Learning Objectives

- Provide an understanding of the value of the multiple ECG and Physiological measures that are recorded from an ECG exercise test
- Clarify the importance of determining the exercise work capacity of a subject
- Detail the role the ECG Exercise Test has in the evaluation of the cardiac status of an individual

Historical Perspective

- Over 2000 yrs ago—Chinese, Romans and Greeks used treadmills for irrigation and construction.
- 1818—Cubitt [British engineer] developed the “stepping wheel”
- “Treading the wheel” for punishment was popular in English prisons.

- 1846—Reformers considered treading the wheel a cruel, inhumane and unhealthy practice
- Edward Smith began respiratory and metabolic testing, thus the beginning the modern era of testing

Subject Population

- Normal Healthy
- Those at risk for CVD
- Post MI
- Post PCI and CABG
- Heart Failure
- Other

ECG Exercise Testing

- Treadmill, Bike, Arm, Arm/Leg
- ECG changes
- Symptoms
- Heart rate, rhythm, blood pressure
- Work capacity
Relative Costs of Testing

- $ ECG Treadmill  1.0
- $ ECHO  3.0
- $ MRI  5.0
- $ Nuclear  5.2
- $ PET
- $ CT
- $ CT Angio

Bruce Protocol

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Circulation 2001; 104: 1699

Exercise ECG Changes of Ischemia

- Horizontal-divergent ST depression of equal to or greater than 1 mm for 80 ms
- Important—degree, time, leads, resolution
- ST elevation in infarct area of > 1 mm is abnormal
- ST elevation with no MI likely indicates significant proximal lesion or spasm

ECG Exercise S-T Changes

- Configuration
- Time of Onset
- Double Product at Onset
- Magnitude
- Duration in Recovery
- Number of Leads

Classic

Upsloping
Blood Pressure Response

- Systolic increases
- Diastolic—same or decreases
- Inadequate increase—[<20-30 mm]
  Consider aortic stenosis, severe LV dysfunction, ischemia or medications
- Some CAD patients—systolic may increase in recovery > maximal exercise

Heart Rate Response

- Increases linearly with work load—both sympathetic and vagal influence
- Slope of increase influenced age, level of conditioning, position, type of exercise and various states of health and therapy

Heart Rate Recovery

- Decrease in heart rate post exercise relates to vagal tone reactivation
- Can be abnormal in coronary artery disease and heart failure

Arrhythmias

- Significant ventricular ectopy during and post exercise is associated with increased mortality
- Wave form is also important
- Atrial arrhythmias are also associated with increased mortality
Conduction Changes

- Left Bundle Branch Block that occurs at heart rate < 125 bpm is often associated with CAD
- Mobitz Type 2 A-V block may reflect severe conduction problems and test should be terminated

Changes in Physical Fitness and All-Cause Mortality

- 9,777 asymptomatic men
- Stress test at baseline and 5 years

Results

- Those that maintained or improved exercise capacity had lower all cause and CV mortality
- 7.9% decrease in all cause mortality if treadmill time increased by one MET over 5 years

Exercise Capacity and the Risk of Death in Women

- 5721 asymptomatic women
- History, exam, and stress ECG (Bruce)
- Exercise capacity measured in METs
- Followed 1992-2000
Exercise Capacity and the Risk of Death in Women

- Largest cohort of asymptomatic women studied
- Longest follow up
- Confirms that exercise capacity is an independent predictor of death

Achieving an Exercise Workload Of Greater Than 10 METS Predicts a Very Low Risk of Inducible Ischemia

Bourque, Beller et al
JACC 2009; 54: 538

RESULTS

- 974 attained >85% MPHR
- 473 [49%] achieved >10 METs
  - Only 2 [0.4%] had ischemia
- Those attaining <7 METs had 18 x more ischemia [7.0%]

RESULTS (Con’t)

- Of 430 reaching >10 METs without S-T changes, none had >10% ischemia
- The prevalence of >10% ischemia was highest in those <10 METs with S-T changes [19%]
Conclusions

• Achieving >10 METs with no S-T depression – essentially no ischemia

• In this group of int-high risk patients [31% of all], elimination of MPI could save significant costs

CABG Survival

• In subjects with an exercise capacity > 10 METs

• CABG was not shown to improve survival compared to medical therapy

Circulation 2001; 104:1710

Contraindications to Exercise Testing

• Unstable Angina
• Aortic Stenosis
• Uncontrolled Hypertension
• Certain Arrhythmias
• Musculoskeletal Issues

Conclusions

• Exercise testing is a noninvasive procedure of great value in the cardiovascular evaluation.

• CPX is more often used in the research setting and is more complete and precise with pulmonary/metabolic measures

Conclusions

• ECG testing is more readily available, less expensive and quickly performed

• The simple ECG exercise test is an excellent means of evaluating symptoms, work capacity, hemodynamic and ECG endpoints