

Cardiomyoplasty: Our Experience After Six Years

Horacio E. Almada, Luis Molteni and Ricardo F. Ferreira

Department of Cardiovascular Surgery, Hospital Frances, Buenos Aires, Argentina

Abstract

The result of our initial 16 patients submitted to cardiomyoplasty procedures from April 1987 to March 1991 are reviewed. All patients had dilated cardiomyopathy of different etiologies and were in functional class (FC) IV (NYHA), with an ejection fraction (EF) ranging between 10 to 23%. The procedure was performed through a single approach using the *latissimus dorsi* muscle, which had been submitted to a previous period of electrical conditioning. Definitive stimulation was achieved with a single pulse double chamber pacemaker. Three patients died at the operation (18.7%). Three patients (18.7%) did not improve their FC and died of heart failure during the early postoperative period at 7, 6 and 7 months after surgery. Two patients died at the fourth postoperative month due to pulmonary thromboembolism and sudden death respectively. They both were in FC II at the time of their death. The remaining 8 patients (50%), survived beyond 18 month and are between I and II FC according to ergometric test, Echo Doppler and Camera Gamma determinations. Five of these patients died between the 19th and 42nd month of follow-up. Three patients are alive at the 40th, 48th and 49th months of follow-up respectively and they are in FC I. Our experience with this procedure indicates that a satisfactory quality of life is obtained in the majority of patients, who otherwise would have a life expectancy less than 12 months in spite of intensive medical therapy.

Key words: Cardiomyoplasty, Heart failure, Dilated Cardiomyopathy, *Latissimus dorsi* muscle.

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The purpose of dynamic cardiomyoplasty is to give support to a failing ventricle by means of a synchronously stimulated skeletal muscle. On the 1980s, several groups initiated the research in this field [3, 4, 6, 7, 8, 12, 20]. In 1985, Carpentier and Chachques performed the first clinical case [5], while our experience began in 1987 [14]. In this review we analyze the surgical technique, the protocol of muscle conditioning and the definitive stimulation of the graft. Our long-term follow-up encourages us to continue this procedure.

Material and Methods

Sixteen patients with dilated myocardopathy of different etiologies were submitted to cardiomyoplasty. The clinical characteristics of the group are given in Table I. In order to enter the surgical protocol the patients had to fulfill the following criteria: a) dilated myocardopathy, b) FC IV (NYHA), c) an EF below 20% determined by Gamma Camera, d) two or more admissions to an intensive care unit for heart failure.

The exclusion criteria are given in Table II.

All patients were submitted to the following studies: electrocardiogram, chest X ray, Ejection Fraction measured by Tc99 at rest and under exercise, ergometric study, Echo-Doppler for measurement of ventricular chambers and aortic root flow, catheterism including coronary arteriography, and myocardial biopsy (this last study whenever possible).

Due to limited availability of cardiomyostimulators which deliver burst, we used a pulse-train neurostimulator (Itrel 7420, Medtronic Inc. Minneapolis, MN) to condition the *latissimus dorsi* muscle (LDM) in situ. The characteristics of the stimulation protocol has been described in previous works [15, 18]. Upon completion of the muscle conditioning the cardiomyoplasty operation was performed. For this purpose, the left LDM was detached from its insertions through a longitudinal incision done parallel to the posterior axillary line. Through a window made in the thoracic wall the LDM graft was introduced into the thorax, by a left thoracotomy the muscle was wrapped around both ventricles and attached to the heart with multiple stitches [16]. The sensing QRS leads and the pacing leads were

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Table 1. Cardiomyoplasty. Characteristics of the group.

Patient	Age	Sex	Etiology	Functional Class	Previous Admissions	Ejection Rest	Fraction Exc.
1	56	M	Postviral	IV	3	10%	14%
2	49	M	Unknown	IV	2	14%	16%
3	33	M	Chagas	IV	4	12%	15%
4	58	F	Chagas	IV	2	10%	11%
5	50	M	Postviral	IV	7	11%	11%
6	43	F	Postpartum	IV	6	12%	14%
7	65	M	Ischemic	IV	2	23%	34%
8	49	F	Unknown	IV	10	15%	15%
9	38	M	Alcoholic	IV	6	18%	20%
10	58	M	Alcoholic	IV	7	15%	19%
11	46	M	Unknown	IV	9	15%	16%
12	52	F	Unknown	IV	5	17%	17%
13	47	M	Unknown	IV	8	12%	14%
14	60	M	Postviral	IV	6	13%	13%
15	50	F	Unknown	IV	5	10%	14%
16	42	M	Ischemic	IV	4	16%	19%

sutured to the right ventricle and the LDM graft respectively. Care was taken to suture the pacing leads in a perpendicular fashion to the graft and separate them by 10 cm. The threshold (first contraction) and the effective contraction were measured. A high output double chamber pacemaker was used (Sequicord IV, Cordis Corp., Miami, FL, Delta CP1, Quadra Teletronics), connecting the sensing (atrial) leads to the right ventricle and the pacing (ventricular) leads to the LDM graft. The generator was placed in a subcutaneous pocket in the abdominal wall. In one patient we used a cardiomyostimulator (Medtronic SP 1005, Medtronic Inc. Minneapolis, MN).

In four patients extracorporeal circulation was required to assist a failing heart during the Cardiomyoplasty procedure, on the seventh postoperative day graft stimulation was initiated at the minimal level and maintained for eight days. After that the pacing was increased until reaching the same output obtained during the operation.

Table 2. Cardiomyoplasty exclusion criteria.

- 1 - EF more than 35% or less than 10%.
- 2 - Multiple organ failure.
- 3 - Simultaneous diagnosis of cancer.
- 4 - Pulmonary hypertension with capilar hyperresistence.
- 5 - Refractive ventricular arrhythmia.
- 6 - Significant valvular insufficiency.

A week after the conditioning protocol was completed an Echo-Doppler was done at the aortic root level to determine the optimal delay so that the best peak flow velocity could be obtained [1, 18]. Usually, this coincided with the opening of the aortic valve.

The following studies were periodically done: electrocardiogram, chest X ray, ergometric test, echo and echo-Doppler and radiocardiogram.

Results

Three patients (18.7%) died at the operation. The causes were rupture of the right ventricle, acute myocardial infarction and irreversible arrhythmia respectively. The remaining patients had a satisfactory postoperative period. In the first five patients of our series a seroma occurred in the area where the LDM had been dissected. This complication was no longer observed after a thoracic elastic bandage was applied in this area in subsequent patients.

In one man (6.2%) the LDM graft did not respond to stimulation and he died in the second postoperative month due to cardiac insufficiency. Two patients (12.5%) who were in advanced class IV before surgery, did not experience any improvement and died at the 6th and 7th postoperative month of heart failure in spite of apparent acceptable LDM graft contraction.

Ten patients (62.5%) considerably improved their cardiac status ranging their FC between I and II. This improvement was noticed at the onset of the stimulation, which progressed during the following months until reaching optimal levels at the 12th postoperative month. In all

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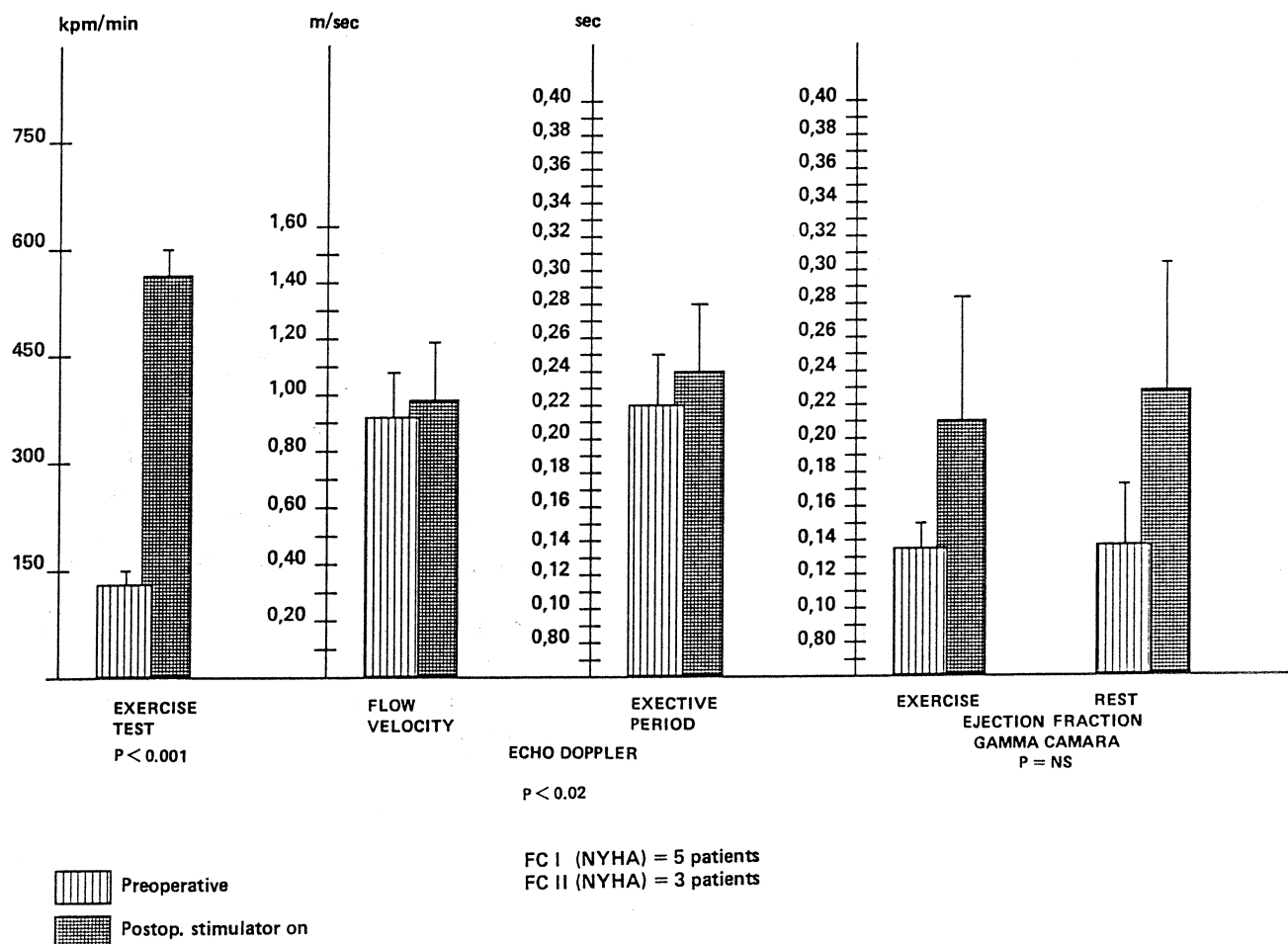


Figure 1. Mean values of preoperative and postoperative ergometric test, flow velocity (Echo-Doppler) and ejection fraction (Gamma Camera) in the patients that has lived more than one year.

of these patients pharmacological treatment was significantly reduced.

One patient (6.2%) died of pulmonary thromboembolism at the fourth postoperative month. He was in FC II immediately before his death. Four patients (25%) died of sudden death probably as a consequence of ventricular fibrillation at the 4th, 23rd, 38th and 42nd postoperative months in spite of Amiodarone treatment.

One patient (6.2%) who had psychiatric disorders discontinued medication and clinical control and died of cardiac insufficiency 19 months after surgery. Another patient (6.2%), who had an alcoholic myocardiopathy returned to heavy alcoholic intake and died of complications secondary to this addition in the 19th postoperative month. Three patients (18.6%) are in their 40th, 48th and 49th postoperative months respectively. They are in FC I with excellent quality life and they did not require subsequent admissions to hospital units. One of these patients underwent a successful cholecystectomy.

Discussion

A significant improvement in the FC was obtained in 62% of the patients submitted to Cardiomyoplasty. This was evidenced by a better life quality and several patients returned to work and returned to practice social and sexual activities.

We reported previously [2-17] that satisfactory results can be achieved with a single pulse double chamber pacemaker. In this regard two aspects should be taken into account: 1) conditioning of the LDM with pulse train pacemaker and 2) the finding of the optimal delay between the QRS and the graft stimulation, in order to produce the muscular contraction during the first portion of the left ventricular ejective period.

However we are aware of the advantages of specially designed devices such as the Cardiomyostimulator which allow a prolonged stimulation of the LDM graft.

Life expectancy in these patients with medical treatment is short usually and should be estimated in no longer than 12 months. On the other hand, of our series of 16 patients, 50% (8 patients) were alive beyond 18 months, five pa-

tients (31,2%) more than 24 months and three patients (28,3%) are still alive after 40 months of follow-up.

We suspect that the best survival, and clinical improvement occur when this procedure is performed in patients in FC III.

The ejection fraction measured by Gamma camera, the haemodynamics parameters, and the Echo-Doppler studies were useful methods to determine the degree of improvement reached with this operations [10-13].

Before surgery, none of the patients were able to reach 150 kgm., but six months after operation three patients reached 450 kgm., and five patients reached 600 kgm.

Conclusions

Cardiomyoplasty is an useful alternative for these patients with dilated cardiomyopathy who do not respond to medical treatment while waiting for a cardiac transplantation.

Grandjean [9] has also shown that cardiomyoplasty offers the best results in patients in functional class III, or early functional class IV.

Address correspondence to:

Horacio E. Almada, Pujol 1516 8° B, (1416) Buenos Aires, Argentina.

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