Heart Failure in Coronary Artery Disease. Synchronizing the Optimal Medical and Surgical Treatment for the Best Outcome

The Surgical Ventricular Restoration is the optimal method

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Cardiac Surgeon
Metropolitan Hospital
Early stage of LV remodeling

- Fibrotic repair of the necrotic area
- Thinning of the infarcted zone
- LV volume increases
- Stroke volume augmentation in an attempt to maintain normal cardiac output as the EF decreases
Postinfarction LV remodelling

- Chamber dilatation
- Abnormal shape
- Systolic+ diastolic dysfunction
- Progressive heart failure syndrome
- Poor 3-year prognosis (NYHA class III-IV)

Diagram showing the phases of LV remodelling:

1. Normal
2. Necrosis MI
3. Slimming
4. Cicatrization Dilatation
5. Hypertrophy of sound myocardium Compensation
6. LV global dilatation
7. Phase III: progressive deterioration
Geometric/secondary Mitral regurgitation

• Annular enlargement
• Papillary muscle displacement
• Tenting of the mitral valve at closure leading to lack of proper coaptation
Transmural Infarct

Regional infarction of more than 30% of LV circumference → progressive dilatation of remote viable muscle → convert normal elliptical shape to a sphere

When ≥ 40% of muscle becomes nonfunctional the normal LVESVI of 25ml/m² → LVESVI>60ml/m²
Sub Endocardial Infarct

Partially necrosed scarred wall
Relative Death Risk Post MI

End Systolic Volume, mL

White HD. Circulation 1987
LVESVI and Congestive Heart Failure

GUSTO I

The propensity for CHF can be predicted by LVESVI measured 90 min after MI. A resting $LVESVI > 60 \text{ml/m}^2$ reflects a threshold likely to be associated with subsequent cardiac mortality.

Migrino RQ: Circulation 1997
A resting LVESVI >60ml/m² reflects a threshold likely to be associated with subsequent cardiac mortality.

Migrino RQ: *Circulation* 1997
LV Volume Predicts Postoperative Course in Patients with Ischemic Cardiomyopathy

- The larger the hearts are, in both diastolic and systolic dimensions, the poorer the predicted response will be to CABG.

- A preoperative LVESVI greater than 100 ml/m2 is an independent predictor of the development of postoperative CHF

CABG for Ischemic Cardiomyopathy

EF < 30%: 5 yr. outcome

Yamaguchi: *Ann Thorac Surg* 1998
SVR

- Patients with a severely dilated LV
  \[ \text{LVESVI} \geq 75 \text{ ml/m}^2 \]
  have a low likelihood of showing improvement in LVEF after revascularization, even in the presence of substantial viability.

LV geometry is destiny
The Rationale to SVR

- LV volume reduction with the exclusion of the asynergic scar
- The reshaping of the distorted chamber
- Improving in cardiac function through the reduction of the LV wall stress
- Combined with myocardial revascularization
- Combined with mitral repair or improvement of mitral function by reducing LV volumes or papillary muscle distance
- Combined with Endocardiectomy /cryotherapy when VT is detected or induced

Attack the triple V of heart failure
VESSEL -VALVE -VENTRICLE
SVR

Anterior-septal-apical Asynergy

Linear Closure
Mod.Linear Closure/septoplasty
EVCPP-Dor
SAVE
Menicanti
**SVR**

**Inferior LV asynergy**
- Longidutinal closure
- Triangular patch
- +/- MV procedure

**Lateral LV asynergy**
- Partial Left Venticulectomy (Batista)
- Apex-sparing Batista (Komeda)
SVR

Scar Resection and Linear closure  
Cooley 1958

Inverted –T closure modification  
Komeda - David
FIRST INTRODUCTION OF THE IDEA OF CIRCULAR CORRECTION
MODIFIED LINEAR CLOSURE WITH PATCH SEPTOPLASTY

Modified linear closure technique + patch septoplasty
Modified linear closure technique & patch septoplasty
Post- MI VSR
Post- MI VSR
Post- MI VSR
Post- MI VSR
Decision to pursue SVR Should be based on:

Viability studies
MRI Volumetric studies and

*Final inspection in the OR*
The Dor Ventriculoplasty

The Fontan stitch
The Dor Ventriculoplasty

CIRCULAR PATCH
when the diameter of the LV defect after the Fontan - suture ≥ 3cm
The Dor Ventriculoplasty

- MI in the antero-septal wall
- Enlarged LVEDVI
  - 100-180 ml/m²
  - EDD ≥6cm
- Asynergy of ≥35%
- Good lateral wall motion
- Good basal wall
- Good RV function
The Dor Ventriculoplasty
Linear suture?
Diastolic volume of 50-60ml/m²
The Menicanti Procedure

- To achieve an elliptical shape in the LV post – SVR
- Creation of a new apex
- Oblique orientation of the patch
Imbricating suture method

Creation of new apex
Narrowing of inter-papillary distance
(when Inter-PPM distance is >3cm)

Inferior reconstruction from inside in multi-MI patients
SAVE operation

SAVE: Septal Anterior Ventricular Exclusion
SAVE operation

pacopexy
INFERIOR WALL RESTORATION
INFERIOR WALL RESTORATION

TRIANGULAR PATCH FOR SEPTAL, BASAL AND LATERAL WALL
Apex-sparing Batista
Komeda and associates
Conclusions

- The STICH trial definitively shows adding SVR to CABG provides no clinical benefit beyond that of CABG alone in the study population.
- Both operative strategies provided similar short- and long-term relief of angina and HF and improvement in 6-minute walk test performance.
Conclusion

• Adding surgical ventricular reconstruction to CABG reduced the left ventricular volume, as compared with CABG alone

• However, this anatomical change was not associated with a greater improvement in symptoms or exercise tolerance or with a reduction in the rate of death or hospitalization for cardiac causes
STICH-hypothesis 2

• The CABG+SVR resulted in a 16ml/m² (19%) reduction in LVESVI, larger than in the CABG-only group, but smaller than in previously reported observation studies.

• This observation raises concerns about the extent of the SVR procedure that was applied in this RCT.
STICH-hypothesis 2

• Experienced surgeons decided to enroll pts for whom they recognized that SVR would prove unnecessary but offered the procedure directly, instead of enrollment in the trial to all pts for whom they were confident the procedure would be beneficial.

• The STICH study did not include a registry arm for SVR-eligible pts who were not randomized.
Patients eligible but not randomized into STICH

• SVR procedure: single center comparison of surgical treatment of ischemic heart failure (STICH) versus (non-STICH) patients

• The NSSVR GROUP
  - had more anterior wall asynergy (60% vs 45%),
  - larger preoperative heart volumes (LVESVI 108ml/m(2) vs 69%ml/m(2))
  - larger volume reductions (34% vs 11%)

• Conclusion: the STICH study may not have included pts most likely to benefit from SVR

Goh S, et al. University of Melbourne, Australia
Ann Thorac Surg 2013 Feb; 95(2):505-12
Favorable effects of left ventricular reconstruction in patients excluded from the Surgical Treatments for Ischemic Heart Failure (STICH) trial

Vincent Dor, MD, Filippo Civaia, MD, Clara Alexandrescu, MD, Michel Sabatier, MD, and Françoise Montiglio, MD

Objective: We sought to examine the hemodynamic effects at 1 month and 1 year of left ventricular reconstruction by means of endoventricular patch plasty for patients with acute or chronic, very severe post-myocardial infarction heart failure who would have been systematically excluded from the Surgical Treatments for Ischemic Heart Failure (STICH) trial.

Methods: From 2002 to May 2008, 274 patients underwent left ventricular reconstruction for post-myocardial infarction scarring; 117 of these patients would not have been eligible for the STICH trial. The pertinent criteria for exclusion included 12 patients with no coronary vessel suitable for coronary artery bypass grafting; 17 patients within a month of myocardial infarction, including 11 with acute heart failure (8 septal ruptures and 3 cases of ventricular tachycardia); 48 patients receiving intravenous inotropes, intra-aortic balloon pumping, or both; 15 patients with bifocal or posterior scarring; 4 patients scheduled for heart transplantation; and 21 patients meeting 5 other exclusion criteria. These patients (mean age, 64 years; age range, 34–83 years) preoperatively had a mean 49% (range, 35%–75%) scarred left ventricular circumference, as determined by means of magnetic resonance imaging assessment. In the patients with chronic heart failure, the preoperative ejection fraction was 26% ± 4% (range, 9%–34%), the end-diastolic volume index was 130 ± 43 mL/m² (range, 62–343 mL/m²), and the end-systolic volume index was 95 ± 37 mL/m² (range, 45–289 mL/m²). Mitrval regurgitation was mild to severe in 56 patients and associated with annular dilatation (&gt;35 mm) in 51 patients. A strategy of left ventricular reconstruction by means of endoventricular circular suturing and patching excluded the scarred left ventricular wall and was balloon sized to provide a diastolic volume of 50 mL/m². Circular patches were used for anteroseptal apical lesions, and triangular patches were used for posterior lesions. The mitral valve was repaired in 51 patients, and coronary revascularization was performed in 105 patients (arterial grafts in 95 and mixed in 12). Seventy-eight patients had endocardectomy, and cryotherapy was used in 39 patients for ventricular tachycardia.

Results: Four in-hospital and 2 delayed deaths occurred during the first year. In 101 patients with chronic heart failure, magnetic resonance imaging revealed that ejection fraction improved from 26% ± 4% preoperatively to 40% ± 8% at 1 month and 44% ± 11% at 1 year postoperatively. At these same time points, the end-diastolic volume index was reduced from 130 ± 43 mL/m² to 81 ± 27 and 82 ± 25 mL/m², respectively, and the end-systolic volume index was reduced from 96 ± 45 mL/m² to 50 ± 21 and 47 ± 20 mL/m², respectively.

Conclusions: With minimal associated mortality, left ventricular reconstruction produces durable improvement in left ventricular function in patients with a large scarred ventricular wall. Considering that this patient cohort would have been systematically excluded from the STICH trial, care should be taken not to extrapolate that study’s results too widely so as to inappropriately deny selected patients an effective treatment for ischemic cardiomyopathies with an injured ventricle. (J Thorac Cardiovasc Surg 2011;141:905-16)
Surgical Ventricular Restoration for Patients With Ischemic Heart Failure: Determinants of Two-Year Survival

Tomasz G. Witkowski, MD, Ellen A. ten Brinke, MD, Victoria Delgado, MD, Arnold C.T. Ng, MBBS, Matteo Bertini, MD, Nina Ajmone Marsan, MD, See H. Ewe, MBBS, Dominique Auger, MD, Kelvin H. Yiu, MBBS, Jerry Braun, MD, Patrick Klein, MD, Paul Steendijk, MD, PhD, Michel I.M. Versteegh, MD, Robert J. Klautz, MD, PhD, and Jeroen J. Bax, MD, PhD

Departments of Cardiology and Cardiothoracic Surgery, Leiden University Medical Center, Leiden, The Netherlands

Background. Surgical ventricular restoration (SVR) improves left ventricular (LV) systolic function by partially restoring the normal geometry of the left ventricle. However, the beneficial effects of this surgical procedure on long-term clinical outcome remain controversial. The present study aimed to evaluate the independent determinants of 2-year morbidity and mortality rates after SVR.

Methods. Seventy-nine patients with ischemic heart disease and LV ejection fraction of 0.35 or less were included. All patients underwent SVR and additionally coronary artery bypass grafting or mitral valve surgery if clinically indicated. Clinical and echocardiographic examination was performed before SVR and at 6 months’ follow-up. The primary end point was a composite of all-cause mortality and hospitalizations for heart failure.

Results. At 6 months’ follow-up a significant improvement in heart failure symptoms was noted. In addition, LV ejection fraction increased from 0.27 ± 0.07 to 0.36 ± 0.10 (p < 0.001). During a median follow-up of 2.7 years, the primary end point was recorded in 22% of the patients. Baseline New York Heart Association functional class IV and a 6-month follow-up LV end-systolic volume index of at least 60 mL/m² were independently associated with worse outcome (hazard ratio, 5.4; 95% confidence interval, 1.9 to 15.2; p < 0.001; hazard ratio, 2.7; 95% confidence interval, 1.3 to 5.6; p < 0.001, respectively).

Conclusions. Advanced heart failure status at baseline and large residual postsurgery LV end-systolic volume index were independently associated with increased mortality and heart failure hospitalization rates at 2 years’ follow-up after SVR.

(Ann Thorac Surg 2011;91:491–8) © 2011 by The Society of Thoracic Surgeons
Fig 5. Kaplan-Meier curves with the cumulative survival rate for the composite end point (death and hospitalization owing to heart failure) in patients (pts) with ischemic heart failure with residual postsurgical left ventricular end-systolic volume index (LVESVI) of at least 60 mL/m² (solid line) or less than 60 mL/m² (dashed line).
Conclusion: In patients undergoing coronary artery bypass grafting plus SVR a survival benefit was realized compared with bypass alone, with the achievement of a postoperative ESVI of 70ml or less.
FIGURE 1.
Rolling 4-year Kaplan-Meier (KM) estimates by operation received and postoperative (post-op) left ventricular end-systolic volume index (LVESVI) for 555 patients with paired LVESVI data. Total group size, 150; increment, 1. CABG, Coronary artery bypass grafting; SVR, surgical ventricular reconstruction.
FIGURE 2.
Cumulative risk of death: coronary artery bypass grafting plus surgical ventricular reconstruction patients (n = 259) and postoperative left ventricular end-systolic volume index ($L V E S V I$) less than or $\geq$60 mL/m$^2$. $HR$, Hazard ratio; $CI$, confidence interval.
Kaplan-Meier Curves: Cumulative risk of death
CABG + SVR patients with same modality
(n=259)

Reduction in Post LVESVI < 30% (n = 163)
Reduction in Post LVESVI ≥ 30% (n = 96)

Reduction in Post - LVESVI  n  death  %

≥ 30%  96  13  13.5%
< 30%  163  36  22.1%

HR = 0.58 (95% CI 0.31 - 1.10; log-rank p=0.0924)

FIGURE 3.
Cumulative risk of death: coronary artery bypass grafting (CABG) plus surgical ventricular reconstruction (SVR) and reduction in postoperative left ventricular end-systolic volume index (LVESVI) less than or ≥30% of baseline LVESVI. HR, Hazard ratio; CI, confidence interval.
EARLY AND MIDTERM RESULTS OF TWO DIFFERENT TYPES OF SURGICAL VENTRICULAR RESTORATION PROCEDURES APPLIED IN ANTEROSEPTAL LV ASYNERGY

M. Panagiotou, D. Tzertzemelis, H. Kiriazis, D. Karangelis, S. Economidou

### Demographics

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<tr>
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<th>Dor</th>
<th>MLC</th>
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<tbody>
<tr>
<td><strong>Patient number</strong></td>
<td>25</td>
<td>33</td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>20 (80%)</td>
<td>30 (91%)</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>5 (20%)</td>
<td>3 (9%)</td>
</tr>
<tr>
<td><strong>Mean Age (years)</strong></td>
<td>62.40</td>
<td>62.64</td>
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<tr>
<td><strong>preop CCS</strong></td>
<td>2.38</td>
<td>2.48</td>
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<tr>
<td><strong>preop NYHA</strong></td>
<td>1.7</td>
<td>1.74</td>
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<tr>
<td><strong>Smoking</strong></td>
<td>52%</td>
<td>54.55%</td>
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<tr>
<td><strong>Hypertension</strong></td>
<td>56%</td>
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<tr>
<td><strong>Dyslipidemia</strong></td>
<td>44%</td>
<td>39%</td>
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<td><strong>Diabetes mellitus</strong></td>
<td>36%</td>
<td>33%</td>
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<td><strong>CKD</strong></td>
<td>24%</td>
<td>12%</td>
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<tr>
<td><strong>COPD</strong></td>
<td>8%</td>
<td>18%</td>
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<tr>
<td><strong>CVA</strong></td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>PRE OP PPM</strong></td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>redo case</strong></td>
<td>0%</td>
<td>3%</td>
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<table>
<thead>
<tr>
<th>RESULTS</th>
<th>DOR</th>
<th>MLC</th>
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<tbody>
<tr>
<td>Mean hospital stay (days)</td>
<td>9.50</td>
<td>10.91</td>
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<tr>
<td>ICU stay (days)</td>
<td>2.68</td>
<td>3.97</td>
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<tr>
<td>30-day mortality</td>
<td>2 (8%)</td>
<td>3 (9%)</td>
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<tr>
<td>3-year mortality / survival</td>
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<td></td>
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<tr>
<td>5 (20%) 20 (80%)</td>
<td></td>
<td>6 (18%) 27 (82%)</td>
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<tr>
<td>5-year mortality / survival</td>
<td></td>
<td></td>
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<tr>
<td>7 (28%) 18 (72%)</td>
<td></td>
<td>9 (27%) 24 (73%)</td>
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<tr>
<td>cardiac related deaths</td>
<td>42.8%</td>
<td>44%</td>
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<tr>
<td>non-cardiac related deaths</td>
<td>28.6%</td>
<td>44%</td>
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<tr>
<td>unspecified deaths</td>
<td>28.6%</td>
<td>12%</td>
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**RESULTS**

<table>
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<tr>
<th>Intraoperative data</th>
<th>Dor</th>
<th>MLC</th>
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<tr>
<td>Mean No of grafts</td>
<td>2.04</td>
<td>2.42</td>
</tr>
<tr>
<td>Additional procedures</td>
<td>2 (8%)</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>mean CPB (min)</td>
<td>155.1</td>
<td>151</td>
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<tr>
<td>mean ACC (min)</td>
<td>121.6</td>
<td>117.6</td>
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<tr>
<td>post IABP</td>
<td>5 (20%)</td>
<td>6 (18%)</td>
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<thead>
<tr>
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<th>DOR</th>
<th>MLC</th>
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<tr>
<td>preop EF</td>
<td>27.6%</td>
<td>30.52%</td>
</tr>
<tr>
<td>preop LVEDD (mm)</td>
<td>68.50</td>
<td>62.87</td>
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<tr>
<td>preop LVESD (mm)</td>
<td>55.67</td>
<td>50.69</td>
</tr>
<tr>
<td>preop IVS (mm)</td>
<td>8.77</td>
<td>9.31</td>
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<tr>
<td>preop PW (mm)</td>
<td>8.9</td>
<td>9.48</td>
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<tr>
<td>postop EF</td>
<td>46.50%</td>
<td>43.6%</td>
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<tr>
<td>postop LVEDD (mm)</td>
<td>57.75</td>
<td>61.15</td>
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<tr>
<td>postop LVESD (mm)</td>
<td>39.45</td>
<td>46.5</td>
</tr>
<tr>
<td>postop IVS (mm)</td>
<td>10.70</td>
<td>9.72</td>
</tr>
<tr>
<td>postop PW (mm)</td>
<td>10.04</td>
<td>9.52</td>
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<tr>
<td>% change EF</td>
<td>68.48</td>
<td>42.86</td>
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<tr>
<td>% change LVEDD</td>
<td>15.69</td>
<td>2.74</td>
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<tr>
<td>% change LVESD</td>
<td>29.14</td>
<td>8.27</td>
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EARLY AND MIDTERM RESULTS OF TWO DIFFERENT TYPES OF SURGICAL VENTRICULAR RESTORATION PROCEDURES APPLIED IN ANTEROSEPTAL LV ASYNERGY

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EARLY AND MIDTERM RESULTS OF TWO DIFFERENT TYPES OF SURGICAL VENTRICULAR RESTORATION PROCEDURES APPLIED IN ANTEROSEPTAL LV ASYNERGY

D.Tzertzemelis, D.Karangelis, H.Kiriazis, S.Economidou, M.Panagiotou
Conclusions

• Despite controversies, SVR seems to have a role in treatment of ischemic HF patients, especially if a post-operative LVESVI ≤70ml/m2 can be predictably achieved.

• The choice to add SVR to CABG should be based on a careful selection of patients, coming from a tight collaboration between surgeons, cardiologists and radiologists.
THANK YOU FOR YOUR ATTENTION