

A COMPUTATIONAL INVESTIGATION OF CARDIOVASCULAR HAEMODYNAMIC ABNORMALITIES IN TURNER SYNDROME PATIENTS

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Girls with Turner syndrome (TS), a chromosomal condition in which a female has complete or partial absence of the second sex chromosome, present a unique group of patients, with an increased risk of cardiovascular disease. Congenital heart abnormalities occur in up to 50% of TS individuals and mortality rates are three times higher compared with the general population, with the most common cause of death being from cardiovascular disease [1-2]. We hypothesise that patients with TS present a greater variance in aortic arch morphology and haemodynamics than their healthy counterparts, because each TS patient is regarded as a unique anatomical and physiological case study.

In this investigation, we present the first ever computational fluid dynamic analysis of TS children, with patient-specific physiologically realistic haemodynamic conditions. Computational models were used to analyse the arterial blood flow in TS children, who are known to present an increased risk of cardiovascular disease. Three-dimensional patient geometries of the aortic arch were reconstructed while numerical simulations were performed within a finite-volume method framework, using patient-specific phase-contrast MRI obtained boundary conditions. Velocity streamlines and time-dependent metrics, such as the time-averaged wall shear stress (TAWSS) and oscillatory shear index (OSI), were computed for all models. Particular attention was paid to regions of low mean and oscillatory haemodynamic wall shear stresses as our current understanding of subclinical atherosclerosis links these blood flow-induced biomechanical stimuli with damage to the arterial vascular endothelium.

Preliminary results have found morphological aortic differences between patients to have a strong effect on the haemodynamic environment and may be a marker for increased cardiovascular risk.

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