EXERCISING THE PATIENT WITH A MECHANICAL CIRCULATORY SUPPORT DEVICE

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In its third annual report, the Interagency Registry of Mechanically Assisted Circulatory Support (INTERMACS) reported that 2868 patients received implantation of one or more durable support devices between June 23, 2006 and September 30, 2010. The number of mechanical circulatory support devices (MCSD) has increased from 100 total implants per year in 2006 to 668 total implants per year through 06/2010, a 568% increase. The majority of these devices are implanted as bridge to transplant therapy even though the number implanted for destination therapy continues to increase. The time on the waiting list and the severity of illness of the patient awaiting heart transplant have also increased. This has led to the increasing use of MCSD to keep patients alive until heart transplant. The most recent report of the Registry of the ISHLT stated that approximately 33% of transplant recipients in 2009 were bridged with a MCSD. The advent of continuous flow (CF) therapy has improved survival to its currently reported two-year survival of 80%. In the most recent INTERMACS reporting period (01-06/2010) 98% of all ventricular assist devices (VAD) implanted were CF pumps. For patients with biventricular failure, the Cardiowest total artificial heart (TAH) is the most effective bridge to transplant with a success rate of 79%.

In addition to prolonged survival, MCSD offers patients the opportunity for enhanced quality of life by improving end organ function and activity tolerance. Advancements in device technology have led to increased portability, patient acceptance, and ability to participate in further activities of daily living. Additionally, patients can undergo physical rehabilitation and/or cardiac rehabilitation to further improve functional capacity, including patients who may have previously been bedridden.

There is however a distinct lack of studies examining the effects of exercise in MCSD patients. To date most of the literature regarding exercise capacity/therapy in these patients has been based upon 1st generation or displacement VADs. These studies support the safety and efficacy of exercise testing/intervention in the VAD patient. Although exercise capacity is generally improved with VAD support, it is generally lower compared with post-heart transplant patients. Exercise capacity in the MCS patient ranges from 14-24 ml.kg.min for peak VO$_2$ although it remains at about 50-60% of predicted compared with normal.

In contrast, de Jonge et al. found that peak VO$_2$, 12-weeks after VAD implant did not differ significantly with peak VO$_2$ at 12-weeks after heart transplant. In this study all patients were started on an intensive post-operative rehabilitation regimen as soon as they were able to mobilize. This alludes to the importance of exercise intervention after VAD implant to optimize functional capacity.

With the advent of CF pumps there has been concern about their effects on exercise hemodynamics. Previous studies have suggested axial-flow rotary pumps provide similar degrees of pressure unloading but less volume unloading of the left ventricle as compared with displacement pumps which may impair exercise performance. Haft and colleagues seem to rebut this suggestion with their finding that exercise performance was similar in those with a CF pump compared with displacement pumps.

The primary goal of exercise rehabilitation with the VAD patient is independent ambulation. The early goals of post-operative mobilization are to offset iatrogenic deconditioning and regain independence. This starts with physical therapy intervention to improve bed mobility, transfer ability, gait, and facilitate pulmonary toilet. Patients are gradually advanced until they can tolerate independent hallway ambulation and then may participate in dynamic aerobic activities such as treadmill or bicycle-ergometer exercise. The exercise prescription for the MCSD patient is similar to that of heart failure with precautions taken for device management. Contraindications to exercise are similar to that of patients with cardiovascular disease. Factors to consider include pre-MCSD physical condition, sternal precautions, arrhythmias, RV failure, post-surgical anemia, hemodynamic stability, and neurological status.
Early mobilization can be progressed using American College of Sports Medicine guidelines for exercise prescription for patients with cardiac disease. Frequency can range from multiple bouts per day to 3-5 days/week as the patient progresses. Intensity is to tolerance if asymptomatic with an RPE < 13 on 6-20 scale. Time can start with 3-5 minute interval bouts as tolerated with progression towards 10-15 minutes continuously before intensity is further augmented.

In the post-acute period (i.e. ≈ 6-8 weeks post-implant) it is reasonable to expect that patients should be able to perform 20–30 minutes or more of moderate intensity aerobic exercise at approximately 3 metabolic equivalents (METs). Once appropriate, the exercise prescription can be further refined with cardiopulmonary exercise testing. This can allow for targeted exercise intensity and be used to provide activity guidelines.

Device-specific factors to consider are drive-line site immobilization, anticoagulation, volume status, pump speed, recognition of device-malfunction alarms, patient independence with power source transfers, and hemodynamic monitoring. All patients should immobilize the percutaneous lead with an abdominal binder to prevent trauma to the driveline exit site. Volume status can be ascertained from device console parameters and blood pressure measurement. Device flows of <3 L/min can indicate device failure and is a contraindication to participation. Changes to pump speed can influence native LV contribution and device flow. Presence of device alarms lead to the cessation of exercise until proper functionality is restored. Patients must be instructed on how to transfer power sources independently to allow increased ambulation and ADL participation. Conventional blood pressure measurement with the use of a stethoscope or automatic monitor may not be accurate in patients with CF pumps. Auscultation with a Doppler-probe and sphygmomanometer is recommended. In general, mean arterial blood pressure measurements should be 70-80 mm Hg. However, Doppler obtained blood pressures can occur at any point during the cardiac cycle but may not represent true systolic, diastolic, or mean values.

In the TAH patient, pump pressure and rate is set by the physician to optimize cardiac output and systemic blood pressure. These fixed settings allow some exercise-induced increase in cardiac output via enhanced venous return. TAH patients can safely participate in exercise training as early as 2 weeks post-implant and demonstrate improvements in exercise capacity. The exercise blood pressure response in the patients is blunted which seems to limit exercise tolerance at ≈ 3 METs.

In summary, the number of MCS devices implanted continues to increase. MCSD support improves exercise capacity yet remains suboptimal. Few studies of exercise intervention confirm safety and efficacy with a stable patient with proper precautions taken for device management.

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References:


