Quantifying hemodynamics of chicken embryo's aortic arches using optical coherence tomography with computational fluid dynamics method

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The most common defect birth defect in the new-borns is the congenital heart defects (CHD) which refer to any abnormality of the heart due to abnormal development before birth. It has been established that hemodynamic could affect the morphology development of the cardiovascular pathways. This is due to mechanical forces on the vessel walls that influence the remodeling biology of the cardiovascular tissue [1]. Thus, a better understanding of these forces could provide deeper insights into strategies for early detection and proper treatment of CHD.

Optical Coherence Tomography (OCT) was selected to capture high-resolution volumetric images (Fig. 1) due to its spatial resolution, high sensitivity, large dynamic range, video rate image acquisition and non-contact imaging [2]. In this study, chicken embryos were used as the animal model to investigate hemodynamic in early developing cardiac structures such as Aortic Arches (AA).

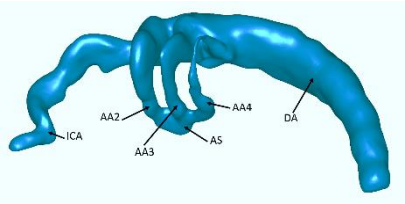

Fig. 1. Cardiovascular Structure

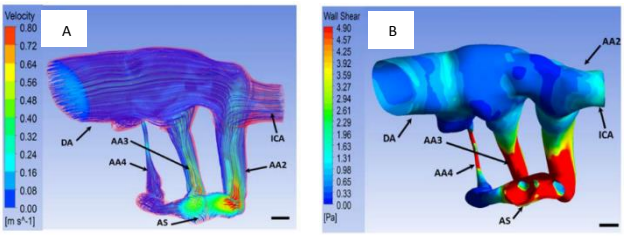

Fig. 2. Isometric view of Stream lines (A) and Shear Stress (B)

Flow mechanics indicated by streamline shows the hemodynamic through the AA (Fig. 2A) and the shear stresses on the vessel wall (Fig. 2B). The study showed the possibility of using OCT along with CFD simulations to provide quantitative information about embryonic flow through Computational Fluid Dynamics (CFD) together with its associated anatomy in the small animal model. Results indicated that high stress area may promote vascular growth to alleviate high shear stress [3].

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