Performance evaluation of a pulsatile ventricular assist device under non physiologic pumping frequencies by means FEM and 2D approach.

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ABSTRACT

A ventricular assist device (VAD) is a blood pump that work in parallel with heart. It is used as mechanic assistance for patients that suffer cardiac insufficiency: as a therapy, as a bridge to transplant or to extend life. The blood flow simulation into VAD is of great interest for the design and evaluation, mainly before to build the prototypes.

In previous works [1, 2], by means of blood flow simulation, was evaluated a new concept of implantable VAD consisting on a pump with a double effect piston driven without contact and four active valves. In this work, the flow into VAD is analyzed for four frequencies values: 1.05, 2.10, 3.15 and 4.20 Hz. The former is a physiologic frequency, the second allows the basal flow rate (5 l/min), while the others are higher in order to assure higher flow rates. The analysis is carried out comparing variables as velocity and pressure distribution into VAD and evaluating blood damage due to acting shear stress over cells.

The blood flow simulation is performed on a 2D simplified geometry using COMSOL Multiphysics software to resolve Navier-Stokes and continuity equations, assuming blood as a Newtonian incompressible fluid. The blood damage is evaluated by means of platelet activation state index and a cumulative damage model [3, 4].

The global variables as flow rate, force and power to impel fluid, are shown in agreement with theoretical predictions. The risk of blood damage raises for higher frequencies, however, the predictions shown that the VAD analyzed is comparable and best to other VAD and mechanical heart valves [5, 6].

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