HEMODYNAMICS IN CHD Result In Brief

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Resolution of congenital heart defects

Congenital heart defects (CHDs) are present in the heart at birth and affect almost 1 % of the population. Besides poor life expectancy and quality of life for patients, considerable health care expenses are also incurred.

Conventionally, severe CHD is treated via high-risk operations on the developed heart in early childhood to restore normal blood circulation, but outcomes are uncertain. No link has been found between genetic mutations and CHD, suggesting that forces causing abnormal blood flow in the foetus are responsible for CHD.

The EU-funded project 'Mechanical regulation of congenital heart defects' (http://staff.dogus.edu.tr/cagatayyalcin/?page_id=33 (HEMODYNAMICS IN CHD)) is investigating the in utero forces that remodel the heart and result in CHD. Researchers plan to investigate the embryonic development of CHD in chicken embryos and thereby find alternative therapeutic options to prevent CHD.

Relevant heart defects were successfully created in chicken embryos using left atrial ligation (LAL) and right atrial ligation (RAL). Blood flow was thereby disturbed on either the left or right side of the heart at early stages of heart development. Measurements were made of morphological changes such as valve size, and haemodynamics were modelled using computational fluid dynamic (CFD) methods.

Using LAL on embryonic day 4, scientists successfully created an animal model of hypoplastic left heart syndrome (HLHS). CHD created using RAL was the first model of its kind to ever be generated to describe CHDs affecting the right side of the heart. 3D geometries from micro-computed tomography (micro-CT) were used to make morphological measurements. Haemodynamics were assessed using ultrasound images. Parameters such as peak velocity and average velocity through the heart valves helped determine shear stress levels and changes in cardiac performance.

Analysis of the ultrasound and micro-CT images revealed some interesting facts. LAL reduces shear stress in certain areas inside the heart, causing underdevelopment of the left atrioventricular valve and left ventricle of the heart. RAL reduced shear stress levels and cardiac work in the right side of the heart while causing remodelling only in the right atrioventricular valve. More information is available on the project website.

CFD modelling should provide in-depth information on changes in haemodynamic environments, such as shear stress levels and their effects on heart development. Correlating the structural changes to haemodynamic alterations should provide novel insight into CHD occurrence, its progression and possible treatment options.

Related information

Report Summary	• Periodic Report Summary - HEMODYNAMICS IN CHD (Mechanical regulation of congenital heart defects)

Subjects

Scientific Research

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