Vascular Model Repository Specifications Document

0064_1001

Species	Human
Anatomy	Aorta
Disease	Congenital Heart Disease Single Ventricle Defect
Procedure	Fontan Aortic Reconstruction

Clinical Significance and Background

Aorta

The aorta is the main and largest artery in the human body, originating from the left ventricle of the heart and extending down to the abdomen, where it splits into two smaller arteries (the common iliac arteries). The aorta distributes oxygenated blood to all parts of the body through the systemic circulation.

The aortic arch loops over the left pulmonary artery and the bifurcation of the pulmonary trunk. In addition to these blood vessels, the aortic arch crosses the left main bronchus. The aortic arch has three major branches: from proximal to distal, they are the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery. The brachiocephalic trunk supplies the right side of the head and neck as well as the right arm and chest wall, while the latter two together supply the left side of the same regions.

Congenital Heart Disease

Congenital heart disease is one or more problems with the heart's structure that exist since birth. Congenital means that you're born with the condition. Congenital heart disease in adults and children can change the way blood flows through the heart. Some types of congenital heart disease may be mild. But complex defects may cause life-threatening complications. However, advances in diagnosis and treatment continue to improve survival for those with congenital heart disease. People with congenital heart disease need lifelong medical care. Treatment may include regular checkups (watchful waiting), medications or surgery.

Single Ventricle Defect

A single ventricle defect (SVD) is a type of heart defect that a child is born with. It occurs when one of the two pumping chambers in the heart, called ventricles, isn't large enough or strong enough to work correctly. In some cases, the chamber might be missing a valve. Single ventricle defects are rare, affecting only about five out of 100,000 newborns. They are also one of the most complex heart problems, usually requiring at least one surgery. There are several types of single ventricle defects which include but are not limited to: tricuspid atresia, hypoplastic left heart syndrome (HLHS), mitral valve atresia (usually associated with HLHS), single left ventricle, double inlet left ventricle (DILV), double outlet right ventricle (DORV), pulmonary atresia with intact

ventricular septum (PA/IVS), Ebstein's anomaly, and atrioventricular canal defect (AV Canal).

Fontan

The Fontan procedure is a type of open-heart surgery. Children who need this surgery usually have it when they're 18 - 36 months old. The Fontan procedure is done for children who are born with heart problems like hypoplastic left heart syndrome (HLHS), tricuspid atresia, and double outlet right ventricle, and depending on the heart problem, children may need the Norwood procedure and Glenn procedure before the Fontan surgery.

After the Fontan procedure, the blood from the lower body goes directly to the lungs. The blood with high oxygen goes into the heart. This way the single ventricle only pumps blood to the body and only pumps blood with high oxygen to the body. There is no more mixing of oxygen-rich blood and oxygen-poor blood.

During the Fontan procedure, the surgeon first disconnects the inferior vena cava (IVC) from the heart and connects it to the pulmonary artery using a conduit (tube). Then, the surgeon makes a small hole between the conduit and the right atrium. This hole (or fenestration) lets some blood still flow back to the heart. It prevents too much blood from flowing to the lungs right away so they have time to adjust. Doctors can close the fenestration later by doing a cardiac catheterization procedure.

Aortic Reconstruction

Aortic root reconstruction is a procedure to treat aortic aneurysm. An aneurysm is a condition characterized by an abnormal bulging or ballooning in the wall of a blood vessel. Aortic root aneurysm can be treated by reconstruction of this delicate area surgically, through aortic root reconstruction. This involves complete resection of the diseased portion of the aorta including the aortic valve. The aortic root is then replaced with an artificial tube (graft) and the aortic valve is replaced with a mechanical or biological valve. This type of aortic root reconstruction is called aortic root replacement. When a mechanical valve is chosen, lifelong anticoagulation therapy is required. When a biological valve is used, re-operation may be required, should the biological valve fail.

Valve sparing aortic root repair is another alternate procedure for aortic root

reconstruction that involves preservation of the patient's own aortic valve. During this procedure, the enlarged section of the aorta is replaced with an artificial tube (graft). The patient's aortic valve stays in place, and is sutured to the inside of the graft. This stabilizes the aortic annulus and prevents further aortic dilatation. It also enhances the durability of the native valve function.

Clinical Data

General Patient Data

Age (yrs)	6
Sex	Female

Specific Patient Data

BSA (m^2)	0.71
CI (L/min/m^2)	2.7
P IVC MP cath	9
P SVC MP cath	9
P LPA MP cath	6
P RPA MP cath	6
P aorta SP cath	95
P aorta DP cath	63
P aorta MP cath	78

Notes

See below for information on the image data and boundary conditions associated with the model.

Image Modality: MR

Image Type: DICOM

Image Source: TLAB

Image Manufacturer: GE MEDICAL SYSTEMS

Boundary Conditions: Refer to boundary conditions in the SimVascular file.

Publications

See the following publications which include the featured model for more details:

Marsden, A. L., Reddy, V. M., Shadden, S. C., Chan, F. P., Taylor, C. A., & Feinstein, J. A. (2010). A new multiparameter approach to computational simulation for Fontan assessment and redesign. Congenital Heart Disease, 5(2), 104-117. http://www.doi.org/10.1111/j.1747-0803.2010.00383.x

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