Non-invasive Biomedical Imaging based *in silico* analysis of Bio-Fluid Mechanics of Moyamoya Disease and Stroke

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1. INTRODUCTION & OBJECTIVE

Cerebrovascular diseases are brain-related disorders that affect arteries and blood supply. The word ”Cerebrovascular” is made up of two words, ”Cerebro” means a large part of the brain and ”vascular” means ”network of arteries and veins”. Cerebrovascular disease and stroke are vital causes of loss of life in adults and children [1]. Stroke is defined as a neurological deficiency in the central nervous system caused by vasculature-related abnormalities. It is the second leading cause of death and disability worldwide. Ischemic stroke occurs in 85% of cases broadly and the rest 15% are hemorrhagic strokes [2]. Moyamoya disease is a cerebrovascular disorder involving the narrowing of internal carotid arteries. ”Moyamoya” is a Japanese word indicating ”hazy puff of cigarette smoke moving in the air”. It consists of an abnormal network of blood vessels at the base of the brain [3] as shown in Fig. 1.

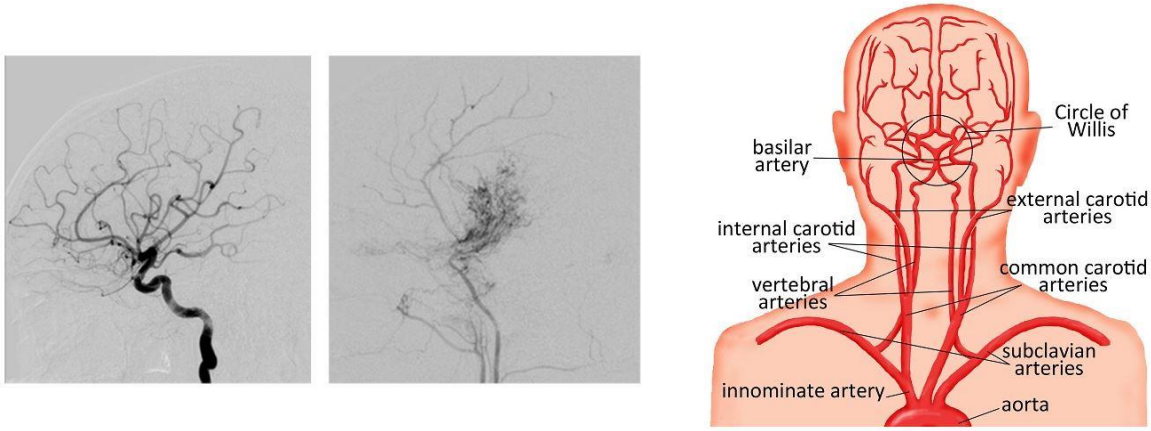


Fig. 1. Image on the left showing normal vasculature of a healthy adult and on right hand side of Moyamoya disease patient

The research objectives of this study are as follows:

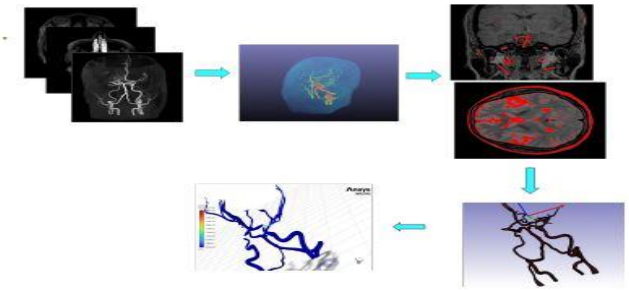
- To compute cerebrovascular bio mechanical hemodynamic parameters of Circle of Willis (CoW) for pre, post and follow-up operative image based on Time-of-Flight Magnetic Resonance Angiography Imaging modality (TOF MRA)

- To compute Cerebral Blood Flow (CBF) from Arterial Spin Labelling (ASL) image datasets and observe bio fluid hemodynamic changes on pre and post surgical 3D volume meshed computational geometries of Internal Carotid Arteries (ICAs), Middle Cerebral Arteries (MCAs) and Anterior Cerebral Arteries (ACAs)
- To incorporate realistic, pulsatile, patient specific boundary conditions at inlets and outlets of MMD affected arteries, and deformable boundary conditions on arterial wall and perform transient CFD flow simulations

- Bio-fluid computational pipeline is shown in figure below. The governing equations are the Continuity equation and the Navier-Stokes equation:

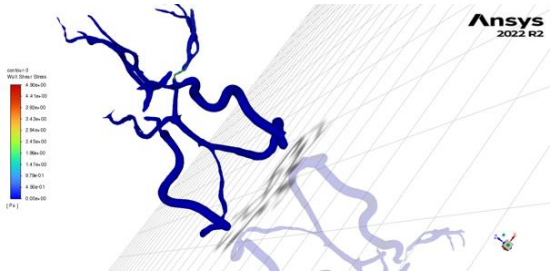
$$\nabla . v = 0 \qquad (1)$$

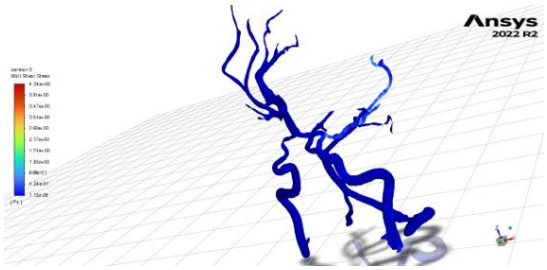
$$\rho(v.\nabla v) = -\nabla p + \mu \nabla^2 v + f$$



2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

It has been observed that Artery Wall Shear Stress (WSS) improved in STA-MCA bypass indicating increase in speed of blood flow in distal arteries





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