The good, the bad, and the ugly: Contemporary options for biventricular support

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Implantation of a long-term mechanical circulatory support device occurred for the first time in 1982, with the implantation of a total artificial heart (TAH) in Barney Clark, MD.¹ Now, more than 3 decades later, the field has evolved substantially, having gone through several paradigm shifts along the way. Left ventricular assist device (LVAD) strategies have largely supplanted cardiac replacement, with the goals of therapy evolving to include “bridge to transplant” and “destination therapy.” Although LVAD technology has transitioned, from pulsatile, to axial and centrifugal flow strategies, the currently approved, long-term biventricular support options bear a striking resemblance to the TAH that was implanted in Dr Clark.

Copeland and colleagues² present a contemporary analysis of biventricular support in their analysis of 408 patients reported to the United Network for Organ Sharing database. In this bridge-to-transplant population, biventricular support was associated with worsening 1- and 6-month survival rates (83% and 68%, respectively), compared with LVAD support (98% and 93%, respectively). Relative to the TAH outcomes presented in 2004 (1-year survival of 70%),² these data suggest that little progress has been made in the treatment of biventricular failure.

In contrast, LVAD outcomes have improved from the early HeartMate II (Thoratec Corporation, Pleasanton, Calif) experience; 6-month survival was reported³ at 75% to 91% in the postapproval data,⁴ and at 92.7% (including all devices) in the current study. In addition, the authors compared various strategies for managing the failing right ventricle. Perhaps as a result of the relatively small sample size, statistical differences were not seen among the various approaches described. As the authors suggest, device selection for biventricular support is often driven by patient characteristics and center experience, rather than by perceived outcomes or anticipated waiting times. From this important analysis, a few general observations are worth noting.

THE GOOD

In selected patients, the Syncardia TAH (SynCardia Systems, Inc, Tucson, Ariz) offers a reasonable strategy for

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Central Message

Biventricular failure presents unique challenges, with outcomes that have failed to keep pace with the progress in managing left ventricular failure alone.

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bridge to transplant, accounting for the majority of implants (172 patients) in the present series. However, size constraints have limited the widespread adoption of this technology, with few centers implanting >5 of these devices annually. Perhaps the availability of the 50-cc design will expand the pool of eligible patients.

THE BAD

Despite the fact that patients who underwent right ventricular assist device insertion after LVAD insertion were excluded, many of the 110 patients that were managed with a CentriMag (Thoratec) right ventricular assist device were likely cases in which the intended approach was to use an LVAD only, with subsequent failure to wean from cardiopulmonary bypass. This strategy, in comparison with planned biventricular support up front, has been shown to decrease survival to discharge.⁵

THE UGLY

Historically, implantation of a Thoratec percutaneous ventricular assist device has been associated with a 60% survival to transplant.⁶ As device technology becomes increasingly miniaturized, paracorporeal approaches likely will be reserved for patients with a low body surface area. The increased mortality rate described in patients who have a higher body surface area (4th quartile) further supports this assertion.

Despite the fact that only 28 patients in this series were implanted with a continuous flow biventricular support

FIGURE 1. Using the HeartWare device for long-term right-sided support can be accomplished by anchoring the inflow cannula to the tricuspid annulus, through the free wall of the right ventricle. The PA is amputated with end-to-end anastomosis of the RVAD outflow graft to the distal PA, and drainage of the proximal PA to the right atrial appendage. PA, Pulmonary artery; RV, right ventricle; LV, left ventricle; RVAD, right ventricular assist device; LVAD, left ventricular assist device.

strategy, this option seems to be gaining traction in the medical literature.^{7,8} Amidst the operative challenges associated with this type of procedure, our group at the Mayo Clinic has recently described a technique whereby the HeartWare (HeartWare International, Inc, Framingham, Mass) device can be secured to the tricuspid annulus via

the right ventricular free wall, connecting the outflow graft to the pulmonary artery with an end-to-end anastomosis and draining the remnant of the right ventricle by a connection to the right atrial appendage (Figure 1).

CONCLUSIONS

The data presented here have important implications for the field. Biventricular failure presents a formidable challenge to improving outcomes, compared with left-sided support strategies. In the absence of a large patient population to drive demand for major technologic advances, consideration should be given to revising the organ prioritization scheme, which fails to account for the differences in outcomes described here. In the absence of a right-ventricle-specific assist device platform, optimizing use of the existing technology may represent the best approach to managing the difficulties associated with treating these patients. Toward that end, this work represents an important step in understanding the complexities and limitations of biventricular support in the current era.

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