Finite Element Analysis of Stresses Developed in Blood Sacs of a Pusherplate Blood Pump

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Abstract:

Mechanical circulatory support (MCS) devices are blood pumps that support or replace the function of the native heart. It is important to minimize the material stresses in the flexing blood sac or diaphragm in order to increase the duration of support these devices can provide. An axisymmetric finite element model of a pusherplate blood pump was constructed to evaluate the effect of various design parameters on the material stresses in a segmented poly(ether polyurethane urea) seamless blood sac. The design parameters of interest were the sac thickness, pump case wall taper, and radius of the sac between the pusherplate and pump case wall. The analysis involved a quasi-static analysis of the systolic ejection phase of the pump. The finite element solution suggested that the principal stresses and strains increased almost linearly with sac thickness. The pump case wall taper had the largest effect; decreasing the peak principal stresses by approximately 35\% when the pump case was straight versus tapered. Lastly, the model demonstrated that the radius of the blood sac between the pusherplate and pump case wall had little or no effect on the magnitude of the blood sac stresses. Therefore, this study suggests that in order to minimize the stresses in a blood sac of a pusherplate blood pump, a straight pump case should be chosen with the thinnest sac.