Cardiac Rehabilitation in Left Ventricular Assist Device Recipients

Can it Bolster the Benefits of Restored Flow?*

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In appropriately selected advanced heart failure (HF) patients, treatment with a left ventricular assist device (LVAD) is associated with significant improvements in physical function and quality of life (QOL) (1). However, despite these improvements, impairments persist, with functional capacity frequently ≈50% of predicted (2–6) and gains in both physical function and QOL lagging behind those of heart transplantation recipients (2,6,7). Cardiac rehabilitation (CR) has been shown to increase exercise capacity, reduce HF symptoms, and improve the health status in patients with chronic stable HF who have a reduced ejection fraction (HFREF) (8,9), prompting the Centers for Medicare and Medicaid Services to recently expand CR coverage to this patient population. However, it has not been established if conventional CR provides additional benefit to LVAD recipients.

The body of literature regarding the feasibility, safety, and efficacy of exercise training in contemporary, continuous flow LVADs is very limited and includes 2 small (n = ≤15) prospective, randomized trials (10,11), a nonrandomized prospective study (12) (n = 70), and a retrospective cohort study (13) (n = 11 LVAD recipients). The exercise interventions in these studies all included endurance training conducted either at home (11,12) or supervised in a facility (10,13). Exercise was initiated as early as before hospital discharge (10) and as late as 6 months post-implantation (11). Endurance training was combined with various other modes of exercise, such as strength training (10,13) or inspiratory muscle training (11), as well as with nonexercise interventions (12). Only the larger, nonrandomized study (after 18 months) demonstrated a significant improvement in exercise capacity in the intervention group compared with the control group (12). The other studies consistently showed improvement in functional capacity and health status in those who received the study intervention, but did not demonstrate significant improvement compared with the benefits achieved with LVAD therapy alone.

The study by Kerrigan et al. (14) presented in this issue of JACC: Heart Failure is, to our knowledge, the largest prospective, randomized trial of exercise training in LVAD recipients to date, and it makes a significant contribution to the existing small body of literature. The investigators randomized 26 LVAD recipients in a 2:1 fashion to 6 weeks of endurance-based CR or usual care beginning approximately 3 months post-LVAD implantation. Adherence to the exercise intervention was excellent (84% completed by 6 weeks) as was retention, with 88% of the patients completing follow-up assessments. Exercise training was generally well-tolerated, with only 1 adverse event (syncope and wide complex tachycardia) in >300 training sessions. There was a significant increase in peak oxygen consumption (VO₂) (10%) in those who received CR; however, similar to previous studies, this was not significantly different than the change in peak VO₂ in those randomized to usual care.

Despite ongoing LVAD support, peak VO₂ remained impaired in both study arms. The limited improvement in peak VO₂ seen here and in other

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studies (2-5) seems contrary to clinical trial data that showed significant improvement in physical function, HF symptoms, and health status with LVAD therapy (1). This apparent discrepancy underscores our limited understanding of the determinants of exercise capacity and associated QOL, as well as the relative importance of peak VO₂ (15) in LVAD recipients.

Fortunately, the paper by Kerrigan et al. (14) provides additional insights into the potential benefit of exercise training in LVAD recipients. Of note, there was a statistically and clinically significant improvement in health status with exercise training. Interventions to further improve patient-centered outcomes are an important priority, especially for patients living with LVADs as destination therapy. In addition, this was the first study of continuous-flow LVAD recipients to report a change in strength in response to exercise training. Baseline leg strength was approximately half that observed in an age-matched healthy cohort. Although not specifically targeted by the study's endurance-based intervention, leg strength improved significantly in the CR group compared with the control group.

The importance of skeletal muscle function in patients receiving LVADs is gaining increased attention. Skeletal muscle weakness is an important marker of frailty and has been associated with an increased risk of poor clinical outcomes following LVAD implantation (16). Kerrigan et al. previously showed that leg strength was associated with health status in LVAD recipients, and that leg strength was potentially more important to physical limitations than peak VO₂ (17). Peripheral factors, including decreased muscle bulk and a shift in skeletal muscle fiber type and capillary density, contribute to functional impairments in chronic stable HFREF patients (18). Persistent functional impairments despite hemodynamic support from an LVAD suggest peripheral factors might continue to limit physical function and diminish QOL in LVAD recipients. Many of the skeletal muscle abnormalities associated with chronic HFREF are responsive to exercise training, and the findings by Kerrigan et al. suggest a potential beneficial role for this therapy in LVAD recipients as well.

In conclusion, although the evidence regarding the role of exercise training in LVAD recipients is very limited, the present study by Kerrigan et al. (14) supports the feasibility, safety, and potential for benefit. With better knowledge of the functional impairments that persist with LVAD support and their impact on health status and clinical outcomes, the growing population of patients living with LVADs may be able to realize the benefits of exercise therapies tailored specifically to their needs. Given all that is asked of patients to undergo LVAD implantation and the significant resources utilized for their care, the goal is to maximize the benefit, and exercise training is likely one important step in making that a reality.

**REFERENCES**


with end-stage heart failure, heart transplant patients, and left ventricular assist device recipients. Transplant Proc 2013;45:3381-5.


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