Rhythms of the HEARTLAND

Exercise and Arrhythmia: Is there too much of a good thing?

2-9-2018

Sunny S. Po, MD, PhD

Warren Jackman Chair of Cardiac Electrophysiology
Director, Clinical Electrophysiology
Heart Rhythm Institute
University of Oklahoma Health Sciences Center

15th Annual

Benefits of Exercise

- A physically active lifestyle leads to a 42-44% reduction in the development of CV diseases (primary prevention).
- Exercise reduces CV mortality and hospital admission in those who have CV diseases (secondary prevention).
- Exercise helps control HTN, diabetes, PAD, CAD, hyperlipidemia, etc

Exercise is a form of Ischemic Preconditioning

- Ischemic preconditioning:
  - brief periods of ischemia before prolonged coronary artery occlusion reduce subsequent infarct size (as much as 75% in animals) and/or the risk of developing VT/VF
- Because of the absence of physiological adaption and improving risk factor during such a short period of time, ischemic preconditioning is thought to be caused by favorable changes in neuro-hormonal and metabolic factors.
- Early protection disappears 2-4 hours after preconditioning
- Delayed protection appears 24 hours later and lasts 2-3 days

Exercise is a form of Ischemic Preconditioning

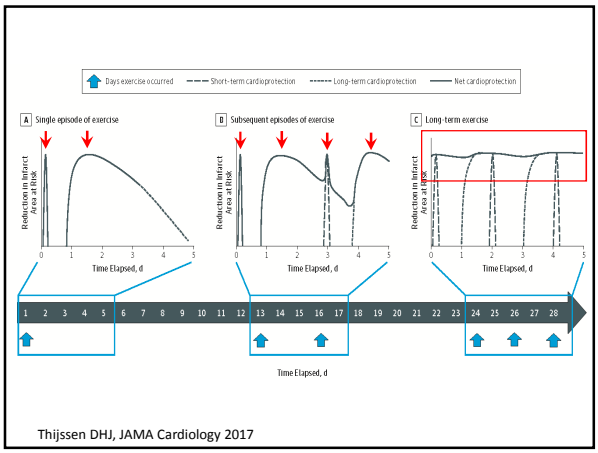
- Exercise:
  - may produce local and systemic factors (adenosine, bradykinins, etc) that are also produced during ischemic preconditioning
  - may produce mild ischemia similar to ischemic preconditioning
  - exercise-induced angina is often significantly reduced on a second exercise effort (warm-up angina)
  - exercise-induced angina also shows biphasic protection

Lambiase PD, JACC 2003;41(7):1174

Exercise is a form of Ischemic Preconditioning

- Greater physical activity level in the week before MI appear to be associated with lower in-hospital mortality and less fatal events.
- Greater physical activity level in the week before CABG appear to be associated with higher rates of survival
- Moderate intensity exercise (below lactate threshold) appears to be enough to release beneficial neuro-hormonal and metabolic factors

Abete P, JACC 2001;38(5):1357 Rengo G, Am Heart J, 2007:154(2):352



Thijssen DHJ, JAMA Cardiology 2017

Benefits of Exercise

- A minimum of 30 minutes of moderate-intensity physical activity (continuous or in 10-minute increments) is required on most (preferably all) days of the week to optimally reduce the risk of CAD
- Equivalent to roughly 1.5 miles/d of brisk walking (approximately150 kcal/d for an average-sized person)
- No CV workup is needed for this level of exercise unless with known history of CV diseases.
- Lesser amounts of ongoing physical activity, such as 15 minutes/d or 90 minutes/wk, are not associated with a survival benefit

Fletcher GF, 2013, AHA Scientific Statement; Circulation 2013;128:p873

Benefits of Exercise

Fletcher GF, 2013, AHA Scientific Statement; Circulation 2013;128:p873

Benefits of Exercise

- Patients with known CV diseases:

  see guideline of pre-exercise workup

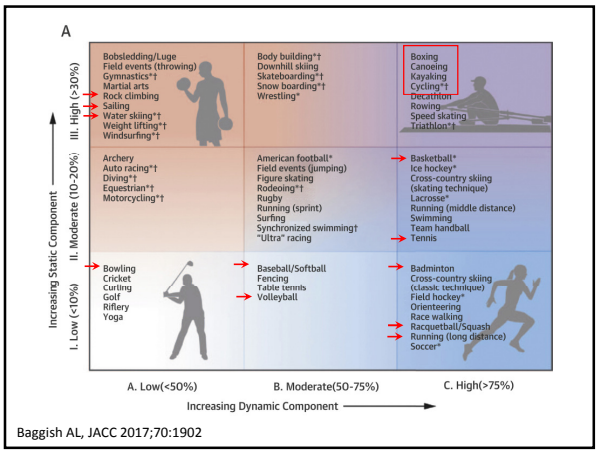
Fletcher GF, 2013, AHA Scientific Statement; Circulation 2013;128:p873

Static and Dynamic Exercise

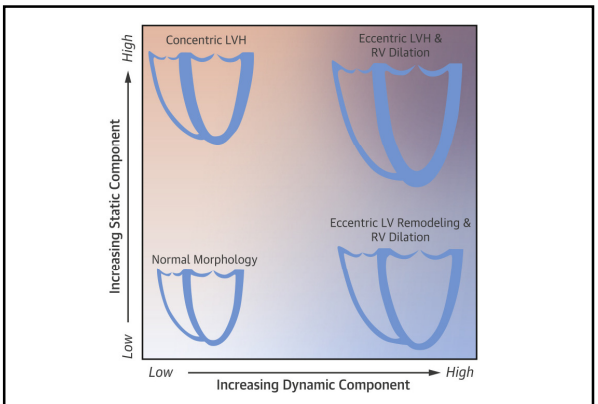
- Static Exercise:
  - short and forceful skeletal muscle contractions → activating afferent metabolic and mechanical signals → increase vascular resistance and BP
  - during acute bouts of static exercise: CV system need to maintain cardiac output in the presence of increased LV afterload
  - e.g. weight lifting, track and field throwing

Static and Dynamic Exercise

- Dynamic or endurance Exercise:
  - repetitive (often rhythmic) contraction and relaxation of large skeletal muscle groups which requires increased oxidative metabolism
  - intensive of dynamic exercise can be measured by oxygen uptake (VO_2)
  - during dynamic exercise, CV system needs to increase cardiac output to ensure adequate delivery of metabolic substrate to muscle
  - increase cardiac output by: increase heart rate, increase stroke volume, reduce systemic vascular resistance



Baggish AL, JACC 2017;70:1902



Baggish AL, JACC 2017;70:1902

Static and Dynamic Exercise

- Most sports involve both static and dynamic activities in different mix
- Dynamic exercise:
  - facing bi-atrial and bi-ventricular volume challenges → chamber dilatation (physiological dilatation of all 4 chamber)
  - LV EF may be slightly below normal at rest but normalizes during exercise
  - Stroke volume, not EF, is regulated by resting metabolism
- Static exercise:
  - facing pressure challenges → only LV thickening with minimal effects on the other 3 chambers
  - LVH (often concentric) rarely exceeds 13 mm

Exercise and Arrhythmia: Is there too much of a good thing?

2-9-2018

Sunny S. Po, MD, PhD

Warren Jackman Chair of Cardiac Electrophysiology
Director, Clinical Electrophysiology
Heart Rhythm Institute
University of Oklahoma Health Sciences Center

The life expectancy you extend by exercising equals the time you spend on exercising

Do not choose a sport that can hurt you!!

Arthritis and Exercise

- During walking, knee joints may bear 2-3x of the body weight → every pound of weight loss → takes away 3 pound of impact on knees
- Impact also transmits to hips, back and neck
- During running, knee joints may bear 4-8x of the body weight → using running as the exercise to lose weight may be a bad idea.
- Shed 3000 calories → lose one pound of weight
  - ingest 150 calories less + burn 150 extra calories → lose a pound of weight every 10 days
  - (20 minutes of exercise may burn 150 calories)

Sudden Death in Athletes

- Coronary artery disease and/or anomaly is the number one killer
- Hypertrophic cardiomyopathy may be the number two killer
- Hereditary arrhythmias account for the rest SCD
  - Arrhythmogenic RV cardiomyopathy/dysplasia (ARVC/D)
  - Long QT, short QT
  - Brugada syndrome (pseudo-RBBB)
  - Catecholaminergic polymorphic VT (CPVT)
  - Early repolarization

Corrado D, EHJ, 2010;31:243

Physiological vs. Pathological ECG Changes

- Physiological changes due to training:
  - Sinus bradycardia, first degree AV block, early repolarization caused by physiological adaptation of cardiac autonomic nervous sytem
  - Pure voltage criteria for LVH (normal ST, T repolarization) due to increased LV thickness and chamber size (left axis deviation, intravetriicular conduction defects are considered abnormal)
  - African American athletes have more prevalent and pronounced ECG changes e.g. voltage criteria for LVH and early repolarization
    - 20% black athletes exhibit LVH >12 mm (only 4% in white athletes)
    - 3% black athletes with LVH > 15 mm

Corrado D, EHJ 2010;31:243

Physiological vs. Pathological ECG Changes

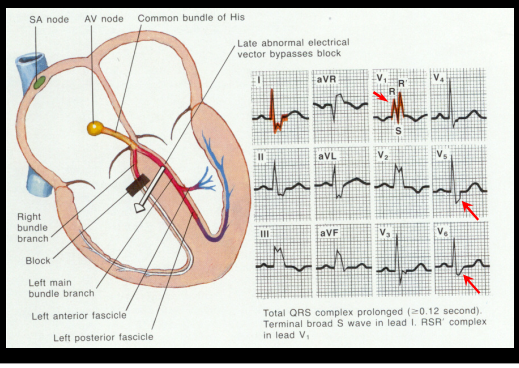
- High endurance training (e.g. cross-country skiing, cycling rowing/canoeing)
  - Great extent of physiological changes (e.g. bradycardia, increased QRS voltage) due to large cardiac output required for these types of exercise
  - In highly trained athletes, sinus bradycardia <30 bpm and asymptomatic sinus pause>2" are not uncommon.
    - Absence of symptoms e.g. dizziness or syncope
    - HR normalizes during exercise
    - Bradycardia reverses with training reduction

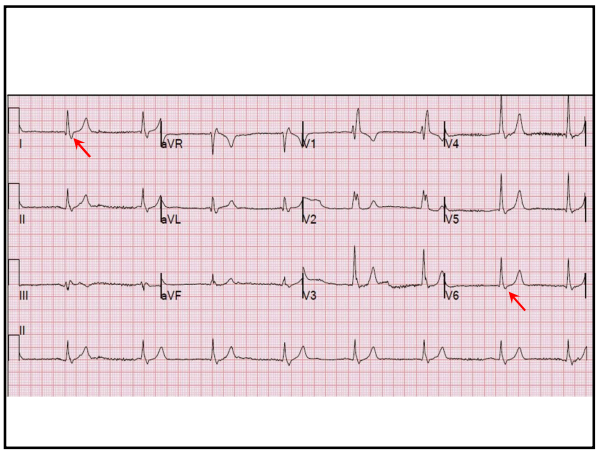
Corrado D, EHJ 2010;31:243

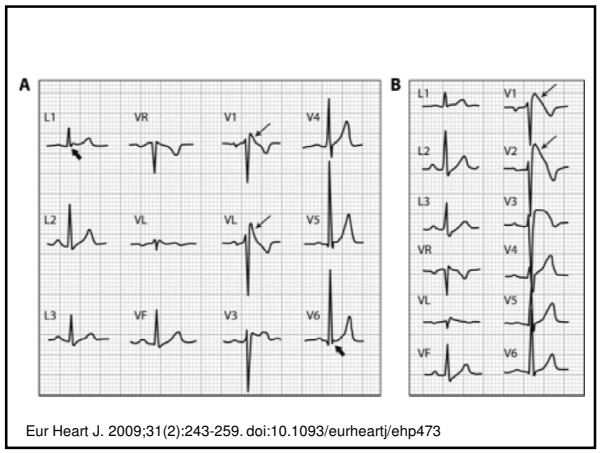
Brugada Syndrome vs. RBB

Eur Heart J. 2009;31(2):243-259. doi:10.1093/eurheartj/ehp473

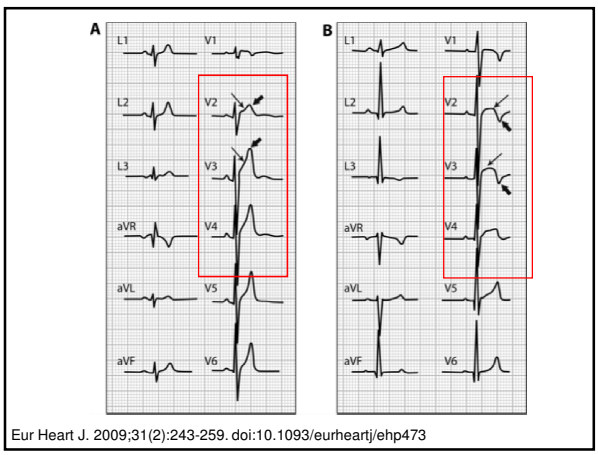
Typical Right Bundle Branch Block



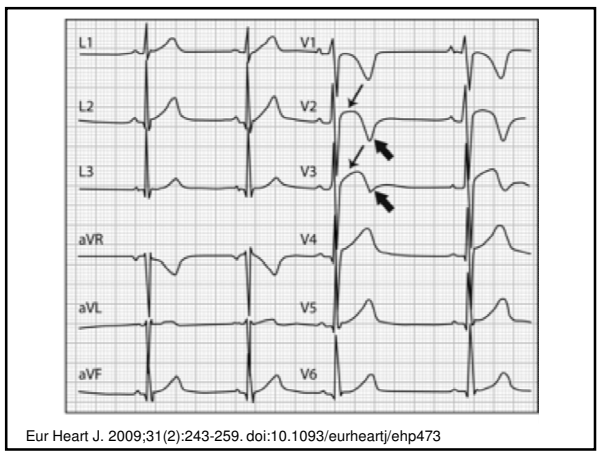




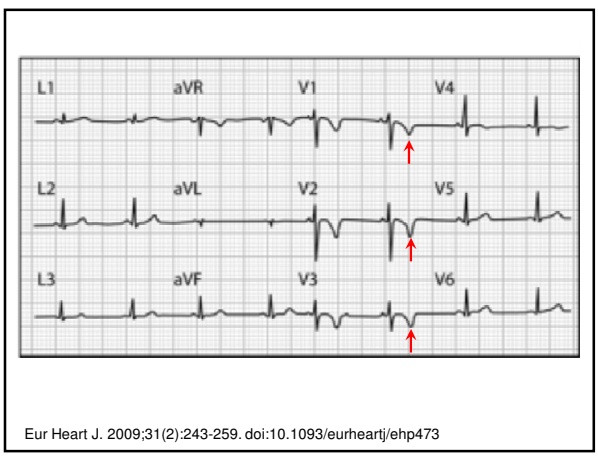
Eur Heart J. 2009;31(2):243-259. doi:10.1093/eurheartj/ehp473



Eur Heart J. 2009;31(2):243-259. doi:10.1093/eurheartj/ehp473



Eur Heart J. 2009;31(2):243-259. doi:10.1093/eurheartj/ehp473

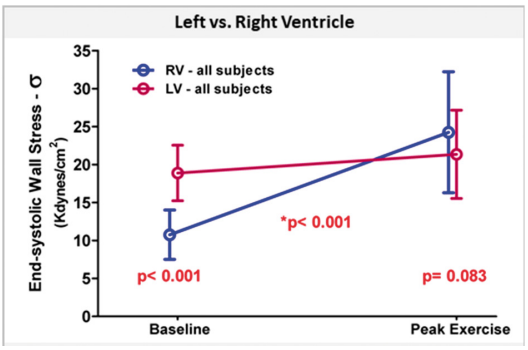


Eur Heart J. 2009;31(2):243-259. doi:10.1093/eurheartj/ehp473

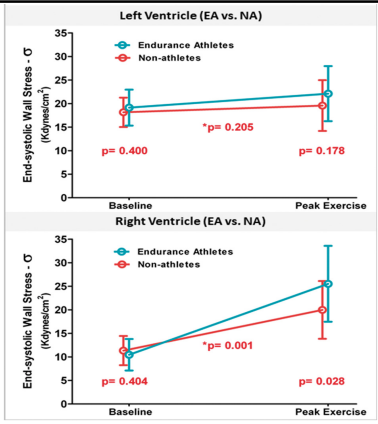
Differential Impact of Exercise on RV and LV

- Ventricular wall stress determines myocardial O_2 consumption
- During exercise, RV wall stress can increase by as much as 170% as compared with 20-25% increase in LV wall stress
- After an endurance race: a decrease in the RV EF but not the LV EF for nearly a week after the race.
- Endurance athletes also achieve much higher peak pulmonary pressure , leading to higher RV load and stroke work during exercise

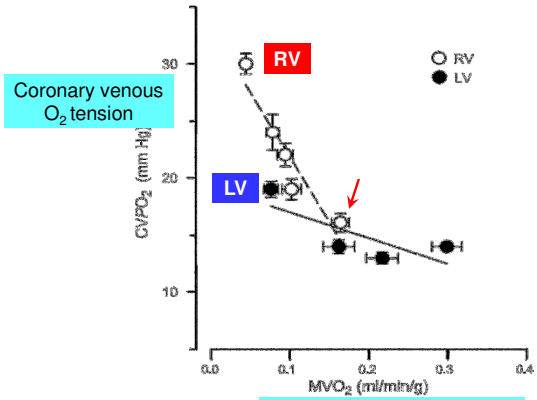
Calkins H, Trends m CV Medicine, 2015(25):181



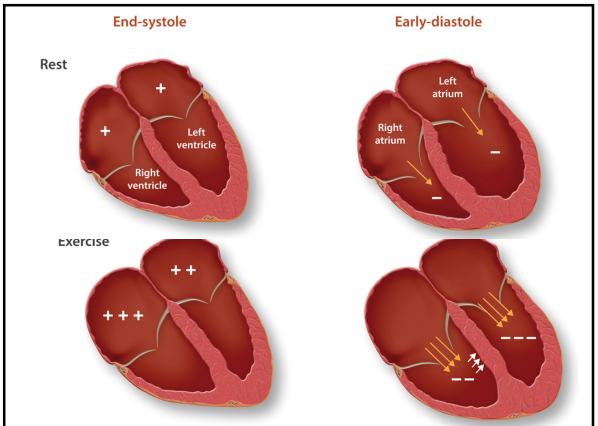
La Gerche, CV Research 2017;113:1499-1508



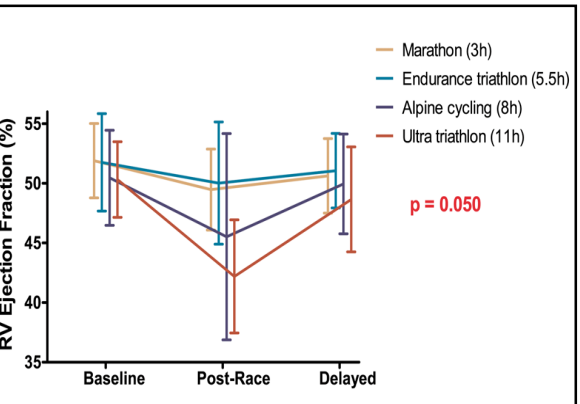
La Gerche, CV Research 2017;113:1499-1508



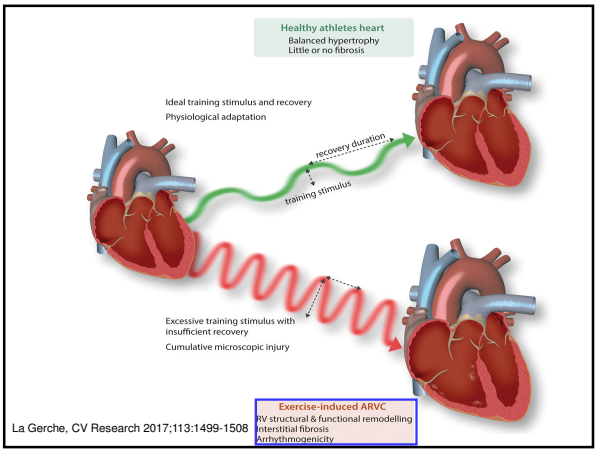
La Gerche, CV Research 2017;113:1499-1508



La Gerche, CV Research 2017;113:1499-1508



La Gerche, CV Research 2017;113:1499-1508



La Gerche, CV Research 2017;113:1499-1508

Exercise-induced ARVD/C

- Disproportional increase in wall stress of RV during exercise causes acute RV dysfunction as a result of micro-trauma
- Repeated RV micro-trauma may result in chronic RV structural and functional changes in *some* endurance athletes.
- LV function is unaffected due to differential responses to physical activity
- Gene-elusive ARVD/C patients are truly gene-elusive?

Calkins H, Trends m CV Medicine, 2015(25):181

The life expectancy you extend by exercising equals the time you spend on exercising

Do not choose a sport that can hurt you!!