

Can Tricuspid Annuloplasty of the Donor Heart Reduce Valve Insufficiency following Cardiac Transplantation with Bicaval Anastomosis?

Alfredo I. Fiorelli, José L. Oliveira Jr., Ronaldo H.B. Santos, Guilherme B. Coelho, Adriana S. Oliveira, Domingos D. Lourenço-Filho, Gisele Lapenna, Ricardo R. Dias, Fernando Bacal, Edimar A. Bocchi, Noedir A.G. Stolf

Heart Transplantation Unit of the Heart Institute of Medicine School of Sao Paulo University, Sao Paulo, Brazil

ABSTRACT

Background: The aim of this study was to evaluate the degree of tricuspid valve insufficiency after orthotopic cardiac transplantation with bicaval anastomosis and prophylactic donor heart annuloplasty.

Methods: At present, our cardiac transplantation experience includes 478 cases. After January 2002, we included 30 consecutive patients in this study who had undergone orthotopic cardiac transplantation and survived >6 months. The patients were divided into 2 groups: group I, 15 patients who underwent transplantation with prophylactic tricuspid annuloplasty on the donor heart with the De Vega technique; and group II, 15 patients who underwent transplantation without this procedure. Their preoperative clinical characteristics were the same. During the late postoperative follow-up, the degree of tricuspid insufficiency was evaluated by transthoracic Doppler echocardiography and assessed according to the Simpson scale: 0, absent; 1, mild; 2, moderate; and 3, severe. Hemodynamic parameters were evaluated invasively by means of a Swan-Ganz catheter during routine endomyocardial biopsies.

Results: The mean follow-up time was 26.9 ± 5.4 months (range, 12-36 months). In group I, 1 patient (6.6%) died from infection in the 18th month after the operation; the death was not related to the annuloplasty. In group II, 1 death (6.6%) occurred after 10 months because of rejection ($P > .05$). After the 24-month follow-up, the mean degree of tricuspid insufficiency was 0.4 ± 0.5 in group I and 1.7 ± 0.9 in group II ($P < .05$). Similarly, the 2 groups were significantly different with respect to the right atrium pressure, which was higher in group II.

Conclusions: Prophylactic tricuspid annuloplasty on the donor heart was able to reduce significantly the degree of valvular insufficiency, even in cardiac transplantation with bicaval anastomosis; however, it did not modify significantly

the hemodynamic performance of the allograft during the investigation period. It is very important to extend the observation period and casuistics to verify other benefits that this technique may offer.

INTRODUCTION

Tricuspid insufficiency is the most frequent valvular abnormality after orthotopic cardiac transplantation, and its incidence varies widely, between 20% and 85% depending on the definition of the insufficiency and how the diagnosis is done [De Simone 1995; Mielniczuk 2005]. The incidence and seriousness of the disease are dynamic and time dependent because of the involvement of many factors during the follow-up with different weights. Fortunately, most patients present a small degree of insufficiency, which medical therapy resolves very well. The use of surgery is an exception. Severe valvular dysfunction produces signs of right heart failure, and tricuspid valve replacement or repair is indicated only when the medical therapy becomes refractory [Chan 2001; Aziz 2002].

Tricuspid insufficiency after transplantation is usually secondary to valvular lesion, ring dilation, or both, and they may coexist to different degrees. Annular dilation is more common, and it occurs early, depending on the type of operative technique. It is much more frequent with the standard surgery than with bicaval anastomosis; with high pulmonary pressure or high vascular resistance; with failure of myocardial preservation, mainly in the right ventricle; with reperfusion lesions; with rejection; and with heart size mismatch between donor and recipient [Aziz 2002; Mielniczuk 2005]. Later, routine endomyocardial biopsies become the main factor for valvular lesions; endocarditis occurs more rarely [Nguyen 2005].

Some investigators have proposed prophylactic tricuspid annuloplasty of the donor heart to decrease the incidence of early postoperative tricuspid insufficiency after biatrial or bicaval cardiac transplantation without increasing the morbidity for the surgery [Brown 2004; Jeevanandam 2004, 2006; Fiorelli 2007].

The aim of this study was to evaluate the effects on valvular regurgitation of prophylactic tricuspid valve annuloplasty during orthotopic heart transplantation with bicaval anastomosis.

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Correspondence: Alfredo I. Fiorelli, Rua Morgado de Mateus, 126/81, Sao Paulo/SP, Brazil. CEP: 0410-050 (e-mail: fiorelliai@uol.com.br; alfredo.fiorelli@incor.usp.br).

Table 1. Preoperative Clinical Characteristics of Patients Who Underwent Transplantation with and without Tricuspid Annuloplasty*

Variables	Group I (with Annuloplasty)	Group II (without Annuloplasty)	P
Sex, n			
Male	9 (60%)	12 (80%)	<.05
Female	6 (40%)	3 (20%)	
Age, y†	39.9 ± 13.7 (18-60)	43.5 ± 14.1 (16-63)	>.05
Cardiomyopathy, n			
Dilated	8 (53.3%)	4 (26.7%)	<.05
Ischemic	3 (20.0%)	7 (46.6%)	<.05
Chagas disease	4 (26.7%)	4 (26.7%)	>.05
NYHA functional class, n			
IV	8 (60%)	7 (70%)	>.05
IV + inotropic agents	5 (40%)	6 (30%)	>.05
IV + IABP	2 (10%)	2 (10%)	>.05
Hemodynamic parameters			
PVR, Wood units‡	3.1 ± 2.1	3.3 ± 1.9	>.05
PASP, mm Hg‡	45.1 ± 22.1	42.3 ± 27.2	>.05
Preoperative LVEF (echo), %‡	22.5 ± 7.2	26.3 ± 4.8	>.05

*NYHA indicates New York Heart Association; IABP, intra-aortic balloon pump; PVR, pulmonary vascular resistance; PASP, pulmonary artery systolic pressure; LVEF, left ventricular ejection fraction; echo, echocardiography.

†Age data are presented as the mean ± SD (range).

‡PVR, PASP, and LVEF data are presented as the mean ± SD.

CASUISTICS AND METHODS

Since 1985, 478 patients have undergone cardiac transplantation in our institution. After January 2002, we initiated the use of prophylactic tricuspid annuloplasty on the donor heart. This practice was carried out in a nonrandomized fashion; however, the data were collected prospectively. Thirty consecutive patients who had survived more than 6 months were included in this study and were divided into 2 groups: group I, 15 patients who underwent transplantation with prophylactic tricuspid annuloplasty on the donor heart; and group II, 15 patients who underwent transplantation without this procedure. The preoperative clinical characteristics of the patients were similar (Table 1).

Tricuspid valvular annuloplasty was performed during preparation of the donor heart. The procedure was performed through the inferior vena cava orifice by means of the De Vega technique, with a ring size of 29 mm. Orthotopic cardiac transplantation was performed in the 2 groups with a bicaval anastomosis technique as described by Sarsam et al [1993] and Aziz et al [2002].

Data for echocardiographic parameters were made with transthoracic Doppler echocardiography and Doppler flux evaluation. Ventricular function was evaluated by measuring the ejection fraction of the left ventricle (Simpson method). The tricuspid valve was observed in the parasternal and the 4-chamber apical views. The degree of tricuspid insufficiency was quantified according to the regurgitation jet area: 0, absent; 1, mild; 2, moderate; and 3, severe [Mugge 1990]. Hemodynamic parameters were evaluated invasively by means of a Swan-Ganz catheter during routine endomyocardial biopsies.

For statistical analyses, data for continuous variables were reported as the mean ± SD, and the unpaired Student t test was used for comparative analyses of the groups. Categorical variables were expressed as frequencies, with chi-square tests used to compare the 2 groups. A *P* value <.05 was considered statistically significant.

RESULTS

The data for preoperative parameters showed that the incidence of the use of inotropic agents and intra-aortic balloon pumps before transplantation was 50% in group I and 40% in group II. None of the patients had a systemic vascular resistance >6 Wood units or a pulmonary artery pressure >60 mm Hg.

The mean follow-up time was 26.9 ± 5.4 months (range, 13-36 months). Table 2 summarizes both the behavior of the patients' echocardiographic and hemodynamic parameters and the clinical complications that occurred by 24 months after transplantation.

The degree of tricuspid regurgitation was significantly higher in group II than in group I (*P* < .05). This behavior is directly reflected in the values for the right atrial pressure, which was significantly increased in group II compared with group I (*P* < .05).

The 2 groups showed no significant differences with respect to other hemodynamic and echocardiographic parameters, and cardiac output and ejection fraction values indicated that the left ventricular contraction functions of the 2 groups were similar (*P* > .05).

Postoperative complications were distributed similarly in the 2 groups and showed no correlations with the use of tricuspid annuloplasty. One death (10%; *P* > .05), from infection, occurred in group I after 18 months. In group II, there was also 1 death, a patient with ventricular tachycardia of unknown cause who died during the eighth month after transplantation.

DISCUSSION

Tricuspid insufficiency following cardiac transplantation is a universal problem that may compromise the results of the operation. The disease etiology is multifactorial, with distortion and dilatation of the tricuspid annulus occurring principally when the classic technique is used. It is also complicated by interference due to pulmonary hypertension and organ rejection [Chan 2001; Aziz 2002]. The chordal damage

Table 2. Behavior of Echocardiographic and Hemodynamic Parameters and Clinical Complications after 24 Months of Follow-up*

Variables	Group I (with Annuloplasty)	Group II (without Annuloplasty)	P
Echocardiographic parameters			
Degree of tricuspid regurgitation	0.4 ± 0.5	1.7 ± 0.9	<.05
Left ventricular ejection fraction	0.58 ± 0.1	0.60 ± 0.1	>.05
Hemodynamic parameters			
Right atrial pressure, mm Hg	5.8 ± 2.3	12.9 ± 2.7	>.05
Right ventricular pressure, mm Hg			
Systolic	35.2 ± 9.7	32.6 ± 10.0	>.05
Diastolic	4.8 ± 3.5	7.8 ± 2.9	>.05
Pulmonary artery pressure, mm Hg			
Systolic	36.5 ± 9.2	34.7 ± 9.8	>.05
Diastolic	10.7 ± 4.2	12.3 ± 3.9	>.05
Mean	17.6 ± 5.6	16.5 ± 7.1	>.05
Pulmonary capillary pressure, mm Hg	11.8 ± 3.9	12.8 ± 4.3	>.05
Cardiac output, L/min	5.6 ± 0.4	5.1 ± 0.5	>.05
Immediate postoperative complications, n			
Respiratory insufficiency	2 (13.2%)	2 (13.2%)	>.05
Renal insufficiency	3 (19.8%)	2 (13.2%)	>.05
Reversible allograft failure	1 (6.6%)	1 (6.6%)	>.05
Postoperative hemorrhage	1 (6.6%)	1 (6.6%)	>.05
Mediastinitis	0	1 (6.6%)	>.05
Late mortality	1 (6.6%, 18 mo, infection)	1 (6.6%, 8 mo, unknown)	>.05

*Data are presented as the mean ± SD where indicated.

caused by endomyocardial biopsies may lead to severe valvular regurgitation; fortunately, these situations are not common. Most patients with benign tricuspid insufficiency do not present with any symptoms. Tricuspid valve repair or replacement is indicated when right heart failure becomes refractory to conservative medical treatment [Chan 2001; Mielniczuk 2005]. In our experience, only 2 patients (0.4%), who were not included in this study, showed severe tricuspid valve insufficiency. One required valve replacement, and the other, with severe allograft disease, is on a waiting list for retransplantation.

The introduction of transplantation with bicaval anastomoses and the use of a longer sheath passing through the tricuspid annulus for the endomyocardial biopsy have significantly reduced the incidence of traumatic valvular lesions.

The occurrence of chordal tissue in the endomyocardial biopsy from the heart transplant is intimately associated with tricuspid insufficiency, and different studies have used echocardiography to retrospectively analyze the occurrence of such findings [Mugge 1990; Sahar 1997; Aziz 2002; Anderson 2004; Mielniczuk 2005; Nguyen 2005].

In a recent study, we observed a smaller incidence of traumatic tricuspid valve injury after biopsy. Some practices have contributed to reducing this incidence, including carrying out biopsies with team sets, using myocardial gallium scintigraphy as a sorting method, and using a biptome with a long sheath [Fiorelli 2009]. We included these practices in our routine follow-up, and they were used with all patients in this study. In this investigation, we reanalyzed all endomyocardial biopsies and found no tricuspid tissue in the myocardial samples. This finding indicates that annular dilatation has more of an impact on the genesis of valvular insufficiency.

The superiority of cardiac transplantation with bicaval anastomosis is well known. This procedure reduces tricuspid valve insufficiency compared with the classic technique because it produces smaller allograft distortion during implantation [Mugge 1990; De Simone 1995; Fiorelli 2007]. Aziz et al [2002] reported that the use of bicaval anastomosis was able to reduce the incidence of tricuspid insufficiency in orthotopic heart transplantation from 51.0% with the classic technique to 19.9% with the bicaval technique.

The configuration of the right ventricle makes the tricuspid valve more susceptible to distortion than the other valves, and for this reason this valve is more often damaged during transplantation. Regurgitation of the mitral, aortic, and pulmonary valves occurs less frequently. The progression of tricuspid annular dilatation secondary to pulmonary hypertension or ischemia lesions plays an important role in this disorder, and there is little that can be done. Orthotopic transplantation with bicaval anastomosis is not totally free from this problem, however. Many groups have incorporated prophylactic tricuspid annuloplasty of the donor heart with the objective of reducing the possibility of later valvular insufficiency, because severe valvular injuries can shorten a patient's survival [Jeevanandam 2004, 2006; Nguyen 2005].

In 2004, Jeevanandam et al reported the first randomized study of prophylactic tricuspid valve annuloplasty on the donor heart [Jeevanandam 2004]. After a year of follow-up, this technique produced an immediate improvement in cardiac function in terms of better right ventricle behavior and reduced perioperative mortality. More recently, these investigators confirmed these expectations with an increase in casuistics and a longer follow-up [Jeevanandam 2006]. In another investigation, the authors reported similar experience with tricuspid annuloplasty in patients who underwent transplantation with the biatrial technique and concluded that there was a significant reduction of valvar regurgitation [Jeevanandam 2006]. It is very important to emphasize that the benefits of annuloplasty with the classic technique are more evident because of the higher valvar distortion [Brown 2004].

Our study was motivated by the real benefits that prophylactic tricuspid annuloplasty in the donor heart can offer to patients and by a necessity of increasing our experience with

this technique. The absence of tricuspid tissue in endomyocardial biopsies and the low pulmonary pressure observed in our patients suggest that annular dilatation plays a more important role in the development of valve regurgitation than other factors. We believe that tricuspid annuloplasty can help to contain annular dilation and thereby delay the appearance of valvular insufficiency or avoid malign forms. Nevertheless, it is extremely desirable to continue this investigation because the initial results have been very favorable. There was no increase in either mortality or morbidity, and there were no technical difficulties.

Limitations of the Study

The limitations of this investigation are that the data were collected prospectively and analyzed retrospectively, the study involved the participation of a single center with a small number of cases, and the study was nonrandomized.

CONCLUSIONS

Prophylactic tricuspid annuloplasty on the donor heart significantly reduced the degree of valvular insufficiency, even in cardiac transplantation with bicaval anastomosis; however, the procedure did not significantly modify the hemodynamic performance of the allograft during the investigation period. It is very important to extend the observation period and increase the number of cases to verify other benefits that this technique may offer.

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