Benefit of the Left Ventricular Repair During Coronary Revascularization in Dilated Ischemic Cardiomyopathy

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Abstract

Objectives: Studying the outcome of the addition of the left surgical ventricular restoration (SVR) to CABG compared to isolated CABG after a time interval from 6 to 24 months from the initial operation. We adopted in this research, the DOR repair using the Endoventricular circular patch to restore the ventricular shape after excision of the scar tissues.

Methods: We collected from our database 32 coronary patients operated between 2005 and 2008. These patients were presented with poor LV function, EF <30%, dilated LV dimension with a LV end diastolic diameter (LVEDD) >6 cm. All the 32 patients had left heart catheterization, left ventriculography, nuclear scanning for viability and function. TEE was done to evaluate the wall motion, function, degree of mitral regurgitation, and LV dimensions including LVesD and LVEDD. 14 of these patients (group A) had DOR repair during the coronary revascularization. 18 patients (group B) had only coronary revascularization without DOR repair and represent the control group. The patients in the 2 groups were assessed in a time interval ranging between 6 and 24 months [average 15 months] from the initial operation. Mortality, morbidity and symptoms of heart failure were compared in both groups. LV function, LV geometry were assessed by TEE and Cine MRI. Results related to the findings were compared statistically with a p value <0.05 considered to be significant. All values were calculated as mean ± SD.

Results: The operative data showed no difference between the 2 groups. The average number of grafts was 3±1 and 3±0.8 respectively in group A and B. Mitral repair was done in 6 cases in group A and 4 cases in group B. No operative mortality in both groups. The post operative IABP was used in 2 patients in group A and were started before surgery to stabilize the patient hemodynamic. In group B, 4 patients needed IABP for post operative cardiac support. The post operative data collection was done over a time interval from 6 to 24 months after the initial operation [average 15 months]. these data showed significant improvement of the LV function and reduction of the LVEDV in group A with the DOR repair. Only 1/14, (7%) patient had signs of congestive heart failure compared to 6/18, (33.3%) patients in group B who received only coronary revascularization. Rehospitalisation was needed for 2/18, (11.1%) patients in group B for signs of heart failure. Persistent moderate mitral regurgitation occurred in 2/18, (11%) cases in group B. One case of late mortality, 18 months after the initial surgery occurred in group B. The Cause was not identified.

Conclusion: DOR ventricular repair associated with coronary revascularisation in patient with dilated ischemic cardiomyopathy could improve the ventricular function and decrease morbidity, mortality, incidence of heart failure and rehospitalisation in this high risk group of patient.

Key Words: Dor repair – Ventricular restoration – Ischemic cardiomyopathy – Revascularisation.

Introduction

ADVANCED cases of long standing ischemic heart disease with multiple infarctions along the course of the coronary pathology ends in variable myocardial damage including scarring, aneurismal formation and dilated cardimyopathy. The repeated anterior myocardial infarctions, result in either akinetic or dyskinetic scar tissue, which progress into aneurismal formation. This will lead to progressive change in the ventricular geometry including the shape and size and subsequent reduction in the left ventricular pumping function. Even total revascularization cannot restore the geometry of the damaged ventricle. Loss of the normal left ventricular geometry including the shape and size is the main cause of the impaired myocardial contractility. The akinetic and dyskinetic scarred tissue constitutes a major handicap for the heart pumping function. The left ventricular dilatation with the resulting mitral annular dilatation and mitral regurgitation adds a high volume overload on the left ventricle and ends in congestive heart failure. In patients with ischemic cardiomyopathy, mitral regurgitation may be related to several possible mechanisms. These include left ventricular dilatation, Papillary muscle ischemia and chordal rupture. Resection of akinetic or dyskinetic scar tissues with restoration of ventricular size and geometry toward normal may improve valve function. Annuloplasty as advocated by Bolling and co-workers [1] may partially compensate for malfunction of the subvalvular apparatus by correcting the annular
dilatation. In some cases the infarcted area shows little infarct expansion and it may take many years for adverse ventricular remodelling to occur. In other cases there is rapid development of an obvious dyskinetic aneurysm and heart failure symptoms. Expansion and thinning of the infarct may produce additional work because of paradoxical motion of the Thinned segment and may result in malalignment of muscle fibers in surrounding contractile segments leading to further decrease in efficiency of contraction. Therefore, coronary revascularization alone in these cases will not provide the optimum management to restore the cardiac function and improve the patient life quality. In the last few years, the importance of restoring the left ventricular geometry in cases of ischemic cardiomyopathy becomes more evident. The left ventricular repair, excision of the scar tissues, restoring the ventricular size and elliptical shape and repairing the mitral valve constitute the main line of management of advanced cases of ischemic cardiomyopathy when associated with the coronary revascularization. However, the unpredictable outcome for ventricular restoration (VR) made this surgical technique with limited use for many years inspite the theoretical support for the benefits. The need of a clear vision of the outcome of VR pushed many centres to study the benefits in combination with CABG. Several imaging methods are now used to determine the myocardial geometry, viability and function. This help to plan for the accurate surgical strategy. These techniques include the TEE, Cine MRI, nuclear scanning (thallium and Muga) and positron emission tomography PET. The objective of our research is to study the outcome obtained with the addition of VR to CABG compared to isolated CABG, after a time interval from 6 to 24 months from the initial operation. We adopted in this research, the DOR repair using the Endoventricular circular patch, pericardial or synthetic to restore the ventricular shape after excision of the scar tissues.

Methods

Retrospective study of 32 coronary patients operated between 2005 and 2008. These patients were presented with poor LV function, EF <30%, dilated LV dimension with a LV end diastolic diameter >6 cm. all the 32 patients had left heart catheterization, left ventriculography, nuclear scanning for viability and function. TEE was done to evaluate wall motion, function, degree of mitral regurgitation, and LV dimensions including LVESD and LVEDD. 14 of these patients (group A) had DOR repair associated with the coronary revascularization. 18 patients (group B) had only coronary revascularization without DOR repair and represent the control group. The patients in the 2 groups were assessed in a time interval ranging between 6 and 24 months from the initial operation. We followed the patient by outpatient visits and day care. Mortality, morbidity and symptoms of heart failure were compared in both groups. LV function, LV geometry including dimensions, shape and wall motion were assessed by TEE and Cine MRI after informed consent. Results related to the findings were compared statistically with a p value <0.05 considered to be significant. All values were calculated as mean ± SD.

Surgical technique:

All the 32 patients were operated by a single surgeon using the standard operative protocols. The patients were scrubbed and draped in the 2 groups as for standard coronary surgery. Coronary revascularization in both groups was done through median sternotomy. In most of the patient left mammary and saphenous vein grafts were used. In some patients we used bilateral mamaries in addition to the venous grafts. The Heart Lung Machine was initiated using arterial aortic cannula and 2 stages single venous cannula. In cases needing additional mitral valve repair, 2 vena caval cannulae were used. Antegrade intermittent blood cardioplegia was used through the aortic root and the venous grafts. Weaning of the Heart Lung Machine was done in the standard way using IABP and cardiac inotropes in some patients. In group A, the DOR repair was done on beating heart (Graph 1). The anterior wall of the left ventricle was opened parallel to the Left Anterior Descending artery. The demarcation line between the scar and viable tissue was identified. The operative identification was supported by preoperative nuclear scanning and TEE. LV scar tissues and aneurysms were excised carefully respecting the demarcation zone. A Fontan continuous stitch using Prolene 2/0 was placed adjacent to the junction between viable and non viable myocardium. A Gortex patch was secured over the ventricular orifice using continuous Prolene stitch. The patch is carefully placed to keep a reasonable LV size and shape. The ideal standard 60 cc LV volume was always targeted in all cases. The free edges of the left ventricle were approximated with interrupted Prolene stitches 3/0 supported with Teflon strips like in linear closure. Reinforcement with running matrix suture was done in all cases. When needed, the repair of the mitral valve was done using mitral annuloplasty with complete rings. Intraoperative TEE was done for all patient after weaning off bypass to evaluate the ventricular size, contractility, walls motion and degree of mitral regurgitation.
Graph (1): With the patient on cardiopulmonary bypass the heart is opened through the thinned area and the surrounding edges are palpated to assess contractility and wall thickening. Areas that do not contract in the unloaded state are considered for excision. (Reprinted with permission from Mickleborough LL. Left ventricular aneurysm: modified linear closure. In: Cox JL, Sundt TM, eds. Operative techniques in cardiac and thoracic surgery: a comparative atlas. Philadelphia: WB Saunders, 1997; 2: 118-31) [2].

Results

In the preoperative demographic data, there was no statistical difference between both groups. In group A, the average age was 57 ±7, male to female ratio was 7 to 1 respectively. In group B the average age was 58 ±8, male to female ratio 6 to 3 respectively. Preoperative clinical and imaging data were compared in both groups with no statistical difference as shown in Table (1).

Table (1): Preoperative clinical data.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group A (14)</th>
<th>Group B (18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYHA class III-IV</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Preoperative EF (%)</td>
<td>26±0.8</td>
<td>28±0.5</td>
</tr>
<tr>
<td>LVedD (cm)</td>
<td>6.1±0.3</td>
<td>5.8±0.7</td>
</tr>
<tr>
<td>Mitral regurgitation &gt;2/4</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Preop IABP</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

The operative data, following the same standard techniques done by a single surgeon, showed no difference between the 2 groups. The average number of grafts was 3±1 and 3±0.8 respectively in group A and B. Mitral repair was done in 6 cases in group A, 4 cases in group B. No operative mortality in both groups was identified. The postoperative IABP was used in 2 patients in group A and were started before surgery to stabilize the patient hemodynamic. In group B, 4 patients needed IABP for post operative cardiac support.

The post operative data collection was done over a time interval from 6 to 24 months after the initial operation after informed consent. Clinical evaluation, TEE and cine MRI were done as an outpatient day care procedure. The results showed significant improvement of the LV function and reduction of the LVedV in group A with the DOR repair Graph (2,3). Only 1/14, (7%) patient had signs of congestive heart failure compared to 6/18, (33.3%) patients in group B who received only coronary revascularization. Rehospitalisation was needed for 2/18, (11.1%) patients in group B for signs of heart failure. Persistent moderate mitral regurgituation occurred in 2/18, (11%) cases in group B. most probably due to persistent LV dilatation. One case of late mortality, 18 months after the initial surgery occurred in group B. The Cause was not identified. Post operative results are shown in Table (2).

Table (2): Post operative follow-up (6 to 24 months).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group A (14)</th>
<th>Group B (18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYHA III/IV</td>
<td>1/14 (7%)</td>
<td>6/18 (33.3%)</td>
</tr>
<tr>
<td>Rehospitalisation</td>
<td>0</td>
<td>2/18 (11.1%)</td>
</tr>
<tr>
<td>EF %</td>
<td>37±3.6</td>
<td>28±3.2</td>
</tr>
<tr>
<td>LVedD</td>
<td>4.1±8.5</td>
<td>5.9±4.6</td>
</tr>
<tr>
<td>Mitral regurgitation</td>
<td>0</td>
<td>2/18 (11.1%)</td>
</tr>
<tr>
<td>Mortality</td>
<td>0</td>
<td>1/18 (5.5%)</td>
</tr>
</tbody>
</table>

Graph (2): Comparison of the EF% before and after surgery in both groups.
**Evaluation of the Benefit of the Circular Patch**

**Graph (3): Comparison of the LVEDD in cm before and after surgery in both groups.**

**Discussion**

The limited data in the literature about the clear benefit of the ventricular restoration surgery combined to the coronary revascularization limit the widespread use of this surgical technique by cardiac surgeons. Although all the information confirm that the changes of the geometry of the left ventricle due to repeated myocardial infarction and scarring affecting its size and shape and subsequently affecting its pumping function. Progressive dilatation of the LV with change in the papillary muscle morphology disturbed the mitral apparatus adding volume overload to the poorly contracting ventricle. The gradual process of heart failure leads to serious influence of the patient quality of life even after revascularization. That is why decision to operate coronary patient with poor LV function is not always straightforward. Although the low EF is an indicator of poor outcome, it is not a contraindication for CABG associated with LV remodeling and mitral repair [2,3].

Our study showed that restoring the LV geometry by the DOR technique could be beneficial to improve the heart pump function and to decrease patient morbidity and mortality. Too small or too large ventricular cavity can affect ventricular function significantly. A preoperative knowledge of normal ventricular geometry is essential before using this surgical technique. The significant reduction of the LV volume was directly proportional to the reduction in heart failure incidence in the DOR group patients. Also the quality of life for this category of patient improves dramatically if revascularization is associated with LV restoration. The marked improvement of the ejection fraction in the DOR group is correlated to the shape and size of the LV cavity helping its normal function. This ventricular restoration helps in the normal function of the mitral apparatus, decreasing the volume overload on the ventricle. The result of this study matched many other researches with larger series of patient, showing improvement of the ventricular function and the patient clinical condition. Dor and colleagues [4] have demonstrated that ventricular restoration (VR) can be performed at the time of CAB with acceptable results. Athanasuleas and associates [5] further validated Dor’s institutional experience demonstrating the safety and efficacy of VR for dilated cardiomyopathy in a multicenter trial. Maxey and colleagues [6] showed an acute increase in LVEF from 0.22 ± 0.03 to 0.33 ± 0.01 in 56 patients who underwent SVR combined with coronary artery bypass grafting. Qin and associates [7] reported an increase in LVEF from 0.27 ± 0.09 to 0.36-0.11 at 6-month follow-up in patients who underwent SVR combined with mitral valve repair. Lynda et al. [8] stated in large series of 282 patients that the 5 year survival rate was 82% with only 8 cases needed transplant for increasing heart failure. Poor outcomes after DOR repair were directly proportional to increased ventricular size, low EF and was reported by many authors [9,10]. Variable surgical techniques were used in the past few years for left ventricular repair associated with coronary revascularization. The new term “surgical ventricular restoration” (SVR) includes operative methods that reduce LV volume and “restore” ventricular elliptical shape [9]. Excision of a thin-walled aneurysm with direct closure is an early method of SVR first described by Cooley et al. [10] and modified over the years. This operation is rarely performed currently because early reperfusion spares epicardial muscle, resulting in regional thick-walled akinesia rather than thin-walled dyskinesia [11]. Dor recognized that the adverse effects of remodelling on the remote non-infarcted myocardium were similar for akinesia and dyskinesia and was the first to utilize the endocardial patch plasty procedure [12]. Operation improves systolic function and New York Heart Association (NYHA) functional class. SVR is not a standardized technique. According to Dor and colleagues, [4] the use of a patch is mandatory, and more recently they introduced the use of a sizer. Caldeira and McCarthy [13] use a double purse-string suture technique; Mickleborough and associates [2] use a linear closure and septoplasty,
sometimes with a patch, and it is difficult to say which other ways of rebuilding the LV are in the hands of surgeons. We agreed with Jatene [9] that performing the repair on beating heart can give better first impression of the real LV geometry and size. On arrested heart the sizer balloon will be of great value to control LV cavity size. The actual imaging module including the MRI, cine MRI, the isotope scanning and TEE proved to be accurate in calculating the LV ejection fraction, the LV dimensions before and after restoration. The post operative medical treatment can help to have optimum results of the LV restoration. These medications include the ACE inhibitors and spironolactone. We are keeping our patient with patch repair on warfarin anticoagulation for at least 3 months.

Conclusion:

DOR ventricular repair associated with coronary revascularisation in patient with dilated ischemic cardiomyopathy could improve the ventricular function and decrease morbidity, mortality, incidence of heart failure and rehospitalisation in this high risk group of patient. More studies should be conducted comparing results of a single standard LV restoration technique.

References