
Editorial

Left ventricular volume reduction for dilated cardiomyopathy

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Left ventricular volume reduction for dilated cardiomyopathy (DCM) is becoming more popular for different reasons: a) the availability of a reasonably satisfactory surgical technique; b) the better comprehension of the role of the mitral valve in the pathophysiology of the disease; c) the shortage of donors for cardiac transplant; and d) the increasing number of patients with long-standing heart failure due to the outstanding improvements in medical treatment.

Before discussing these aspects, we need to correctly define the object of this paper from the surgical point of view.

Surgical definition of dilated cardiomyopathy

Strangely, to date, in the surgical papers regarding this topic¹⁻⁴ no definition of DCM has been made. As dilation of the left cavity is a compensatory mechanism of reduced contractility, the ejection fraction *per se* is not a reliable indicator of the clinical status of the patient and of the mechanism at the basis of the disease. Integration of different aspects is needed to identify a group of patients whose disease can be approached with similar surgical strategies. In a previous article⁵ we gave a definition that, even if not perfect, was able to fulfill such a purpose.

From the surgical point of view, DCM, independently of its etiology, is defined as: 1) dilation of the left ventricular cavity > 110 ml/m²; 2) an ejection fraction < 35%; 3) dilation of the base of the heart, as an expression of dilation of the mitral valve annulus; and 4) functional mitral regurgitation that needs to be surgically corrected.

The key points of this definition are the third and the fourth as development of functional mitral regurgitation is crucial in the natural history of DCM⁶⁻⁸. It allows identification of patients with DCM who have a different long-term post-surgical prognosis from that of patients who meet the first two criteria, as, for instance, patients with big apical left ventricular aneurysms and normal mitral function without dilation of the base of the heart.

Mitral valve and dilated cardiomyopathy

When the mitral valve is competent, DCM is well controlled by medical treatment. When functional mitral regurgitation occurs, it causes an immediate deterioration of the clinical status of the patient, shortening his life expectancy. The mechanisms at the basis of the development of functional mitral regurgitation are several:

- lateral, posterior and apical displacement of the papillary muscles. This mechanism causes:
- an increase in the distance over which the mitral leaflets are tethered from the papillary muscles to the anterior annular ring and restricts their possibility to close at the annular level. Consequently,
- the leaflets assume a tented geometry, the length of leaflet coaptation decreases, the excursion angle of the posterior leaflet decreases and the coaptation depth of the leaflets increases;
- when functional mitral regurgitation starts, the mitral annular area increases together with the dilation of the mitral annulus and consequently the base of the heart enlarges.

Apical displacement of both papillary muscles, the main determinant of these modifications and, consequently, of the degree of functional mitral regurgitation⁹, is related to the left ventricular sphericity which is at the basis of all these mechanisms. Postulated by Kono et al.^{10,11}, it was recently demonstrated *in vivo* by Otsuji et al.¹². The same authors also demonstrated that functional mitral regurgitation with global left ventricular dysfunction occurs only if the left ventricle dilates, the only mechanism at the basis of the associated geometric changes.

Surgical techniques

Mitral valve surgery is the crucial point of surgery in any kind of DCM. Elimination of mitral regurgitation deeply modifies the natural history of the disease rendering it more amenable to medical treatment. The mitral valve can be repaired, overreducing the mitral annular size. For this purpose, a 26 artificial or pericardial ring is applied. We also performed a De Vega-like posterior annuloplasty, with a 2/0 Ti-cron suture, using a 26 ring sizer to achieve the desired annular reduction. The purpose of the overreduction of the mitral annulus is to maximally reduce the surface area of the orifice of the mitral valve, thus allowing the leaflets that have a functionally reduced surface, to close it. However, this is not the rule. It was demonstrated¹³ that a significant percentage of patients who had been submitted to correction of functional mitral regurgitation with a ring develops recurrent mitral regurgitation. This finding is attributable to different factors. The subvalvular anatomy of the mitral valve can be altered to such an extent that correct valve functionality is not possible even if the annulus is overreduced. Furthermore, any device that is used to reduce the mitral annulus displaces the posterior annulus (that is mobile) towards the anterior one (that is fixed), increasing the distance between the papillary muscles and the posterior annulus and thus further reducing the ability of the posterior leaflet to move anteriorly and to coapt. In these cases it is mandatory to replace the mitral valve and to spare the subvalvular apparatus. We identified the coaptation depth (mm) of the mitral leaflets as a parameter which is easy to determine and that can allow a correct choice of the surgical strategy: if 10 mm or less, mitral annuloplasty will result in durable stability; if 11 mm or more, mitral valve replacement has to be performed¹⁴.

Since isolated mitral valve surgery is at the basis of chronic left ventricular remodeling, in many cases the left ventricular cavity has to be significantly reshaped, mainly in post-ischemic DCM, and direct left ventricular surgery has to be associated with mitral valve surgery.

Partial left ventriculectomy (Batista operation) impressed the surgical world for the strength of the theory at its basis: in patients with idiopathic DCM the volume can be reduced by eliminating the portion between

the papillary muscles (that can be included in the resection). The mitral valve can be replaced or repaired (Alfieri stitch). Volume reduction reduces wall stress and increases the percentage of cardiac work devoted to mechanical activity. Globally, the contractility of the heart becomes more effective. The impact of this idea was incredible and gave rise to great enthusiasm. However, the early and mid-term results were disappointing¹⁵ and it was suggested that, even if the concept was basically correct, the unpredictability of results in apparently similar cases was such that patient selection was surely inappropriate. This procedure is today in standby to achieve a better comprehension of the surgical indications. However, the revolutionary Batista concept had an unexpected side effect: the eyes of surgeons opened up and it was suddenly discovered that in patients with DCM, disease palliation could be achieved by non-transplant surgery.

Whereas the Batista operation was conceived for patients with idiopathic DCM, other procedures could be used in patients with ischemic DCM: the Dor operation¹⁶ and the Guilmet operation¹⁷. These procedures have specific indications. When the infarct area includes both the septum and the free wall to a similar extent, the Dor operation (circular endoplasty) is indicated. When the septum is mainly involved, the Guilmet operation (septoexclusion) allows selective elimination of the septum from the left ventricular cavity, rendering the heart conical in shape.

Tricuspid annuloplasty is often performed using any technique. The same applies for coronary bypass grafting. However, inducible ischemia must not be present in the patient's preoperative work-up and grafting has to be a complementary procedure.

Surgical indications and contraindications

The current possibilities of heart transplant in Italy preclude surgery for patients who a) are out of the program, and b) refuse heart transplant. Whereas point b) is clear, which patients are included in point a) is not as evident. During 1999, 337 patients had a heart transplant in Italy, the same number as in 1998 (n = 338). In the overall Italian experience, the 30-day mortality was 10% and the 1- and 5-year actuarial survivals were 80 and 70% respectively. Generally, patients aged ≥ 65 years as well as patients with a serum creatinine level ≥ 2 mg/dl are not submitted to heart transplant. Owing to the poor short- and long-term outcomes, chronic hepatic failure (serum bilirubin levels ≥ 2 mg/dl) as well as poorly controlled diabetes and vascular peripheral disease are often considered as contraindications for heart transplant. It is clear from these data that, at present, patients to be included in point a) are those who are older than 65 years and subjects of any age but with some kind of organ failure.

However, even if any patient can be considered a possible candidate for left ventricular volume reduction, an

Table I. Short- and long-term results of our experience in Group A patients.

Procedure	No. patients	30-day mortality	Survival (%)		
			1 year	3 years	5 years
Isolated mitral valve surgery	52	2 (3.8%)	90.4	82.7	78.8
Mitral valve surgery	35	6 (17.1%)	77.1	68.6	–
+ Batista operation	13	3 (23.1%)	61.5	53.8	–
+ Dor or Guilmet operation	22	3 (13.6%)	77.0	72.7	–

important contraindication exists, limiting the early and late survival. Chronic right ventricular failure related to pulmonary hypertension with severe organ failure is not acutely restored by any procedure we can perform on the left side of the heart. Often these patients are inotrope- and/or intra-aortic balloon pump-dependent and surgery is a real emergency. Surgical treatment is not denied. However, results are very poor.

In accordance with these principles, candidates to surgery were divided into two groups⁵. Group A included patients with good or moderately impaired right ventricular function, with or without tricuspid regurgitation, a mean pulmonary pressure < 40 mmHg and normal or mildly impaired renal or liver function. Group B included patients with severely impaired right ventricular function, severe tricuspid regurgitation, a mean pulmonary pressure > 40 mmHg, moderate to severe organ failure, dependency on inotropes and/or an intra-aortic balloon pump. In patients with clinical characteristics similar to those of the latter group, conventional surgery for DCM is often ineffective.

The short- and long-term results of our experience in Group A patients are shown in table I.

Future developments

The widespread use of non-transplant surgery for DCM and further analysis of long-term results will permit cardiac surgeons to perform these techniques in patients who are candidates for heart transplant thus postponing the latter surgical technique. The global benefit of a palliative operation could include the possibility of tissue matching between the donor and the recipient, thus improving the short- and long-term outcomes and increasing not only the length but also the quality of life. This will be possible only if the operative mortality and mid-term survival, at least in selected patients, are such that left ventricular volume reduction for DCM is both safe and effective. Our efforts are, today, directed towards this end.

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