

# Vascular Model Repository

## Specifications Document



0065\_1001

<b>Species</b>	Human
<b>Anatomy</b>	Aorta
<b>Disease</b>	Congenital Heart Disease Single Ventricle Defect
<b>Procedure</b>	Fontan Aortic Reconstruction

# Clinical Significance and Background

## Aorta

The largest blood vessel and the human body's primary artery, the aorta is responsible for carrying oxygenated blood pumped from the heart to rest of the body. The aorta is divided into four sections: the ascending aorta, the aortic arch, the thoracic aorta, and the abdominal aorta.

The ascending aorta starts at the left ventricle of the heart where at the root, it supplies blood to the heart muscle through the coronary arteries. From the aortic root, the ascending aorta continues to rise up until it reaches the aortic arch.

The aortic arch loops over the bifurcation of the pulmonary trunk and has three major artery branches leaving through the top: the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery. The brachiocephalic trunk sends blood to the right side of the brain and right arm/neck/chest while the left common carotid artery sends blood to the left side of the brain and the left subclavian artery sends blood to the left arm/neck/chest.

After the aortic arch, the aorta begins to descend all the way to the abdomen. The section of the descending aorta that starts after the aortic arch and ends at the diaphragm is called the thoracic aorta, and it supplies blood to the chest and spinal cord.

The last section of the aorta, the abdominal aorta, starts at the diaphragm and ends just above the pelvis. This section is responsible for supplying blood to the stomach, kidneys, liver, and intestines. Past the abdominal aorta, the artery branches into two separate iliac arteries, one for each leg, which are responsible for supplying oxygenated blood to the legs and lower half of the body.

## 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)	5
Sex	Female

### Specific Patient Data

BSA (m <sup>2</sup> )	0.68
CI (L/min/m <sup>2</sup> )	2.8
P IVC MP cath	11
P SVC MP cath	11
P LPA MP cath	7
P RPA MP cath	9

## Notes

Model of neo-aorta on patients who have undergone the Fontan procedure with aortic reconstruction. See [DOI](#) for more details. See below for information on the image data and boundary conditions associated with the model.

**Image Modality:** CT

**Image Type:** DICOM

**Image Source:** TLAB

**Image Manufacturer:** SIEMENS

**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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AND/OR

N.M. Wilson, A.K. Ortiz, and A.B. Johnson, "The Vascular Model Repository: A Public Resource of Medical Imaging Data and Blood Flow Simulation Results," J. Med. Devices 7(4), 040923 (Dec 05, 2013) doi:10.1115/1.4025983.

AND/OR

Reference the official website for this data: [www.vascularmodel.com](http://www.vascularmodel.com)

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