Tailoring Cardiac stress testing. When and how to use Exercise, Vasodilators and Inotropes.

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Provocative Stress Tests

Pharmacological

Atropine
The right test for a specific Pt
49% of vasodilators + exercise

58% of vasodilators + exercise

Exercise 47%

Exercise 43%

SR Underwood
ECNC Survey

2005

2007
Test Temporal Trend

N= 1550/1600 pts/yr
Choice of a provocative Test

Please consider:

• Clinical Instability
  • CHF
  • Concomitant endocarditis or pericarditis
• Recent MI (<4 days)
• Left main disease
• Recent history of malignant arrhythmias
• Severe obstruction of LV outflow tract
• Severe hypertension
• Aortic Dissection
• Severe systemic diseases
• Aortic stenosis or moderate severe mitral stenosis
Consider Rest EKG

1) PM
2) LBBB
3) Repolarization abnormalities

NO

Unable to exercise, Neurological- Orthopedic limitations

NO

Pharmacological Stress Test

yes

NO

yes
Diagnostic Accuracy of Exercise $^{201}$Tl SPECT in Patients with Conduction Abnormalities

Specificity

Tawarahara et al, Am J Cardiol 1992

- Normals: 94%
- RBBB: 86%
- RBBB+LFB: 50%
- RV Pacing: 44%
- LBBB: 30%
Stress Perfusion Scintigraphy in LBBB: “False Positive” Septal Defects

Vaduganathan, JACC 1996;28:543

- Exercise (n.206)
- Adenosine (n.127)
- Dobutamine (n.50)

$p < 0.001$

46% 11% 8%
Is the pt able to exercise >85% PMHR?

NO
1) Hypertension
2) Beta-blockers
3) Anti-arrhythm. 
4) Anamnesis
5) COPD

NO

Valutazione ECG di base
1) PM
2) BB Sin
3) Alterata ripolarizzazione

NO

Test Farmacologico

Is the pt able to exercise >85% PMHR?

Ergomethry

yes
Submaximal stress test diagnostic implications

Iskandrian, 1989
Pharmacological Test

I° Choice: Vasodilators
1) Adenosin
2) Dipyridamole
3) (A2a-selective agonists)

CONSIDER

Absolute Contraindications:
- Asthma
- AVB II°, sick sinus syndrome
- Systolic Pressure < 90 mmHg

Relative Contraindications:
- Xantines Absumptions in the last 12 hours
- I° AVB
- Sinus Bradicardia (< 40 bpm)

TEST

NO

yes
Consider

Emodynamically significat LV outflow tract obstruction

Moderate-severe aortic stenosis

Atrial Tachyarrhythmia with uncontrolled ventricular response

History of ventricular tachicardia

Uncontrolled hypertension by drugs

Aortic dissection or aortic aneurism

Beta blockers therapy

**1° Choice: Vasodilators**

1) Adenosin
2) Dipiridamol
3) (A2a-selective agonists)

**2° Choice**

Dobutamine

TEST

NO

yes

NO

yes
Pharmacological Test

1st Choice: Vasodilators
1) Adenosin
2) Dipindamol
3) (A2a-selective agonists)

CONSIDER

Absolute Contraindications:
- Asthma
- AVB II, sick sinus syndrome
- Systolic Pressure < 90 mmHg

Relative Contraindications:
- Xerostomia
- Absorptions in the last 12 h
- 1st AVB
- Sinus Bradycardia (< 40 bpm)

Emodynamically significant LV tract obstruction

Modify medication regimen

Evaluate again physical exercise stress test option

2nd Choice: Dobutamine

if NO

TEST

if YES

Evaluate again physical exercise stress test option

Postpone evaluation
Strenght of exercise stress test

More physiological

Additional information:

Exercise tolerance

Haemodynamic (BP, chronotropic modulation, etc.)

Arrhythmias

Symptoms
Exercise Stress Test

Submaximal test

Stop exercise
Reevaluate pharmacological stress test

Atropine
Atropine Administration in Stress Testing

From 1997:

- Atropine in 37% (0.5 mg):
  - 38.6% exercise tests (MPHR 72%→85%)
  - 36.1% pharmacological tests (MPHR 63%→78%)
- # Exercise tests: from 31% (1996) to 57% (2008)
- Significant Side effects: 7 pts
  - 2 urinary retention
  - 4 high HR response in AF
  - 1 PSVT
Atropine (0.5-1 mg iv) Augmentation in Exercise Sestamibi SPECT

Max age-pred. HR

Exercise

Exercise + Atropine

p <0.01
Atropine in Patients with Submaximal Exercise Test

De Lorenzo et al; JNC 2003

47/717 (7%) patients with <85% MPHR
Atropine 0.6-1.2 mg
P<0.001

P<0.001

![Graph showing HR and MPHR before and after atropine administration](graph.png)
Contraindications to atropine

- Glaucoma
- Obstructive Uropathy, prostatic hypertrophy
- Atrial fibrillation with uncontrolled HR
- Previous adverse reaction
- Driving precaution
A difficult Pt…. Pt with COPD

Limited exercise tolerance…….. But:

Limited possibilities for pharmacological stress test:

- Asthmatic Component → adenosine/dypiridamole
- Arrhythmias → dobutamine
- Teophilline derivatives → adenosine/dypiridamole
- B2-agonist → dobutamine

Consider Exercise stress Test
Er+Atropine
(O2 support)
Diagnostic Accuracy of MPI

Leppo, J Nucl Cardiol 1996
Biokynetic of Tallium-201 after stress in normals
Stress Tests

- Dypiridamole
- Exercise
- Adenosine
- Atropine
- Dobutamine
Limitations of Vasodilator Stress Testing

- Increased Splanchnic Uptake of Tracer
- Unable to Evaluate the Efficacy of Medications
- Lack of Exercise Data
- Side Effects
Symptoms Associated with Adenosine/Dipyridamole Infusion

- Vasodilation
- Flushing
- Headache
- Nausea
- Dizziness
- Activation of Peripheral Respiratory Centers
- Dyspnea
- Activation of Nociceptors
- Chest Pain (without ischemia)
Adenosine and Noncardiac Symptoms
Effects of Combined Exercise

Pennel et al, JACC 1995
Association of Exercise Reduces Adenosine/Dipyridamole Side Effects

- Hemodynamic response to exercise reverse hypotension and vasodilation
- Catecholamine drive reduces splanchnic, cerebral and skin vasodilation
- Psychologic component
Combined Test
Extent of Ischemia

Candell-Riera et al, JACC 1997

Pennel et al, JACC 1995
Association of Exercise to Adenosine Stimulation Improves Images Quality

Pennel et al, JACC 1995
Combined Test  
Exercise+Ado/dip

1) No physical limitation to exercise
2) No contraindications to ergometry
3) No contraindications to Ado/dip
Intracenter Experience
The Physician Performing the Stress Test

Main Subspeciality

Operator A  Echography
Operator B  Clinical/General Cardiologist
Operator C  Exercise/functional Evaluation
Operator D  Dedicated Nuclear Cardiologist
Take home messages:

- MPI combined with Exercise stress test is still the 1° choice procedure.
- When Exercise stress test cannot be adequately performed, Pharmacological testing is an useful alternative with good sensitivity and Specificity.
- The choice of the test must be tailored according to pt needs and characteristics.
- Hybrid tests should be considered.
Thanks!