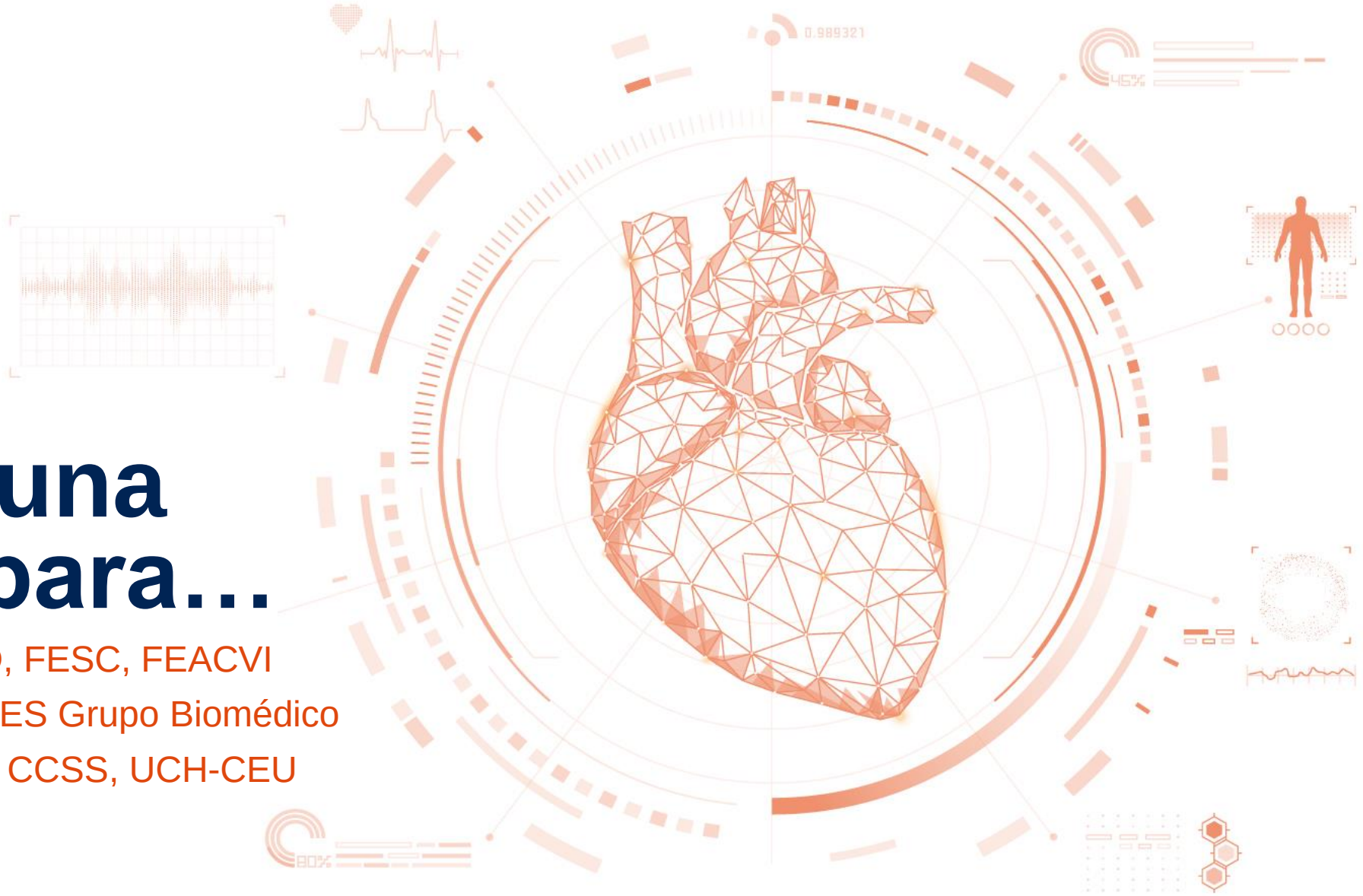
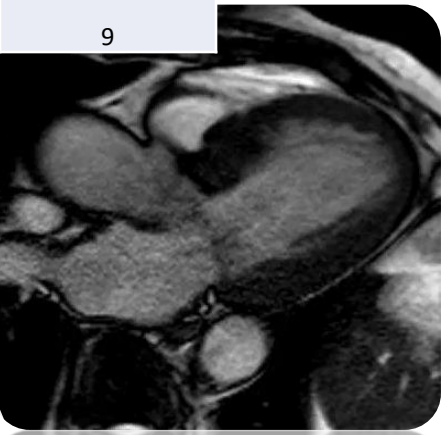
almirall
feel the science



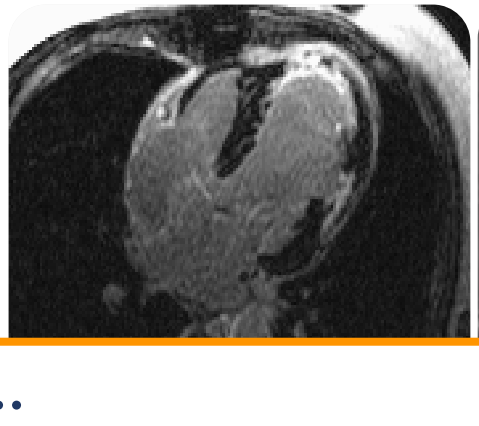
Yo pediría una cardioRM para…

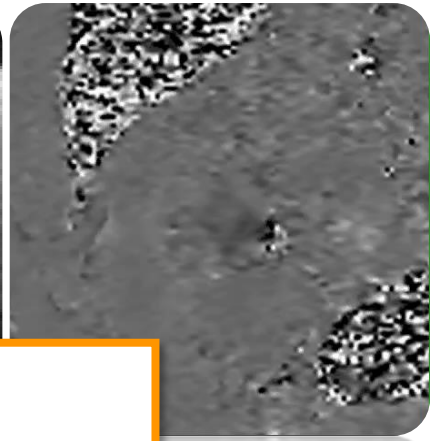
Dr. Alicia M. Maceira, MD, PhD, FESC, FEACVI
Unidad Cardiovascular, ASCIRES Grupo Biomédico
Dpto de Medicina, Facultad de CCSS, UCH-CEU
Valencia



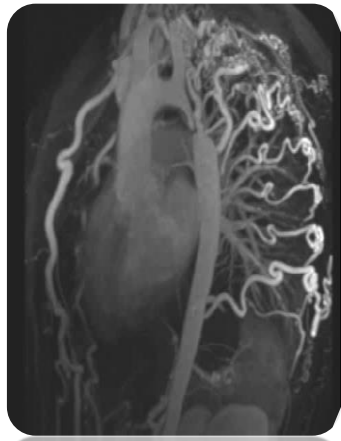
SSFP Cine

TSE





ntraste de fase

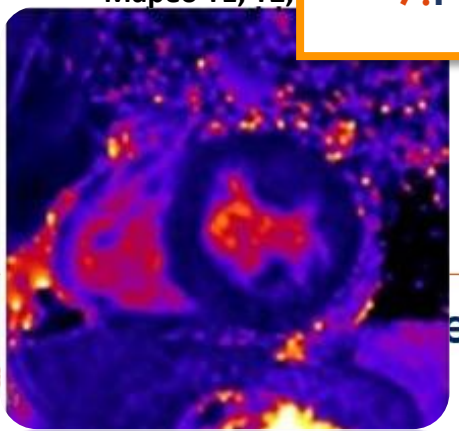


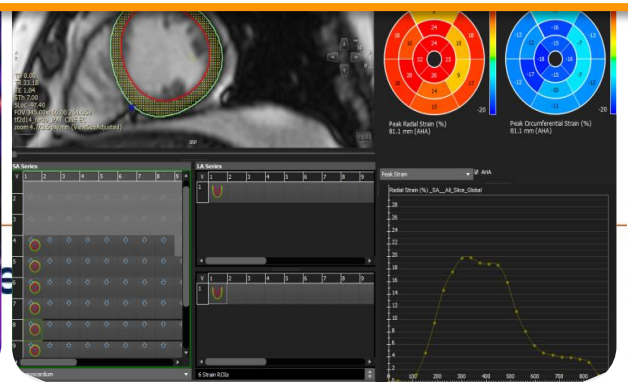
Angiografía RM 3D

YO PEDIRÍA CRM PARA....

1. Medición de dimensiones y función sistólica VI y VD
2. Estudio de cardiopatía isquémica
3. Miocardiopatías (MCD, MCH, MCR, MCA), miocarditis, d.d. corazón de atleta
4. Pericardiopatías, tumores, trombos
5. C. Congénitas
6. Valvulopatías complejas
7. Patología de grandes vasos

Mapeo T1, T2,





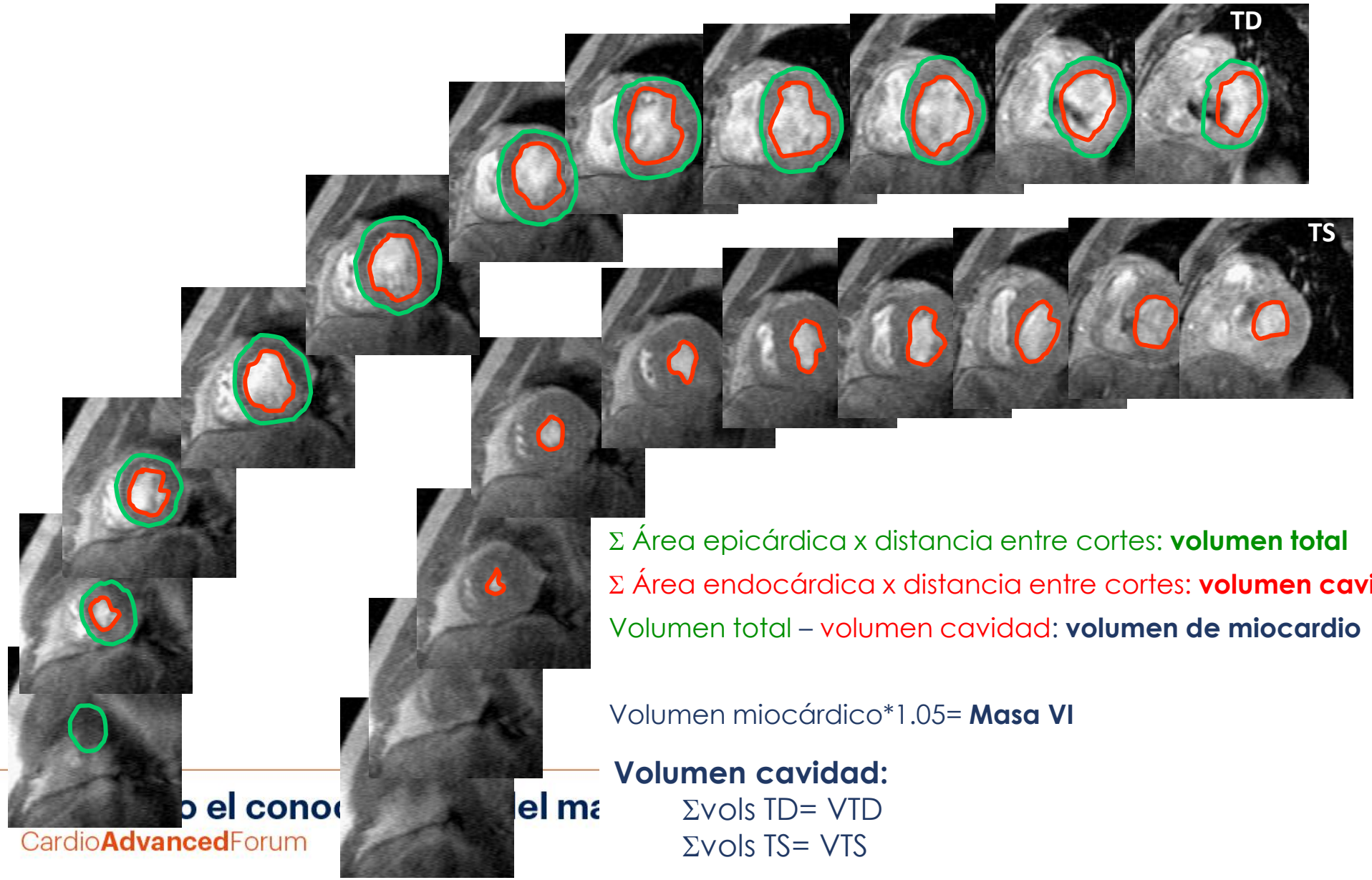
Leiner *et al. J Cardiovasc Magn Reson* (2020) 22:76
https://doi.org/10.1186/s12968-020-00682-4

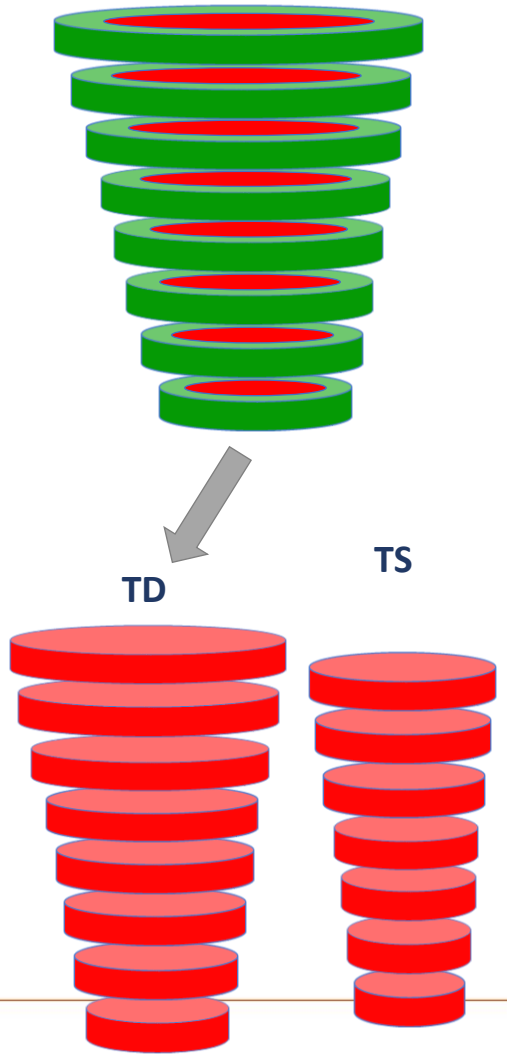
Journal of Cardiovascular Magnetic Resonance

REVIEW Open Access

SCMR Position Paper (2020) on clinical indications for cardiovascular magnetic resonance

1. Estudio de dimensiones y función ventricular





Σ Área epicárdica x distancia entre cortes: **volumen total**

Σ Área endocárdica x distancia entre cortes: **volumen cavidad**

Volumen total – volumen cavidad: **volumen de miocardio**

Volumen miocárdico*1.05= **Masa VI**

Volumen cavidad:

Σvols TD= VTD

Σvols TS= VTS

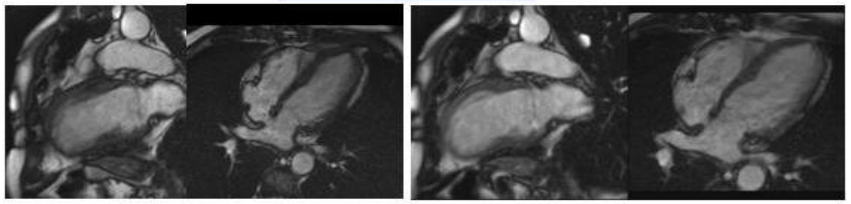
Maceira, JCMR 2006

2. Cardiopatía isquémica

68% de nuestras indicaciones

Detección de isquemia

Dobutamina



Vasodilatadores (dipiridamol/adenosina/regadenoson)

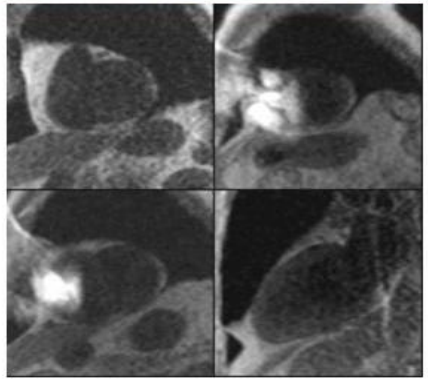
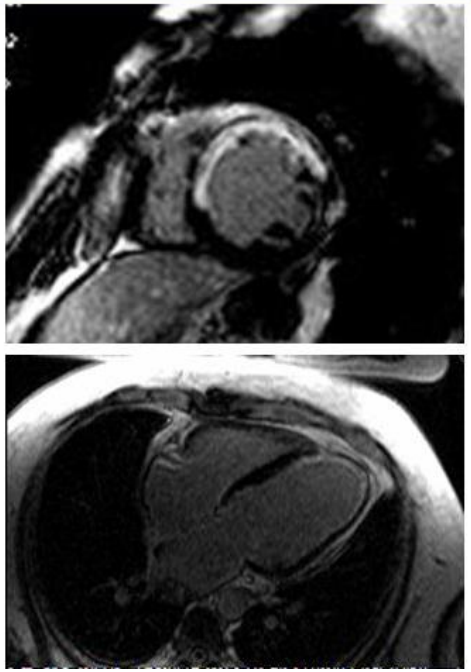


Table 3 Indications for CMR in coronary artery disease

Indication	Class
1. Acute coronary syndromes	I
2. Chronic coronary artery disease	I
3. Myocardial infarction with non-obstructive coronary arteries (MINOCA)	I
4. Coronary artery anomalies	II

Detección de necrosis

Captación tardía contraste

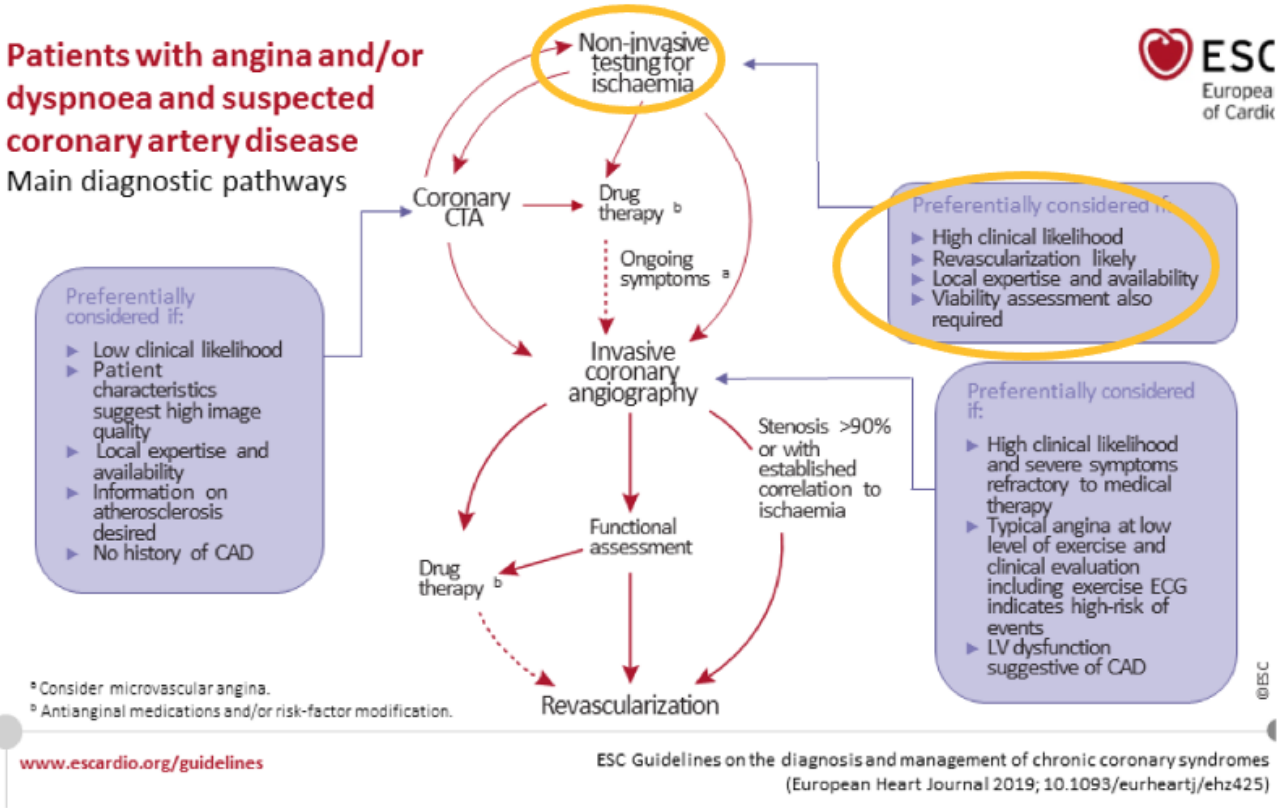


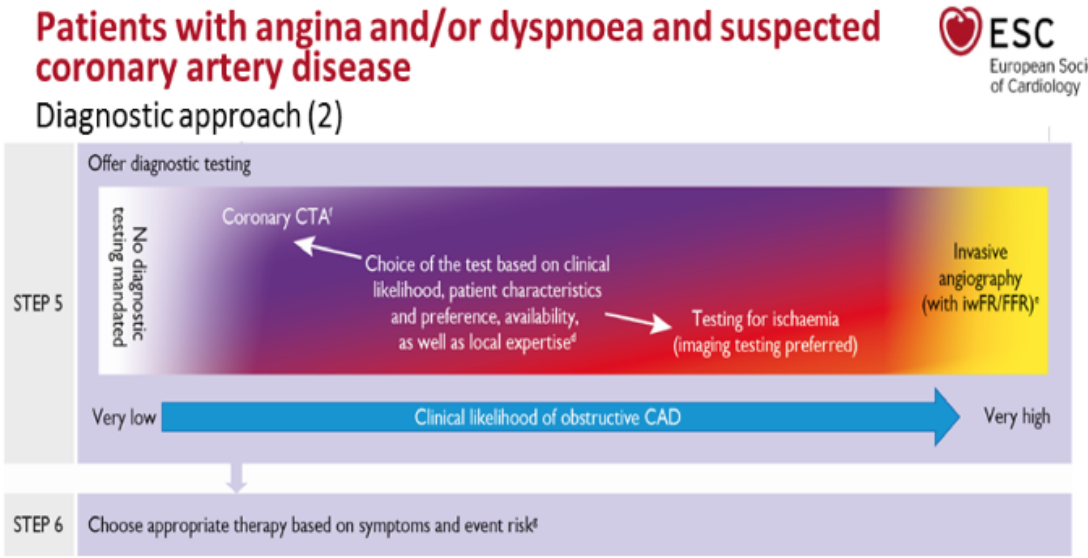
JCMR 2020

Selección tipo PRUEBA INICIAL NO INVASIVA según:

1. **Probabilidad clínica EAC**
2. **Precisión Dx del test**
3. **Características del paciente** (FC, obesidad,colaboración)
4. **Caract. del medio** (experiencia local, disponibilidad)

I C





ESC guidelines CCS. EHJ 2019

DETECCIÓN DE ISQUEMIA_CRM DE ESTRÉS

ESC European Society of Cardiology

2018 ESC/EACTS Guidelines on myocardial revascularization

Indications for revascularization in patients with stable angina or silent ischaemia

Extent of CAD (anatomical and/or functional)		Class[a]	Level[b]
For prognosis	Left main disease with stenosis >50%.[c] [68–71]	I	A
	Proximal LAD stenosis >50%.[c] [62,68,70,72]	I	A
	Two- or three-vessel disease with stenosis >50% with impaired LV function (LVEF ≤35%).[c] [61,62,68,70,73–83]	I	A
	Large area of ischaemia detected by functional testing (>10% LV) or abnormal invasive FFR.[d] [24,59,84–90]	I	B
	Single remaining patent coronary artery with stenosis >50%.[c]	I	C
For symptoms	Haemodynamically significant coronary stenosis[c] in the presence of limiting angina or angina equivalent, with insufficient response to optimized medical therapy.[e] [24,63,91–97]	I	A

CRM I

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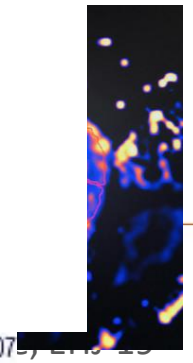
Table 6 Definitions of high event risk for different test modalities in patients with established chronic coronary syndromes[a] [102–104]

Exercise ECG	Cardiovascular mortality >3% per year according to Duke Treadmill Score
SPECT or PET perfusion imaging	Area of ischaemia ≥10% of the left ventricle myocardium
Stress echocardiography	≥3 of 16 segments with stress-induced hypokinesia or akinesia
CMR	≥2 of 16 segments with stress perfusion defects or ≥3 dobutamine-induced dysfunctional segments
Coronary CTA or ICA	Three-vessel disease with proximal stenoses, LM disease, or proximal anterior descending disease
Invasive functional testing	FFR ≤0.8, iwFR ≤0.89

Stress CMR	89 (85–92)	87 (83–91)	7.10 (5.07–9.95)	0.13 (0.09–0.18)

ivo

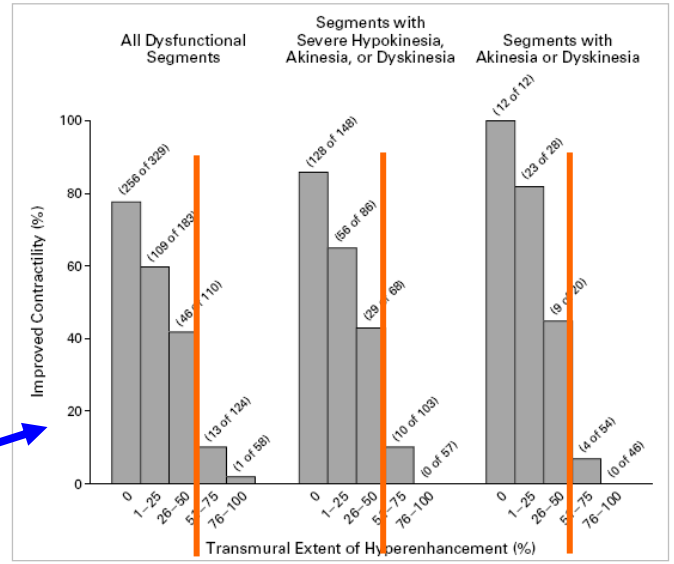


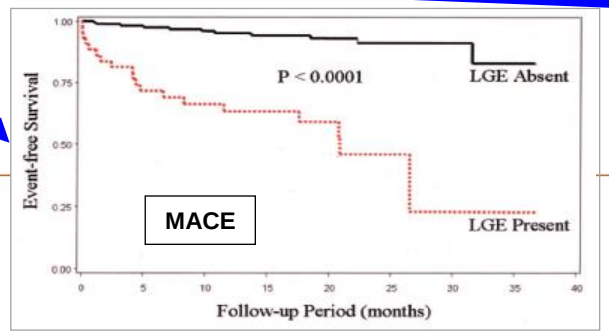
Bodi, JACC'07

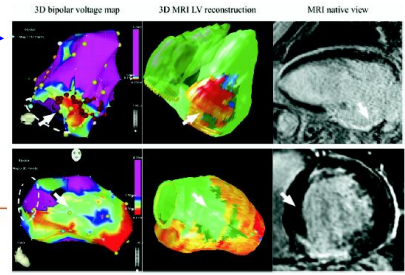
CRM EN ESTUDIO DE VIABILIDAD

El miocardio viable recupera su función contráctil tras la revascularización
Criterio CRM: transmuralidad de la necrosis <50% del grosor parietal

1. Morfología	grosor telediastólico
2. Cines	FE VI y VD alteraciones segmentarias de la contractilidad engr. reposo / dobutamina
3. STIR	detección de edema
4. Perfusión en reposo	obstrucción microvascular
5. Realce tardío de gadolinio	detección de necrosis transmuralidad predicción de eventos, arritmias
(Torsión, velocidad mioc.	tagging reposo / dobutamina)
((Espectroscopia	metabolismo))



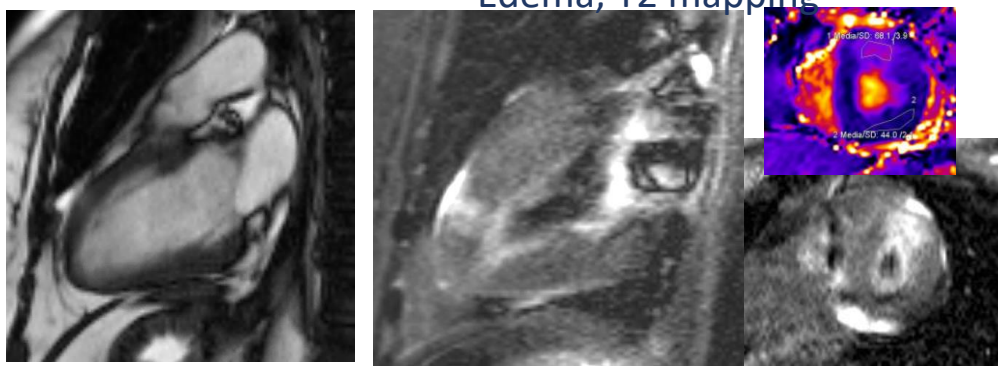




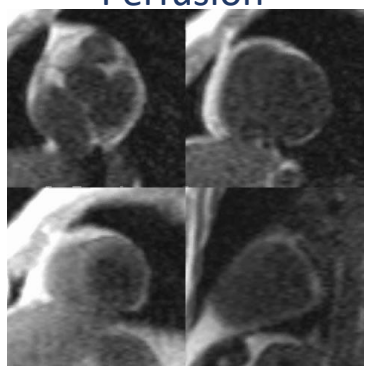
CRM EN D.D. SCA

A **L.F.G., Mujer 54 años, HTA, exfumadora. Ingreso por dolor torácico, elev. ST, elev. enzimática Coronarias normales**
Miocarditis vs IAM con coros normales

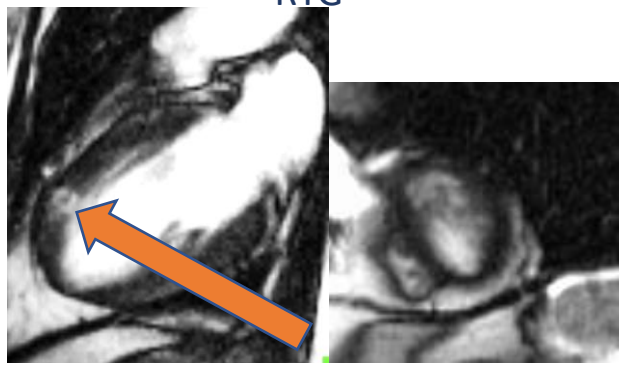
Edema, T2 mapping



Perfusión

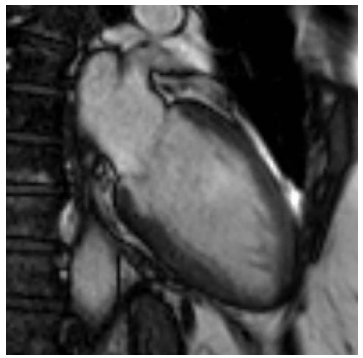


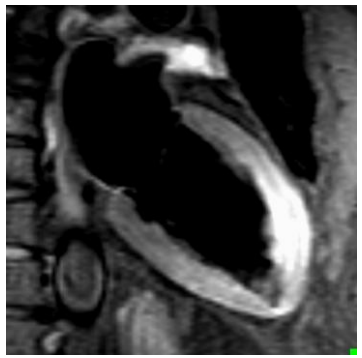
RTG



B **P.R.P., Mujer 58a, HTA, exfumadora. Idéntica HªCª**

Edema



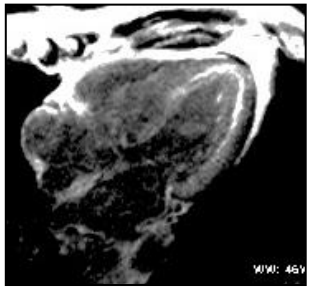


RTG

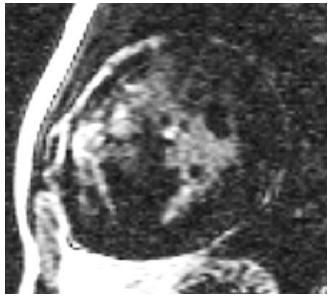
3. Miocardiopatías y miocarditis

Miocardiopatías, 14% de nuestras indicaciones

Amiloidosis



MCH



DAVD

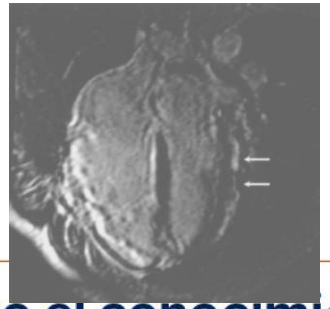


Table 4 Indications for CMR of cardiomyopathies

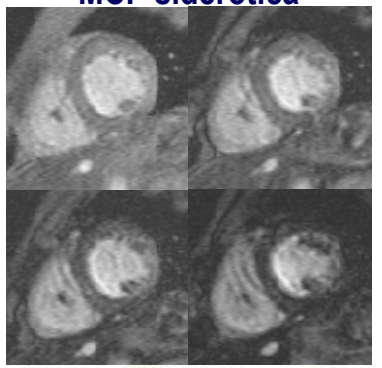
Indication	Class
1. Dilated cardiomyopathy	I
2. Myocarditis	I
3. Hypertrophic cardiomyopathy	I
4. Arrhythmogenic cardiomyopathy	I
5. Cardiac amyloidosis	I
6. Myocardial iron overload	I
7. Left-ventricular noncompaction	I
8. Fabry's disease	I
9. Cardiac sarcoidosis	I
10. Stress-induced (Takotsubo) cardiomyopathy	I
11. Endomyocardial fibrosis	I
12. Restrictive cardiomyopathy	II
13. Chemotherapy induced CMP	II
14. Athlete's heart	II

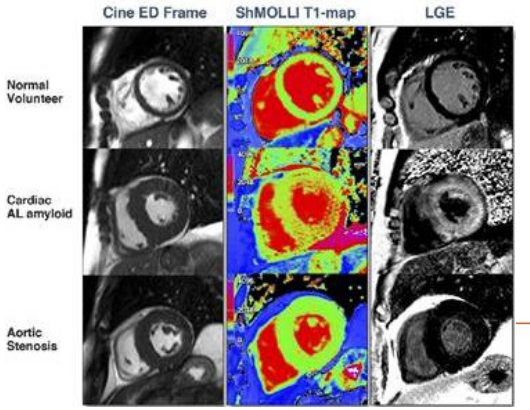
1. Estudio anatómico y de función ventricular
2. Medición de gradientes, velocidades subaórticas
3. Valoración de perfusión en reposo/estrés
4. Angiografía coronaria
5. Caracterización tisular:
   - Detección de edema miocárdico
   - Imagen multiparamétrica
   - Realce tardío de gadolinio

   UTILIDAD DIAGNÓSTICA Y PRONÓSTICA

MCPNC

MCP siderótica





JCMR 2020

MIOCARDITIS_UPDATED LAKE LOUISE CRITERIA

JACC STATE-OF-THE-ART REVIEW

Cardiovascular Magnetic Resonance in Nonischemic Myocardial Inflammation

Expert Recommendations

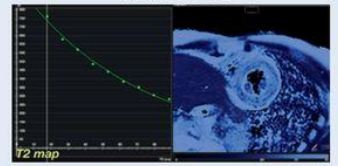
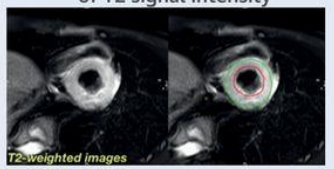
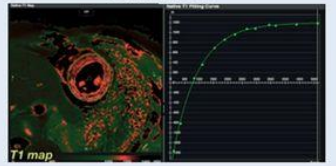
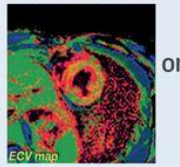
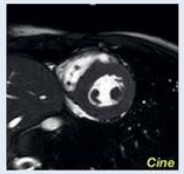
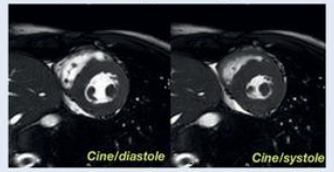
Vanessa M. Ferreira, MD, DPhil,[a] Jeanette Schulz-Menger, MD,[b] Godtfred Holmvang, MD,[c] Christopher M. Kramer, MD,[d] Iacopo Carbone, MD,[e] Udo Sechtem, MD,[f] Ingrid Kindermann, MD,[g] Matthias Gutberlet, MD,[h] Leslie T. Cooper, MD,[i] Peter Liu, MD,[j] Matthias G. Friedrich, MD[k,l,m]

Más especificidad con combinación de edema y otros marcadores de inflamación:

Al menos un criterio T2 + al menos un criterio T1
T2map o T2-STIR + T1map o RTG

Un único marcador apoya el diagnóstico si la clínica acompaña, pero menos específico

CENTRAL ILLUSTRATION: Overview of the Updated Lake Louise Criteria

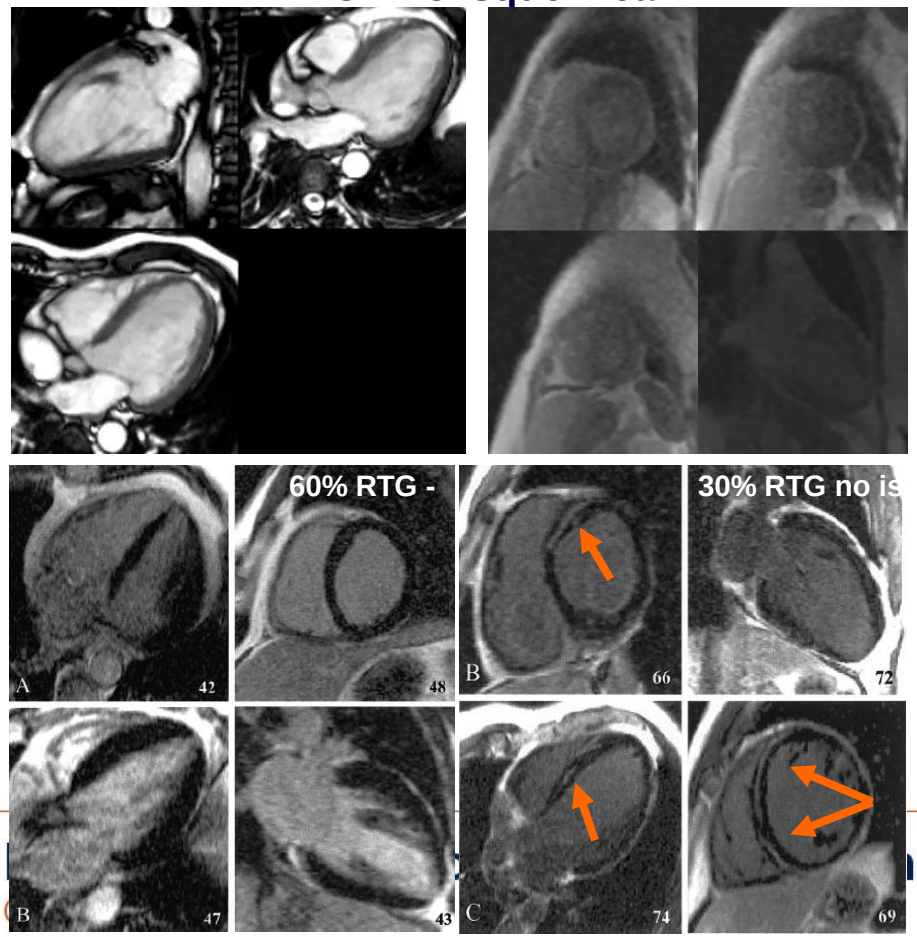
	2018 Lake Louise Criteria	CMR Image Examples
Main Criteria	**Myocardial Edema** (T2-mapping or T2W images)	Regional or global increase of native T2  or Regional or global increase of T2 signal intensity 
	Non-ischemic Myocardial Injury (Abnormal T1, ECV, or LGE)	Regional or global increase of native T1  or Regional or global increase of ECV  or Regional LGE signal increase 
Supportive Criteria	**Pericarditis** (Effusion in cine images or abnormal LGE, T2, or T1)	Pericardial effusion 
	Systolic LV Dysfunction (Regional or global wall motion abnormality)	Regional or global hypokinesis 

Ferreira, V.M. et al. J Am Coll Cardiol. 2018;72(24):3158-76.

CRM en MCD

Valor diagnóstico y pronóstico
Excluir componente isquémico. Caracterizacin tisular: edema, cicatriz, fibrosis, infiltración
Considerar (al menos una vez) en todos los pacientes con MCD

MCD no isquémica



Diagnóstico de MCD no isquémica:
- 60% RTG negativo
- 25% RTG no isquémico
- 9% RTG isquémico

Pronóstico:
- Volúmenes ventriculares
- FEVI
- FEVD
- Extensión de la fibrosis focal (RTG)

A más RTG peor pronóstico:
- Más arritmias
- Menos recuperación funcional

Valoración para resincronización

ESC European Society of Cardiology
European Heart Journal - Cardiovascular Imaging (2019) 0, 1–19 doi:10.1093/ehjci/jez178
EACVI Consensus Document

Multimodality imaging in the diagnosis, risk stratification, and management of patients with dilated cardiomyopathies: an expert consensus document from the European Association of Cardiovascular Imaging

Erwan Donal[1,2]*, Victoria Delgado[3], Chiara Bucciarelli-Ducci[4], Elena Galli[1,2], Kristina H. Haugaa[5], Philippe Charron[6,7]†, Jens-Uwe Voigt[8], Nuno Cardim[9], P.G. Masci[10], Maurizio Galderisi[11], Oliver Gaemperli[12], Alessia Gimelli[13], Yigal M. Pinto[14]†, Patrizio Lancellotti[15], Gilbert Habib[16,17], Perry Elliott[18,19]†, Thor Edvardsen[5], Bernard Cosyns[20]‡, and Bogdan A. Popescu[21]‡

Table 4 Diagnostic criteria for relatives of familial DCM[1]

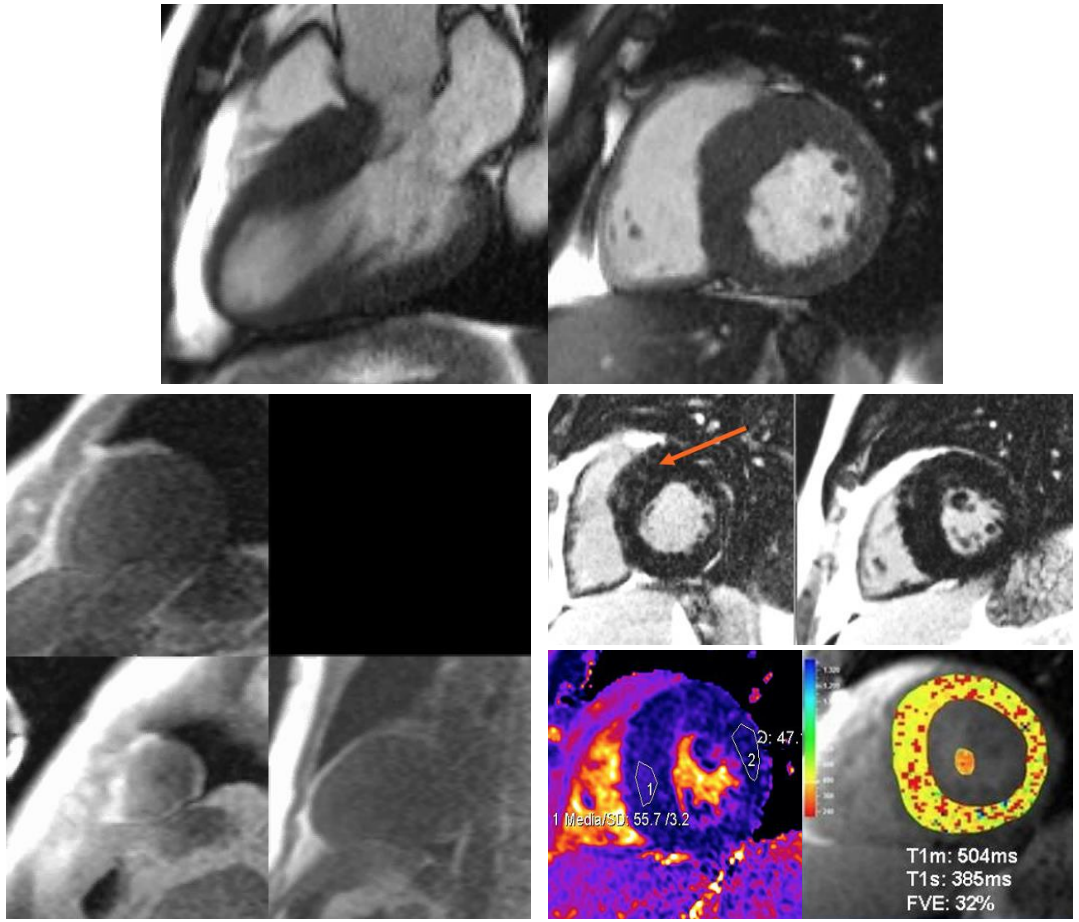
Major
1. Unexplained decrease of LVEF ≤50% but >45%

OR
2. Unexplained LVED dilatation (diameter or volume) according to nomograms (LVED diameter/volume 2 SD + 5% since this more specific echocardiographic criterion was used in studies that demonstrated the predictive impact of isolated dilatation in relatives).

Minor
1. Complete LBBB or AV block (PR ≥200 ms or higher degree of AV block).
2. Unexplained ventricular arrhythmia (100 ventricular premature beats per hour in 24 h or non-sustained ventricular tachycardia, ≥3 beats at a rate of ≥120 bpm).
3. Segmental wall motion abnormalities in the left ventricle in the absence of intraventricular conduction defect.
4. Late enhancement (LGE) of non-ischaemic origin on cardiac magnetic resonance imaging.
5. Evidence of non-ischaemic myocardial abnormalities (inflammation, necrosis, and/or fibrosis) on EMB.
6. Presence of serum organ-specific and disease-specific AHA by one or more autoantibody tests.

Note: Feature shown by two independent imaging modalities.[1]

CRM en MCH



Diagnóstico: Detección de fenotipos, formas apicales
Diagnóstico diferencial con otras causas de hipertrofia
Gradiente subaórtico, grosor parietal, SAM, tamaño auricular

Pronóstico: Grosor parietal > 30mm
RTG (si existe: peor pronóstico, cuanto más haya: peor
Dilatación de AI, gradiente subaórtico….

Recommendations for CMR Imaging
Referenced studies that support the recommendations are summarized in Online Data Supplement 4.

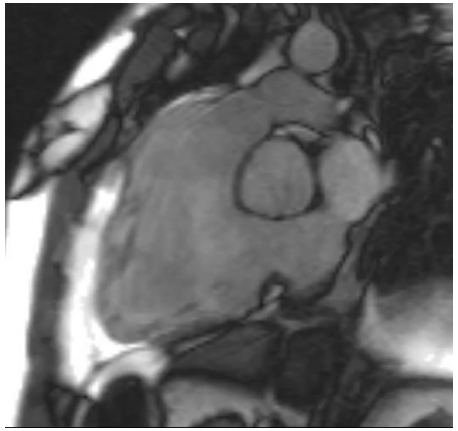
COR	LOE	Recommendations
1	B-NR	1. For patients suspected to have HCM in whom echocardiography is inconclusive, CMR imaging is indicated for diagnostic clarification.[74–80]
1	B-NR	2. For patients with left ventricular hypertrophy in whom there is a suspicion of alternative diagnoses including infiltrative or storage disease as well as athlete's heart, CMR imaging is useful[74–80] (Figure 1).
1	B-NR	3. For patients with HCM who are not otherwise identified as high risk for sudden cardiac death (SCD), or in whom a decision to proceed with implantable cardioverter-defibrillator (ICD) remains uncertain after clinical assessment that includes personal/family history, echocardiography, and ambulatory electrocardiographic monitoring, CMR imaging is beneficial to assess for maximum left ventricular (LV) wall thickness, ejection fraction (EF), LV apical aneurysm, and extent of myocardial fibrosis with late gadolinium enhancement.[38,74–87]
1	B-NR	4. For patients with obstructive HCM in whom the anatomic mechanism of obstruction is inconclusive on echocardiography, CMR imaging is indicated to inform the selection and planning of SRT.[88–92]
2b	C-EO	5. For patients with HCM, repeat contrast-enhanced CMR imaging on a periodic basis (every 3 to 5 years) for the purpose of SCD risk stratification may be considered to evaluate changes in late gadolinium enhancement and other morphologic changes, including EF, development of apical aneurysm, or LV wall thickness (Figure 1, Table 7).

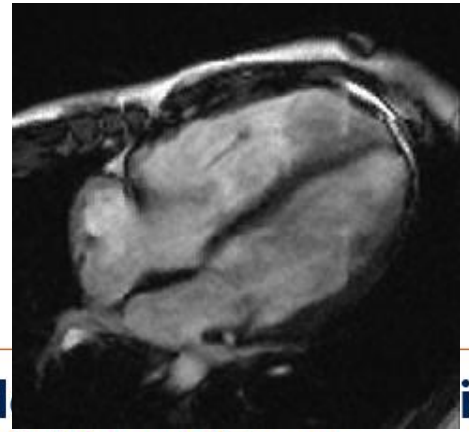
Circulation 2020

CRM EN MCA

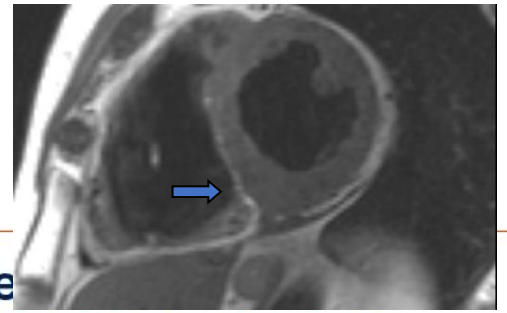
Diagnóstico: Disfunción sistólica de VD
Alt. segmentarias de la contractilidad VD
Fibrosis (RTG) VI y VD
Imagen paramétrica

Pronóstico (si hay RTG: peor)

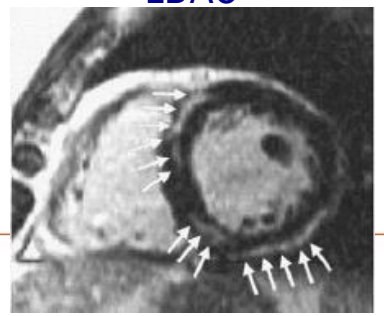


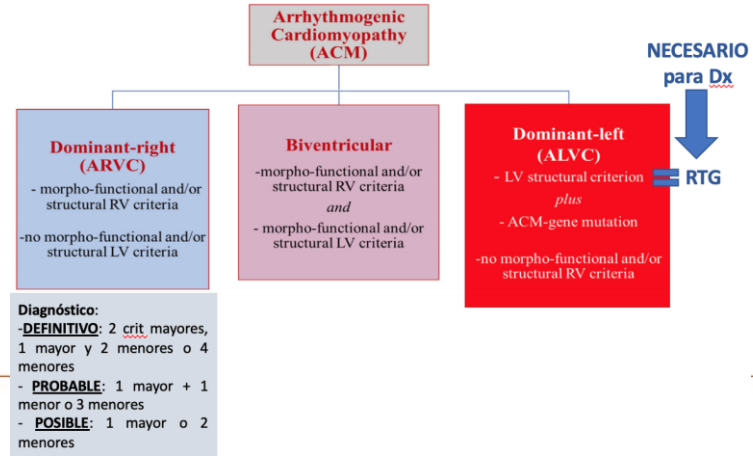


Categoría	VD (criterios ITF 2010 ACTUALIZADOS)	VI (nuevos criterios)
I. Morpho-functional ventricular abnormalities	*By echocardiography, CMR or angiography:* *Major* • Regional RV akinesia, dyskinesia, or bulging *plus* one of the following: - global RV dilatation (increase of RV EDV according to the imaging test specific nomograms) - global RV systolic dysfunction (reduction of RV EF according to the imaging test specific nomograms) *Minor* • Regional RV akinesia, dyskinesia or aneurysm of RV free wall	*By echocardiography, CMR or angiography:Minor* • Global LV systolic dysfunction (depression of LV EF or reduction of echo-cardiographic global longitudinal strain), with or without LV dilatation (increase of LV EDV according to the imaging test specific nomograms for age, sex, and BSA) *Minor* • Regional LV hypokinesia or akinesia of LV free wall, septum, or both
II. Structural myocardial abnormalities	*By CE-CMR:Major* • Transmural LGE (stria pattern) of ≥1 RV region(s) (inlet, outlet, and apex in 2 orthogonal views) *By EMB (limited indications):Major* • Fibrous replacement of the myocardium in ≥1 sample, with or without fatty tissue	*By CE-CMR:Major* • LV LGE (stria pattern) of ≥1 Bull's Eye segment(s) (in 2 orthogonal views) of the free wall (subepicardial or midmyocardial), septum, or both (excluding septal junctional LGE)



LDAC





Corrado, EHJ 2020; Shen-Chowdry, JACC 2008; Bonma AJC 2007

CRM EN MCR y MC INFLAMATORIA

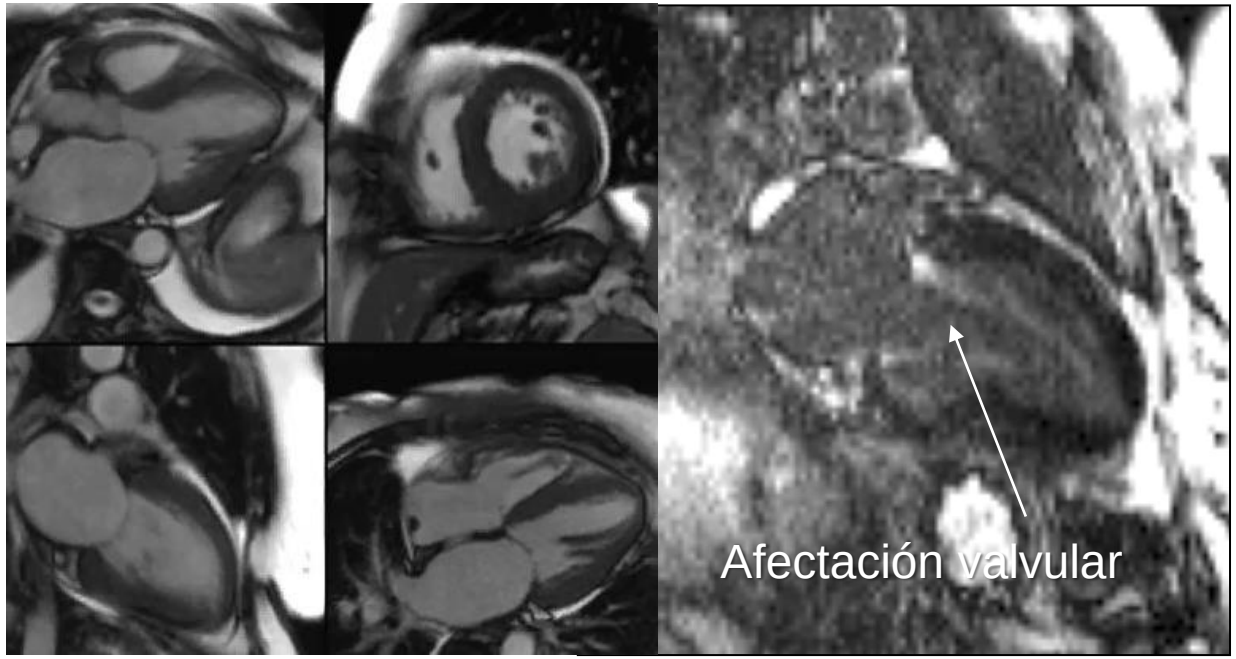
Detección de restricción, hemodinámica restrictiva

Estudio etiológico (sarcoidosis, amiloidosis, fibrosis endomiocárdica,...)

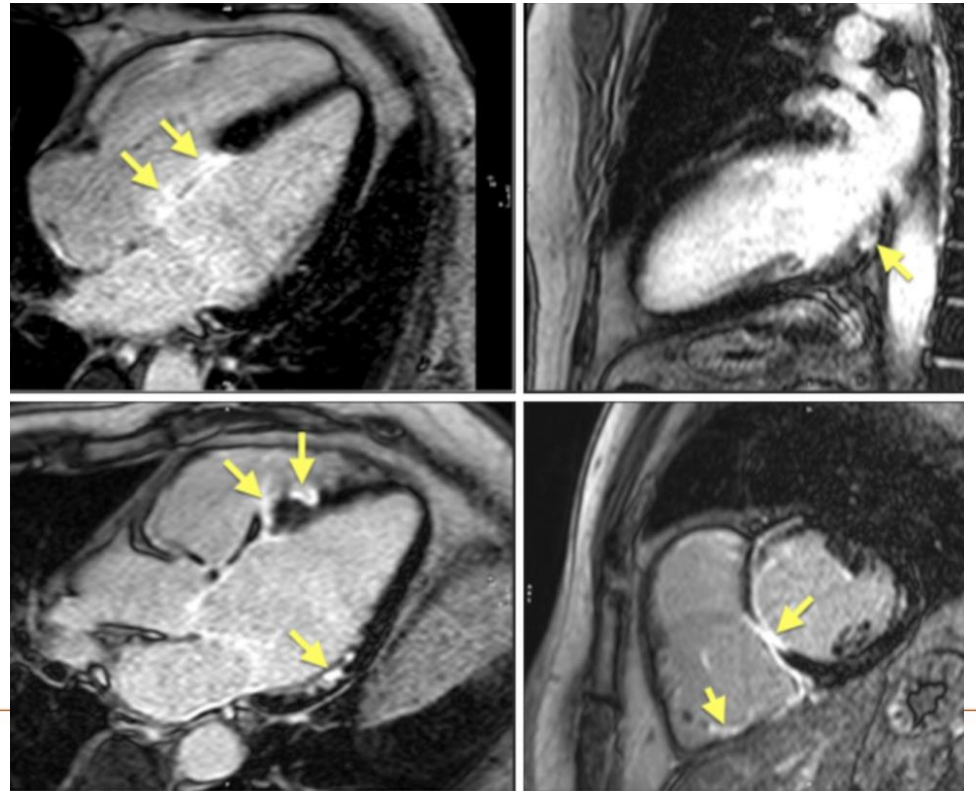
D.D. con pericarditis constrictiva

Pronóstico: edema, RTG, imagen multiparamétrica

Amiloidosis

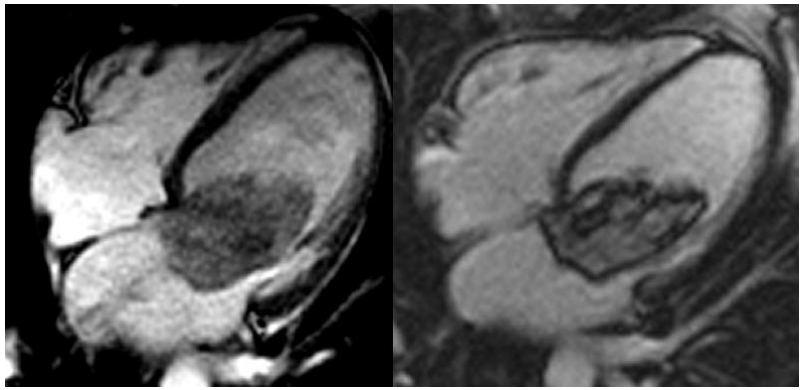


Sarcoidosis



4. Pericardiopatías, tumores, trombos

Mixoma



Fibroma

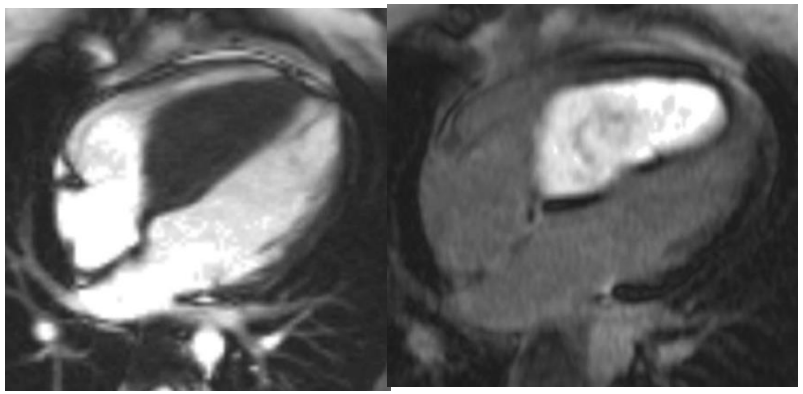
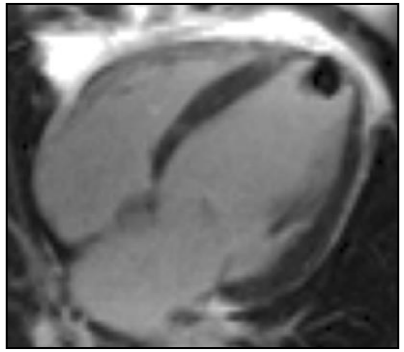


Table 5 Indications for CMR in pericardial disease

Indication	Class
1. Pericardial effusions	III
2. Pericardial inflammation	I
3. Pericardial constriction	I
4. Congenital anomalies of the pericardium	I

Trombo VI



Trombo AD

Table 6 Indications for CMR of cardiac masses

Indication	Class
1. Suspected cardiac mass	I
2. Differentiation between benign, malignant and non-tumourous masses	I
3. Guide surgery and/or biopsy if this is deemed appropriate	I
4. Follow-up of benign cardiac tumours that do not require urgent intervention for changes over time	I
5. Evaluation of tumour resection/debulking, monitoring recurrence after surgery and regression or progression after chemotherapy or radiotherapy	I
6. Extra-cardiac extension of cardiac tumours or cardiac extension of tumours originating from surrounding structures	I
7. Impact of cardiac masses on hemodynamics	I

5. Cardiopatías congénitas

6% de indicaciones

Valoración inicial y seguimiento en GUCH

1. **Shunt I-D:** Intracardíacos: CIV, CIA, DVPA parcial, Canal AV,
   Extracardíacos: PDA, Fístula de seno de Valsalva

2. **Malformaciones izquierdas sin shunt/ shunt I-D / bidireccional:**
   Coartación de aorta
   Estenosis aórtica (supra, valvular, sub), válvula bicúspide
   Regurgitación mitral

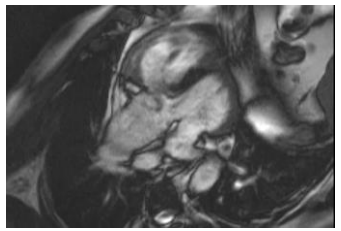
3. **Malformaciones derechas sin shunt / shunt D-I / bidireccional:**
   Estenosis pulmonar con septo íntegro, T.Fallot, Ebstein

4. **Malformaciones de las conexiones venosas pulmonares:** DVPAT

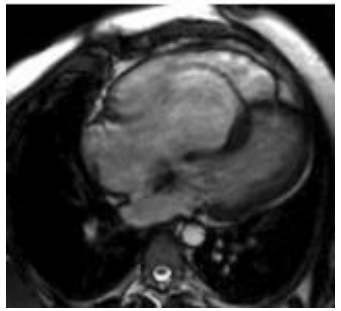
5. **Malposiciones:** Levocardia, Dextrocardia, Mesocardia
   D-TGA, VD de doble salida, L-TGA, V. Único

6. **Malformaciones coronarias:** Fístula AV coronaria, ALCAPA

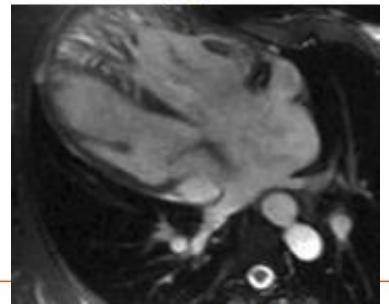
TF

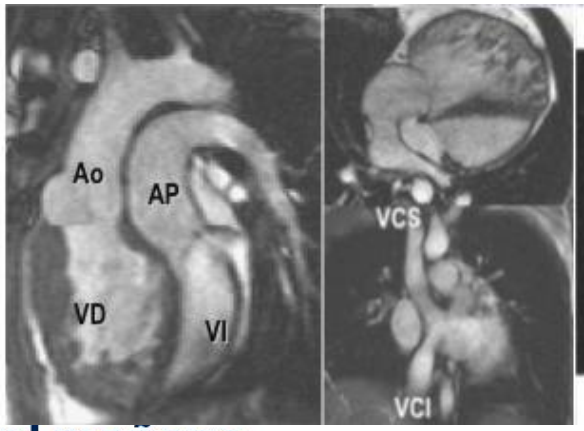


Ebstein

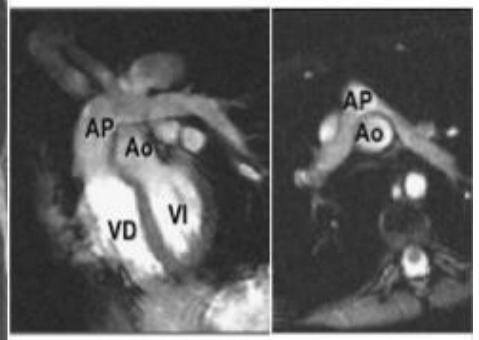


CIV

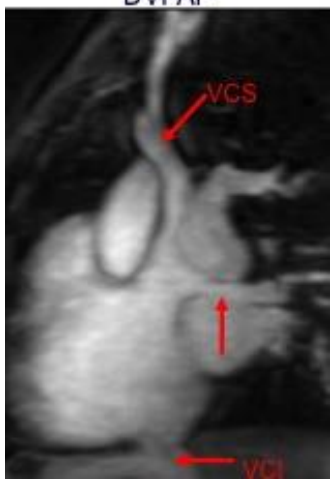




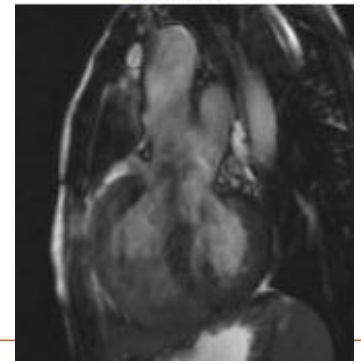
TGA



DVPAP



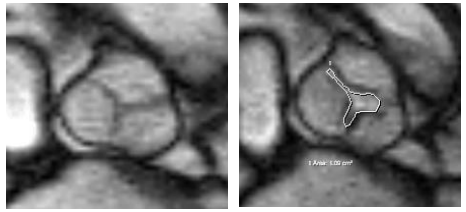
Truncus



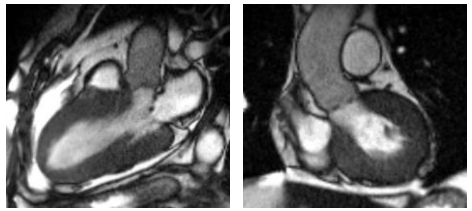
6. Valvulopatías

CRM EN ESTENOSIS AORTICA

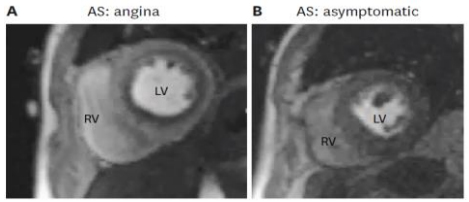
- Masa y función VI
- Anatomía valvular. AVAo



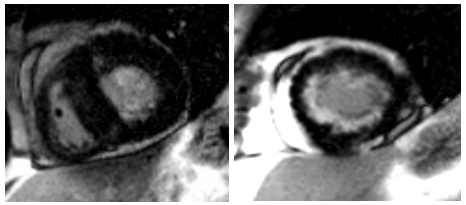
- Detección de estenosis subvalvular y supravalvular
- Raíz aórtica y Ao ascendente



- Hipoperfusión en estrés

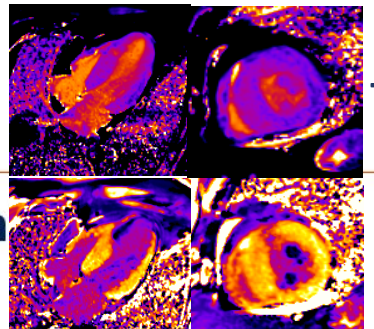


- Realce tardío de gadolinio: fibrosis focal, necrosis



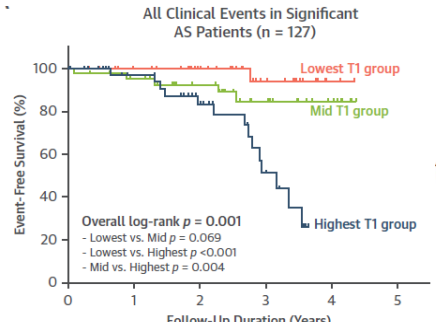
En > 50% de ptes
↑ mortalidad x 2
(total y CV)

- Imagen multiparamétrica



T1 nativo (1020 ms)

Post-Gd (ECV 33%)



Lee H. JACC 2018

Table 7 Indications for CMR in valvular heart disease

Indication	Class
1. Aortic stenosis	II
2. Identification of sub- and supravalvular stenosis	I
3. Aortic regurgitation	II
4. Ascending aortic flow patterns in aortic stenosis	Inv
5. Mitral stenosis	III
6. Mitral regurgitation	II
7. Pulmonary stenosis	I
8. Pulmonary regurgitation	I
9. Tricuspid stenosis	III
10. Tricuspid regurgitation	II
11. Prosthetic valve disease	II

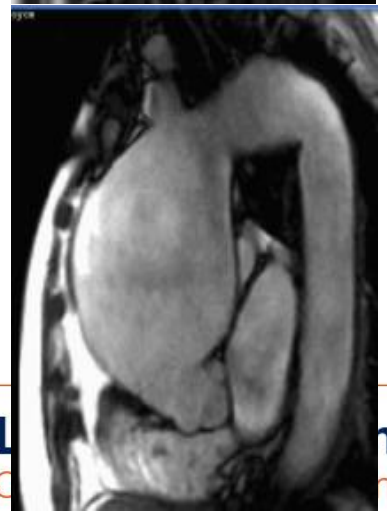
8. Patología de grandes vasos

4% de indicaciones

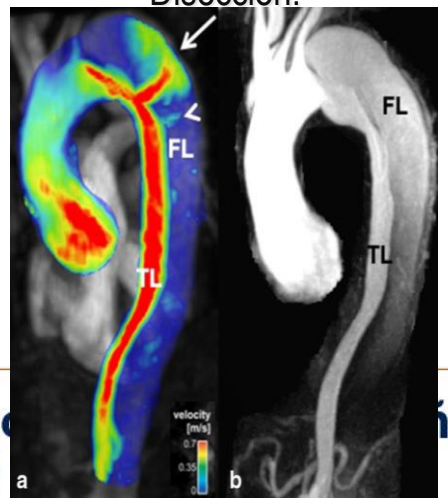
Estudio anatómico y funcional
Medición de velocidad de flujo, cuantificación p. valvular
AngioRM
¿Flujo 4D?

Aneurisma: localización, extensión, seguimiento
Disección, HIM, UPA

Aneurisma de aorta



Disección.



H.I.M.

U.P.A

Arteritis (Takayasu)

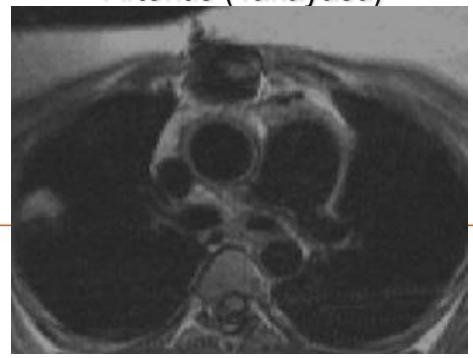


Table 2 Indications for CMR in acquired diseases of the vasculature

Indication	Class
1. Diagnosis and follow-up of thoracic aortic aneurysm including connective tissue diseases	I
2. Diagnosis and planning of stent treatment for abdominal aortic aneurysm	II
3. Follow-up of stented abdominal aortic aneurysm	III
4. Aortic dissection	
Diagnosis of acute aortic dissection	II
Diagnosis and follow-up of chronic aortic dissection	I
5. Diagnosis of aortic intramural hematoma	I
6. Diagnosis of penetrating aortic ulcers	I
7. Pulmonary artery anatomy and flow	I
8. Pulmonary emboli	
Diagnosis of central pulmonary emboli	III
Diagnosis of peripheral pulmonary emboli	III
Assessment of chronic pulmonary embolic disease	III
9. Assessment of aortic arch arteries	I
10. Assessment of aortic branch arteries including the Adamkiewicz artery	II
11. Assessment of carotid, vertebral and circle of Willis arteries	I
12. Assessment of upper extremity arteries	I
13. Assessment of hand arteries	II
14. Assessment of renal arteries	I
15. Assessment of mesenteric arteries	I
16. Assessment of pelvic and lower extremity arteries	I
17. Assessment of pulmonary veins	I
18. Assessment of thoracic, abdominal and pelvic veins	I
19. Assessment of lower extremity veins	I
20. Assessment of atherosclerotic plaque in the carotid artery	II
21. Assessment of atherosclerotic plaque in the aorta	II
22. Assessment of vascular wall inflammation in large and medium sized arteries	II
23. Assessment of aortic pulse wave velocity	Inv
24. Endothelial function	Inv

CRM puede proporcionar información exacta y reproducible para diagnóstico y pronóstico, y para decidir el manejo en un amplio espectro de patologías cardiovasculares

Los rápidos avances tecnológicos han permitido una expansión de la capacidad diagnóstica e indicaciones clínicas de la técnica