Vascular Model Repository Specifications Document

0224_H_AO_AOD

Legacy Name: TBAD_EN_EX

Model added: 2 Aug 2023

Species	Human
Anatomy	Aorta
Disease	Aortic Dissection
Procedure	None

Clinical Significance and Background

Aorta

The largest blood vessel and the primary artery of the human body, the aorta is responsible for carrying oxygenated blood pumped from the heart to the 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 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 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, and both iliac arteries are responsible for supplying oxygenated blood to the legs and lower half of the body.

Aortic Dissection

Aortic dissection occurs when the innermost layer of the aorta begins to tear. From there, blood rushes through the initial tear and splits (dissects) the inner and middle layers of the aorta. If blood manages to penetrate the outer layer of the aorta, then the aortic dissection can become deadly. There are two types of aortic dissections: Type A and Type B. Type A aortic dissections are the most common and most dangerous of the two and involve a tear occurring in the ascending aorta while Type B aortic

dissections involve a tear occurring in the descending/lower aorta.

Clinical Data

General Patient Data

Age (yrs)	25
Sex	Female

Specific Patient Data

The three-element Windkessel boundary parameters include the total resistance R_T, total capacitance C_T, and ratio of distal to proximal resistance k_d. R_T and C_T are distributed across outlets according to measured flow splits and the respective value for k_d. ETS scalar parameters k_s (elastic response) and c_s (viscoelastic response) were chosen to match the minimum-to-maximum dilation of the simulation to MRI-measured values. Fluid and structural density (p_f and p_s), fluid viscosity u_f, and elastic modulus E_y,t were prescribed according to benchtop measurements or manufacturer's information.

R_T (Mpa s ^-3)	169
C_T (m^3 Pa^-1)	1.50 x 10^-8
k_d	0.9
k_s (MN m^-3)	-18
c_s (kN s m^-3)	-30
p_f (kg m^-3)	1100
u_f (Pa s)	0.0042
p_s (kg m^-3)	1450
E_y,t (MPa)	1.2

Notes

A 25-year-old woman with a subacute, uncomplicated Type-B Aortic Dissection (TBAD). This is the modified version of 0221_H_AO_AOD where the entry and exit tear area were both reduced by 27%. Since this model is a modification of a previous model, no medical image is available; however, the medical image of the original model this model was based on can be found in 0221_H_AO_AOD. \nSee model R in paper 2 for more details. See below for information on the image data.

Publications

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

Bäumler, K., Zimmermann, J., Ennis, D.B., Marsden, A.L., Fleischmann, D. (2023). Hemodynamic Effects of Entry Versus Exit Tear Size and Tissue Stiffness in Simulations of Aortic Dissection. In: Tavares, J.M.R.S., Bourauel, C., Geris, L., Vander Slote, J. (eds) Computer Methods, Imaging and Visualization in Biomechanics and Biomedical Engineering II. CMBBE 2021. Lecture Notes in Computational Vision and Biomechanics, vol 38. Springer, Cham.
https://doi.org/10.1007/978-3-031-10015-4_13

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