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Fluid-Structure Interaction Modeling of a Pediatric Ventricular Assist Device

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Background. Cardiovascular diseases are the main cause of death in the world and, due to the limited availability of fresh organs, Ventricular Assist Devices (VADs) are adopted as an effective bridge to transplantation. In particular, appropriate pediatric VADs are currently under development in order to reduce the thrombogenic potential of previous rescaled adult devices [1].

Materials and methods. We developed a comprehensive and innovative characterization of a 12cc pneumatic pediatric Ventricular Assist Device (pVAD) adopting a Fluid-Structure Interaction (FSI) approach able to reliably reproduce the realistic behavior of both blood and air chambers, thus focusing on the dynamics of the thin membrane separating the two fluids.

Comparable working conditions, between our computational model and an experimental mock circulatory loop, were achieved extracting *in vitro* experimental pressure waveforms; these were then applied, as boundary conditions to the blood and air domains.

The explicit finite element solver LS-DYNA (Livermore, CA, USA) was adopted: simulations were performed using a penalty-coupling algorithm in order to couple the eulerian fluid elements to the lagrangian structural ones [2].

Results. Computational velocities were comparable with the experimental ones, acquired by means of particle image velocimetry (PIV). Both the numerical inlet and outlet velocities were within the experimental range, with a maximum velocity between 0.5 and 0.7 m/sec. The FSI-derived kinematics of the membrane well compared, in terms of displacement and velocity, with the ones extracted from the mock-loop *in vitro* tests using an High Speed Video Camera.

Conclusions. The developed FSI model proved able to provide a comprehensive assessment of the continuous, time-dependent and three-dimensional pVAD fluid dynamics as well as to capture the three-dimensional and asymmetric kinematics of the pVAD membrane.

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[2] F. Sturla et al., Med Eng Phys (2012) 35(12):1721-30