The Heart of the Ultramarathoner

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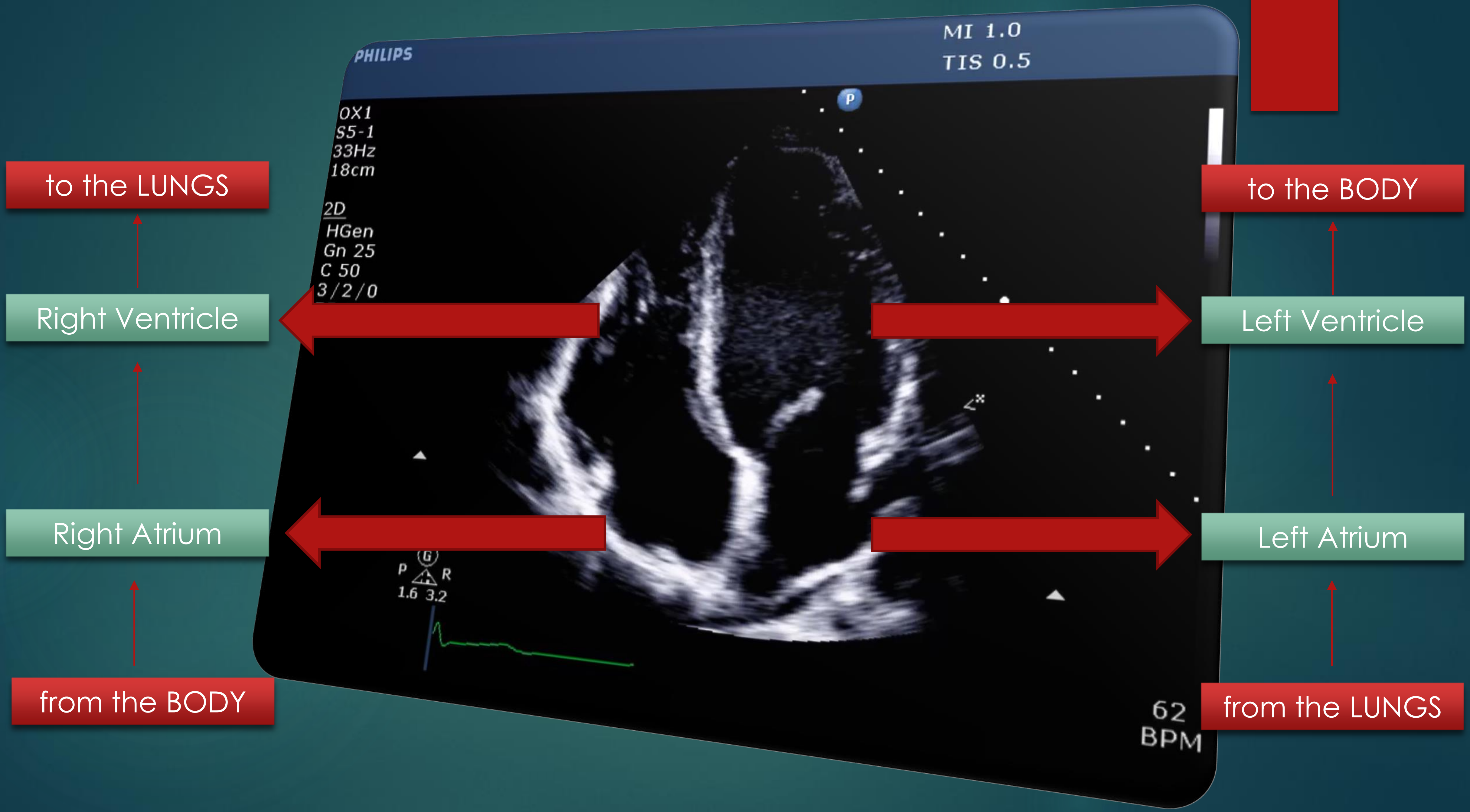
LIVERPOOL JOHN MOORES UNIVERSITY

Overview

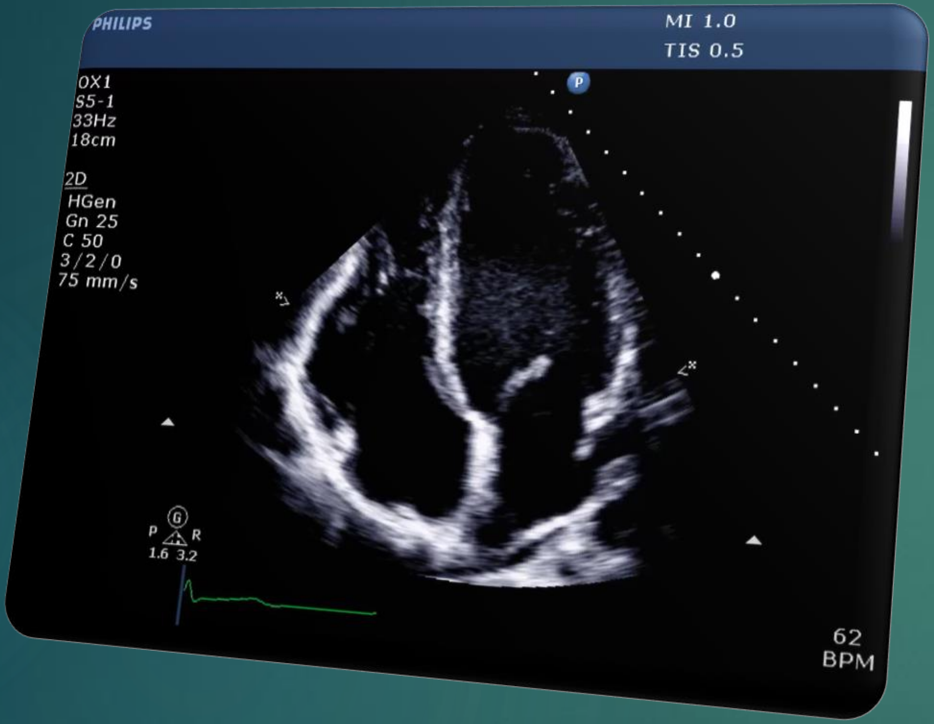
- Revision on cardiac physiology
- Chronic adaptation in the ultramarath

- Acute cardi ion

IS THERE CAUSE FOR CONCERN?



to the LUNGS
Right Ventricle
Right Atrium
from the BODY
to the BODY
Left Ventricle
Left Atrium
from the LUNGS
PHILIPS
MI 1.0
TIS 0.5
0X1
S5-1
33Hz
18cm
2D
HGen
Gn 25
C 50
3/2/0
P
R
1.6 3.2
62
BPM



WALL STRESS

Respond to Body Requirements

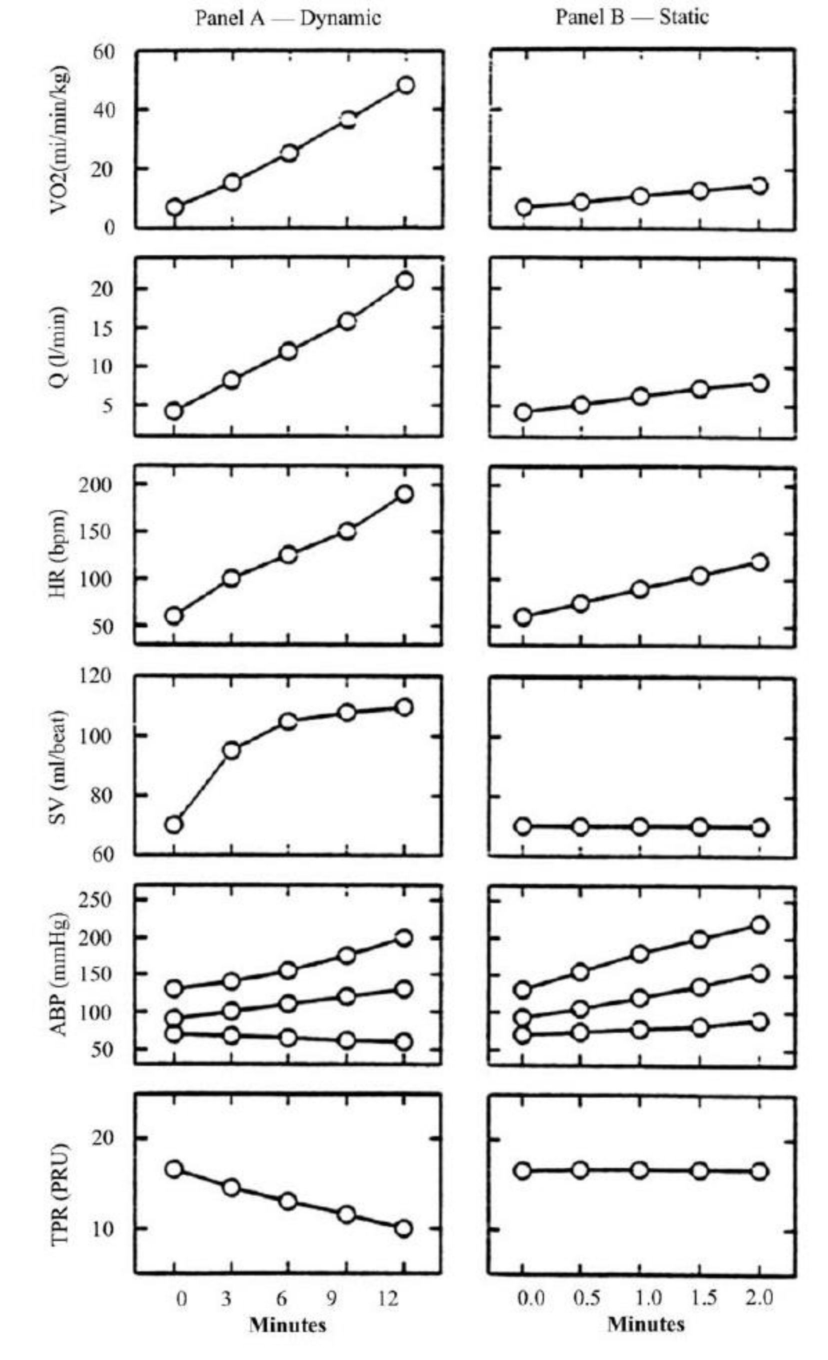
Ability to modify STROKE VOLUME / CARDIAC OUTPUT

PRELOAD

AFTERLOAD

CONTRACTILITY / RELAXATION

HEART RATE



Sympathetic Stimulation

Systemic and

ed Heart
te

Enhanced Myocardial Perfusion

creased Myocardial Relaxation

Increased Stroke Volume / Cardiac Output

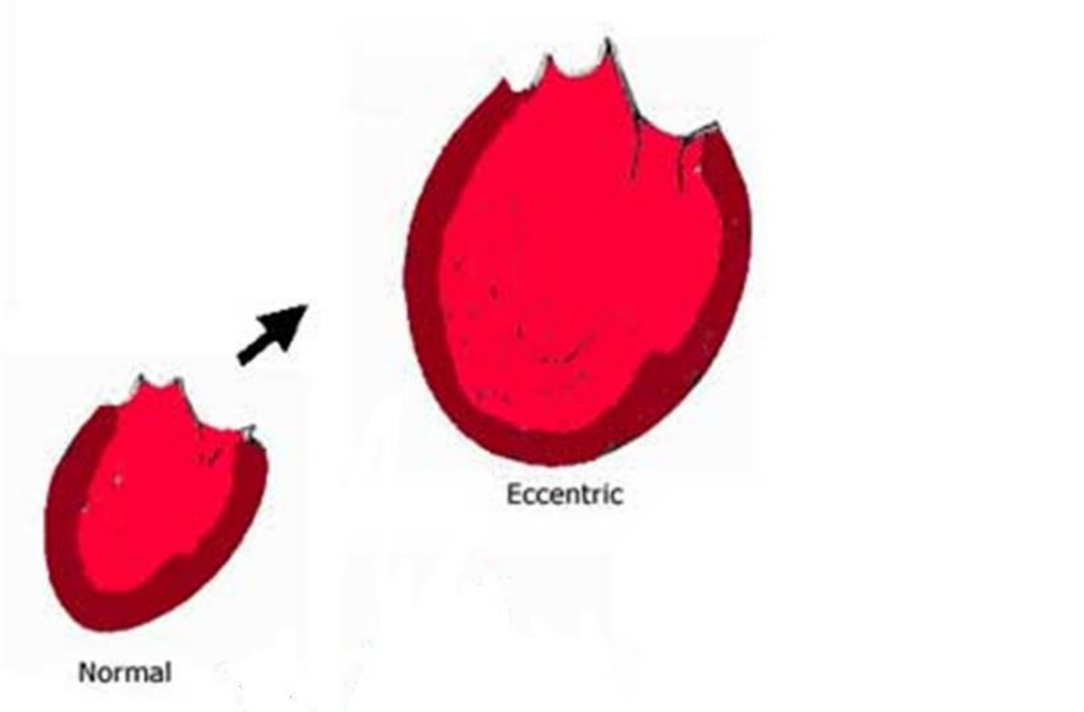
Chronic Adaptation

Increasing Static Component ↑	A. Low (<40% Max O_2)	B. Moderate (40-70% Max O_2)	C. High (>70% Max O_2)
III. High (>50% MVC)	Bobsledding/Luge*†, Field events (throwing), Gymnastics*†, Martial arts*, Sailing, Sport climbing, Water skiing*†, Weight lifting*†, Windsurfing*†	Body building*†, Downhill skiing*†, Skateboarding*†, Snowboarding*†, Wrestling*	Boxing*, Canoeing/Kayaking, Cycling*†, Decathlon, Rowing, Speed-skating*†, Triathlon*†
II. Moderate (20-50% MVC)	Archery, Auto racing*†, Diving*†, Equestrian*†, Motorcycling*†	American football*, Field events (jumping), Figure skating*, Rodeoing*†, Rugby*, Running (sprint), Surfing*†, Synchronized swimming†	Basketball*, Ice hockey*, Cross-country skiing (skating technique), Lacrosse*, Running (middle distance), Swimming, Team handball
I. Low (<20% MVC)	Billiards, Bowling, Cricket, Curling, Golf, Riflery	Baseball/Softball*, Fencing, Table tennis, Volleyball	Badminton, Cross-country skiing (classic technique), Field hockey*, Orienteering, Race walking, Racquetball/Squash, Running (long distance), Soccer*, Tennis

Increasing Dynamic Component →

Isotonic Exercise
CHRONIC

Increased Preload



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↓

nproved R

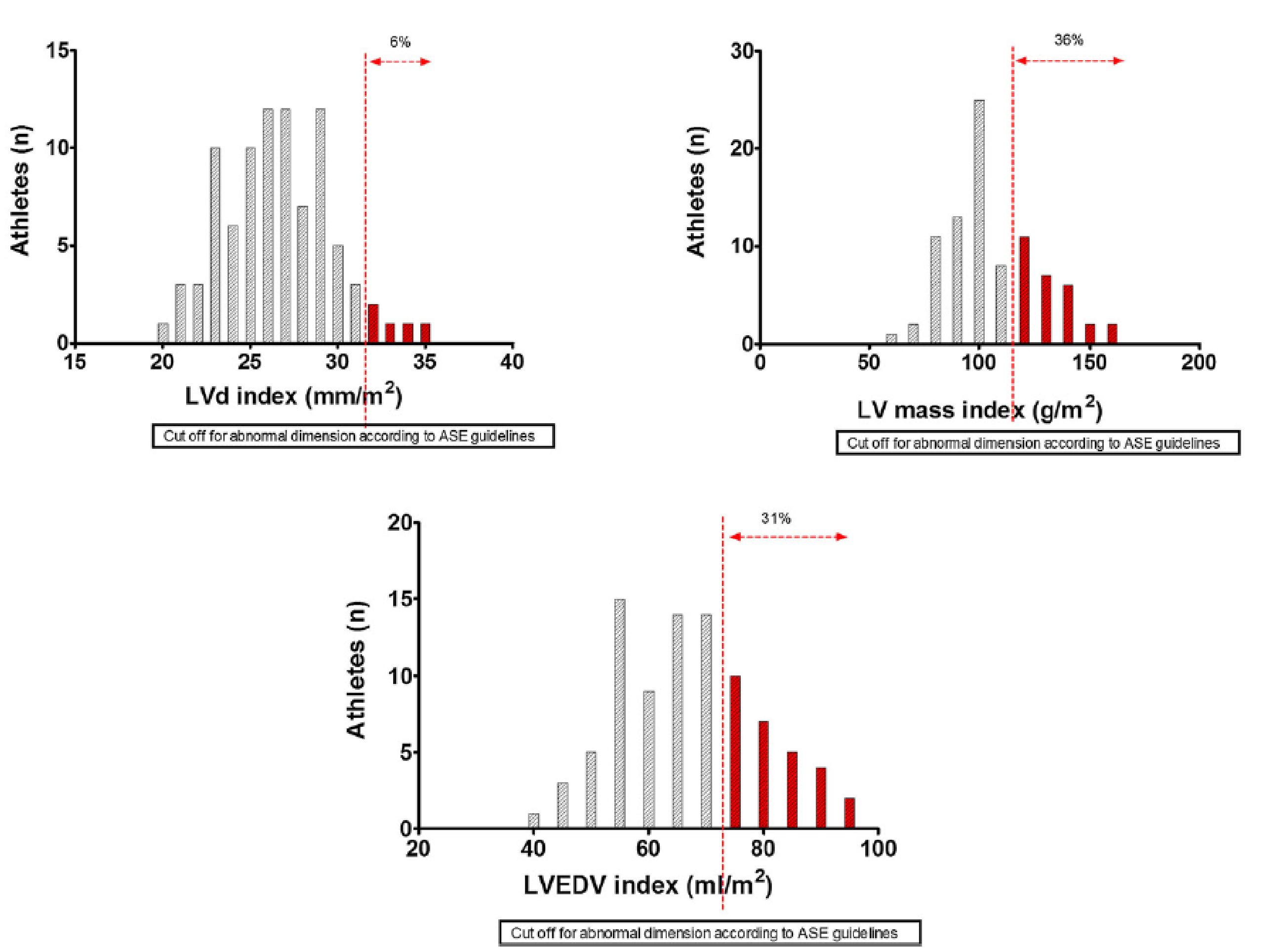
Improves with Exercise
Cardiac Reserve

Table 1 LV Structural and Functional Data in Male and Female Ultramarathoners

	Whole Cohort (n = 165)	Male	Female
LVIDd (cm)	5.2 ± 0.4 (4.2–6.2)		
LVIDd/BSA$^{0.5}$	3.8 ± 0.3 (3.2–4.5)		
IVSd (cm)	1.1 ± 0.2 (0.6–1.4)		
IVSd/BSA$^{0.5}$	0.8 ± 0.1 (0.5–1.0)		
PWTd (cm)	0.9 ± 0.1 (0.6–1.2)		
PWTd/BSA$^{0.5}$	0.7 ± 0.1 (0.5–0.9)		
LV mass (g)	180 ± 46 (89–300)		
LV mass/BSA$^{1.5}$	70 ± 13 (39–105)		
LAD (cm)	3.6 ± 0.4 (2.5–4.7)		
LAD/BSA$^{0.5}$	2.7 ± 0.3 (1.9–3.5)		
AoRt (cm)	2.8 ± 0.4 (1.7–3.8)		
AoRt/BSA$^{0.5}$	2.0 ± 0.3 (1.3–2.9)		
LVEDV (ml)	131 ± 28 (70–222)		
LVEDV/BSA$^{1.5}$	52 ± 10 (26–90)		
LVESV (ml)	46 ± 19 (18–87)		
LVESV/BSA$^{1.5}$	18 ± 7 (8–38)		
EF (%)	65 ± 10 (49–82)		
E/A	1.44 ± 0.37 (0.72–2.84)		
S' (cm/s)	9 ± 2 (6–14)		
E' (cm/s)	11 ± 2 (6–18)		
E/E'	7.16 ± 1.95 (3.80–16.71)		

Data are mean ± SD (range).

AoRt = aortic root dimension; BSA = body surface area; E' = velocities; EF = ejection fraction; IVSd = interventricular septal = left ventricular end-diastolic volume; LVESV = left ventricula PWTd = posterior wall thickness at end-diastole; S' = peak se



ges for the General
pulation

< 6 cm, f < 5.4 cm)

n < 225 g, f < 162 g)

< 155 ml, f < 104 ml)

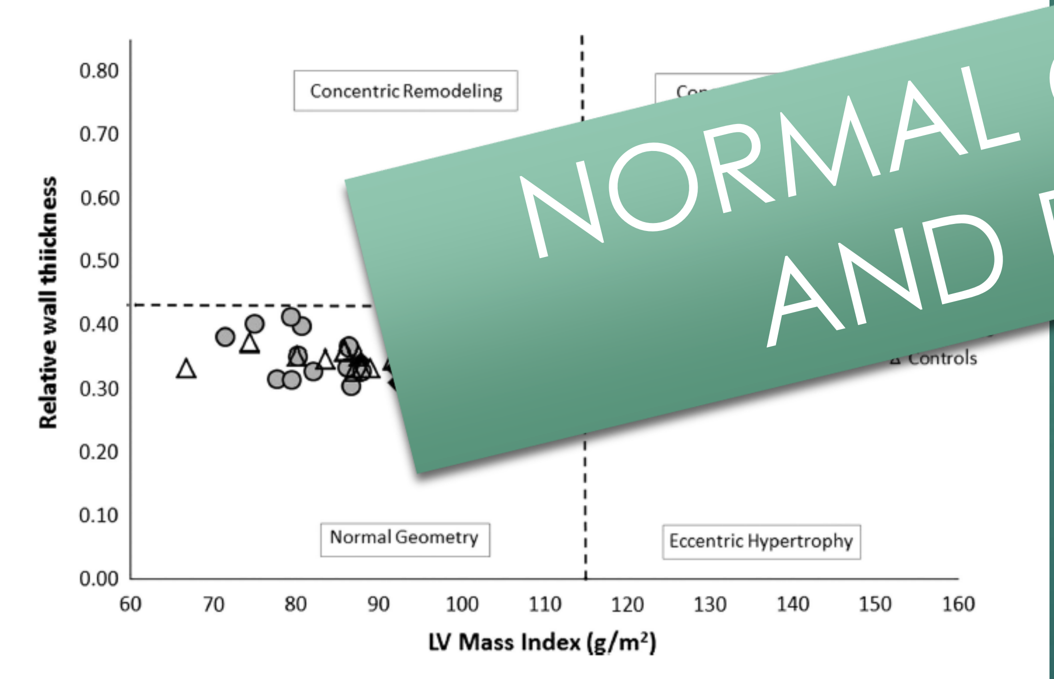
George et al 2011

Oxborough et al 2012

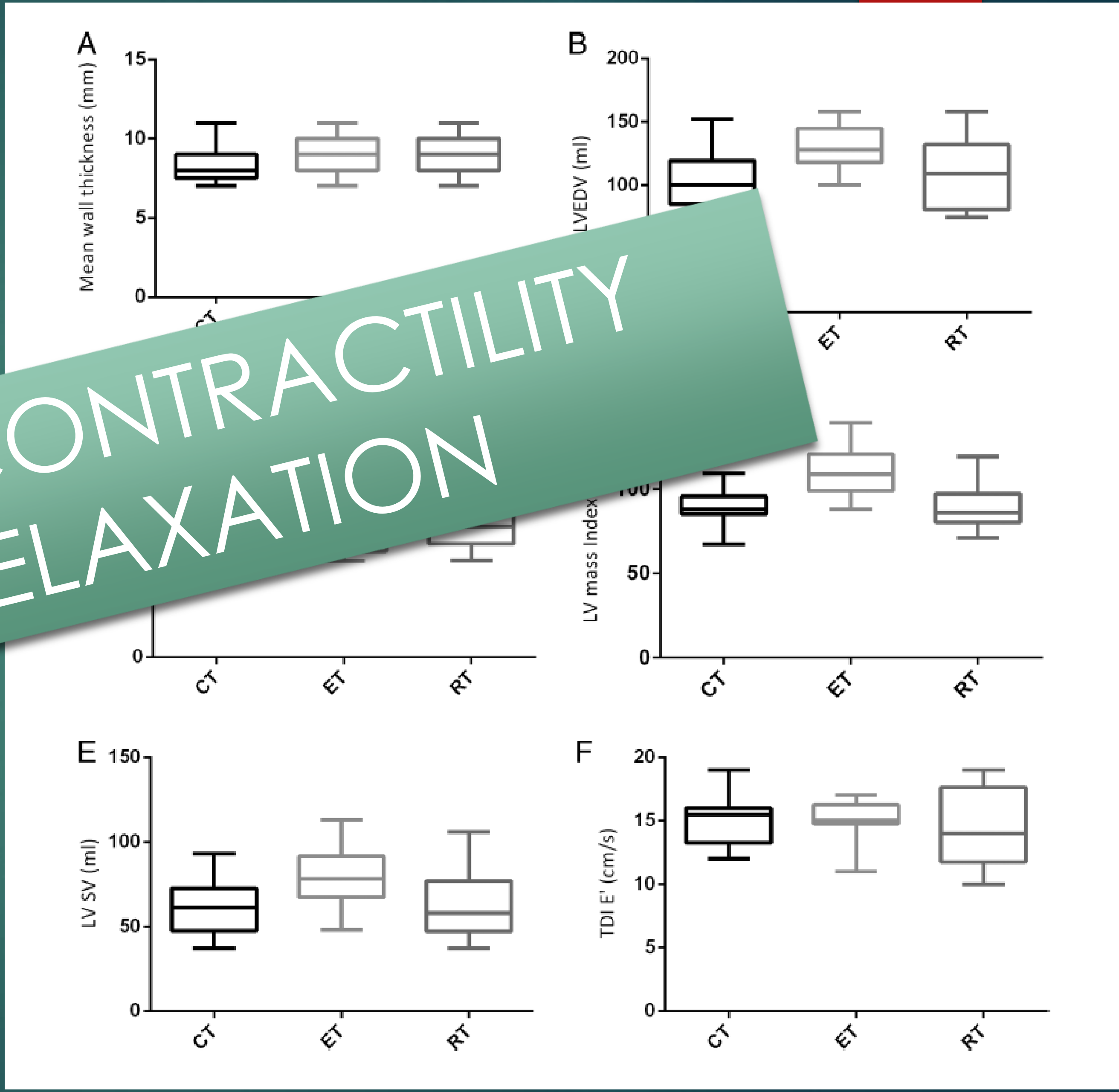
ORIGINAL ARTICLE

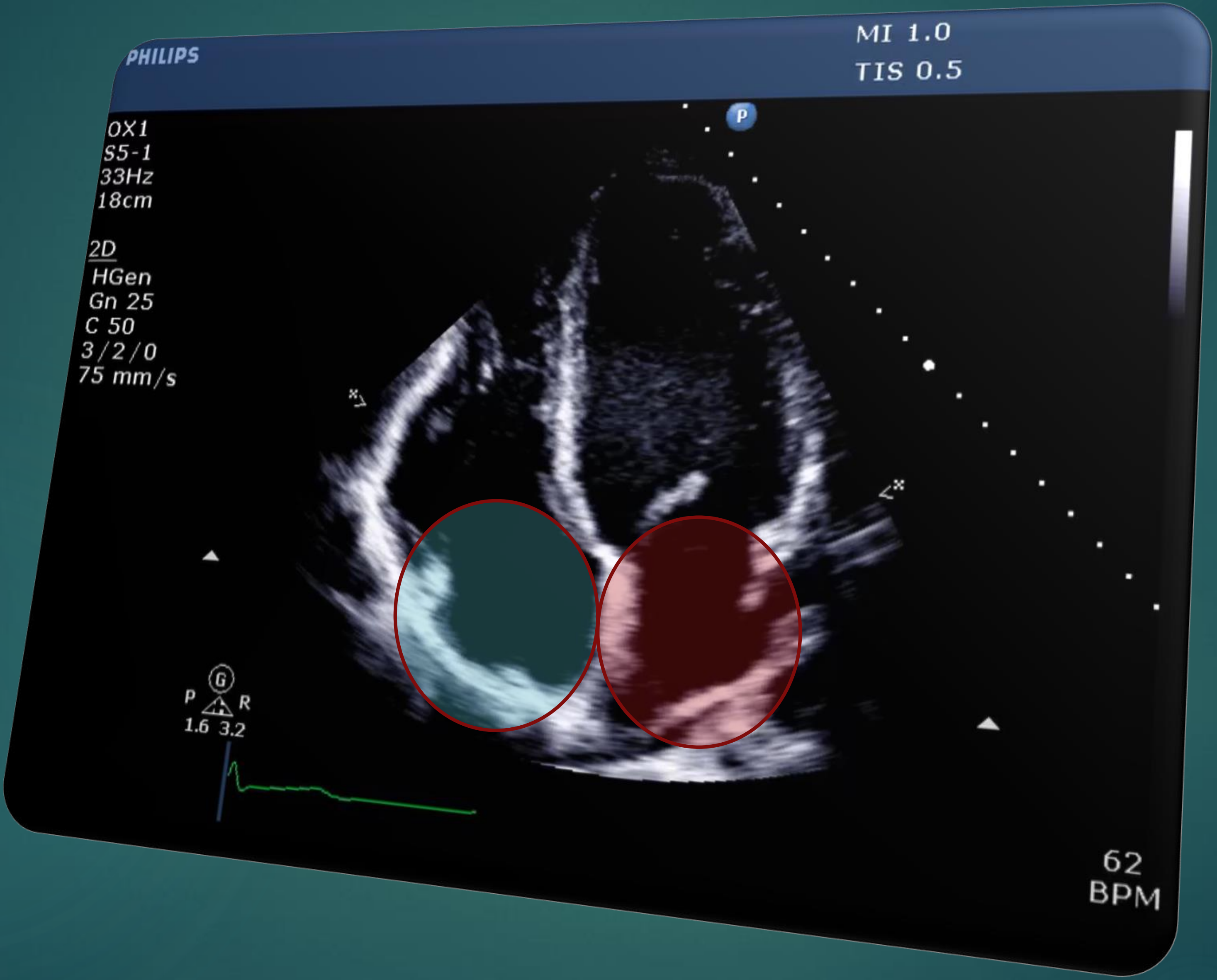
Predominance of normal left ventricular geometry in the male 'athlete's heart'

Victor Utomi,[1] David Oxborough,[1] Euan Ashley,[2] Rachel Lord,[1] Sarah Fletcher,[3] Mike Stembridge,[4] Rob Shave,[4] Martin D Hoffman,[5] Greg Whyte,[1] John Somauroo,[1,6] Sanjay Sharma,[7] Keith George[1]



NORMAL CONTRACTILITY AND RELAXATION

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MI 1.0
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33Hz
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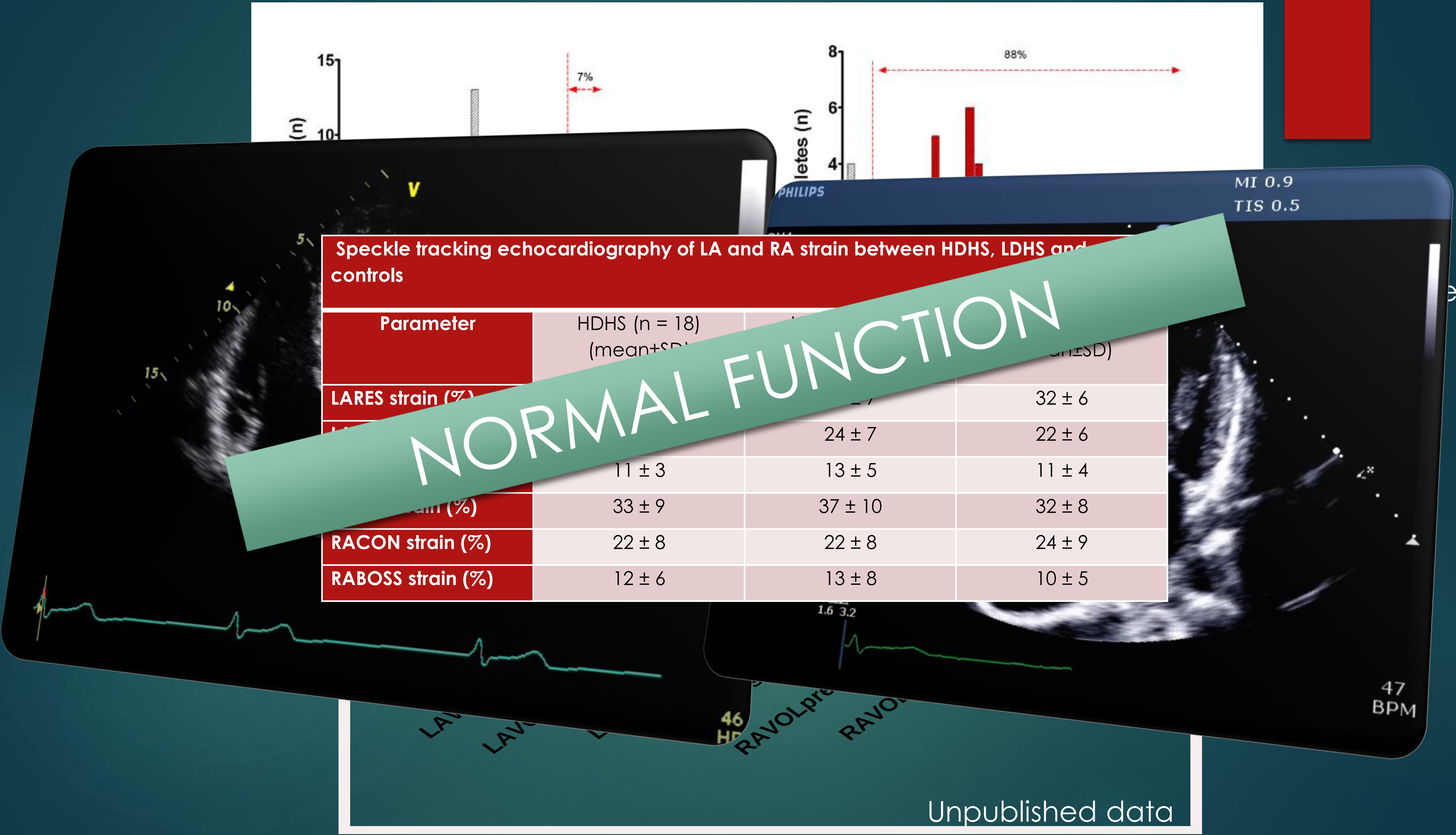
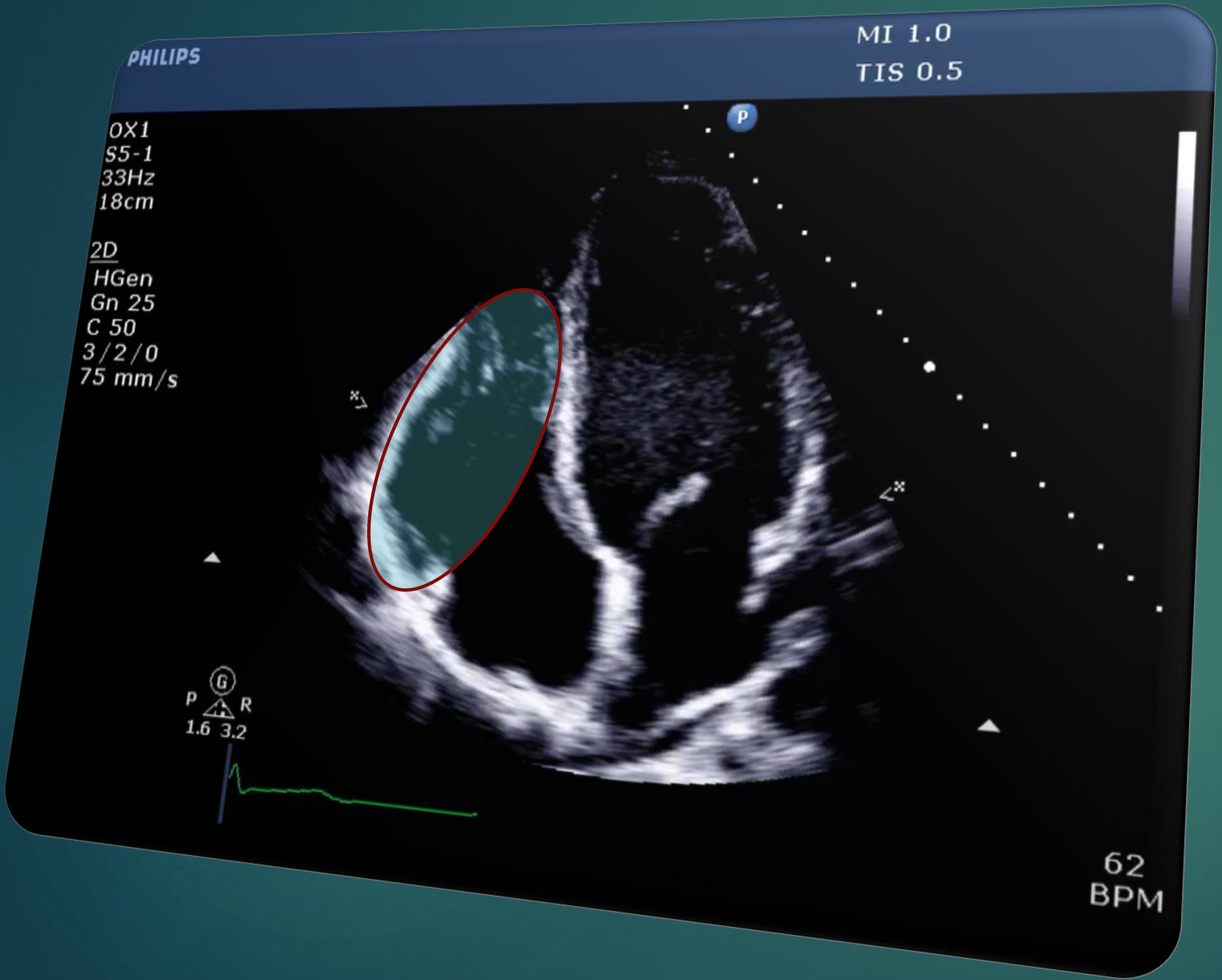


Speckle tracking echocardiography of LA and RA strain between HDHS, LDHS and controls

Parameter	HDHS (n = 18) (mean±SD)	[illegible]	[illegible] (mean±SD)
LARES strain (%)	[illegible]	[illegible] ± 7	32 ± 6
[illegible]	[illegible]	24 ± 7	22 ± 6
[illegible]	11 ± 3	13 ± 5	11 ± 4
[illegible] strain (%)	33 ± 9	37 ± 10	32 ± 8
RACON strain (%)	22 ± 8	22 ± 8	24 ± 9
RABOSS strain (%)	12 ± 6	13 ± 8	10 ± 5

NORMAL FUNCTION

Unpublished data



PHILIPS
MI 1.0
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OX1
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33Hz
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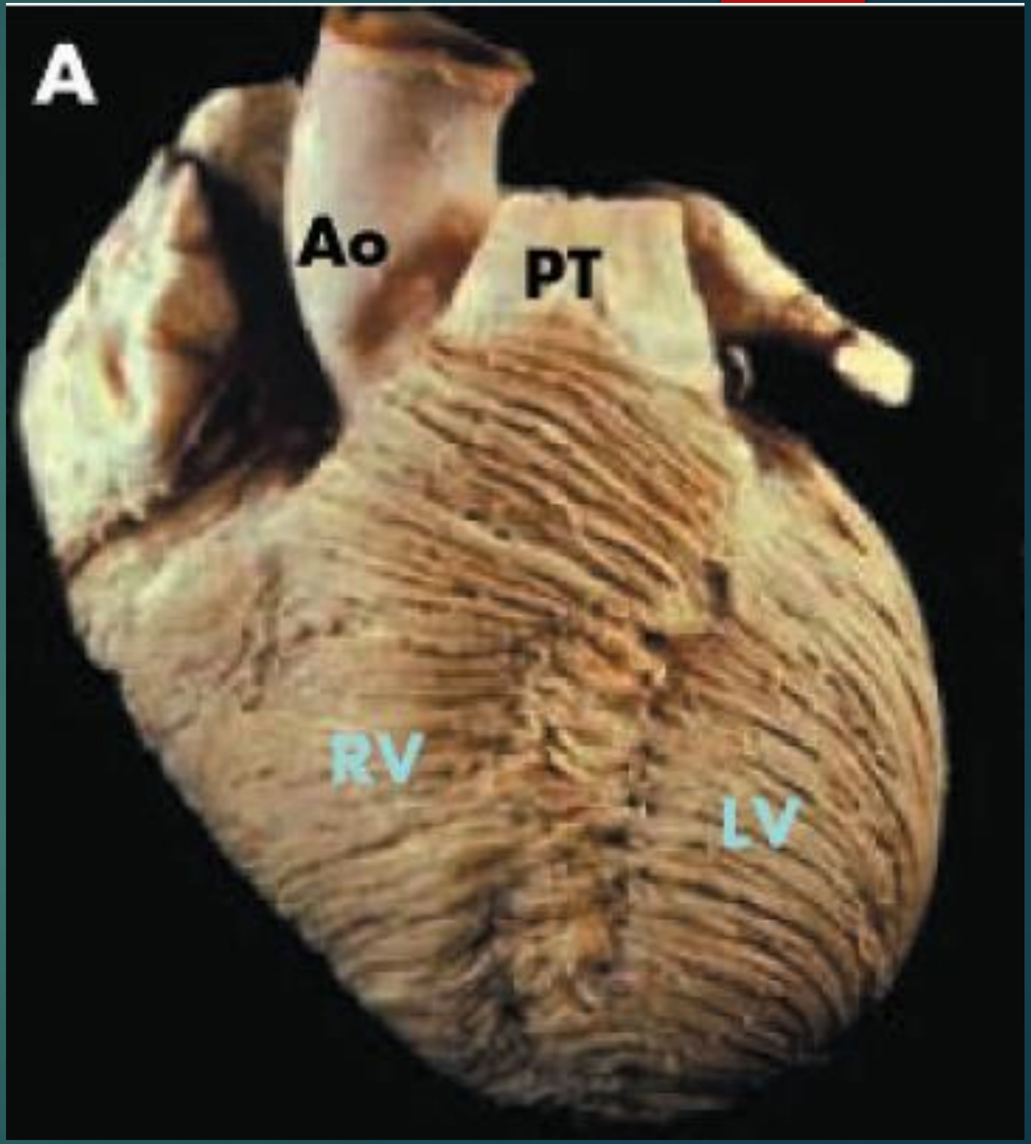
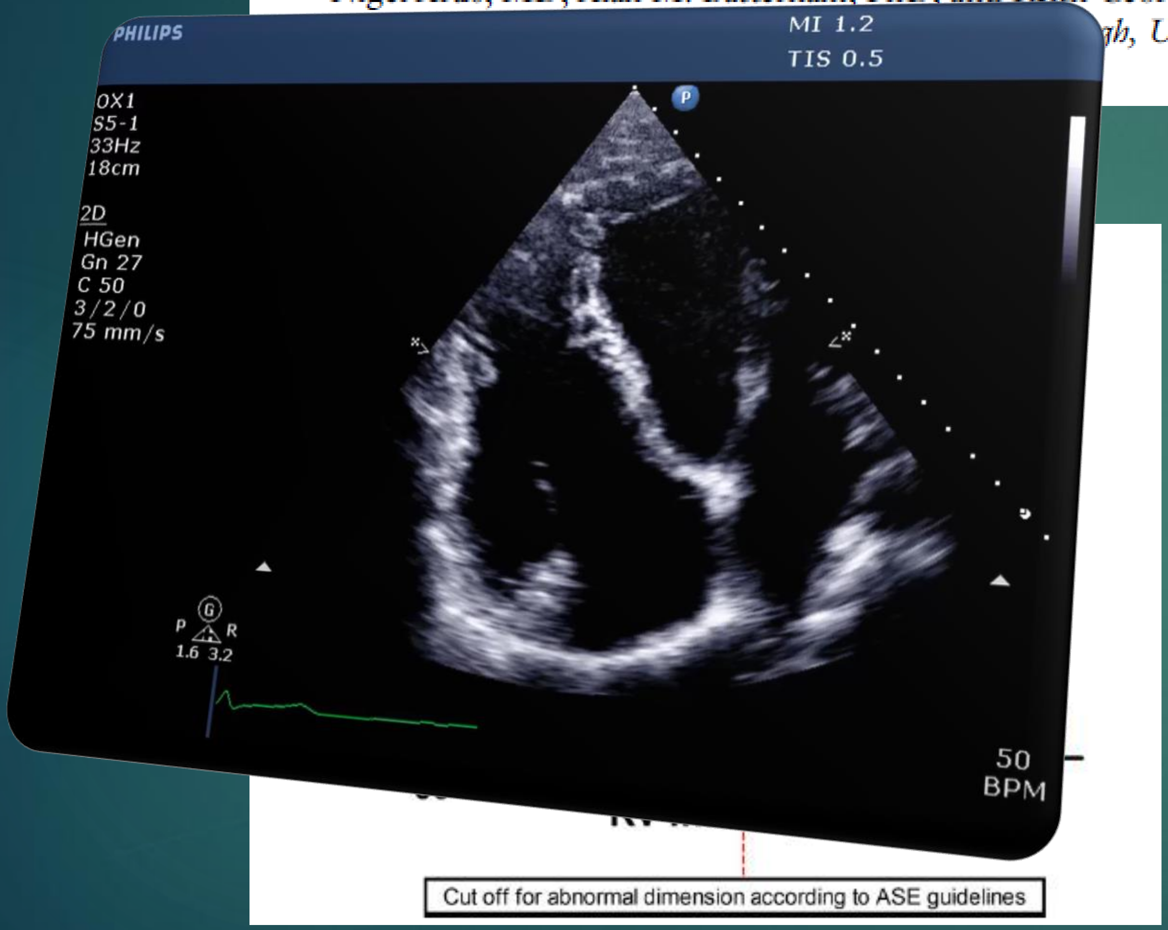
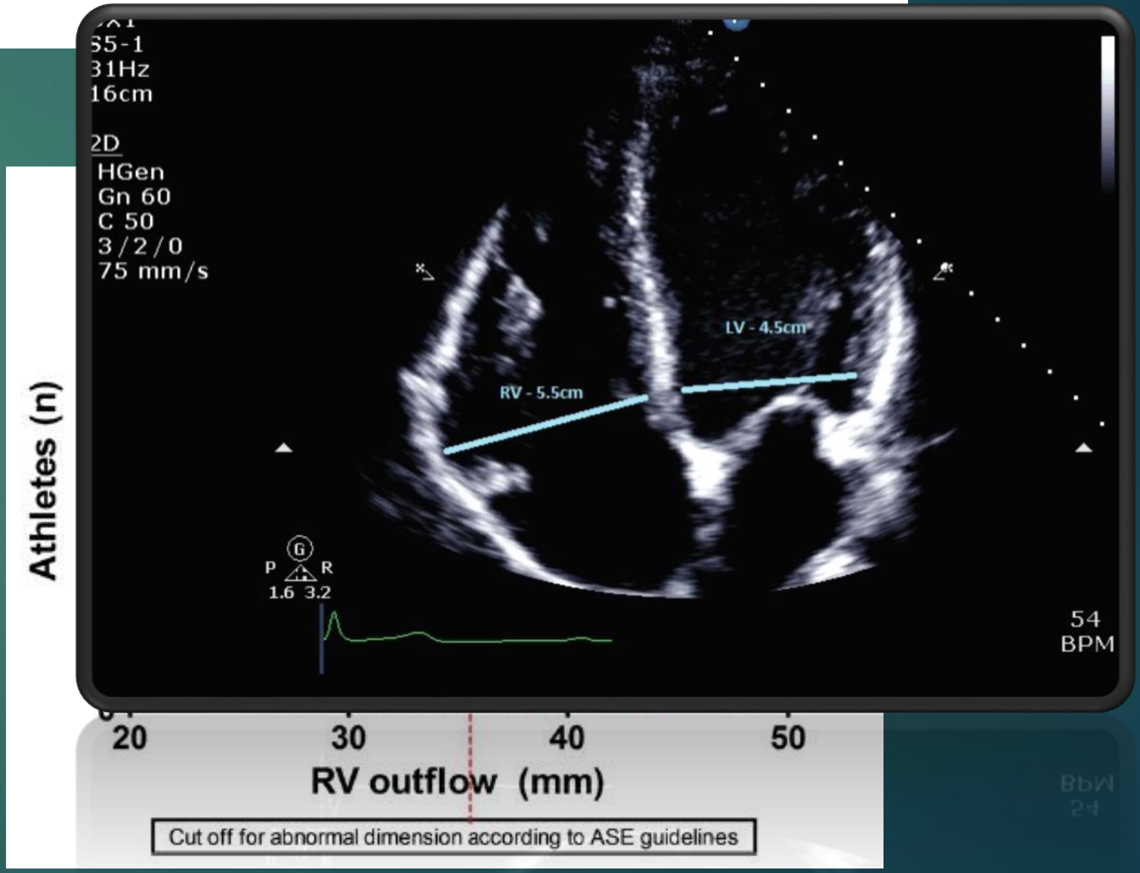


A
Ao
PT
RV
LV

The Right Ventricle of the Endurance Athlete: The Relationship between Morphology and Deformation

David Oxborough, MSc, Sanjay Sharma, MD, Robert Shave, PhD, Greg Whyte, PhD, Karen Birch, PhD, Nigel Artis, MD, Alan M. Batterham, PhD, and Keith George, PhD, *Leeds, London, Cardiff, Uxbridge, Liverpool,* … *gh, United Kingdom*





Parameter	ET	RT	CT
RVOT PLAX (mm)	31 ± 4 [23:37]	29 ± 4 [22:35]	30 ± 4 [23:38]
RVOT PLAX (mm/[m^2]$^{0.5}$)	21 ± 3 [17:26]	20 ± 3 [16:24]	21 ± 2 [17:25]
RVOT1 (mm)	32 ± 5 [24:40]	31 ± 5 [22:42]	32 ± 3 [23:36]
RVOT1 (mm/[m^2]$^{0.5}$)	22 ± 3 [18:27]	21 ± 3 [16:25]	22 ± 3 [17:27]
RVOT2 (mm)	[illegible]	[illegible]	[illegible]
RVOT2 (mm/[m^2]$^{0.5}$)	[illegible]	[illegible]	[illegible]
RVD1 (mm)	[illegible]	[illegible]	[illegible]
RVD1 (mm/[m^2]$^{0.5}$)	[illegible]	[illegible]	[illegible]
RVD2 (mm)	[illegible]	[illegible]	[illegible]
RVD2 (mm/[m^2]$^{0.5}$)	[illegible]	[illegible]	[illegible]
RVD3 (mm)	[illegible]	[illegible]	[illegible]
RVD3 (mm/[m^2]$^{0.5}$)	[illegible]	[illegible]	[illegible]
RV diastolic area (cm^2 [illegible]	[illegible]	[illegible]	[illegible]
RV diastolic area (cm^2/m^2)	[illegible]	[illegible]	[illegible]
RV systolic area (cm^2)	14 ± 2 [10:18]†	13 ± 3 [8:18]	11 ± 3 [7:18]
RV Systolic area (cm^2/m^2)	9 ± 2 [7:13]†	8 ± 2 [5:13]	7 ± 2 [5:13]
RV wall thickness (mm)	4 ± 1 [3:5]†	4 ± 1 [3:5]	3 ± 1 [2:4]
RV wall thickness (mm/[m^2]$^{0.5}$)	2.8 ± 0.4 [2.1:3.2]†	2.3 ± 0.4 [1.1:3.1]	2.1 ± 0.5 [1:3]

Parameter	ET	RT	CT
RVFAC (%)	50 ± 10 [40:62]	50 ± 10 [42:60]	[illegible]
TAPSE	24 ± 3 [21:29]	24 [illegible]	[illegible]
RVOT VTI	18 ± 3 [15: [illegible]	[illegible]	[illegible]:20]
RVSV (ml)	[illegible]	[illegible]	99 ± 33 [42:149]
RVSV (m[illegible]	[illegible]	[illegible] 10 [21:49]	32 ± 11 [22:51]
[illegible]	[illegible]:17]	15 ± 2 [13:18]	14 ± 2 [11:17]
[illegible]	1.7 ± 0.3 [1.1:2.3]	1.8 ± 0.3 [1.4:2.2]	1.7 ± 0.3 [1.3:2.3]
[illegible] cm/s	15 ± 2 [13:19]	16 ± 3 [14:19]	14 ± 3 [9:17]
RVE' ([cm/s]/cm)	1.7 ± 0.3 [1.2:2.4]	1.7 ± 0.4 [0.5:2.8]	1.7 ± 0.4 [1.0:2.5]
RVA' cm/s	12 ± 2 [10:17]	12 ± 1 [9:14]	12 ± 2 [9:14]
RVA' ([cm/s]/cm)	1.5 ± 0.4 [0.9:2.4]	1.3 ± 0.4 [0.7:2.4]	1.4 ± 0.3 [0.7:2.0]

NORMAL FUNCTION

Unpublished Data

Cardiac Adaptation in the Ultramathoner

- Chamber enlargement
  - Predominantly right ventricle and atria
  - To a lesser degree the left ventricle

Enables higher stroke volumes during exercise

More efficient cardiac function

NORMAL FUNCTION

Cardiac Adaptation – The Electrocardiogram

ESC classification of ECG ab	
Group 1 (training-related)	
Sinus bradycardia	
First degree AV block	
Incomplete RBBB	
Early repolarisation	
Isolated QRS voltage criteria f	
	hemiblock
	Right axis deviation / left posterior hemiblock
	Right ventricular hypertrophy
	Ventricular pre-excitation
	Complete LBBB or RBBB
	Long-QT or short-QT interval
	Brugada-like early repolarization

LVH = left ventricular hypertrophy; LBBB = left bundle branch block; RBBB = right bundle branch block.

ESC guidelines – Corrado et al 2009

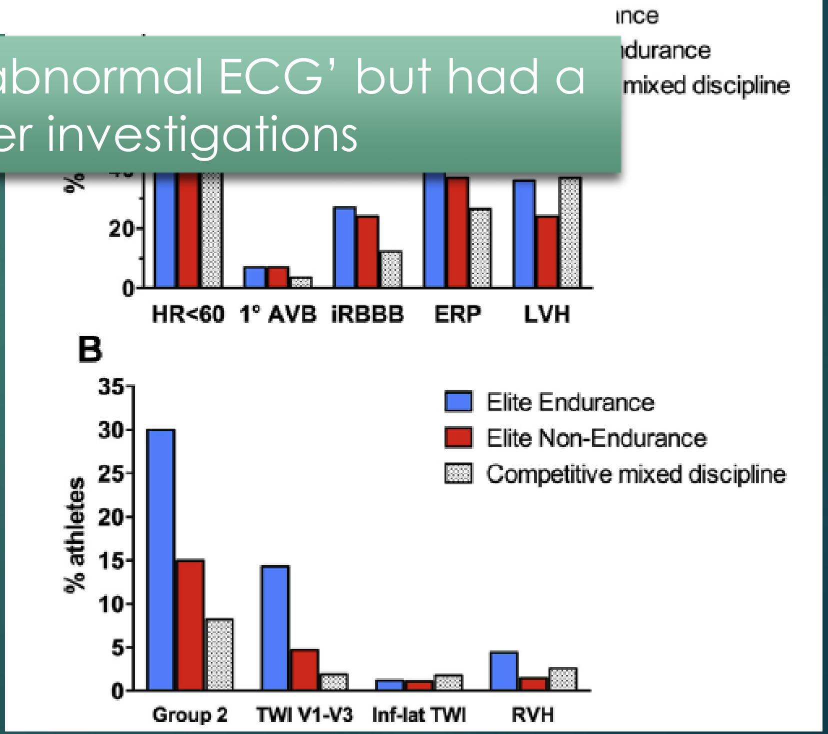
The Seattle Criteria increase the specificity of preparticipation ECG screening among elite athletes

Maria Brosnan,[1,2] Andre La Gerche,[1,2] Jon Kalman,[3] Wilson Lo,[4] Kieran Fallon,[5] Andrew MacIsaac,[1] David Prior[1,2]

ectrocardiographic
ndurance Athletes

on Kalman, PhD, MBBS[c],
nd David L. Prior, PhD, MBBS[a,b]

Using this criteria 4% of athletes had 'abnormal ECG' but had a normal heart following further investigations



ECG data from Western States 2013

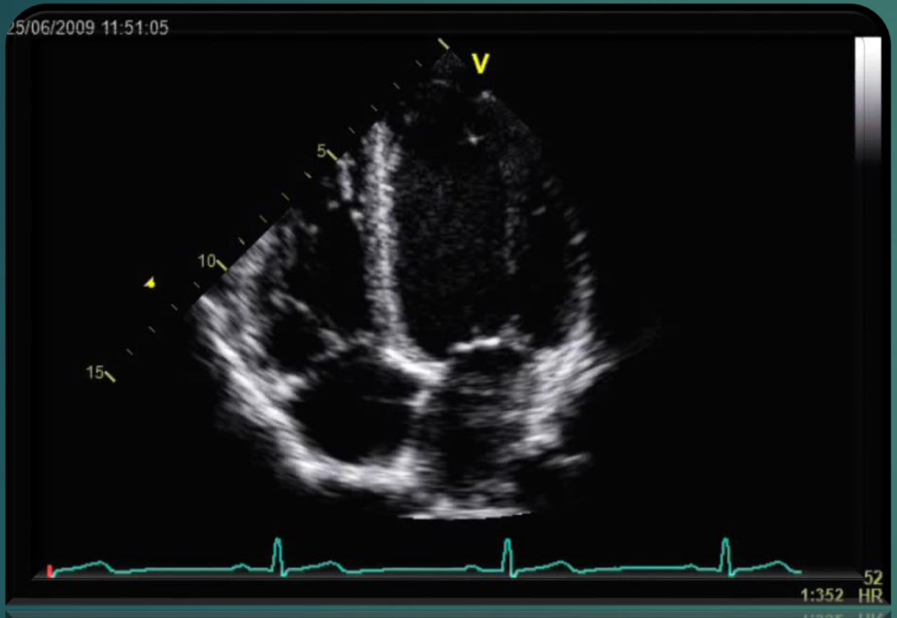
ABNORMAL ATHLETE CRITERIA (Seattle)	Numbers of Veteran Athletes (%) (WS100 n = 48)	Number of Young Athletes (%) (Brosnan et al 2013 n = 1078)
T Wave Inversion >1mm (2 or more adjacent (V2-V6 / II and AVF, I and AVL))	1 (2)	25 (2.3)
ST Depression	0 (0)	2 (0.2)
Pathologic Q Waves	0 (0)	2 (0.2)
Intraventricular Conduction Delay or complete LBBB	1 (2)	1 (0.1)
Left Axis Deviation	3 (6)	6 (0.6)
Left Atrial Enlargement	1 (2)	5 (0.5)
Right Ventricular Hypertrophy	1 (2)	5 (0.5)
Right Atrial Enlargment	0 (0)	6 (0.6)
Ventricular Pre-Excitation	0 (0)	1 (0.1)
Long QT Interval	0 (0)	0 (0)
Short QT Interval	0 (0)	0 (0)
Brugada type 1 ECG Pattern	0 (0)	0 (0)
Premature Ventricular Extra-systoles (more than 2 per strip)	1 (2)	1 (0.1)
Ventricular Arrhythmias	0 (0)	0 (0)
TOTAL	8 (17)	48 (4.5)

Unpublished Data

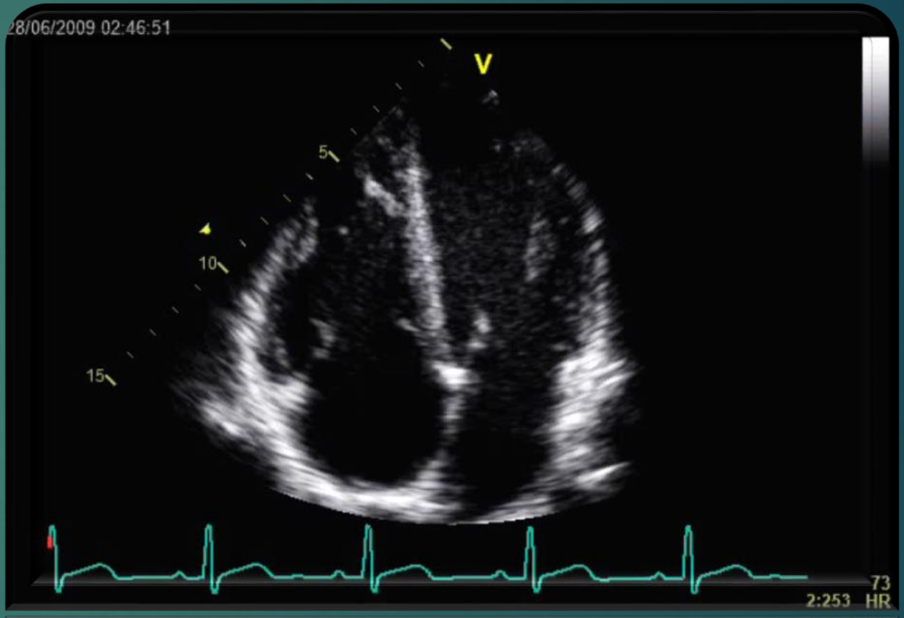
ACUTE CARDIAC RESPONSE TO AN ULTRAMARATHON

What is the Echocardiographic Diagnosis?

DAY 1

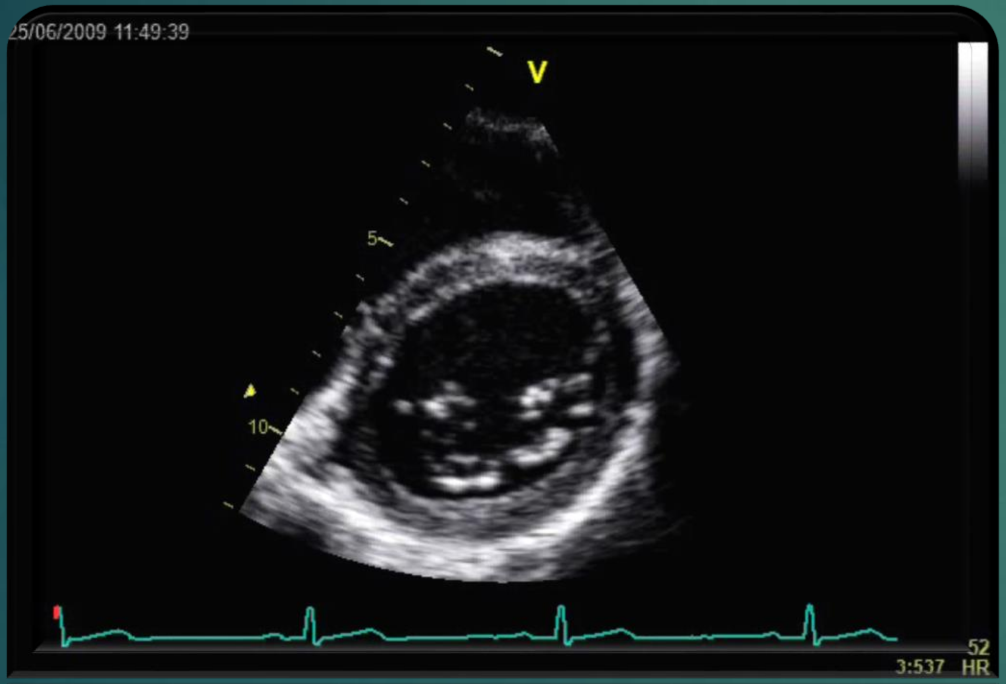


24 Hours Later

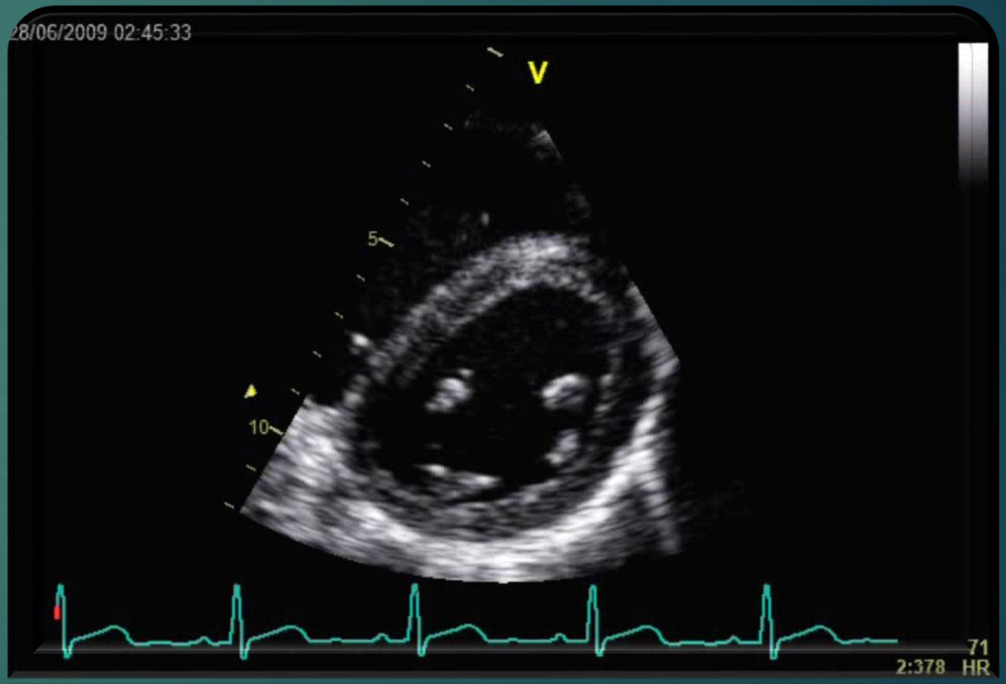


What is the Echocardiographic Diagnosis?

DAY 1

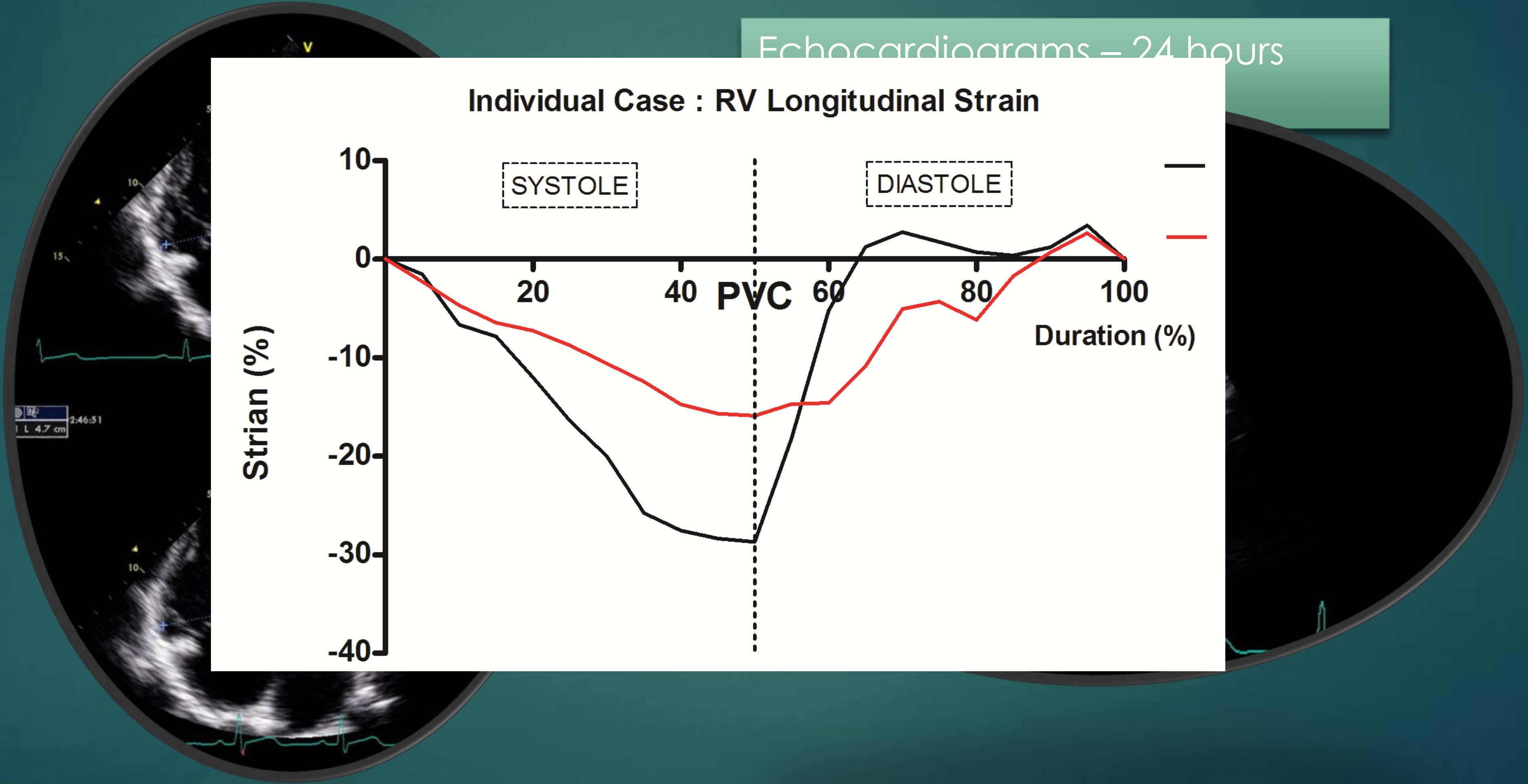


24 Hours Later



What is the Echocardiographic Diagnosis?

Echocardiograms – 24 hours



What is the Echocardiographic Diagnosis?

Echocardiograms – 48 hours apart

...load

?Pulmonary Embolism

? Acute RV Obstruction

? RV volume overload

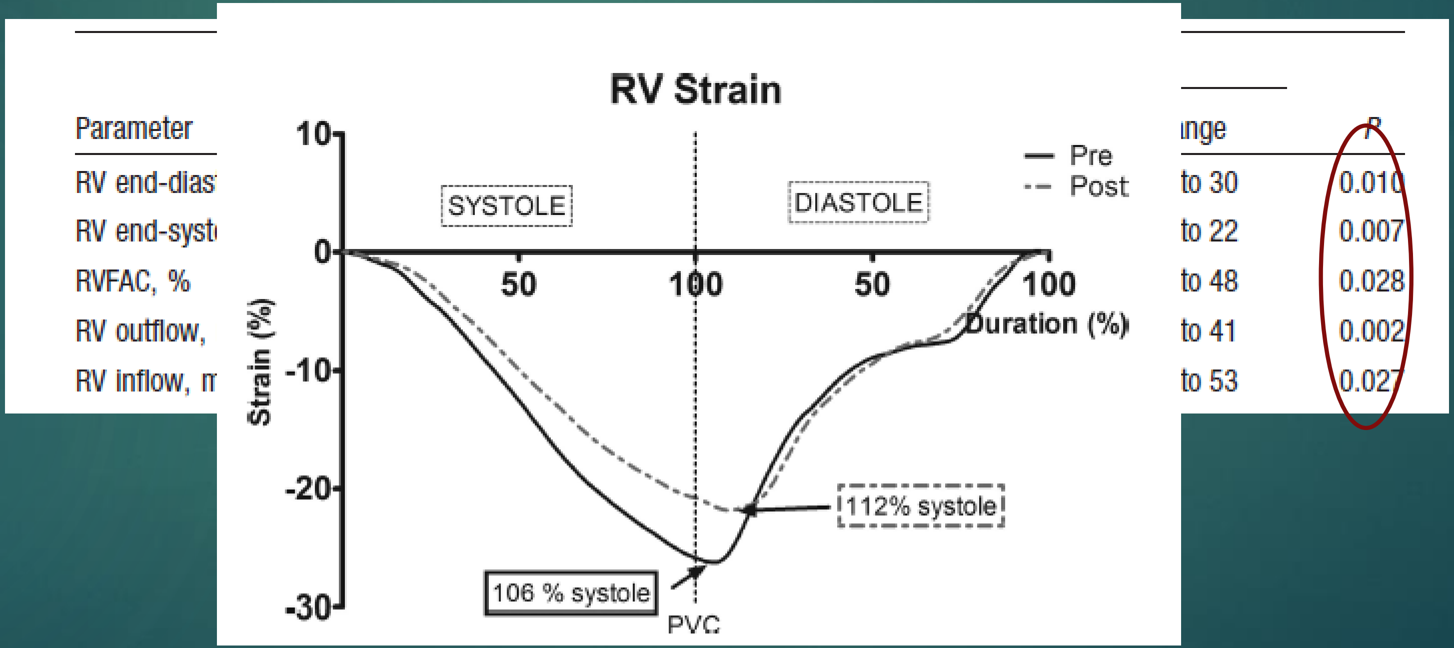
POST WESTERN STATES

Dilatation and Dysfunction of the Right Ventricle Immediately After Ultraendurance Exercise

Exploratory Insights From Conventional Two-Dimensional and Speckle Tracking Echocardiography

David Oxborough, MSc; Robert Shave, PhD; Darren Warburton, PhD; Karen Williams, MSc; Adele Oxborough, BSc; Sarah Charlesworth, PhD; Heather Foulds, MSc; Martin D. Hoffman, MD; Karen Birch, PhD; Keith George, PhD

(*Circ Cardiovasc Imaging*. 2011;4:253-263.)



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(*Circ Cardiovasc Imaging*. 2011;4:253-263.)

Table 4. Major Significant Bivariate Correlations

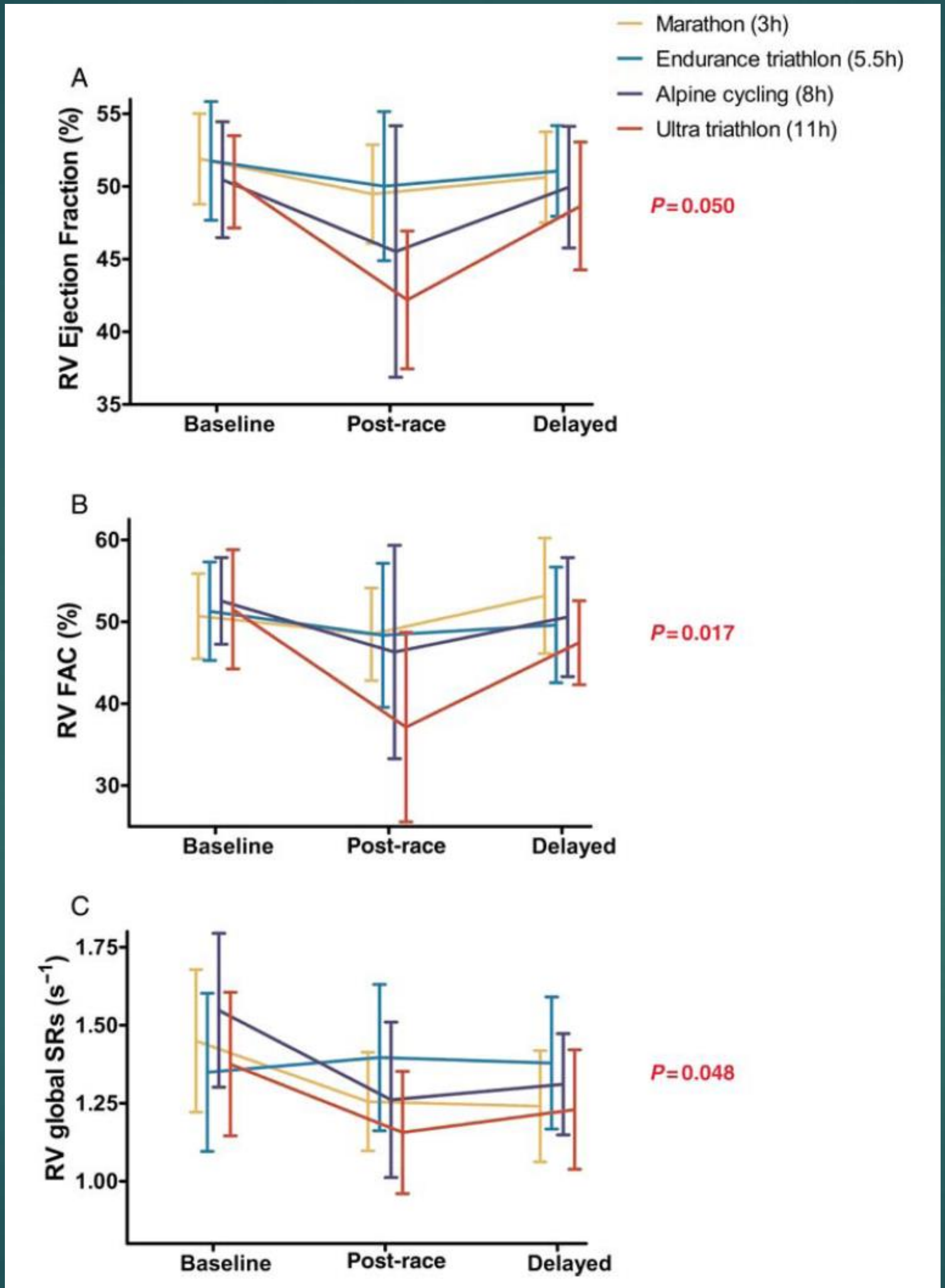
Parameter	Bivariate Correlation *r*	Bivariate Correlation *P*
RV ε:long SRe′	0.560	0.024
RV ε:circ SRe′	0.482	0.050
LVEI:RVFAC	−0.457	0.034
LVEI:RV SRs′	−0.466	0.042
Finishing time:RV inflow	−0.637	0.008
Finishing time:RV diastolic area	−0.604	0.017
No. ultramarathons:RV inflow	−0.577	0.002
No. ultramarathons:RV diastolic area	−0.529	0.035
Training status:LVEI	−0.541	0.030

Exercise-induced right ventricular dysfunction and structural remodelling in endurance athletes

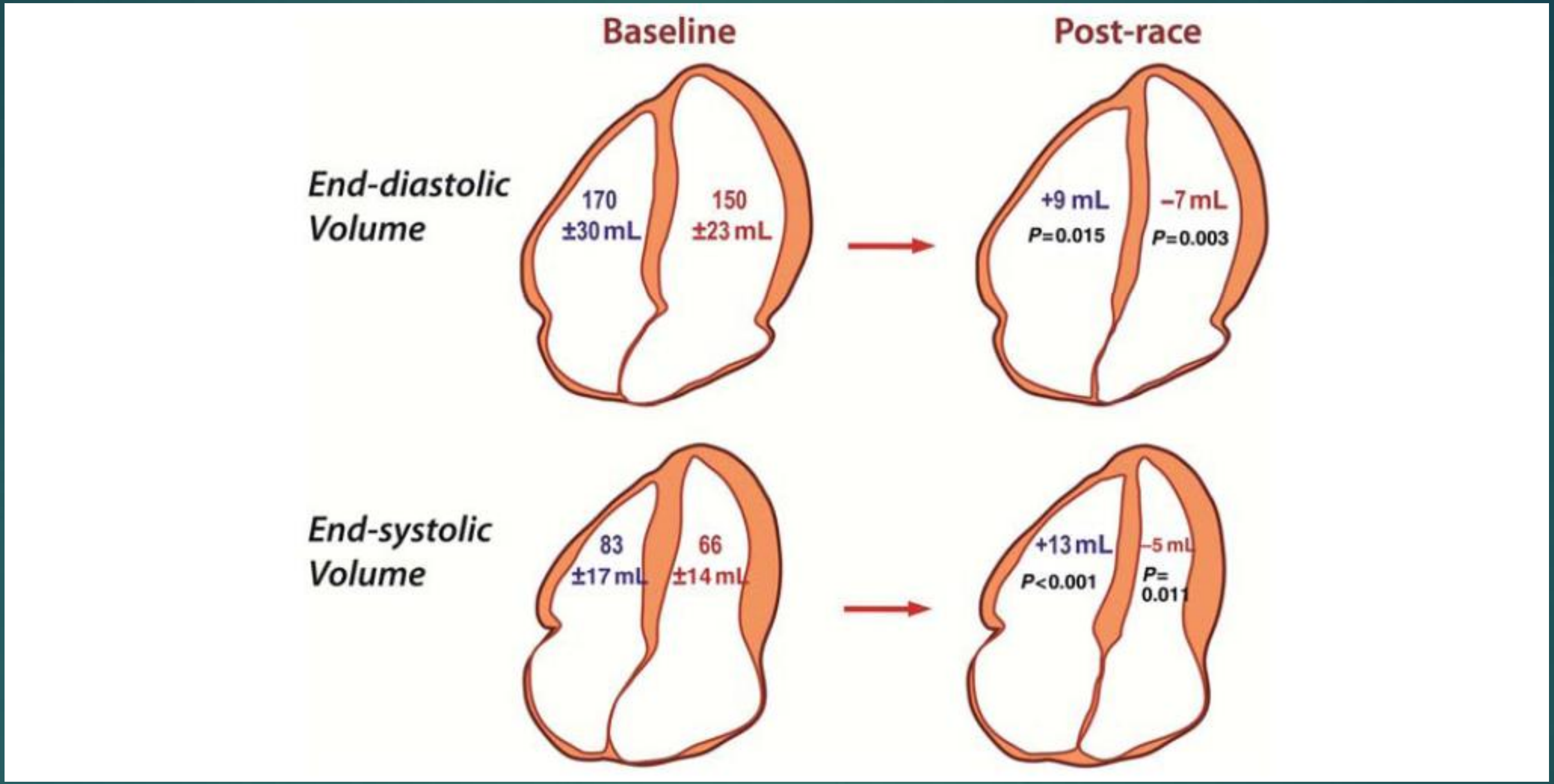
André La Gerche[1,2*], Andrew T. Burns[3], Don J. Mooney[3], Warrick J. Inder[1], Andrew J. Taylor[4], Jan Bogaert[5], Andrew I. MacIsaac[3], Hein Heidbüchel[2], and David L. Prior[1,3]

Right ventricular measures				
RVEF (%)	51.0 ± 3.6	46.4 ± 6.5	50.0 ± 3.8	<0.0001
RVFAC (%)	51.5 ± 6.0	44.3 ± 11.2	49.8 ± 6.6	<0.0001
TAPSE (mm)	24.9 ± 3.9	24.0 ± 4.5	26.5 ± 4.1	0.035
RV strain (%)	−27.2 ± 3.4	−23.7 ± 3.7	−25.6 ± 3.0	0.001
RVSRs (s^{-1})	−1.42 ± 0.24	−1.26 ± 0.23	−1.29 ± 0.19	0.008

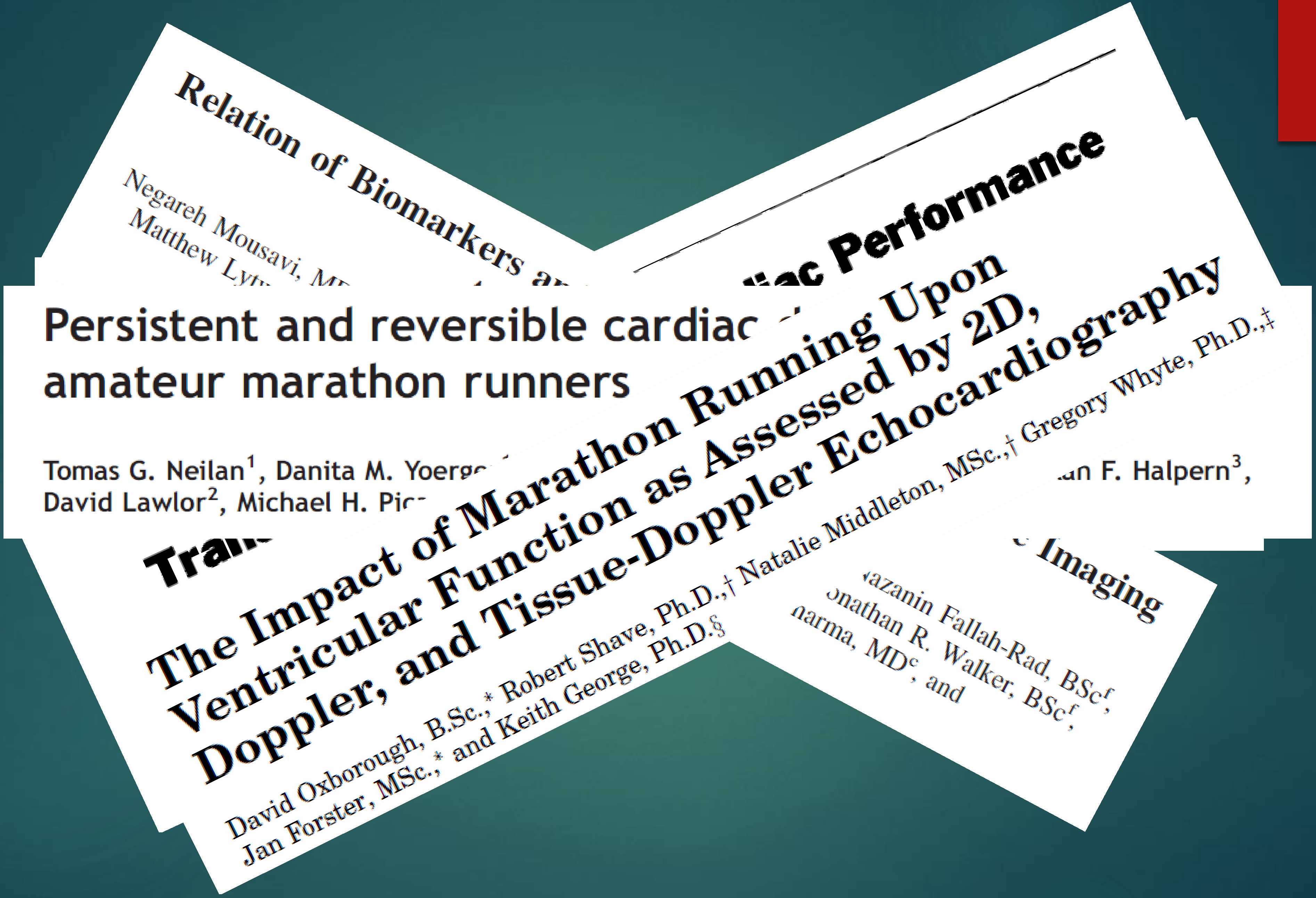
Ventricular interaction				
RV end-systolic diameter (mm)	20.2 ± 5.2	23.8 ± 6.1	21.5 ± 5.1	0.018
LV end-systolic diameter (mm)	37.7 ± 3.8	35.2 ± 3.2	37.5 ± 3.6	0.003
RV:LV end-systolic diameter ratio	0.54 ± 0.14	0.69 ± 0.19	0.58 ± 0.13	<0.0001
Eccentricity index	1.04 ± 0.13	1.10 ± 0.15	1.01 ± 0.10	0.006



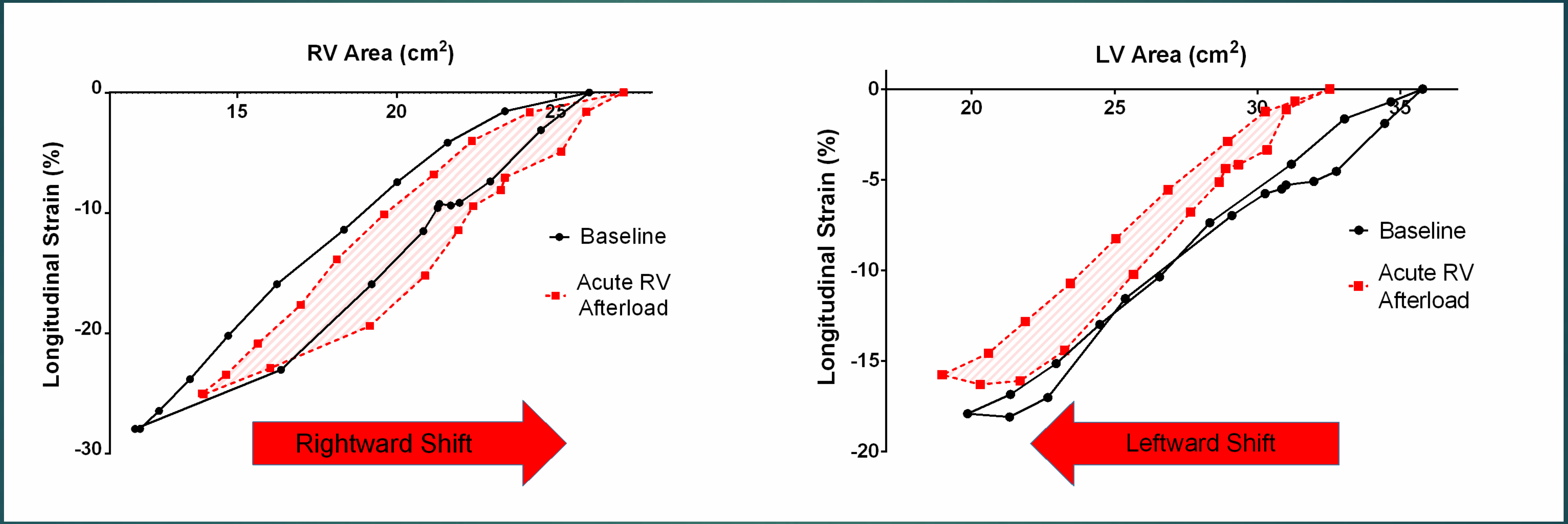
La Gerche et al 2011



La Gerche et al 2011


Relation of Biomarkers an
Negareh Mousavi, MD
Matthew Lyt
iac Performance
Persistent and reversible cardiac
amateur marathon runners
Tomas G. Neilan[1], Danita M. Yoerge
an F. Halpern[3],
David Lawlor[2], Michael H. Pic
Tra
The Impact of Marathon Running Upon
Ventricular Function as Assessed by 2D,
Doppler, and Tissue-Doppler Echocardiography
David Oxborough, B.Sc.,* Robert Shave, Ph.D.,† Natalie Middleton, MSc.,† Gregory Whyte, Ph.D.,‡
Jan Forster, MSc.,* and Keith George, Ph.D.§
Imaging
azanin Fallah-Rad, BSc[f],
onathan R. Walker, BSc[f],
narma, MD[c], and

Right Heart Post-Ultramarathon



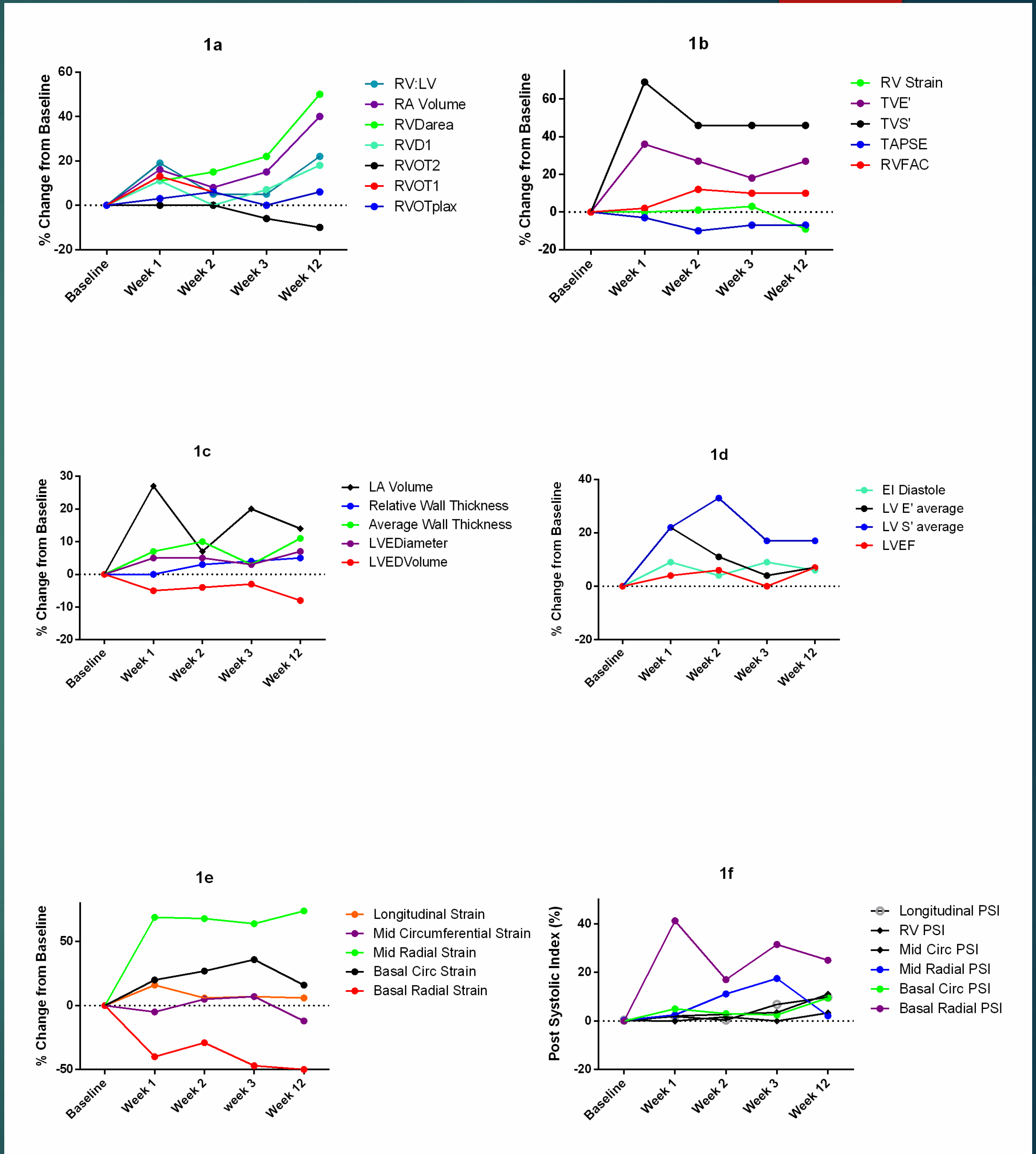
Unpublished Data

OMCR
OMCR 2014(4 pages)
doi:10.1093/omcr/omu026

Case Report

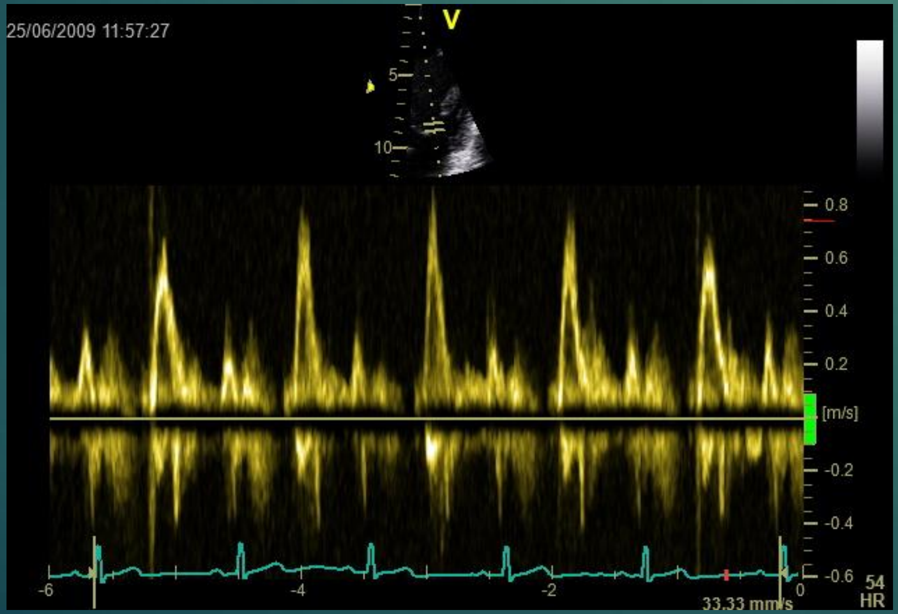
Acute response and chronic stimulus for cardiac structural and functional adaptation in a professional boxer

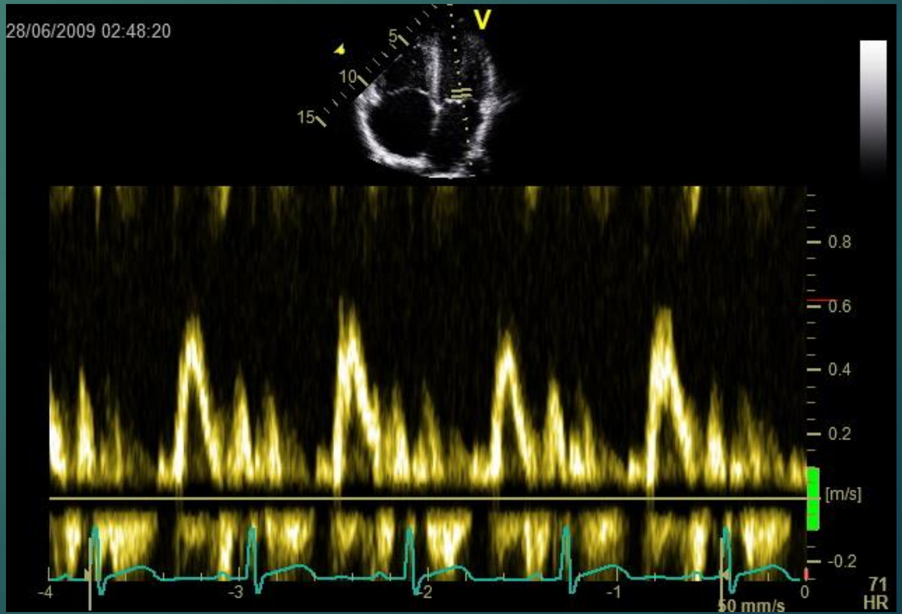
David Oxborough[1,*], Keith George[1], Victor Utomi[1], Rachel Lord[1], James Morton[1], Nigel Jones[2] and John Somauroo[1,3]

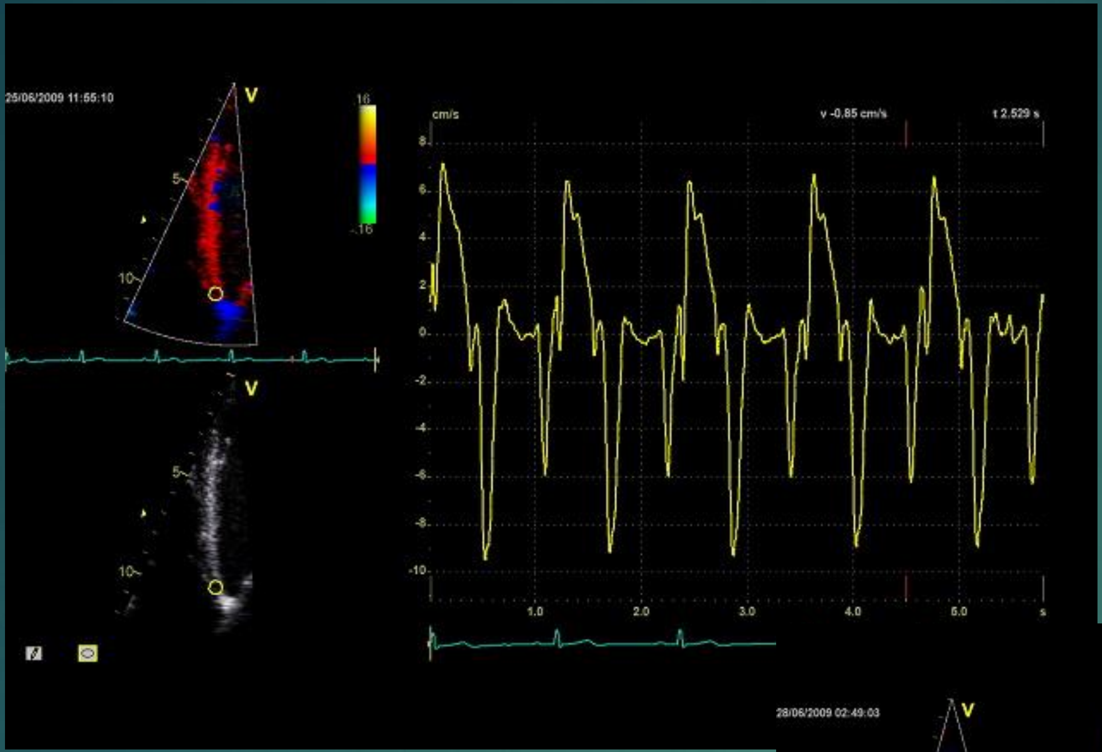


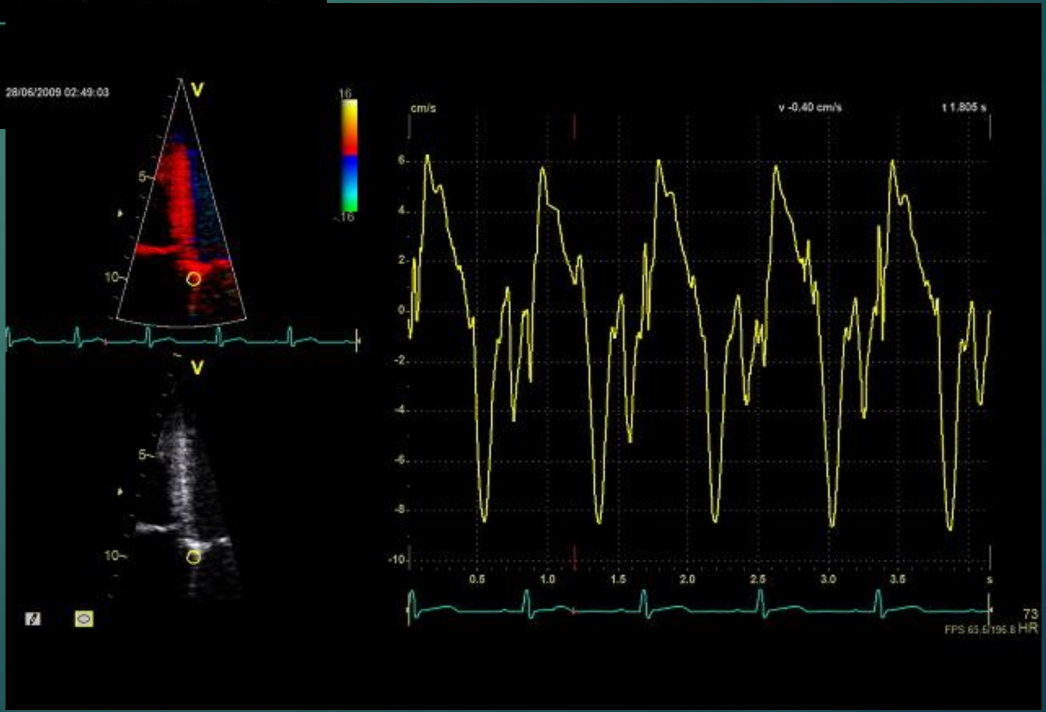
The Left Ventricle

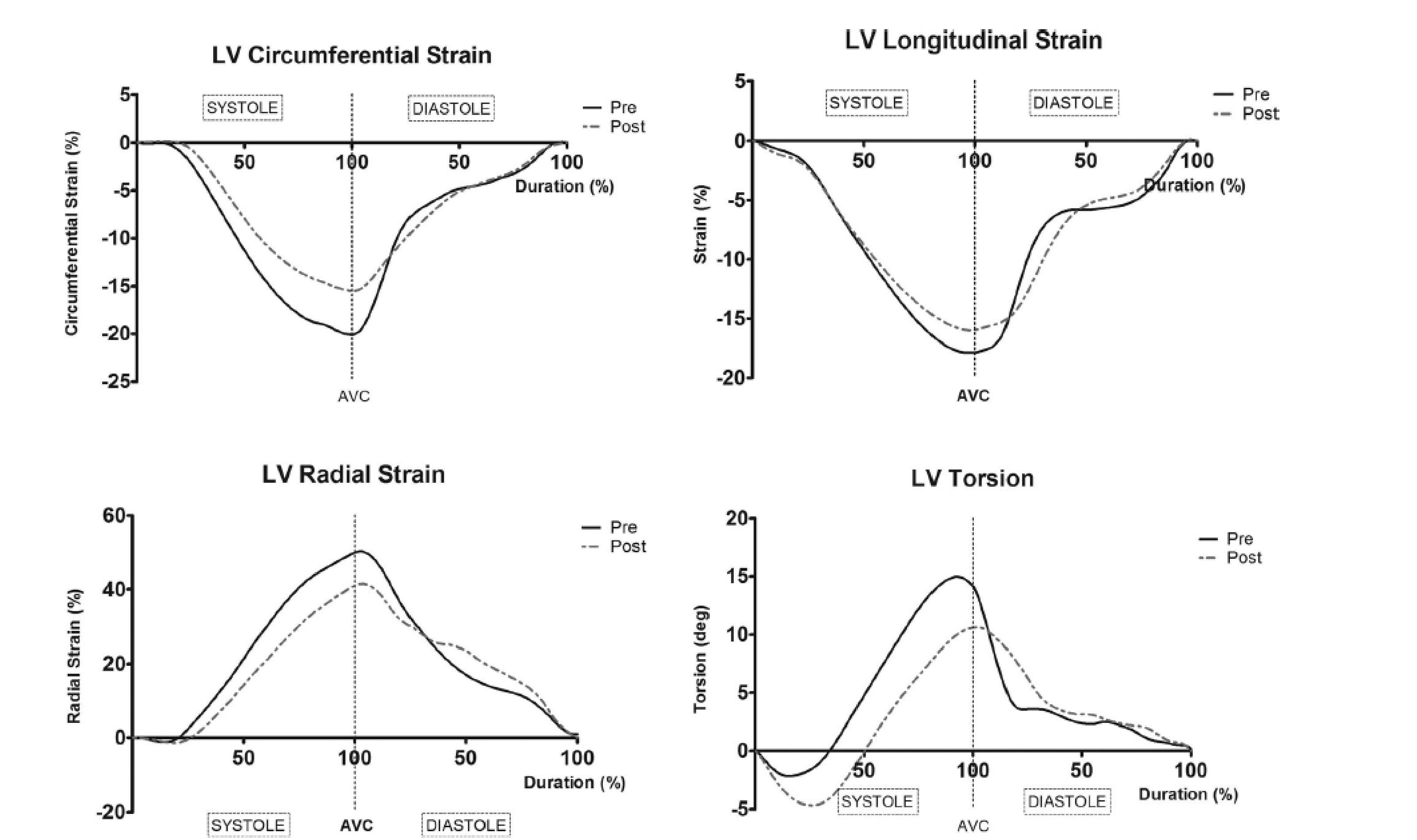
- Reduction in Diastolic Filling
- Reduction in Systolic function (at higher exercise volumes)
  - Strain imaging
  - Torsion

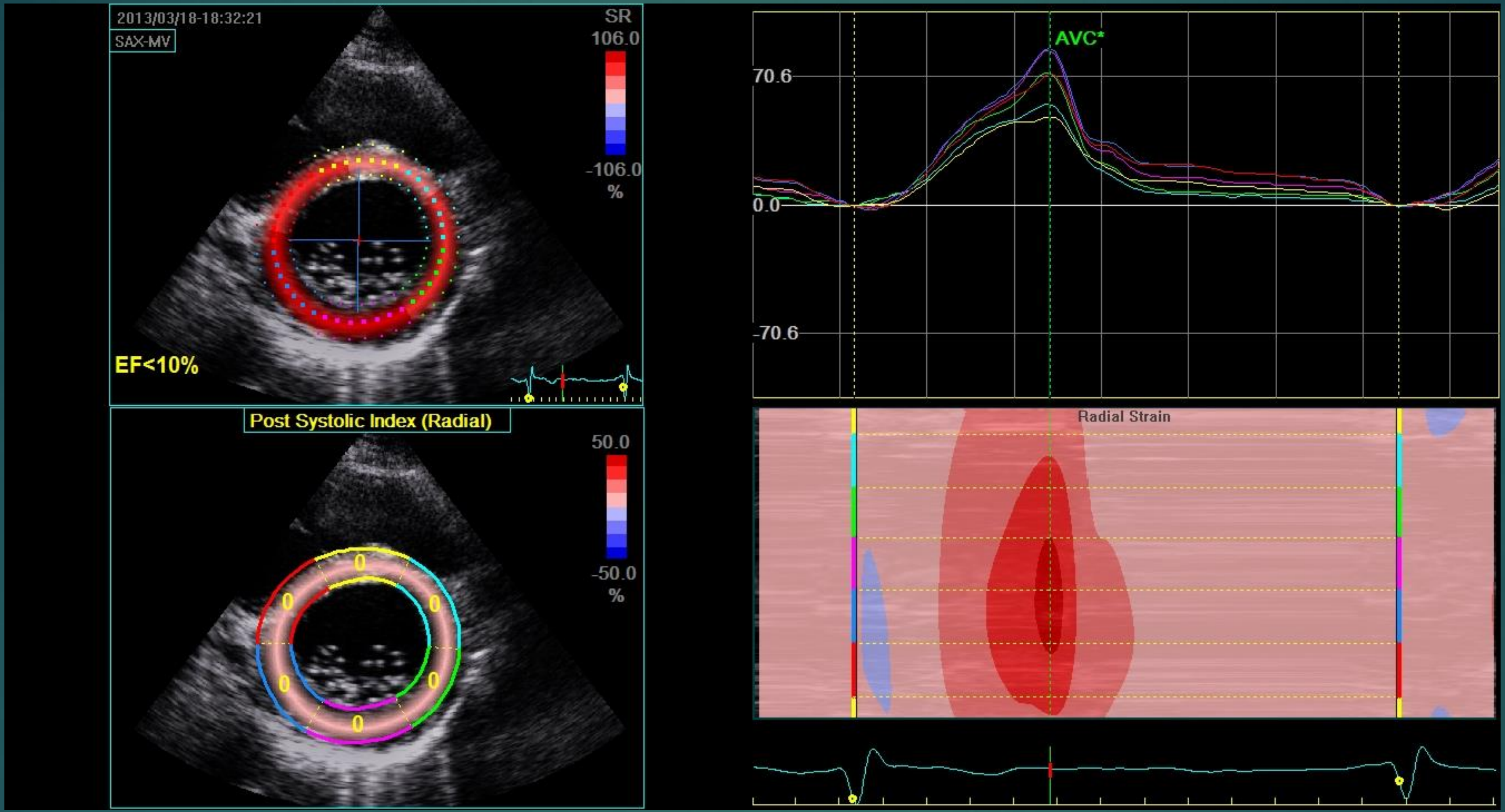




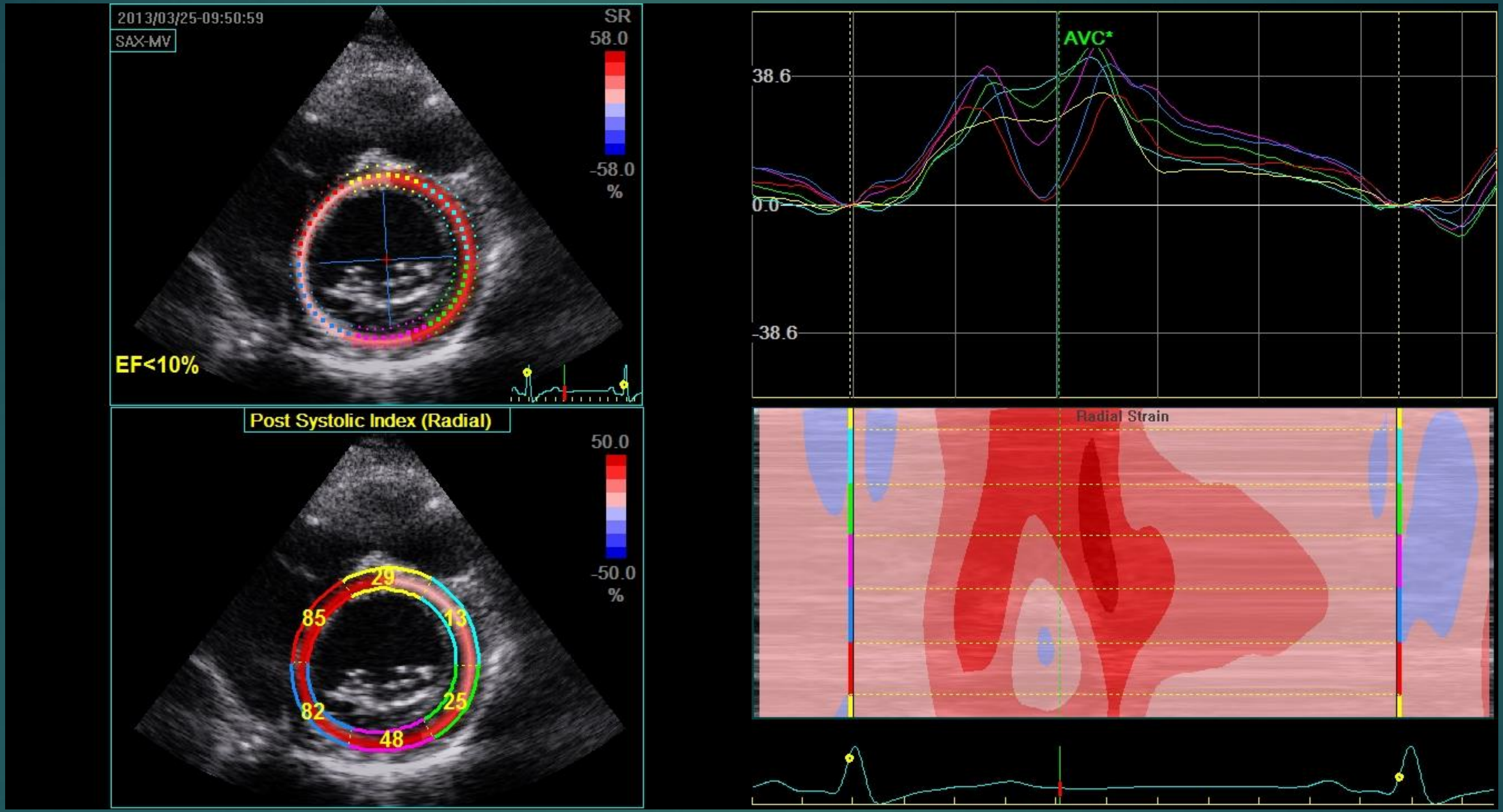

25/06/2009 11:55:10
cm/s
v -0.85 cm/s
t 2.529 s


28/06/2009 02:49:03
cm/s
v -0.40 cm/s
t 1.805 s
HR


LV Circumferential Strain
Circumferential Strain (%)
SYSTOLE
DIASTOLE
Pre
Post
Duration (%)
AVC
LV Longitudinal Strain
Strain (%)
SYSTOLE
DIASTOLE
Pre
Post
Duration (%)
AVC
LV Radial Strain
Radial Strain (%)
Pre
Post
Duration (%)
SYSTOLE
AVC
DIASTOLE
LV Torsion
Torsion (deg)
Pre
Post
SYSTOLE
DIASTOLE
Duration (%)
AVC



2013/03/18-18:32:21
SAX-MV
SR
106.0
-106.0
%
EF<10%
Post Systolic Index (Radial)
50.0
-50.0
%
AVC*
70.6
0.0
-70.6
Radial Strain


2013/03/25-09:50:59
SAX-MV
SR
58.0
-58.0
%
EF<10%
Post Systolic Index (Radial)
50.0
-50.0
%
29
85
13
82
25
48
AVC*
38.6
0.0
-38.6
Radial Strain

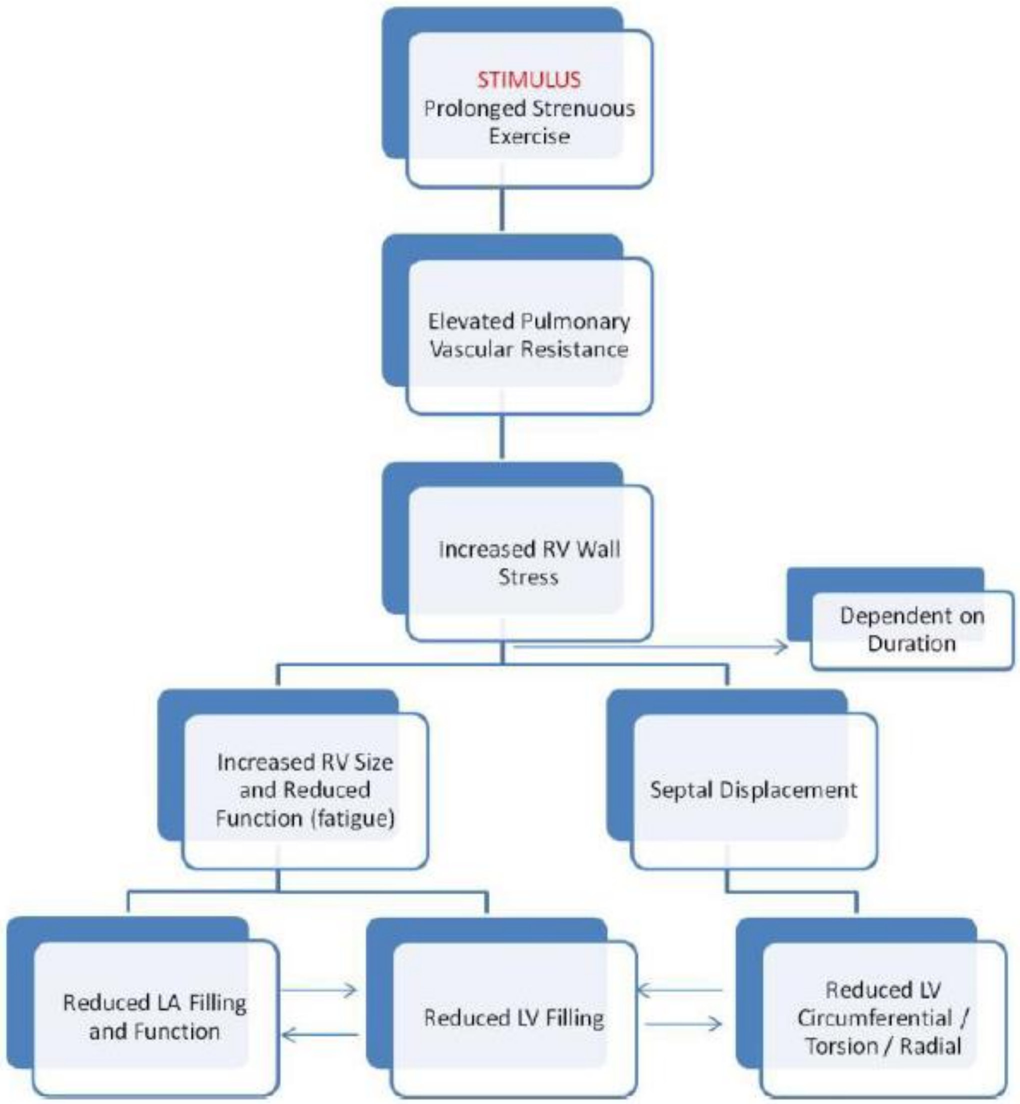
A Depression in Left Ventricular Diastolic Filling following Prolonged Strenuous Exercise is Associated with Changes in Left Atrial Mechanics

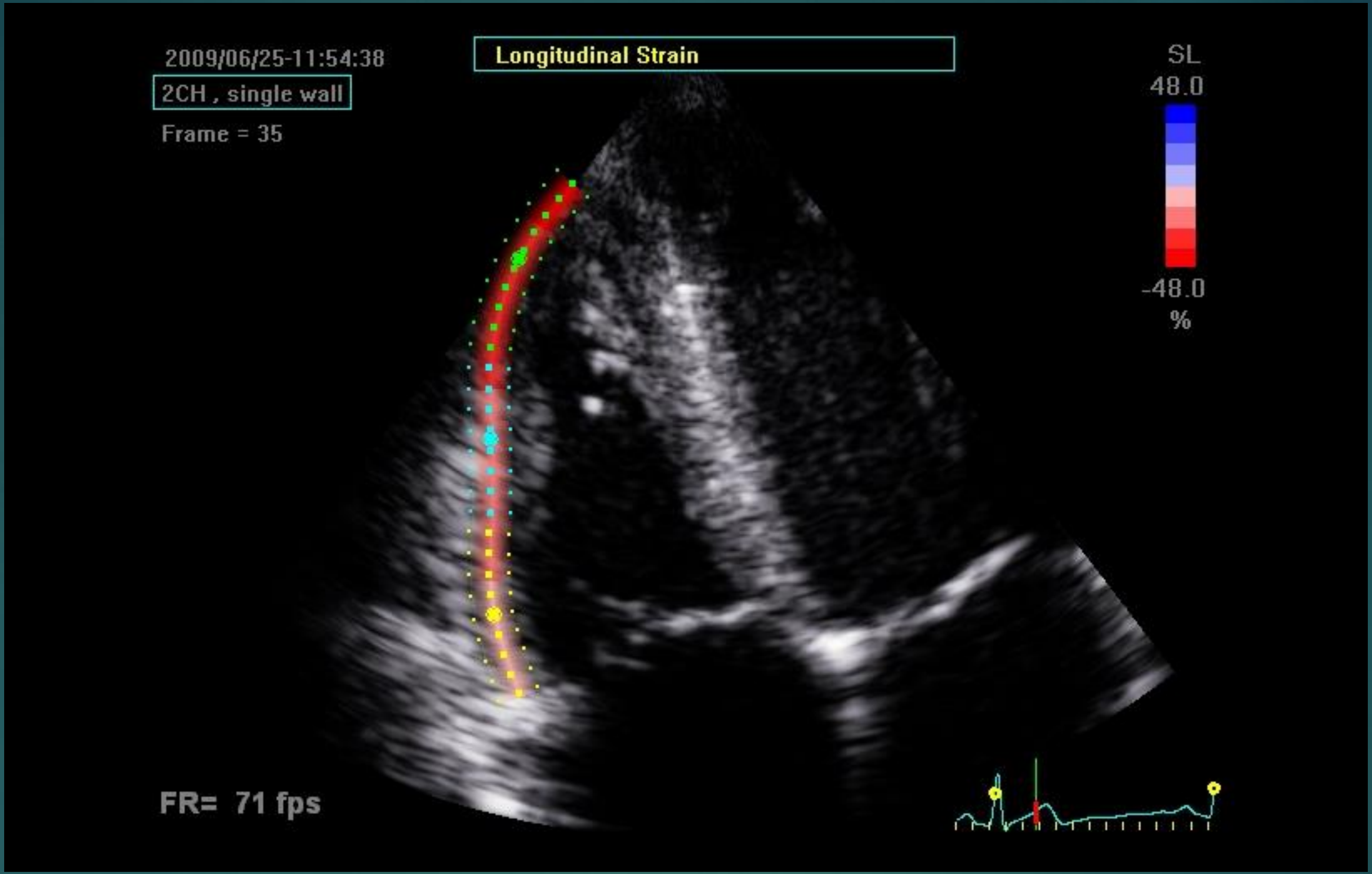
David Oxborough, MSc, Greg Whyte, PhD, Mathew Wilson, MPhil, Rory O'Hanlon, MRCPI, Karen Birch, PhD, Robert Shave, PhD, Gillian Smith, MSc, Richard Godfrey, PhD, Sanjay Prasad, MRCP, and Keith George, PhD, *Leeds, Liverpool, Walsall, and London, United Kingdom*

Journal of the American Society of Echocardiography
Volume 23 Number 9

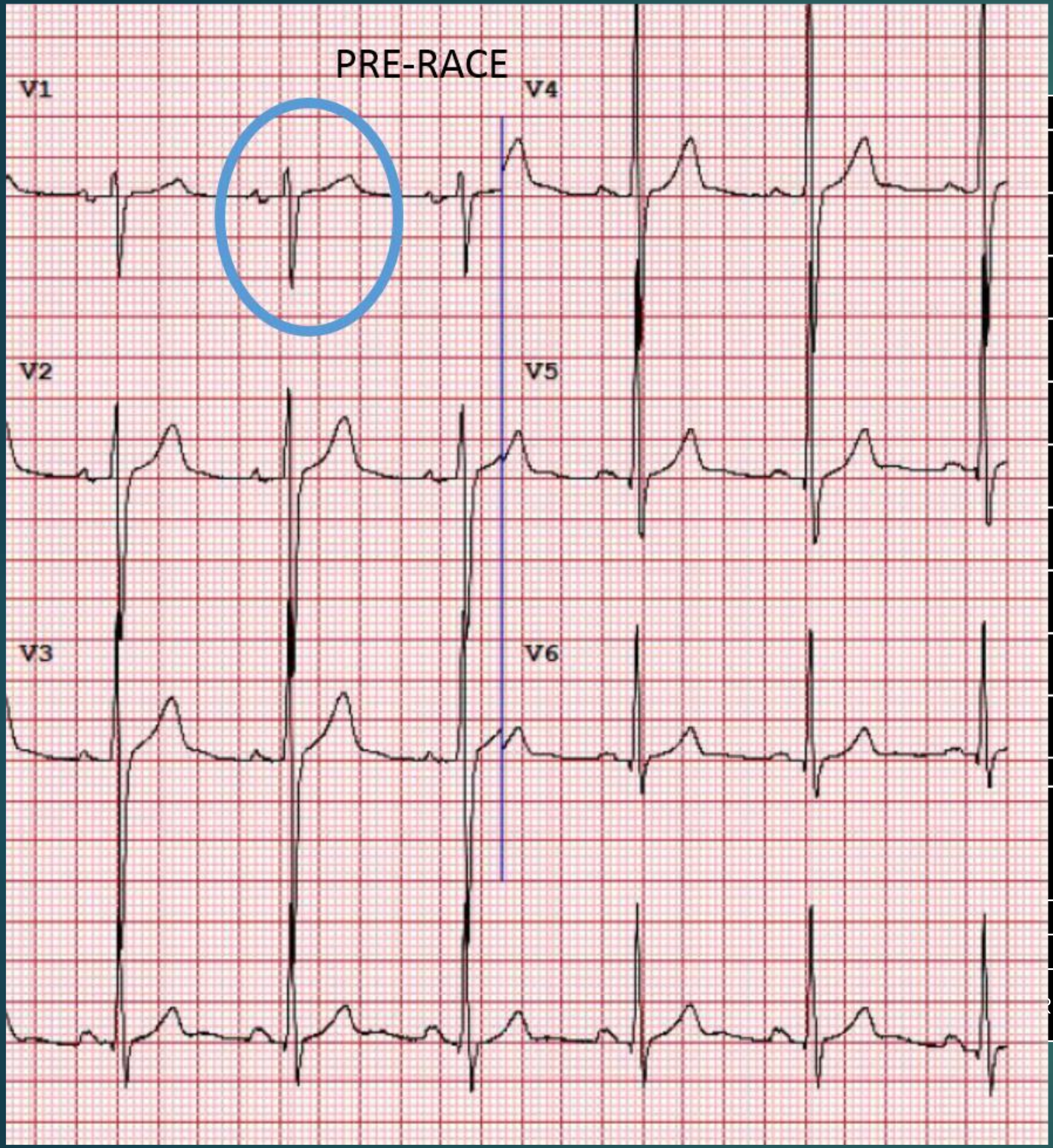
Table 2 LA functional data

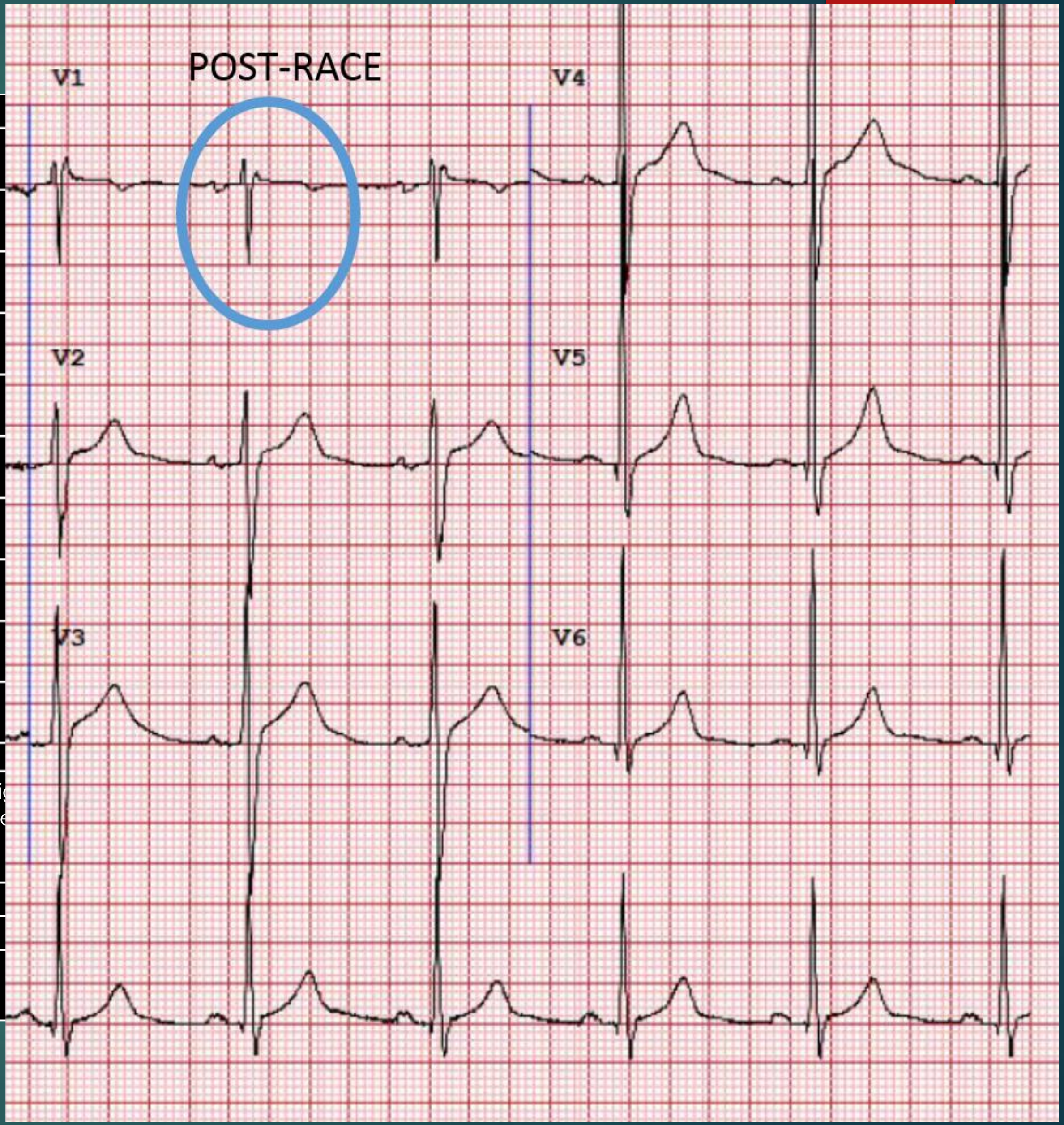
Parameter	Before exercise	Immediately after exercise	6 hours after exercise
Aact (TS-onset) (ms)	33.5 (25.6 to 41.4)	53.5 (42.4 to 64.6)*	51.1 (41.5 to 60.8)†
Aact (TS-peak) (ms)	108.8 (97.9 to 119.7)	118.3 (106.3 to 130.2)	114.2 (104.7 to 123.6)
Aϵ (%)	53.1 (42.8 to 63.2)	44.2 (37.1 to 51.1)*	51.7 (43.1 to 60.4)†
ASRs (L/s)	2.79 (2.35 to 3.25)	2.62 (2.15 to 3.09)	2.77 (2.24 to 3.3)
ASRe (L/s)	−4.37 (−5.12 to −3.63)	−3.24 (−3.84 to −2.64)*	−3.90 (−4.66 to −3.14)
ASRa (L/s)	−2.95 (−3.56 to −2.33)	−3.24 (−4.02 to −2.54)*	−2.88 (−3.66 to −2.10)
LAES (mL)	65 (43 to 79)	57 (43 to 76)*	67 (45 to 85)‡
LApreA (mL)	47 (32 to 64)	49 (37 to 65)	49 (35 to 67)
LAED (mL)	37 (26 to 48)	35 (27 to 46)*	38 (28 to 48)‡
Reservoir volume (mL)	28 (16 to 37)	23 (10 to 47)*	29 (14 to 47)‡
Conduit volume (mL)	74 (50 to 112)	66 (36 to 103)*	66 (35 to 103)
Booster volume (mL)	10 (5 to 17)	14 (4 to 29)*	11 (4 to 25)


STIMULUS
Prolonged Strenuous Exercise
Elevated Pulmonary Vascular Resistance
Increased RV Wall Stress
Dependent on Duration
Increased RV Size and Reduced Function (fatigue)
Septal Displacement
Reduced LA Filling and Function
Reduced LV Filling
Reduced LV Circumferential / Torsion / Radial



RV involvement is significant


PRE-RACE
V1
V2
V3
V4
V5
V6


POST-RACE
V1
V2
V3
V4
V5
V6

Cardiac Biomarkers

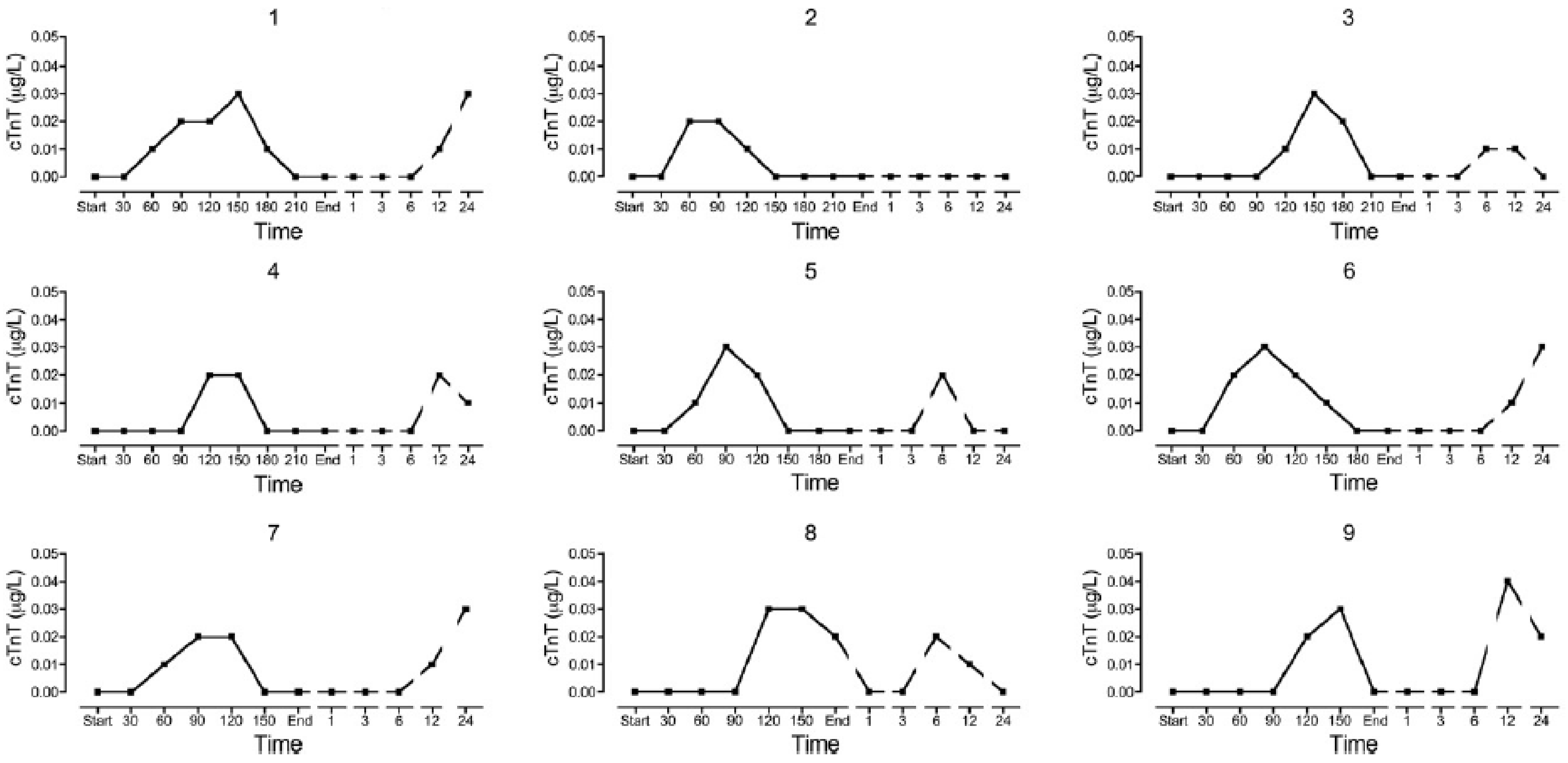


Figure 3 Individual cTnT Release During and After Completion of a Marathon

Individual cardiac troponin T (cTnT) release during (min) and after (h, after exercise) completion of a marathon. Reprinted with permission from Middleton et al. (2).

Summary

- Big hearts functioning well
- Completing an ultramarathon leads to some acute changes in structure and function – particularly the right ventricle
- Cardiac biomarker release appears to be a physiological phenomenon

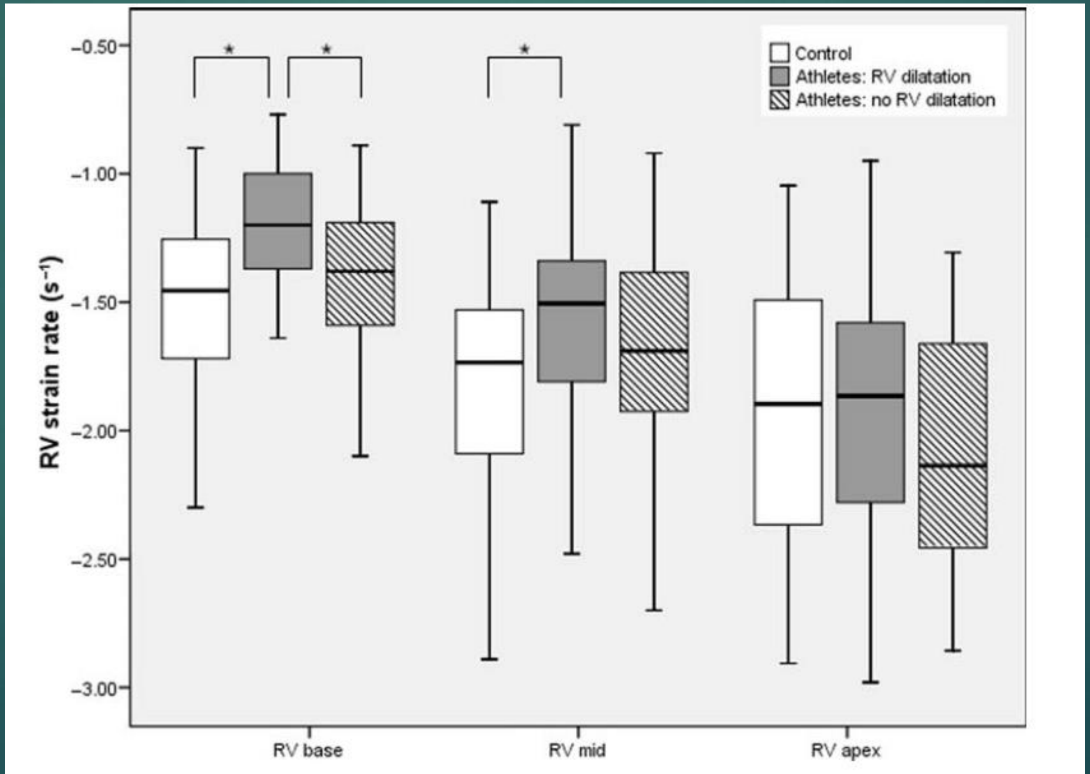
- This acute event is likely to act as a stimulus for PHYSIOLOGICAL cardiac adaptation

DOES REPEATED EXPOSURE AND INSUFFICIENT RECOVERY TIME LEAD TO PATHOLOGICAL CARDIAC ADAPTATION?

Echocardiographic tissue deformation imaging of right ventricular systolic function in endurance athletes

Arco J. Teske[1]*, Niek H. Prakken[2], Bart W. De Bo…
Edwin P. Martens[3], Pieter A. Doevendans[1], and M…

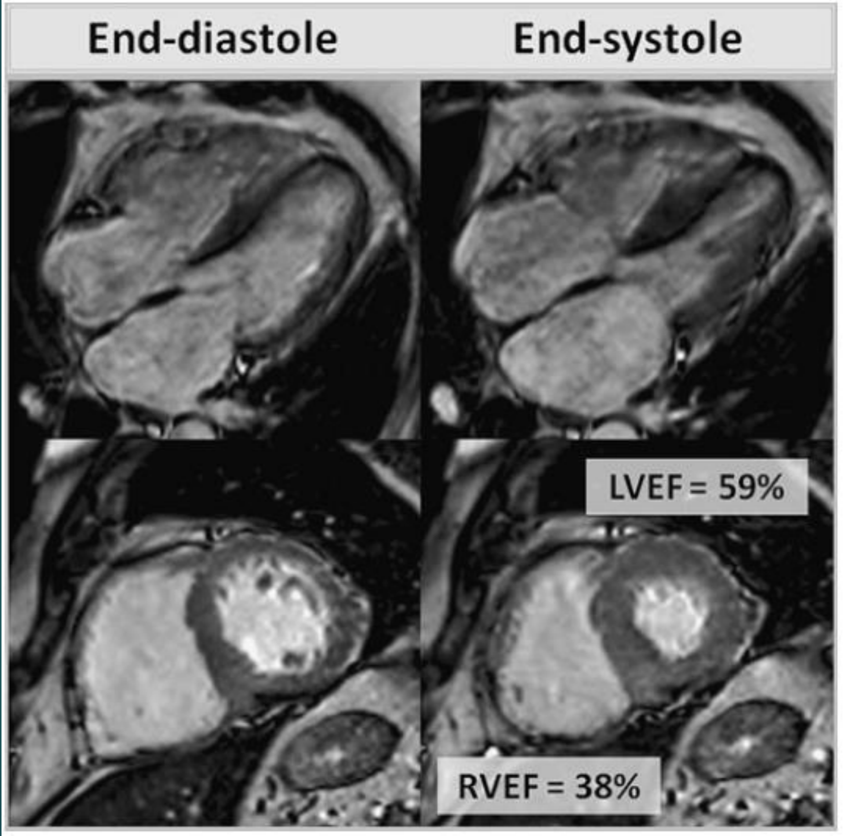
European Heart Journal (2009) **30**, 969–977

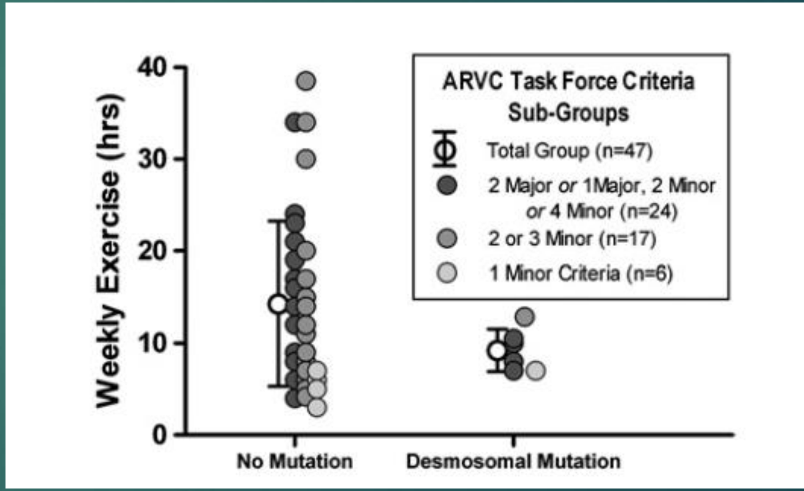


Lower than expected desmosomal gene mutation prevalence in endurance athletes with complex ventricular arrhythmias of right ventricular origin

A La Gerche,[1,3] C Robberecht,[2] C Kuiperi,[2] D Nuyens,[1] R Willems,[1] T de Ravel,[2] G Matthijs,[2] H Heidbüchel[1,3]

Heart 2010;**96**:1268–1274.

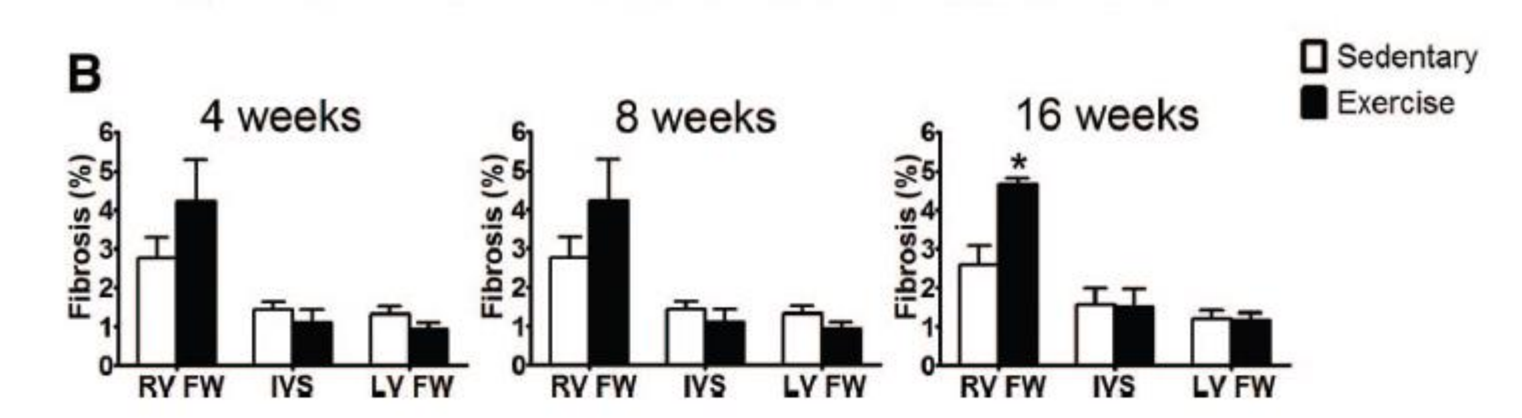


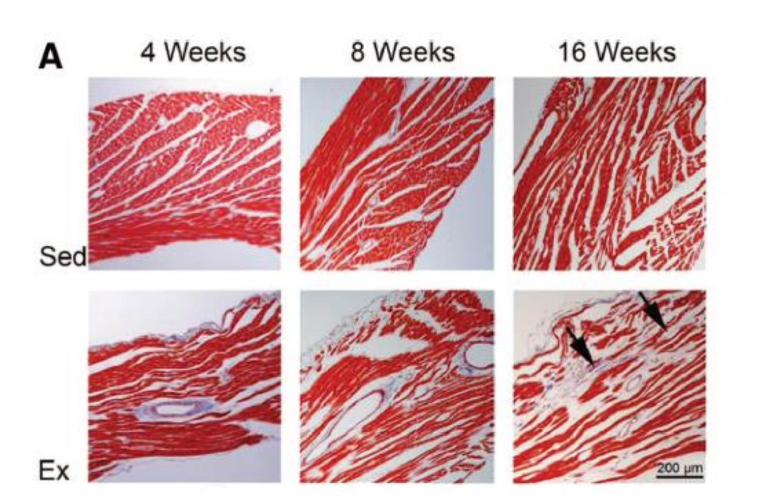


Cardiac Arrhythmogenic Remodeling in a Rat Model of Long-Term Intensive Exercise Training

Begoña Benito, MD*; Gemma Gay-Jordi, PhD*; Anna Serrano-Mollar, PhD; Eduard Guasch, MD;
Yanfen Shi, MD; Jean-Claude Tardif, MD; Josep Brugada, MD, PhD;
Stanley Nattel, MD†; Lluis Mont, MD, PhD†

(*Circulation*. 2011;123:13-22.)





Diverse patterns of myocardial fibrosis in lifelong, veteran endurance athletes

M. Wilson,[1] R. O'Hanlon,[2,3] S. Prasad,[2] A. Deighan,[4] P. MacMillan,[5] D. Oxborough,[6] R. Godfrey,[7] G. Smith,[2] A. Maceira,[8] S. Sharma,[9] K. George,[10] and G. Whyte[10]

J Appl Physiol 110: 1622–1626, 2011.

Table 3. *Location and extent of LGE in veteran athletes*

Participant No.	Age, yr	Percentage of Total LGE Mass, g	LGE Pattern	Perfusion Defect	Interpretation	Location
1	67	18.9	CAD	Yes	Probable dual infarction	Septal and lateral wall
2	50	8	Non-CAD	No	Probable myocarditis	Epicardial lateral wall
3	66	3	Non-CAD	No	Nonspecific	Basal and midinsertion point
4						...nt mid and apical
5						...or mid/apical
6						...nt

LGE; late ...

DATA IS SPARSE

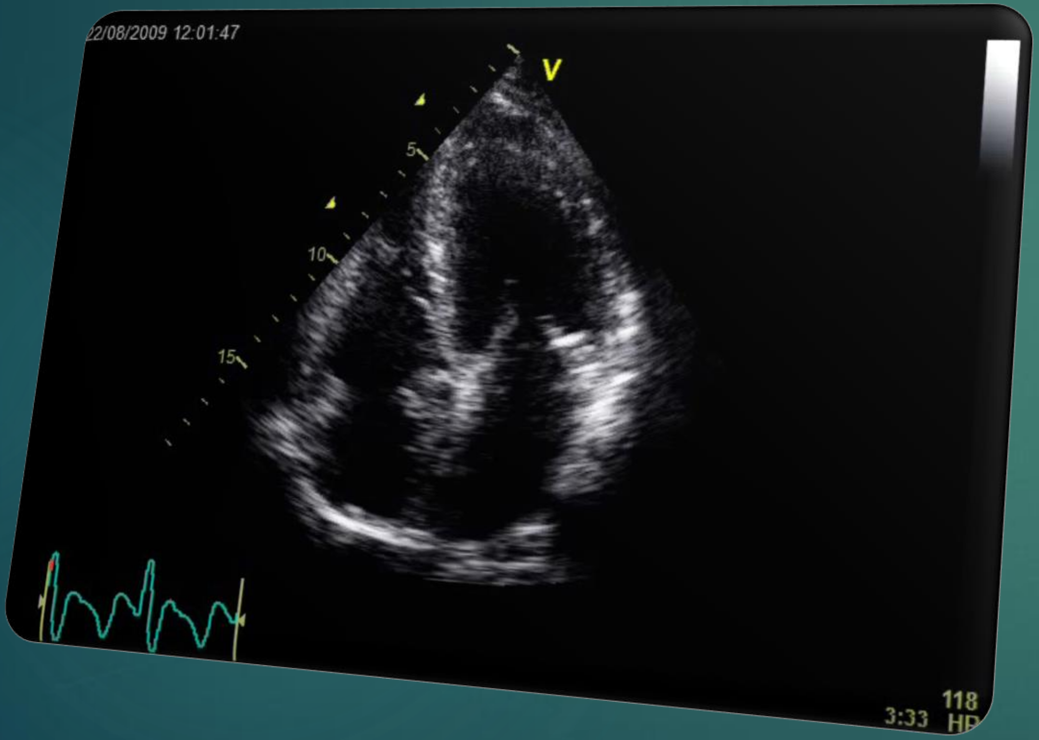
HETEROGENEOUS PRESENTATION

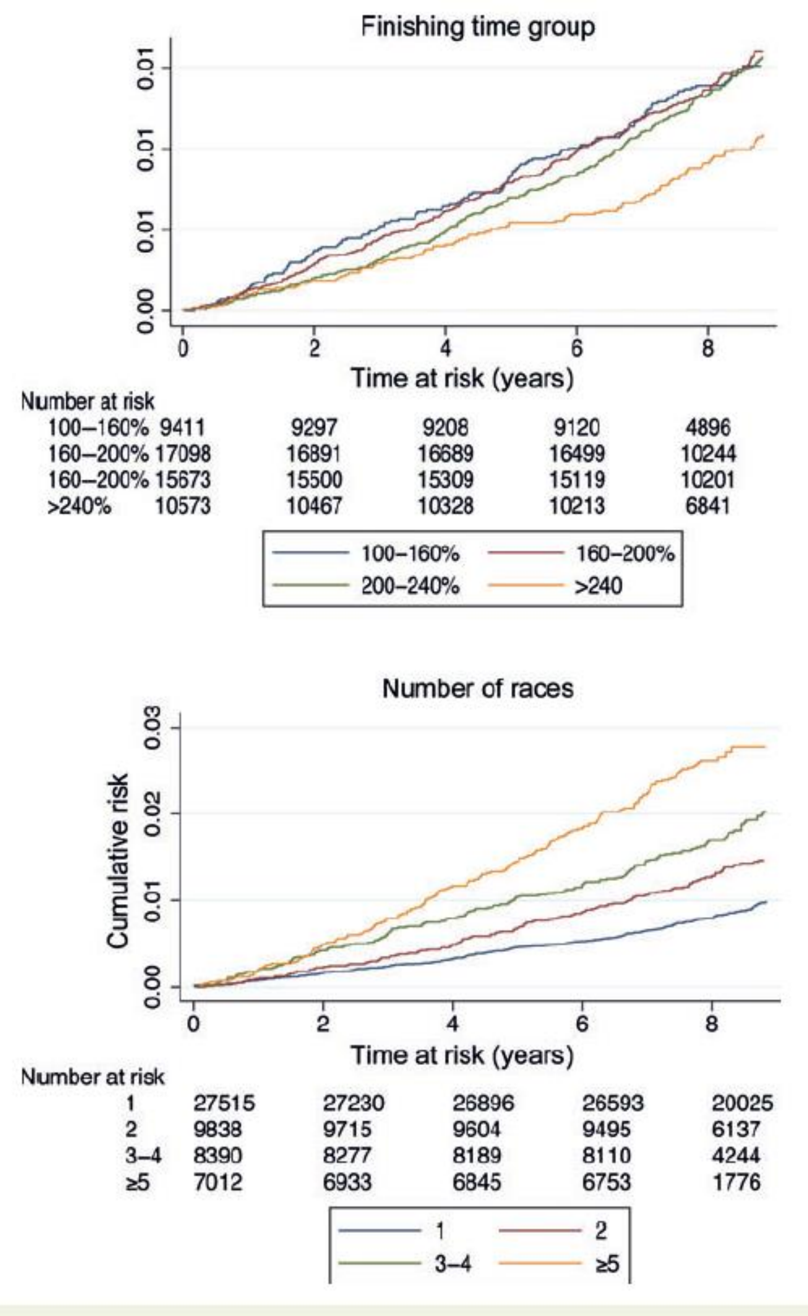
?GENETIC PREDISPOSTION

DEFINITELY FURTHER WORK IS REQUIRED

Risk of arrhythmias in 52 755 long-distance cross-country skiers: a cohort study

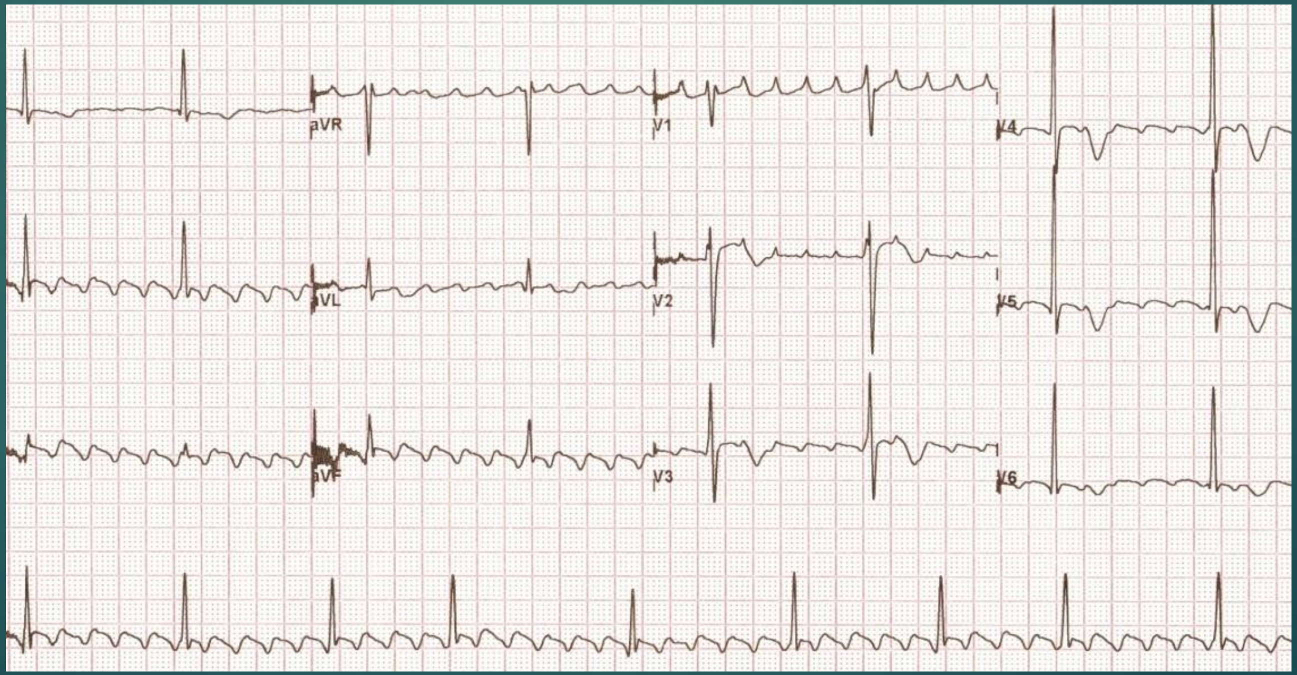
Kasper Andersen[1]*, Bahman Farahmand[2,3], Anders Ahlbom[2], Claes Held[1], Sverker Ljunghall[1], Karl Michaëlsson[4], and Johan Sundström[1]





Atrial Arrhythmias

- Elevated risk of AF in endurance athletes (Furlanello 2008; Sorokin 2009; Abdulla 2009)
  - LA size, ANS balance, competitive stress ??




Missouri Medicine
The Journal of the Missouri State Medical Association
www.msma.org
March/April 2014
Marathon
In the Long Run
Not Heart Heal
Increased Coronary Plaque in Marathoners
Heart Problems in Extreme Endurance Athletes
Pheidippides' Final Words: "My Feet Are Killing Me!"
Pheidippides' Final Words: "My Feet Are Killing Me!"
by John C. Hagan, III, MD
Cardiotoxicity
nce Exercise
Among
by Robert S. Schwartz,
Gretchen Peichel,
MD, Kevin M
Wickstrom, BS,
Knickelbine,
Coronary Artery
as a Result of Ext
by Peter A. McCullough, MD, MPH & Carl J. Lav
In the long run, you may
end up with a broken heart.

Men			
Characteristic	Sedentary (n=23)	Marathon (n=50)	p value
Age, years	55.43 ± 10.39	59.44 ± 6.66	NS, 0.051
Systolic BP, mmHg*	134.00 ± 18.35	127.02 ± 13.74	NS
Diastolic BP, mmHg	79.30 ± 10.39	79.04 ± 9.40	NS
Heart Rate, bpm	70.83 ± 10.57	52.36 ± 9.31	< 0.001
Height, inches*	70.39 ± 2.10	70.10 ± 2.44	NS
Weight, kg*	96.8 ± 17.0	76.9 ± 11.5	< 0.001
BMI, kg/m^2*	30.29 ± 5.16	24.16 ± 2.88	< 0.001
Hypertension	15/23 (65.2)	12 / 47 (25.5)	0.001
Hyperlipidemia	19/23 (82.6)	22 / 47 (46.8)	[illegible]
Diabetes	4 / 23 (17.39)	0 / [illegible]	[illegible]
History of Smoking, %	9 / 23 (39.1)	26 [illegible]	NS
Creatinine, mg/dl*	1.03 ± 0.20	1.1[illegible] 1.00	NS
Total Cholesterol, mg/dl*	183.56 ± 48.59	186.44 ± 28.83	NS
HDL, mg/dl	46.67 ± 8.86	58.02 ± 11.58	< 0.001
LDL, mg/dl*	108.13 ± 45.23	111.90 ± 26.09	NS
Triglycerides, mg/dl*	130.80 ± 63.00	83.36 ± 38.58	NS

- Small sample size
- **'tried'** to match groups for cardiac risk factors
- Not peer reviewed

MARATHON RUNNING DOES NOT PROTECT AGAINST CORONARY ARTERY DISEASE

Table 2
Lesion Prevalence across [illegible] Subjects

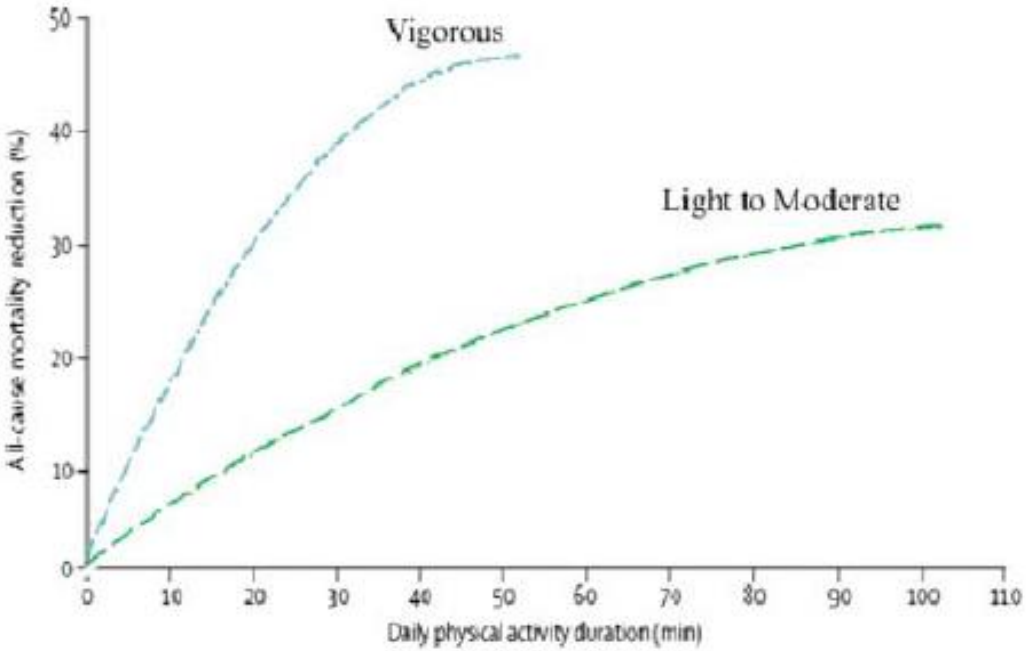
[illegible] - Men			
[illegible]	[illegible]edentary (n=23)	Marathon (n=50)	p value
Number of lesions	47	95	-
Lesion prevalence	12 (52.2)	30 (60.0)	NS

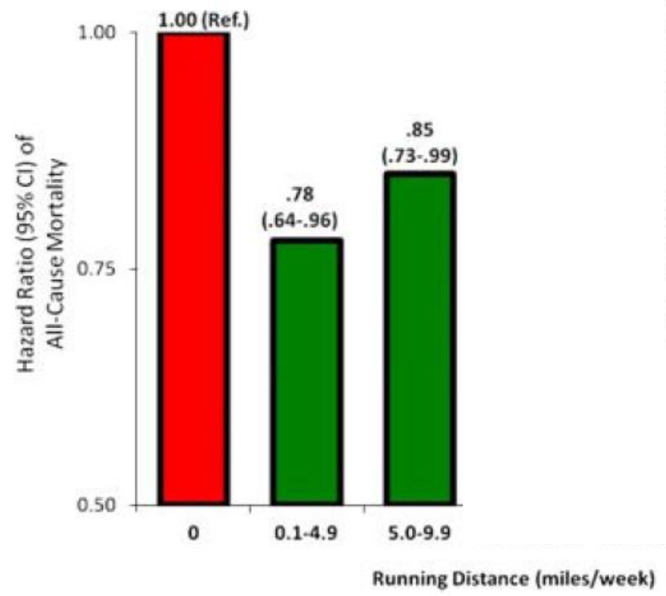
Values presented are mean ± SD or n (%)
p values from Fisher's Exact Test/T-test

DOES NOT SUGGEST MARATHON RUNNING ***CAUSES*** CORONARY ARTERY DISEASE

Run for your life … at a comfortable speed and not too far

James H O'Keefe,[1,2] Carl J Lavie[3,4]





All-cause mortality by running distance per week.[16]

d for too many
rogress towards

Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study

Chi Pang Wen*, Jackson Pui Man Wai*, Min Kuang Tsai, Yi Chen Yang, Ting Yuan David Cheng, Meng-Chih Lee, Hui Ting Chan, Chwen Keng Tsao, Shan Pou Tsai, Xifeng Wu

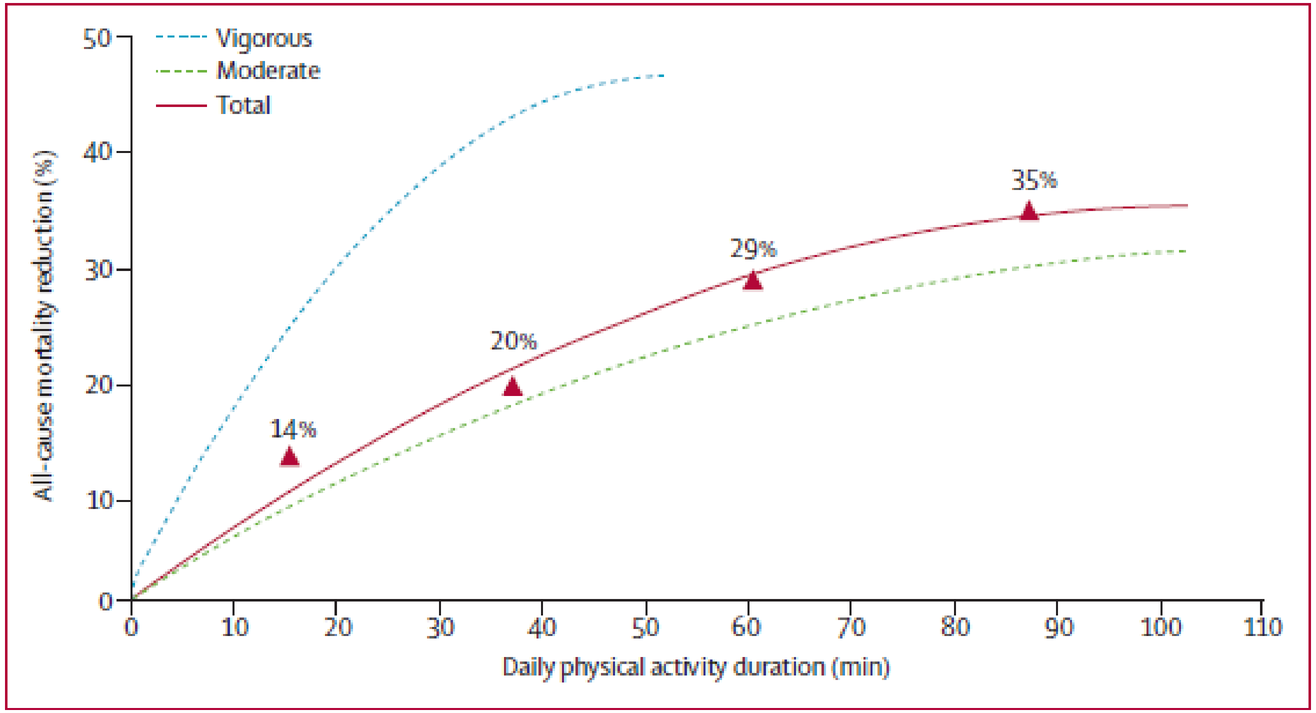


Figure 2: Daily physical activity duration and all-cause mortality reduction

The Lancet

Run for your life … at a comfortable speed and not too far

James H O'Keefe,[1,2] Carl J Lavie[3,4]

O'Keefe JH, *et al*. *Heart* April 2013 Vol 99 No 8

"One possible explanation for the U-shaped curve observed by Lavie and colleagues is that the authors adjust for body mass index, hypertension and hypercholesterolaemia. Running has been shown to lower those risk factors in a dose-dependent fashion with no sign of negative returns until at least 50 miles/ week. Arguably, adjusting for all these factors is akin to adjusting for low-density lipoprotein (LDL) values in a study analysing the survival benefit of taking statins to treat hypercholesterolaemia. Put simply, this editorial represents a selective interpretation of the available data, at the best." – ***Thomas Weber***

Summary

- Cardiac structure adapts to running ultramarathons in order to improve efficiency and ability to generate and cope with higher stroke volumes.
- Cardiac function is generally normal at rest with a high reserve during exercise.
- There is some minimal evidence of detrimental impact on the myocardium demonstrated by fibrosis – this is in a very small number and may well be no different to control subjects.
- There is a higher incidence of atrial fibrillation in ultramarthoners.
- Data on increased mortality and increased prevalence of CAD is unfounded.

The Future

Thank you for listening