

The Impact of Disturbed Flow Induced Arterial Stiffness on Mechanotransduction in Endothelial Cells

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Introduction

The number one leading cause of death is cardiovascular disease generating on average 635,260 death a year. In our case we will focus of the impact of the distributed flow induce by the arterial stiffens on the mechanotransduction in the Endothelium cell . Atherosclerosis is caused by the thickening of blood vessels due to fat deposits building up over time, causing a plaque blockage. In addition to causing a loss of space in the lumen, there is calcification and the firming and whitening of fibrous tissues; causing a loss of compliance. Current research suggests that arteriosclerosis is most likely to accrue in the branches, circular, and curved regions of the aorta. This is largely because blood flow entering the aorta is unidirectional, and when the branch is reached, arterial flow is no longer unidirectional, causing a disturbance flow (D flow). When D flow occurs, it affects not only blood flow, but wall tissue, causing it to become increasingly stiff and changing the collagen in the fiber. Our research will evaluate how the stiffness and disturbance of blood vessels will affect the force transmission of the cellular organ using different parameters such as adhesion junction , glycocalyx, stress fibers),. We hypothesize that the components of the wall, epithelium cells affected by D flow, and stiffness of the wall tissue will impact the force transmitting components such as the relaxation time. While maintaining the same thickness for each case trial. Force components will be computed to different cases that will be studied.

Data

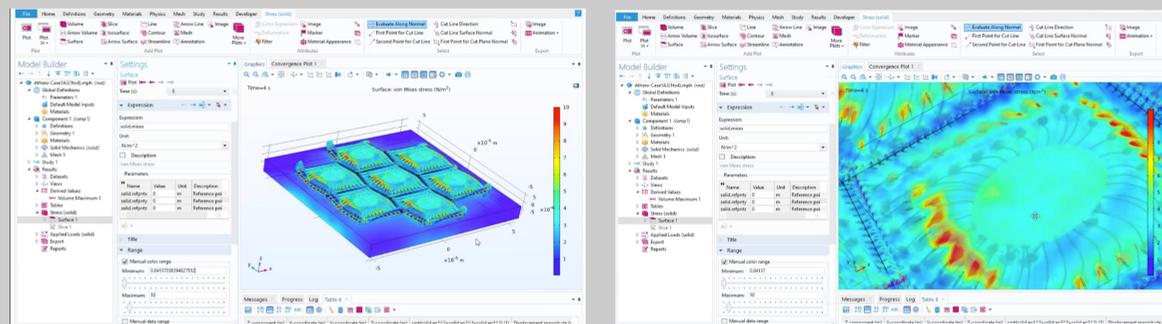


Image 1

Image 2

Results

In images1 and 2 we notice that the stress fibers have deformed proving are hypothesis that disturbed flow induced stiffness of the arterial wall will significantly impact the activation of mechanosensors relative to unidirectional flow applied on straight regions of the vasculature . Our results show that changes in the stiffness promotes the activation of mechanosensors in cells exposed to disturbed flow while it doesn't have same influence in ECs exposed to unidirectional flow.

Conclusion

Our study quantifies the forces on integrins, adherence junctions, filaments and other substructures in the range that activate mechanotransduction. Our results provide insight into mechanisms underlying the progress of atherosclerosis and identifies new pathways that may lead to novel therapies to suppress the disease progression.

Method

In this study we used a three-dimensional mutli-structucral model composed of, glycocalyx, apical cortex layer, cytoskeleton ,stress fiber and adhesion junctions(ADJ), focal adhesion, nucleus, and cytosol to investigate mechanotransmission in the epithelial cells (ECs), expose to the distributed flow over time at the aorta. To be able to identify the components that are affected by the viscosity of the blood we will be testing the glycocalyx layer, actin cortical layer, nucleus, cytoskeleton, focal adhesions (FAs), stress fibers and adhesion junctions (ADJs). As mention before the study will be stimulated by time depended to observe any changes in viscosity components, relaxation time that is happening in the aorta that is affecting the heart rate and the thinking of the tissue.

Reference

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