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Partial Support in Chronic Heart Failure

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Abstract

Partial left ventricular assist device (LVAD) support offers several advantages in treating chronic heart failure. It also raises concerns about insufficient support, worsening symptoms, and impediment of myocardial recovery. The clinical trial results for the CircuLite device (Medtronic) have shown that close monitoring can ensure improved outcomes for partial support. Another study on the ovine model demonstrated that partial and full support have similar effects regarding reverse remodeling. Thus, patients receiving partial LVAD support need regular follow-up care. Clinical assessment of symptoms and organ function must be used alongside objective judgment of patients' needs to ensure support levels are appropriately adjusted.

Keywords: echocardiography, heart failure, hemodynamics, partial support, left ventricular assist device

Advantages of Partial Left Ventricular Assist Device Support

There are several advantages to running a left ventricular assist device (LVAD) at partial support levels.[1] In both the immediate post-operative and chronic phases, partial support results in less risk for suction. Another advantage of running pumps at lower speeds is the reduced risk of aortic valve regurgitation. In addition, more washout of the pump is possible. Finally, smaller pumps can be inserted when only partial support is needed, and minimally invasive approaches can be utilized.[2] However, one can intuitively consider the disadvantages of partial support. The risks have been reported and were explored in this presentation.

Disadvantages of Partial Left Ventricular Assist Device Support

Will heart failure symptoms increase?

If insufficient support is provided to the patient, heart failure symptoms could be exacerbated. Thus, the support of each patient must be optimized. Uriel et al. demonstrated that combined invasive hemodynamic and echocardiographic Ramp tests could help optimize the care of patients with LVADs.[3] This study identified the need for repetitive Ramp testing as patients' needs (for both speed [rotations per minute/RPM] and medicinal management) can change over time. In a follow-up study (NCT03021239), the group underscored the importance of conducting tests that both increased and decreased the RPM settings.[4] The study demonstrated that such repetitive testing and the associated adjustments resulted in clinical benefits.

Data collected from the clinical trial for the CircuLite device (Medtronic) supports the theory that close monitoring can ensure improved outcomes from partial support.[4] The CircuLite device requires an atrial cannulation; thus, users were obliged to run the device at partial support levels (2.5-3.0 L/min). The system evolved through four versions, during which the surgical implant procedure was optimized, and patient selection criteria were refined. Between 2007 and 2013, 66 European patients were enrolled in the "Conformite Europeenne" (CE) mark trial. The Universitair Ziekenhuis (UZ) Leuven Center enrolled 30 patients (26 of those were included in the CE-mark trial, and the other four were commercial patients). The unique atrial cannulation allowed the use of this device in patients that are difficult to serve with other LVADs, such as patients with restrictive cardiomyopathy or systemic right ventricle. The trial showed that patients did sustain hemodynamic performance with regard to increased cardiac output and decreased pulmonary capillary wedge pressures (both P values were less than 0.001). In addition, organ function (creatine levels) and quality of life measures significantly improved through the chronic follow-up period. Unfortunately, the trial was stopped due to a number of pump-related adverse events. However, the evidence demonstrated the successful treatment of chronic (not acute) heart failure with partial support, and no aortic regurgitation was noted as a complication in this experience.

Will partial support impede myocardial recovery?

Some argue that partial support could inhibit the ability of myocardial tissue to recover because the ventricles are not being unloaded. The concern comes from studying the first explanted hearts that received partial support.[5] Reverse remodeling was observed when ex-vivo end-diastolic pressure-volume relationships (EDPVRs) were evaluated; the level of remodeling in partially supported hearts was less when compared to those that received full support. Importantly, the observations were collected over a short period of time (mean of 50 days of support) in a small number of patients. We know from other studies[5-7] that true myocardial recovery takes several months; thus, this initial evidence may not be as strong as once believed.

In light of this, we used a chronic heart failure animal model to study ischemic cardiomyopathy.[8] Briefly, the proximal left anterior descending artery (LAD) is occluded for one hour, and the mid-LAD and mid-D2 are permanently ligated. Sheep were randomized at six weeks of age (Table 1). At 12 weeks, all animals were sacrificed, the VADs were explanted, and autopsies were performed. End-diastolic and end-systolic volumes were measured by magnetic resonance imaging (MRI) at 6 and 12 weeks. The ventricle volumes of animals in the control and medical management alone groups were further dilated. No change in volume was noted for the full support group, but both partial support groups demonstrated a decreased volume (reversed remodeling) at 12 weeks. Likewise, the partial and full support groups noted a significant reduction in myocyte hypertrophy compared to the control group. Thus, the mechanisms of reverse remodeling may be related to the level of mechanical support, and the effect of partial support is greater than or equal to that of full support. Of note, medical management alone seems to have limited effects. The plasma renin level was normalized by mechanical support alone.[9]

Table 1. *Experimental Group Assignments. Abbreviations: VAD, ventricle assist device; ACE-1, angiotensin-converting enzyme one; ARB, angiotensin receptor blocker*

	VAD Support	Medical Support
Control	None	None
Medical Management Alone	None	ACE-1 + ARB
Full Support	Full	None
Partial Support w/Medical	Partial	None
Partial Support w/o Medical	Partial	ACE-1 + ARB

Conclusion

All patients with VADs require optimized heart failure management. Without question, patients have a wide range of needs that often evolve. Thus, patients need regular follow-up care and adaptation of support levels (RPMs/Ramp testing) and medications. Adjustments should be guided by clinical assessment of symptoms, organ function, fluid status, and N-terminal pro-brain natriuretic peptide (NT-proBNP) levels. Furthermore, VAD systems need to be able to adapt to patient needs, whether they be for full or partial support. One suggestion to improve future management is to add real-time sensors (i.e., left

ventricular pressure and end-diastolic pressure) to improve the monitoring of patients so that physicians can determine whether partial or full support is needed. Currently, we have to use clinical parameters (which are invasive) and can change quickly.

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