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A NUMERICAL INVESTIGATION OF HAEMODYNAMIC ABNORMALITIES IN TURNER SYNDROME AORTAE

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Girls and women with Turner syndrome (TS) face a lifelong battle with their cardiovascular health. Congenital heart disease, including bicuspid aortic valve, aortic stenosis, and coarctation of the aorta, is present in up to 50% of individuals and a major contributor of increased morbidity [1-2]. Cardiovascular disease (CVD), including early-onset hypertension, is the primary cause of excess mortality, accounting for half of all deaths, and at a rate three-fold higher than in the general population [3-4]. We hypothesise that aortic morphology is more varied in the Turner syndrome population and is accompanied by abnormal blood flow patterns.

In the present study, computational fluid dynamic (CFD) modelling was used to solve the complex hemodynamic environment in patient-specific geometries, and important biomarkers of cardiovascular disease were computed. Specifically, simulations were performed for four Turner syndrome children and three age-matched healthy controls using patient-specific inlet boundary conditions obtained from phase-contrast MRI data. Visualisation of multidirectional blood flow revealed an increase in vortical flow in the arch, supra-aortic vessels, and descending aorta, and a correlation between the presence of aortic abnormalities and disturbed flow. Compared to the relatively homogeneous pattern of time-averaged wall shear stress (TAWSS) on the healthy aortae, a highly heterogeneous distribution with elevated TAWSS values was observed in the TS geometries. Visualization of further shear stress parameters, such as oscillatory shear index, relative residence time, and transverse WSS, revealed dissimilar heterogeneity in the oscillatory and multidirectional nature of the aortic flow. Considering the younger age of these girls (average age 13 ± 2 years), these findings may be an indication of atherosclerotic disease manifesting earlier in life in Turner syndrome females.

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