Speckle Tracking in Endurance Athletes

Dr Leah Wright

PhD, DMU Cardiac. BSc

Cardiometabolic Health and Exercise Physiology & Imaging Research lab

AUSTRALIA'S LEADING
ECHOCARDIOGRAPHY
CONFERENCE

17-19 March 2025
Marvel Stadium, Melbourne

THE COMMON GOOD
AN INITIATIVE OF THE PRINCE CHARLES HOSPITAL FOUNDATION

Baker
HEART & DIABETES INSTITUTE

Structure

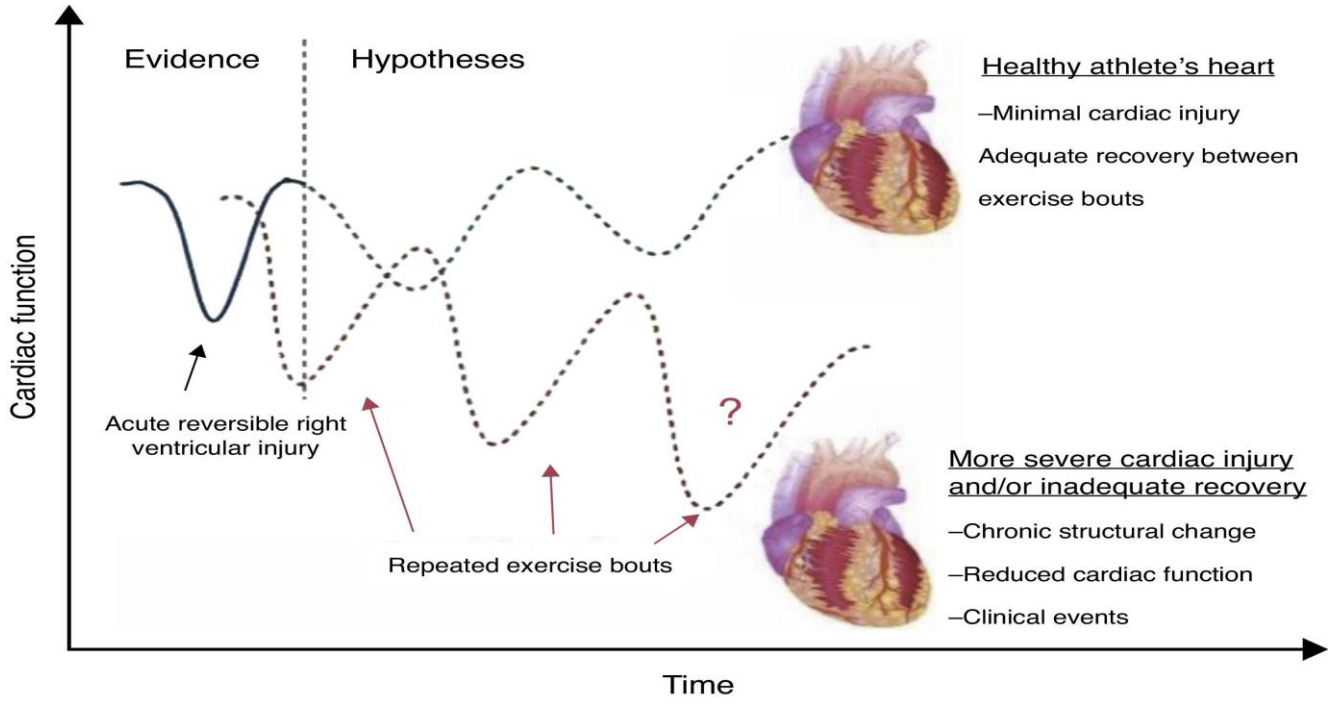
1. Cardiovascular risk in athletes
2. Left Ventricular Strain
3. Right Ventricular Strain
4. Left Atrial Strain
5. Conclusions

Baker
HEART & DIABETES INSTITUTE

Cardiovascular Disease in Athletes

It is well documented that exercise training (endurance exercise) leads to physiological remodeling (1-2):

- Lower resting heart rates
- Greater cardiac volumes
- RV/LV ratio changes

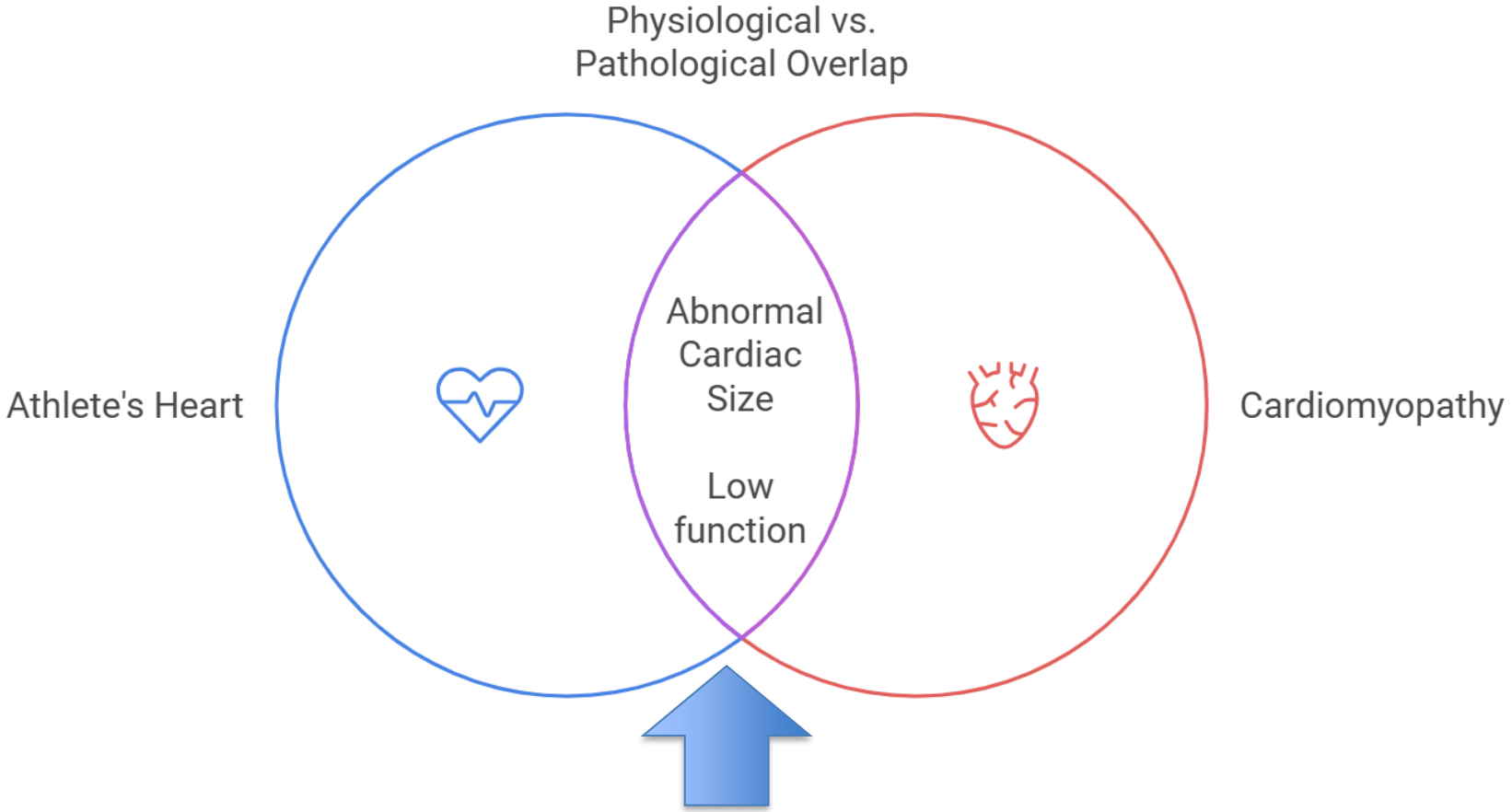


Remodeling is likely to relate to the exercise intensity (total exercise duration)

1. Morganroth et all. Ann N Y Acad Sci. 1977;301:931–941 2.. Morganroth J, Ann Intern Med. 1975;82:521–524. Figure. Dores et al Revista Portuguesa de Cardiologia (English Edition) 34 (1) 2015;m 51-64

Baker HEART & DIABETES INSTITUTE

Grey zone; When is remodelling “bad”



How much remodeling is “too much” ?
Can we detect future events in patients with distinct remodeling patterns?

Baker
HEART & DIABETES INSTITUTE

Cardiovascular disease in athletes

We appreciate that there are unique risk profiles in athletes (although sudden cardiac death in athletes is rare):

- Intense endurance exercise has been linked to an increased prevalence of fibrosis and both atrial and ventricular arrhythmias[1]
- With increased screening, asymptomatic LV dysfunction is a prevalent finding, and yet there is scant evidence to guide evaluation and management

Can speckle-tracking echocardiography be used to determine outcomes and guide follow-up?

Baker HEART & DIABETES INSTITUTE

1. Parry-Williams et al *Nat Rev Cardiol*. 2020;17:402–412.

Asymptomatic screening vs Clinically Indicated

Normal reference ranges are from different population groups. How can we use strain imaging?

- LV mass and wall thickness increase
- RV dysfunction
- Asymmetrical chamber size increases
- LV dysfunction and enlargement

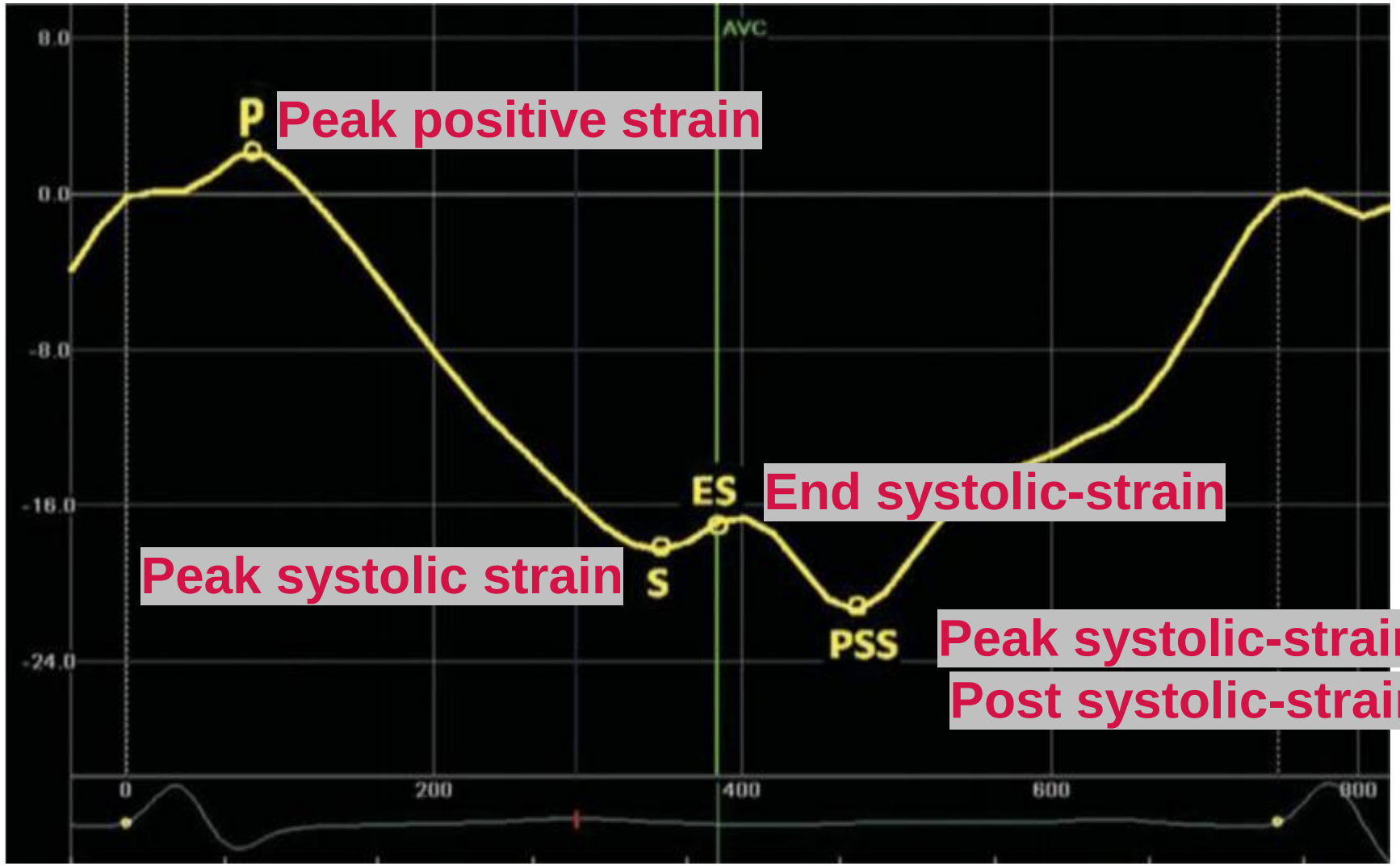
Important not to analyse results out of context:

- Any symptoms, arrhythmia results
- Training load
- ? Family history of SCD or cardiac disease

Difference between retrospective versus prospective trial data

Baker HEART & DIABETES INSTITUTE

Speckle Tracking



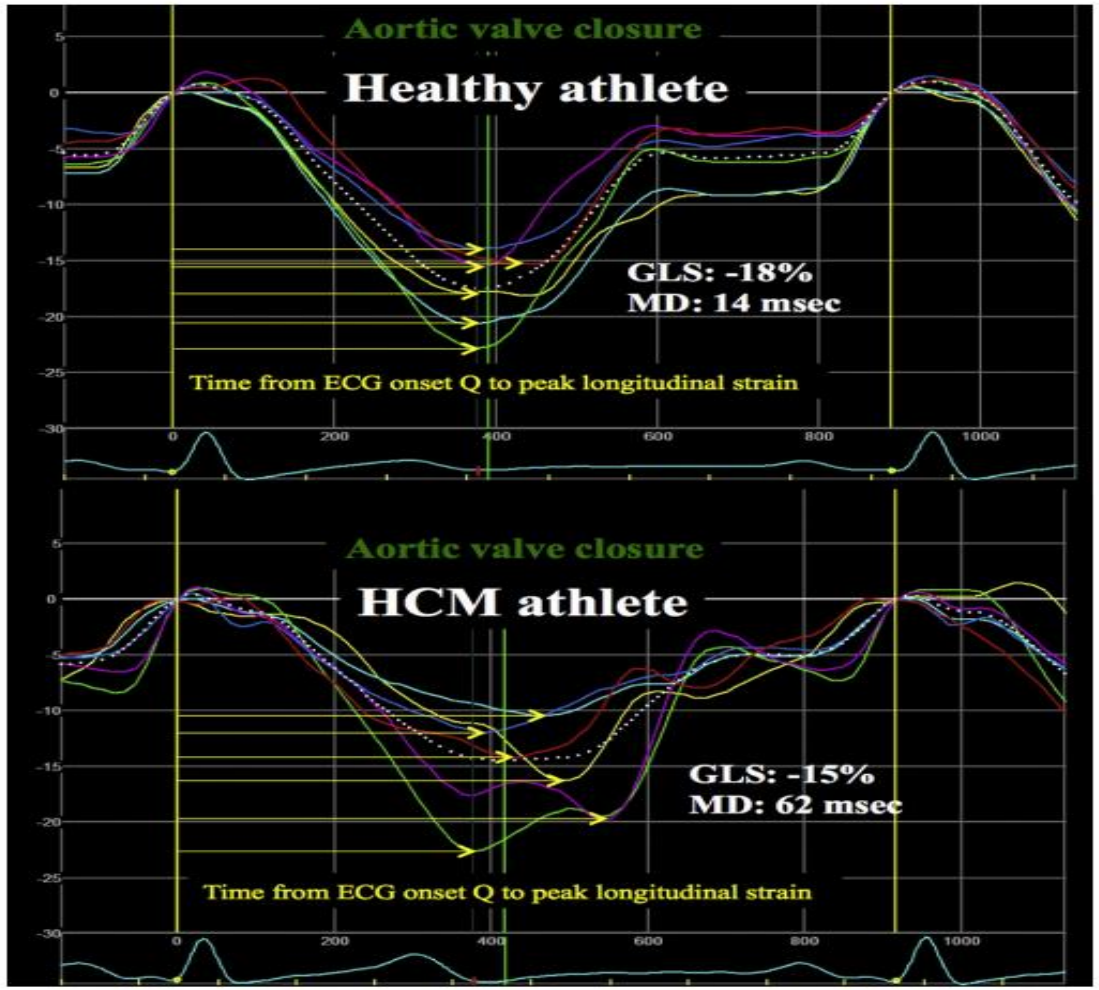
Task force recommendations:

End-systolic strain (ESS) should be reported as a default parameter for the description of myocardial deformation

Baker HEART & DIABETES INSTITUTE

European Heart Journal – Cardiovascular Imaging (2015) **16**, 1–11

Speckle Tracking: Mechanical dispersion



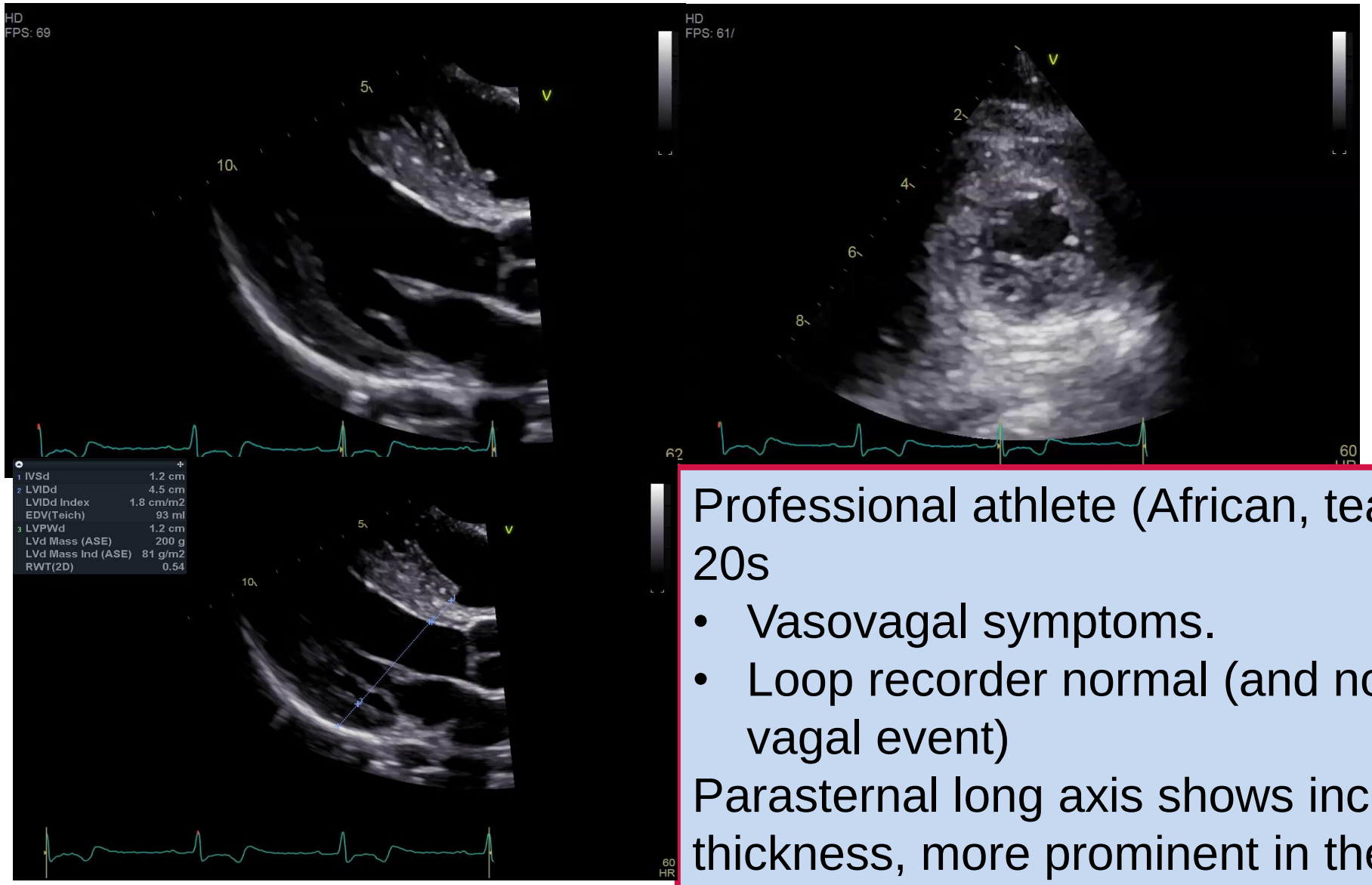
Mechanical dispersion assessed by strain reflects heterogeneous myocardial contraction:

- Standard deviation of time interval from ECG start points to peak negative strain
- Values above 35 ms are typically considered abnormal and may indicate an increased risk of arrhythmias or other cardiac issues[1]

Image. Schnel. JASE. Volume 30, Issue 3, March 2017, Pages 251-261 2. Maisuradze. Archives of medicine. 2022. 14 (4) 2022 : 001-0051)

Baker HEART & DIABETES INSTITUTE

Case study 1: Increased Wall thickness

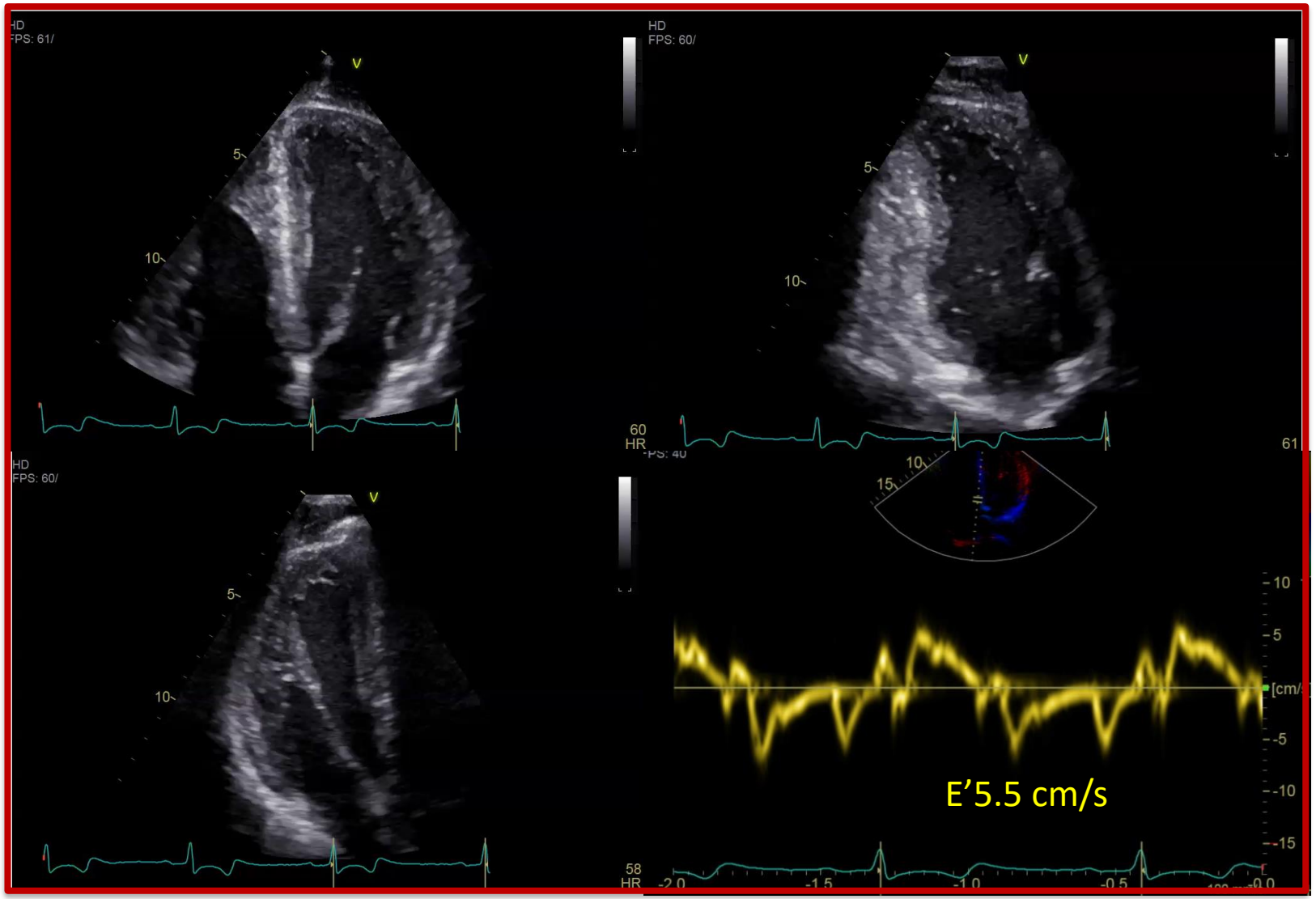


Professional athlete (African, team sport), male 20s

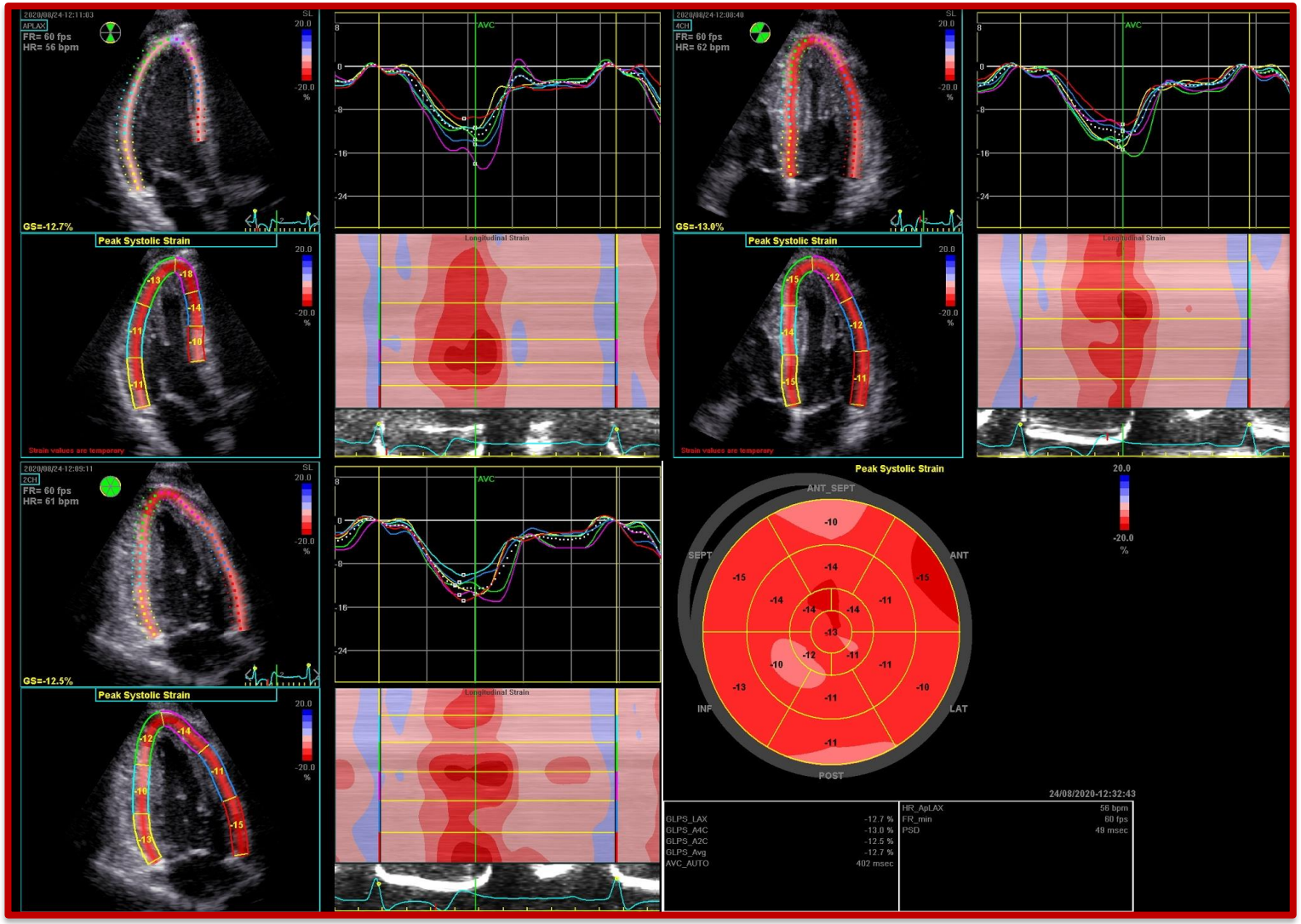
- Vasovagal symptoms.
- Loop recorder normal (and normal SR during a vagal event)

Parasternal long axis shows increased wall thickness, more prominent in the apex

Case study 1: Increased wall thickness



Case Study 1: Increased Wall thickness



Findings:

- Globally reduced LV strain (-13%). MD 49 ms.
- High V02 with no arrythmias on exercise
- cMRI showed wall thickness up to 18mm
- Small amount of late gadolinium enhancement (mid-wall of the septum and the inferior RV insertion point)

Baker HEART & DIABETES INSTITUTE

Case Study 1. Take home points

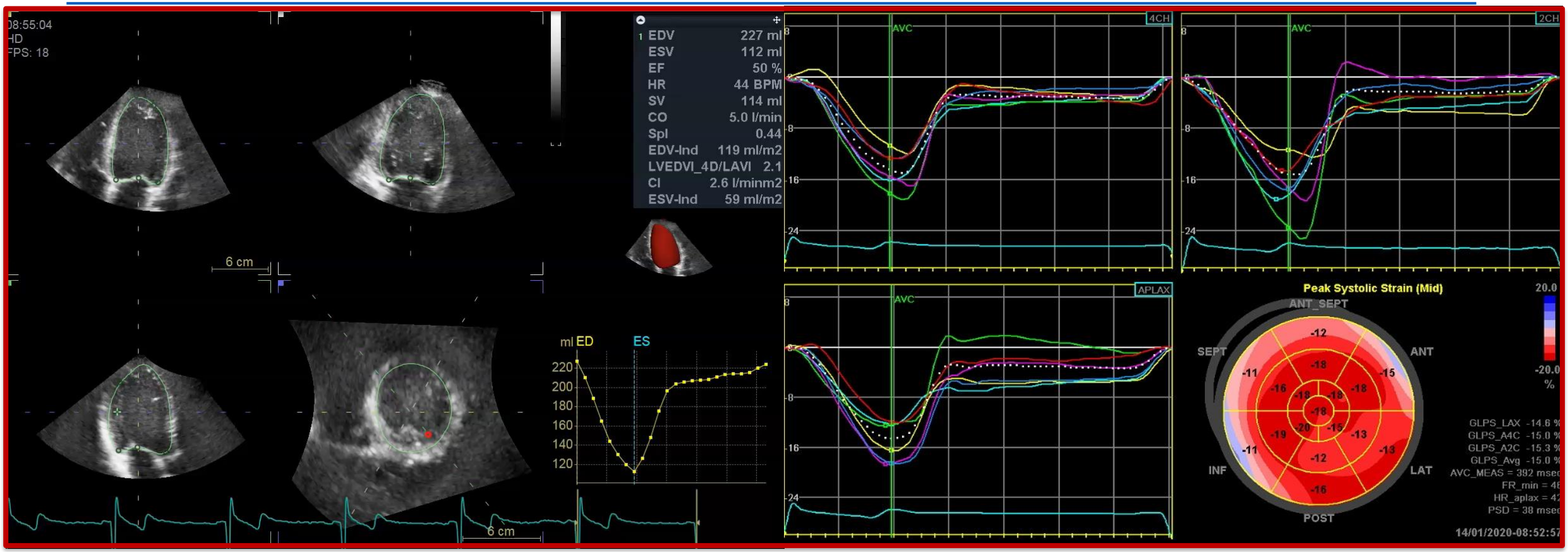
Grey zone: LVH with LV wall thickness above the limits of normal for an athlete, but less than the diagnostic threshold for HCM of 15 mm [1]

- Athletes of African or Caribbean descent more frequently exhibit grey-zone hypertrophy[2]
- Average two-dimensional (2D) global longitudinal strain (GLS) is reduced in subjects with HCM as compared to healthy athletes[3]
- An increase in LV wall thickness with a reduction in cavity size is *not* a feature of healthy athletic remodelling
- Other markers of HCM, septal doppler, LVOT obstruction – critical!!

1. Brosnan et al . HLC 2018, 1052-1062 . J Am Coll Cardiol, 51 (2008) 2. Int J Cardiovasc Imaging, 32 (9) (2016). 3 Int J Cardiovasc Imaging (2011) 27 (91)

Baker HEART & DIABETES INSTITUTE

Case Study 2: Mild LV dysfunction



Asymptomatic Screening Endurance athlete
Dilated LV and bradycardic
Low EF and GLS and borderline MD…Is this an alarm?

Baker
HEART & DIABETES INSTITUTE

Case study 2. Mild LV dysfunction

Claessen et al studied 281 elite endurance athletes (predominantly cyclists, runners, rowers). **1 in 6 elite endurance athletes has reduced EF:**

- Those with reduced EF had similar cardiorespiratory fitness to those with preserved EF, but **showed enhanced augmentation of EF with exercise**
- In athletes with reduced EF 31.8% met criteria for reduced LV GLS (defined as >–17.0%; 31.8% versus 15.6%; *P*=0.010)
- Similar, low levels of myocardial fibrosis (cMRI LGE), and a good short-term clinical outcome
- Athletes were followed for a median of 4.4 years. No athletes developed symptomatic heart failure or documented sustained atrial or ventricular arrhythmias.

Claessen et al Circulation. 2024;149:1405–1415

Baker HEART & DIABETES INSTITUTE

Case study 2. Mild LV dysfunction

What is the evidence in slightly abnormal strain in asymptomatic screening…

- Long-term data is needed in this population. Cautious to apply outcome data from other studies on GLS

Use of exercise testing in this population?

- Cardiac reserve during exercise (+ or – GLS)

? Time to peak and mechanical dispersion?

Training load and arrythmia status critical

Extreme caution labelling “dysfunction”

Baker
HEART & DIABETES INSTITUTE

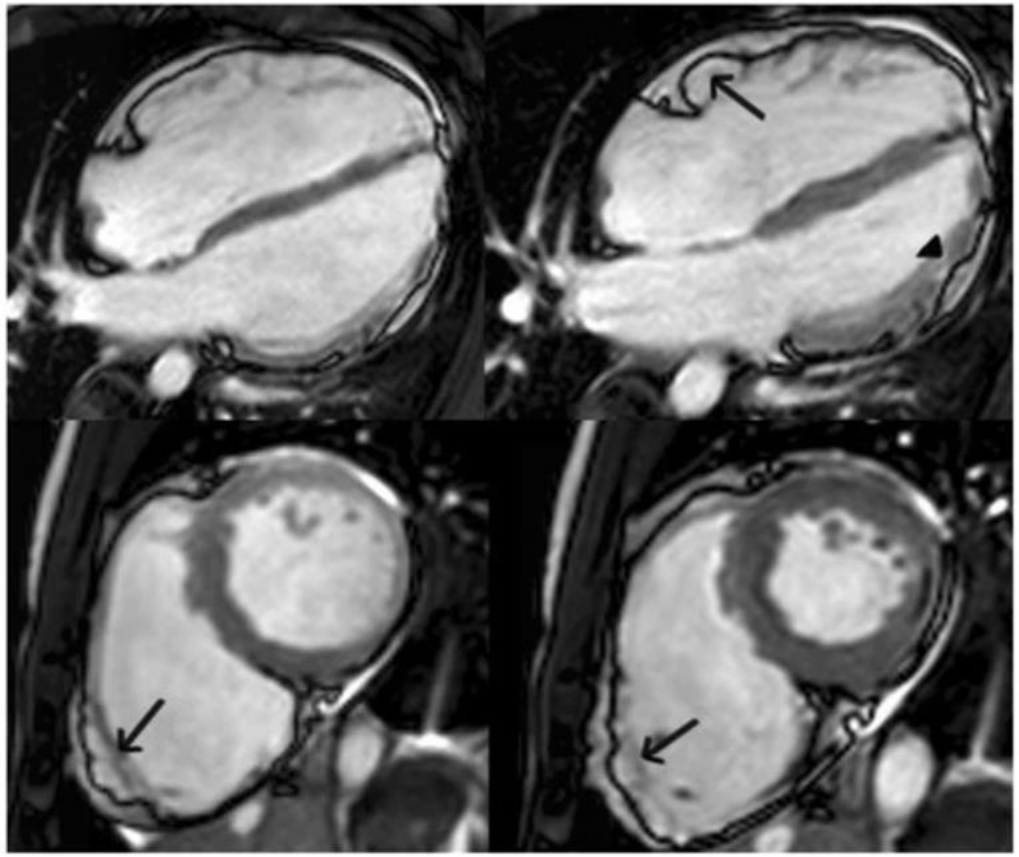
Case 3. Right ventricular Dysfunction

Arrhythmogenic right ventricular cardiomyopathy stems from mutations in genes:

- Accounts for 5% to 10% of sudden unexplained death in individuals <65 years of age [1].
- Genetic vs “exercise-induced ARVC”

Modified Task Force Criteria include TTE and CMR:

- Right ventricular outflow tract (RVOT)
- Chamber enlargement
- Systolic dysfunction and regional wall motion abnormalities

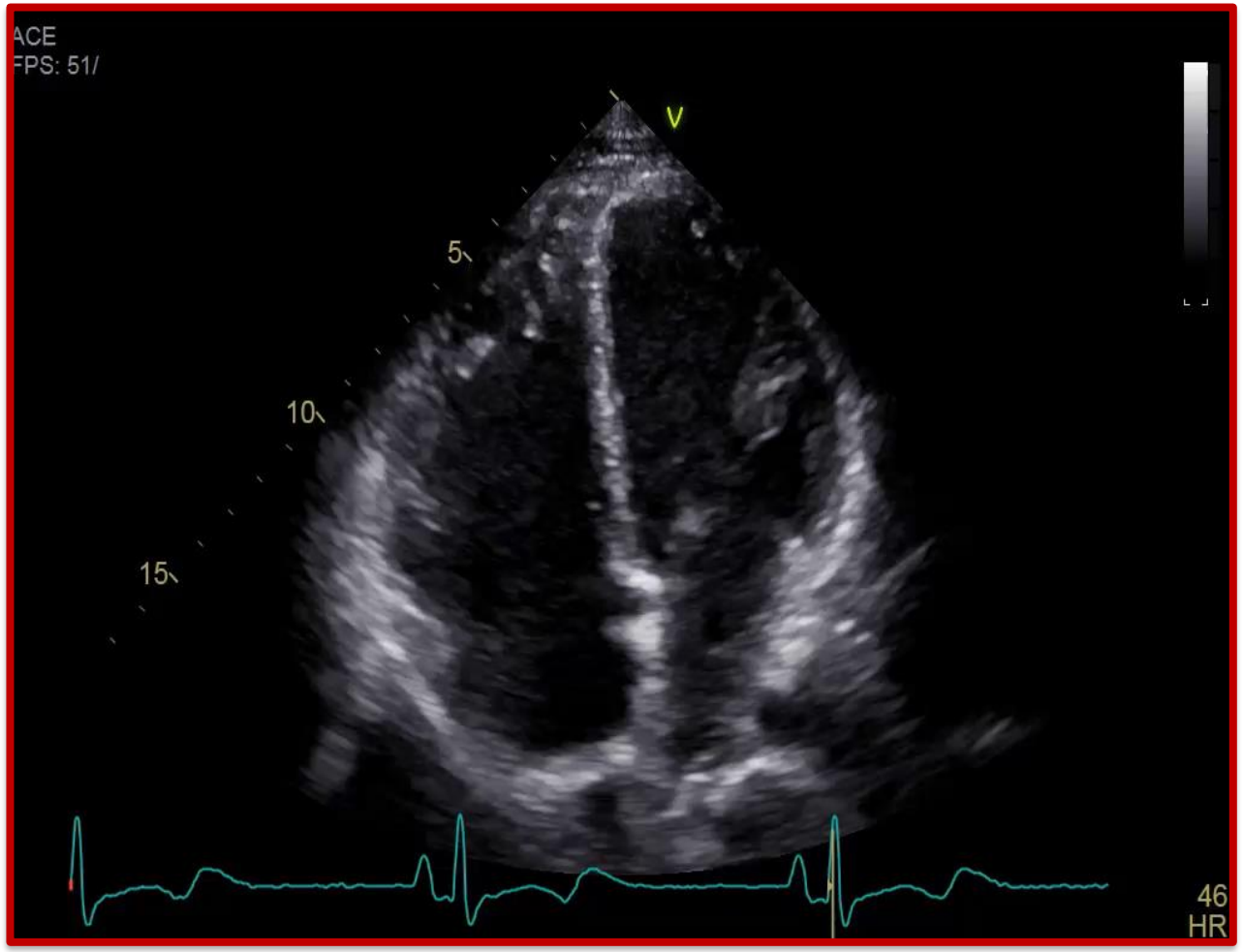


Journal of Cardiovascular Magnetic Resonance 16; 50 (2014)

Baker HEART & DIABETES INSTITUTE

1. Groeneweg JA,. Circ Cardiovasc Genet 2015;8:437–46.

Case study 3. RV dysfunction



Clinical notes:

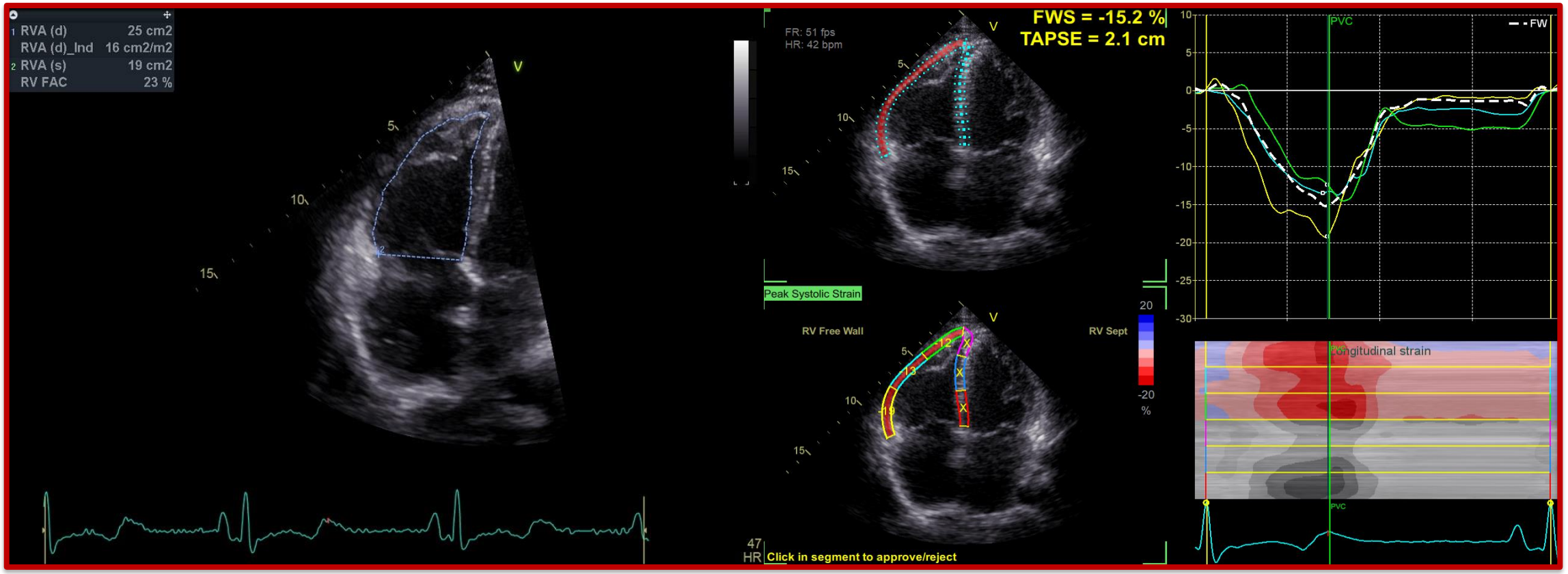
- Swimmer
- Cardiac admission, occurred during exercise (symptomatic)
- ECG shows low voltages and T-wave inversions in V1-V4 with bradycardia
- An aborted exercise test revealed non sustained VT.

Echo:

Asymmetrical RV enlargement

Baker HEART & DIABETES INSTITUTE

Case study 3. RV dysfunction



Echocardiography findings

RV TAPSE normal, RV FAC reduced

- RV free wall strain reduced
- Some late time to peak in segments

Baker HEART & DIABETES INSTITUTE

Case study 3. RV dysfunction

In 160 athletes assessing RVLS and MD (Kirkels et al) :

- Patients who experienced VA had a greater proportion of abnormal strain patterns and higher RV mechanical dispersion
- Mechanical (strain) abnormalities were present in early stages of the disease, before structural or electric abnormalities were evident;
- Strain and MD were independently associated with VA
- Strain imaging was comparably associated with VA as CMR parameters of RV enlargement, systolic dysfunction, and patchy fibrosis

1. Kirkels FP, et al. J Am Coll Cardiol Img 2021;14:900–10.

Baker HEART & DIABETES INSTITUTE

Case study 4. Left atrial dysfunction

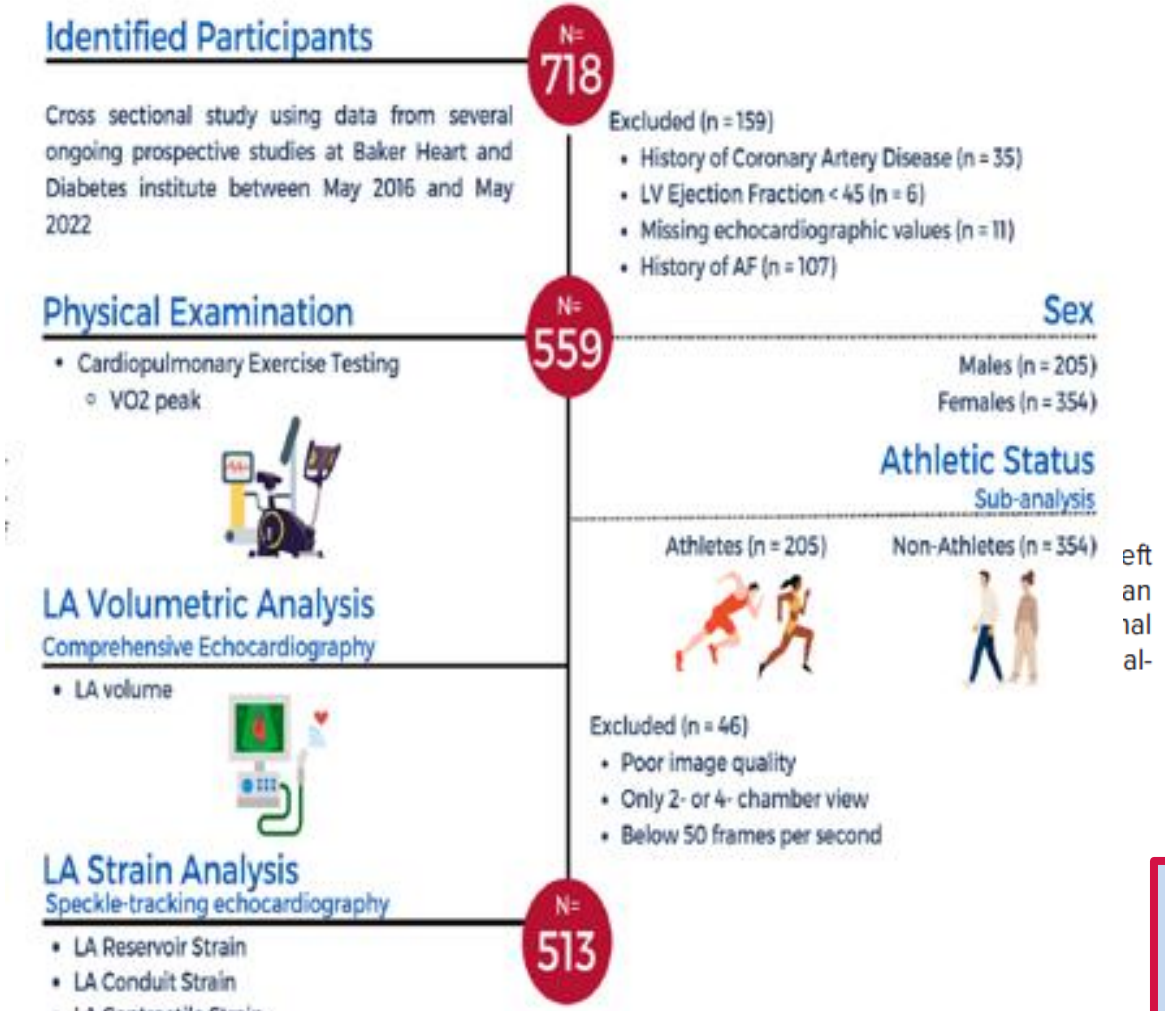
Presence of low left atrial strain in athletes with known AF…what does it mean?

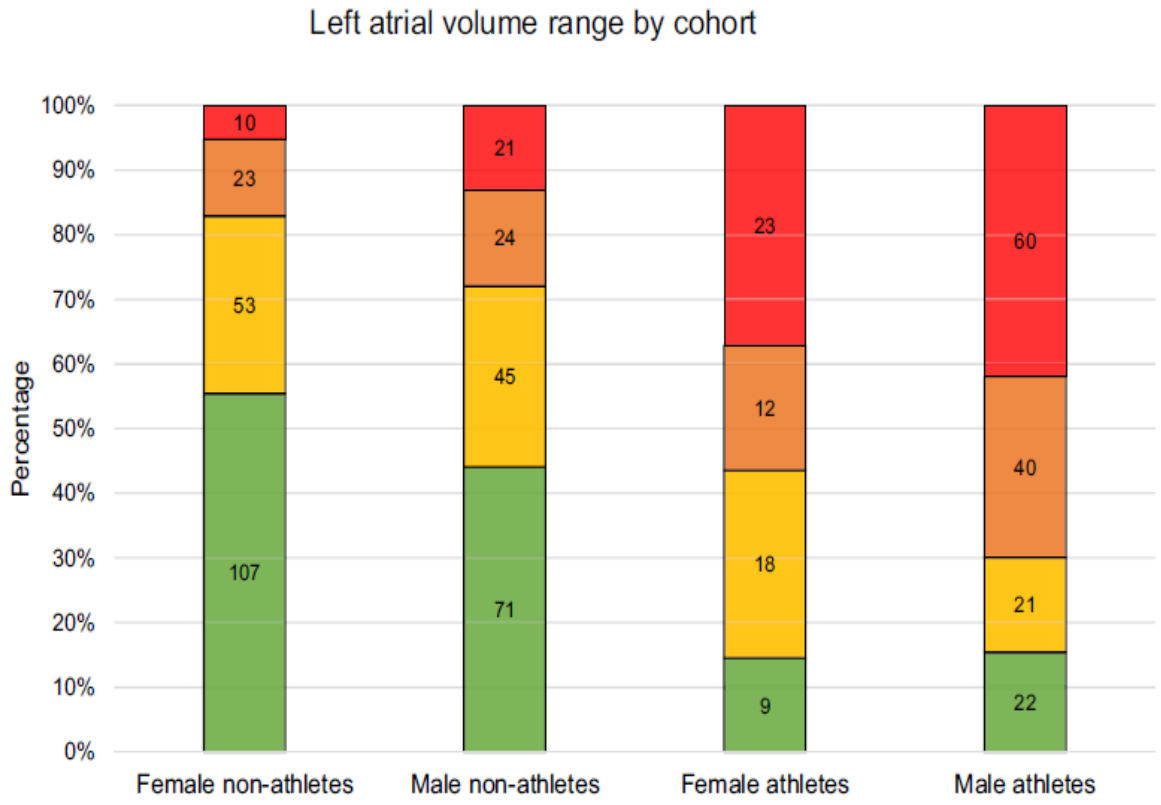
- There is a dose-response association between AF and cumulative exposure to endurance exercise
- In ~3500 Norwegian men aged ≥53 years the risk of AF increased by 16% per decade of regular exercise (U-shaped relationship)
- LA enlargement is an established risk factor for the development of AF in non-athletes, but at the same time LA enlargement is common even in healthy athletes [1]

1. Tsang . Mayo Clin Proc 2001;76:467–75.

Baker HEART & DIABETES INSTITUTE

Case study 4. Left atrial dysfunction

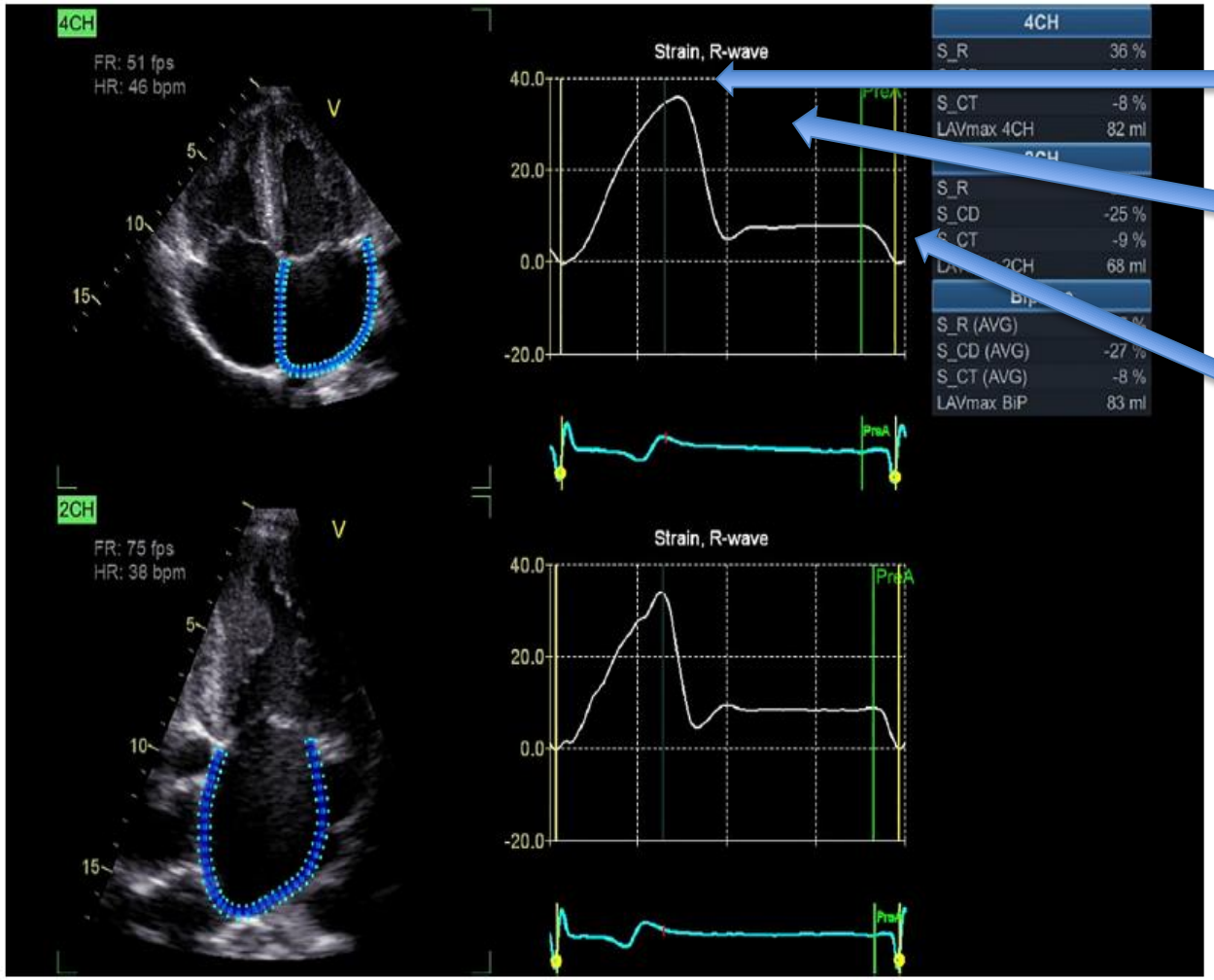




In the study population, 85% of athletes presented with LAE.

Spencer: Am J Physiol Heart Circ Physiol 326: H1269–H1278, 2024.

Case study 4. Left atrial dysfunction



Left atrial reservoir

Left atrial conduit

Left atrial contraction (p wave)

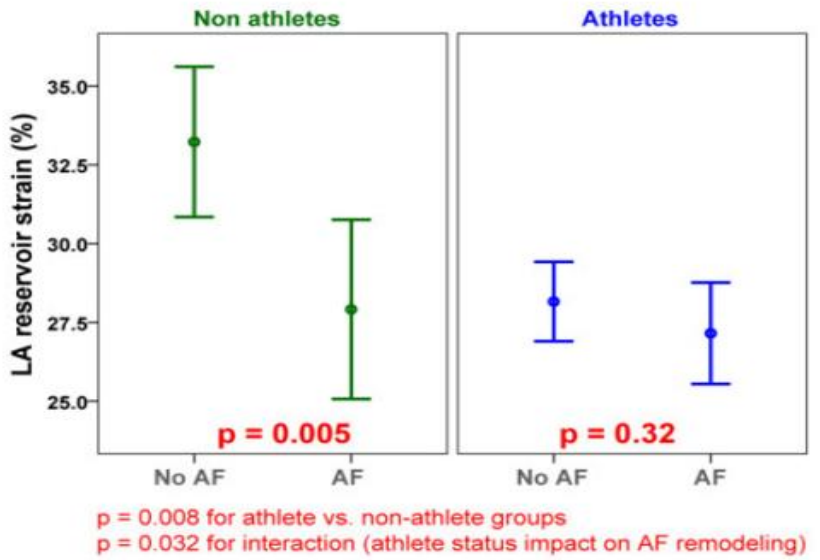
Baker HEART & DIABETES INSTITUTE

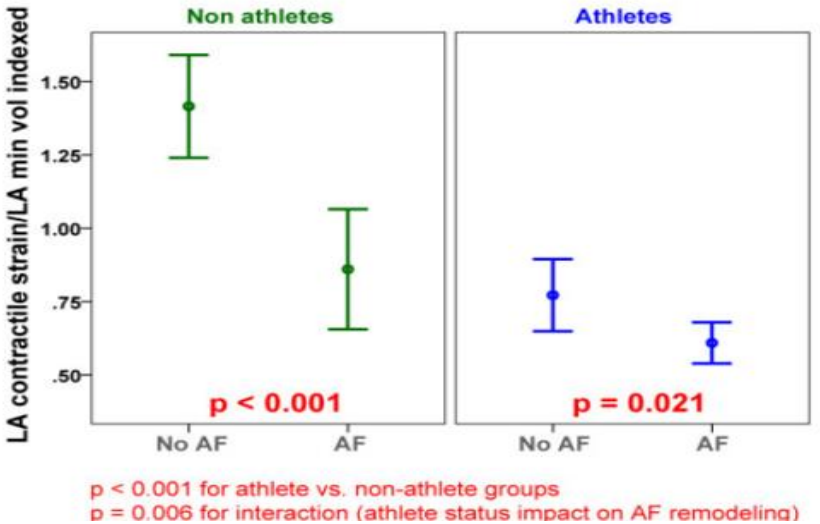
Case study 4. Left atrial dysfunction

Four groups (n = 36 each):

- Endurance athletes + or - paroxysmal AF
- Non-athletes with paroxysmal AF & non-athletic healthy controls

- All athletes and non-athletes with PAF had reduced LA reservoir and contractile strain compared with healthy controls
- The ratio of LA contractile strain to LA min was significantly lower in both athletes and nonathletes with AF compared with their matched non-AF controls





1) Claessen European Heart Journal - Cardiovascular Imaging (2020) 21

Case study 4. Left atrial dysfunction

Findings on LA function in endurance athletes:

- LA size is associated with greater CRF (greater incidence of AF)
- There is still debate about how to best use LA strain in this context
- Previous animal experiments demonstrated that even brief episodes of AF, lasting less than 60min, result in marked depression of left atrial function ([1])(mechanical stunning)
- Are functional changes in the athletes with paroxysmal AF are a consequence rather than a predictor of AF
- Clinically, LA strain and diastolic function classification seems to be a useful clinical application

1. ‘J Am Coll Cardiol 1998;32:2081–6.

Baker HEART & DIABETES INSTITUTE

Conclusions

Speckle tracking imaging is an essential component of the detection of myocardial disease:

- Reference ranges and outcome data have been produced using very different cohorts, use caution when labelling patients with “cardiomyopathies”
- Similarly, prospective data is still coming. Cross-sectional retrospective ranges are the predominant research currently

Contextualize findings with symptom status, arrhythmia, and functional capacity

Beyond GLS, it is important to review strain curves for myocardial deformation properties (LV and RV)

Baker
HEART & DIABETES INSTITUTE