ΕΠΑΝΑΓΓΕΙΟΣΗ ΣΕ ΠΟΛΥΑΓΓΕΙΑΚΟ
ΑΣΘΕΝΗ ΜΕ ΣΟΒΑΡΗ ΚΑΡΔΙΑΚΗ
ΑΝΕΠΑΡΚΕΙΑ

ΘΕΛΩ ΠΑΝΤΑ ΔΟΚΙΜΑΣΙΑ
ΒΙΩΣΙΜΟΤΗΤΑΣ !!

Δημήτρης Τσιάπρας  MD FESC

Ωνάσειο Καρδιοχειρουργικό Κέντρο
Prognostic significance of ischemic cardiomyopathy

>1200 patients with invasive evaluation for cardiomyopathy over 15 years

Ischemic etiology is also an independent predictor of mortality in risk models:

Seattle Heart Failure Model (SHFM)

Heart Failure Survival Score (HFSS)


Levy et al, Circulation 2006
ΙΑΤΡΙΚΗ ΒΟΗΘΕΙΑ ΕΠΙ ΖΩΝΤΩΝ & ΤΕΘΝΕΟΤΩΝ?
In medically treated pts with severe global LV dysfunction early after AMI, the presence of myocardial viability identified as inotropic reserve after LDDSE is associated with a higher probability of survival.

Picano et al Circ 1998;98:1078
Hybernation

Stunning

SCAR
ΒΙΩΣΙΜΟΤΗΤΑ ΜΥΟΚΑΡΔΙΟΥ?

- ΑΚΕΡΑΙΟΤΗΤΑ ΜΕΜΒΡΑΝΗΣ
- ΑΚΕΡΑΙΟΤΗΤΑ ΑΡΔΕΥΣΗΣ
- ΛΕΙΤΟΥΡΓΙΚΟΤΗΤΑ ΚΑΙ ΕΦΕΔΡΕΙΑ ΜΥΟΚΑΡΔΙΑΚΟΥ ΙΣΤΟΥ
ΜΕΘΟΔΟΙ ΑΝΙΧΝΕΥΣΗΣ ΒΙΩΣΙΜΟΤΗΤΑΣ

ΜΥΟΚΑΡΔΙΑΚΗ ΑΡΔΕΥΣΗ

PET (NH3)
Myocardial Contrast Echo

ΜΕΤΑΒΟΛΙΚΗ ΔΡΑΣΤΗΡΙΟΤΗΤΑ
Fluorodeoxyglucose (FDG)

ΑΚΕΡΑΙΟΤΗΤΑ ΚΥΤΤΑΡΙΚΗΣ ΜΕΜΒΡΑΝΗΣ
Thallium 201
Technetium 99

ΑΠΕΙΚΟΝΙΣΗ - ΤΑΥΤΟΠΟΙΗΣΗ ΟΥΛΗΣ
CMR - Late enhancement

ΛΕΙΤΟΥΡΓΙΚΗ ΕΦΕΔΡΕΙΑ
Stress Echo
Stress MRI
ΜΥΟΚΑΡΔΙΑΚΗ ΒΙΩΣΙΜΟΤΗΤΑ & ΣΥΣΤΟΛΙΚΗ ΠΑΧΥΝΣΗ
Viability Evaluation: Rest Echocardiography

Parietal Thickness

J M Cwajg et al.
JACC 2000; 35:1152-61

Zaglavara T et al.
Heart 2005; 91:613-17

Thrombus

D A Cusick et al.
Echocardiography 2000; 17:547-54

Extent of LV remodeling

A Pasquet et al.
VIABILITY INTERROGATION

LV Dysfunction

LV Wall Thickness In Area of Dysfunction

Echo

Wall Thickness $\leq 5-6$ mm
(Probability of improvement of LV function $<5\%$)

Wall Thickness $>5-6$ mm
(Probability of improvement of LV function $\geq 50\%$)

LDDE and SPECT

Viable

Not viable

Viable

Revascularization

No Revascularization

Revascularization

JACC Cardiovasc Imaging. 2008
ΒΙΩΣΙΜΟΤΗΤΑ
ΑΠΟΚΑΤΑΣΤΑΣΗ ΜΥΟΚΑΡΔΙΑΚΗΣ
ΣΥΣΤΟΛΙΚΗΣ ΠΑΧΥΝΣΗΣ

Χρόνια Ισχαιμική Μυοκαρδιοπάθεια
Διαγνωστικό Πρωτόκολλο Dobutamine

Πρώτη επιλογή για την ανίχνευση βιωσιμότητος του μυοκαρδίου (ischemic cardiomyopathy) και της εκτίμησης της συστολικής εφεδρείας (contractile reserve)

DOBUTAMINE- ATROPINE

![Graph of Dobutamine and Atropine dosages over time.](image)
- Improved Contractility in 4/16 segments
- LV wall thickness > 6 mm
- Post Systolic Thickening
- GLS rest > 5%, Radial Strain > 17%
• ΒΙΩΣΙΜΟΤΗΤΑ:
  - Βελτίωση συστολικής πάχυνσης και κινητικότητος (inotropic reserve)
  - Διφασική απάντηση (καλύτερος προγνωστικός παράγοντας ανάνηψης)

• ΜΗΧΑΝΙΣΜΟΙ ΒΕΛΤΙΩΣΗΣ
  - Διέγερση β υποδοχέων
  - Περιφερική αγγειοδιαστολή
  - Αύξηση μυοκαρδιακής αιμάτωσης

HEART FAILURE POST MI - 3V CAD

BIPHASIC RESPONSE INFERIOR SCAR ANTERIOR VIABILITY + ISCHEMIA
LEFT VENTRICULAR SYSTOLIC RESERVE
SEGMENTAL MYOCARDIAL SYSTOLIC RESERVE
LEFT VENTRICULAR REMODELING
The greater improvement in EF is observed in patients with dysfunctional but viable LV segments. Patients with small ESV and viable myocardium have the best prognosis.

Shortening of the LAD flow diastolic PHT in patients with reperfused anterior MI reflects scarred myocardial tissue in the anteroapical wall


Figure 2 Receiver operating characteristic curve of PHT of diastolic LAD flow. PHT value of 265 ms depicted group A patients with 79% sensitivity and 94% specificity.
**Strengths:**
- Simultaneous LV function and myocardial perfusion assessment
- Improved image resolution (over SPECT)
- Cost economy, portability
- Viability detection: Sn: 89%

**Limitations:**
- Lower Sp: 51%
- Artifacts

0 : Ελλειψη σκιαγράφησης
0,5 : Τμηματική σκιαγράφηση
1 : Πλήρης και ομογενής

HARMONIC TRIGGERING MODE
QUANTITATIVE STRESS ECHO BY STRAIN IMAGING

Strain-Rate Imaging

a) echo / scintigraphy

b) strain rate [s⁻¹]

c) strain [%]

d) ECG

Voigt J-U et al, Circulation 2003
FDG uptake in >2 vascular territories & scar<40% of LV
Improved perfusion >20 of LV
< 50% Hyperenhancement / per segment
ΣΥΓΚΡΙΣΗ ΑΝΑΙΜΑΚΤΩΝ ΜΕΘΟΔΩΝ ΕΚΤΙΜΗΣΗΣ ΒΙΩΣΙΜΟΤΗΤΑΣ

PROGNOSTIC ROLE OF VIABILITY ASSESSMENT POST MI

PROGNOSTIC ROLE OF VIABILITY ASSESSMENT POST MI AND PRIMARY PCI

MYOCARDIAL VIABILITY TESTING & IMPACT OF REVASCULARIZATION ON PROGNOSIS IN PTS WITH CAD & LV DYSFUNCTION: A META-ANALYSIS

MYOCARDIAL VIABILITY TESTING & IMPACT OF REVASCULARIZATION ON PROGNOSIS IN PTS WITH CAD & LV DYSFUNCTION: A META-ANALYSIS

65.1% reduction in mortality for patients with viable myocardium treated by revascularization.

No relevant prognostic difference between the two therapeutic strategies for patients without viability.

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Class</th>
<th>Level</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>CABG is recommended for patients with significant LM stenosis and LM equivalent</td>
<td>I</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>with proximal stenosis of both LAD and LCx arteries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CABG is recommended for patients with significant LAD artery stenosis and</td>
<td>I</td>
<td>B</td>
<td>112,288</td>
</tr>
<tr>
<td>multivessel disease to reduce death and hospitalization for cardiovascular</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>causes.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV aneurysmectomy during CABG should be considered in patients with a large</td>
<td>IIa</td>
<td>C</td>
<td>55</td>
</tr>
<tr>
<td>LV aneurysm, if there is a risk of rupture, large thrombus formation or the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aneurysm is the origin of arrhythmias.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myocardial revascularization should be considered in the presence of viable</td>
<td>IIa</td>
<td>B</td>
<td>55</td>
</tr>
<tr>
<td>myocardium.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2014 ESC/EACTS Guidelines on myocardial revascularization

Eur Heart J 2014: 35, 2541–2619
Myocardial contractile reserve is more often associated with response to therapy, whereas dyssynchrony criteria are equally distributed in the two groups.

EVALUATION FOR VIABILITY AND SCAR TISSUE FOR CRT 6 MONTHS OUTCOME

Bleeker et al Circulation. 2006
Myocardial Viability and Survival in Ischemic Left Ventricular Dysfunction

Robert O. Bonow, MD

On behalf of the STICH Trial Investigators
Patients randomized in STICH Revascularization Hypothesis

1212

SPECT n=471

Dobutamine echo n=280

321 150 130

Patients with usable myocardial viability test

601

Patients with no usable myocardial viability test

114 Nonviable

487 Viable

Patients with usable myocardial viability test
Myocardial Viability and Mortality

Variables associated with mortality

<table>
<thead>
<tr>
<th></th>
<th>Chi-square</th>
<th>p</th>
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<tbody>
<tr>
<td>Risk score</td>
<td>33.26</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LV ejection fraction</td>
<td>24.80</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LV EDVI</td>
<td>35.36</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LV ESVI</td>
<td>33.90</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Myocardial viability</td>
<td>8.54</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Myocardial Viability and Mortality

- **Without viability**
  - 114 at 0 years
  - 99 at 1 year
  - 85 at 2 years
  - 80 at 3 years
  - 63 at 4 years
  - 36 at 5 years
  - 16 at 6 years

- **With viability**
  - 487 at 0 years
  - 432 at 1 year
  - 409 at 2 years
  - 371 at 3 years
  - 294 at 4 years
  - 188 at 5 years
  - 102 at 6 years

HR 0.64, 95% CI 0.48, 0.86, P 0.003
Myocardial Viability and Mortality + CV Hospitalization

- **Without viability**: 0.59 (0.47, 0.74) p = 0.001
- **With viability**: 0.63

<table>
<thead>
<tr>
<th>Years from Randomization</th>
<th>Univariate</th>
<th>Multivariable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chi-square</td>
<td>p value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>20.27</td>
<td>&lt;0.001</td>
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<tr>
<td>5</td>
<td>8.60</td>
<td>0.003</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Without viability</th>
<th>114</th>
<th>56</th>
<th>41</th>
<th>34</th>
<th>22</th>
<th>14</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>With viability</td>
<td>487</td>
<td>327</td>
<td>284</td>
<td>238</td>
<td>166</td>
<td>94</td>
<td>41</td>
</tr>
</tbody>
</table>
Myocardial Viability and Mortality

Without Viability

- **MED** (33 deaths)
- **CABG** (25 deaths)

With Viability

- **MED** (95 deaths)
- **CABG** (83 deaths)

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>N</th>
<th>Deaths</th>
<th>HR</th>
<th>95% CI</th>
<th>Interaction P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without viability</td>
<td>114</td>
<td>58</td>
<td>0.70</td>
<td>0.41, 1.18</td>
<td>0.528</td>
</tr>
<tr>
<td>With viability</td>
<td>487</td>
<td>178</td>
<td>0.86</td>
<td>0.64, 1.16</td>
<td></td>
</tr>
</tbody>
</table>
... Η ΣΤΡΑΒΟΣ ΕΙΝΑΙ Ο ΓΙΑΛΟΣ...
Η ΣΤΡΑΒΑ ΑΡΜΕΝΙΖΟΥΜΕ !!!
STICH Viability Hypothesis

In patients with CAD and LV dysfunction, assessment of myocardial viability does not identify patients who will have the greatest survival benefit from adding CABG to aggressive medical therapy.
Coronary Artery Bypass Graft Surgery in Patients with Ischemic Heart Failure

Eric J. Velazquez, MD on behalf of the STICH Investigators
April 4, 2011
All-Cause Mortality — As Randomized

HR 0.86 (0.72, 1.04)
P = 0.123

Adjusted HR 0.82 (0.68, 0.99)
Adjusted P = 0.039
Coronary-Artery Bypass Surgery in Patients with Ischemic Cardiomyopathy

Death from Any Cause (Primary Outcome)

- Hazard ratio, 0.84 (95% CI, 0.73–0.97)
- P=0.02 by log-rank test

Medical therapy
CABG

Years since Randomization

Death from Cardiovascular Causes

- Hazard ratio, 0.79 (95% CI, 0.66–0.93)
- P=0.006 by log-rank test

Medical therapy
CABG

Death from Any Cause or Cardiovascular Hospitalization

- Hazard ratio, 0.72 (95% CI, 0.64–0.82)
- P<0.001 by log-rank test

Medical therapy
CABG

Years since Randomization
High adherence to guideline-directed medical therapy and lower mortality in patients receiving medical therapy alone (about 7% per year).

The prospective randomized nature of study may have eliminated selection bias.

Different thresholds used in the definition of viability between SPECT and DSE.

Significant crossover between the treatment arms.

Moreover, the STICH viability trial was merely a sub-study that was not powered to detect a difference between the two groups and the use of viability testing was not randomized.
A conservative management strategy may not be inferior to one of coronary arteriography with the intent to revascularize in patients with heart failure, LV systolic dysfunction, and extensive myocardial viability.
BENEFIT FROM REVASCULARIZATION IS ASSOCIATED WITH INCREASING AMOUNTS OF MYOCARDIAL HIBERNATION

Long-Term Follow-Up of Outcomes With F-18-Fluorodeoxyglucose Positron Emission Tomography Imaging—Assisted Management of Patients With Severe Left Ventricular Dysfunction Secondary to Coronary Disease

The lessons learned from clinical trials on imaging such as that given by the STICH is that we cannot rely on one single parameter.

There is no convincing evidence that the assessment of myocardial viability should not be included in the work-up of the chronic dysfunctioning patient, at least not on the basis of the STICH trial.

The currently accepted appropriate (and less appropriate) indications for clinically driven testing of myocardial viability are to remain unchanged, at least for the time being.

- Mack MJ. Nat Rev Cardiol 2011;8:427–8
- American College of Cardiology Foundation Appropriate Use Criteria Task Force J Am Soc Echo 2011;24:229
Patient with left ventricular (LV) dysfunction

Myocardial viability imaging

Viable myocardium:
The muscular wall of the heart, does not contract normally at rest but has the potential to recover its function

- Positron emission tomography (PET)
  Assess myocardial perfusion and metabolism
- Single-photon emission computed tomography (SPECT)
  Estimate resting perfusion, stress-induced ischemia, scarring and cardiac function
- Echocardiography
  Assess cardiac size, shape, wall thickness and wall motion
- Cardiac MRI
  Assess myocardial scarring as evidence of nonviable tissue

Does patient have viable myocardium?

Revascularization improves outcomes, cardiac function and functional class

Mortality increases with OMT alone

Revascularization does not predict better outcomes than optimal medical therapy (OMT) alone

Patients with severe LV dysfunction benefit most from revascularization; a high peri-procedural risk must be balanced against late mortality benefit.
MYOCARDIAL VIABILITY-STATE OF THE HEART: IS IT STILL RELEVANT AND HOW TO BEST ASSESS IT WITH IMAGING?

TRENDS IN CARDIOVASCULAR MEDICINE 2018; 28: 24 – 37
IS THERE A CLEAR ANSWER???

YES !!

NO !!

VIABILITY IMAGING
Prognostic Value !!
Therapeutic Guiding tool !!
ΠΑΡΑΚΛΗΣΗ ΓΙΑ ΧΕΙΡΟΥΡΓΙΚΗ ΕΠΑΝΑΙΜΑΤΩΣΗ!!