Endstage Congestive Heart Failure Post Myocardial Infarct Treated My Left Ventricular Reconstruction (LVR) with Endoventricular Patch Plasty and Conservation of a “Physiological Diastolic Volume Index”

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Abstract

About a series of 117 patients, in endstage chronic heart failure post myocardial infarct, excluded from the “Stich Trial 2002-2008” for permanent ischemic ventricular failure or posterior localization or during the first month post IDM, and assessed by magnetic resonance imaging (MRI) (pre-operatively, 1 year and 10 years after reconstructive surgery).

Keywords: Endstage Congestive Heart Failure; Myocardial Infarct; Endoventricular Patch

Introduction

At the Monaco Cardio Thoracic Center, “Single Facility Tray” devoted to cardio thoracic and vascular diseases opened in 1987, with a permanent team of 3 cardiologists, 3 anaesthetists and 3 surgeons, since twenty years, the Cardiac Magnetic Resonance Console (MRI) - in our technical floor - is managed by a cardiologist (Filippo Civaia) trained for these techniques, at the end of the last century, in London (D. Pennel) in Bad Nauheim (Prof Klovekorn) and in Chicago (Dr Pohost).

Indeed, it appears at the end of the twentieth century, that MRI was mandatory, for taking in charge at each step Myocardial Infarct or Acute Coronary Syndrome as pointed already by Bellanger [1] and Mahrholt [2] to look clearly where is precisely located the ischemic or necrotic trans mural or sub endocardial scar and its extension showing again the superiority of MRI on all other techniques of imaging: as angiography, echocardiography, scintigraphy and others.

MRI post acute coronary syndrome or myocardial infarct (with or without coronary recanalization at the acute phase)

A- During the acute phase of a coronary syndrome (and if possible before coronary angiogram) the Cardiac Magnetic Resonance with Gadolinium and Adenosine is administrated intravenously to look at the myocardium and to precise if there is ischemia then recanalization of culprit artery is favourable, or a necrosed area, this necrosed area being immediately visible by the Gadolinium Late Extension and call “no reflow zone” (Figure 1). In a such situation the repermeabilization of the thrombosed artery has a potential risk of occluding the collaterals still circulating downstream: “the Myocardial Reperfusion Injury” [3].

B- After myocardial infarct and during medical treatment of patient with all eventual complications, MRI is capital to look:

a- At the morphology (Figure 2a and 2b “silhouettes”) in order to precise site and extension of the infarct not only in antero-lateral region, but also in posterior and lateral area. The scar can be trans-mural or sub endocardial and the extension of the scar is calculated on the 4 projections (2 cavities, 4 cavities, left ventricular outflow tract, and short axis) in order to dress a CARTOGRAPHY (Figure 3a) with a percentage of scared perimeter of the left ventricle.
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Figure 1: aspect of no reflow on the first days after infarct, then the fibrous scar after weeks and the asynergic ventricle after months and years.

Figure 2a: Top: LAD thrombosis and transmural infarct plus dyskinesia. Down: Recanalized LAD with sub endocardial infarct and akinesia.

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When the scar is transmural, in almost all cases there is a dyskinetic wall, but when the scar is sub endocardial, surrounded by a lay of normal myocardium, the scarred area is more akinetic. In addition, it is mandatory to look carefully the non-infarcted myocardium surrounding the scar which is affected by a “Deleterious Excentric Systolic Motion” (in opposition with the normal concentric contraction). This non-infarcted area is merged in the so call “Wall Motion Abnormalities” in the analyses and assessments by angiography and echography. When the normal centripetal contraction of this portion of the myocardium return, after reconstruction when the scarred area is resected. This portion of normal, but dyskinetic wall is capital and useful to calculate the theoretical volume of the non-infarcted myocardium; which is not precisely assessed, by echo angiography.

b- Marisa Di Donato [4] analysed 902 patients who had in our unit a MRI cartography post myocardial infarct, and shows that a scar above 30% is always a trigger of congestive heart failure (Figure 3b and 3c) and all parameters of the dilatation of cardiac cavities and mitral annulus, were in correlation with the size of the scar, and statistically the receiving operative curves (ROC) shows that the precise values of the scar which is deleterious for the ventricle function, is 0,31%.

**Figure 2b:** Silhouettes of the heart must be analyzed in 2 chambers, 4 chambers and short axis views.

**Figure 3a:** The MRI cartography establishing the percentage of asynergic wall and the calculation of the theoretical contractile area diastolic volume index.
**Figure 3b:** Percentage of scar analyze of more than 900 post myocardial infarct cartographies with at left, the sub group of patient of MRI after previous coronary recanalization.

**Figure 3c:** Correlation between size scar and degree of dilatation of LV.
In 1985 we presented [6] our first series of ventricular reconstruction post myocardial infarct by endoventricular circular patch plasty (EVCPP)

A- This technique of EVCPP was proposed to be use in 1985 and we presented our first series of ventricular reconstruction post myocardial infarct by this technique of the Endo Ventricular Circular Patch Plasty [5] (Figure 4) after large endocardectomy to treat ventricular arrhythmias as proposed by Josephson [7].

Since the 90’s we completed this technique with a balloon sizing inflated at the theoretical physiological “contractile area diastolic volume index” of the rebuilt left ventricular cavity with a balloon inflated at the “theoretical contractile area diastolic volume index-C.A.D.V.I” of the patient, in order to avoid post operatively a pulmonary hypertension due to a restrictive cavity.

This contractile area diastolic volume index is always assessed during the cartography by the suppression from end diastolic volume of the percentage of scared area (Figure 3).

B- In 2002, even if we were contacted many times by the organisers, we refused to participate to “The Stich Trial” (2002 - 2008), when we learned (Table 1) that it was reserved only for anterior aneurysms, and myocardial MRI was not requested for the pre op assessment. Giving a look to the criteria of exclusion from The STICH (investigator meeting chapter 3, p17-18) (Table 1) it can be seen that during this period, of Trial, among 274 patients operated in our unit for LVR, 117 were excluded for various reasons (Table 2a) and we published the final results of this series in the Journal of Thoracic Surgery [5] (Table 2b) with a Kaplan Meier survival curve at 1 and 5 years post operatively. It’s seems for us important to point out the interest to look at this series in 2018, 10 years after the end of the STICH Trial, looking at 79 survivors patients.

Based on our experience, it can be summarize why EVCPP works (Table 3a and 3b).

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Table 1

<table>
<thead>
<tr>
<th>Mitral valve (MV) surgery (51 pts)</th>
<th>Revascularization (107 pts)</th>
<th>Ventricular reconstruction (117 pts)</th>
<th>Cardio-pulmonary bypass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post. annuloplasty: 31</td>
<td>Only arterial: 105</td>
<td>Endocardectomy: 78</td>
<td>Time: 102 min±35</td>
</tr>
<tr>
<td>Idem + Edge to Edge: 18</td>
<td>Only venous graft: 2</td>
<td>+ cryotherapy: 39</td>
<td>Ao. Cross clamp: 74 min±23</td>
</tr>
<tr>
<td>MV replacement: 1</td>
<td>Distal anasto.: 1.9±0.8</td>
<td>Patch: 117</td>
<td>Dacron: 108</td>
</tr>
<tr>
<td>- after failure E to E: 1</td>
<td></td>
<td>Pericardium: 9</td>
<td>Septal hinge: 2</td>
</tr>
</tbody>
</table>

SECONDARY RESULTS

Not Improved pts: 8 (2 deaths 1st year) 1st month deaths: 4 (3.5%)

3 CAUSES OF SECONDARY FAILURE (remodeling recurrence):

- Diastolic incompetence
  (or to small LV volume)

- «Neglected» mitral insufficiency
  ... per op checking

- Continuum in remodelling
  - & evolution of coronary disease
  - Questionable indication (bifocal scars)
  ... the delay

But ... 111 survivors over 1 year (95%) with progressive improvement

In STICH ventricular arrhythmias (33%) not mentionned or assessed

Table 2a
Table 2b

2002 – May 2008: **117 I.F.V** (excluded from STITCH)

**LATE RESULTS**

111 survivors over 1 year (95%) with progressive improvement

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Looking at four examples of patients surviving at so-called inoperable situations, we want illustrate such cases with images:

- Figure 5: the desperate (“compassioned”) indication in a 82 years old patient in 2002 in severe CHF post LAD thrombosis. The LVR associate with mammary implantation on distal bed patent LAD (interest of brief unclamping of the mammary to look at the bleeding area to stop the resection). The patient had a normal life in 2012, and died of respiratory insufficiency in 2018, 16 years after this compassioned indication, when he was 98 years old.

**Table 3b**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>EDVI</strong></td>
<td>121 ml/m²</td>
<td>54 ml/m²</td>
</tr>
<tr>
<td><strong>ESVI</strong></td>
<td>95 ml/m²</td>
<td>23 ml/m²</td>
</tr>
<tr>
<td><strong>LVEF</strong></td>
<td>22%</td>
<td>53%</td>
</tr>
<tr>
<td><strong>LAVI</strong></td>
<td>41.5 ml/m²</td>
<td>39 ml/m²</td>
</tr>
<tr>
<td><strong>SI</strong></td>
<td>0.42</td>
<td>0.59</td>
</tr>
<tr>
<td><strong>EDVI</strong></td>
<td>54 ml/m²</td>
<td>44 ml/m²</td>
</tr>
<tr>
<td><strong>ESVI</strong></td>
<td>25 ml/m²</td>
<td>20 ml/m²</td>
</tr>
<tr>
<td><strong>LVEF</strong></td>
<td>53%</td>
<td>54%</td>
</tr>
<tr>
<td><strong>LAVI</strong></td>
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</tr>
<tr>
<td><strong>SI</strong></td>
<td>0.42</td>
<td>0.48</td>
</tr>
</tbody>
</table>

**Figure 5**: Second patient 85 years old man.

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b- Video 1a and 1b example of a patient in waiting list for heart transplantation in 2002 at two University Hospitals. After LVR the same year, surviving with a normal life, as truck driver after 15 years in 2019.

c- A large postero-latero septal localization operated in 2002 (Figure 6, Video 2a-2c) and died in 2018 for a pancreatic cancer.

d- And chiefly, the spectacular cases of a 75 years old patient (Figure 7, Video 3 and 4) who was hospitalized in 3 University hospitals North West France for intractable congestive heart failure after LAD reopening at the acute phase, complicated by the occlusion of the first patent septal artery in 2007. He was refused for any type of reconstructive surgery of mechanical assistance, or heart transplantation because too old.

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Figure 6: Postero lateral and septal ventricular aneurysm.

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Figure 7: Observation.

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The first MRI was only accomplished in our Center: EF 9% ESVI: 289 ml/m², EDVI: 320 ml/m²; the BNP was over 4000 and pulmonary pressure over 80. But the contractile area has a volume above 70 ml so CAdVI above 40 - 50m² by Sq.m.bsa. he survived to surgery in spite of a “predictive mortality score above 80%”) and was living normally at one year, playing golf, and the reconstructed ventricle was controlled at 5 and 10 years by MRI after surgery. Patient still alive in normal life in 2019.

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The experience of our group based on a series above 1800 cases allows to say that if after myocardial infarct complicated by CHF MRI shows that the non scared LV cavity has a theoretical “CADVI” above 40 - 50 ml LVR is efficient with a satisfactory long term results [8,9].

Synthesis in Conclusion

It can be pointed out, with an experience of our group over 1800 cases of LVR since the eighties that looking at the figure 8:

a- All patient after myocardial infarct (with or without coronary revascularization) must be followed step by step with MRI and the precise analyse of the final scar, its localisation and its extension and its consequence are mandatory.

b- The sphericity index: the dilatation is more often elliptical than spherical.

c- The mitral insufficiency in 85% of cases is due to a ventricular enlargement and distention of the posterior mitral annulus: ischemic mitral regurgitation is not a valvular but a ventricular disease.

d- The GLE map is guiding the endoventricular resection.

e- The diastolic volume sizing at the theoretical CADVI is a must.

f- The systolic centripetal contraction of the non-infarcted myocardium is restored on the rebuilt ventricle.

Figure 8: Synthesis.
Bibliography


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