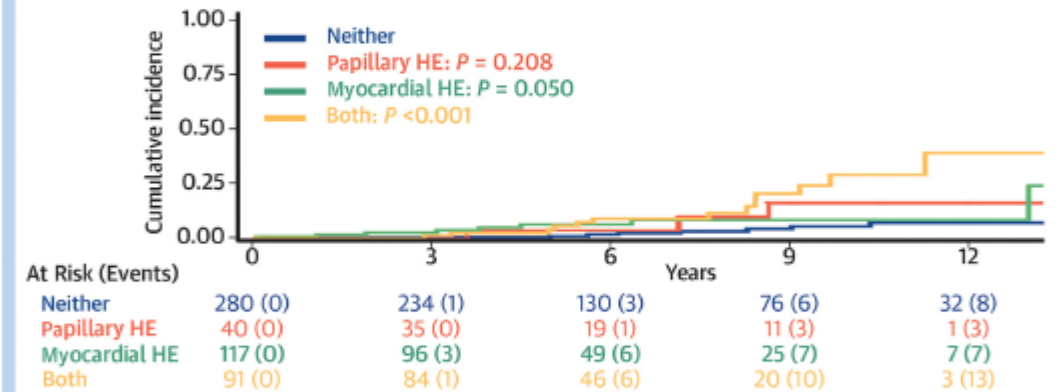
Prevalence and Clinical Implications in a Large Population With Dilated Cardiomyopathy

All-cause mortality			
Papillary HE	1.99 (0.80-4.90)	0.137	1.24 (0.49-3.11)
Myocardial HE	1.51 (0.75-3.07)	0.249	1.41 (0.69-2.87)
Papillary and myocardial HE	3.17 (1.74-5.77)	<0.001	2.33 (1.26-4.30)
Age	1.04 (1.02-1.07)	<0.001	1.03 (1.01-1.06)
Sex (female)	0.65 (0.37-1.14)	0.134	0.68 (0.38-1.19)
LV ejection fraction	0.96 (0.94-0.98)	<0.001	0.97 (0.95-0.99)
Sudden cardiac death			
Papillary HE	2.42 (0.65-8.95)	0.187	1.65 (0.44-6.27)
Myocardial HE	2.55 (0.98-6.63)	0.055	2.48 (0.94-6.50)
Papillary and myocardial HE	4.91 (2.09-11.53)	<0.001	3.77 (1.59-8.94)
Age	1.02 (0.99-1.04)	0.248	1.00 (0.97-1.03)
Sex (female)	0.45 (0.19-1.03)	0.059	0.47 (0.20-1.10)
LV ejection fraction	0.95 (0.92-0.98)	<0.001	0.96 (0.93-0.99)
Life-threatening arrhythmia			
Papillary HE	0.00 (0.00-xx) ^a	0.985	0.00 (0.00-xx) ^a
Myocardial HE	2.23 (0.68-7.30)	0.187	2.09 (0.63-6.93)
Papillary and myocardial HE	4.26 (1.37-12.33)	0.007	3.94 (1.34-11.58)
Age	0.99 (0.95-1.02)	0.390	0.98 (0.94-1.01)
Sex (female)	0.79 (0.30-2.07)	0.628	0.88 (0.33-2.37)
LV ejection fraction	0.96 (0.93-1.00)	0.048	0.96 (0.93-1.00)
Heart failure hospitalization			
Papillary HE	1.25 (0.28-5.58)	0.775	1.07 (0.23-4.94)
Myocardial HE	1.10 (0.39-3.12)	0.865	0.97 (0.34-2.79)
Papillary and myocardial HE	3.36 (1.50-7.52)	0.003	2.97 (1.30-6.80)
Age	1.01 (0.98-1.04)	0.516	1.00 (0.97-1.03)
Sex (female)	1.23 (0.60-2.52)	0.566	1.41 (0.68-2.91)
LV ejection fraction	0.96 (0.94-0.99)	0.011	0.97 (0.94-1.00)

Papillary muscle and myocardial delayed hyperenhancement



D Combined papillary muscle delayed hyperenhancement (papHE) and myocardial delayed hyperenhancement (HE) are associated with sudden cardiac death



E	Multivariable analysis, adjusting for age, sex, and LVEF	HR (95% CI)	P Value
PapHE		1.65 (0.44-6.27)	0.460
Myocardial HE		2.48 (0.94-6.50)	0.066
PapHE + myocardial HE		3.77 (1.59-8.94)	0.003

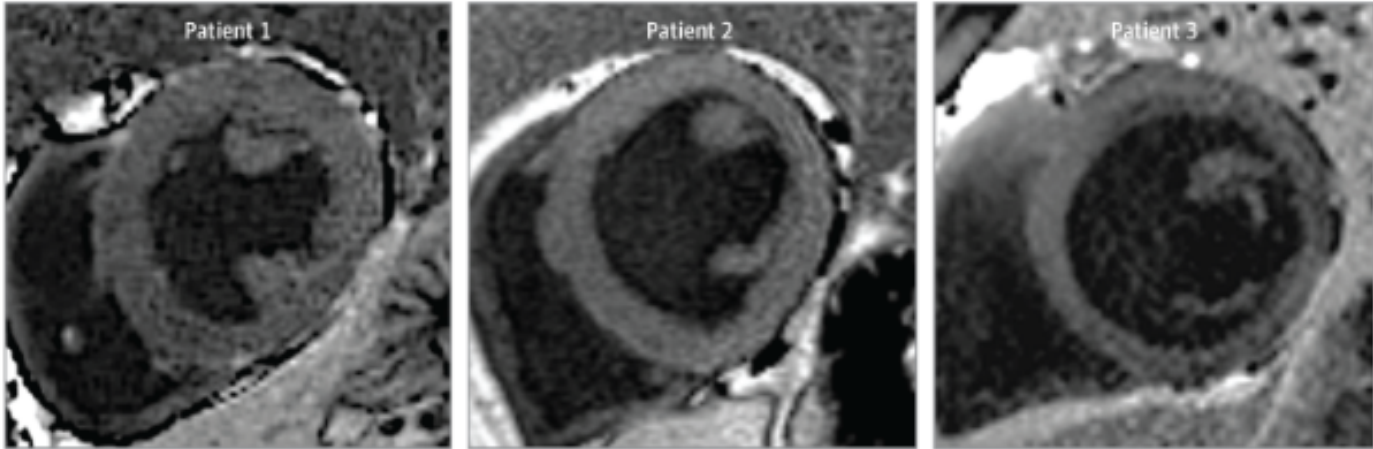
Prognostic Value of Papillary Muscle Scarring in Patients With Dilated Cardiomyopathy

Yodying Kaolawanich, MD; David C. Wendell, PhD; Han W. Kim, MD; Enn-ling Chen, PhD; Céleste Chevalier, MD; Piyapat Chunharas, MD; Michele A. Parker, MS; Raymond J. Kim, MD

Abstract | Full Text

470 patients (mean [SD] age, 55.3 [14.3] years; 205 female patients [43.6%]).

JAMA Cardiol. 2025; 10(12):1267-1275. 10.1001/jamacardio.2025.3822



B Papillary muscle scarring present

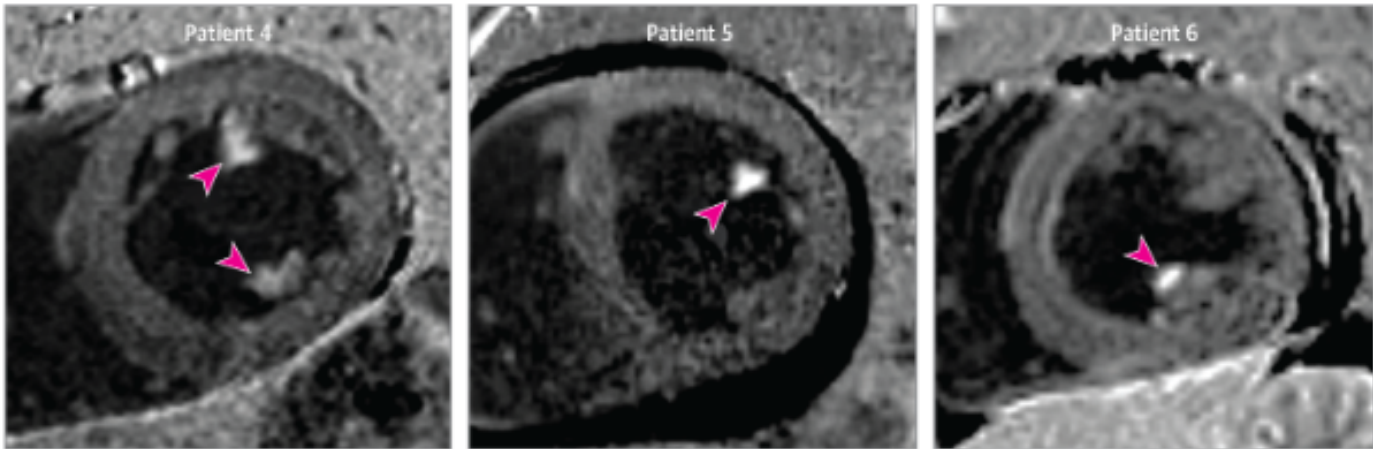
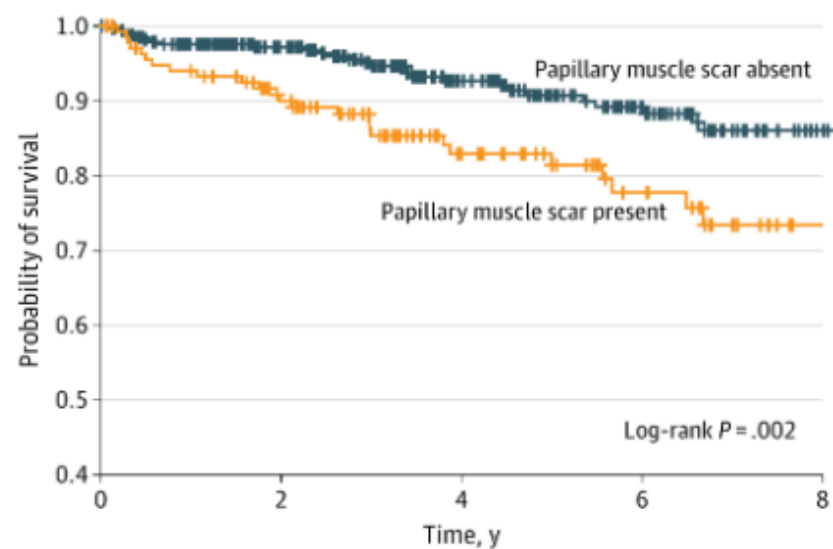


Table 1. Baseline Characteristics of Patients With Dilated Cardiomyopathy With and Without Papillary Muscle Scar

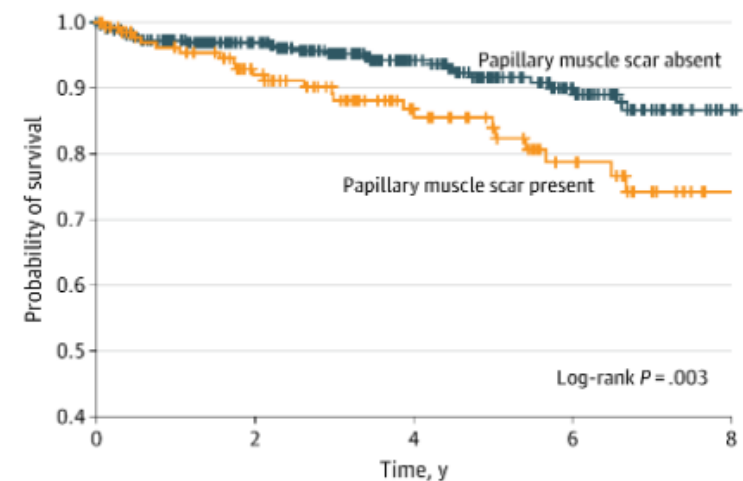
Characteristic	No. (%)			P value
	All (N = 470)	Papillary muscle scar Present (n = 137)	Absent (n = 333)	
Age, mean (SD), y	55.3 (14.3)	60.0 (12.7)	53.4 (14.4)	<.001 ^a
Sex				
Female	205 (43.6)	51 (37.2)	154 (46.2)	.07
Male	265 (56.4)	86 (62.8)	179 (53.8)	
Body mass index, mean (SD) ^b	30.5 (7.4)	29.6 (6.5)	30.8 (7.8)	.11
Blood pressure, mean (SD), mm Hg				
Systolic	126.3 (20.5)	125.4 (19.7)	126.6 (20.8)	.54
Diastolic	72.5 (13.0)	70.9 (12.1)	74.5 (13.3)	.01 ^a
Heart rate, mean (SD), beats/min	81.5 (17.2)	79.5 (16.2)	82.4 (17.5)	.11
Family history of DCM	5 (1.1)	2 (1.5)	3 (0.9)	.63
Paroxysmal atrial fibrillation	91 (19.4)	30 (21.9)	61 (18.3)	.37
Presyncope or syncope	36 (7.7)	9 (6.6)	27 (8.1)	.57
History of sustained VT or VF	2 (0.4)	0	2 (0.6)	.36
Coronary artery disease risk factors				
Hypertension	282 (60.0)	76 (55.5)	206 (61.9)	.20
Diabetes	107 (22.8)	40 (29.2)	67 (20.1)	.03 ^a
Hyperlipidemia	173 (36.8)	58 (42.3)	115 (34.5)	.11
Cigarette smoker	191 (40.6)	58 (42.3)	133 (39.9)	.63
NYHA functional class III-IV	115 (24.5)	38 (27.7)	77 (23.1)	.29
Electrocardiogram				
Left bundle branch block	101 (21.5)	35 (25.6)	66 (19.8)	.17
QRS complex widening (>120 ms)	122 (26.0)	43 (31.4)	79 (23.7)	.09
Medications				
ACE inhibitor or ARB	358 (76.7)	103 (75.2)	255 (77.3)	.63
Amiodarone	32 (6.9)	12 (8.8)	20 (6.1)	.29
Aspirin	221 (47.3)	62 (45.3)	159 (48.2)	.56
β-Blocker	363 (77.7)	110 (80.3)	253 (76.7)	.39
Calcium channel blocker	35 (7.5)	8 (5.8)	27 (8.2)	.38
Digoxin	23 (4.9)	8 (5.8)	15 (4.6)	.56
Loop diuretic	290 (62.1)	79 (57.7)	211 (63.9)	.20
Oral antidiabetic	63 (13.6)	27 (19.9)	36 (10.9)	.01 ^a
Spironolactone	154 (33.0)	41 (29.9)	113 (34.2)	.37
Statins	171 (36.6)	54 (39.4)	117 (35.5)	.42
Warfarin or DOAC	88 (18.8)	29 (21.2)	59 (17.9)	.41
CMR				
LV end diastolic volume index, mean (SD), mL/m ²	110.4 (33.4)	111.3 (31.9)	109.9 (34.1)	.68
LV end systolic volume index, mean (SD), mL/m ²	77.9 (33.2)	79.0 (33.2)	77.4 (33.1)	.63
LV ejection fraction, mean (SD), %	31.2 (10.5)	30.7 (11.0)	31.4 (10.3)	.52
Mitral regurgitation				
None	106 (22.6)	25 (18.2)	81 (24.3)	.32
Mild	286 (60.9)	92 (67.2)	194 (58.3)	
Moderate	72 (25.3)	18 (13.1)	54 (16.2)	
Severe	6 (1.3)	2 (1.5)	4 (1.2)	
LV mass index, mean (SD), g/m ²	102.6 (27.4)	105.0 (29.9)	101.5 (26.4)	.65
Midwall scar present	109 (23.2)	46 (33.6)	63 (18.9)	<.001 ^a
Midwall scar extent, median (IQR), % of LV mass ^c	2.7 (1.8-5.0)	2.8 (1.8-5.4)	2.6 (1.7-4.4)	.37

A Cardiac death



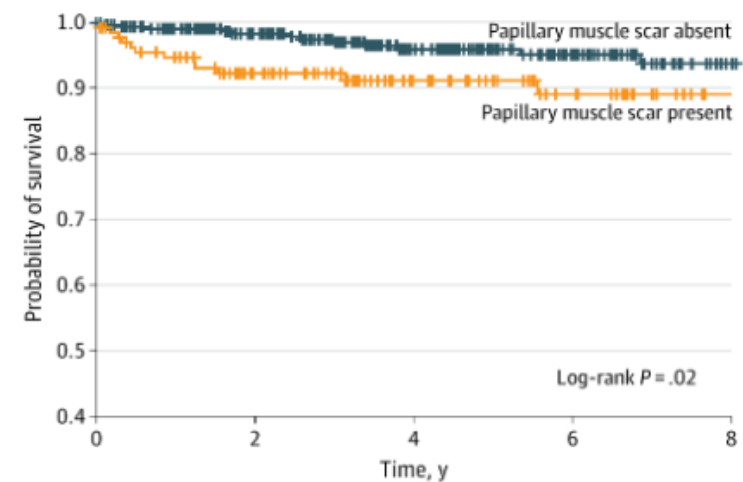
No. at risk					
Papillary muscle scar absent	333	247	159	95	44
Papillary muscle scar present	137	104	65	39	18

B Heart failure death or cardiac transplant



No. at risk					
Papillary muscle scar absent	333	247	159	95	44
Papillary muscle scar present	137	104	65	39	18

C SCD or aborted SCD



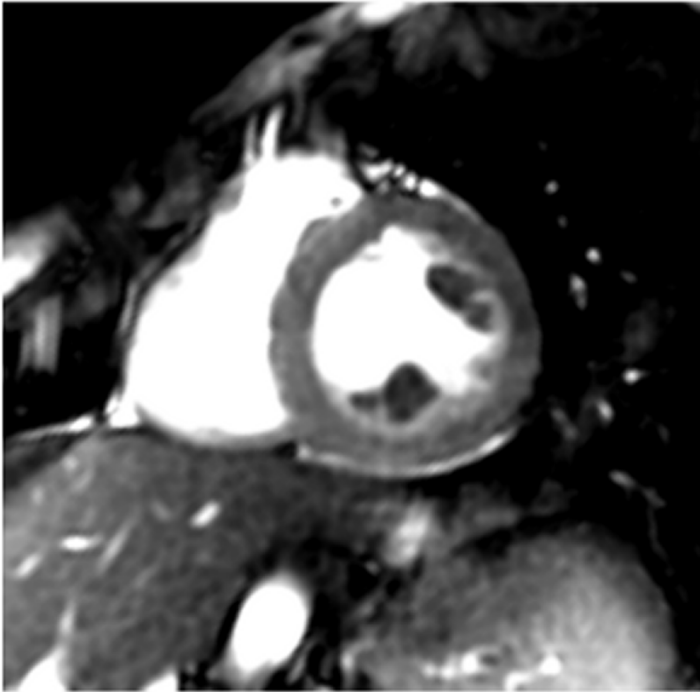
No. at risk					
Papillary muscle scar absent	333	251	162	98	44
Papillary muscle scar present	137	38	63	39	18

Table 3. Predictors of Cardiac Death

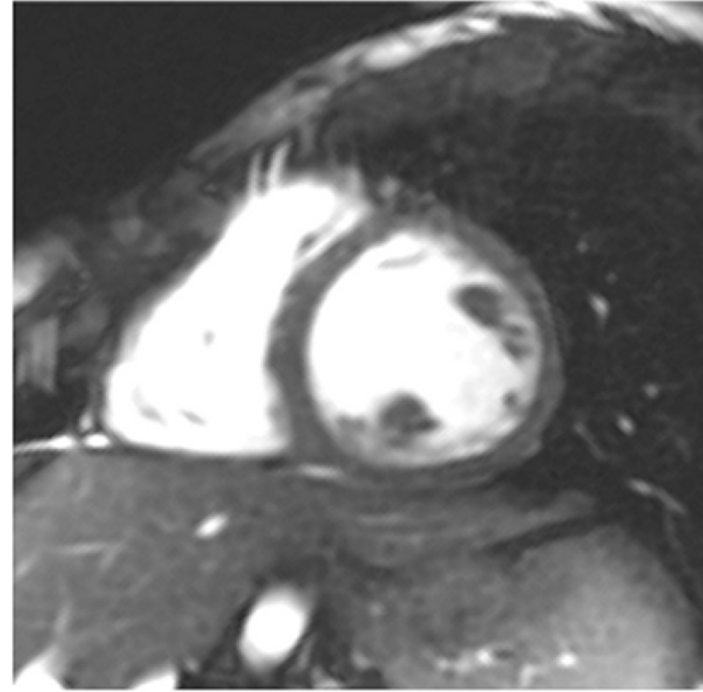
Predictor	Univariable analysis		Multivariable analysis			
	HR (95%CI)	P value	Model 1 ^a	P value	Model 2 ^b	P value
Age	1.03 (1.01-1.05)	.01 ^c	1.02 (1.003-1.05)	.02 ^c	NA	NA
Sex male	1.68 (0.94-2.99)	.08	NA	NA	NA	NA
Body mass index	0.99 (0.95-1.02)	.45	NA	NA	NA	NA
Systolic blood pressure	0.99 (0.98-1.01)	.24	0.99 (0.98-1.01)	.53	NA	NA
Diastolic blood pressure	0.99 (0.97-1.01)	.20	NA	NA	NA	NA
Heart rate	1.01 (0.99-1.02)	.44	1.006 (0.99-1.02)	.51	NA	NA
Family history of DCM	NA ^d	NA	NA	NA	NA	NA
Paroxysmal atrial fibrillation	2.26 (1.28-3.99)	.005 ^c	NA	NA	2.01 (1.13-3.55)	.02 ^c
Presyncope or syncope	1.80 (0.81-3.99)	.15	NA	NA	NA	NA
History of sustained VT or VF	5.07 (0.70-36.94)	.11	NA	NA	NA	NA
Hypertension	0.96 (0.56-1.66)	.88	NA	NA	NA	NA
Diabetes	1.47 (0.81-2.68)	.20	NA	NA	NA	NA
Hyperlipidemia	0.67 (0.37-1.22)	.19	NA	NA	NA	NA
Cigarette smoking	0.91 (0.52-1.60)	.75	NA	NA	NA	NA
NYHA functional class III-IV	3.56 (2.07-6.10)	<.001 ^c	NA	NA	2.98 (1.72-5.16)	<.001 ^c
Electrocardiogram						
Left bundle branch block	0.56 (0.27-1.20)	.14	NA	NA	NA	NA
QRS complex widening	0.95 (0.52-1.76)	.88	NA	NA	NA	NA
CMR						
LV end diastolic volume index	1.003 (0.99-1.01)	.48	NA	NA	NA	NA
LV end systolic volume index	1.006 (0.99-1.01)	.16	NA	NA	NA	NA
LV ejection fraction	0.97 (0.94-0.99)	.01 ^c	0.98 (0.95-1.005)	.10	NA	NA
LV mass index	1.02 (0.99-1.04)	.19	NA	NA	NA	NA
Midwall scar present	2.46 (1.43-4.24)	.001 ^c	1.84 (1.04-3.25)	.03 ^c	1.81 (1.04-3.17)	.03 ^c
Papillary muscle scar present	2.30 (1.34-3.95)	.002 ^c	1.86 (1.07-3.24)	.03 ^c	1.92 (1.11-3.32)	.02 ^c

'Dark' Papillary muscles in pts with VA

End-systole



End-diastole



P.O. 21 y Cardiac arrest during sport activity, no
LGE

Dark papillary muscles sign: a novel prognostic marker for cardiac magnetic resonance

Giovanni Donato Aquaro¹  · Carmelo De Gori¹ · Giulia Grilli² · Roberto Licordari³ · Andrea Barlison⁴ · Giancarlo Todiere⁴ · Umberto Ianni⁵ · Matteo Parollo¹ · Crysanthos Grigoratos⁴ · Luca Restivo² · Antonlo De Luca² · Lorenzo Fagglioni⁶ · Danla Cloni¹ · Gianfranco Sinagra² · Gianluca Di Bella³ · Emanuele Neri⁶

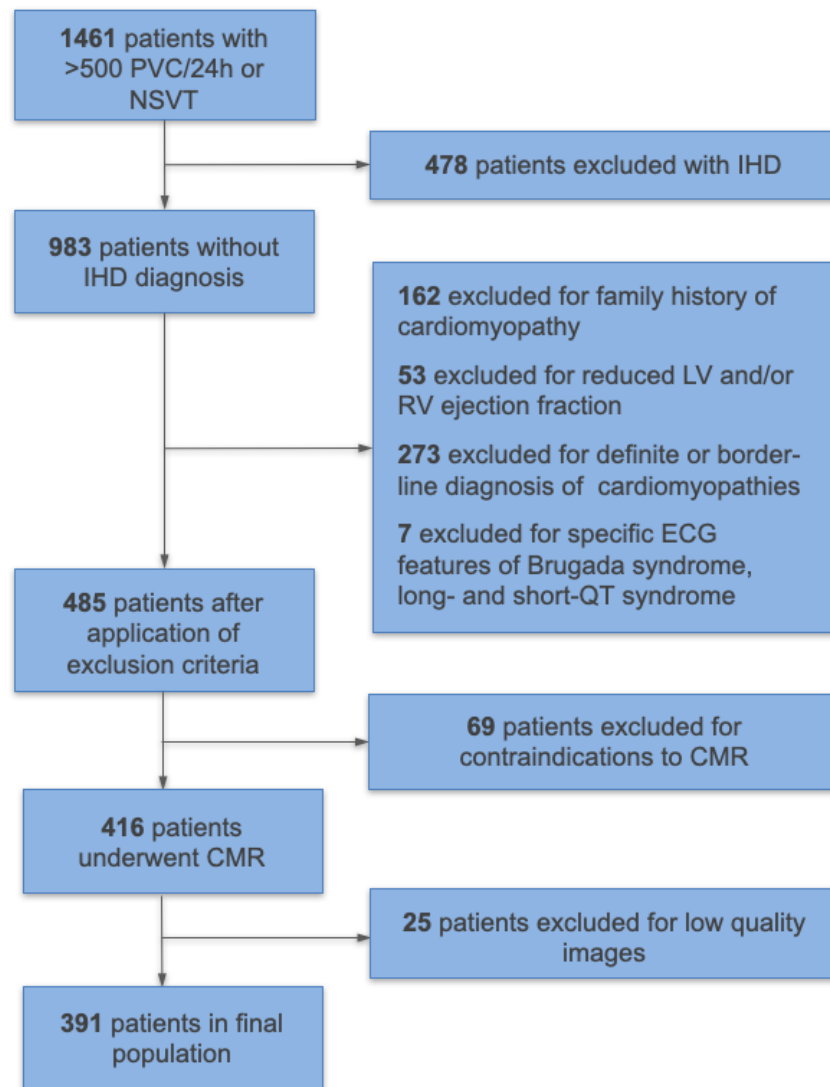
Abstract

Objectives The prognostic role of left ventricular (LV) papillary muscle abnormalities in patients with preserved LV systolic ejection fraction (LVEF) is unknown. We sought to evaluate the prognosis role of LV papillary muscle abnormalities by CMR in patients with ventricular arrhythmias, preserved LVEF with no cardiac disease.

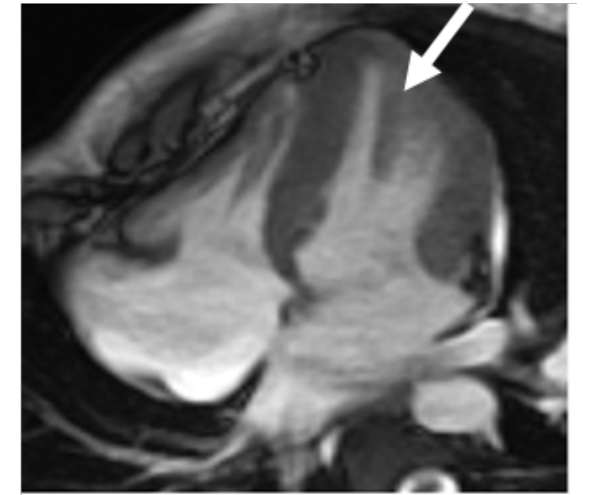
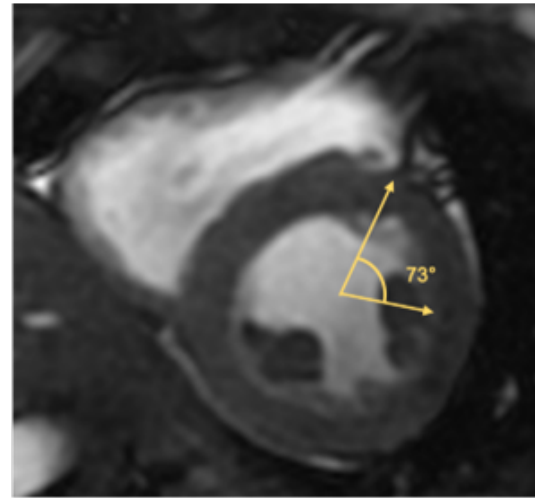
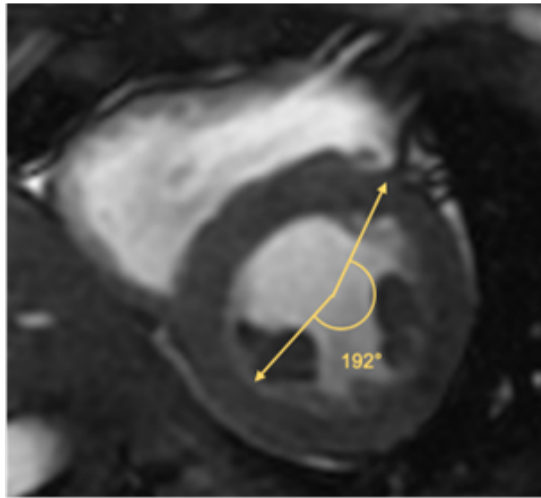
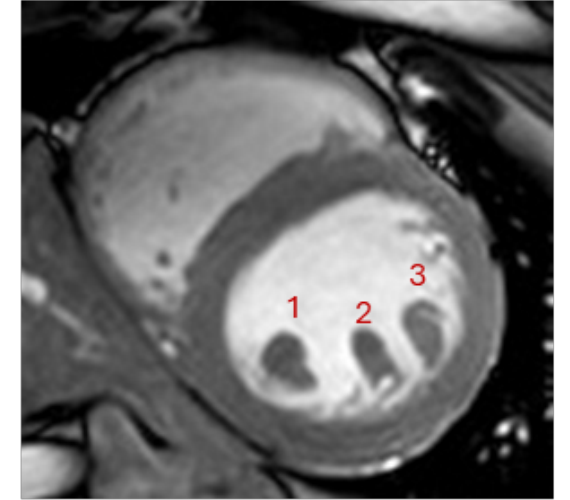
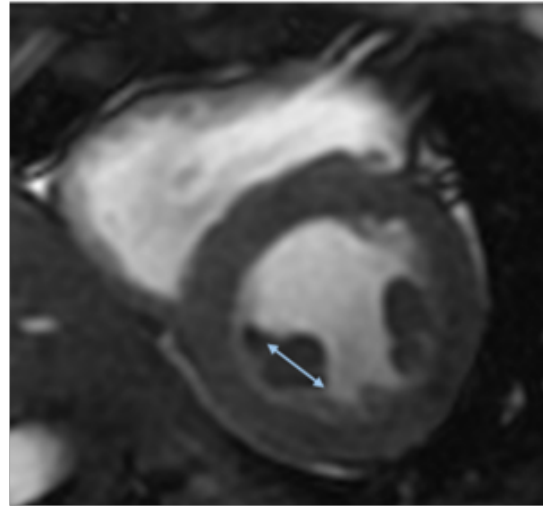
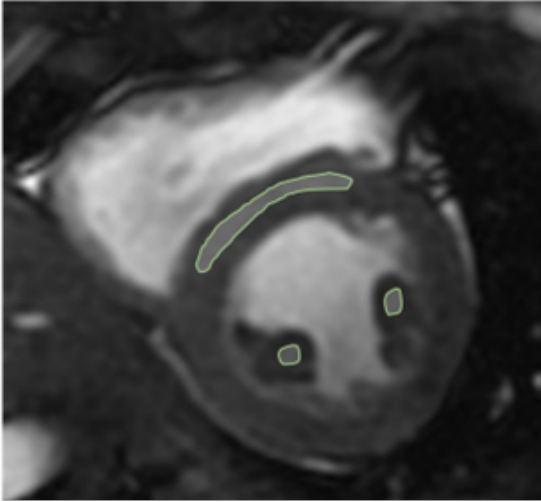
Methods A total of 391 patients with > 500/24 h premature ventricular complexes and/or with non-sustained ventricular tachycardia (NSVT), preserved LVEF, and no cardiac disease were enrolled. Different features of LV papillary muscles were considered: supernumerary muscles, papillary thickness, the attachment, late gadolinium enhancement (LGE). Dark-Paps was defined as end-systolic signal hypointensity of both papillary muscles in early post-contrast cine CMR images. Mitral valve prolapse, mitral annular disjunction (MAD), and myocardial LGE were considered.

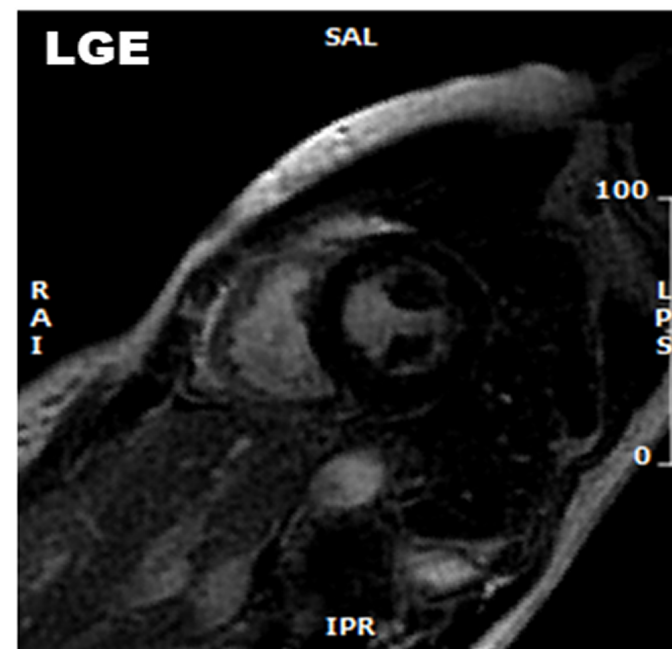
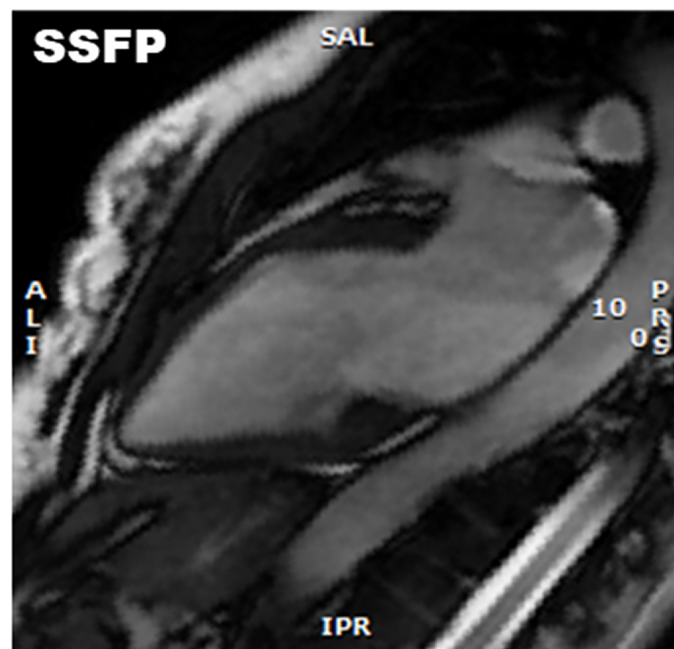
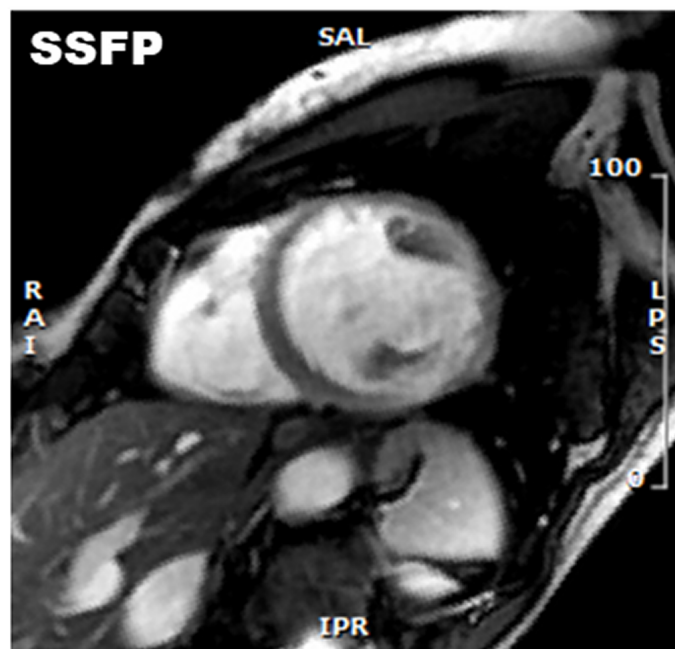
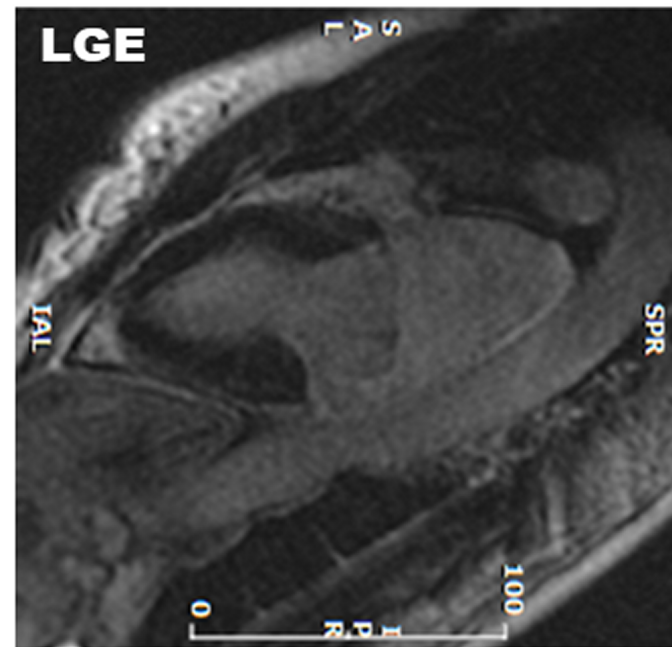
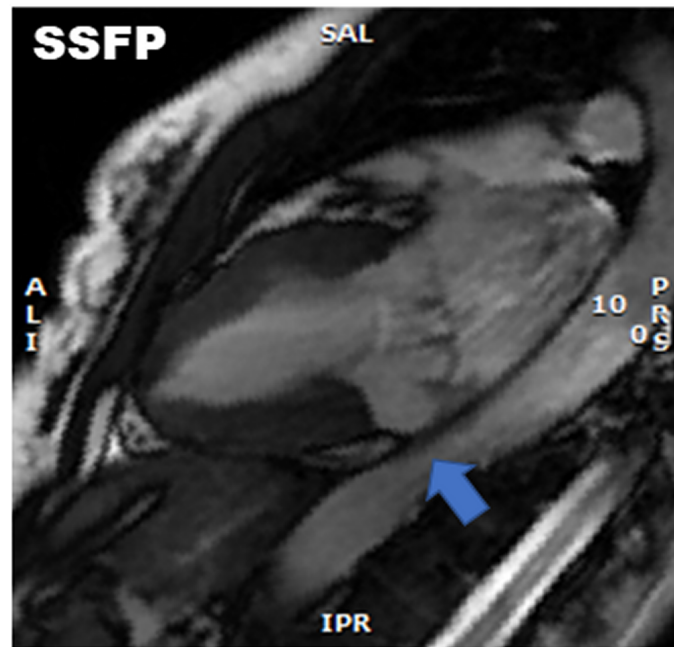
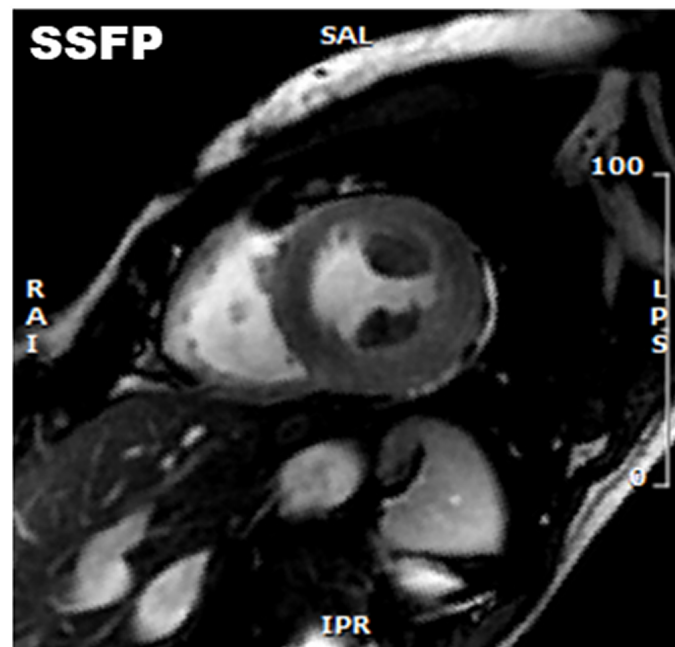
Results Dark-Paps was found in 79 (20%) patients and was more frequent in females. It was associated with higher prevalence of mitral valve prolapse and MAD. During a median follow-up of 2534 days, 22 hard cardiac events occurred. At Kaplan-Meier curve analysis, patients with Dark-Paps were at higher risk of events than those without ($p < 0.0001$). Dark-Paps was significantly associated with hard cardiac events in all the multivariate models. Dark-Paps improved prognostic estimation when added to NSVT ($p = 0.0006$), to LGE ($p = 0.005$) and to a model including NSVT+LGE ($p = 0.014$). Dark-Paps allowed a significant net reclassification when added to NSVT (NRI 0.30, $p = 0.03$), to LGE (NRI 0.25, $p = 0.04$), and to NSVT + LGE (NRI 0.32, $p = 0.02$).

Conclusions In LV papillary muscles, Dark-Paps is a novel prognostic marker in patients with ventricular arrhythmias and preserved ejection fraction.

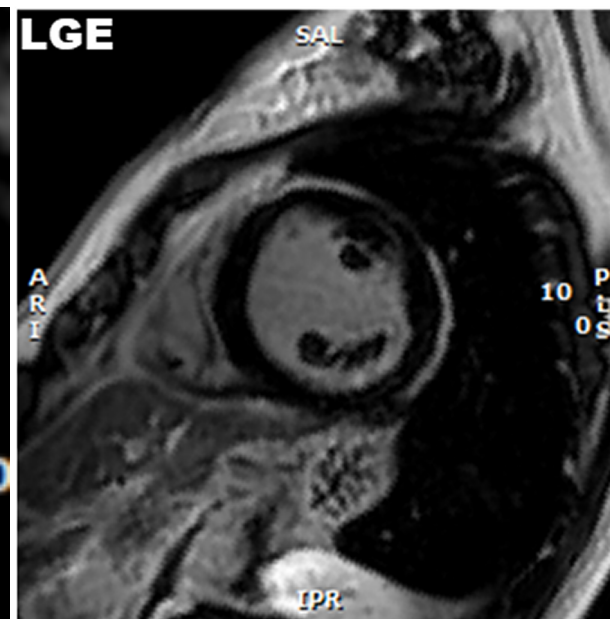
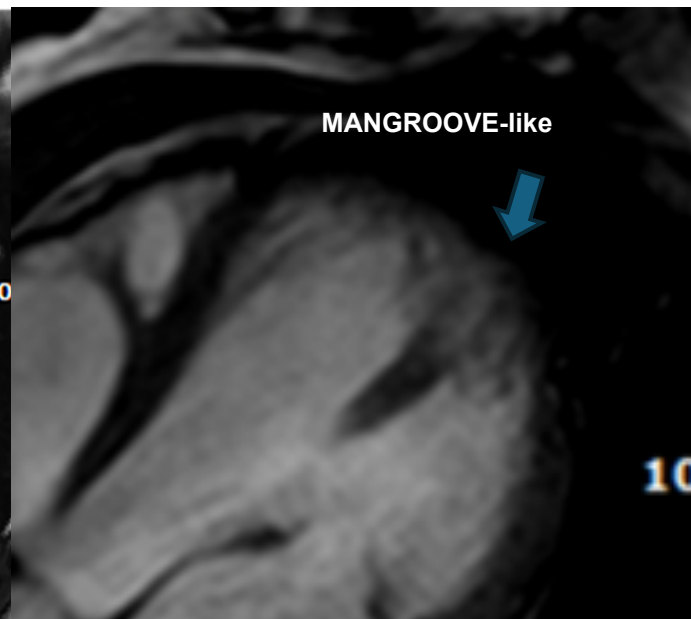
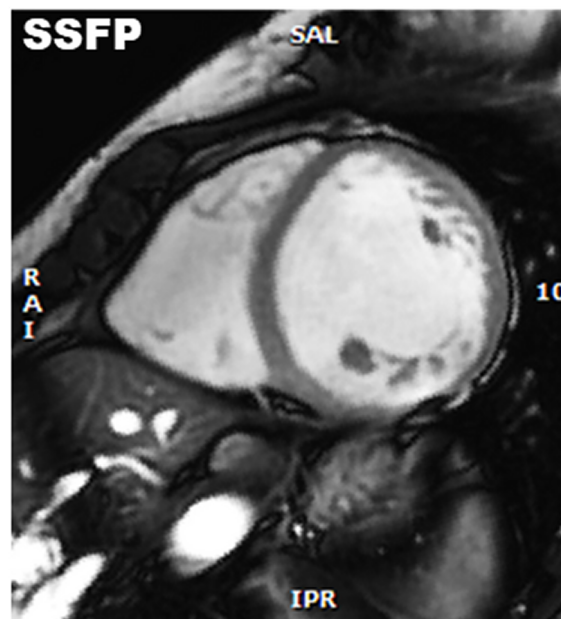
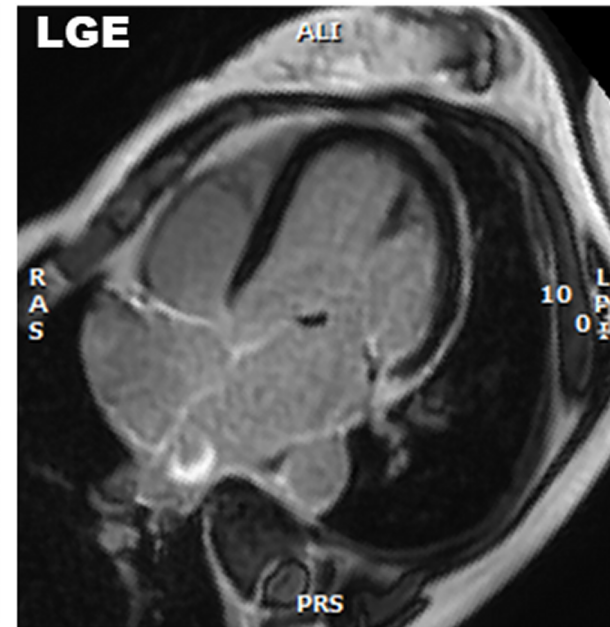
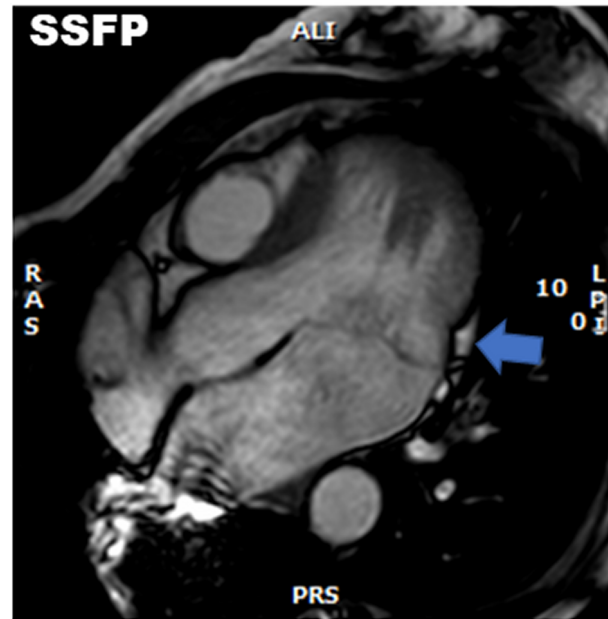
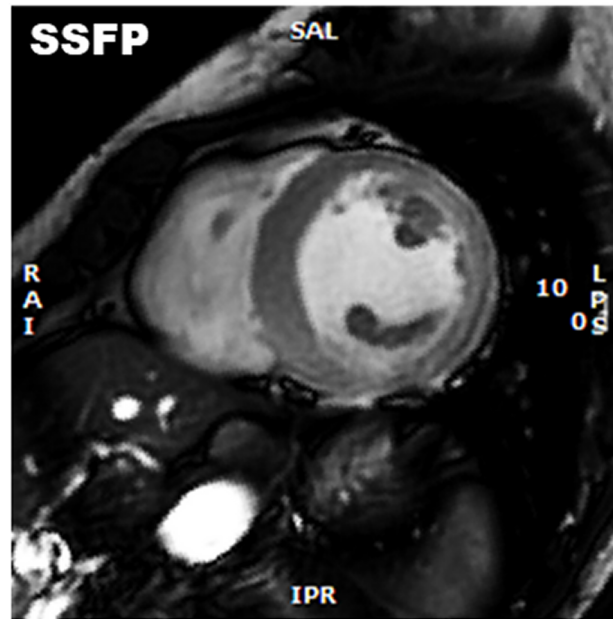


Papillary muscle parameters





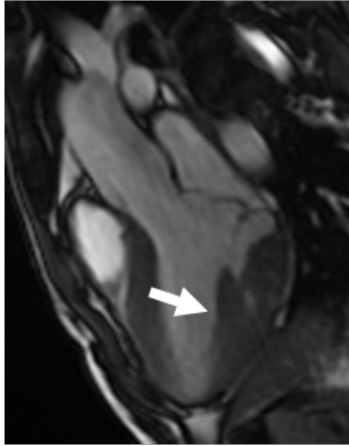
End-systolic 'Dark' Papillary muscles



'Dark' Papillary muscles was associated with mangroove-like attachment, MAD, and LGE

Attachement of papillary muscles

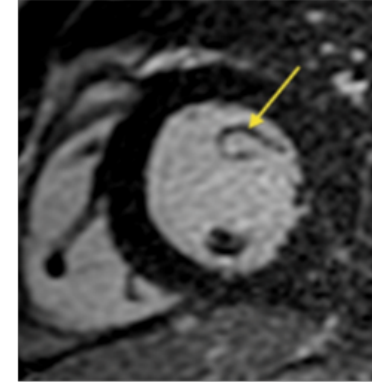
A)



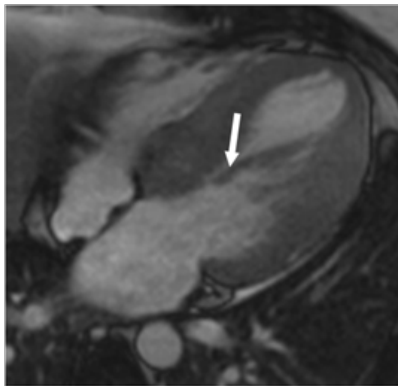
“finger”
or
“sequoia-like”



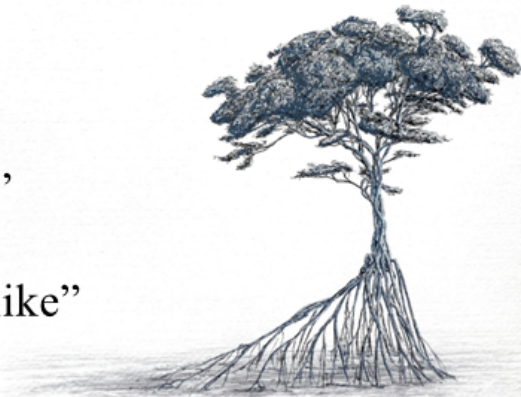
Fibrosis of papillary muscle



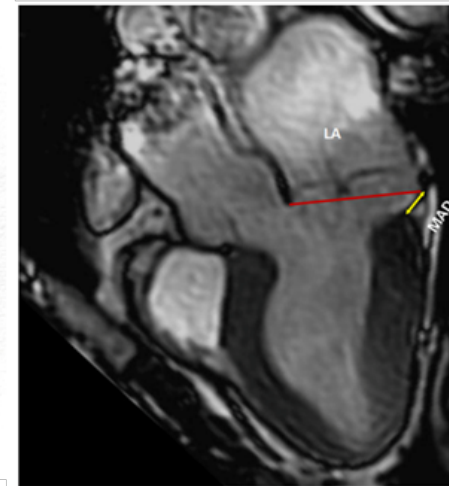
B)



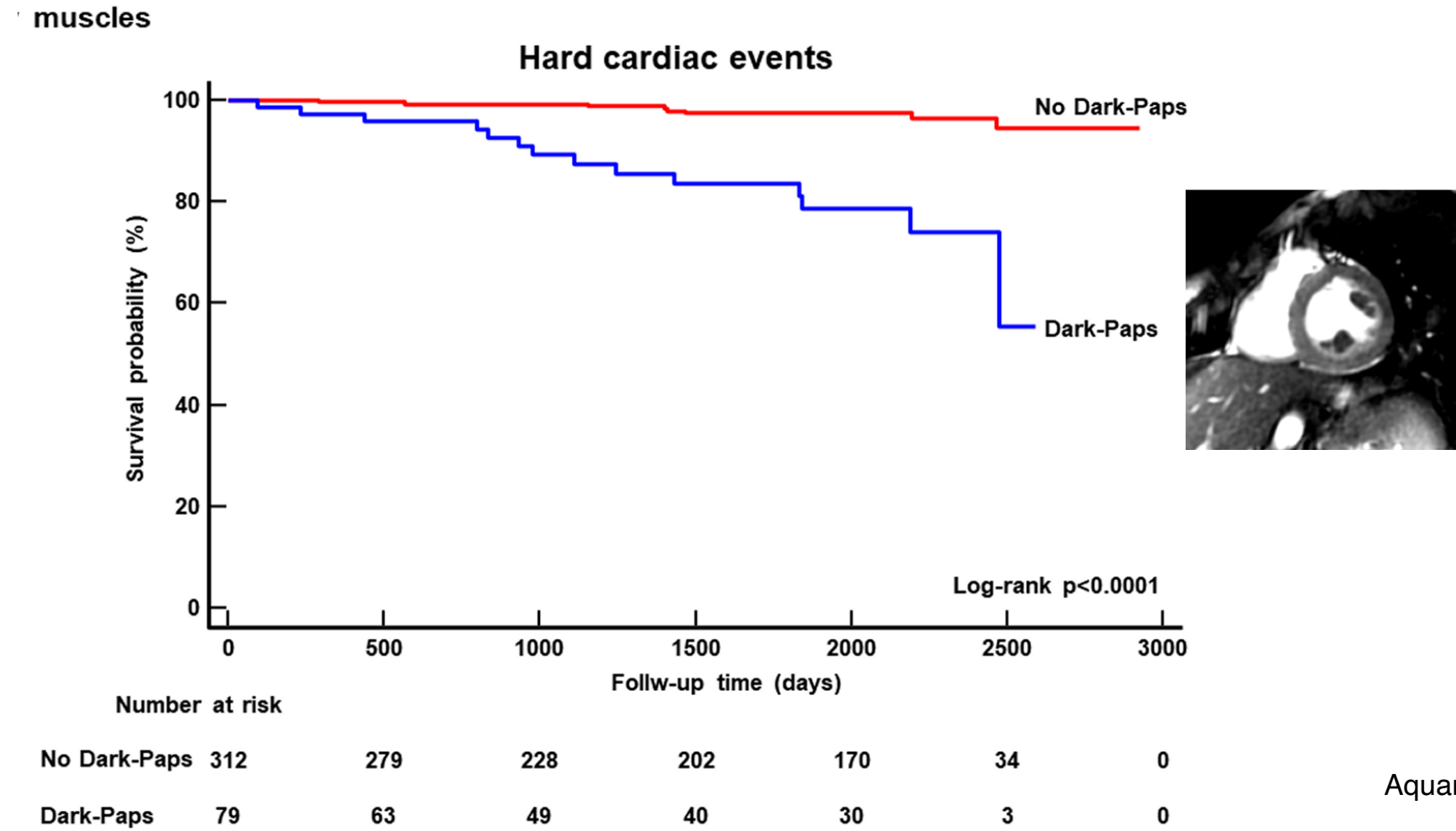
“tethered”
or
“mangroove-like”



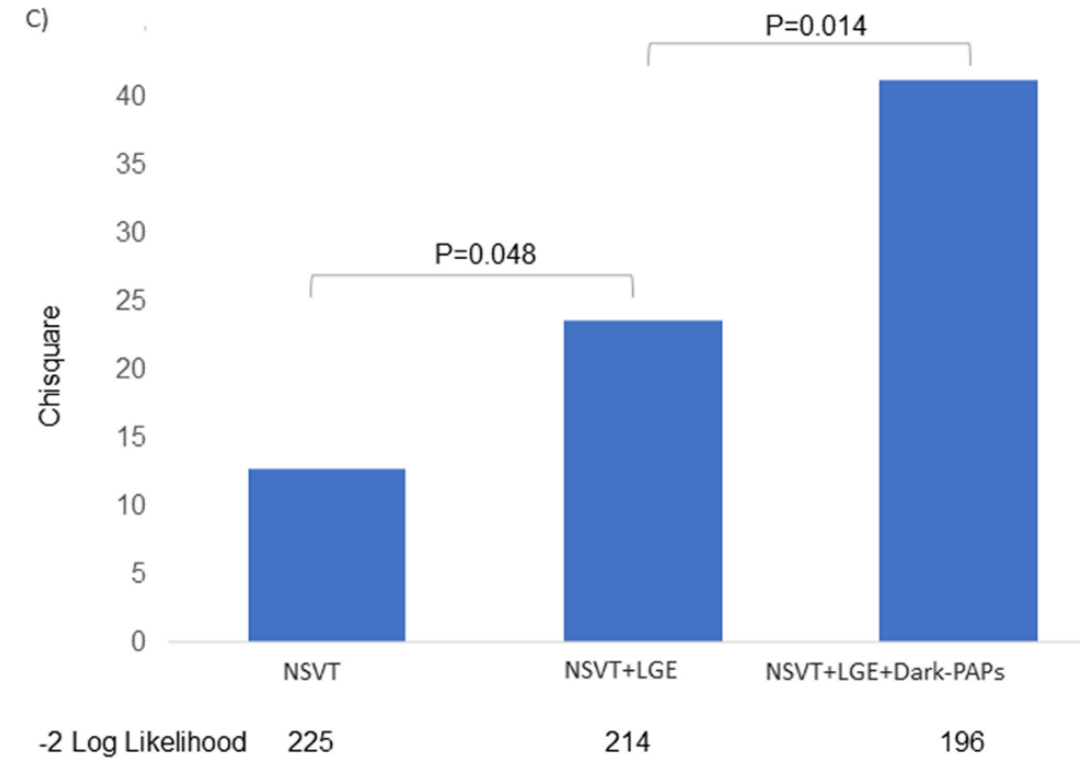
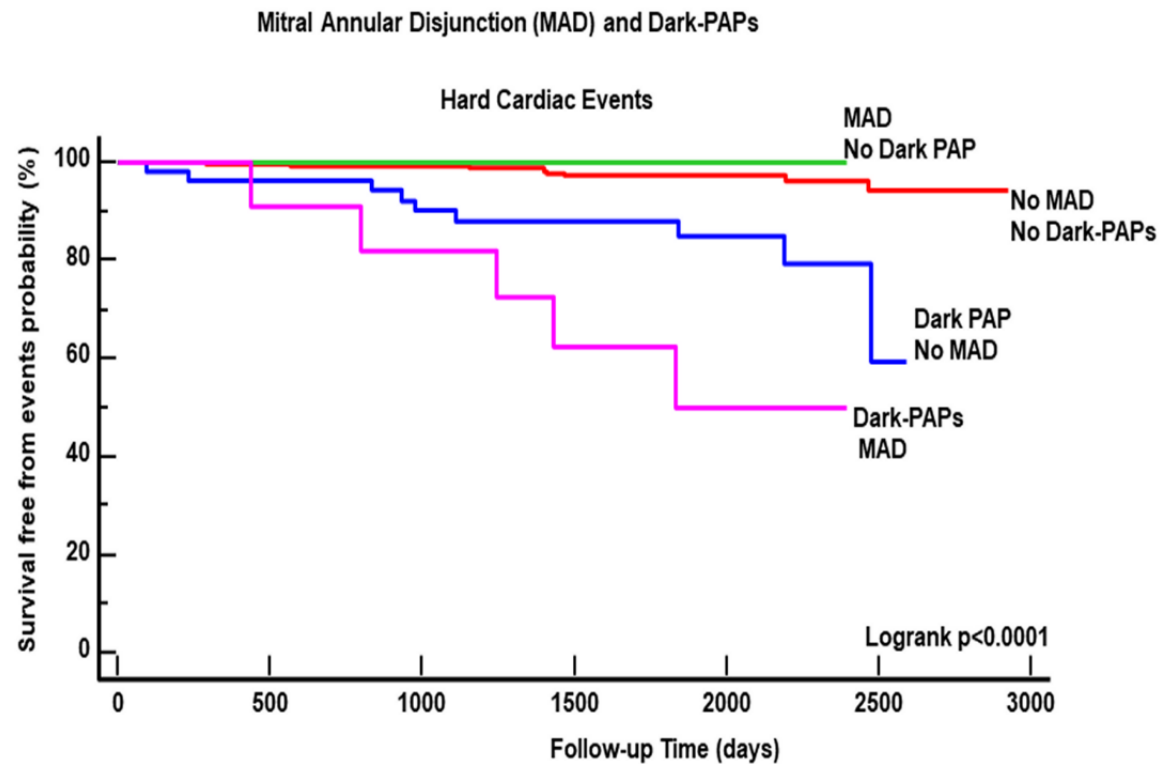
MVP +/- MAD



Prognostic role of 'Dark' Papillary muscles in pts with VA



Prognostic role of 'Dark' Papillary muscle in pts with VA



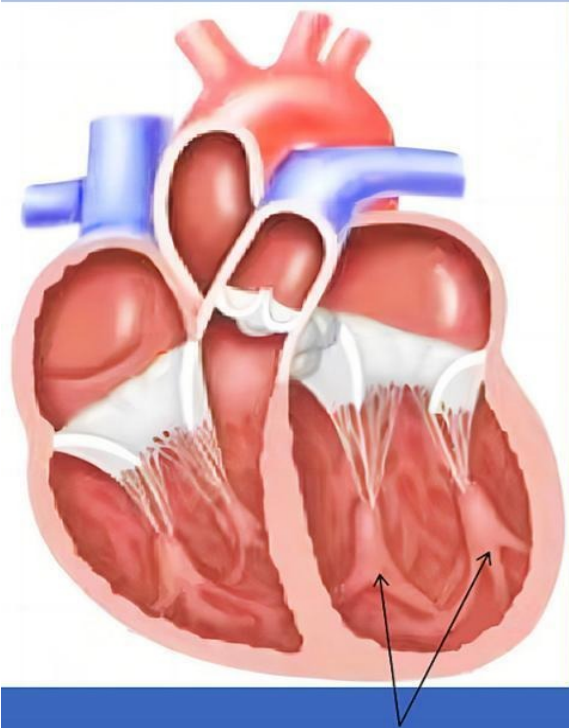
Dark papillary muscles: A new piece of the puzzle in understanding mechanical stretch injury associated with mitral annular disjunction

	Univariable logistic regression analysis	
Parameter	OR (95% CI)	p
MVP	6.74 (1.99-22.84)	0.002
MAD in laterall wall $\geq 4\text{mm}$	7.88 (1.73-35.78)	0.008
MAD in 3 and more walls	5.91 (1.70-20.51)	0.006
MR vol $\geq 16\text{ml}$	10 (1.39-71.86)	0.02
MR RF $\geq 18\%$	10 (1.39-71.86)	0.02

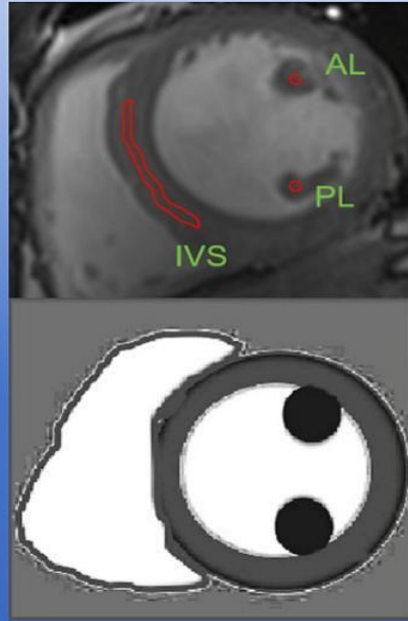
119 patients (32.2 %) had Dark-Paps
141 patients (38.2 %) experienced MACE during a median follow-up of 22 months

Dark papillary muscles sign is a new prognostic indicator in patients with dilated cardiomyopathy: A multi-center study

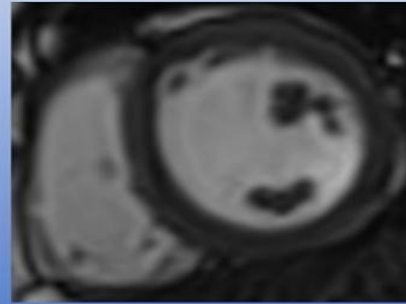
Dark-Paps in DCM patients



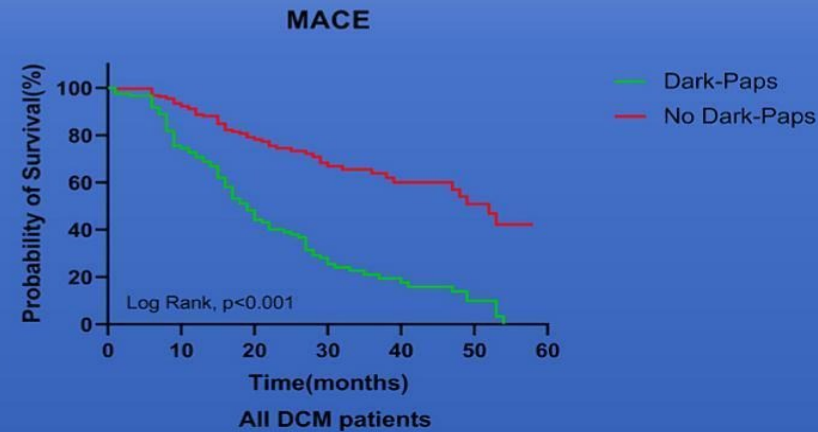
Papillary muscles in dilated LV



Dark-Paps was defined when the signal intensity of both papillary muscles was lower than the signal of interventricular septum



A DCM patient with Dark-Paps

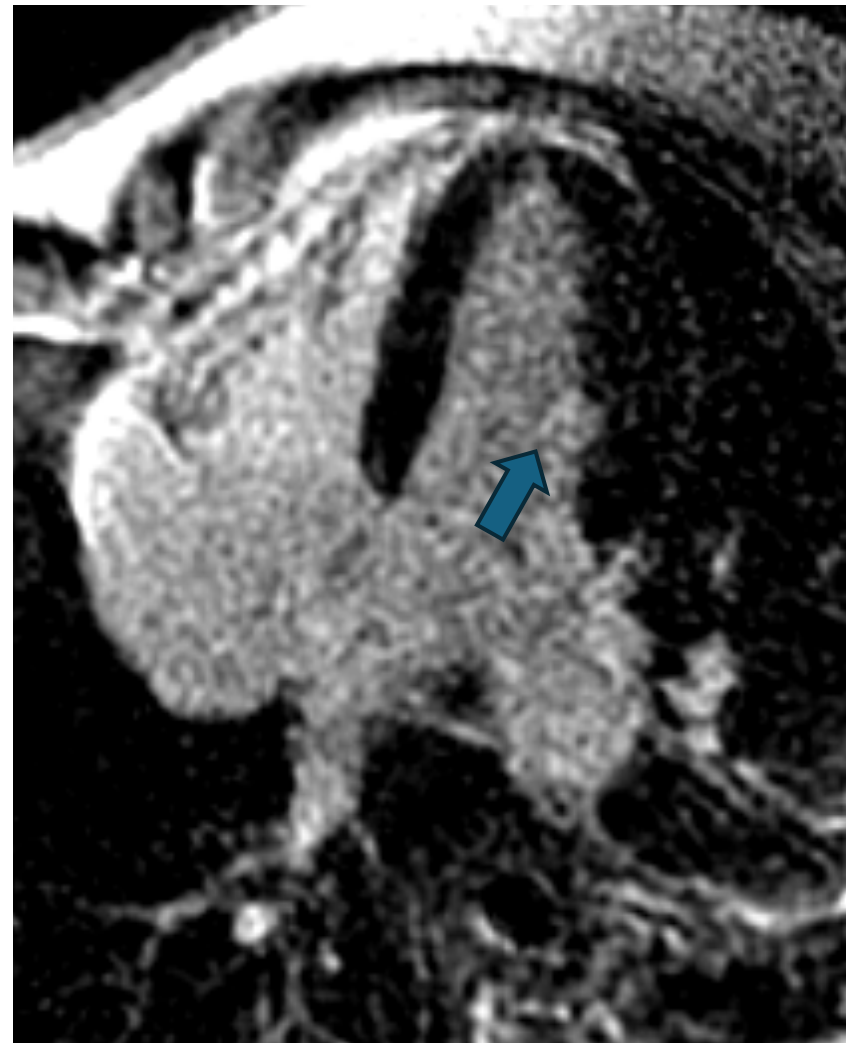
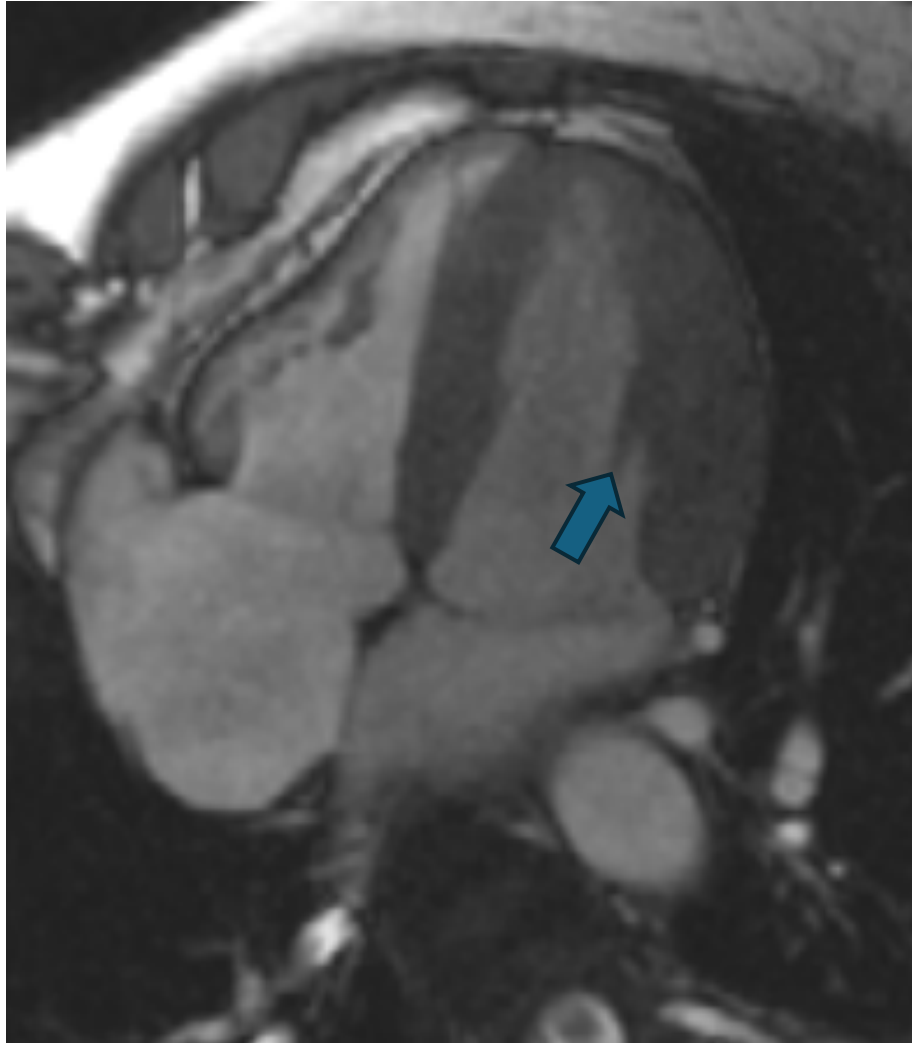


Patients with Dark-Paps had worse survival free from MACE than those without

Shan 2024

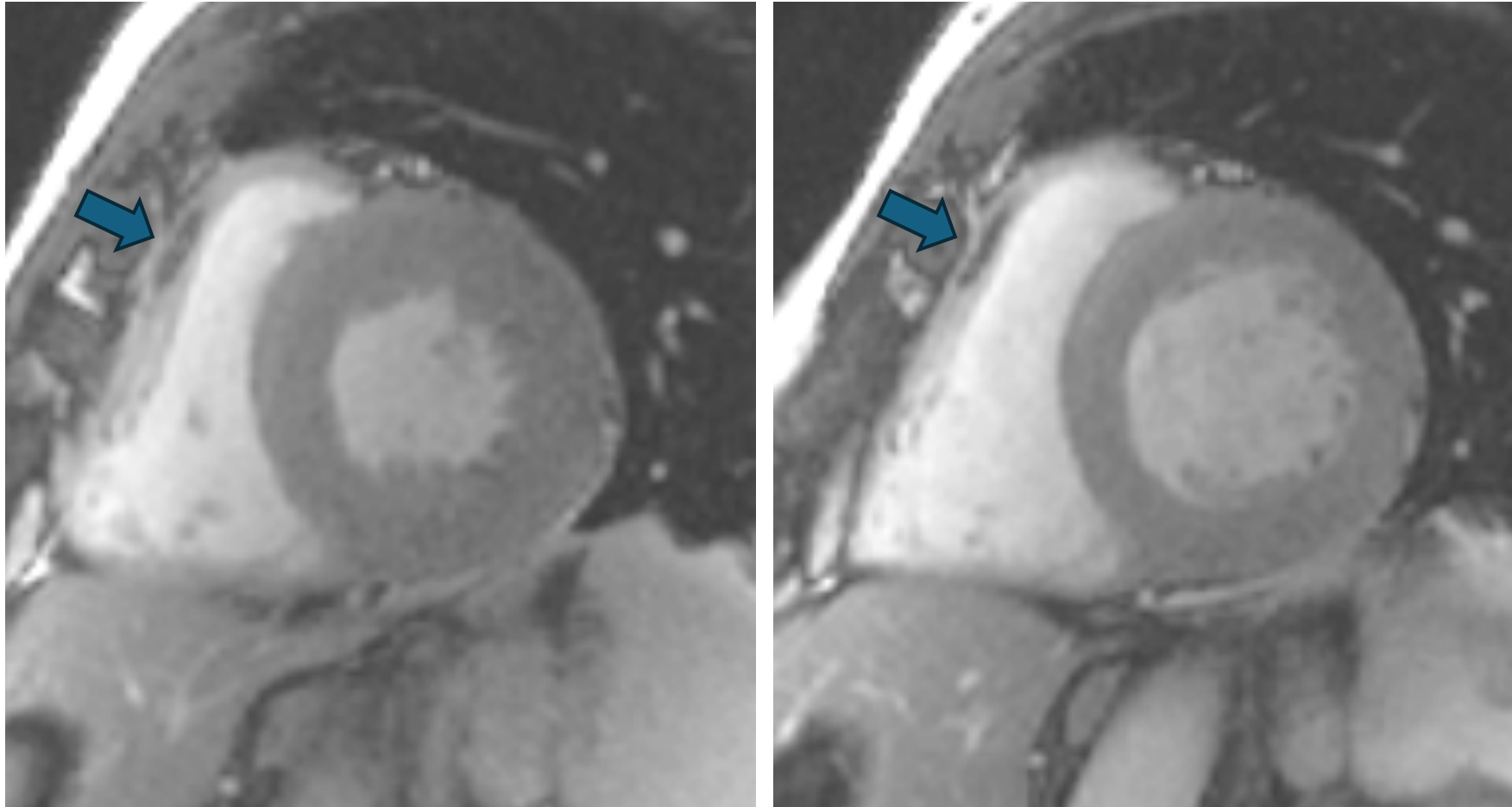
Dark-Paps maintained an independent predictor of MACE in a multivariate model that included left ventricular ejection fraction (LVEF) and late gadolinium enhancement (LGE) extent (HR: 3.49; $p < 0.001$). Furthermore, adding Dark-Paps to the multivariate model greatly enhanced the prognostic role of endpoint events (C-statistic improvement: 0.652-0.777, Delong test: $p < 0.001$).

51y old male with FV during bicycle
Echocardiography: ndn
Coronary angiography: no stenosis



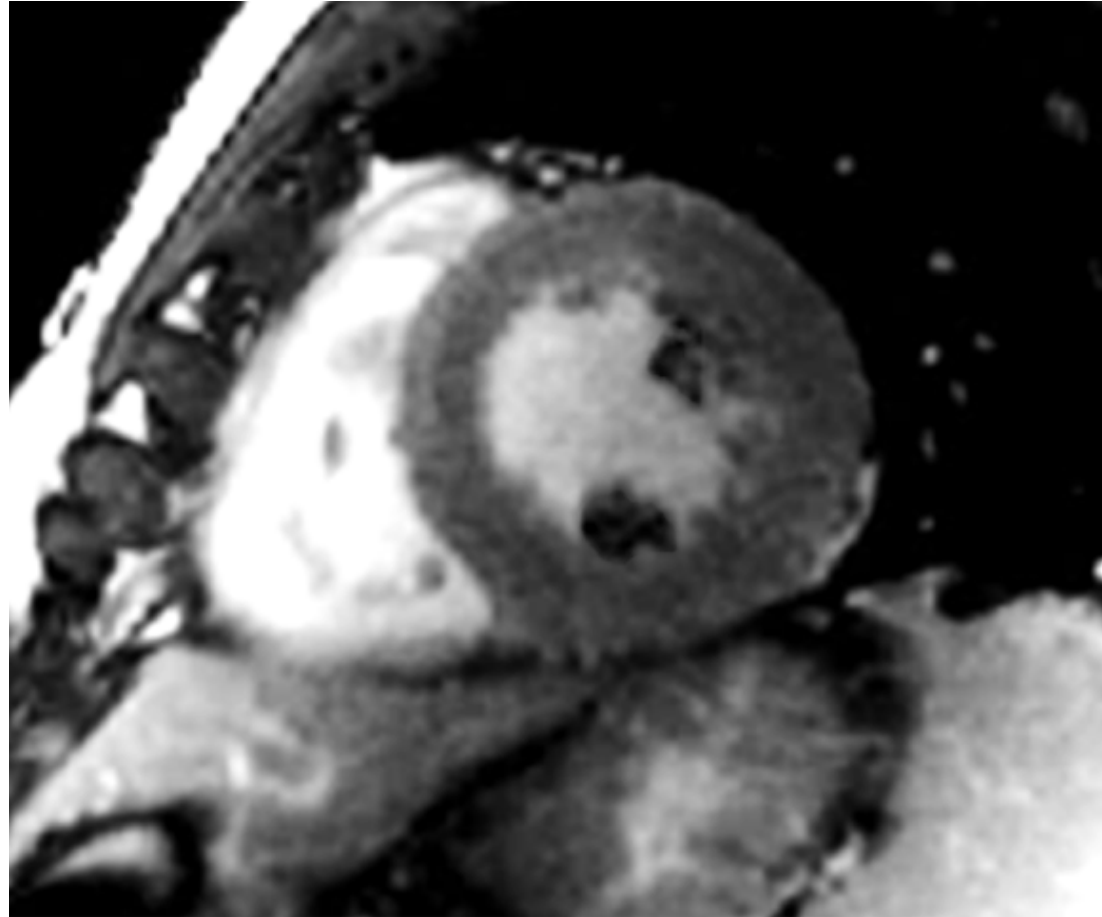
Fibrosis of papillary head

51y old male with FV during bycicle



RV 'India Ink': fat metaplasia

51y old male with FV during bicycle



Dark Papillary muscle