Investigation of the Relationship Between Wall Shear Stress and Young's Modulus of the Arterial Wall in Ascending Thoracic Aortic Aneurysms

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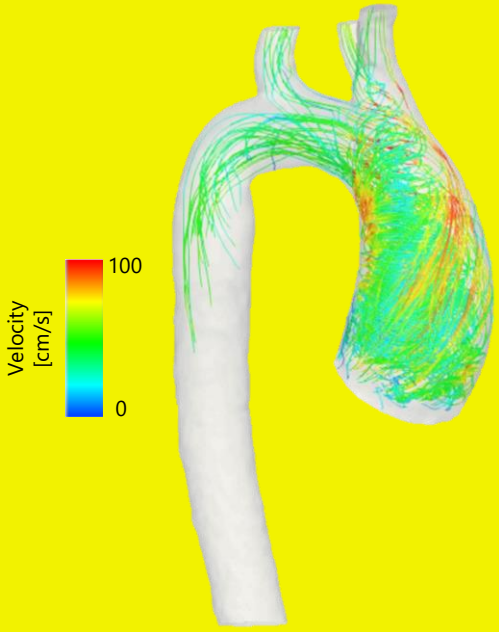
BACKGROUND

- Ascending thoracic aortic aneurysms (ATAAs) and dissections are increasingly prevalent and potentially fatal pathologies of the aorta that can be treated through surgical repair.
- The decision to repair the aorta is determined by the maximum diameter being greater than a defined threshold, for which the risk of dissection/rupture is significant.
- It is thought that hemodynamic factors may play an important role in the growth and rupture of ATAAs.
- Computational fluid dynamics (CFD) and 4D MRI allow hemodynamic factors to be calculated non-invasively.

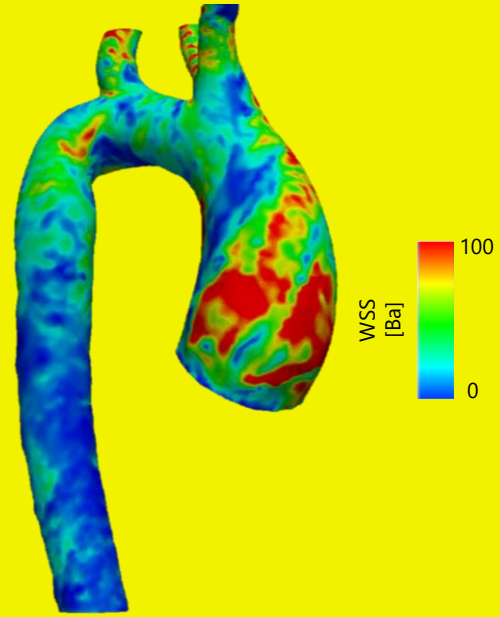
OBJECTIVES

- Determine the relationship between hemodynamic factors and arterial wall strength in ATAAs towards the development of a hemodynamic based criterion for surgical intervention.
- Determine the impact non-patient specific boundary conditions have on CFD derived WSS and whether they can accurately predict a patient's WSS distribution.

Computational fluid dynamic simulations of the ascending aorta may provide insight on the relationship between wall shear stress (WSS) and arterial wall strength.



Velocity streamlines at peak systole



WSS distribution at peak systole

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METHODS

1. Patient specific computational models are developed to simulate the hemodynamics within the aorta.
2. Boundary conditions are extracted from pre-operative 4D MRI scans.
3. Young's modulus was found through biaxial tensile testing of the patient's resected aneurysm.
4. WSS in the areas of the resected aorta samples are compared to the Young's modulus.

Resected aortic aneurysm sample.

DISCUSSION

If a distinct relationship exists between WSS and arterial wall strength CFD may become an important clinical tool to aid in the decision of when surgical intervention is performed.