How to perform a useful stress ECG in your practice: Indications, contra-indications and correct interpretation

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Introduction

Stress ECG one of most commonly performed Cardiac tests

It has low cost

Safe

Absolute Contra indications

Acute Myocardial infarction (< 2 days)

High risk unstable angina

Decompensated CCF

Uncontrolled arrhythmia with heamodynamic compromise

Advanced AV block

Acute Myocarditis/Pericarditis

Severe symptomatic Aorta stenosis

Severe HOCM

Uncontrolled HPT

PE/ Aortic dissection

Gibbons ***et al.*** **2002**
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Relative Contra Indications

Left main stenosis

Moderate stenotic valve lesions

Electrolyte abnormalities

Tachy or brady arrhythmia

Hypertension

Outflow tract obstruction

High degree AV block

Ventricular aneurysm

Uncontrolled endocrine disorder

Neuro, Musculo skeletal or rheumatoid disorder exacerbated by exercise

Gibbons *et al.* **2002**
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Indications

Coronary artery disease

Valvular disease

Evaluation of Cardiac transplant patients

Dysrhythmias

Exercise stress testing in Coronary artery disease

Diagnosis

Mean Sensitivity of 68%

Mean Specificity of 77%

Bayes theorem

The probability of a patient having the disease after a test is performed will be the product of the disease probability before the test and the probability that the test provided a true result

Diagnostic testing

Most value in intermediate pretest probability group as it has the largest potential effect on diagnosis

Gibbons *et al.* 2002
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Exercise stress testing in Coronary artery disease(2)

Prognosis

- Left ventricular function
- Severity of Coronary artery disease
- Coronary plaque events
- Electrical stability
- General Health

Exercise testing divide into 3 groups

Low Risk	Annual mortality 0.5%
Intermediate Risk	Annual Mortality 0.5-5%
High risk	Annual Mortality >5%

Duke Treadmill score

- Exercise time – {(5XSTsegment depression)+(4xAngina index)}

Exercise Physiology

Increase in ventricular rate due to vagal withdrawal

Increased alveolar ventilation

Increased venous return due to sympathetic veno-constriction

Cardiac output increase 4 to 6x

- Early: Frank starling mechanism
- Late: Heart rate

Strenuous exercise

- Vasoconstriction except in muscle,cerebral and coronary beds

O2 extraction increase

Rise in Systolic Blood pressure, mean blood pressurs and pulse pressure

Exercise Physiology (2)

Maximum heart rate

- 220 –age (males)
- 206 -0.88(age) females

Post exercise

- Vagal reactivation

Metabolic equivalent

- 3,5ml O_2/kg/min

Exercise Physiology(3)

Myocardial O2 consumption

- Heart rate
- Systolic blood pressure
- End diastolic volume
- Wall thickness
- Contractility

Rate pressure product

- Estimate perfusion requirements
- 20-35mmHg x beats/min

Exercise physiology (4)

Coronary blood flow

- Increased by decreasing coronary resistance as O2 extraction is at maximum
- In obstruction distal perfusion pressure falls
- Causes subendocardial ischeamia

Ischeamia causes

- Electrical gradients between epicardium and endocardium
- St segment changes
- Mediated by K^{ATP} channel

Performing a Stress ECG

No eating, drinking alcohol or caffeine or smoke 3 hours before test

Comfortable clothes

Rest ECG standard + Modification in supine and standing positions

Skin preparation

- Alcohol
- Rub with rough patch
- Silver chloride electrodes

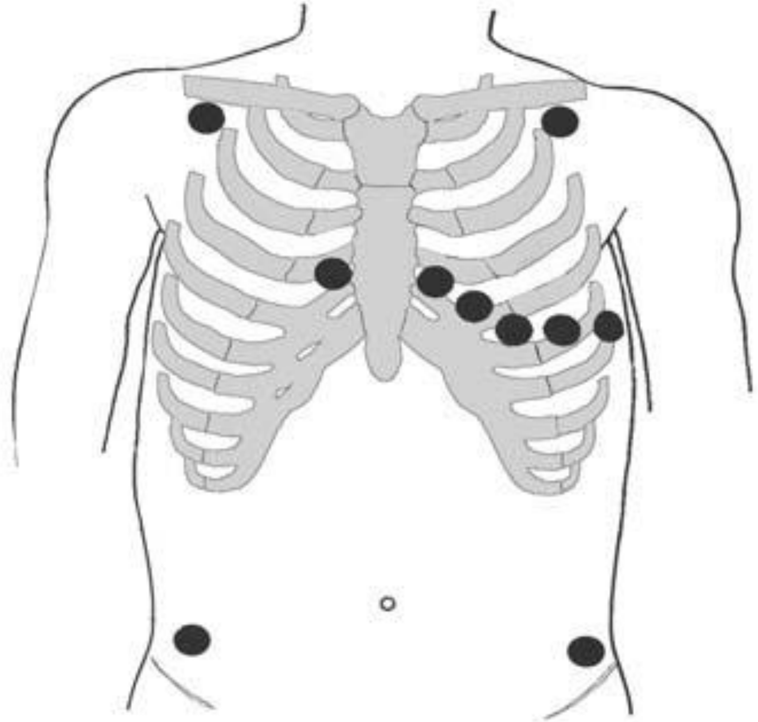
Cables

- Light flexible and shielded

ECG

Mason–Likar modification

- Moving extremity electrodes to the torso
- Arms : most lateral aspect of infraclavicular fossae
- Leg stable position above iliac crests and below ribs
- Effects of lead changes
  - Right axis shift
  - Increased voltage in inferior leads
  - Loss of inferior Q waves
  - New Q waves in AVL



Exercise protocols

Low intensity warm up

Continuous progressive exercise phase

Warm down period

Exercise Protocols (2)

Static exercise

- Isometric
- Low change in Cardiac output
- Increased peripheral resistance decrease blood flow

Dynamic exercise protocols

- Arm ergometry
- Bicycle 25w/minute increase
- Treadmill
  - Bruce protocol
    - Large increase in VO2 between stages
  - Naughton and webber 1MET increase between stages
  - Handrails should not be grabbed

Terminating exercise testing

Absolute indications

Drop in Systolic BP> 10mmHG with signs of ischemia

Moderate to severe Angina

Increasing nervous system symptoms

Signs of poor perfusion

Technical difficulty

Subjects desire to stop

Sustained Ventricular Tachycardia

ST elevation

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Terminating exercise test

Relative indications

Drop in BP without ischemia

ST segment depression of > 2mm

Arrhythmias other than sustained VT

Symptoms

Development of BBB or IVCD not able to distinguish from VT

Worsening chest pain

Hypertensive response (Systolic BP> 250, Diastolic BP>115)

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Interpretation

Reason test was stopped

Heamodynamic data

- Heart rate
- Blood pressure
- Total exercise duration
- Peak METS
- Exercise Duration

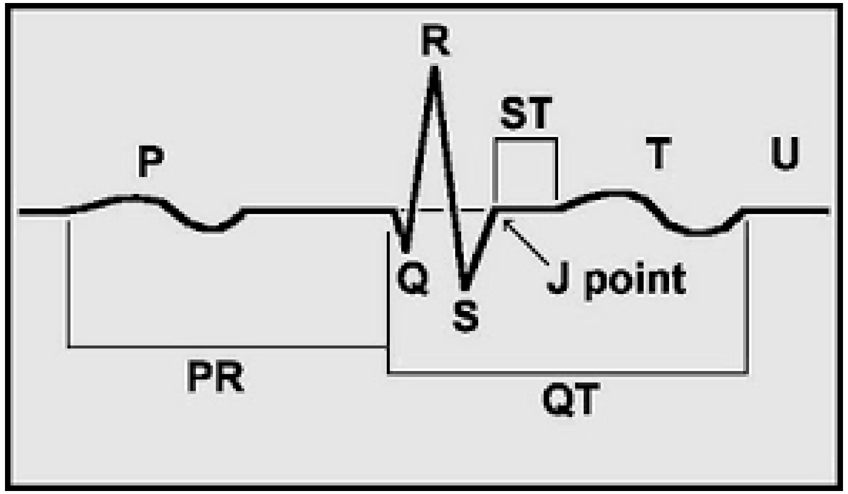
Ischeamic evidence

- Time to symptoms
- ST segment changes
- Number of leads involved

ST segment Displacement

Measurement of ST segments

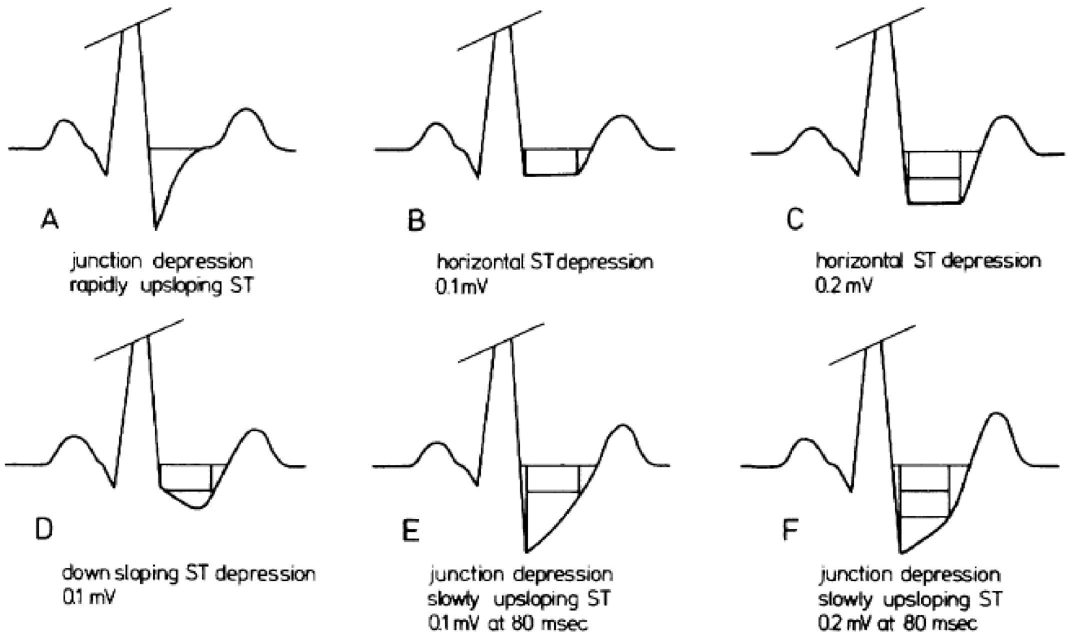
- PQ point=isoelectric point
- J point depression of > 0,1mV abnormal
- ST80 more than 1mm depressed if Heart Rate more than 130 ST60
- Horizontal or down sloping ST segments thus 0,7-1mV/sec
- 3 consecutive beats non computer rhythm,
- ST segment is depressed at rest additional 1mm ST depression
  - If more than 1mm depressed at rest less specific ? Imaging



ST segment depression

Types

- J Point depression
- Horizontal or downsloping ST segments
- May persist during rest
- 10% of patients only have ischeamic changes during recovery phase



Circulation: Vol 61, no4 p671-678

Upsloping ST segment displacement

J point depression maybe normal

But

- ST 80 < 1,5mV depressed
- Slope should be more than 1mV/sec

Slow upsloping

- Indicative of fixed obstruction

Causes of false positive ST depression

Aneamia

Digitalis

Cardiomyopathy

Glucose load

Hypokaleamia

Hyperventilation

LVH

Sudden excessive exercise

Inter Ventricular Conduction Defects

Mitral valve prolapse

Pre excitation

Aortic stenosis

Severe hypertension

Severe Volume overload

SVT

ST segment elevation

J Point elevation of more than 1mV in 3 consecutive beats

Infarct territory with Q waves

- Frequent in Anterior infarctions
- In Q wave leads not indicative of worsening ischeamia

Non infarcted territory with nonQ waves

- Indicator of transmural ischeamia
- Vasospasm or critical narrowing

T wave changes

Non specific

May indicate ischaemia if pseudo normalization occurs

Needs validation by more specific methods

Computerized Assessment

Medians obtained

Calculate

- J point
- ST segment slope
- ST60-80

Medians may be inaccurate due to signal distortion

ST/Heart rate slope assessment

- Improves sensitivity
- Exceeding 2,4mv/beats/minute
- >6mV/beats/minute

Other important observations

Blood pressure

- Fall in BP
- Exaggerated response

Maximal work capacity

- Risk of death decreased by 13% for each MET increase in work capacity
- Need to perform at least to 85-95% to test cardiac reserve

Heart rate response

- Failure to increase appropriately associated with a poorer prognosis
- Inability to increase HR to 85%
- Heart rate reserve (HRpeak-HRrest)/(220-age-HRrest)

Heart rate recovery

- Slow deceleration of heart rate
- HRR=HRpeak-HR1minute
- <18beats/min

Rate pressure product

- Normal 20-35mmHg/beats/minute

Chest discomfort

Parameters associated with a poor prognosis

Duration of symptom limiting exercise less than 5 Mets

Failure to increase Systolic BP to 120 or sustained decrease of BP >10mmHg of baseline rest levels

ST segment depression of more than 2mm, downsloping segments, starting at less than 5 METS, involving >5 leads, lasting 5 min into rest

Exercise induced ST elevation

Angina Pectoris at low workload

Reproducible sustained VT

Duke Treadmill score

- -11

Asymptomatic patients

If abnormal stress test 9x greater risk over next 5 years

Selection should be based on risk profiles

Serial change from normal to abnormal have the same importance as initial abnormal test

20-30% of asymptomatic women will have an abnormal test

Dysrhythmia in stress ECG

Ventricular ectopy 0-5%, not associated with poor outcome in asymptomatic patients

Prognostic value in known IHD low

Ventricular ectopy in rest have a higher associated mortality

Exercise testing provokes VT in most patients with history of VT

RBBB ectopy has worse prognosis than LBBB

SVT not dx for IHD and has no prognostic implications

AV block: Helps determining the need for a pacemaker

Development of LBBB increase risk of death 3x

RBBB commonly has ST depression in V1-V4

WPW invalidates the use of ST segment analysis

Safety of exercise testing

Mortality is less than 0.01%

Morbicdity is less than 0.05%

In population with VT risk 2,2% for sustained symptomatic VT

Resuscitation equipment and defibrillator should be available

Conclusion

Stress ECG is economic and safe to perform

Diagnostic value

Prognostic value

May be used in other settings than ischeamic heart disease

Specific clinical applications

Influence of drugs

Women

- Decreased diagnostic accuracy
- Higher sympathetic discharge during exercise
- Integrate all data
  - Exercise capacity
  - HR and BP changes
  - Consider imaging
- Hypertension
  - Peak systolic Bp > 214mmHg
  - Increased Sys/Diast BP at 3 minute of rest
  - High likelihood of developing HPT