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"I hear reggae rhythms, disco drums, thumping hip-hop, toe-tapping western swing, and 80's techno beats. I think your pacemaker is stuck on 'shuffle'!"

Exercise Benefits and Risks

Denise Sorrentino MD Cardiologist /Electrophysiologist Iowa Heart Center

Phidippides Cardiomyopathy



Disclosures

- Analyze
- Medtronic
- Medtronic TYRX
- St. Jude Medical
- Employer-Mercy/Des Moines

What do these three famous people have in common?









- A. They all are famous scientists
- B. They are all running late for dinner
- **C**. They are all famous endurance athletes who died young in the midst of running
- D. Not enough information given to answer

Phidippides died after running from Marathon to Athens 490BC



Jim Fixx died age 52 in midst of his daily run



Micah True/Caballo Blanco famed ultrarunner died after a 12 mile run

BORN TO RUN A Hidden Tribe, Superathleter

A Hidden Tribe, Superathletes, and the Greatest Race the World Has Never Seen Christopher McDougall

"McDougst's book remining me of why I have to run." — Bill Rodern, Sall Francisco Obsonch





Rise of Endurance Exercise

- 1976-- 25,000 finishers of marathons in US
- 2014-- marathons in US were completed by
 550,637!



In 2014 there were more than 1,200 "ultramarathon" races – more than triple that in 2004

Bassler Hypothesis

In the 1970s, Thomas Bassler put forth the **Bassler Hypothesis**"

If you could run a marathon in under 4 hours it gave you immunity against having a heart attack for the next 6 years

Sudden Cardiac Death



Causes of SCD in athletes

- Conditions causing myocardial ischemia
- Atherosclerotic coronary artery disease
- Coronary artery spasm
- De novo coronary artery thrombus
- Intramyocardial bridging
- Hypoplastic coronary artery
- Anomalous coronary arteries
- Coronary artery dissection
- Structural Abnormalities
- Hypertrophic cardiomyopathy
- Mitral valve prolapse
- Valvular heart disease
- Lipomatous infiltration of the right ventricle
- Marfan's syndrome
- Right ventricular dysplasia
- Aortic stenosis
- Sickle cell trait
- Arrythmias
- Wolfe-Parkinson-White
- Lown-Ganong-Levine
- Long QT syndrome
- Ventricular arrhythmias
- Medial hyperplasia and intimal proliferation of the main sinus node artery
- Miscellaneous
- Myocarditis
- Anabolic steroid use
- Cocaine abuse
- Sarcoidosis

Most common causes of exercised induced Sudden Death

- Hypertrophic cardiomyopathy—VT/VF
- Coronary artery disease—ischemia
- Anomalous coronary artery
- Primary arrhythmia (long QTc, catecholaminergic VT, primary VF)
- Arrhythmogenic Right Ventricular Cardiomyopathy
- Phidippides Cardiomyopathy

Phidippides Cardiomyopathy

- Cardiac remodeling as a result of prolonged strenous exercise
- Pressure and volume overload transiently of RA/RV
- Elevated cardiac markers
- Volume depletion and reduced renal filtration
 With repetitive cycles of training, recovery, repeat training, chronic structural changes

may occur

Phidippides Cardiomyopathy

- Long term changes have been found to include patches of cardiac fibrosis
- These patches of fibrosis then can allow for zones of "reentry" for potential arrhythmias

Endurance Exercise

- During long distance running and cycling, the heart is put into a state of increased cardiac output
- RA/RV dilate in approximately 1/3 of all marathoners
- Troponin and BNP are often found to be elevated post race
- It takes several days to weeks for right heart to return to baseline state post race

Dose Limit??

- Exercise—like a pharmacologic agent, may have an upper dose limit
- Above this, adverse effects (muscle trauma, metabolic derangements, cardiovascular stress)may exist.
- Large recent trial showed benefits of exercise beginning at 15 minutes per day and the benefits continue up to 1 hour per day and then plateau

Mortality benefits of exercise



Daily physical activity duration (min)







Athletes Heart

- Chronic endurance training increases demands on the heart—esp in endurance athletes.
- Distance runners, rowing, swimming and cyclists have adaptations including enlarged LV and RV volumes, increased LV wall thickness and increased LA size
- In these endurance athletes, cardiac size does not always regress back to normal after competition

Cardiac Remodeling during Endurance Training

- Cardiac output at rest is 5L/min but increases up to 25L/min with vigorous endurance training
- Long term daily training may cause dilation of RA and RV
- Post exercise the dimensions may not always be restored

Cardiac Remodeling La Gerche et al/Eur Heart J, 2012

- Cohort of 40 highly trained athletes (marathon, half and full triathalon, alpine cyclists)
- Troponin and BNP elevated post event
- Reduced RVEF
- In this cohort, 12.5%had scarring on gadolinium enhanced MRI
- Scarring and RV remodeling most common in athletes with largest accumulated experience

Effects on RV ejection fraction



Troponin-T levels



Cardiac Remodeling Heidbuchel et al, Eu Heart J, 2003

- Study showed that endurance athletes with symptoms of arrythmias (palpitations) had 50% incidence of RV structural abnormalities on MRI imaging
- These authors speculated a syndrome of "exercise-induced arrhythmogenic RV cardiomyopathy"

MRI imaging

 Delayed gadolidium enhancement in 5 athletes reveal patchy myocardial fibrosis that may develop and become substrate for arrhythmia



Coronary Artery Calcification Mohlenkamp et al, Eu Heart J, 2008

- 108 middle –aged German marathoners compared to age matched controls
- Greater atherosclerotic burden in the marathons using Calcium Score CT
- Adverse cardiovascular event rate was equivalent to a population with established coronary disease

Coronary Artery Calcification Schwartz et al, ACC 2010

- Cohort of US long term marathoners (>25 marathons in 25 years)
- Found more calcified plaque volume in the marathoners when compared to sedentary age-matched controls (274mm cubed vs. 169mm cubed) on CT coronary angiography

Calcification of coronary arteries



Proarrhythmic effects of endurance training

- Rhythm disturbances may be the most common problem for veteran endurance athletes
- Long term endurance training has been associated with as much as a 5-fold increase in the prevalence of atrial fibrillation

Atrial fibrillation post race



Mechanism of atrial fibrillation in endurance athletes

- Increased vagal and sympathetic tone
- Long term bradycardia
- Atrial wall fibrosis
- Increased atrial size—left atrium may be enlarged in up to 20% competitive athletes
- Recent research shows endurance athletes may have a reduced levels of HCN₄ protein in the SA node leading to more bradycardia

Ventricular arrhythmias

- Generally originate from mildly dysfunctional right ventricle
 OR
- Interventricular septum

The patchy myocardial fibrosis may develop as a reparative response to damaged myocardium which allows reentry

Ventricular fibrillation



Pathophysiology of long term endurance training

- Heavy and sustaining training generates free radicals that may not be fully buffered
- Oxidative stress—transient cardiomyocite dysfunction
- This may stimulate—lymphocytes, macrophages, mast cells, myofibroblasts, procollagen and fibrosis deposition

Proposed Pathogenesis







Terms and Conditions

What does this imply??



Should we stop exercising?



Indisputable BENEFITS

- Daily activity is highly effective for prevention and treatment of our most common diseases: HTN, diabetes, obesity, heart failure and depression
- People who exercise regularly have markedly lower rates of disability and mean life expectancy 7 years longer than that of physically active counterparts



The American Heart Association Recommendations for Physical Activity in Adults



© 2013 Learn more at heart.org/ActivityRecommendations.



"To prevent a heart attack, take one aspirin every day. Take it out for a run, then take it to the gym, then take it for a bike ride..."

CONCLUSIONS

 The benefits of regular daily exercise are indisputable! In order to reverse the crippling epidemic of type II diabetes, obesity and associated heart disease—all children and adults must exercise

CONCLUSIONS

 High intensity, high endurance training although may lead to RV chamber enlargement and fibrosis, coronary calcification, and large artery stiffening



"What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?"

Moderation...



Future Outlook

- Small studies are available, but due to the massive continued and growing participation in endurance sports, there is a great opportunity to study effects
- Echocardiography, Calcium scoring, CT angiography and serum biomarkers can be evaluated pre an post event
- Post race RVEF over time may help determine "safe" timing to return to training

Still go for it!!



Thank you!

