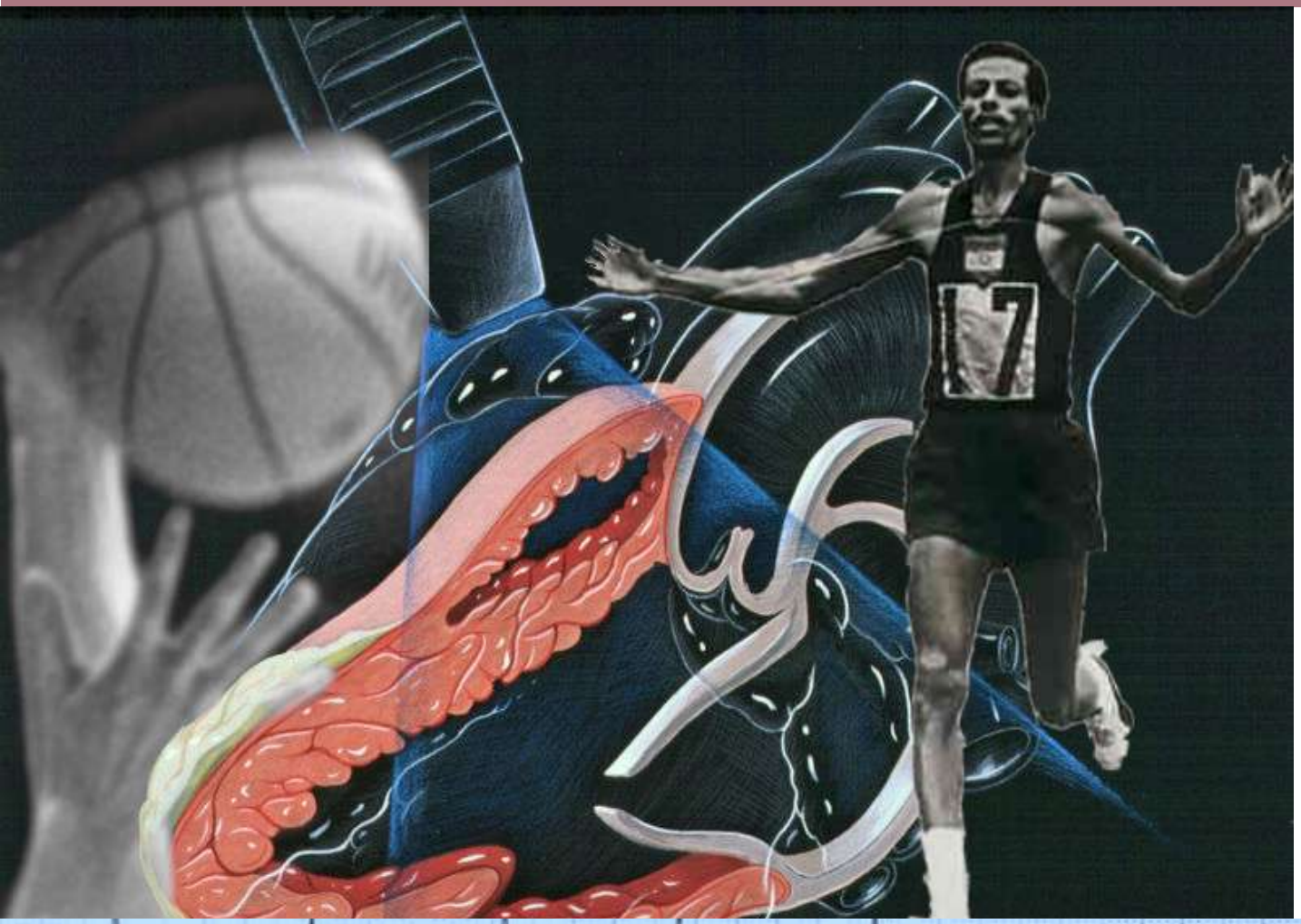
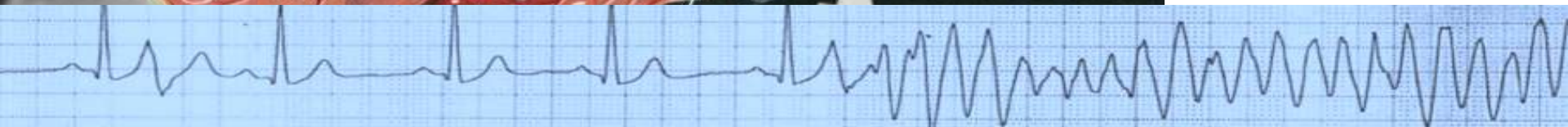
Gli esami strumentali cardiologici per il Medico dello Sport

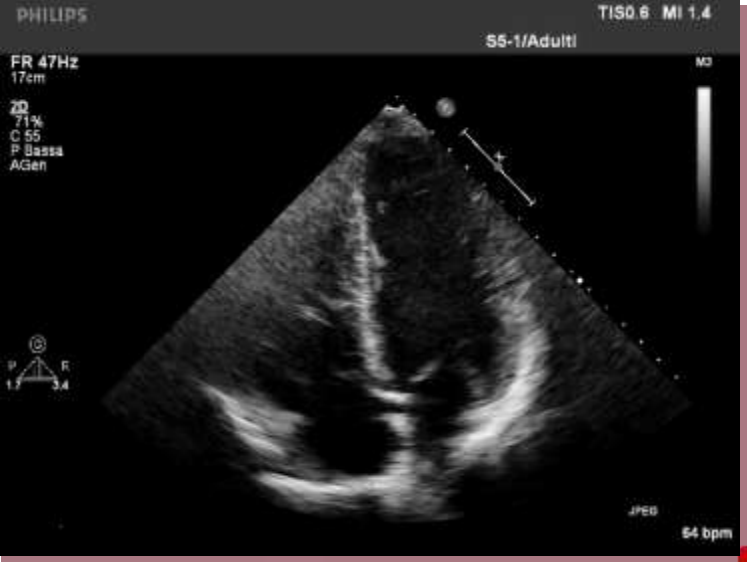


L'Ecocardiogramma

Renato Di Gaetano
Cardiologia - Bolzano

Südtiroler Sanitätsbetrieb
Azienda Sanitaria dell'Alto Adige
Azienda Sanitera de Sudtirol

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PHILIPS
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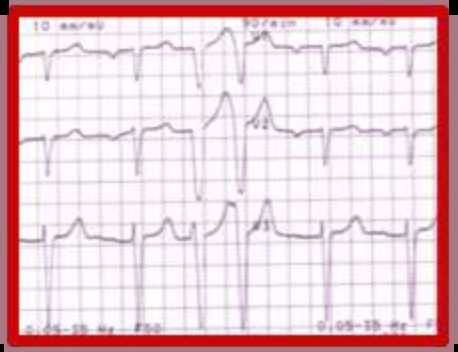

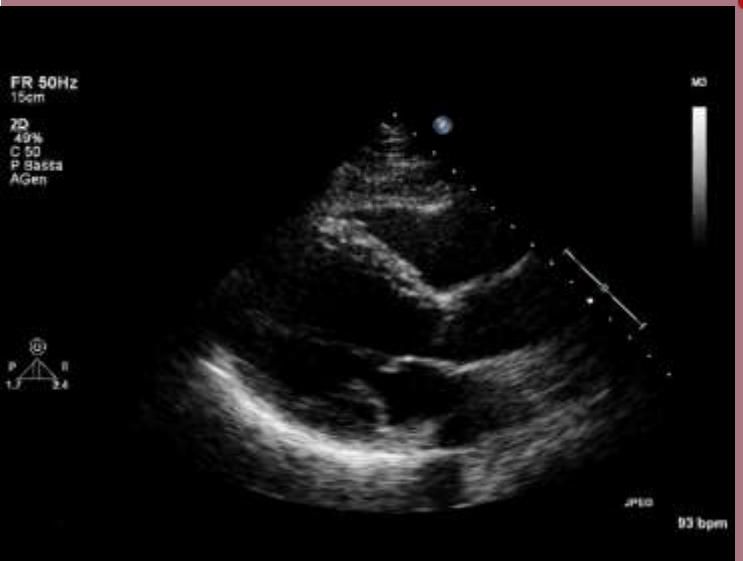
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C 50
P Bassa
AGen
M3
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55 bpm

Le indicazioni ai test di Imaging

Clinical history

SCD or CMP in family
Palpitations
Syncope
Chest pain

Physical examination

Cardiac murmus
Abnormal cardiac sound
Marfanoid Habitus

12-leads ECG

T wave inversion
ST-segment depression
Pathologic q waves
Complete LBBB
Abnormal Stress test

Indication to cardiovascular Imaging

Clinical indications to perform cardiovascular imaging studies in athletes


European Association of Preventive Cardiology (EAPC) and European Association of Cardiovascular Imaging (EACVI) joint position statement: recommendations for the indication and interpretation of cardiovascular imaging in the evaluation of the athlete's heart

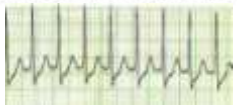
Clinical history:	Imaging tests of choice	Heart disease	Additional testing
SCD in the family Known cardiomyopathy in the family	Echocardiography CMR	Cardiomyopathies Mitral valve prolapse	Clinical and genetic family screening in selected cases
Palpitations	Echocardiography	Cardiomyopathies	Consider 24-h and/or long-term ambulatory ECG monitoring and/or electrophysiological study in selected cases
Syncope	CMR	Coronary artery disease/ anomalies	CT according to clinical suspicion Consider stress echo to rule out LV outflow obstruction
Chest pain	Echocardiography	Coronary artery disease/ anomalies	Consider the risk profile, age and radiation exposure
	CMR CT Nuclear imaging		Consider exercise stress imaging

Physical examination	Imaging tests of choice	Heart disease	Additional testing
Cardiac murmurs Abnormal cardiac sound	Echocardiography	Valvular heart disease Congenital heart defects	Additional tests on the basis of echocardiographic findings and clinical suspicion (e.g. CMR)
Marfanoid habitus	Echocardiography CT CMR	Marfan disease	Clinical and genetic family screening Accurate evaluation of thoracic aorta

European Heart Journal (2018) 39, 1949–1969

Clinical indications to perform cardiovascular imaging studies in athletes

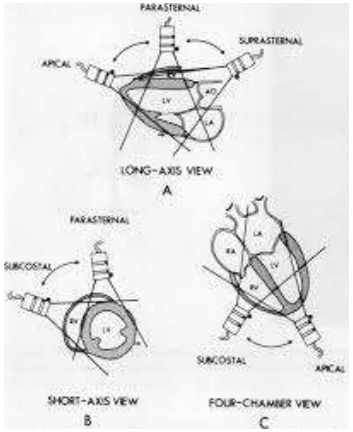
12-leads electrocardiogram	Imaging tests of choice	Heart disease	Additional testing
T-wave inversion	Echocardiogram CMR	Cardiomyopathies Myocarditis	Clinical and genetic family screening Annual follow-up with imaging tests in athletes with normal findings at initial evaluation
ST-segment depression	Echocardiogram CMR	Cardiomyopathies Myocarditis Coronary artery disease Valve disease	Consider exercise stress imaging Coronary CT or nuclear imaging in athletes with clinical suspicion of coronary artery disease
Pathologic Q-waves	Echocardiogram CMR	Cardiomyopathies Myocarditis Coronary artery disease	Consider exercise stress imaging Coronary CT or nuclear imaging in athletes with clinical suspicion of coronary artery disease
Complete LBBB	Echocardiogram CMR CT Nuclear imaging	Cardiomyopathies Myocarditis Cardiac sarcoidosis Valve disease Coronary artery disease/ anomalies	Comprehensive cardiac evaluation for exclusion of heart disease Consider exercise stress imaging
Bifascicular block (RBBB and left anterior hemiblock)	Echocardiogram	Cardiomyopathies Myocarditis Cardiac sarcoidosis Coronary artery disease	Additional tests on the basis of echocardiographic findings and clinical suspicion
Non-specific intraventricular conduction delay	Echocardiogram	Cardiomyopathies Coronary artery disease/ anomalies	Additional tests on the basis of echocardiographic findings and clinical suspicion
Minor non-voltage criteria for LV or RV hypertrophy (atrial enlargement and QRS axis deviation)	Echocardiogram	Cardiomyopathies Valve disease Congenital heart disease Pulmonary hypertension	Additional tests on the basis of echocardiographic findings and clinical suspicion
Abnormal exercise testing (repolarization abnormalities/ symptoms/arrhythmias)	Echocardiography CMR CT Nuclear imaging	Coronary artery disease/ anomalies Cardiomyopathies Myocarditis	Consider the cardiovascular risk profile and age Consider also exercise stress imaging Low-radiation examinations advised in young individuals



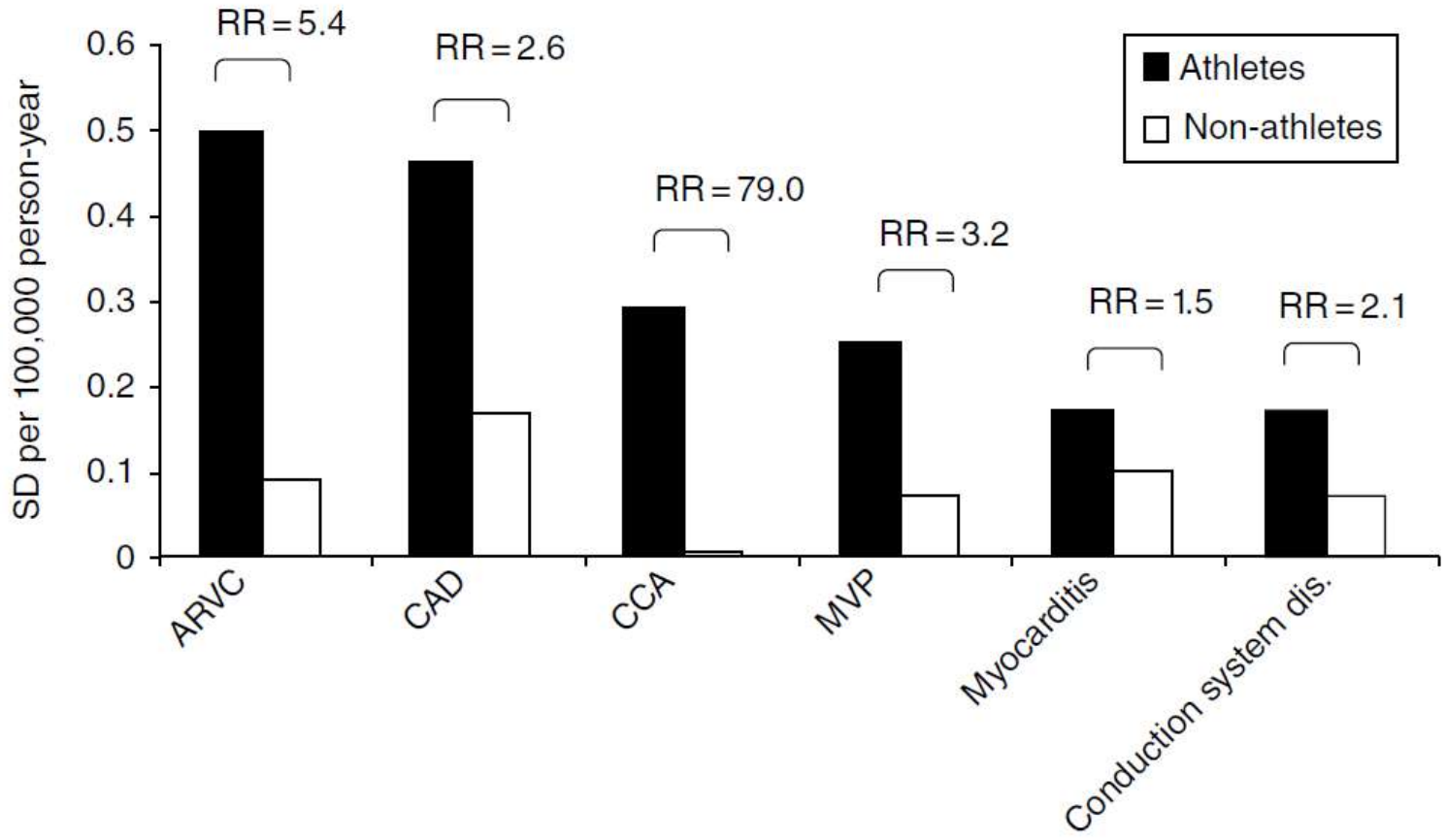
European Heart Journal (2018) 39, 1949–1969

Most common aetiologies of sudden cardiac death in athletes

Heritability	Structurally abnormal heart	Structurally normal heart
Inherited	Cardiomyopathies	Channelopathies
	HCM	Long QT syndrome
	ARVC	Brugada syndrome
	IDCM	Cathecol-aminergic polimorphic ventricular tachycardia
	Congenital coronary anomalies	
	Bridged coronary arteries	Wolff–Parkinson–White
	Aortic diseases	
Acquired	Myocardial ischaemia	Commotio cordis
	Myocarditis	Drugs and stimulants
	Cardiac sarcoidosis	Electrolyte imbalance
	Valvular heart disease	



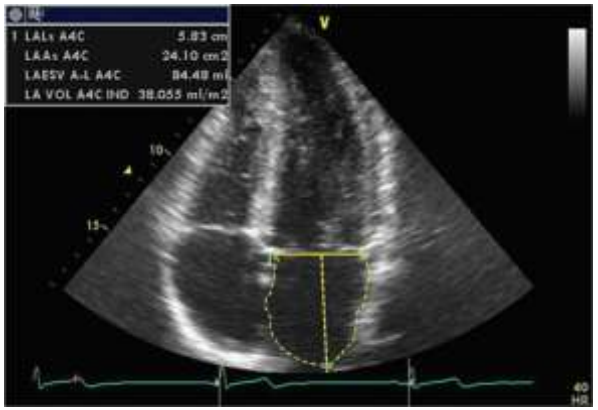
Incidence and relative risk of sudden cardiac death in athletes for specific cardiovascular causes



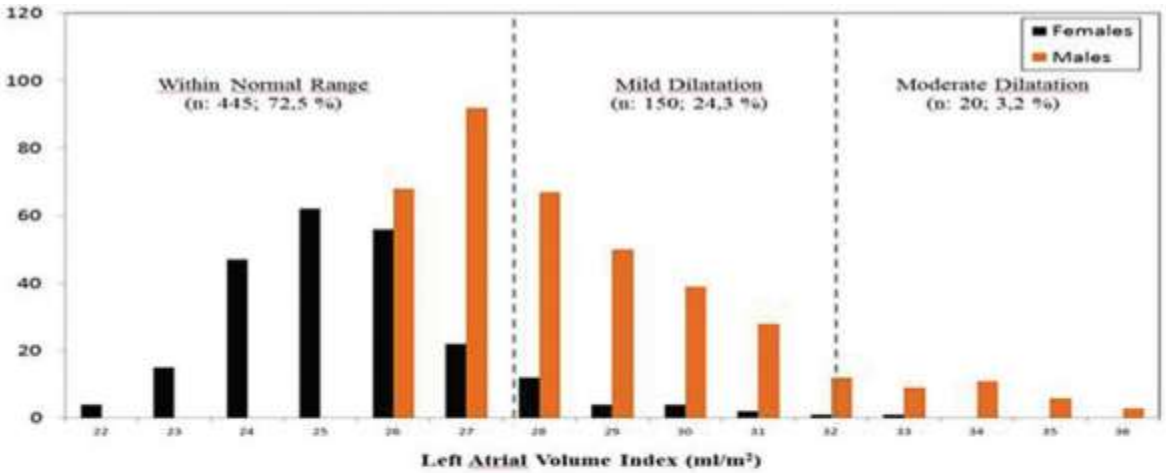
Key echocardiographic measurements to be measured in athletes

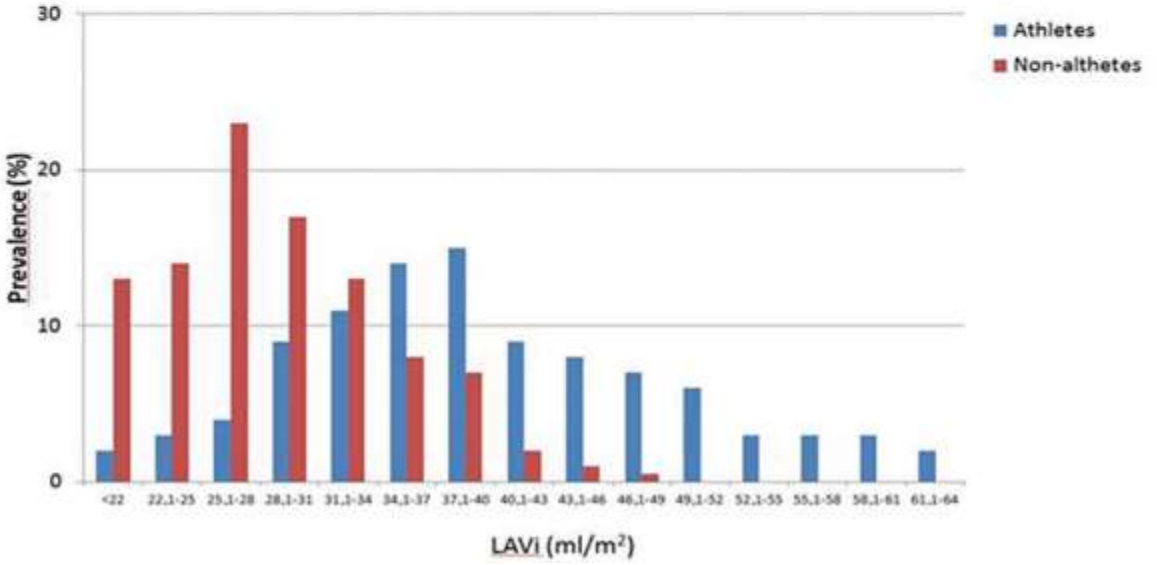
Left ventricle	Right ventricle
LV mass index (g/m^2)	RV free wall (mm)
LV end-diastolic volume (mL)	RV basal diameter (mm)
Septal wall thickness (mm)	RV base to apex diameter (mm)
LV EF (%)	TAPSE (mm)
LV SV (mL)	IVC size (mm)
LV CO (L/min)	IVC respiratory reactivity (%)
Transmitral E/A ratio	
E velocity deceleration time (ms)	
Annular s′ velocity (ms)	
Annular e′ velocity (cm/s)	
E/e′ ratio	
e′/a′ ratio	

Key echocardiographic measurements to be measured in athletes



Left atrial size





Am Heart J 2010;159:1155–61

Eur J Echocardiogr 2011;12:826–33.

Average and upper limits of the main echocardiographic LV parameters in elite athletes

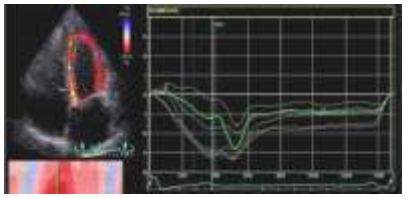
Type of sport	Parameter	Average value	Upper limit	No athletes
Endurance/strength	LV end-diastolic diameter (adult male) (mm)	55	70	50.2
Endurance/strength	LV end-diastolic diameter (adult female) (mm)	49	66	45
Endurance/strength				
Endurance	LV end-diastolic diameter (adolescent) (mm)	51	60	
Endurance/strength	LV wall end-diastolic thickness (adult male) (mm)	10	16	6 –10
Endurance /strength	LV wall end-diastolic thickness (adult female) (mm)	9.5	13	6 – 9
Endurance/strength	LV wall end-diastolic thickness (adolescent) (mm)	9.5	12	
Endurance/strength	LV wall end-diastolic thickness (black athlete) (mm)	11.5	16	
Endurance/strength	LA diameter (male) (mm)	37	50	30-40
	LA diameter (female) (mm)	32	45	27-38
Endurance/strength	LA volume index (male) (ml/m^2)	28	36	15-23
	LA volume index (female) (mL/m^2)	26.5	33	15-23
Endurance /strength	IVS Tissue Doppler s′ (cm/s)	13	18	
	IVS Tissue Doppler e′ (cm/s)	24	21	13-17
	LV Tissue Doppler s′ (cm/s)	15	20	
	LV Tissue Doppler e′ (cm/s)	16	22	
	LV Tissue Doppler e′/a′ (cm/s)	1.45	1.7	1.18

Average and upper limits of the main echocardiographic LV parameters in elite athletes

Type of sport	Parameter	Average value	Upper limit	No athletes
Endurance/power	RV end-diastolic diameter (basal) (RVD1) (mm) (male)	43.5	55	33
	RV end-diastolic diameter (basal) (RVD1) (mm) (female)	39	49	31
	RV end-diastolic diameter (middle ventricle) (RVD2) (mm) (male)	34	47	27
	RV end-diastolic diameter (middle ventricle) (RVD2) (mm) (female)	32	43	25
	RV end-diastolic diameter (base-to-apex) (RVD3) (mm) (male)	89	109	
	RV end-diastolic diameter (base-to-apex) (RVD3) (mm) (female)	82	100	
	RV proximal outflow tract diameter (RVOT1) (mm) (male)	32	43	28
	RV proximal outflow tract diameter (RVOT1) (mm) (female)	30	40	36
	RV distal outflow tract diameter (RVOT2) (mm) (male)	23.5	32	22
	RV distal outflow tract diameter (RVOT2) (mm) (female)	21.5	29	20
Endurance	RA area (cm^2/m^2) (male)	19.5	28	19 – 29
	RA area (cm^2/m^2) (female)	15.5	24	17 - 27
Endurance/power	Pulmonary artery systolic pressure (mmHg)	24	40	20
Endurance/power	TAPSE (cm)	2.1	2.6	1.9 – 2.5
	RV area change (%)	48.5	54	49 +/- 7

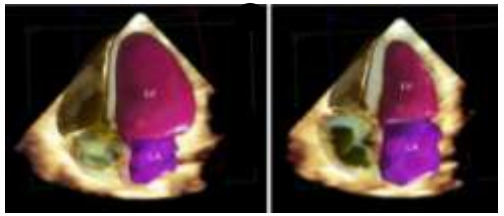
Indication to complete the routine echocardiographic evaluation by speckle-tracking or by 3D chocardiography

Indications for speckle-tracking echocardiography



- Identification of pre-clinical anomalies useful to the differential diagnosis between athlete's heart and early DCM (LV)
- Identification of pre-clinical anomalies useful to the differential diagnosis between athlete's heart and early HCM (LV)
- Characterization of regional wall motion abnormalities (LV and RV)

Indications for 3D echocardiography

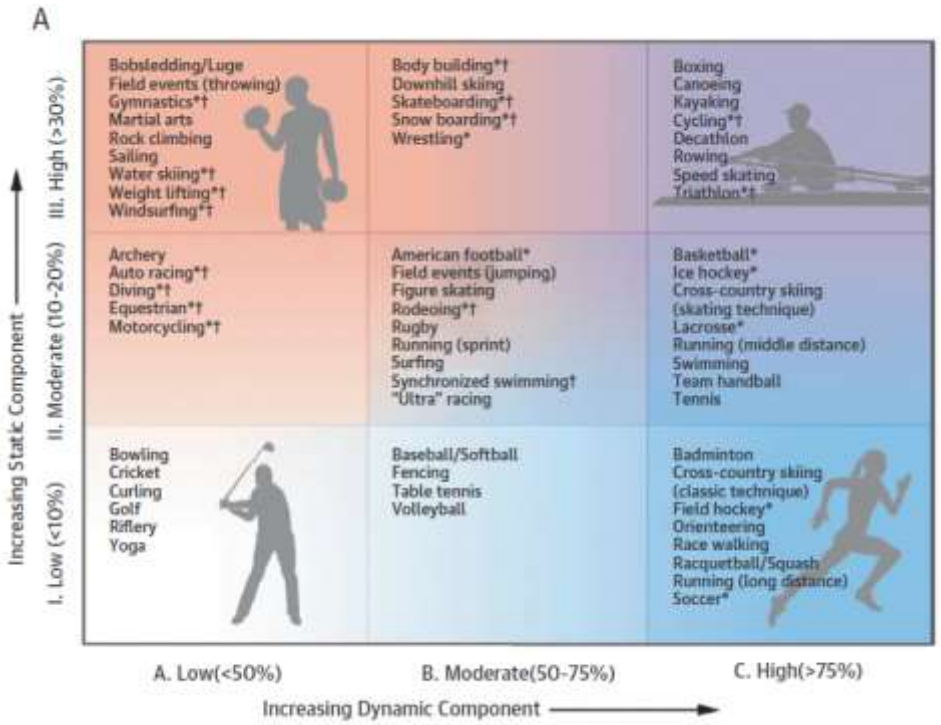


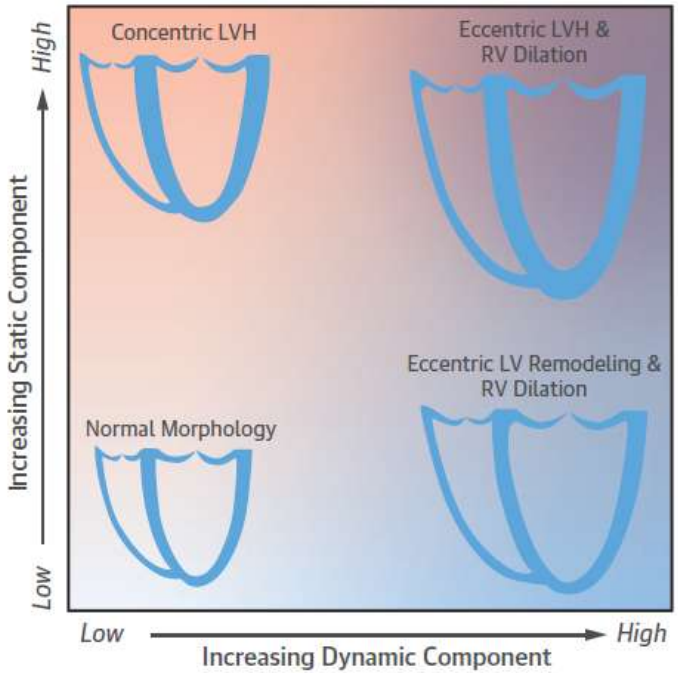
- Better assessment of LV volumes and function
- Assessment of pattern of LV geometry
- Quantification of the extent of LV trabeculation

Athlete's characteristics

The Interplay Between Exercise Physiology and EICR

Physiological classification of common sporting disciplines





Sports Cardiology

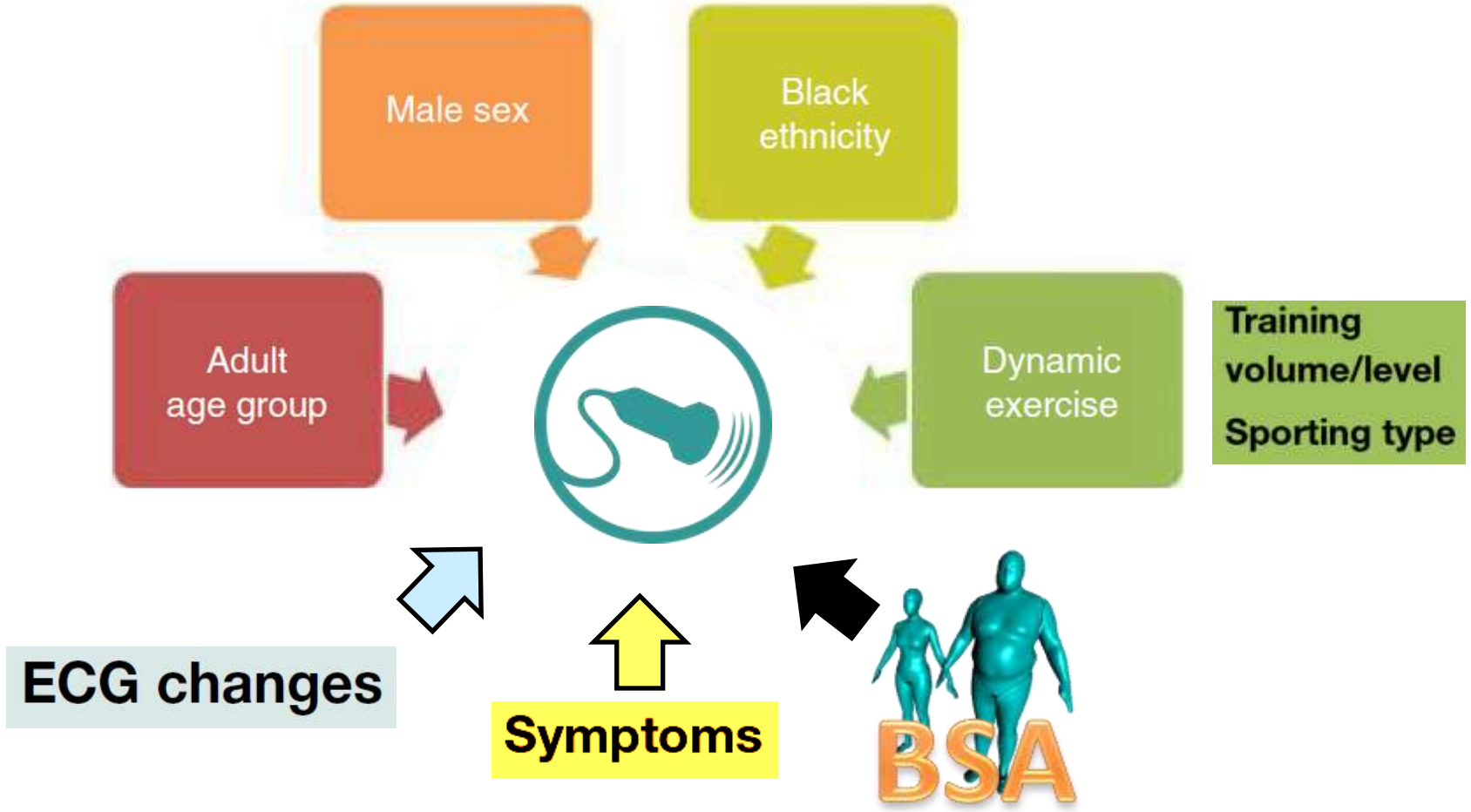
Core Curriculum for Providing Cardiovascular Care to Competitive Athletes and Highly Active People

Aaron L. Baggish, MD,[a] Robert W. Battle, MD,[b] James G. Beckerman, MD,[c] Alfred A. Bove, MD, PhD,[d] Rachel J. Lampert, MD,[e] Benjamin D. Levine, MD,[f] Mark S. Link, MD,[f] Matthew W. Martinez, MD,[g] Silvana M. Molossi, MD, PhD,[h] Jack Salerno, MD,[i] Meagan M. Wasfy, MD,[a] Rory B. Weiner, MD,[a] Michael S. Emery, MD,[j] for the ACC's Sports and Exercise Council Leadership Group

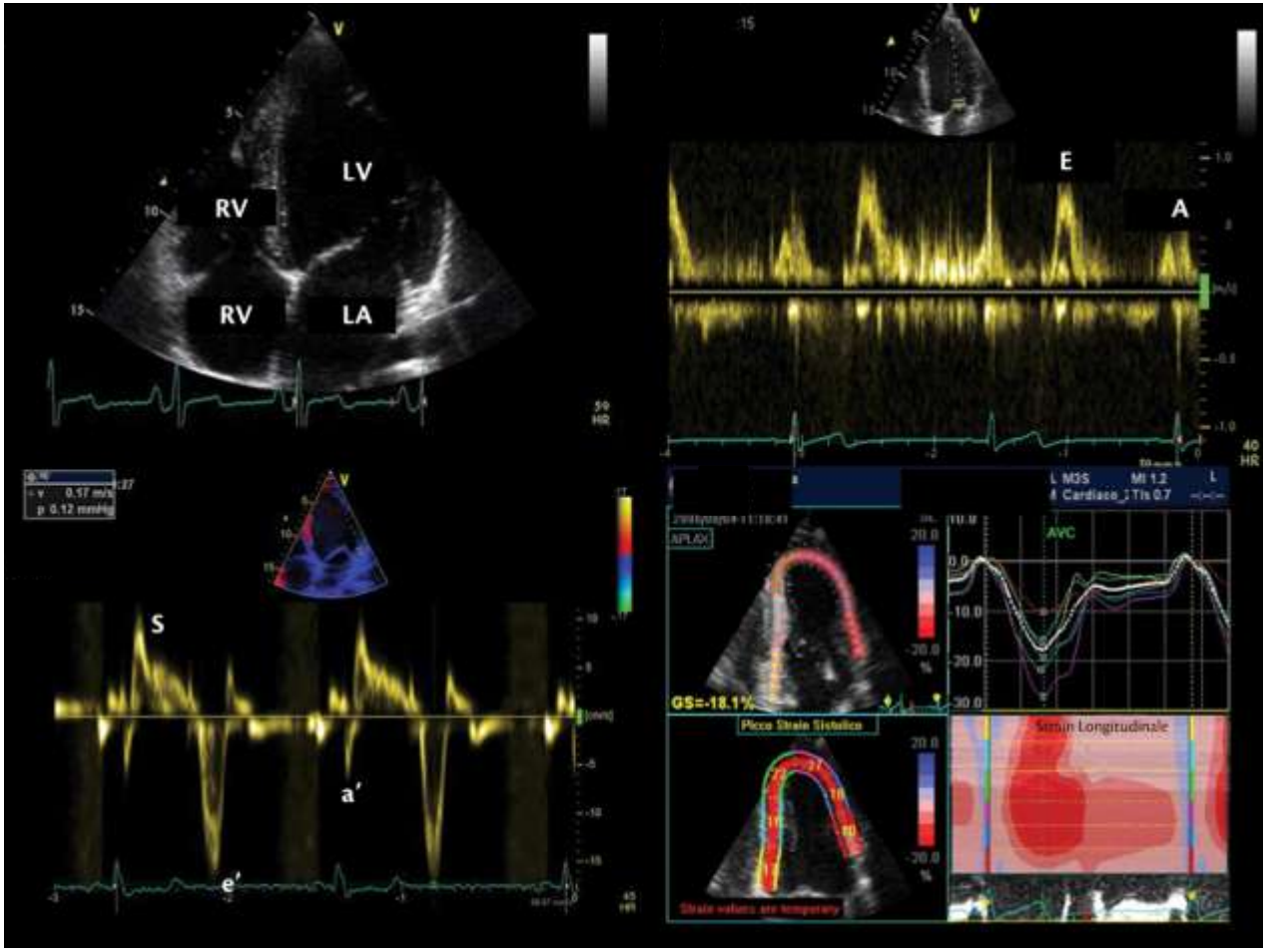
J Am Coll Cardiol 2017;70:1902–18

Athlete's characteristics and Echocardiography

Demographic factors that require consideration prior to examination



Athlete’s left heart



A 25-year-old male competitive endurance athlete (swimmer)

Athlete's left heart

European Journal of Echocardiography (2009) 10, 350–356
doi:10.1093/ejechocard/jep017

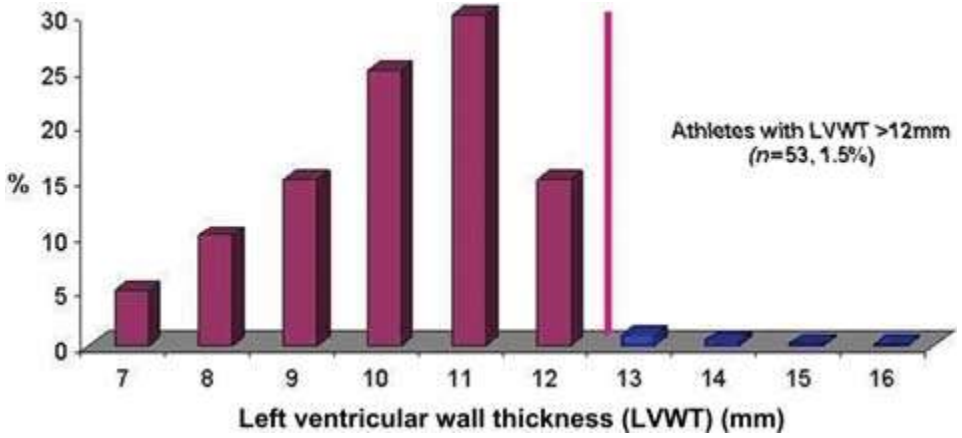
REVIEW PAPER

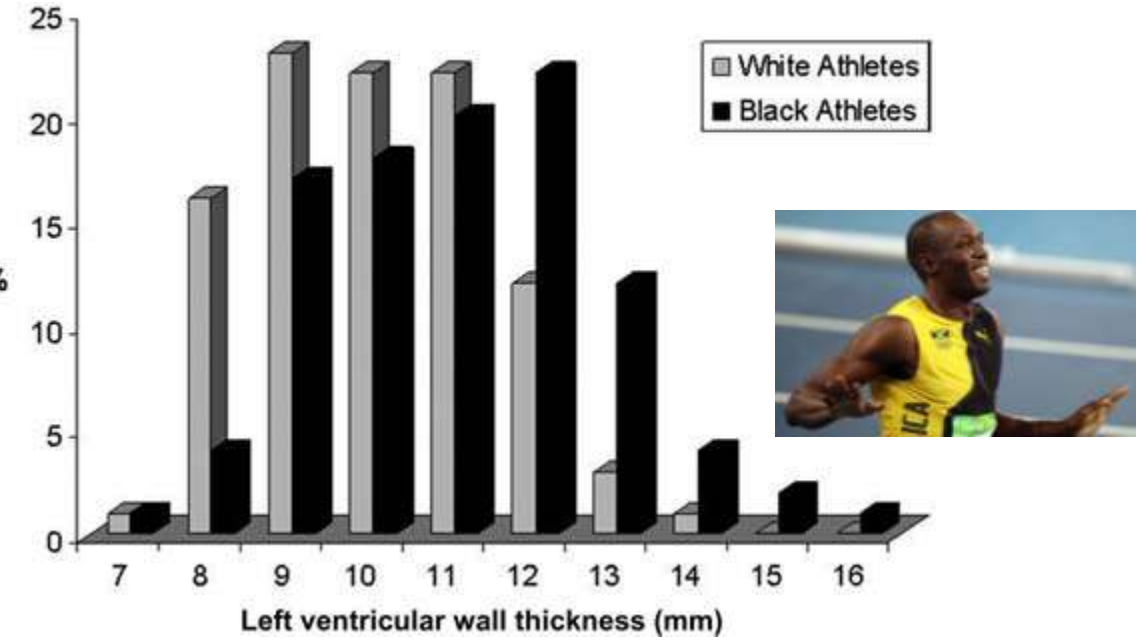
Left ventricular hypertrophy in athletes

John Rawlins, Amit Bhan, and Sanjay Sharma*

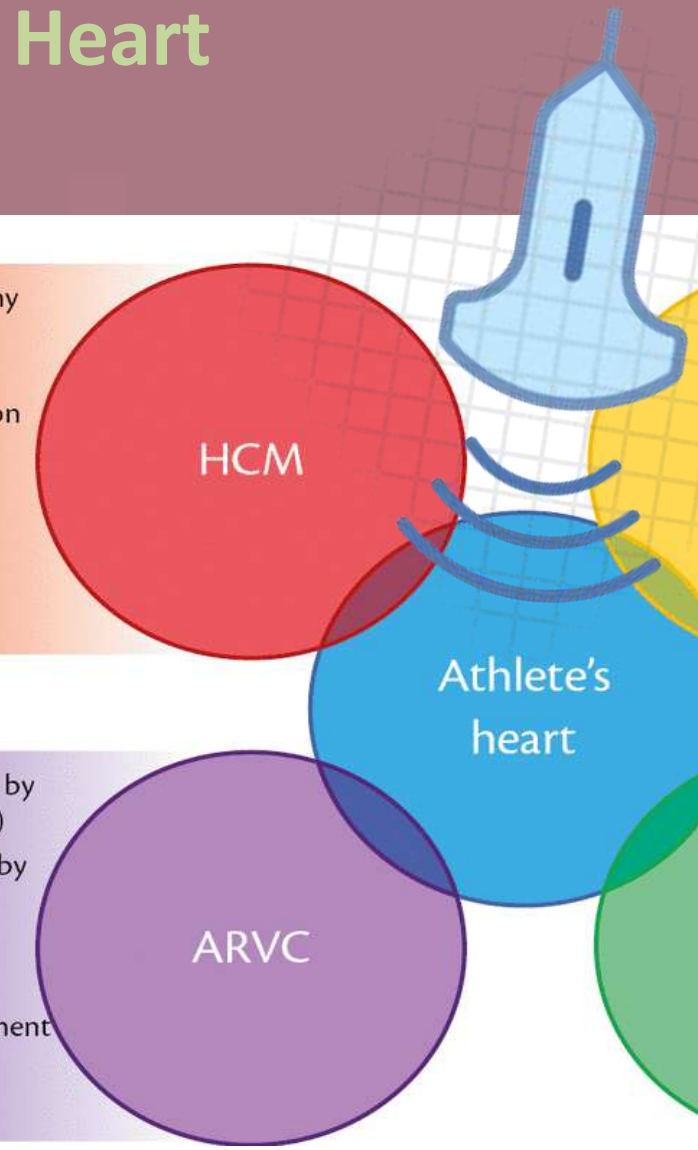
King's College Hospital, Denmark Hill, London SE5 9RS, UK

Received 8 January 2009; accepted after revision 7 February 2009; online publish-ahead-of-print 26 February 2009





Athlete's Heart



- Asymmetric LV hypertrophy
- LV cavity <54 mm
- RWT >0.45
- LV outflow tract obstruction
- Diastolic dysfunction
- E' velocity <8 cm/s
- GLS <−15%
- Positive LGE
- No major changes with deconditioning

- Disproportionate LV enlargement in relation to RV
- Resting EF <45%
- No substantial increase in EF with exercise echo
- Diastolic impairment
- GLS <−15%
- Positive LGE

- RV enlargement as defined by major TFC (indexed values)
- RV dysfunction as defined by major TFC
- Regional wall motion abnormalities
- Dysproportionate enlargement of the RV compared to LV
- Positive LGE

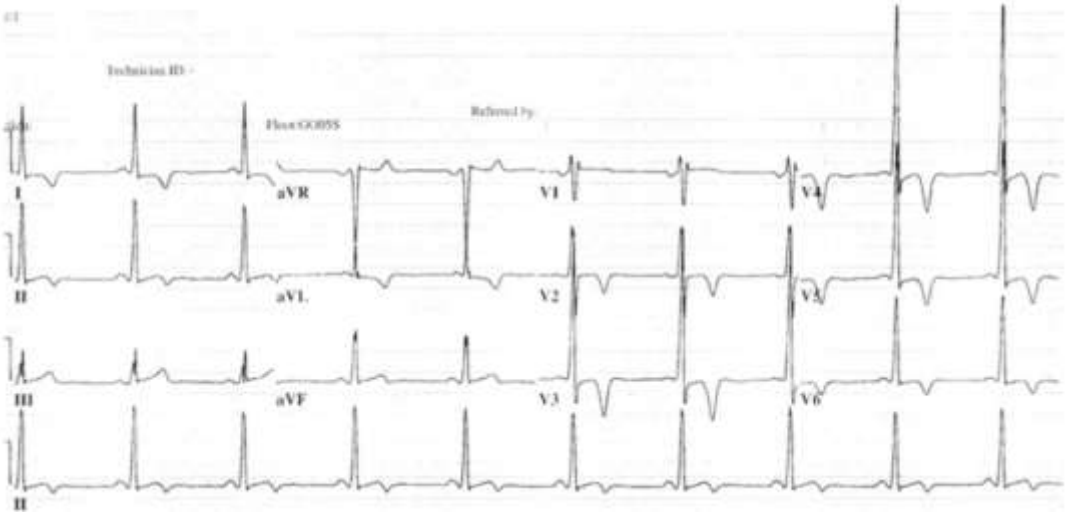
- N/C >2.0 in systole
- Reduced thickness of the compact layer <8 mm in systole.
- LV systolic dysfunction (EF<50%)
- LV diastolic dysfunction
- Positive LGE

Imaging testing should be interpreted in the context of clinical presentation (symptoms, ECG abnormalities, arrhythmias) and family history

Hypertrophic Cardiomyopathy

Table 13.1 Proposed criteria for diagnosis of HCM in adult members of affected families

Major criteria	Minor criteria
Echocardiography	
LV wall thickness ≥13 mm in the anterior septum or posterior wall or ≥15 mm in the posterior septum or free wall	LV wall thickness ≥12 mm in the anterior septum or posterior wall or ≥14 mm in the posterior septum or free wall
Severe SAM	Moderate SAM
	Redundant mitral valve leaflets



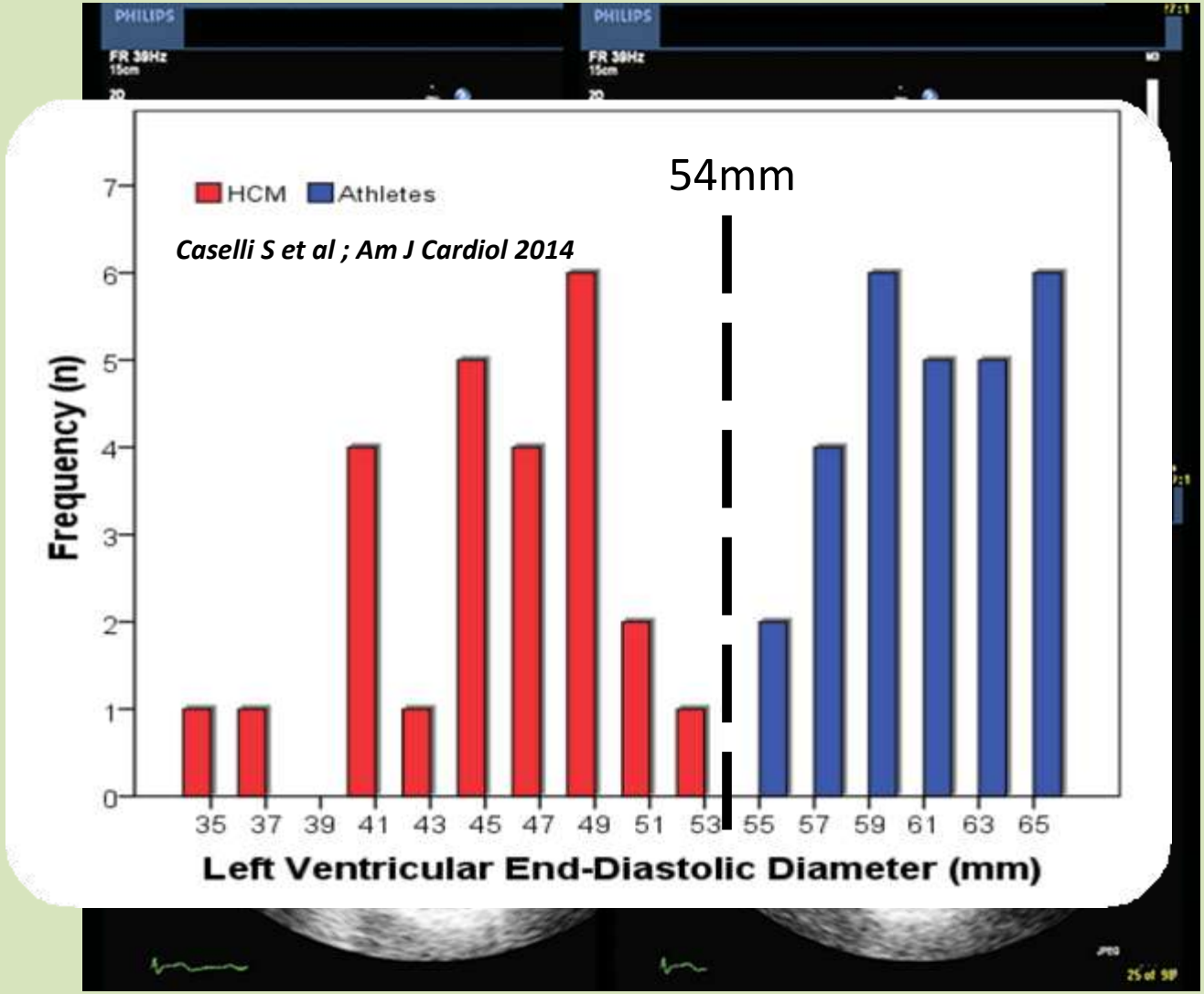
Hypertrophic Cardiomyopathy

LVWT 13mm

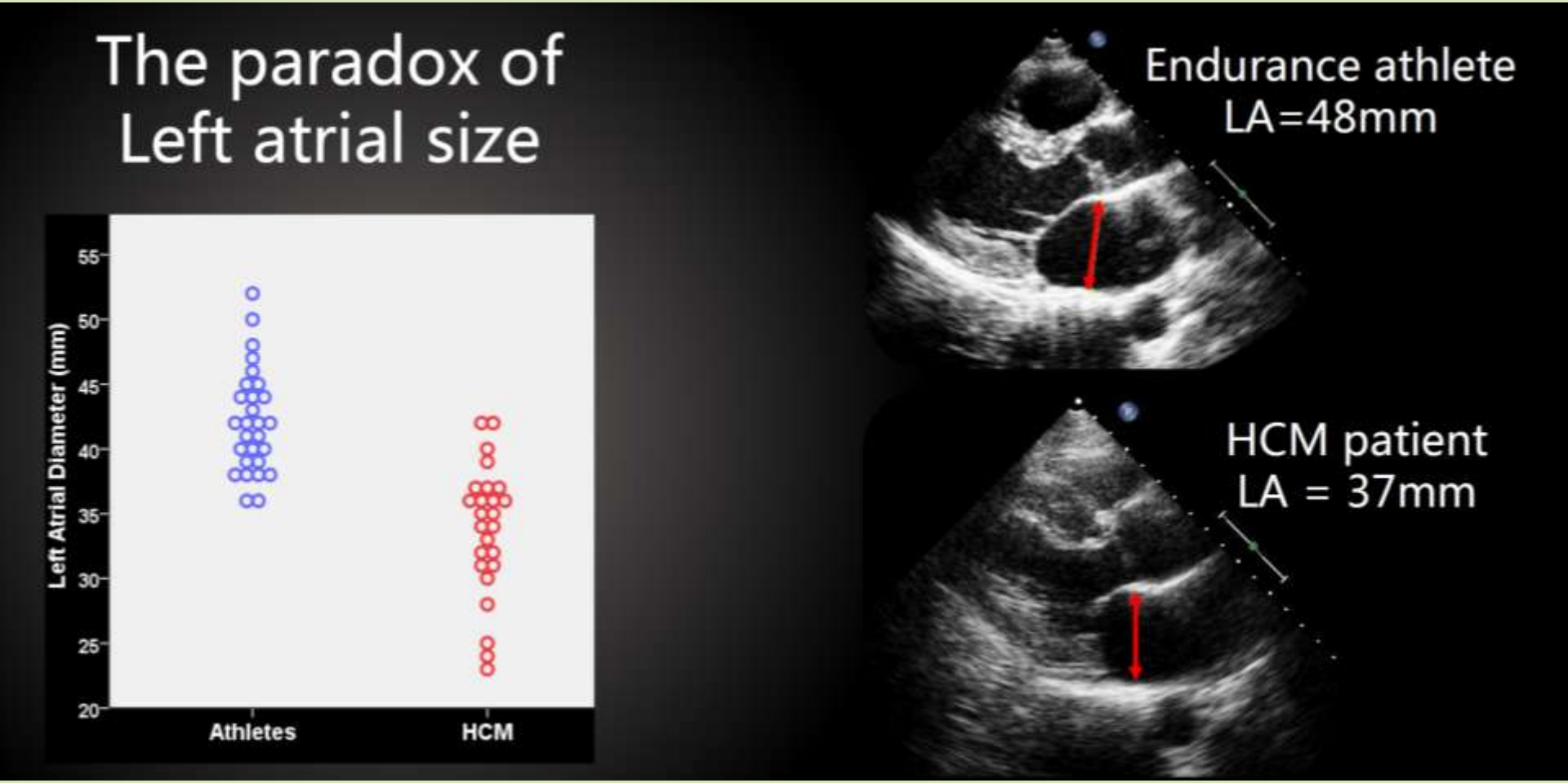
LVDd 58mm

LVWT 13mm

LVDd 44mm



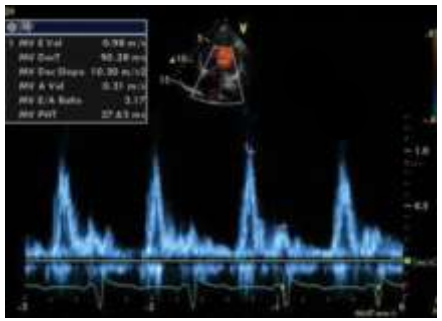
Hypertrophic Cardiomyopathy

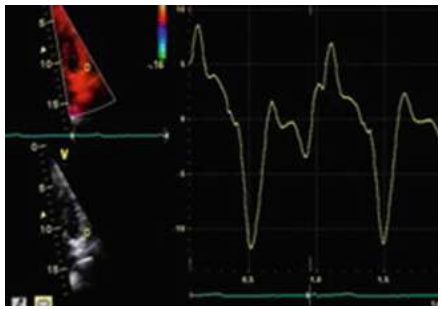


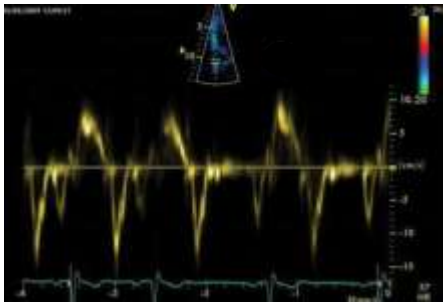
Caselli S et al ; Am J Cardiol 2014

Hypertrophic Cardiomyopathy

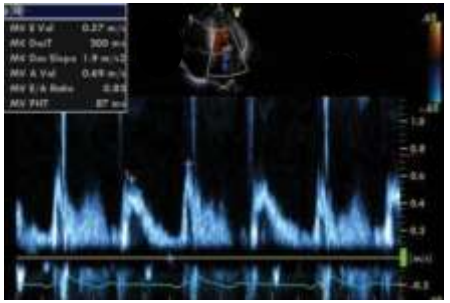
Normal

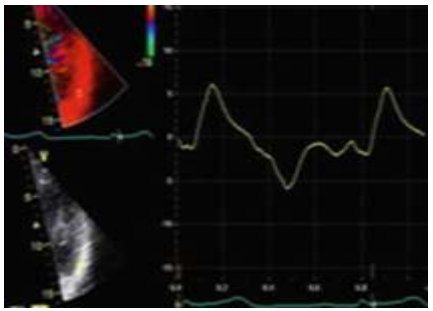


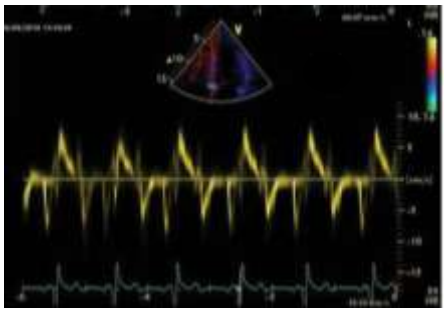




HCM

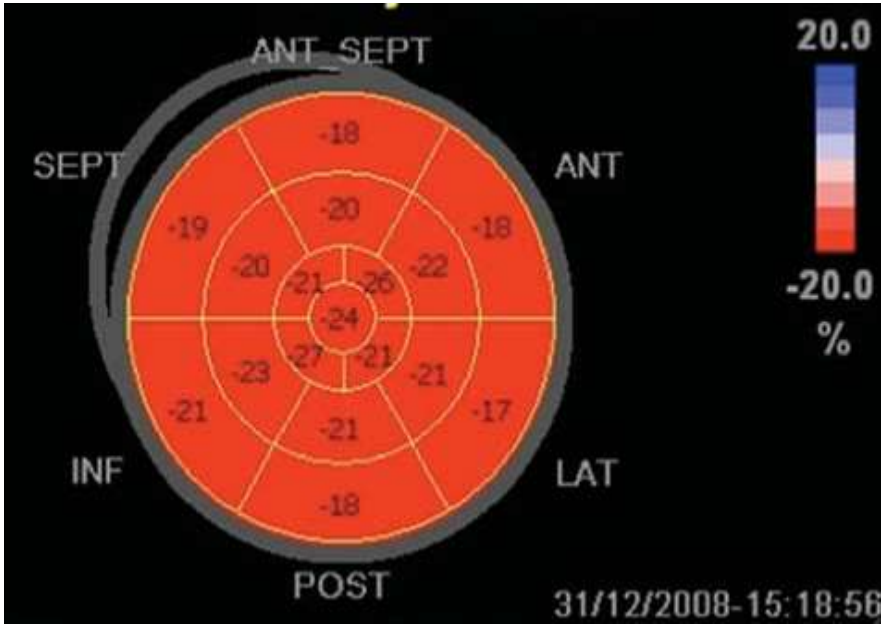




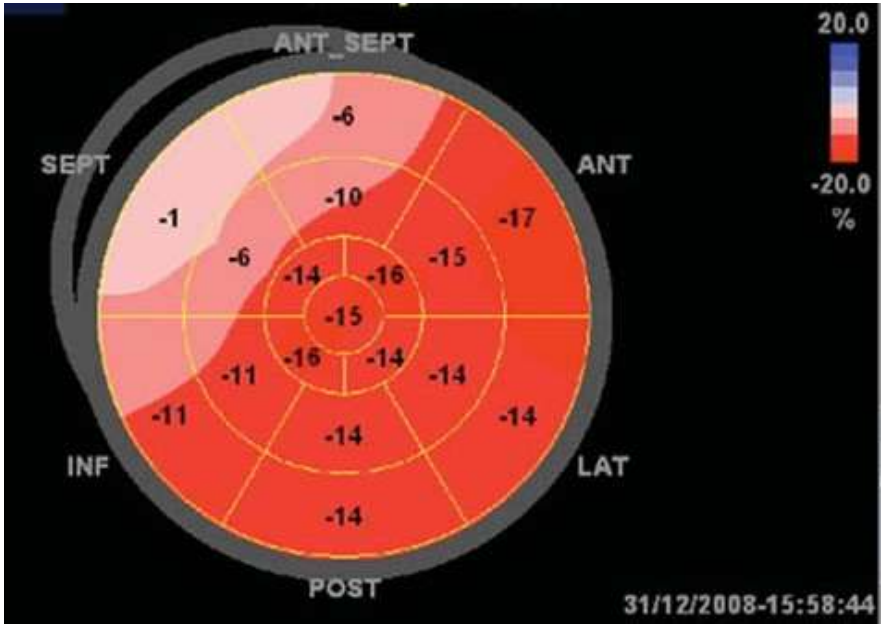


Hypertrophic Cardiomyopathy

Normal



HCM



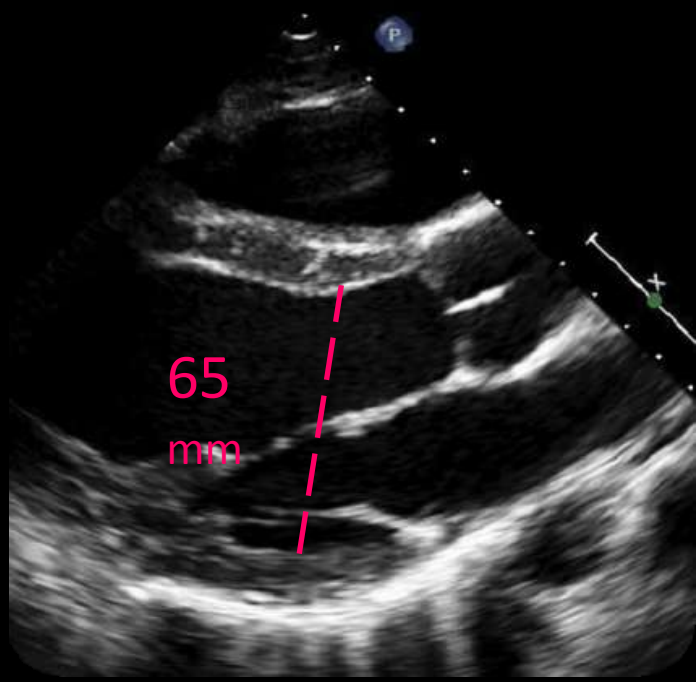
Dilatative Cardiomyopathy

- LV cavity size may exceed 60mm in 14% of athletes.
(Pelliccia Ann Int Med 1999)

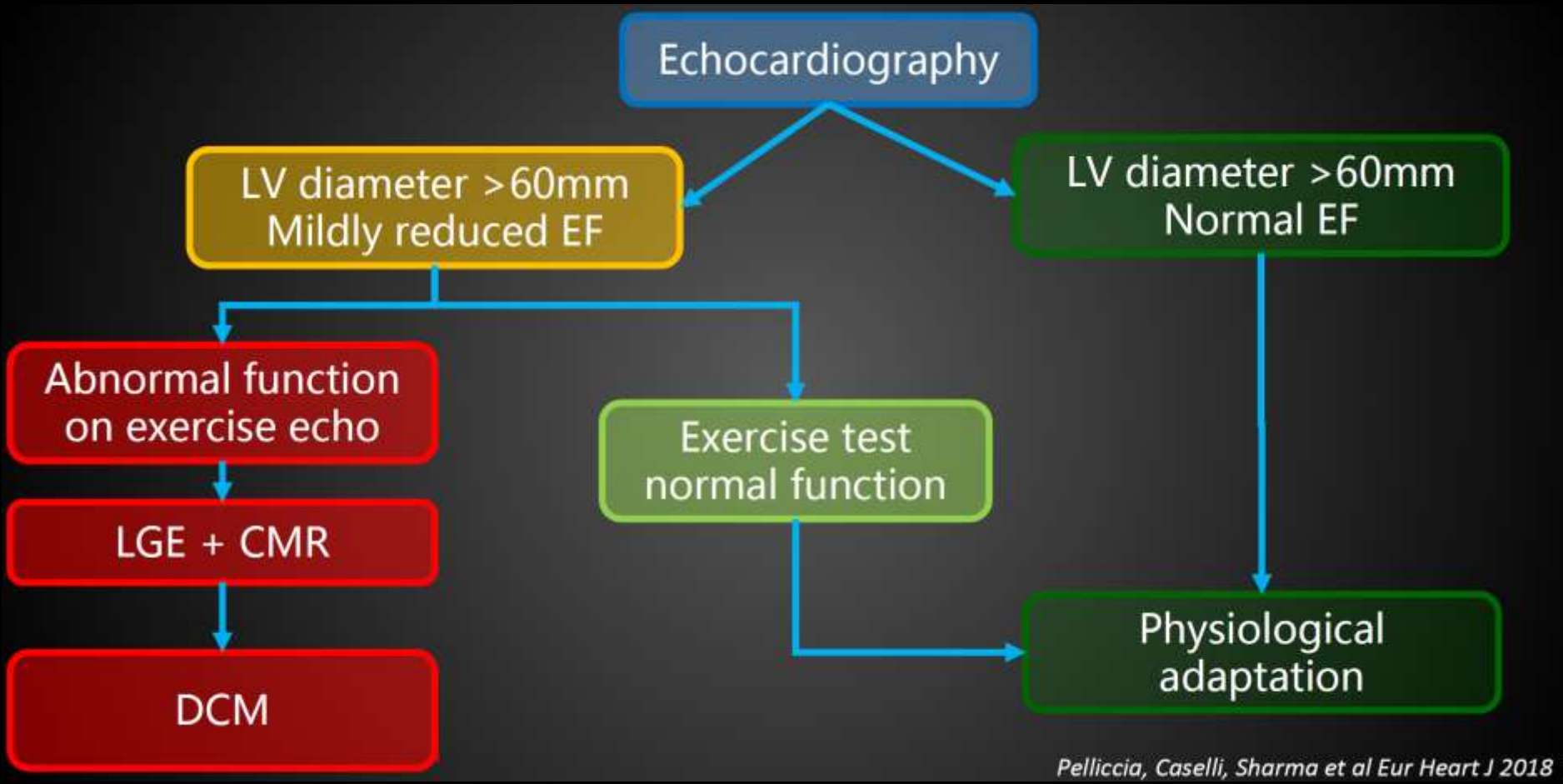
- Ejection fraction is usually preserved:

  - 1145 Italian Olympic Athletes
  EF > 50% in all
  (Caselli S et al JASE 2015)

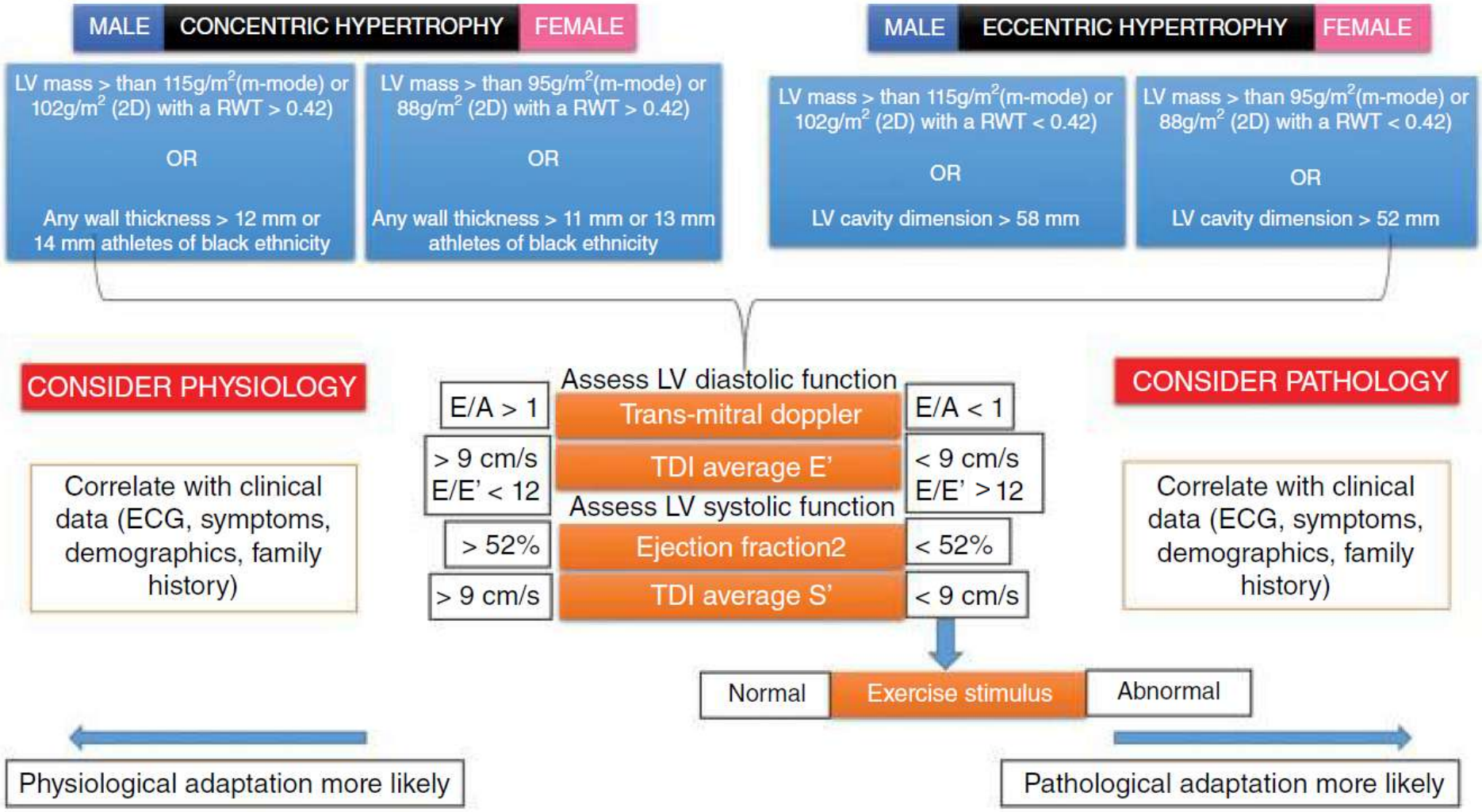
  - 526 NBA basketball player
  EF < 50% in <1%
  (Engel D et al. JAMA Cardiology 2016)



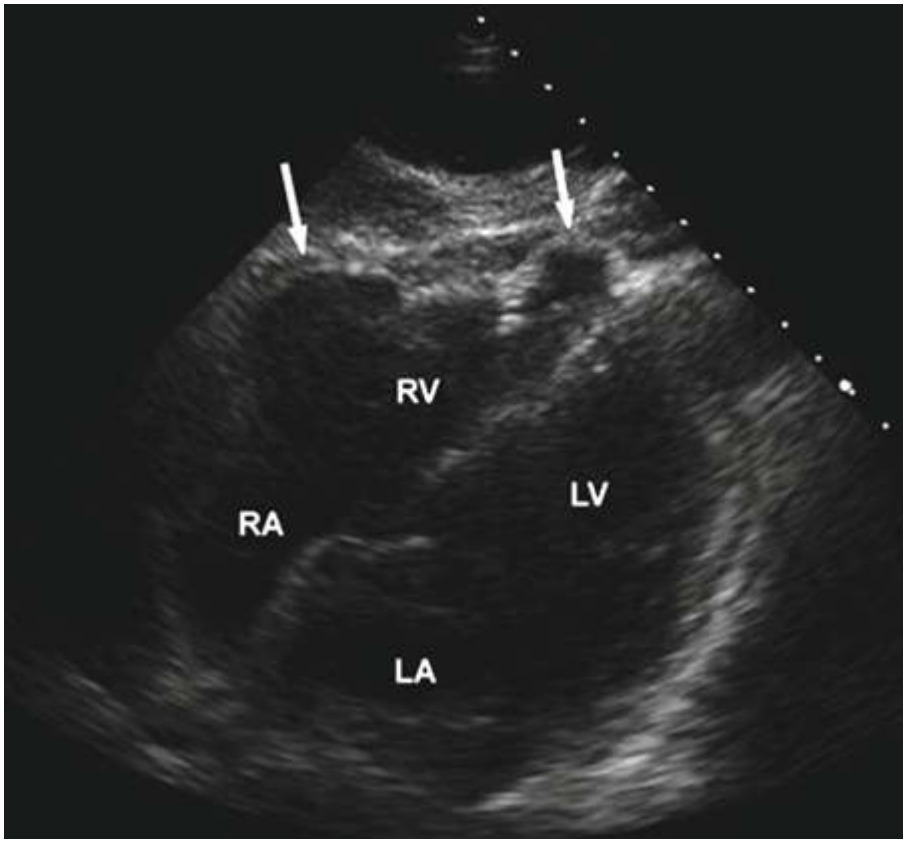
Dilatative Cardiomyopathy



Left ventricular Disfunction



Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy



Frequency of qualitative echocardiographic abnormalities in probands with arrhythmogenic right ventricular dysplasia/cardiomyopathy

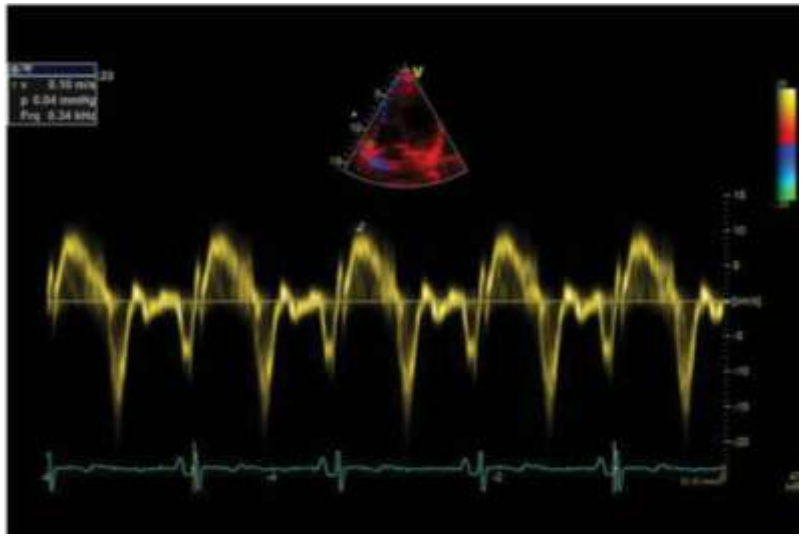
	Number	Percent
RV global function		
Normal	11	38
Mildly reduced	8	28
Severely reduced	10	34
RV regional WMA	23	79
RVOT	13	45
Anteroseptal	16	55
Anterior	20	70
Apex	21	72
Septal	16	55
Inferior basal	17	59
Inferior apical	15	52
Hyperreflective moderator band	9	31
Excessive/abnormal trabeculations	15	54
Sacculations	5	17

Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy

Tissue Doppler and strain echocardiography measurements in patients with ARVD/C

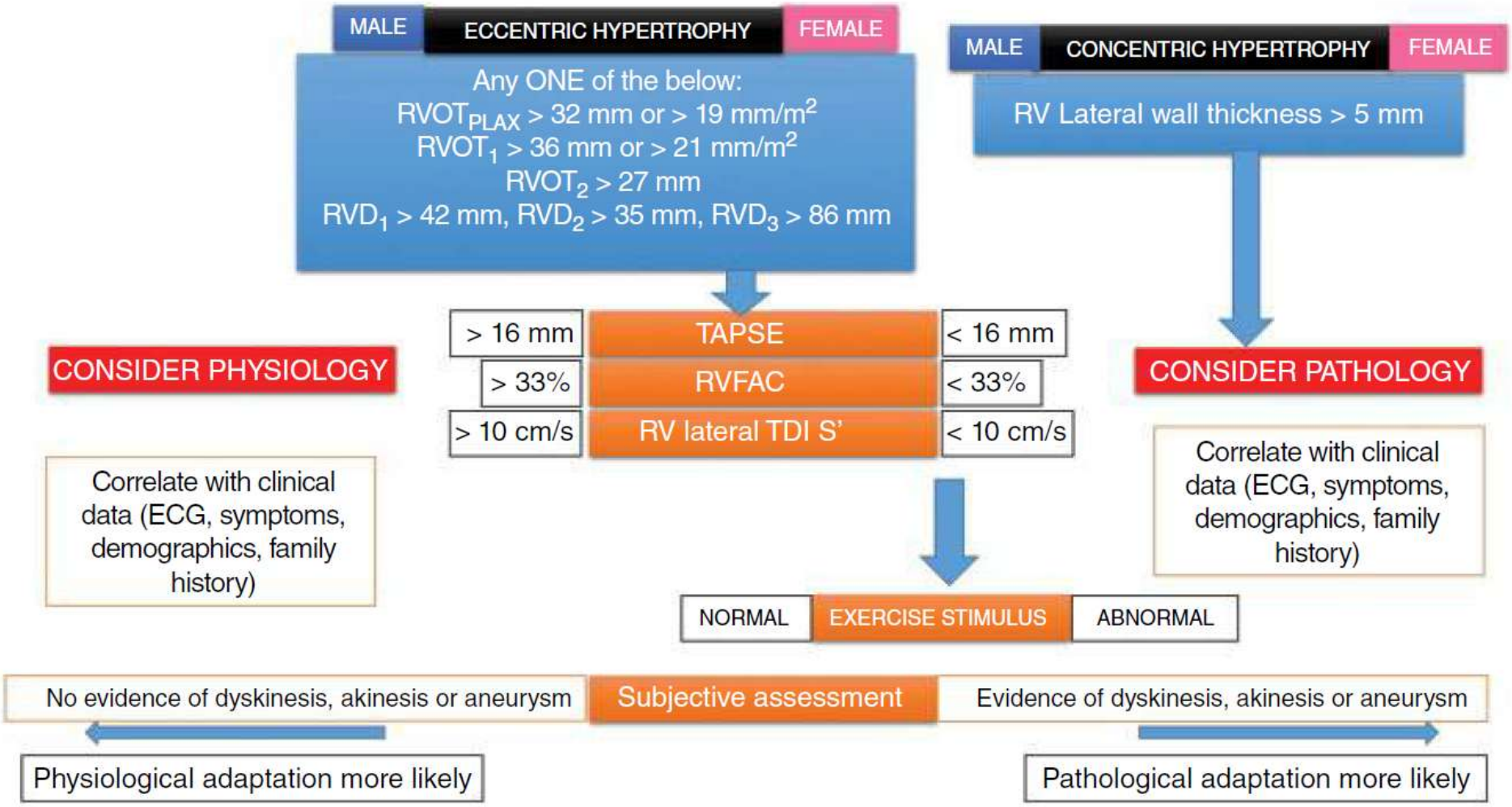
	Mean ±SD	Sensitivity (%)	Specificity (%)
RV systolic velocity (S', cm/s)	6.4 ± 2.2	67	89
Early diastolic velocity (E, cm/s)	−6.7 ± 2.7		
RV displacement (mm)	13.7 ± 5.8	77	71
Strain (ε, %)	−10 ± 6	73	87
Strain rate (s^{-1})	−1 ± 0.7	50	96

Adapted from [57]

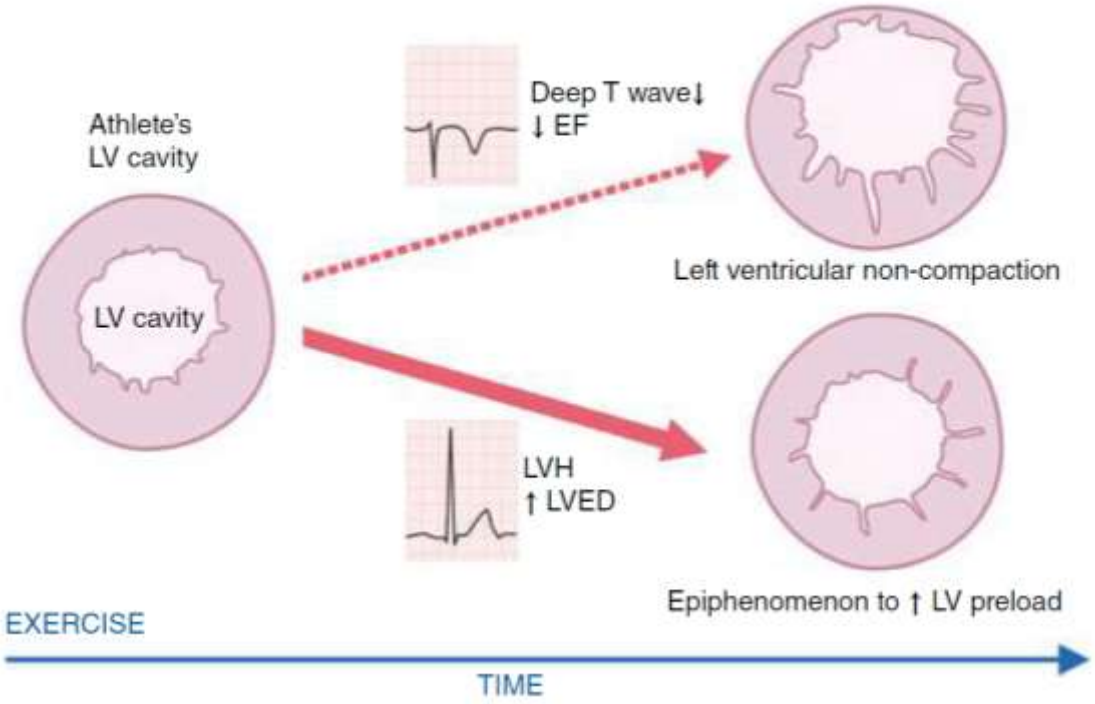


RV lateral TDI S' < 10cm/s

Right ventricular Disfunction



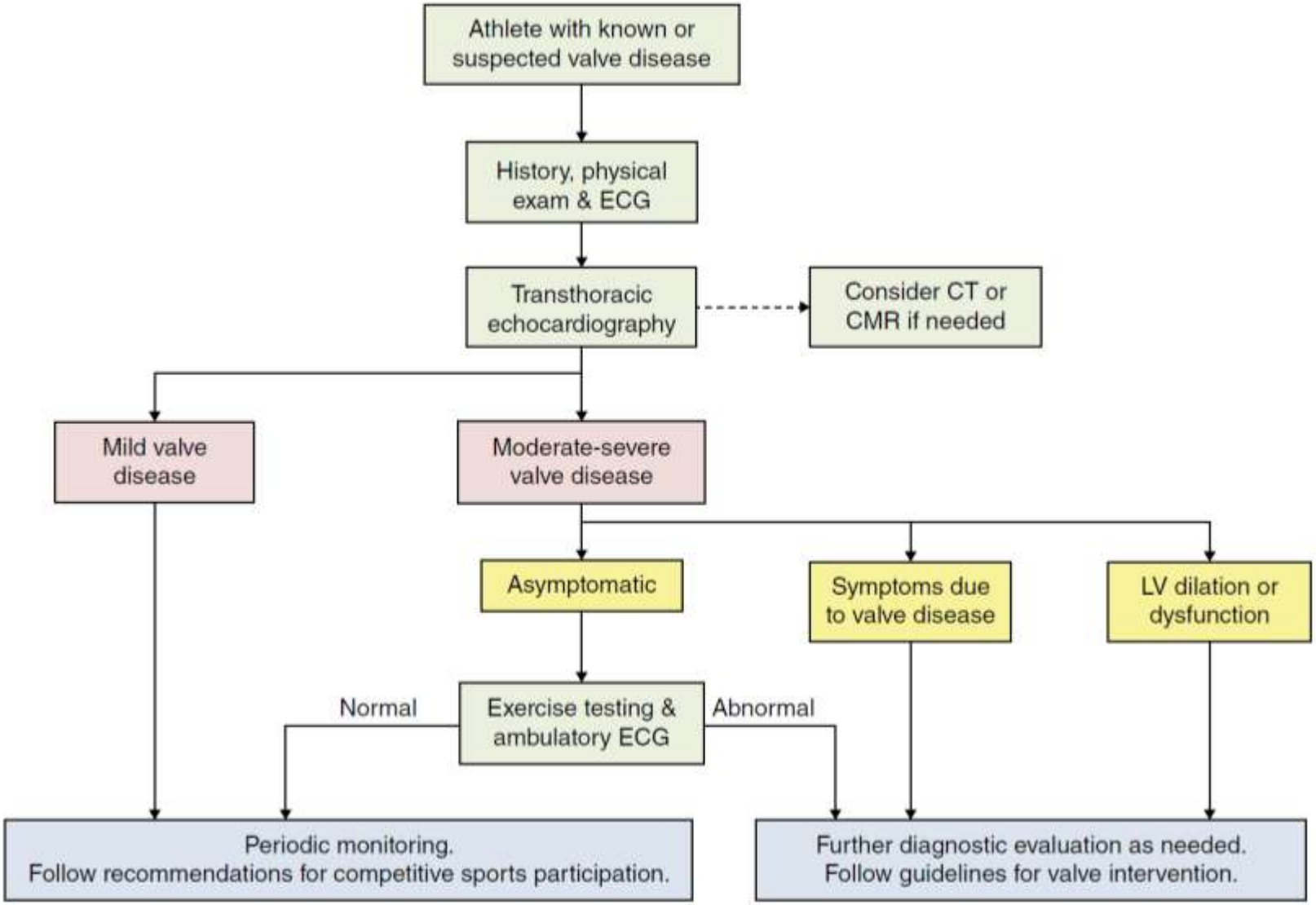
Left Ventricular Noncompaction



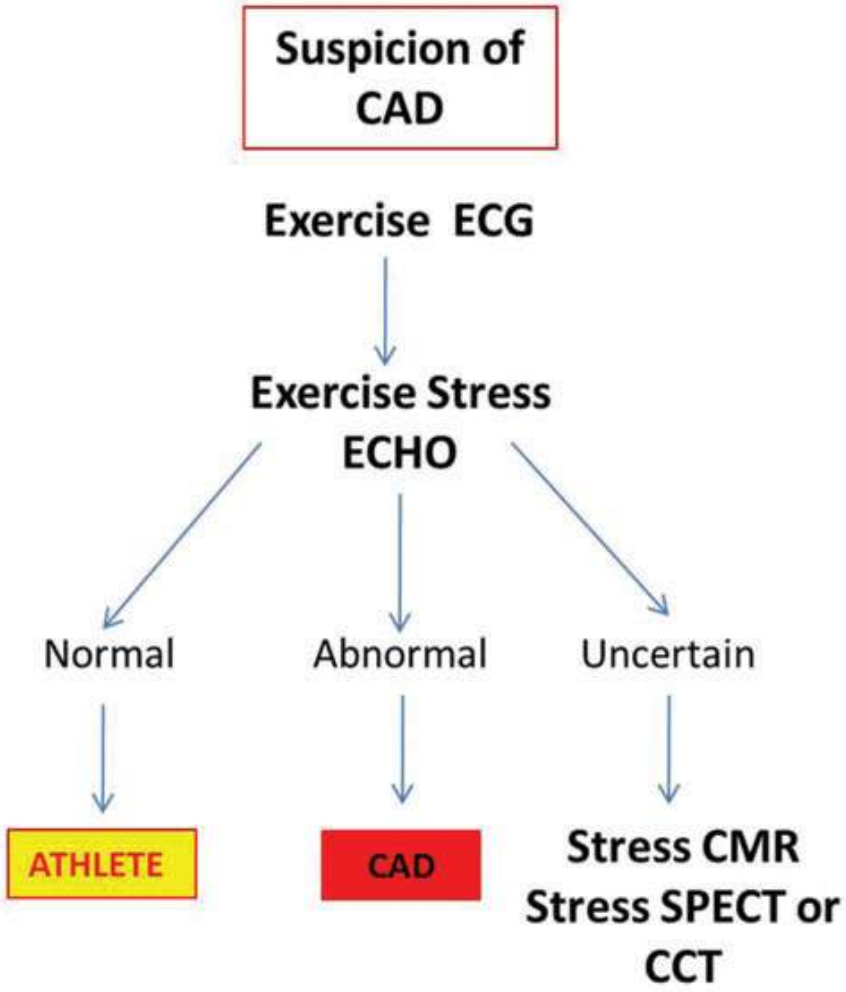
Echocardiographic Signs suggesting LVNC

- ✓ *Global or regional LV systolic dysfunction*
- ✓ *Positive criteria with a reduced thickness of the compact layer*
- ✓ *E' lateral < 9cm/sec.*
- ✓ *LVEF reduction on Exercise Echo*
- ✓ *Abnormal myocardial strain*

Valvular Disease in Athletes

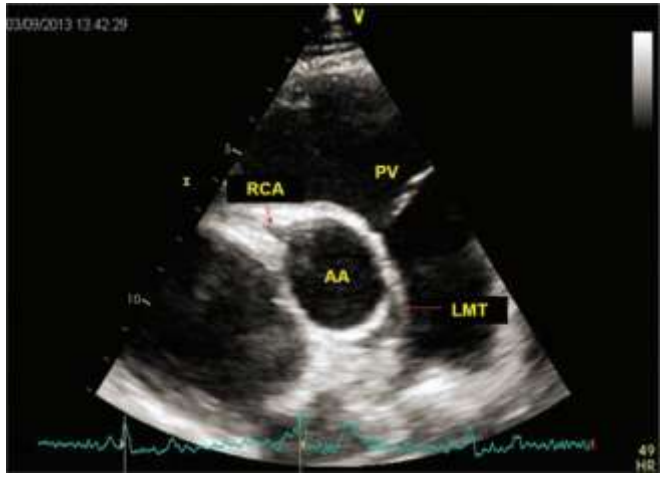


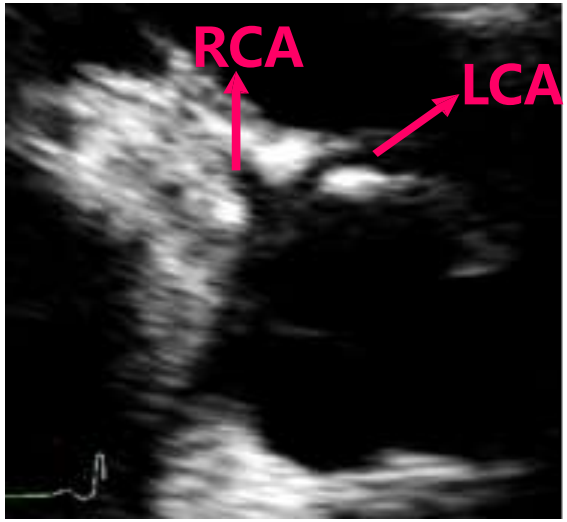
Disorders of the Coronary Arteries in Athletes



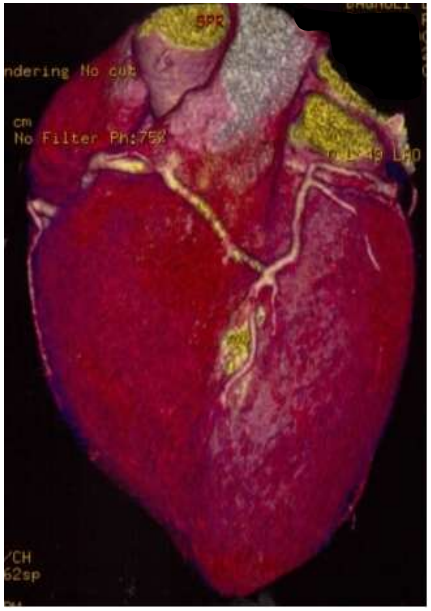
Disorders of the Coronary Arteries in Athletes

Echocardiography

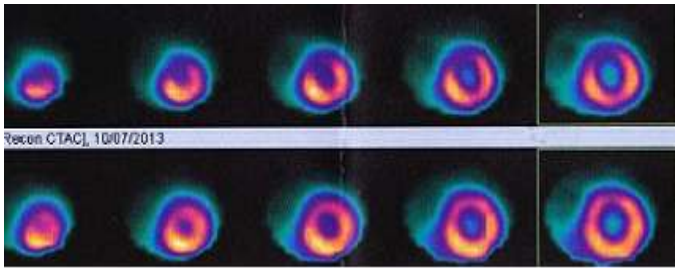


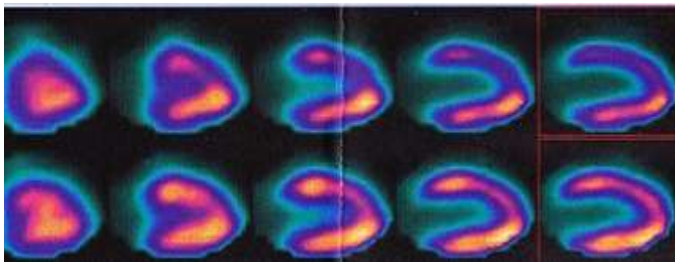


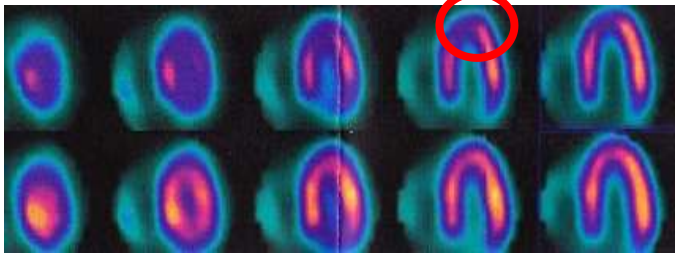
CT angiography



Nuclear imaging



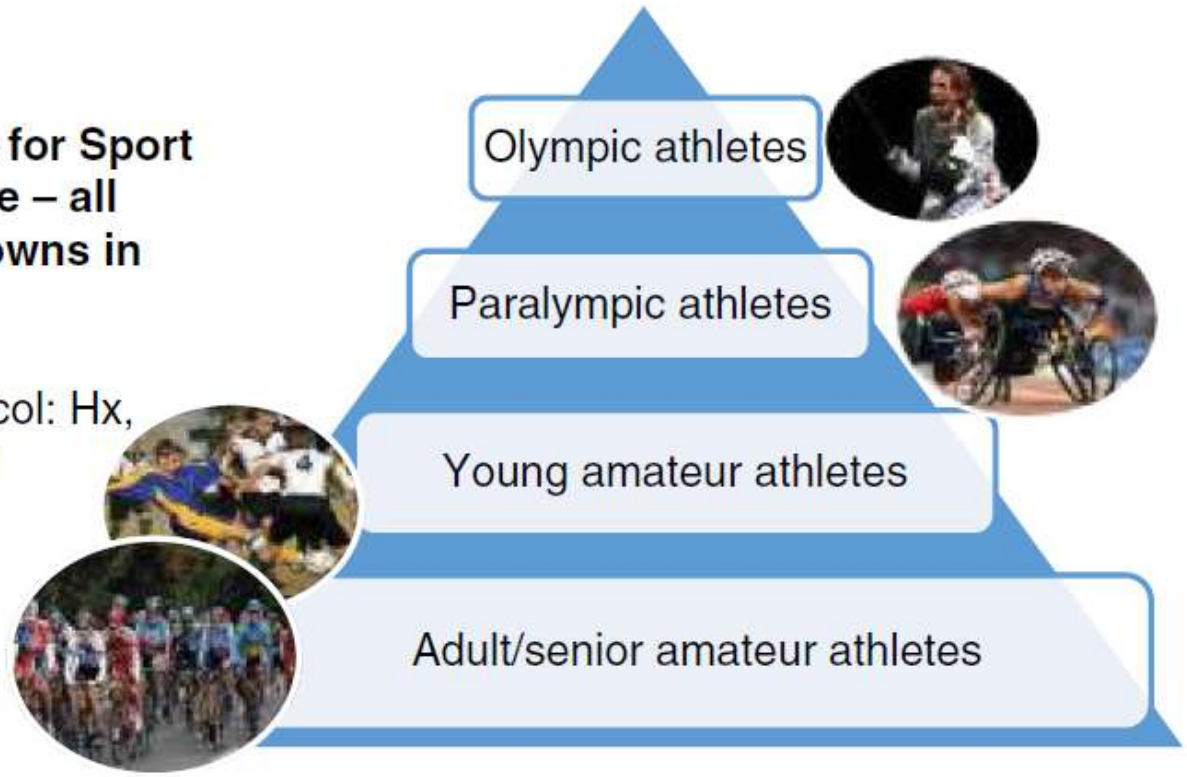




National screening programmes for athlete populations in Italy

Centers for Sport Medicine – all major towns in Italy

CV protocol: Hx, PE, ECG



Institute of Sport Medicine and Science, Rome

CV protocol: Hx, PE, ECG, exercise ECG, echocardiography

Echocardiography for differential diagnosis

HCM

DCM

LVNC

ARVC

Athletes

Marfan's disease

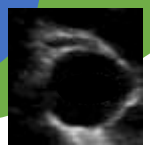
- Overlap with cardiomyopathies

BAV

CAA

MVP

- Intrinsic subclinical abnormalities



Take Home Message

- L’ecocardiogramma è il test di imaging di riferimento nello sportivo in cui accanto ad un rilievo di aritmia vi sia il sospetto di una patologia strutturale sottostante
- Le indicazioni all’esame ecocardiografico devono essere poste solo dopo una attenta analisi della storia clinica dello sportivo e della tipologia dello sport praticato e dopo un rigoroso esame obiettivo ed una corretta analisi dell’ECG
- Quale esame di secondo livello l’ecocardiogramma fornisce utili e precise informazioni per poter differenziare in molti casi un quadro di adattamento fisiologico allo sport da aspetti anche precoci di cardiopatia strutturale
- Nonostante la semplice esecuzione e le tecnologie ecocardiografiche avanzate i limiti della metodica sono inquadrabili negli aspetti più complessi di overlap tra cuore d’atleta e cardiomiopatia o altre cardiopatie per lo più congenite.


Grazie!