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3D Modeling of Murine Abdominal Aortic Aneurysms: Quantification of Segmentation and Volumetric Reconstruction

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ABSTRACT

Abdominal Aortic Aneurysms (AAA) cause 5,900 deaths in the United States each year. Surgical intervention is clinically studied by non-invasive techniques such as computed tomography and magnetic resonance imaging. However, three-dimensional (3D) ultrasound imaging has become an inexpensive alternative and useful tool to characterize aneurysms, allowing for reconstruction of the vessel, quantification of wall stress through computational fluid dynamics (CFD) simulation, and possible prediction of aortic expansion and rupture. However, current analysis techniques for these images require the use of multiple software for either modeling or simulation, prompting the need for alternatives to improve data processing. This study monitors the development of AAAs in apolipoprotein E-deficient mice infused with Angiotensin II using 3D ultrasound imaging with the purpose of evaluating the accuracy of SimVascular a semi-automated specialized open source simulation software, for image reconstruction. The total volume to length ratio of the suprarenal aorta was obtained for 7 mice and compared to software that allows only segmentation and volume quantification (VevoLAB; FUJIFILM VisualSonics). We found that the volume per length measurements obtained with SimVascular (1.58 ± 1.17 mm^2) were not significantly different from those obtained by VevoLAB (1.56 ± 1.14 mm^2, $p=0.47$). In conclusion, SimVascular is an optimal tool for reconstructing vessel geometries from 3D ultrasound data due to its robust accuracy, efficiency, and semi-automatic computational processing capabilities used for modeling that will allow for future CFD simulation.

KEYWORDS

Abdominal Aortic Aneurysm, Ultrasound, 3D Modeling