Haemodynamic Analysis in Arterial Models in relation to Pulmonary Valve Treatment in Adults with Congenital Heart Disease

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Introduction

Pulmonary artery stenting and valve replacement (PVR) are common interventions in an increasing population of adult patients with previously repaired congenital heart disease [1]. Indications for intervention include assessing regional haemodynamics and effects on right ventricular volume and function. [2]. The criterion for intervention remains largely empirical and the optimal timing remains unknown.

This work aims to investigate the altered haemodynamic environment of adults with congenital heart disease, pre- and post- operative PVR to establish a computational fluid dynamic (CFD) derived metrics for determining the optimal requirement for PVR and stenting. In this initial work, we present CFD results in simplified geometries representing the proximal pulmonary artery and bifurcation.

Methods

Blood flow simulations were performed using an implementation of the finite volume method. The flow was assumed to be incompressible and governed by the Newtonian Navier-Stokes equations. Physiological vessel dimensions and boundary conditions were used in the models. Local velocities and wall shear stress values were evaluated numerically.

Results and Discussion

Blood flow in the pulmonary bifurcation is strongly dependent on local geometrical characteristics and haemodynamic conditions. An increase in the flow separation is observed when the angle of the bifurcation increases. In addition, the geometry has a significant effect on the velocities and shear stresses developed on the vessel wall. Future work will involve anatomically-correct reconstructions from CT and MRI image data of adult congenital heart patients that have or are about to undergo pulmonary valve replacement. Numerical studies of these models will provide an insight into the underlying flow mechanisms of more complex 3D patient-specific geometries.

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References

[1] Kogon B.E., et al (2015) *Seminars in Thoracic and Cardiovascular Surgery*. **27** p57

[2] Buechel, E.R.V., et al. (2005). *European Heart Journal*. **26** p2721