Sports Medicine Highlights from the first ACC Symposium on Sports Cardiology

Disclosures

- Biomedical Systems (Consultant)
- Biotie (Consultant)
- Cook MED Institute (CEC)
- Eli Lilly (DSMB, Consultant)
- Euthymics (Consultant)
- Intercept (Consultant)
- NFL Scouting Combine (Cardiac Testing)
- Synosia (Consultant)
- Xenoprot (Consultant)
Sports Section launched in 2012
• 455 signed up for complimentary membership
Sports Section grew to 3,900 members in 2013
• 1,700 paid section members
• 2,200 complimentary (fellows in training)

Sports Cardiology Topics
• Defining the athlete and cardiovascular adaptation
• Causes, epidemiology and prevention of sudden death in athletes
• Interpretation of cardiac diagnostic tests in athletes
• Return to play decisions

Defining the American Athlete
• Size of the population
  • 4,000,000 – 5,000,000 High School / Youth
  • 500,000 NCAA
  • Countless “Masters” to “weekend warriors”
Defining the American Athlete

• Diversity of the population
  • Age
  • 5 - ??
• Gender
  • Title IX
• Activity
  • Extremes of competition

Athletes Have Changed in Shape

20% of the 2013 NFL Scouting Combine Players > 300 lbs.

Cardiovascular Adaptation to Exercise Training

• Aaron Baggish – Harvard
• Ben Levine - Texas
Historical Data: Causality?

Does exercise cause heart enlargement or do people born with "big hearts" simply self select for sport?

Cardiac Remodeling: Physiology

Endurance Activities
- Sustained VO2
- 4 to 5 times rest
- Min H R x SV
- Vasodilation

Volume Challenge

Strength Activities
- Repetition SBP
- Systemic BP > 200 mmHg
- Student Max. Contraction
- Vasconstriction

Pressure Challenge

Harvard Athlete Initiative

Strength Athletes
- Pre-Study Period
- June, July, August

Endurance Athletes
- Study Period
- September, October, November
Cardiac Remodeling: Physiology

Sport Specific Physiology & Remodeling

- Mixed
- Rowing
- Cycling
- Triathlon
- American Football/ Lineman
- Soccer
- Marathon Running
- Ultra-Racing
- Isometric
- Isotonic

Cardiac Remodeling: Future

- Confirm a new paradigm
- Functional Correlates of Remodeling
- Genetics of Variability
- Long term Implications of Remodeling (?)

Why Do An Exercise ECG In An Athlete?

To provoke a cardiac arrhythmia (in an athlete with palpitations, syncope/near syncope or known cardiovascular disease);

To provoke ischemia in an athlete with chest pain (looking for premature CAD, coronary anomaly, deeply tunneled LAD);

To follow-up on an abnormal resting ECG or monitor the hemodynamic response to exercise (usually as a consequence of #1)
Causes, Epidemiology, and Prevention of Sudden Cardiac Death in Athletes

• Mark Link - Tufts
• Paul Thompson - Hartford Hospital
• Mary Jo Gordon

Faces of SCA

"Pistol" Pete Maravich (age 40, died during pickup basketball game of previously undetected coronary artery anomaly)

Reggie Lewis (age 27, died during off-season practice with no cardiovascular history)

Hank Gathers (age 23, died during basketball game, autopsy demonstrated HOCM)
Faces of SCA

Piermario Morosini (age 25, died after on-field SCA)

Fabrice Muamba (age 23, survived on-field cardiac arrest, retired from soccer)

Annual Incidence of SCD in Athletes

Annual incidence of sudden cardiac death (SCD) in athletes per 100,000/year (per 100K/yr).

Causes of Sudden Death in 387 Young Athletes

Causes of sudden death in 387 young athletes, including hypertrophic cardiomyopathy (HOCM), commotio cordis, coronary artery anomalies, LVH (idiopathic), myocarditis, ruptured aortic aneurysm, bridged coronary artery, aortic stenosis, atherosclerotic CAD, dilated CM, myxomatous mitral valve degeneration, asthma, heat stroke, drug abuse, other CV causes, and long-QT syndrome.
Patient Presentation

- June, 1993: 36 y/o female runner, weight lifter, volunteer FF/EMT presents with palpitations and near-syncope

Family History

Family of eight (8) children:
- 2 sisters w/ LQTS and aborted SCA; one at age 17 (proband), other at age 22
- 1 sister, 1 brother asymptomatic w/ LQTS per ECG
- Father w/ multiple syncopal episodes
- Nephew w/ LQTS; 2 aborted SCAs at age 11
- Maternal grandfather had SCD at age 37
- Paternal great aunt had SCD at age 15
- Paternal 1st cousin w/ TdP at age 35
ECG at age 36 years

Patient Clinical Course

• Placed on β-blocker; ICD not implanted
• Physician advised no running; patient complied
• Patient did well from age 36 – 49
• Inferior MI at age 49 (Jan ’07); peak troponin = 24.9; Cardiac rehab (Feb. – June ’07)
• Syncope (Oct. ’07) following cerebral angiogram; CPR
• ICD implanted (Nov. ’07)

Patient Presentation

• Post-MI:
  – Total cholesterol = 266
  – BMI = 30.1
  – Cath report: OM branch occlusion; 30-40% proximal vessel narrowing; discrete LV akinesis; EF = 65
  – Nuclear stress: Moderately severe inferolateral wall defect, reversible w/ rest
Outcome

- Post-MI Cardiac Rehab
- Genetic testing results (Oct.’11): KCNH2/LQTS-2, G584S mutation
- ICD Sports Registry:
  - Fourteen (14) – 5k races (Aug.’11-Oct.’12)
- National Weight Control Registry:
  - BMI = 21.4
  - Total cholesterol = 200 (w/o Rx)

Interpretation of Cardiac Tests in Athletes

- ECG
  - Kovacs
  - Lawless

- ECHO
  - Baggish

- MRI
  - Martinez
Interpretation of Cardiac Tests in Athletes

- ECG

Summit on ECG Interpretation in Athletes
February 2012, Seattle WA

Summit on ECG Interpretation in Athletes
February 2012, Seattle WA
Sensitivity and specificity of ECG

<table>
<thead>
<tr>
<th>DISEASE</th>
<th>Likely to be detected w/ ECG</th>
<th>ECG Findings</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long QT syndrome</td>
<td>High</td>
<td>Q-T c ≥ 440 msec males</td>
<td>83-100%</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q-T c ≥ 460 in females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brugada syndrome</td>
<td>Low</td>
<td>RBBB, and &quot;coved&quot; ST elevation in V1 and V2</td>
<td>At least 20%</td>
<td>High</td>
</tr>
<tr>
<td>Coronary anomalies</td>
<td>Low</td>
<td>None characteristic</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Lawless and Best: Electrocardiograms in athletes: MSSE 40: (5) 787, 2008

Interpreting Athlete ECGs
QT Measurement and Correction

Richard J MD FACC
Krannert Institute of Cardiology
Indiana University School of Medicine
Indianapolis, IN

Normal Distribution of QTc
Challenges to QT Measurement

• "there are difficulties in the exact determination of the points which are to be used for the measurement of the QT interval in a given complex"

• "there are difficulties when the actual QT duration is corrected for heart rate"

Factors known to effect QT interval

• Heart Rate
• Meals
• Autonomic system
• Posture
• Electrolyte balance
• Time of day
• Emotional State
• Interaction with Staff or other Subjects
On Screen Calipers

QTc Interval by Age and Gender

Relative Performance of QT Correction Formulas

Dmitrienko et al DII, 2005

RR interval=60/Heart rate
Accuracy of QT Interval Correction Methods for Prediction of Drug-Induced Torsades de Pointes

<table>
<thead>
<tr>
<th>Method</th>
<th>R²</th>
<th>Area under ROC curve</th>
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<tbody>
<tr>
<td>QT uncorrected</td>
<td>0.44</td>
<td>0.97</td>
</tr>
<tr>
<td>QT Fridericia</td>
<td>0.39</td>
<td>0.97</td>
</tr>
<tr>
<td>QT Bazett’s</td>
<td>0.31</td>
<td>0.93</td>
</tr>
<tr>
<td>RR interval</td>
<td>0.17</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Circulation 2004;110:III-580

Results

Receiver Operating Characteristics Curve – Uncorrected QT Interval

Circulation 2004;110:III-580

Receiver Operating Characteristics Curve – Bazett’s-Corrected QT Interval

Circulation 2004;110:III-580
Results
Receiver Operating Characteristics Curve – Fridericia-Corrected QT Interval


NFL Combine Echo Data, 2011–2013 (N=985)
Red Flags

• LVEF < 50%
• IVS thickness > 1.6cm
• Concentric LVH > 2.0 cm.
• Any regional wall motion abnormality
• Aortic diameter > 4.0 cm.
• Greater than moderate valvular regurgitation
• Any valvular stenosis
• Aberrant coronary artery
• Pericardial effusion > normal variant
• ASD / VSD
• Dextrocardia
• Congenital structural abnormality

Red Flags (revised)

• LVEF < 50%
• IVS thickness > 1.6cm
• Concentric LVH > 2.0 cm.
• Any regional wall motion abnormality
• Aortic diameter > 4.0 cm.
• Aberrant coronary artery
• ASD / VSD

NFL Scouting Combine
Facts/ Figures

• 342 players
• 3 days available for screening, with concentration on 2 days
• Coordinated with non-CV screenings
• Volumes
  – 342 resting 12 lead ECGs
  – 342 resting echo / doppler / strain studies
  – Anticipate 50-100 stress echos
NFL Scouting Combine
Facts/Figures

• Ages 21-24

• Height 5'5" – 6'8"

• Weight 150 – 400 lbs

Screening Flow

- Resting 12 lead
- Cardiologist Read

- Resting Echo/Doppler
- Cardiologist Read

- Modified Bruce
- Cardiologist Read

Franchise Medical Teams

Establishing Reference Ranges

• 3 years data approximately 1,000 players

• Quantitative data on chamber size, wall thickness, systolic and diastolic function

• Exploratory analyses – e.g. global LV strain
Return to Play Decisions

Challenge I

- Genetics
  - Multiple new channelopathies identified since 2005

- Readily available genetic testing

- Heart Rhythm Society 2011 Guidelines re: Genetic testing in suspected channelopathies
Return to Play Decisions
Challenge II

Athletes Have Changed in Other Characteristics

External Environment Has Changed
External Environment Has Changed

“Requires that the student athlete who is suspected of experiencing a symptom of sudden cardiac arrest be removed from play”

Google search on “Athlete heart screen” = 2,670,000 hits

www.simonsfund.org

Sudden Cardiac Arrest Legislation by State

On May 30, 2012, Pennsylvania passed the Sudden Cardiac Arrest Prevention Act — the first law in the country requiring schools and teams to recognize and act upon athletic symptoms. The bill was created by Simon’s Fund and championed by Representative Mike Carroll.

Now we are working with lawmakers in other states. What is the status in your state?

Alabama
Arkansas
California
Colorado
Connecticut
Delaware
Florida
Georgia
Hawaii
Idaho
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
New Hampshire
New Jersey
New Mexico
New York
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
Wyoming

www.simonsfund.org
Summary and Conclusions

- Millions of athletes of all shapes and sizes are in need of expert cardiac care
- Thousands of ACC members have expressed an interest in the topic and have come together in the ACC Sports Cardiology Section
- Bethesda 36 will be updated soon (Joint AHA/ACC document on participation)