

MRA and Doppler Ultrasound of laryngeal blood flow under hormonal and hydration modulation

Geometry Measurements

The following vascular parameters were quantified: (1) cross-sectional area of the ECA at the STA branch point, (2) cross-sectional area of the ECA at the OA branch point, (3) cross-sectional area of the STA (4) distance from the carotid bifurcation to the STA branch point.

The measurement tool on SimVascular* was used to quantify the vascular parameters. For the distance measurements, the center of the path line was followed from the defined origin to endpoint using transverse and sagittal views. The transverse plane was used to manually outline the wall of the vessel to obtain cross-sectional area measurements. The same analytical approach was used for all animals across the experimental groups and timepoints.

Some anatomical exceptions were observed in the vasculature of these rats. Typically, the STA branches from the ECA above the carotid bifurcation and OA. Two scans showed branching of the STA from below the carotid bifurcation and one scan showed branching of the STA superior to the carotid bifurcation and inferior to OA.

3D Modeling

SimVascular was used to build three-dimensional models of the cerebral artery network from echocardiographic and magnetic resonance images. Custom path lines were created for each of the arteries (ECA, ICA, OA, and STA), with ECA as the parent vessel and the remaining arteries as the branch vessels. Path lines were created by manually adding points on the vessel of interest. Each point was centered with the help of the coronal, sagittal, and axial views. The first point of the path line for the branch vessel was overlapped with the parent vessel to ensure the inlet of the branch vessel is properly integrated within the parent vessel. The spacing between points was approximately 1.5 mm to facilitate accurate segmentation and was adjusted as needed. Due to the relative scale and limited resolution of the images, segmentation of each vessel was performed manually. SimVascular currently performs segmentation on a 2D plane. Hence, 3D models of the vessels are generated by compiling multiple 2D segmentations along the path lines. The cross section at each point along the path line was outlined to create a contour group for the segmentation process. Splinepoly tool was used to manually create cross-sectional contours to accurately reflect the vascular geometry. The junction of the branch vessel and the parent vessel was blended using the blend function and an appropriate radius of the blending sphere. Once the segmentation was complete, lofting preview was used to visualize the final 3D geometry.

*Updegrave A, Wilson NM, Merkow J, Lan H, Marsden AL, Shadden SC. SimVascular: An Open Source Pipeline for Cardiovascular Simulation. *Ann Biomed Eng.* 2017 Mar 1;45(3):525-41. doi:10.1007/s10439-016-1762-8

*Updegrave A, Wilson NM, Shadden SC. Boolean and smoothing of discrete polygonal surfaces. *Adv Eng Softw.* 2016 May 1;95:16–27. doi:10.1016/j.advengsoft.2016.01.015