Exercise Tolerance Testing

• SESSION OBJECTIVES
  – ETT Indications
  – ETT Contra-indications
  – ETT Protocols
  – ETT Interpretation of results
EXERCISE TOLERANCE TESTING INDICATIONS

1) Known coronary disease
2) Diagnosis of chest pain
3) Organic Heart disease
4) Heart failure / HOCM
5) Diagnosis/detection of arrhythmias
6) Research
7) Screening
8) Pacemaker evaluation
1. **Known Coronary Disease**

- functional capacity – to assess prognosis and give an indication of severity
- symptom evaluation
- severity of disease – to assess prognosis and treatment regimen
- site of disease – may be established assuming normal coronary anatomical positions
- response to treatment
- rehabilitation assessment
- post Myocardial Infarction – assessment of residual viable myocardium and risk of future cardiac events
2. Diagnosis of chest pain
   - Ischaemic heart disease
   - Other causes

3. Organic Heart disease
   - functional capacity
   - symptom evaluation
   - severity of disease
   - response to treatment
4. Heart failure / HOCM
   - functional capacity
   - symptom evaluation
   - risk stratification
   - response to treatment

5. Diagnosis/detection of arrhythmias
   - type
   - severity of associated symptoms
   - assessment of treatment
6. Research

7. Screening
   • Familial conditions
   • pilots
   • HGV drivers
   • Others

8. Pacemaker evaluation
   • physiological pacemaker response (Dual chamber, Rate Response)
   • pacemaker function during exercise
EXERCISE TOLERANCE TESTING CONTRA-INDICATIONS

The overall benefits of the exercise test must outweigh the risks.

1) Absolute Contra-Indications
2) Relative Contra-Indications
1. Absolute Contra-Indications

- Recent/Acute Myocardial Infarction
- Unstable Angina i.e. rapidly increasing angina
- Known left main stem stenosis
- Uncontrolled atrial/ventricular arrhythmias
- Uncontrolled hypertension at rest (>180/100)
- Complete Heart Block
- Acute congestive/left ventricular failure
- Severe Aortic Stenosis
- Suspected dissecting aneurysm
- Endo/Myo/Peri carditis
- Recent systemic/pulmonary embolus
- Psychosis
- ST depression > 2mm on the resting ECG in most leads - ? subendocardial ischaemia
2. Relative Contra-Indications

- Moderate Aortic Stenosis
- Controlled CCF
- Second degree AV block
- Cardiomyopathy including HOCM (dependant on severity)
- Mitral Valve Disease
- Frequent Ventricular Ectopics
- Neuromuscular disease
- Other uncontrolled medical conditions e.g. Diabetes
ECG changes which preclude reliable ECG information

- Left Bundle Branch Block
- Wolff Parkinson White syndrome
- Left Ventricular Hypertrophy with strain
- Extensive Anterior Infarct

Drugs and the Exercise Tolerance Test

Several drugs may affect interpretation of the test
- Beta-Blockers
- Digoxin
- Diuretics
- Antiarrhythmics
- Psycomotor drugs
EXERCISE TOLERANCE TESTING PROTOCOLS

1) Bruce
2) Modified Bruce
3) Naughton
4) Ellstad
5) Masters Two Step
1. Bruce

- most commonly used
- intense workload over a relatively short period
- progressively increases in speed
- progressively increases gradient
- 3 minute stages

2. Modified Bruce

- for patients unable to attempt Bruce (post Infarction, arthritic conditions)
- more gentle protocol
- 1st three stages, increase in gradient only
- 3 minute stages
3. Naughton

- longer protocol
- gentle workload
- used for high risk patients (post Infarction, CCF)

4. Ellstad

- constant incline
- increase in speed only
5. Master Two Step

- 1st type of formal exercise
- no longer used

The Bruce protocol is the most commonly used protocol.

Maintaining a standard accepted protocol is important in establishing consistent and accurate results.
The Stress Testing Laboratory

1) Clinical area Modified Bruce
2) Equipment
3) Bicycle
4) Drugs
1. Clinical area

- high level of cleanliness
- should contain following equipment and drugs
- comfortable, relaxing environment
- position of laboratory

2. Equipment

- Treadmill
- bicycle ergometer
- ECG machine/Exercise testing system (computer)
- Cardiac monitor
- Defibrillator
- Resuscitation Box/trolley
- Oxygen supply
- suction
- IV giving set, saline, venflon etc
3. Bicycle

- fixed bicycle on which a load may be placed
- patient is seated
- more difficult for many patients
- cleaner trace, reduction of muscle artefact
- athletes

Patients who are unable to perform physical exercise may be referred for

- Dobutamine stress test
- radio-isotope scan (MIBIS)
- increase HR, contractility, cardiac output
4. Drugs

- Resuscitation drugs: adrenaline, atropine, lignocaine, Ca chloride
- Antiarrhythmic drugs: verapamil, digoxin, lignocaine
- Dilators: GTN spray, IV nitrates
Parameters Monitored throughout the test

- ECG
- Heart rate
- Blood pressure
- Appearance of patient
- Symptoms
EXERCISE TOLERANCE TESTING
INTERPRETATION OF RESULTS

1) Normal response to exercise
2) Angina
3) ECG changes during exercise
4) Termination End Points
5) Recovery
6) Arrhythmias
7) Bundle Branch Block and exercise
1. Normal response to exercise

- Shortened PR interval
- P wave becomes taller
- Downward displacement of the PR segment
- Shortened QT interval
- Reduced R wave amplitude
- Increased Q wave amplitude
- The J point moves below the baseline (1mm only)
- The ST segment slopes upwards (positive slope)
- T wave changes can occur in normal individuals

Rest

Exercise
2. ANGINA

Relation to exercise
• Angina is usually provoked by exertion, nearly always of walking
• The amount of exercise required to provoke Angina varies in any individual
• Emotion, tachycardia may provoke Angina

Duration of the attack
Most attacks last 1-3 minutes. The duration is seldom less than 30 seconds or more than 15 minutes, although the sensation of discomfort may persist after the pain has gone.

Relation to exercise
• Angina is usually provoked by exertion, nearly always of walking
• The amount of exercise required to provoke Angina varies in any individual
• Emotion, tachycardia may provoke Angina

Symptoms associated with Angina
• Chest pain, tightness
• SOB
• Tachycardia
• Hypertension
3. ECG CHANGES DURING EXERCISE

The Positive Test

- **Normal**
- **Borderline**
  - 30% False positive
- **Abnormal**
  - 15% False positive
  - <1% False positive
4. Termination End Points

- Progressive chest pain
- Dyspnoea
- Fatigue
- Dizziness
- Ataxia
- Hypotension or failure of BP to rise during ETT
- Severe Hypertension (> 250/120mmHg)
- Poor heart rate response
- More than 2mm ST segment depression
  (allow further if required by consultant)
- Progressive ST segment elevation
- AV block
- Frequent ventricular ectopy
- Ventricular arrhythmias
- Rapid supra-ventricular arrhythmias
5. Recovery

ECG, Heart rate and blood pressure should all return to normal post exercise.

The recovery time should be extended if necessary.

The time for recovery depends on the duration of the test, however a prolonged recovery time should be taken into consideration when determining the result of the test.

More than 10 minutes, even with a long exercise time achieved is considered abnormal.

Occasionally, abnormal ST segment depression occurs in recovery due to the fact that a high heart rate is still maintained into the recovery period.
6. Arrhythmias

• Can occur in healthy subjects as well as those with cardiac disease
• Ventricular arrhythmias are more significant
• Occasional VE’s occur in 30 – 40 % of healthy subjects
• Occasional VE’s occur in 50 – 60 % of subjects with IHD
• Increasing frequency of ventricular ectopy during exercise is suggestive of ischaemia

Atrial Fibrillation
Ventricular Tachycardia
Ventricular Ectopics During Recovery
Sinus Arrest
7. Bundle Branch Block and exercise

Right Bundle Branch Block (RBBB)
It has been found that when RBBB develops during exercise (usually at slower heart rates rather than maximal heart rate) it is likely to be associated with coronary disease or other types of myocardial abnormality.

Left Bundle Branch Block (LBBB)
This tends to be associated with a decrease in the left ventricular function and has a poor prognosis.
In patients who have LBBB alternating with normal conduction, the function of the ventricle, during the beats associated with the block, has been demonstrated to be less effective in patients with reduced left ventricular function.
This may be due to degenerative changes in the conduction system, myocarditis, LVH or cardiomyopathy.
Any Questions?