What's New in MCS

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Jaime A. Hernandez-Montfort MD MPH
Advanced Heart Failure and Transplant Cardiologist
Heart Failure Program
Baystate Health
Springfield, MA
jaime.hernandez@bhs.org

Reviews:

Circulation Heart Failure

1. Ambardekar AV, Hunter KS, Babu AN et al. Changes to aortic wall structure, composition, and stiffness with continuous-flow left ventricular assist devices- a pilot study. Circ Heart Fail 2015;8:944-952.

Age-matched proximal aortic wall tissue samples collected from 15 consecutive patients with end-stage HF at the time of cardiac transplantation were compared to a non-failing donor hearts. There was data collected from 4 patients without an LVAD (HF group) and 7 patients supported with a continuous flow LVAD (HF+LVAD) without severe aortic regurgitation, pump thrombosis or pre-existing aortopathy. All the HF+LVAD patients were pulseless without evidence of aortic valve opening on echocardiography: 3 patients were supported by HeartMate II and 3 patients by HeartWare HVAD with a mean duration of support of 230 days (44-595 days). Aortic morphometry and composition in addition to biomechanical testing was performed to determine the stress-strain relationship of the vessel. Compared to the HF, the aortic walls from HF+LVAD had an increase in wall thickness, collagen and smooth muscle content accompanied by a reduction in elastin and mucinous ground-substance content. Stress-strain curves from aortic walls showed increased vessel stiffness in HF+LVAD as compared with HF and non-failing groups. The physiological modulus, obtained at the patient's mean arterial pressure to assess stiffness at physiological stress in conjunction with the stress-strain composition was analyzed to provide information relating stiffness mechanics to the content of the aorta. There was progressive stiffness of the physiological modulus of the aorta ranging from 74.3 +/- kpA in non-failing to 134.4 +/- kPa in the HF to 201.7+/-36.4 kPa in the HF+LVAD groups ($p < 0.001$).

Commentary: The pilot study by Ambardekar and others provides important insight in regards to the effect of non-pulsatile continuous flow LVADs (CF-LVAD) on the aortic structure and composition of patients with advanced heart failure being bridged to cardiac transplantation. It provides multiple avenues for hypothesis generation that can lead to more robust studies, particularly exploring the relationship of structural aortic changes with CF-LVAD and associated complications, pulsatility, outcomes after heart transplantation and myocardial recovery.

ASAIO Journal

2. Tolpen S, Kanmaat K, Reider C et al. Programmed speed reduction enables aortic valve opening and increased pulsatility in the LVAD-assisted heart. ASAIO J 2015; 61:540-547.

A experimental study in the CF-LVAD HeartMate II controller called programmed low speed algorithm (PLSA) that enables aortic valve opening without compromising cardiac output was performed using the San Diego State University (SDSU) cardiac simulator (CS) which is a mock-loop of the LVAD-assisted heart configured to study aortic valve biomechanics during programmed speed reduction. The

hemodynamics measured includes distal aortic and left ventricular assist device (LVAD conduit) flows, as well as left ventricle and aortic pressures. A high-speed video camera is used to measure aortic valve opening (AVO) area and time. The programmed speed algorithm (PLSA) includes a periodic dwell time during which the LVAD operates at low speed (LFP) then resumes its normal fixed speed (FSP). The rate of deceleration and rate of acceleration can be prescribed to control the rate of speed change. The experimental protocol was performed in two steps: first establishing the non-PLSA hemodynamics as a baseline, followed by measurements under several PLSA conditions. For the non-PLSA conditions six different LVAD speeds were tested (6,7,8,9,10 and 11 krpm) at three levels of cardiac function (CS): off (no cardiac function, closed aortic valve and series condition) , low (cardiac output of 2.8 L/min, stroke volume 40 ml) and medium (3.5 L/min, stroke volume 50 ml and ejection fraction of 28%) (CS off, CS low and CS med). Results showed that PLSA controller set at 10 krpm, dropping to 7 krpm for dwell time of 6 s, adequately produced AVO for all tested cardiac functions with only minimal changes in cardiac output. AVO frequency was independent of opening area and systolic duration and both decreased with increasing LVAD support. Also aortic pulsatility index quadrupled in the aortic root and doubled in the distal aorta during PLSA conditions, supporting evidence of AVO and blood mixing during PLSA conditions.

Commentary:
The study by Tolpen and others is an important contribution to the field of mechanical circulatory support as it facilitates our hemodynamic understanding of the dynamic contributions between native heart function and mechanical circulatory support. The evaluation of a programmed speed algorithm in a cardiac simulator opens an opportunity for modifying the usual pulseless destiny of patients supported with CF-LVAD Heart Mate II, furthermore re-generating multiple hypothesis on the potential role of the algorithm on device pulsatility, native heart function and cardiac output preservation.

Other Articles/Journals:

ASAIO Journal:

1. Russo MJ, Jeevanandam V, Hur MJ et al. Prophylactic subclavian artery intraaortic balloon counterpulsation is safe in high-risk cardiac surgery patients. ASAIO J 2015; 61:e36-39.
2. Hakaweish I, Cole A, Cooley E et al. Roller and centrifugal pumps: A retrospective comparison of bleeding complications in extracorporeal membrane oxygenation. ASAIO J 2015; 61:496-501.
3. Sieg A, Mardis A, Mardis CA et al. Developing an anti-Xa-based anticoagulation protocolfor patients with percutaneous ventricular assist devices. ASAIO J 2015;61:502-508.
4. Imamura T, Kinugawa K, Nitta D et al. Opening of aortic valve during exercise is key to preventing development of aortic insufficiency during ventricular assist device treatment. ASAIO J 2015; 61: 514-519.
5. Bradford CD, Stahovic MJ, Dembitsky WP et al. Safety of prothrombin complex concentrate to control excess bleeding during continuous flow LVAD insertion. ASAIO J 2015; 61: 509-513.

Journal of Cardiac Failure:
No additional articles.

Circulation Heart Failure:
No additional articles.

The Journal of Thoracic and Cardiovascular Surgery:
No additional articles.

European Journal of Heart Failure:
No additonal articles.