Limited mechanical circulatory support following orthotopic heart transplantation

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Abstract

Shortage of donors enhances harvesting of borderline hearts. When such organs fail, a ventricular assist device may salvage the patient waiting for either recovery or for retransplantation. We describe a series of 12 patients who required circulatory support following orthotopic heart transplantation, with the use of four different devices. Four patients survived. The aim of this study is to define: (1) what is the best timing for implantation; (2) which is the best ventricular assist device in this indication; and (3) a subgroup of acute right heart failure with a specific outcome.

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1. Introduction

A constant number of orthotopic heart transplantations need mechanical circulatory support for refractory cardiac failure. In these cases, in spite of intensive pharmacological therapy, the hemodynamic conditions following the cardio-pulmonary bypass (CPB) indicate the necessity of a mechanical circulatory support. Then we have to choose the type of system and the optimum time of intervention for its implantation. The aim of this study was to define the best strategy in this usual problem, with an experience of four types of mechanical circulatory supports in 12 refractory cardiac failures following orthotopic heart transplantation. We individualized a subgroup of patients with right ventricular assist device and specific results.

2. Patients and methods

Between 1987 and 2003, 1095 heart transplant procedures were performed at our center. Among these transplantations, 12 needed mechanical circulatory support for refractory cardiac failure. All these 12 patients were in end-stage heart failure before transplantation; 9 suffered from idiopathic cardiomyopathy, 2 from severe ischemic cardiopathy and 1 from familial hypertrophic cardiomyopathy. Four patients had received a biventricular Thoratec® support before transplantation. All the recipients were males with a median age of 39 years (ranged 18 to 57 years). The median age of the donors was 43 years (ranged 15 to 58 years). Recipients and donors were matched for body weight and size, as well as blood group compatibility. Before transplantation the median pulmonary arterial resistance was 3.5 Wood units (ranged 1.7 to 8.6 Wood units). All pulmonary hypertension was reversible under a dobutamine or nitric oxide test. During the orthotopic heart transplantation procedure, mechanical assist devices were implanted for primary graft failure (n=7) and for acute right heart failure (n=5). There was no acute rejection. Among the primary graft failures, 5 patients received a Jarvik 7 device, 1 patient received a peripheral extracorporeal membrane oxygenation (ECMO), and 1 patient received a Nippon Zeon assist as left ventricular support. Among the right heart failures, 4 patients received a Biomedicus centrifugal pump as right ventricular support and 1 patient received a peripheral ECMO. The median pulmonary arterial resistance in this subgroup of right heart failures was 2.8 Wood units (ranged 1.7 to 4 Wood units). The median ischemic time of grafts was 168 min (ranged 62 to 245 min) and the median support time was 168 h (ranged 3 to 744 h). In all right cardiac failures, pharmacological therapy included the administration of catecholamines, phosphodiesterase-III-inhibitors, prostaglandin derivatives and nitric oxide nebulization before the necessity of support.

3. Results

In the subgroup of four patients with right ventricular assist device therapy due to right heart failure of the transplanted organ, three patients were weaned from Biomedicus centrifugal pump 7 days after implantation. Another patient was weaned from peripheral ECMO 7 days after implantation. One patient with Jarvik assist implanted...
Table 1
Outcome during the support

<table>
<thead>
<tr>
<th></th>
<th>Biomedicus</th>
<th>Jarvik</th>
<th>ECMO</th>
<th>Nippon Zeon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-transplanted</td>
<td>–</td>
<td>1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Weaned</td>
<td>3</td>
<td>–</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td>Alive</td>
<td>3</td>
<td>1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Severe bleeding</td>
<td>–</td>
<td>3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Death/sepsis</td>
<td>–</td>
<td>1</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td>Death/dysfunction</td>
<td>–</td>
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<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Death/multiorgan failure</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

31 days earlier, was retransplanted. All these patients are alive except the patient weaned from peripheral ECMO who died in due course because of sepsis. All the other patients died, in spite of mechanical support, from multiple organ failure and sepsis (Table 1). We did not observe any neurological complications during support. The median time of the delay between the arrest of the CPB and the support implantation was 30 min (ranged 0 to 2880 min). This delay was contained between 0 and 30 min in all the survivors. In the subgroup of right ventricular support the indication of support was decided in the operating room in all cases.

4. Discussion

Unsuccessful transplantation can be explained by right heart failure, primary graft failure, and acute rejection. In such cases, mechanical circulatory support facilitates hemodynamic stability until the transplanted heart is recovered [1], or until a new heart has been found for retransplantation [2]. The choice of the system and appropriate time selection to assist a failing transplanted heart depends on the individual diagnosis and on the hemodynamic instability. Considering our results, we advocate to assist failing transplanted hearts immediately, to avoid irreversible myocardial damage, increased total CPB time and increased inotropic requirements [3]. Furthermore, we advise an early implantation of the support to avoid the development of multisystem organ failure. Using a centrifugal pump allows this early implantation which might explain the better results observed in this group of patients. According to these results we advocate using a centrifugal pump [4] instead of pulsatile devices in this situation. The advantage of the Biomedicus centrifugal pump is its rapid implantation [5]. An unfavorable factor is when the pulmonary artery pressure (PAP) becomes suprasystemic and disturbs the working of the pump. Regarding our good results in the subgroup of 4 patients with right ventricular assist device, we consider that the Biomedicus centrifugal pump is the method of choice for isolated right-heart support without suprasystemic PAP. The advantage of the peripheral ECMO is its easiness to remove it without opening the chest. Another advantage is that, if the predominance between left cardiac failure and right cardiac failure is difficult to determine, it treats both of them. By means of these supports, the weaning is often possible after short-term support; in our experience the optimal time is 7 days. Nowadays the number of the donors is limited and the remaining heart grafts are not so efficient compared with the past. This specific approach using quick limited assistance in heart transplantation with difficult hemodynamic conditions could encourage us to do more heart transplantsations in spite of the limitations, which can be overcome by limited mechanical assistance.

References