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A Computational Study of Energy Efficiency and Pressure Losses in the Total Cavopulmonary Connection ALISON MARSDEN, IRENE VIGNON-CLEMENTEL, JEFFREY FEINSTEIN, CHARLES TAYLOR, Stanford University — The total cavopulmonary connection (TCPC) is an operation performed to treat single ventricle congenital heart defects. The superior and inferior vena cavae are connected to the pulmonary arteries in a t-shaped junction, separating the systemic and pulmonary circulations. In this work, we hypothesize that the effects of respiration and exercise cause significant hemodynamic disturbances and energy loss. Time- dependent, 3-D blood flow simulations are performed using a custom finite element solver and patient specific geometry. Blood flow features, pressure, and energy losses are analyzed at rest and with increasing flow rates to simulate exercise conditions. Resistance boundary conditions are enforced at the pulmonary artery outlets. Energy efficiency is high at rest but drops substantially with maximal exercise. Flow vortices increase in intensity with respiration and exercise, explaining higher energy dissipation when compared to rest. Pressure drop and energy loss in the TCPC are small at rest but increase to significant levels, even at moderate exercise. We conclude that the effects of respiration and exercise should be incorporated in models to provide realistic evaluations of TCPC performance, and for future work in optimizing TCPC geometry.

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