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Numerical simulation of blood flow across the fenestration in Total Cavopulmonary Connection.

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Introduction: To assess and predict the flow across the fenestration in total cavopulmonary connection using numerical simulation. The provision of fenestration or connecting IVC graft with the atrium is very important to reduce the systemic venous pressure. The reduction in systemic venous pressure is done at the cost of reduced pulmonary blood flow as some volume of the venous return is shunted out via fenestration to the atrium. The flow across the fenestration is function of fenestration area and configuration.

Method: An idealized CAD geometry of extra-cardiac total cave-pulmonary connection with atrial chamber is designed. The IVC conduit of 18 mm diameter follows curvature of atrium, before joining the confluence. The fenestration is at midpoint of IVC graft. The outlet to atrium is placed diametrically opposite to the fenestration site. The inlet boundary conditions at IVC and SVC are in terms of steady volumetric flow. Outflow boundary conditions at LPA and RPA are steady pressures whereas outlet boundary condition at right atrium is pulsatile pressure. The simulation is carried out for the varying diameter of fenestration (4 mm, 8 mm, 12 mm, 16 mm and 20 mm diameter.)

Results and Conclusions: The flow simulation for a given set of atrial, LPA and RPA outlet pressures helps in optimization of fenestration diameter in order to provide adequate pulmonary blood flow. This information is very important for determining appropriate fenestration diameter.