Cardiac Arrhythmia In Sportsmen
A Neglected Problem

Anil Saxena
Director Cardiac Pacing & Electrophysiology
Fortis Escorts Heart Institute, New Delhi
Physical Exertion and Sudden Death

- The potential for the physical exertion to take its toll on participants dates back to 490 BC.
- Messenger Philippides ran from Marathon to Athens (25 miles) to announce victory and died soon after suddenly.
Defining The Problem

- Arrhythmia may be unexpected, may cause fatal events
- Devastating to the families, community, and physicians, in light of the youthful age of victims.
- Many asymptomatic (or mildly symptomatic) patients with genetic CV disease desire a physically active lifestyle with recreational and leisure-time activities.
- Dilemma of designing noncompetitive exercise for:
  - Athletes with genetic CV disease after disqualification from competition,
Causes Of Sudden Death In Young Athletes

- Definite or possible HCM 44%
- Coronary artery anomalies 17%
- Other congenital or anatomic 12%
- Infective and infiltrative 7%
- Coronary atherosclerosis 3%
- Aortic rupture 2%
- Other 9%

The benefits of exercise

- **Neurological**
  - ↓ Anxiety/depression
  - ↓ Dementia
  - ↑ Cognitive function
  - ↓ Risk of Stroke

- **Cardiovascular**
  - ↓ Mortality
  - ↓ Coronary artery disease
  - ↓ Blood pressure
  - Cardiac rehab

- **Endocrine**
  - ↓ Weight
  - ↓ Diabetes
  - ↓ LDL
  - ↑ HDL

- **Oncological**
  - ↓ Prostate Cancer
  - ↓ Breast Cancer
  - ↓ Bowel Cancer

- **Musculoskeletal**
  - ↓ Osteoporosis
  - ↓ Falls
  - ↓ Disability

*Sanjay Sharma et al EHJ (2015) 36, 1445 - 1453*
Cardiovascular and peripheral adaptation to exercise in athletes

Structural changes
- LVWT 10-25%
- LV and RV cavity 15%
- Bi-atrial dilatation

Functional changes
- Functional changes
- diastolic filling
  - E’ > 9 cm/s
  - E/E’ < 6
  - S’ > 9
- Stroke volume

Electrical changes
- Sinus bradycardia
- Sinus arrhythmia
- First degree AV block
- Voltage LVH, and RVH
- Incomplete RBBB
- TWI in V1-V4 in black athletes

Peripheral changes
- Skeletal muscle fibres
- Capillary conductance
- Oxidative capacity
- Mitochondrial enzymes
- O₂ Peak consumption
Increased Incidence Of Arrhythmias In The Athlete’s Heart

Heart block
- PPM in 3% athletes vs. 0% non-athletes
  - *Balderesberger et al. EHJ 2007
  - *Stein et al. JACC 2002

Atrial flutter
- 31% vs. 8% are endurance athletes
  - *Claessen, La Gerche, Heidbuchel Heart 2011

Atrial fibrillation
- 1% of community
- 3 – 10% athletes

Ventricular premature beats (ectopics)
- Common in athletes
  - Usually completely safe
    - *Biffi JACC 2004

Ventricular tachycardia
- Rare. Potentially serious
  - Most often of RV origin
  - ??? More common in athletes
    - *Heidbuchel, Hoogsteen et al. EHJ 2003

LV Scar / arrhythmias
- Schnell et al. BJSM 2015
Differentiating features between physiological cardiac changes and cardiomyopathy in athletes.
“Philippides cardiomyopathy”

- Vigorous exercise increases the demand for oxygen
- Release of catecholamines, and changes in free fatty acid metabolism,
- Acute effects (dilatation, diastolic dysfunction),
- Subacute effects (overexpression of cardiac fibrotic marker, collagens, and fibronectin-1),
- And finally, chronic effects, developing areas of fibrosis, a substrate for both AF and ventricular arrhythmias.
Healthy training versus overtraining of the heart:

Healthy training with balanced exercise and recovery results in physiological remodelling in which enhanced cardiac structure and function enable greater cardiac performance during exercise.

Excessive exercise (training which is too intense and/or recovery that is too short) may cause cardiac injury and proarrhythmic remodelling which predominantly affects right ventricle.
Commotio Cordis

- Commotio cordis, or VF resulting from blunt chest wall trauma, is the second-leading cause of SCD in young athletes.
- Outcome depends on recognition and access to an AED.
- AED devices should be deployed with a response time of < 5 minutes to provide greatest survival benefit.
- Efforts are also underway to design safer sports equipment to prevent commotion cordis.
- Return to sports participation in survivors of commotion cordis is left up to personal discretion.

Commotio Cordis

Arrhythmias Associated With Sports

- Sinus Bradycardia
- Atrial Arrhythmias
- VEBs
- Malignant Ventricular Arrhythmias
Bradyarrhythmias

How Slow Is Too Slow in the Athlete?

ECG findings associated with low heart rate in athletes

Very Common
- Sinus bradycardia
- Sinus arrhythmia
- Sinus pauses

Common
- Wandering atrial pacemaker
- Junctional escape beats
- First-degree AV block
- Type I second-degree AV block (Wenckebach phenomenon)

Uncommon
- Type II second-degree AV block
- Third-degree AV block
- Sinoatrial type I block
- Sinoatrial exit block
- Ventricular escape beats

Recommendations :- Sinus Bradycardia

Athletes with sinus bradycardia, sinus exit block, sinus pauses, and sinus arrhythmia

**Asymptomatic**
- Can participate in all competitive athletic activities unless excluded by structural heart disease or other arrhythmias
  - (Class I; Level of Evidence C).

**Symptomatic**
- Should be evaluated for structural heart disease and be treated by pacemaker
- If treatment of the bradycardia eliminates symptoms, they can participate in training and competition unless excluded by structural heart disease or other arrhythmias
  - (Class I; Level of Evidence C).

Maron et al. JACC 2015;66:2350
Type II Second-Degree (Mobitz) AV Block

Wide QRS, including RBBB

- Athletes with a wide QRS should receive a pacemaker
  (Class I; Level of Evidence C)

Narrow complex

- Pacemaker is reasonable for asymptomatic athletes
  (Class IIa; Level of Evidence C)

Maron et al. JACC 2015;66:2350
For an athlete with previously symptomatic CPVT or an asymptomatic CPVT athlete with exercise-induced PVC in bigeminy, couplets, or NSVT, participation in competitive sports is not recommended except for mild sports.

(Class III; Level of Evidence C)

Maron et al. JACC 2015;66:2350
Asymptomatic athlete with genotype-positive/phenotype-negative (i.e., concealed channelopathy)

- LQTS, CPVT, BrS, ERS, IVF, or short-QT syndrome to participate in all competitive sports with appropriate precautions, including:
  1) Avoidance of QT-prolonging drugs for athletes with LQTS
  2) Electrolyte/hydration replenishment and avoidance of dehydration for all
  3) Avoidance or treatment of hyperthermia from febrile illnesses or training-related heat exhaustion or heat stroke for athletes with either LQTS or Brugada Syndrome
  5) Acquisition of a personal AED as part of the athlete’s personal sports safety gear
  6) Establishment of an emergency action plan with the appropriate school or team officials

(Class IIa; Level of Evidence C).

Maron et al. JACC 2015;66:2350
Evaluation of an athlete with a suspected arrhythmia should include:

- A 12-lead ECG
- Echocardiogram
- Exercise test
- Ambulatory ECG monitor
- ELR or ILR in selected cases
- MRI Scan in selected cases
ECG Changes In Athletes

Athletes with isolated borderline changes are only investigated in the presence of symptoms, abnormal physical examination, or relevant family history. The presence of borderline changes categorizes the athlete's ECG as abnormal.

**Training Related Normal Variants**
- Sinus bradycardia
- First-degree AV block
- Incomplete RBBB
- Early repolarisation
- Isolated QRS voltage criteria for LVH

**Borderline Variants**
- Left atrial enlargement
- Right atrial enlargement
- Left axis deviation
- Right axis deviation
- RVH
- TWI up to V4 in BAs†

**Training Unrelated Changes**
- ST segment depression
- Pathological Q-waves
- TWI beyond V2 in WAs beyond V4 in BAs
- Complete LBBB or RBBB
- Epsilon waves
- QTc ≥470 msec in males ≥480 msec in females
- Ventricular pre-excitation
- Type 1 Brugada-like ER

If present in **ISOLATION**

If **TWO OR MORE** present

*In otherwise asymptomatic athletes with no family history or abnormal examination findings
†When preceded by characteristic convex ST-segment elevation

Sanjay Sharma et al EJH (2015) 36, 1445 - 1453
J-point elevations and J-waves/early repolarization in athletes

- Most are benign.
- Association of inferior ER with SCD has been described in athletes SCA, from Italy.
- Inferior ER prevalence significantly higher in athlete SCA population compared with control athletes population - (14.3 vs. 2.1%).

European Heart Journal (2012) 33, 2639–2644
Brugada Syndrome:

- SCD occurs in up to 33% of patients
- May be the initial presentation
- VT not clearly provoked by exercise, but it can be by hyperthermia
- Therefore, athletes with Brugada should be restricted from all strenuous competitive sports
- Guidelines for recreational activity are more lenient than they are for other inherited cardiovascular disease
Echocardiography: Trabeculations in the left ventricle

MRI Scan: Non-compacted and compacted layers of myocardium

Implantable Defibrillators And Sports

- The 36th Bethesda Conference and ESC are in agreement that individuals with an ICD should participate in Class IA competitive sports only.

- The basis for excluding athletes with ICDs from competition is:
  - Increased risk of ICD discharges,
  - The unpredictable performance of these devices under the extreme environmental and physiological conditions associated with intense competition,
  - Device misfiring or lead fracture,
  - Possibility of syncopal events secondary to ICD discharge, or the arrhythmia itself.
Thank you