

Ventricular Mechanical Support

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In this issue of the Argentine Journal of Cardiology, Bertolotti et al. from the Hospital Universitario Fundación Favaloro (1) present excellent results with the Levitronix CentriMag® centrifugal flow pump in patients with cardiogenic shock. With this centrifugal flow pump, whose magnetically levitated rotor is the only mobile piece, femoral arteriovenous implantation with extracorporeal membrane oxygenator (ECMO) or left atrioaortic or right atriopulmonary implantation can be performed. Its clinical application has attracted great interest: simple and easily transportable management that represents an excellent alternative to hospitals without cardiac transplantation program, univentricular or biventricular support, high flows reaching up to 10 L / min, low hemolysis, low thromboembolism, albeit requiring anticoagulation, and low cost. (2) In my personal experience, out of 102 assist device implantations during the 1987-2011 period, 32 were with Levitronix CentriMag® pump, becoming the most implanted assist device since 2006. Although authorized as Class I support up to 30 days, we also use it as Class II support, with pump replacement every four weeks.

The results reported by Bertolotti et al. (1) show 40% mortality. It is an excellent result and it would be more representative to describe 60% survival since all the patients had refractory cardiogenic shock in INTERMACS 1, despite inotropic support; therefore, survival without support would have been null. Is support justified considering the price and that the healthcare system cannot provide unlimited benefits with limited resources? Lack of survival in this group of patients without support justifies the treatment. Moreover, the reduced price of CentriMag® assist device compared to other Class II and III medical assist devices is validated as bridge to decision in patients requiring long-term support, gaining precious time to assess patient viability.

Is the cost-benefit and cost-utility ratio justified, especially as a conclusive therapy? Any new treatment is asked to improve survival and quality of life.

These achievements can change the cost and reduce hospitalizations and interventions. The annual cost of a patient with heart failure in Europe is € 6000, with hospitalizations representing 70 % of expenditure. (3) However, in Grade D heart failure, the annual cost increases to 20000 €, (4) similar to Class II support and equivalent to 70 % resynchronization pacemaker cost and 30% of Class III ventricular assistance. The support benefit is higher than that obtained with cardiac resynchronization and the implantation of a defibrillator, (5) whose application is accepted for a significant number of patients awaiting transplantation, representing 35% in my experience. In the REMATCH study, the average cost per patient was US\$ 250000 (including the system's US\$ 65000), comparable to the cost of heart transplantation in the United States (US\$ 205000), liver transplantation (US\$ 250000) and patient medical treatment in NYHA Class IV.

Bertolotti et al.'s (1) article reading is an excellent opportunity to make multiple reflections and pose ourselves several questions which we have not yet fully answered:

A. When to implement support and how long should it be maintained? The leading cause of death in both Bertolotti et al.'s article (1) and in the SECTCV Spanish Registry of Circulatory and Respiratory Assistance is multiple organ failure despite high flows, resulting from heart failure and pre-implant cardiogenic shock. Hence the importance of timely implantation, neither too early nor too late, because desperate measures often fail and unloading the cardiologist's consciousness should not be a sufficient implantation criterion. A strategy that gives good results is to indicate support as soon as we feel the patient may need it.

In Bertolotti et al.'s article, (1) the average support time was 6 days. In our series, the average time was 22 days in the bridge to transplantation group, even though support involves urgent code and high transplantation probability in the next few days, and 48 days in the bridge to recovery group. (2) While in the 1980s and 1990s, the patient was included in the

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waiting list immediately after implantation, the strategy was changed since 2000, giving priority to the resolution of multiple organ failure under support, performing transplantation after recovering the hematologic, hepatic, renal and neurological functions. The average support period as bridge to recovery, which represents 17 of the 102 patients in our experience, has been 48 days, since although recovery in patients with myocarditis may occur in a few weeks, those who have suffered acute myocardial infarction with cardiogenic shock require more than a month and those with dilated cardiomyopathy several months before support withdrawal.

B. Should support indications as bridge to recovery increase? Support as bridge to recovery was reserved for patients with myocarditis, alcoholic cardiomyopathy and selected cases of primary graft failure. However, evidence of recovery in patients with support as bridge to transplantation, its correlation with molecular biology studies and the development of recovery techniques have generated increasing interest, justifying the periodic evaluation of recovery in patients in the waiting list for transplantation.

C. Univentricular or biventricular support? Biventricular support has been implemented in 50 % of patients in the SECTCV Spanish Registry of Circulatory and Respiratory Assistance and in 95 % of patients in Bertolotti's study. (1) Patients with right ventricular dysfunction or pulmonary hypertension require biventricular assistance. Other patients require implantation of temporary right assist device in the early post-operative period after implantation of the left assist device, as a result of changes in the right circulation generated by the left assist device operation. In our series, the percentage of patients with biventricular support is 32% and has been further reduced in the last decade. (2) This is because we avoid premature overload through limited flows during the first two days, i.e. support is begun with a reduced flow which is gradually increased, reaching the ideal cardiac output at 48-72 hours.

D. Does pulsatility bring advantages to the support system? Assistance with Levitronix CentriMag® centrifugal flow pump and new Class III HeartMate and HeartWare medical assist devices are not pulsatile. Our group has experimentally shown that pulsatile centrifugal pump support preserves better the structure and function of the lungs, liver and kidneys than nonpulsatile support. (5-8) Therefore, in patients with CentriMag® centrifugal flow pump we have maintained for several days the intra-aortic balloon pump assistance before implantation. However, recent studies in Class III assistance suggest that the reversal of pulmonary hypertension is more effective with continuous flow pumps than with pulsatile pumps. (9) The reduction of pulmonary hypertension is a consequence of the reduction in left ventricular filling pressure. Pulsatile flow pumps reproduce the physiology of the cardiac cycle, while continuous flow pumps reduce left ventricular pressure during the whole cardiac cycle,

improving ventricular geometry restoration.

E. Is ventricular assistance an alternative to heart transplantation? Ventricular assistance as bridge to transplantation has represented, until now, most indications. Donor-recipient disparity, heart failure reversibility, treatment integrations and the development of new support systems must change this perspective, expanding support indications and reducing the main role of support as bridge to transplantation: a) definitive assistance in patients with transplantation contraindications is a reality. The results of the HeartMate and HeartWare systems compete, in terms of survival and quality of life, with cardiac transplantation in high-risk patients. b) Left ventricular assistance with Class III centrifugal and axial flow pumps for 3-6 months reduces fixed pulmonary hypertension and is an accepted strategy for the inclusion of patients in the waiting list for transplantation. c) The possibility of recovery and support as definitive treatment extends support indications and does not rule out assistance implantation in patients with heart transplantation contraindications.

The growing interest of heart failure reversibility and the application of new alternatives have generated therapeutic strategies designed to integrate biology and medical technology and thus act on the biomechanical, molecular and neurohormonal mechanisms of heart failure. (10) Treatment should consider the biomechanical model of heart failure as well as the therapeutic approach to neurohormonal activation, apoptosis and changes in the extracellular matrix. The optimization of new surgical restoration techniques, passive constriction and ventricular support as definitive therapy or bridge to recovery requires confirmation of Torrent-Guasp's heart model. (11, 12) Improvement in the spatial resolution of medical imaging and computational techniques should be able to answer questions about fluid dynamics with heart failure and in ventricular assistances. (13)

Ventricular support has begun a new era through the experience acquired over the past three decades and the recent addition of new, less aggressive, simple and small Class I and III support systems. To the traditional bridge to transplant indication a growing interest has been generated by its indication as bridge to recovery of the native heart and as definitive support therapy. (14) However, for health systems to accept and support this treatment, it is necessary to involve cardiologists in clinical trials and enhance the cost-benefit and cost-utility studies with larger series and lower associated patient morbidity.

Conflicts of interest

None declared

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