Hemodynamic exercise response in calves with an implantable biventricular centrifugal blood pump


Abstract
An implantable biventricular assist device (BVAD) has been developed at Baylor College of Medicine using 2 centrifugal blood pumps. The aim of this study was to investigate the exercise-reflex response during nonpulsatile biventricular assistance and to evaluate to which degree the autoregulation of the system would accommodate the changed hemodynamic situation during physical exercise. The Baylor Gyro PI 710 BVAD has been implanted into 2 calves (strain half-Dexter) in a biventricular bypass fashion with native heart remaining. Allowing a 10 day convalescence, 2 animals were subjected to incremental exercise tests. The speed of the treadmill was increased at zero slope from 0.7 mph to 1.5 mph with increments of 0.2 mph every 3 min. During the exercise the pump flows were maintained at a fixed rate (6.93 ± 0.01 L/min for the left ventricular assist device and 5.36 ± 1.44 L/min for the right ventricular assist device). Hemodynamic parameters and pump performance were recorded continuously. The cardiac output (CO) and heart rate (HR) increased significantly during the exercise. CO increased from 11.1 ± 0.3 to 13.1 ± 0.4 L/min, and HR increased from 99 ± 7.1 to 114 ± 2.8 bpm, respectively. Mean aortic pressure, central venous pressure, and left arterial pressure did not change significantly. Also, no change was observed for the left and right pump flows. This totally implantable BVAD showed excellent long-term performance without any mechanical problems. It is feasible to operate without impairment under physical activity. However, the natural heart dominated the hemodynamic response during exercise under BVAD support. The left and the right pump flows did not increase spontaneously with exercise. We therefore conclude that a servo CO control system is necessary to regulate pump flows even during moderate exercise.

Artif Organs 2001; 25(12):1018

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