Coronary Revascularization for Severe LV Dysfunction

Is the concept of viability testing still viable?

Banff 2017
Prognosis of Patients With LV Dysfunction and CAD

Major determinants

- Pt with CAD
  - Severity of LV dysfunction

- Pt with LV dysfunction
  - Severity of CAD/ischemia

Results of revascularization – a paradox

- Periprocedural risk
- Late mortality
Survival in Patients with LV Dysfunction (CASS Randomized Trial)*

Overall trial results were neutral

Passamani: NEJM, 1985
**STICH Trial – 10-Year Outcomes**

1,212 Pts (EF ≤0.35)

**Death from Any Cause (Primary Outcome)**

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

**Death from Cardiovascular Causes**

- Hazard ratio, 0.79 (95% CI, 0.66-0.93)
- \(P=0.005\) by log-rank test

**Death from Any Cause or Cardiovascular Hospitalization**

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

**NNT – 14**

*Velasquez: NEJM, 2016*
Mechanisms of Improved Prognosis Following Revascularization – ?

Potential benefits

↑ in resting LVEF
Recovery in regional function

Prevention of ventricular arrhythmias

↓ Inducible ischemia and repetitive stunning

↓ Ventricular remodeling

↓ Diastolic dysfunction

↓ Symptoms of CHF

? Benefits independent of effects on ischemia & viability but prevention of recurrent events
Proportion of Patients without SCD – CASS Registry

Patients with CHF

2-Vessel Disease

Patients without sudden death (%)

P<0.0001

Medical

CABG

98%

83%

Years

Processed Medical

Processed CABG

P<0.0001

91%

69%

3-Vessel Disease

Patients without sudden death (%)

Years

Holmes: Circ, 1986
Definition of Viable Myocardium

Myocardium that is dysfunctional at rest and not scarred and has the potential for functional recovery

“Hibernation’ should be used retrospectively only to describe those segments which actually improve following revascularization

Shah: EHJ, 2013
Before Surgery – LVEF = 26%

Wall Motion (Continued)

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<tr>
<th>Baseline</th>
<th>Wall Motion Score Index</th>
<th>Anterior</th>
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Base
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After Surgery – LVEF = 45%

Wall Motion

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Viability and Prognosis in Patients with LV Dysfunction

Different Substrates

- Hibernation (resting ischemia)
- Repetitive stunning (inducible ischemia)
- Extent of scar
- Extent of remodeling
- Duration of hibernation

“How much is enough – not an all or none issue”

Need for combined imaging approaches to characterize substrates and reversibility
Quantity of Viable Myocardial Required to Improve Survival With Revascularization in Patients With Ischemic Cardiomyopathy

- 29 studies
- 4,167 patients
- Meta-analysis

<table>
<thead>
<tr>
<th>Method</th>
<th>% Viable/myocardium</th>
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<tbody>
<tr>
<td>PET</td>
<td>25.8</td>
</tr>
<tr>
<td>Stress Echo</td>
<td>35.9</td>
</tr>
<tr>
<td>SPECT</td>
<td>38.7</td>
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Optimal Threshold for Presence of Viability

Inaba: J NuclCardiol, 2010
Clinical Indications for Viability Testing

- Severe CAD and no history of MI
- Absent Q waves on ECG
- Significant angina or stress-induced ischemia
- “Flash” pulmonary edema with subsequent improvement
- Clinical EF?

Patients with CAD and severe LV dysfunction (EF ≤0.35)

Angiography
- Subtotal occlusions
- Collaterals
STICH – Myocardial Viability and Survival

601 pt – viability testing

Hazard ratio 0.64
95% CI 0.48-0.86
P=0.003

Without viability (114 pt)
With viability (487 pt)

Years since randomization
Probability of death

Bonow: NEJM, 2011
STICH – Myocardial Viability and Survival

<table>
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<th>Subgroup</th>
<th>No.</th>
<th>Deaths</th>
<th>HR (95% CI)</th>
<th>P</th>
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<tr>
<td>Without viability</td>
<td>114</td>
<td>58</td>
<td>0.70 (0.41-1.18)</td>
<td>NS</td>
</tr>
<tr>
<td>With viability</td>
<td>487</td>
<td>178</td>
<td>0.86 (0.64-1.16)</td>
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Bonow: NEJM, 2011
“If you are not confused by this – you are not thinking clearly.”

Pogo
STICH Viability Study

Limitations

- Study is underpowered
- Non-randomized – viability performed at physician discretion and unblinded
- Baseline differences between pt with/without viability testing – ↓ comorbidities

- Generalizability to contemporary population
  - ICD – 50%
  - CRT – 20%

- 85% of patients in substudy – non-USA

- 3 VD only present in approximately one third

- Viability determined in a binary fashion – PET and CMRI – greater accuracy and provide additional information

- Does not distinguish between dysfunctioning potentially viable myocardium and reversibility
Role of Viability Testing in Clinical Decision Making in Patients With LV Dysfunction

**Not Essential**
- Significant angina
- Good distal vessels
- ECG: No Q waves, Preserved voltage
- Reasonable surgical risk

**Potentially Helpful**
- Severe LV dysfunction
- Extensive LV remodeling
- Multiple comorbidities
- Incomplete revascularization is likely
- Angina – less severe
Inducible Myocardial Ischemia and Outcomes of Revascularization

- STICH Trial
- EF < 0.35

Stress testing
- Inducible ischemia 64%
- % ischemic myocardium (18±11%)

Panza: JACC, 2012
Impact of Ischemia and Scar on Therapeutic Benefit from Coronary Revascularization

- 13,969 pt
- Adenosine or exercise SPECT

Role of ischemia in pt with >10% fixed myocardial defect
- % ischemic myocardium = P=0.089
- Ischemia treatment interaction = P=0.489

Hachamovich: EHJ, 2011
Impact of Ischemia and Scar on Therapeutic Benefit from Coronary Revascularization

- 13,969 pt
- Adenosine or exercise SPECT

Role of ischemia on benefit of revascularization was nullified by presence of extensive infarction/scar

![Log hazard ratio vs. Total myocardium ischemic (%)](image)

- Medical therapy
- Early revascularization

Hachamovich: EHJ, 2011
Importance of Angina in Patients With Coronary Disease, Heart Failure, and Left Ventricular Systolic Dysfunction
Insights From STICH

Jolicouer et al

“Presence of angina does not confer markedly worse prognosis or a greater benefit from revascularization by CABG. But CABG does improve angina symptoms compared with medical therapy alone.”

Angina in Revascularization of Ischemic Cardiomyopathy
The Whole Quilt, or Just a STICH?*

Jeffrey B. Geske, MD, Bernard J. Gersh, MB, CnB, DPhilip.
Is There a Role for Viability and Ischemia Testing? Is the Concept Still Valid and Rational?

- STICH patients: No
- Other patient subgroups: Yes

• No effect of viability, inducible ischemia and angina on surgical outcomes
• ↑ remodeling with non-viability but no effect on surgical outcomes

Bonow: NEJM, 2011; Panza: JACC, 2012
Jolicouer: JACC, 2015; Bonow: JACC, 2015
In patients with LV dysfunction and CAD, are the presence of viability, inducible ischemia and angina still therapeutic targets?

**YES**

**Considerations**

- Viability and Ischemia
- Extent of scar and remodeling

What is the point of no return?
Role of Viability Testing

Conclusions

• May predict response to revascularization in **selected** pts with CAD and LV dysfunction

• Marker of prognosis

• May influence response to medical therapy

• Impact of viability and residual ischemia may be overwhelmed by extensive scar and remodeling.

• Should “not” be a routine determinant of decision to revascularize
“The reports of my death are greatly exaggerated.”

Text of a cable sent by Mark Twain from London to the press in the U.S. after his obituary had been mistakenly published.