Sports Cardiology

The Basics

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Clinical Cardiology
Memorial CVI

Sports Cardiology
Memorial Sports Medicine Center
Disclosures

• None
Case

- 23 year old healthy women’s college basketball player
- Chest pain x 1-2 weeks
- Positional in nature, worse when lying down and turning
- Gets short of breath with practice
- Generally feels unwell
- Had a cough and cold 2 weeks ago
- Exam unremarkable
Case

• No past medical history
• There is no family history of sudden cardiac death, unexplained motor vehicle accidents, unexplained drowning, fainting. There is no history of death from heart disease prior to the age of 50 years. There is no history of disability from heart disease in someone under 50 years
• No medications
• Rare alcohol, no tobacco, no illicit drug use, no performance enhancing drugs, no OTC supplements, no caffeine
Case

- Exam notable for irregularity in her heart rhythm, likely premature beats
- EKG shows sinus rhythm (normal rhythm) with a PVC
Case

• Can she play?
  1) This is nothing. Clear her immediately and return to play
  2) There is something bad. She should never play again
  3) Obtain additional testing and then decide
  4) Refer to a Sports Cardiologist
Overview

• Background of Sports Cardiology

• Evaluation of an athlete
  • EKG, Echo

• Conditions that affect athletes

• Sudden Cardiac Death
What is Sports Cardiology?

- Dedicated cardiac care professional, amateur, highly competitive and highly active individuals
- Growing population
- Age range: Early teens to 70s, 80s and older
- Different clinical presentation, needs and treatment than a “usual cardiac patient”
- Increasingly recognized as a necessity at the amateur and professional athletic levels
History

• Pheidippides
  • Inspiration for marathon

• Ran from Marathon to Athens to deliver news of a Greek military victory against the Persians at the Battle of Marathon

• Suddenly collapsed and died
History

• “Skiing causes an enlargement of the heart which can perform more work than a normal heart.”

• First description of an athletic heart in 1899 by S. Skilanglauf Henschen
  • Used percussion to demonstrate cardiac enlargement in cross country skiers

• Concluded both right and left dilatation and hypertrophy and that this was normal and favorable

• Some felt this was a sign of weakness due to strain
Care of the Athletic Heart

JUNE 21 - 23, 2018
Cvent Summit Lodge
Park City, Utah

COORDINATING DIRECTOR
Matthew Mythen, MD, FACC
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#SportsCardio
“A highly competitive athlete being evaluated by a general cardiologist is like taking a Lamborghini to a Chevy dealership. Sure, they’ll try to fix it. But, they don’t know what the $!&* they’re doing”
<table>
<thead>
<tr>
<th>Increasing Static Component</th>
<th>Increasing Dynamic Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>III. High (≥50% MVC)</td>
<td>A. Low (&lt;40% Max O₂)</td>
</tr>
<tr>
<td></td>
<td>B. Moderate (40-70% Max O₂)</td>
</tr>
<tr>
<td></td>
<td>C. High (&gt;70% Max O₂)</td>
</tr>
<tr>
<td>Archery, Auto racing*, Diving*, Equestrian*, Motorcycling*</td>
<td>American football*, Field events (jumping), Figure skating*, Rodeoing*, Rugby*, Running (sprint), Surfing*, Synchronized swimming*</td>
</tr>
<tr>
<td>Billiards, Bowling, Cricket, Curling, Golf, Riffley</td>
<td>Baseball/Softball*, Fencing, Table tennis, Volleyball</td>
</tr>
</tbody>
</table>
Normal “Pre-training”
Cardiac Structure and Function

Endurance Training

Right Ventricle

Left Ventricle

Strength Training

Characteristic Adaptations

- Mild to Moderate Eccentric LVH and RV dilation
- Biatral enlargement
- Normal to slightly reduced resting LVEF
- Normal or enhanced Early LV Diastolic Function
- Normal or enhanced LV twisting / untwisting

Characteristic Adaptations

- Mild concentric LVH but No RV remodeling
- Normal to mildly enlarged left atrial size
- Normal to hyperdynamic resting LVEF
- Normal to slightly reduced early LV diastolic function
- Compensatory increase in late LV diastolic function

Weiner RB, Baggish AL. Exercise Induced Cardiac Remodeling. Progress in Cardiovascular Disease; Cardiovascular Care of the Athletic Patient; 54.5:380-386
Sports Cardiology

• The sports the athlete participates in and the exercise he or she does will dictate how the heart remodels to exercise

• Same concept as weight training
  • i.e. High reps, low weight versus low reps, high weight
Case

• 18 year old male, high level Division I football recruit; Asymptomatic
• No family history
• Normal exam
• EKG checked for unclear reasons
Case

• Can he continue to play?
  1) This is nothing. Clear him immediately and return to play
  2) There is something bad. He should never play again
  3) Obtain additional testing and then decide
  4) Refer to a Sports Cardiologist
How do we evaluate athletes?

- Personal history
  1. Exertional chest pain/discomfort
  2. Unexplained syncope/near-syncope
  3. Excessive exertional and unexplained dyspnea/fatigue, associated with exercise
  4. Prior recognition of a heart murmur
  5. Elevated systemic blood pressure
  6. Prior sport restriction
  7. Prior cardiac testing

- Family history
  8. Premature death before age 50 years due to heart disease in ≥1 relative
  9. Disability from heart disease in a close relative <50 years of age
  10. Specific knowledge of certain cardiac conditions in family members: hypertrophic or dilated cardiomyopathy, long-QT syndrome or other ion channelopathies, Marfan syndrome, or clinically important arrhythmias

- Physical examination
  11. Heart murmur
  12. Femoral pulses to exclude aortic coarctation
  13. Physical stigmata of Marfan syndrome
  14. Brachial artery blood pressure (sitting position)
How do we evaluate athletes?

• The pre-participation history and physical is endorsed by all the major governing bodies of Internal, Family, Sports and Cardiovascular medicine

• Endorsed by the NCAA
How do we evaluate athletes?

- What about the EKG?

- What about echocardiograms?
Screening and EKGs

• No US guidelines suggest that a pre-participation EKG is mandatory

• Specifically *not* recommended for routine use by the American College of Cardiology and American Heart Association
  • But can be used as part of a shared decision-making process if all stakeholders agree
Screening and ECGs

- Europe, Israel and International Olympic Committee
  - Add ECG
Why the ECG Debate?

- Steinvil et al. Mandatory Electrocardiographic Screening of Athletes to Reduce Their Risk for Sudden Death. JACC. 2011;57:1291-1296
Screening and EKGs

• Sinus bradycardia
• First degree AV block
• Early repolarization (maybe)
• Left ventricular hypertrophy
• Left or right axis deviation
• Incomplete right bundle branch block
• Mobitz I
Screening and EKGs

• The EKG of a well trained athlete can be very difficult to interpret

• Set of guidelines exist as to what is normal and what is not
“Everything in life seems to happen in 3s. For health, you can control what you eat, you can control how you exercise but you cannot control your genes.”
Hypertrophic Cardiomyopathy

- Abnormally thick left ventricle of the heart
- Most often genetic
- Thought to be the number one killer of young athletes in the USA
Hypertrophic Cardiomyopathy

“Gray Zone” of LV Wall Thickness
(males: 13–15 mm, Females: 12 mm)

HCM

Athlete’s Heart

asymmetric – [LV Hypertrophy] - symmetric
<45mm – [LV cavity] - >55 mm
abnormal – [LV shape] - ellipsoid
non-dilated LV – [Left atrium ↑]- LV enlarged
abnormal – [LV filling/relaxation ]- normal
present – [CMR delayed-enhancement] - absent

[Bizarre ECG Patterns]
< 45 ml/kg/min – [max. VO2]- >50 ml/kg/min

[Regression of LVH with deconditioning]
[Family history of HCM]
[Pathogenic sarcomere mutation]
Case

• 18 year old male, former basketball player, comes to hospital with palpitations

• Stopped playing basketball due to palpitations
• What does the EKG show?
  1) Normal sinus rhythm
  2) Expected EKG abnormality for an athlete
  3) Concern for an underlying abnormality
Electrophysiologic Abnormalities

- Long QT syndrome
- Brugada Syndrome
- Wolf-Parkinson-White Syndrome (WPW)
- Catecholaminergic Polymorphic Ventricular Tachycardia
- Supraventricular Tachycardia (SVT)
  - Atrial fibrillation
- Stimulant use
  - Illicit drugs, Redbull/Four Loko/Monster/Rockstar/etc.
Atrial Fibrillation

- Atrial fibrillation increases with the more endurance exercise a man does
- Women appear to be protected

N.A. Mark Estes III, and Christopher Madias JACEP 2017;3:921-928
CENTRAL ILLUSTRATION: Proposed Pathophysiologic Mechanisms of AF in the Endurance Athlete

Atrial Fibrillation Endurance Athlete

Supporting Evidence

High (Proven)  Intermediate (Possible)  Low (Speculative)

Arrhythmogenic Right Ventricular Dysplasia

• Most common cause of SCD in European Athletes
  • Most common in the Mediterranean regions

• Genetic condition in which the electrical communication connections between heart cells become unstable, scarred
  • Causes right ventricular failure

• The more physical activity, the worse the disease
Structural Cardiac Abnormalities

• HCM, ARVD

• Coronary artery anomalies
  • Malformation of the course of the heart arteries
    • Sudden death

• Valvular disease
  • Aortic stenosis (bicuspid aortic valve)
  • Mitral valve prolapse
    • Mitral regurgitation
Diseases of the Aorta

• Marfan Syndrome

• Ehlers Danlos Syndrome
Acquired Cardiac Abnormalities

• Coronary artery disease
  • Especially prevalent in age > 35
  • More coronary calcium in males with high doses of endurance training

• Myocarditis
  • Infection and inflammation of the heart
    • Electrical instability and sudden death

• Commotio Cordis
  • Trauma at precisely the wrong moment

• Illicit drug, stimulant use

• Temperature related illness
  • Hypo/hyperthermia
    • Heat exhaustion, heat stroke
    • Maybe the most common?
Case

• 46 year old male amateur half marathon runner
• Most recently went into ventricular fibrillation at mile 12 of a half marathon
• Workup completely negative
  • Cath, EP study, cardiac MRI, echo
  • Labs normal
• No family history of sudden cardiac death
• ICD placed
• Comes for a sports cardiology evaluation
Can we clear him to run again?

1) No way!
2) Yes, but I am not volunteering at his next race
3) Further testing
4) Let’s talk about it...
Sudden Death and Sports Participation

• Highly visible

• Lots of media attention

• Lots of inaccurate information
  • “Heart attack”
‘Don’t die. Don’t leave us.’ The frantic effort to save the life of SC State’s Ty Solomon

By Steve Wiseman
Sudden Death and Sports Participation

Structural Cardiac Abnormalities
- Hypertrophic cardiomyopathy
- Arrhythmogenic right ventricular cardiomyopathy
- Congenital coronary artery anomalies
  - Marfan syndrome
  - Mitral valve prolapse/Aortic stenosis

Electrical Cardiac Abnormalities
- Wolff Parkinson White syndrome
- Congenital long QT syndrome
  - Brugada syndrome
- Catecholaminergic polymorphic ventricular tachycardia

Acquired Cardiac Abnormalities
- Infection (myocarditis)
- Trauma (commotio cordis)
- Toxicity (illicit/performance enhancing drugs)
- Environment (hypo/hyperthermia)

Chranda et al. Sudden Cardiac Death in Young Athletes: Practical Challenges and Diagnostic Dilemmas. JACC; 2013; 61.10:1027-1040
Incidence of SCD

- 2.3-4.4/100,000 in American athletes

- 3.6/100,000 prior to screening laws in Italy
  - Now 0.3/100,000

- 5.6/100,000 in Black athletes

- College:
  - 1/54,000 athletes/year during or soon after exertion
  - 1 in 38,000 male; 1 in 122,000 female exertion-related
  - 1 in 22,000 Black; 1 in 68,000 White

- Compare
  - 5/100,000 homicides in the US each year (CDC)
  - 10.2/100,000 motor vehicle deaths in 2014 in the US (IIHS)
Sudden Cardiac Death

Compare
5/100,000 homicides in the US each year
10.2/100,000 motor vehicle deaths in 2014 in the US
Sudden Death and Sports Participation

- Screening can help to identify these athletes before something bad happens

- Controversy in the guidelines

- Lack of access to health care professionals able to accurately interpret the screening tests in this population
  - Can lead to a dangerously high false positive rate
    - Hold athletes from competition unnecessarily
Screening Cost

• AHA estimate

• Assume 10 million high school and middle school athletes

• $25 for H&P and $50 for EKG=$750 million for SCREENING ONLY

• 15% likely to be referred
  • Another evaluation with H&P ($100) and TTE ($400)=$750 million
  • $1.5 billion total
    • Possibly $500 million more for administrative costs
Screening Cost

• 10,000/10 million athletes would have HCM, ARVD or electrophysiologic abnormalities detectable on EKG

• $330,000/athlete to be detected

• 10% with the disease have increased risk of death
  • $3.4 million to prevent each death—High value, cost-conscious care?
ICDs and Sports

• In the coming years, we are likely to see more athletes participating with ICDs

• Evidence to suggest that it may be safe to play
  • Will still get shocked for the “right reasons”
    • May have inappropriate shocks too

• Wording in the guidelines to emphasize shared decision making between the physician and athlete
ICDs and Sports

Table 3.
Number of Shock Events and of Individuals Receiving Shocks, Total Cohort

<table>
<thead>
<tr>
<th>Rhythm</th>
<th>Competition Related, n*</th>
<th>Physical Activity Related, n†</th>
<th>Other, n</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventricular tachycardia</td>
<td>22/16</td>
<td>14/11</td>
<td>11/8</td>
<td>47/35 (9)</td>
</tr>
<tr>
<td>Ventricular fibrillation</td>
<td>8/6</td>
<td>3/3</td>
<td>10/5</td>
<td>21/14 (4)</td>
</tr>
<tr>
<td>Sinus tachycardia</td>
<td>7/6</td>
<td>6/3</td>
<td>1/1</td>
<td>14/10 (3)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>5/3</td>
<td>10/6</td>
<td>3/3</td>
<td>18/12 (3)</td>
</tr>
<tr>
<td>Other supraventricular tachycardia</td>
<td>2/2</td>
<td>2/2</td>
<td>0/0</td>
<td>4/4 (1)</td>
</tr>
<tr>
<td>Noise</td>
<td>0/0</td>
<td>2/2</td>
<td>8/5</td>
<td>8/7 (2)</td>
</tr>
<tr>
<td>T-wave oversensing</td>
<td>2/2</td>
<td>1/1</td>
<td>1/1</td>
<td>4/4 (1)</td>
</tr>
<tr>
<td>Other</td>
<td>3/2</td>
<td>1/1</td>
<td>1/1</td>
<td>5/4 (1)</td>
</tr>
<tr>
<td>Total, n (%)</td>
<td>49/36 (10)</td>
<td>39/29 (8)</td>
<td>33/23 (6)</td>
<td>121/77 (21)</td>
</tr>
</tbody>
</table>

Cardiovascular priorities in college student-athletes range from more accurately defining the risk of SCD to developing and implementing referral centers and emergency action plans. AED = automated external defibrillator; CPR = cardiopulmonary resuscitation; SCD = sudden cardiac death.

Summary

• The heart is like any muscle. It will change depending on the kind of exercise it is exposed to
  • This makes testing difficult to interpret in athletes

• Exercise and sports are not immune therapy. Cardiac issues still happen

• SCD in athletics is highly visible and highly controversial
  • Screening can help
  • More ICDs coming
  • KNOW CPR!!
Thank you