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Numerical curved artery model relates blood entrance conditions to evolution of vortices FREE

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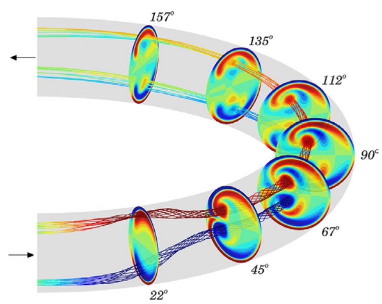
Simulations show the role of uniform velocity in reducing shear stress along blood vessel walls, inducing cardiovascular disease.



As human arteries, such as the aorta, curve throughout the body, multiple vortices form and create spiraling blood flow. The abnormal shear stress produced by these vortices can induce cardiovascular disease.

Cox and Plesniak conducted a numerical investigation relating blood entrance conditions to the evolution of multiple 3D vortex pairs and shear stress distribution in a curved artery model. By simulating a Newtonian blood-analog fluid subjected to a pulsatile flow through a curved artery, the researchers characterized secondary flow patterns.

"This work provides insight into the effect that blood flow development has on the formation of vortices inside curved arteries and subsequent wall shear stress patterns that emerge, ultimately impacting the progression of atherosclerosis," said author Christopher Cox.

When the velocity field upstream of the curve across the diameter of the artery is uniform in space, called a developing flow condition, overall wall stress is reduced.

Peak axial velocity under a developing entrance condition is skewed less towards the outer wall and of lower magnitude than under a fully developed condition.

The decreased axial velocity associated with undeveloped conditions produces smaller centrifugal forcing and pressure gradients, reducing secondary flow and inhibiting growth of any interior flow vortices, such as multiple Dean-type and Lyne-type vortical structures

Cox hopes the results help the field better understand the influence of blood flow development on coronary disease. The researchers look to further study specific hemodynamic metrics to assess the local variation in blood flow characteristics as it relates to the initiation and progression of atherosclerosis.

Source: "The effect of entrance flow development on vortex formation and wall shear stress in a curved artery model," by Christopher Cox and Michael W. Plesniak, *Physics of Fluids* (2021). The article can be accessed at https://doi.org/10.1063/5.0062565.